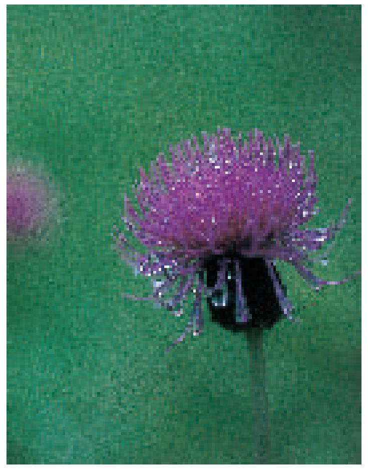

Ministry of the Environment
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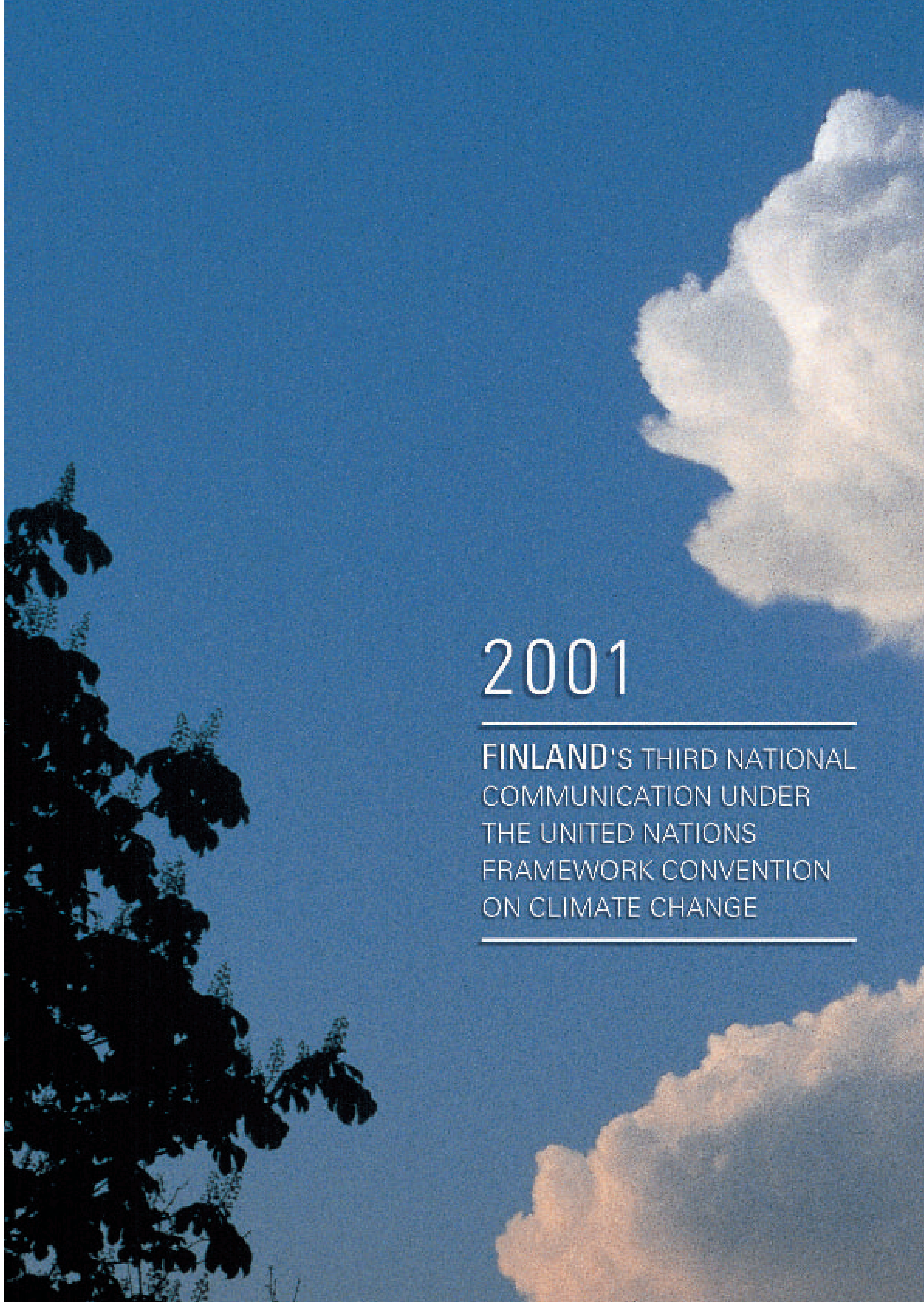
FINLAND'S THIRD REPORT UNDER THE UNFCCC



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FINLAND'S THIRD NATIONAL COMMUNICATION UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

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Committee for Preparing the Third National Communication:

Seppo Sarkkinen, Ministry of the Environment (chairman)
Heikki Granholm, Ministry of Agriculture and Forestry
Leo Kolttola, Statistics Finland
Mirja Kosonen, Ministry of Trade and Industry
Jaakko Ojala, Ministry of the Environment
Jouko Petäjä, Finnish Environment Institute
Anu Pärnänen-Landtman, Ministry for Foreign Affairs
Jaana Roos, Ministry of Education
Heikki Sourama, Ministry of Finance
Risto Saari, Ministry of Transport and Communications
Esko Kuusisto, Finnish Environment Institute (secretary)

Editors:

Esko Kuusisto, Finnish Environment Institute
Kari Hämekoski, Electrowatt-Ekono Oy

Photos:

Esko Kuusisto

Graphic design:

Kirsti Pohjapelto

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CONTENTS

FOREWORD

The United Nations Framework Convention on Climate Change (FCCC) entered into force globally on March 21, 1994. Finland ratified the Convention on May 31, 1994. Since then further progress was made in the international negotiations under the Convention and, as a result, the Kyoto Protocol was agreed on. Finland, as a member of the European Union, agreed to the legally binding commitments of the Kyoto Protocol to reduce greenhouse gas emissions. Under the burden-sharing agreement between the EU Member States, Finland is committed to stabilising its emissions at the 1990 level in the first commitment period of the Protocol.

In accordance with the Convention, Finland has submitted annual inventories of greenhouse gas emissions by sources and of removals by sinks to the UNFCCC Secretariat. This report is the third in the series of National Communications that relay information on the Finnish inventories and on the national circumstances and policies and measures. Like the earlier Communications, the Third National Communication strives to follow the guidelines agreed upon by the Conference of Parties under the UNFCCC.

Unlike its predecessors, however, the Third National Communication benefits from the completion of the National Climate Strategy of Finland, which is the result of a firm commitment to the Kyoto Protocol by Prime Minister Paavo Lipponen's Second Government. An appointed ministerial working group carried out the work on the Strategy. The National Climate Strategy contains the principles, objectives, policies and measures that the Government finds necessary to meet Finland's national commitments. Thus, it contains information closely related to this report. Specifically, the 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.

Furthermore, the Third National Communication is the result of co-operation between Finnish governmental bodies, namely, the Ministry of Agriculture and Forestry, the Ministry of the Environment, the Ministry of Trade and Industry, the Ministry of Transport and Communications, the Ministry of Foreign Affairs, the Ministry of Finance, the Finnish Environment Institute and Statistics Finland. In addition, several other relevant government institutions have assisted in the preparation of the Communication. The work was co-ordinated by a special interministerial working group. Dr. Esko Kuusisto of the Finnish Environment Institute acted as the chief editor of this report, while Mr. Kari Hämekoski has been the lead author for Chapters 4 and 5.

Finland's greenhouse gas emissions are now approaching the 1990 level. Emission levels however have varied considerably in the 1990s, depending on economic trends in the energy-intensive industries, the generation of hydroelectric power, the import of electric power and the availability of other energy sources not emitting carbon dioxide. Measures aimed at improving energy efficiency, increasing the production and utilisation of renewable energy sources, and curbing the methane emissions of waste management, including landfills, have played a major role in the trends in emission levels in the past decade.

Many steps have been taken on both national and international levels to study and mitigate the global phenomenon of climate change since the completion of the First National Communication. Still, six years later, many more steps are needed if clear demonstrable progress in the protection of climate in the future is to be seen. The Third National Communication of Finland contributes its own share to the global efforts.

Helsinki, October 2001

Satu Hassi
Minister of the Environment

1 EXECUTIVE SUMMARY

1.1. NATIONAL CIRCUMSTANCES

Geographic, economic and other national conditions affect significantly a country's greenhouse gas emissions. They also influence a country's possibilities to reduce its emissions.

Finland is one of the northernmost countries in the world. With a total area of 338 145 km^2, it is Europe's seventh largest and the EU's fifth largest country. Forests cover four-fifths of the land area; only nine per cent is classified as agricultural land. 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 a turn towards declining population is expected to occur in the 2020s. About one million people live in the Helsinki metropolitan area. There is a strong internal migration from small municipalities to urban areas.

Finnish industry is export-oriented. 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, but in the past few years the emerging market economies have also become important trading partners.

For a number of decades the Finnish economy was characterised by fast growth combined with sensitivity to international market variations. In the early 1990s, Finland fell into a deep recession: the rate of unemployment increased to 17%, and the gross domestic product plummeted by about ten per cent between 1991 and 1993. In recent years, the Finnish economy has been growing fast again – between 1995 and 1999 GDP grew an annual average of about four per cent. In 1999, Finland's gross national product per capita was around EUR 23 400. In the same year, Finland's total exports amounted to EUR 39.2 billion in 1999, and total imports EUR 29.7 billion.

About two-thirds of the energy used in Finland comes from imported primary sources. The main domestic sources are hydropower and biomass residues from the forest industry, supplemented by peat. In 1999, the gross consumption of primary energy in Finland amounted to 31.3 million tonnes of oil equivalent (Mtoe) or 1313 PJ (Fig. 1-1). The most notable decrease in the 1990s has taken place in oil consumption, which still accounts for 28% of total primary energy supply. Among the energy sources with increasing utilisation are wood-based fuels and natural gas. Owing to the upgrading of the existing nuclear power plants, the share of nuclear energy in Finland's diversified energy mix has increased.

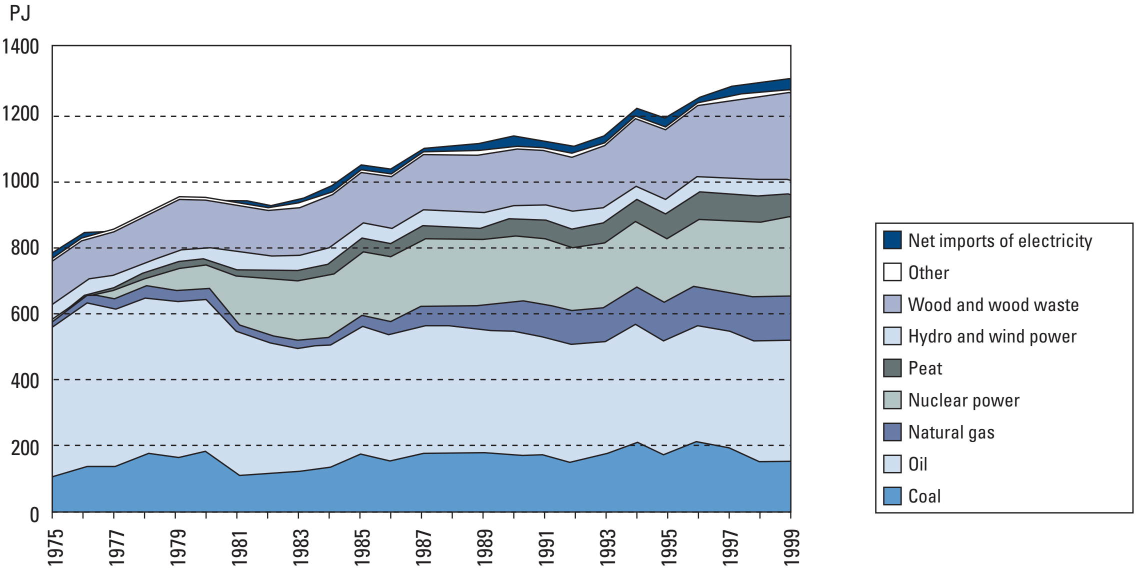


Figure 1-1.
Gross consumption of primary energy in Finland in 1975–1999. The conversion of primary energy units into oil equivalent units follows the international methodology, recommended by the International Energy Agency.

Renewable energy and slowly renewable biomass, peat, covered 28% of the total primary energy supply in 1999. The trend has been upwards, mainly owing to the increased use of black liquor and industrial wood wastes within the pulp and paper industry, and the growth in other energy wood consumption. Industrial combined heat and power production (CHP), as well as CHP with district heating, provide good potential for cost-effective use of renewables.

Because of the country's northerly location, Finland uses a lot of energy for space heating. This is the source of most CO_2 emissions by households and by the public and tertiary sectors. However, during the past two 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 up considerably, especially in the 1970s.

Finland's electricity markets were opened to competition in 1995, when the Electricity Market Act came into force. The generation and sale of electricity were deregulated. The share of imported electricity has stayed at high level in Finland throughout the 1990s.

There are 78 000 km of public roads in Finland, 25 000 km of streets, and 280 000 km of private roads. Finland has 2.4 million automobiles; the number increased by 7.6% in the period 1990–1999. 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 3.4 million mobile telephone connections in Finland at the end of 1999, equivalent to 652 per one thousand inhabitants. The number of Internet connections was 1.2 million, i.e. 121 per 1000. These figures were higher than in any other EU Member State.

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 1999, the number of active farms fell from 130 000 to 90 000. Agriculture accounted for five per cent of the employed work force in 1999.

The total volume of stock in Finnish forests amounts to approximately two billion cubic metres. For over thirty years, the increment of stock has exceeded harvesting volumes and natural decay. Today, the annual increment of all forests is about 75 million cubic metres. Half of the original peatland area in Finland has been drained for forestry purposes, which has increased the annual increment of stock by about 15 million cubic metres. The area of forests strictly protected from fellings totals 1.5 million hectares.

For decades, the forest industry has been the backbone of Finland's national economy. The export income of the wood processing industry and the employment which it offers have maintained a fairly constant economic growth. In 1999, the export value of forest industry products was EUR 11.5 billion. The rapidly internationalised Finnish forest industries have also recently taken operations outside their home country.

The annual waste generation in Finland from various activities amounts to about 70 million tonnes. Recovery rates vary according to the type of waste. Agricultural waste has the highest recovery level, while the lowest recovery levels are those for solid municipal waste, construction waste, waste from energy and water supply, and hazardeous waste, i.e. some 20–30% each. In the 1990s, local authorities have increasingly cooperated in waste management. The number of active landfills has dramatically decreased: from almost one thousand in 1990 to about 300 in 1999.

1.2. GREENHOUSE GAS INVENTORY INFORMATION

The total anthropogenic greenhouse gas emissions without land-use change and forestry in Finland were 76.2 Tg of CO_2 equivalent in 1999. This was 1.1% under the 1990 baseline level (Fig. 1-2). The land-use change and forestry sector (LUCF) has constituted a net sink during the whole of the 1990s. In 1999 the size of this net sink was estimated to be 10.8 Tg of CO_2 equivalent.

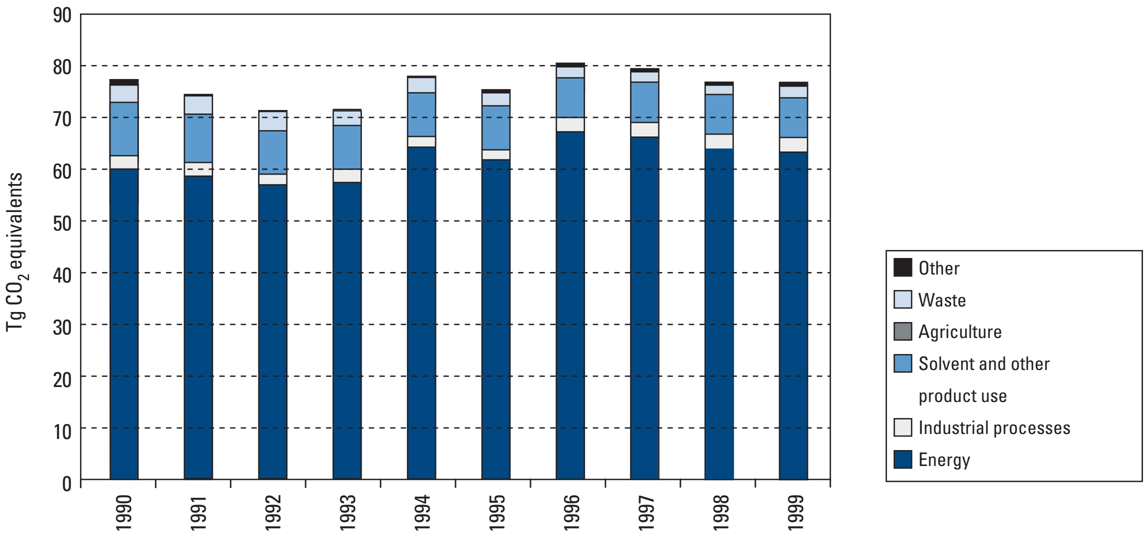


Figure 1-2.
Finland's greenhouse gas emissions (excluding land-use change and forestry) by sector in 1990–1999.

Finland's greenhouse gas inventory is compiled in accordance with UNFCCC Reporting Guidelines on annual inventories, with some exceptions based on national circumstances or national research. Emissions and removals by sinks of greenhouse gases from various sources have been estimated using methodologies that are consistent with the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.

The largest emission source is the energy sector, CO_2 from fossil fuel combustion (56.8 Tg in 1999) accounted for 75% of the total national emissions. Fugitive CO_2 emissions from fuels, mainly associated with peat production, are also significant in Finland. The estimated emissions for 1999 are 3.5 million tonnes CO_2-eq. or about 4.5% of total greenhouse gas emissions. The estimated N_2O emissions from the energy sector account for 3.2% of the total emissions in 1999. These emissions come mainly from fluidized bed combustion and transportation. Energy-related CH_4 emissions are mainly due to incomplete combustion and accounted for only 0.7% of the total national emissions in 1999.

Energy industries caused most of the emissions in the energy sector, 34% in 1999. Manufacturing industries and construction produce much energy themselves, and their share of the emissions was also significant, 27%. Transportation accounted for about one-fifth of the energy-related emissions in 1999.

Liquid fuels accounted for about 47%, solid fuels (coal and peat) almost 39% and gaseous fuels about 14% of the energy-related CO_2 emissions in 1999.

Energy consumption has grown steadily in Finland since the energy crisis in the mid-1970s. This growth continued in the 1990s with the exception of the first few years of the decade, when Finland experienced a severe recession. The growth in energy consumption has only partly been reflected in the CO_2 emissions from fuel combustion because the use of renewable energy has increased. A shift from coal and peat to natural gas, upgrading of the existing nuclear power plants, improved energy efficiency and the good availability of hydropower in the Nordic electricity markets have also contributed to this trend.

Industrial greenhouse gas emissions contribute less than four per cent to the total anthropogenic greenhouse gas emissions in Finland. The most important industrial greenhouse gas emissions are the N_2O emissions from nitric acid production, and CO_2 emissions from cement and lime production. HFCs, PFCs and SF_6 are together only about 0.5% of the total greenhouse gas emissions in Finland. The only direct greenhouse gas source identified in the solvent use sector is the use of N_2O in industrial, medical and other applications.

In 1999 Finnish agricultural greenhouse gas emissions were 7.6 Tg CO_2 equivalents, which is around 10% of the total greenhouse gas emissions in Finland. The trend in the agricultural emissions has been declining in the 1990s. The most important of the agricultural emissions is the nitrous oxide emissions from agricultural soils; smaller amounts of N_2O are emitted from manure management.

The carbon dioxide emissions from cultivation and liming of agricultural soils are also important. These emissions are estimated for three subcategories: cultivation of mineral soils, cultivation of organic soils and liming. Cultivation of organic soils causes most of the reported agricultural CO_2 emissions, about 65% in 1999.

Enteric fermentation and manure management are the main sources of agricultural methane emissions in Finland. Agricultural soils can also act as sources or sinks of methane. Quantitative information on methane emissions or removals from agricultural soils is scarce, and estimates of these have therefore not been included in this inventory.

Tree growth has been rather steady in Finland during the 1990s and the calculated increment in the stem volume has varied between 73.4 and 78.0 million m^3. The annual changes in tree harvesting and cutting have been larger and the drain has varied from 44.6 to 69.4 million m^3. Hence also the annual net removals of CO_2 from the atmosphere have varied much during this period (10–38 Tg/year). – The CO_2 emissions from biomass burning were 29.0 Tg in 1999.

Solid waste disposal in landfills and dumps causes relatively large CH_4 emissions in Finland: about two per cent of total emissions in 1999. During the 1990s, these emissions have decreased by more that 50%. The decrease has been mainly due to the implementation of the new waste law in Finland in 1994. This law has led to less waste generation, increased recycling and reuse of waste material, and alternative treatment methods to landfills have been endorsed.

Emissions from international bunkers amounted to about four per cent of total anthropogenic greenhouse gas emissions in Finland in 1999. About two-thirds of the emission come from marine bunkers and one-third from aviation. The total emissions from international bunkers have fluctuated somewhat during the 1990s, but no fast growing trend has been noticed.

1.3. POLICIES AND MEASURES

1.3.1. National Climate Strategy

Climate change mitigation is one of the top environmental policy priorities in Finland. Finland ratified the UN Framework Convention on Climate Change on May 3, 1994. According to the burden sharing of the Kyoto commitment within the EU, Finland will have to maintain the 1990 emissions level by 2008–2012. Finland signed the Kyoto Protocol on May 29, 1998. The ratification is planned to take place in line with the other EU Member States.

The Finnish Government started preparations for the National Climate Strategy in 1999. The Strategy was adopted by the Government on March 15, 2001, and supported by Parliament in its statement on June 19, 2001.

Finland's Third National Communication is largely based on the National Climate Strategy, as well as on the background documents, research and sectoral reports of strategy formulation, and on the work of an inter-ministerial committee for preparing the third national communication.

1.3.2. Scenarios

The preparations for the National Climate Strategy were started by sector in 1999. The ministries most involved were the Ministry of Trade and Industry, the Ministry of the Environment, the Ministry of Transport and Communications, the Ministry of Agriculture and Forestry. The Ministry of Trade and Industry has coordinated the preparation process and a Kyoto Ministerial Working Group has formulated policy options.

The background material for the National Climate Strategy was compiled of sector-specific reports made by the ministries. In order to make economic assessments of various policy options, two separate model projects were used. By the help of model calculations the emissions were finetuned to the target level in the years 2008–2012. This was not exactly the result of the sectoral programmes.

Two scenarios are discussed in this context: a ‘with measures’ scenario for the years 2000–2020 and a ‘with additional measures’ scenario for the years 2000–2010. Both scenarios are based on the National Climate Strategy. In addition, emission projections from agriculture and F-gas emissions were updated according to the latest data for the ‘with measures’ and ‘with additional measures’ scenarios.

The ‘with additional measures’ scenario is defined until 2010 in line with the National Climate Strategy. There are no political decisions concerning new and additional policies and measures beyond 2010.

1.3.3. Sectoral policies

The general objective of Finland’s energy policy has been to ensure a reliable supply of energy at competitive prices. The energy supply is quite diversified and energy imports cover about 70% of total use. Discussions on policies and measures in the energy sector are divided in three sections:

First, policies and measures in the 1990s are discussed as mitigation impact compared with the original base scenario can be estimated only for CO_2 during the 1990s. The mitigation impact of individual policies and measures is not quantified.

Second, policies and measures in the ‘with measures’ scenario are presented for the years 2000–2020. No mitigation impact is calculated as no comparable ‘without measures’ scenario is defined.

Third, policies and measures in the ‘with additional measures’ scenario are presented for the years 2000–2010. Policies and measures in this scenario are basically intensified and updated versions of the ones in the previous scenarios. Energy conservation programme was revised in 2000 and new Action plan for renewable energy was accepted in 2000. Additional measures concerning electricity supply have also been defined and two main alternatives have been presented: a shift from coal to natural gas in the generation of electricity and heat or a new nuclear power plant unit replacing coal in electricity generation. Policies and measures are defined until the end of the first commitment period.

The mitigation impact of individual policies and measures is not estimated. The aggregate effect of additional policies and measures in the energy sector is approximately 11 Tg by 2010 compared with the ‘with measures’ scenario.

In the transport sector the climate change policy has become an integrated part of the transport policy in the 1990s both at the national level and within the European Union. The aim is to restrain the growth of transport and thereby to reduce the environmental impacts of transport, including greenhouse gas emissions.

In agriculture, there are no major differences between the 'with measures' and 'with additional measures' scenarios from GHG emissions point of view, because the main policies and measures are already included in the 'with measures' scenario. Several measures, with a focus on other issues, have together with the structural change in the Finnish agriculture enabled a significant reduction of greenhouse gas emissions in agricultural sector from 10.2 Tg CO_2 -eq. in 1990 to 7.6 Tg CO_2-eq. in 1999.

The climate strategy measures concerning forestry are based on the National Forestry Programme, which was approved by the Government in 1999. International agreement is still pending on the rules and modalities for the calculation of carbon sinks e.g. how carbon stock changes in the soil are taken into account in inventories.

Measures in waste management have reduced GHG emissions. Government decisions on landfills and the collection and recovery of waste paper, the waste tax and the adoption of the National Waste Plan have lowered these emissions by 2 Tg CO_2 eq from 1990 to 1999.

1.3.4. Horizontal policies

Finland was the first country to introduce a CO_2 tax in 1990, initially with few exemptions for specific fuels or sectors. This tax was based on the carbon content of fuels. After a number of increases in the CO_2 tax rate in the early 1990s, the first major change occurred in 1994, when an additional component based on the energy content of the fuels was introduced, as well as special taxes on nuclear power and hydropower.

The second important revision of energy taxation took place in 1997, prompted by the opening of the Nordic electricity market. To avoid harming the competitiveness of domestic industries, the carbon/energy tax based on fuel inputs in the electricity sector was scrapped and an electricity consumption tax was introduced, with a lower rate for industry and greenhouse cultivation (slightly above half the rate on households and service sectors). Source fuels for heating and transport continued to be taxed, but only on their carbon content, with a reduced rate for natural gas and peat.

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

There are several important national technical 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.

1.3.5. Combined effects of policies and measures

The combined effects of sectoral policies and measures in the 'with additional measures' scenario in 2000–2010 have been presented in Table 1-1.

If energy is utilised more efficiently, as assumed in the energy conservation programme and the present strategy, emissions can be reduced by the equivalent of a further 3–4 Tg of CO_2 eq. Implementing all the measures included in the programme promoting renewable sources of energy could result in the reduction of emissions to 4–5 Tg of CO_2 eq maximum in 2010. A reduction in emissions equivalent to over 1 Tg of CO_2 can be achieved with measures concerning methane and other greenhouse gases. Meeting these objectives calls for highly intensified use of economic instruments and success in their targeting.

In electricity production, a reduction in emissions equivalent to 6–10 Tg of CO_2 minimum should be achieved by the year 2010. This reduction in emissions can be achieved either by allowing the construction of additional nuclear power generation capacity, or by limiting coal consumption.

Table 1-1.

Combined effects of policies and measures in the 'with additional measures' scenario in 2000–2010

Set of policies and measures	Reduction in emissions by 2010, (Tg CO_2 eq)
Energy conservation	3–4
Promotion of renewable sources of energy	4–5
Measures concerning other greenhouse gases	More than 1
Action concerning electricity production	6–10
Total of necessary emissions reduction	**14**

1.4. PROJECTIONS AND ASSESSMENT OF POLICIES AND MEASURES

1.4.1. Carbon dioxide emissions in 1990–1999

The First National Communication of Finland reported a scenario that originated from the energy strategy preparations 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, it was assumed that in certain circumstances the demand for electricity would have to be wholly covered by domestic production and the electricity imports might gradually be replaced by coal-fired power plants. It is natural that these assumptions lead to high emission levels (Fig. 1-3). As noted earlier, the assumptions behind this scenario are considered irrelevant after 1999.

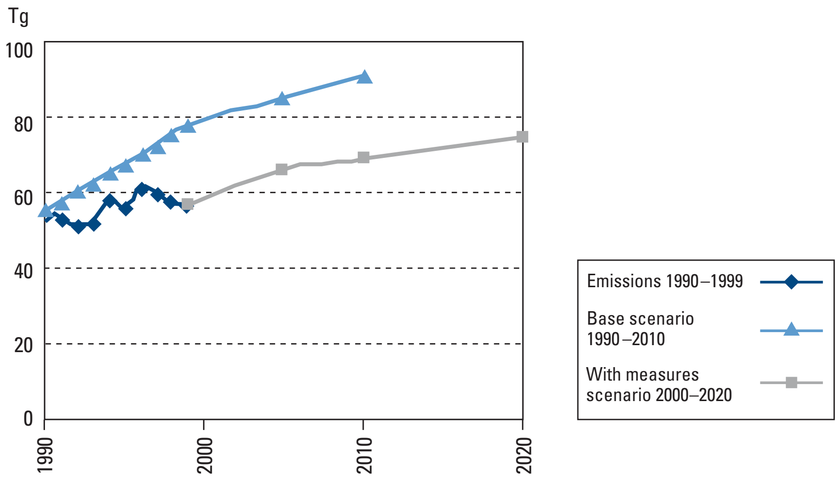


Figure 1-3.
Comparison of the base scenario of Finland's First National Communication with the 'with measures' projections (CO_2 emission from fuel combustion).

The increase of emissions of the base scenario never materialized, owing to an active energy policy, favourable trends in the Nordic electricity markets and milder than normal weather conditions, among other things. In 1999 the actual CO_2 emissions from fuel combustion were approximately 57 Tg, which is significantly lower than the emission level of the base scenario.

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 in the Nordic market was in most years high in comparison with electricity demand. Therefore, production of coal-fired condensing power in Finland remained on a relatively low level.

One-quarter of the difference between the base scenario and the actual emissions is due to a change in the fuel mix in the 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: 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 has also been important in this positive development, but their mitigation impact in relation to the base scenario has not been quantified in detail.

1.4.2. Projected greenhouse gas emissions for 2000–2020

Two scenarios are discussed in this context: a 'with measures' scenario for the years 2000–2020 and a 'with additional measures' scenario for the years 2000–2010. Both scenarios are based on the National Climate Strategy with the modifications described in Section 1.3.2.

The main characteristic of the 'with measures' scenario is the assumption of unchanged energy and climate policy. The prevailing measures would be kept in force in real terms but no new additional measures would be taken (other assumptions of the 'with measures' scenario can be found in Table 5-1).

Under these assumptions the emissions would increase from 77.1 Tg equivalent of CO_2 in 1990 to about 86 Tg in 2005 and close to 90 Tg in 2010 (Fig. 1-4). For the 'with additional measures' scenario, the corresponding values would be 84 Tg and 76 Tg, respectively. The distribution of emissions by gas are given in Table 1-2 and by sector in Table 1-3.

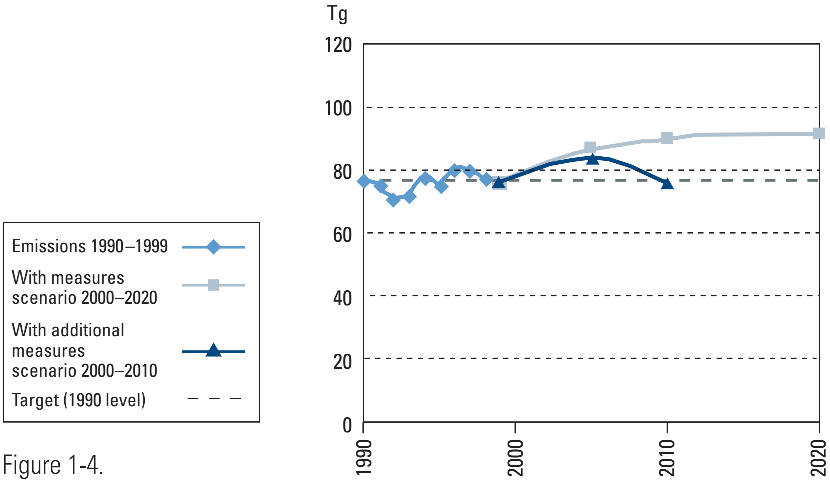


Figure 1-4.
Comparison of the 'with measures' scenario for the years 2000–2020 with the 'with additional measures' scenario of the National Climate Strategy for the years 2000–2010. All GHG emissions are considered, excluding land-use change and forestry.

In order to meet the climate strategy targets, the Government finds it necessary to implement a new energy conservation programme, and a new programme for promoting renewable sources of energy. Together these programmes may account for about half of the targeted annual emissions reduction. A reduction in emissions equivalent to a million tonnes of CO_2 may be achieved with measures concerning methane and other GHGs.

Another half of the targeted emissions reductions would be achieved in the heat and electricity supply sectors, where the use of coal must be reduced considerably by increasing the utilisation of natural gas, or by building more nuclear power capacity, or by a combination of these two measures.

Table 1-2. Greenhouse gas base year emissions, current emissions and projected emissions (Tg CO_2 eq) in Finland

Greenhouse gas	Base year (1990)	1999	2005	2005	2010	2010	2020
			With measures	With add. measures	With measures	With add. measures*	With measures
CO_2	62.5	64.2	73.3	71.5	76.4	64.7	81.7
CH_4	6.1	3.9	3.7	3.8	3.5	2.8	3.1
N_2O	8.4	7.7	8.3	7.8	8.3	7.4	8.4
HFCs+PFCs	0.001	0.35	1.1	0.6	1.7	0.9	2.2
SF_6	0.07	0.03					
Total CO_2 eq	**77.1**	**76.2**	**86.3**	**83.8**	**89.9**	**75.8**	**95.4**

** The base year (1990) figures have recently been revised. Therefore the target figure for 2010 (75.8 Tg) differs from the 1990 emissions (77.1 Tg).*

Table 1-3. Greenhouse gas base year emissions, current emissions and projected emissions (Tg CO_2 eq) in Finland by sector

Sector	Base year (1990)	1999	2005	2005	2010	2010	2020
			With measures	With add. measures	With measures	With add. measures***	With measures
Energy*	46.4	49.7	59.0	57.3	62.3	51.3	67.6
Transport	13.2	13.5	13.8	13.7	13.9	13.7	13.8
Industrial processes	2.9	2.8	3.6	3.0	4.5	2.6	5.2
Solvents**	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Agriculture	10.2	7.6	7.4	7.4	6.8	6.7	6.8
Waste	3.8	1.7	1.7	1.7	1.6	0.8	1.2
Other	0.6	0.8	0.7	0.7	0.7	0.7	0.7
Total CO_2 eq	**77.1**	**76.2**	**86.3**	**83.8**	**89.9**	**75.8**	**95.4**

** Excluding transport, ** Solvents and other product use, *** The base year (1990) figures have recently been revised. Therefore, the target figure for 2010 (75.8 Tg) differs from the 1990 emissions (77.1 Tg).*

Carbon dioxide emissions associated with energy generation and utilisation are key factors in meeting Finland's national target. The government's climate strategy is based on a commitment to continued improvements in the efficient use of energy. The use of renewable sources of energy will be boosted. The actions in these fields will be taken regardless of the measures implemented in electricity production.

Despite improved energy conservation measures, total energy and electricity consumption is estimated to continue rising, albeit clearly slower than in the past decades. Because of the rise in electricity consumption and phasing out of ageing power plants, new power plants should be built. Basing the climate strategy on large imports of electricity is not justified. The measures concerning electricity production are based on the assumption that electricity imports will diminish from their record high levels of recent years.

The long-term vision and strategy of the Ministry of Transport and Communications contains projected trends of passenger and road transport volumes until 2025. Behind these trends is the vision of a future transport system that should be based to an increasing extent on sustainability and increasing use of information technologies. Such a transport system should take into account economic, ecological, social and cultural viewpoints. The strategy aims at reaching a transport system in which the demand for road transport should peak by the year 2020 and start thereafter to decrease.

Greenhouse gas emissions of industrial processes have been quite stable during the 1990's. The biggest share, about half the sectors emissions, comes from N_2O emissions, the CO_2 emissions originating from cement and lime production. The level of the F-gas emissions grew rapidly during the 1990s from practically zero to 10% of the industry's emissions. Without additional measures, their share will be about 40% by 2010.

Greenhouse gas emissions from agriculture have diminished since 1990. This trend will be safeguarded in the common agricultural policy of the EU by adopting support measures encouraging such production that minimises the burden on the greenhouse gas balance, besides other objectives.

According to Finland's National Forest Programme 2010 and a number of studies made for the preparation of the National Climate Strategy of Finland, net removals from forests are estimated to be between 3 to 10 Tg CO_2 in 2010.

In waste management, efforts will be made to utilise source-separated waste fractions as materials, on the one hand, and to utilise combustible, unusable waste separated at source or at a processing utility as energy in existing energy production plants, on the other hand. Furthermore, more and more efforts are being made to reduce the generation of waste.

Emission projections from international bunkers are based on estimates by Statistics Finland. A slight increase of emissions from international bunkers is expected, and no specific policies and measures are defined for this sector.

1.5. CLIMATE CHANGE IMPACTS, ADAPTATION AND VULNERABILITY

The first climate change scenarios for Finland were developed for SILMU, the Finnish Research Programme for Climate Change, in 1991. The central temperature scenario gave a mean annual warming of 2.4°C by 2050 and 4.4°C by 2100. This was about one and a half times greater than the average global warming expected in the scenarios of the First IPCC Assessment over the same period.

A new, more comprehensive set of scenarios for Finland's future climate and its impacts are under development in the FINSKEN project. This project will result to mutually consistent scenarios of temperature and precipitation, socio-economic and technological conditions, atmospheric composition, acid deposition and sea-level change.

At present, the anticipated impacts of climate change on Finland's nature, agriculture and forestry can be summarized as follows (mainly according to the results of the SILMU programme):

– *The winter in southern Finland may be much milder than today, and floods may be severe in autumn and winter. In northern Finland, the risk of large spring floods is obvious, because winter precipitation may increase, mainly falling as snow. Dam safety should be re-evaluated throughout the country.*

– *The lack of snow cover will make the agricultural soils of southern Finland susceptible to increased leaching of nutrients. Nitrate leaching from forest areas may also increase significantly.*

– *The duration of ice cover in lakes and in the Baltic Sea will become shorter. In summer, the surface water temperatures will increase and lead to extensive algal blooms. Sea level rise may not be a problem on the coastal areas of Finland, because the post-glacial rebound will compensate for it. However, there is a slight risk of unfavourable changes in storm occurrence and wave climate.*

– *Wetlands may be considerably affected by changes in temperature, precipitation, evapotranspiration, and in the load of organic and inorganic matter from their catchments.*

– *Climate conditions impose a significant constraint on agriculture in Finland. The growing season is estimated to lengthen by about ten days for each one degree warming in the annual mean temperature. In all parts of Finland, the warming might enable a wider selection of crops to be cultivated in the future. For example, maize could be cultivated reliably in many parts of southern Finland in 2050 under the SILMU central scenario.*

- *New agricultural challenges and risks are also likely to appear with a changing climate. The range and damage potential of pests and diseases are expected to change unfavourably. Furthermore, increased precipitation may have implications for farm operations, quality of the harvest and overwintering of crops.*

- *Climate change is likely to modify substantially the boreal forests in Finland. The two most important coniferous trees, Scots pine and Norway spruce, 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.*

- *The enhancement of tree 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.*

- *Milder winters may increase the risk of damage caused by insect pests overwintering in the egg form in tree canopies. There might be some counteracting effects, especially through changes in the activity of natural enemies. The risk of damages from fungi, fire and wind may also be greater as a result of milder winters, less snow and shorter periods of frozen soil.*

The estimation of the economic effects of climate change in Finland has been considered to be difficult. Sector-by-sector estimates have indicated that the Finnish economy might benefit by about one per cent of GNP by 2050. However, detailed evaluations have not been made for all sectors, and many effects cannot easily be valued in economic terms. Moreover, international agreements and responsibilities as well as negative effects of climate change in other parts of the world may result in significant costs for Finland.

No systematic vulnerability assessment of climate change impacts in Finland has been made. Some research has been made and estimates presented, particularly in those sectors where harmful consequences are potentially high.

Silviculture is a very important climate sensitive part of the Finnish economy. Finnish forestry researchers consider that the genetic adaptability of our most important tree species – pine, spruce and birch – is exceptionally good, because Finland is located between continental and maritime climates. However, the risk of new pests and insects in a warmer climate should be considered. Similar risks will occur in agriculture, although this sector may otherwise benefit considerably because of longer growing seasons and higher temperatures.

As to the long-term risks involved with climate change in Finland, the possibility of lower activity of the Gulf Stream has been discussed. According to the Third Assessment Report of IPCC, it could lead to a considerable cooling of climate in the whole northern Europe. The probability of this cooling is negligible in this century, but it might increase thereafter.

Adaptation offers a means to reduce the possible effects of future climate change. Measures to adjust to climate change can be taken both on an individual level and by society as a whole. For many issues, very little research or even discussion of the need for adaptation to climate change in Finland has thus far taken place. Such issues include extreme weather events, water supply, biodiversity and human health.

The Finnish economy is deeply dependent on the forest sector. Because of the long time periods involved, the forest might be more sensitive to climate change than other ecosystems or agriculture. Over the next few decades warming could enhance forest growth. However, Finland should also be prepared for a greater risk of forest damage.

The adaptation of agriculture to climate change depends – in addition to the farmer – on technological progress and agricultural policies at the regional, national and international level. One challenge will be the development of new crop varieties, which are able to exploit the future conditions optimally. Maintaining soil properties suitable for crops might also require considerable efforts in the future.

As to water resources, changes in hydrological regimes and leaching should be anticipated. An increase of winter flows can also alter considerably the conditions for hydropower production. Some research has been already done to guarantee dam safety also in the changed hydrological regime.

1.6. FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

Finland supports development efforts which aim at reducing widespread poverty in developing countries, combatting global threats to the environment by helping the developing countries to solve their environmental problems, and promoting social equality, democracy and human rights.

As new and additional resources for solving global environmental problems, Finland contributed in 1997-2000 altogether USD 18.3 million to the Global Environment Facility. This contribution brings forward Finland's aims to promote the environmental agreements and develop their monitoring.

In the 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.

Official development assistance (ODA) is one of the major tools Finland can provide to assist developing countries to enhance the objectives of the UNFCCC. The most significant channels of Finnish ODA are bilateral project and programme funding and the concessional credits. During the reporting period the most important ODA sectors contributing to the mitigation of climate change have been forestry, agriculture and energy. In support to the adaptation capacities the most important lines of action have been capacity building and vulnerability assessments.

Cross-sectoral linkages between sustainable forest management and climate change require study and research. Finland is one of the major donors to the WIDER Institute of the UN, which has, in cooperation with the European Forest Institute (EFI), carried out research projects on the role of forests in the implementation of international conventions of climate change and biological diversity.

Finland has promoted and supported joint environmental and other programmes in its neighbouring regions since 1991. The focal areas are the southern neighbours – Estonia, Latvia and Lithuania – and northwestern Russia, particularly the St. Petersburg region, the Republic of Karelia and the Murmansk region. During the 1990s, Finland channelled EUR 110 million into this environmental cooperation. Four-fifths of the funds have been allocated to investment projects, one fifth to technical assistance.

The primary aim of the cooperation is to prevent transboundary air and water pollution. Relative to the costs involved, cooperation with the neighbouring regions is a very efficient way of protecting the Finnish environment.

The cooperation will continue and its forms and focus will develop. For example, the consideration of the Kyoto mechanisms may be one alternative in the future. As to the Baltic countries, the preparation for EU accession is a priority when identifying new projects.

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.

An interdisciplinary effort called the Finnish Research Programme on Climate Change (SILMU) was carried out in the first half of the 1990s. The key research areas 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 total budget was around EUR 14 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).

The Finnish Global Change Research Programme (FIGARE), financed by the Academy of Finland together with several ministeries, was launched in 1999 and continues until 2002. The main objective of this programme is to find scientific, social, economic and technological solutions to help intervene in the process of global change or adapt to the ongoing changes. The programme has a budget of EUR 6.7 million.

Under the Technology and Climate Change Programme (CLIMTECH), technologies that can be applied to control greenhouse gas emissions and climate change will be investigated. The programme includes both the control and reduction of emissions within Finland as well as the use of Finnish technology to limit emissions elsewhere. The total budget of this programme for the years 1999–2002 is EUR 2.5 million.

The Finnish Meteorological Institute and the Department of Meteorology at the University of Helsinki have research programmes in climate processes, modelling and prediction. The impacts of climate change, socio-economic analyses, and mitigation and adaptation technologies are studied at a variety of institutes and universities. 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.

The Finnish Forest Research Institute (METLA) started in 2000 an extensive research programme on pools and fluxes of carbon in Finnish forests and their socio-economic implications. The role of peat in Finnish greenhouse gas balances has been extensively studied at various universities and research institutes. Agricultural research related to climate change is carried out in various universities and in the MTT Agrifood Research Finland.

The Arctic is a priority area for studying the effects of global change, because of the magnitude of expected climate changes there and the fragility of the environment. The Northern Dimension, the initiative submitted by Finland to the European Union to strengthen the position of the EU in northern Europe, has increased the awareness of the Arctic and of issues related to northern regions. Finland's Arctic research strategy has four priority areas: natural resources, global change, man and communities, and the infrastructure.

As to the 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 up 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).

During the last ten years, Finland's total contribution to cooperation projects concerning meteorological technology transfer and education/training has been about EUR 16.5 million. Projects have been carried out in some thirty countries all over the world. The Finnish Meteorological Institute has had the main responsibility in this work.

1.8. EDUCATION, TRAINING AND PUBLIC AWARENESS

Climate change issues have been extensively discussed in Finland. The Finnish media has eagerly participated in this discussion, particularly during international climate negotiations, and in cases of major weather catastrophes like floods and cyclones. Climate-related topics have also been included in environmental education at various levels since the early 1990s.

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 ministries have environmental websites with up-to-date information about a variety of issues. New statistics and research results are made readily available to the public.

A broad-based Climate Commission led by the Ministry of the Environment has a special task of promoting awareness of climate change issues. The members of the Committee represent different ministries, industries, NGO's and labour unions. The meetings are an opportunity for information sharing and exchange of views. The Climate Commission also organises public seminars, which deal with topics of climate negotiations. Similar seminars have also been organised by the Finnish National IPCC Committee.

The collection and distribution of information is also an essential task of Motiva, in its aims at increasing energy efficiency in households, transport, services and industry. Motiva is the Information Centre for Energy Efficiency, which primarily operates with the budgeted funds of the Ministry of Trade and Industry. Climate issues are also included in the information distributed by FINERGY, the Finnish Energy Industries Federation.

The municipal sector works in Finland in different ways to reduce greenhouse gas emissions and to increase public awareness of climate change issues. One way is the Cities for Climate Protection campaign. In Finland there are 41 cities or municipalities participating in this worldwide campaign at the moment. They represent almost half of population. The campaign is coordinated by the Association of Finnish Local and Regional Authorities (ALFRA).

Several non-governmental organizations (NGOs) have been active in climate change issues. They have participated in national seminars, public discussions, TV debates and other events. Some NGOs have also sent representatives to Kyoto and other COPs.

The scientific knowledge on climate change has also been made widely available to the citizens. This has taken place mainly through books, CD roms and exhibitions. Ordinary citizens have also been interviewed on climate change issues. In general, the emphasis in their risk perceptions is on local environmental risks like air and water pollution. The most serious consequences of climate change are thought likely to occur elsewhere than in Finland.

In the discussions between researchers and policy-makers several alternatives have emerged for slowing down the growth of emissions in Finland. These include investing in research and technology, joint implementation, technology transfer, and measures that serve also other social purposes. More disputed measures include energy and carbon taxes, the selection of appropriate forms of energy production, and solutions involving urban planning and transport policy.

2 NATIONAL CIRCUMSTANCES

2.1. GEOGRAPHIC PROFILE

Finland lies between the 60th and 70th parallels of latitude, and a quarter of the country lies north of the Arctic Circle. To the west and south, it has a long coastline on the Baltic Sea with numerous islands. 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, 1269 km.

Much of the country is a gently undulating plateau of old bedrock. Nearly the whole of Finland is in the boreal coniferous forest zone, and 76% of the total land area is classified as woodland, while only some 9% is farmed. Finland has over 34 000 km^2 of inland water systems, or about 10% of its total area (Table 2-1). There are some 190 000 lakes and almost as many islands, over half of the latter along the Baltic Sea coast. High rounded fells form the landscape in Finnish Lapland, the most northernly part of the country.

Table 2-1

Land use in Finland in 1960–1999 (km^2)

Land use classification	1960	1990	1999
Agricultural land	31 400	26 665	27 014
Forest and other wooded land	224 400	233 665	230 042
Built-up and related land	3 400	9 390	11 970
Open wetlands and other open land	46 000	34 873	35 062
Water	32 600	33 552	34 057
Total	**337 800**	**338 145**	**338 145**

Data for 1999 are not completely comparable to the data of 1960 and 1990.

2.2. CLIMATE PROFILE

The climate of Finland shows characteristics of both a maritime and a 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 in these latitudes, e.g. Siberia and south Greenland. The temperature is raised by the Baltic Sea, inland waters and, above all, by air flows from the Atlantic, which are warmed by the Gulf Stream.

The mean annual temperature is about 5.5°C in southwestern Finland, decreasing towards the northeast. The 0°C mean limit runs slightly to the south of the Arctic Circle. Temperature differences between regions are 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, in 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 characterized 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, where about half of the precipitation falls as snow, the annual amount is only about 600 mm.

The annual variation in precipitation is similar throughout the country, the driest month being March. Then 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 sometimes exceeds 900 mm elsewhere. The highest daily rainfall recorded is almost 200 mm, but values in excess of 50 mm are rare. Except in coastal regions, at least half the days in the year have some rain.

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 snow cover is deepest around mid-March, with an average of 60 to 90 cm in eastern and northern Finland and 20 to 30 cm in southwestern Finland. The lakes freeze over in October in Lapland and early December in southern Finland. The ice is thickest in March or April, at about 50 to 80 cm. In severe winters, the Baltic Sea may ice over nearly completely, but in mild winters it remains open except for the far ends of the Gulf of Bothnia and the Gulf of Finland.

Fog is most common in autumn, in southern and southwestern Finland, usually at night and early in the morning. In winter, though, fog can occur in daytime too. Early winter is often quite foggy in a corridor of about 40 to 80 km from the coast.

The winds in Finland blow most commonly from the southwest and least commonly from the northeast; all other directions occur with equal frequency. The average wind speed is 3 to 4 m/s inland, slightly higher on the coast and 5 to 7 m/s in maritime regions. High winds are rare, particularly inland. Storms, with a wind force of over 20 m/s, occur on one to three days every month on the open sea in autumn and winter. In spring and summer, storms are rare; inland they are rare in all seasons, although occasionally devastating local trombies may occur in summer.

Cloud cover is especially abundant in Finland in autumn and winter, increasing from the northwest towards the southeast; about 65% to 85% of the sky is then covered in cloud. Clear days occur most frequently in May and June, and least frequently in November and December. In summer, the regions north of the Arctic Circle are characterized by polar days, when the sun does not set at all. Even in southern Finland, the longest day is nearly 19 hours.

2.3. POPULATION PROFILE

The population of Finland was 5.17 million in December 1999. In the 20th century, the population increased by 49%, in the 1990s by 3.4%. The average population density is only 17.0 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 5.26 million, for 2020 it is 5.29 million.

The population is concentrated in the southern parts of the country, with about one million people living in the metropolitan Helsinki area. The capital Helsinki itself had a population of 551 000 in December 1999. The province of Lapland, although almost one-third of the area of Finland, had a population of only 194 000.

There is a strong internal migration from small municipalities to urban areas. In the 1990s, the population of the six largest localities increased from 1.61 million to 1.81 million, while at the same time many communities, particularly in Lapland and eastern Finland, had a declining population.

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 permanently in Finland was about 85 000 in December 1999.

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. President Tarja Halonen was elected in February 2000 and the next presidential elections will be held in the year 2006. The President is chosen by direct popular vote, with a run-off between the two leading candidates to emerge after the first round of voting. The government must enjoy the confidence of Parliament, which has 200 members elected by universal suffrage every four years.

After the elections of 1999 the Social Democratic Party had 51 parliamentary seats, the Centre Party 48, the National Coalition 46, the Left Wing Alliance 20, the Swedish People's Party 12, the Greens 11 and the Christian League 10. The Rural Party and the Reform Party had one each. The multiparty coalition government formed in 1999 is headed by Prime Minister Paavo Lipponen, the leader of the Social Democratic Party.

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

The Autonomous Province of Åland consists of 6 554 islands in the southwestern archipelago of Finland. About 95% of the population of 26 000 are Swedish-speaking. The Autonomy Act, last revised in 1991, gives the Ålandic Legislative Assembly the right to enact laws, e.g. in municipal taxation, building and planning and the protection of the environment. It has also given Åland the opportunity not to consent to membership of the European Union.

2.5. EDUCATION AND RESEARCH

All children in Finland receive compulsory basic education between the ages of 7 and 16. Education beyond the age of 16 is voluntary, taking the form of either a three- to four-year course in upper secondary school or 2 to 5 years at a vocational school. There are 21 universities or institutes of higher education, with a total student population of around 135 000, of whom 52% are women. About 55% of the population have completed post-primary education, 13% have a university degree or equivalent qualification.

Over 90% of primary and secondary schools and all vocational schools and colleges were connected to the Internet in 1999. Almost 90% of libraries offerred their clients access to the Internet. The library network is dense in Finland and about half the population use lending services. The circulation of daily newspapers is the highest in the EU, around 470 per 1000 inhabitants.

In 1996, the Finnish government adopted a programme to raise the level of research and development funding 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. Finland is now among the world top countries in terms of relative research input.

The private sector's share of research funding has risen to almost 70% in 1999. The share of university research funding has been growing slightly throughout the 1990s, while the share taken up by state research institutes for sectoral research has declined.

The development of Finnish researcher training has been one of the main priorities in science policy over the past decade. In addition to the graduate school system created in 1995, programmes have been implemented to develop postdoctoral research and to promote women's research careers. Today there are 100 graduate schools and the total number of doctoral students in these graduate schools is nearly 4000. Most graduate schools are networks of several universities. The annual number of new PhDs is presently about 1000; twice as many as in 1990.

2.6. BUILDING STOCK AND URBAN STRUCTURE

Characteristically, Finland is a land of small towns and communities. The bigger towns are located in the south and west and the size of towns becomes 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 450 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 holiday cottages, agricultural buildings and other outbuildings.

Finland's building stock is rather new: 85% of the buildings have been constructed after 1950. The floor space per person in 1999 was 35 m^2, as compared to 19 m^2 in 1970 and 31 m^2 in 1990. The average size of a dwelling is 76 m^2.

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 and 92% have hot water. At present, technically inadequate housing is a problem mainly in rural areas and among the elderly.

Although the use of wood in towns has declined noticably, 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 holiday cottages. 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 build pleasant new urban environments built of wood and to 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.

On average, Finns spend one-fifth of their disposable income on housing. Two-thirds of Finland's housing stock consists of owner-occupied homes and about 30% of the housing stock is rented. 'Right of occupancy' is a new form of tenure falling between rental and owner-occupancy. Half of Finland's rental housing is state-subsidized while the rest is financed on the free market. When the economy slowed down in the early 1990s, the level of free market production fell rapidly. In contrast, the state-subsidized production was kept at a relatively high level. In recent years, the housing market has recovered.

The National Programme for Sustainable Construction (1998) promotes ecologically sustainable development in housing, construction and real estate. In connection with the programme, the government and the building sector will agree on how to promote sustainability in building design, production, the construction process and maintainance (Fig. 2-1). In accordance with another government decision, building waste must be graded and recycled (50% by 2000 and 70% by 2005).

The need for new housing is expected to continue at a level of 30 000 to 40 000 dwellings per year well past the year 2000. The main reasons for this are the changing age structure of the population, decreasing household size and continuing migration to urban centres.

Figure 2-1.
Experimental building is being used to test the results of research and development work in the construction sector and to speed up the introduction of technical innovations. The largest urban experimental area is Viikki, a suburban development close to Helsinki, where construction began in 1998. The ecological criteria developed for this project will be used to guide regulations on construction in urban areas elsewhere in the country.

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 the control by central government is reduced. The act emphasizes matters related to community structure and the availability of services, and includes many more instruments for dealing with urban development policy than the present legislation.

2.7. ECONOMIC PROFILE

For a number of decades the Finnish economy was characterised by fast growth combined with sensitivity to international market variations. In the early 1990s, however, as the externally financed asset value bubble burst, Finland fell into a recession of unprecedented depth. At the time, Finnish institutions and production structures were unable to adequately adjust to the demands of the new operating environment, where capital movement had become free. This was further exacerbated by the cyclical downturn in Europe and the collapse of Finland's trade with the Soviet Union. Indeed, gross domestic product plummeted by about 10 per cent between 1991 and 1993.

The recession gave, however, a boost to the structural changes that became inevitable as Finland progressed towards an open economy and further integrated with the European Community. Consequently, economic fundamentals and structures are now far healthier and stronger than at the turn of the last decade. The Finnish economy is now growing fast again – between 1995 and 1999 GDP grew an annual average of about four per cent. In 1999, Finland's GNP per capita was around 23 400 euros.

A 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%. Export growth has been exceptionally fast in the electronics and electrotechnical industry, which in 1999 already accounted for 28% of all exports, more than the pulp and paper industry, which stood at 23%.

Finland's total exports amounted to EUR 39.2 billion in 1999, total imports being EUR 29.7 billion. The surplus, EUR 9.6 billion, was slightly smaller than in 1998.

The majority of Finland's exports go to the European Union, but in the past few years the emerging market economies, such as China, have become significant trading partners. Following the collapse of the Soviet Union, exports to the CIS region came to a virtual standstill. In 1997 the share of Finnish exports to Russia edged up to over seven per cent, but dropped again in the wake of the economic crisis in Russia, and was at about four per cent in 1999.

In the late 1980s the unemployment rate was a mere 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 has gradually declined, being at 10 per cent in 1999. In the communities of southern Finland, unemployment rates in 1999 were 5–10%, whereas they reached 20% in Lapland and eastern Finland.

The pre-recession level in private consumption was regained in 1997. In the wake of the recession, the propensity of businesses and households to raise loans and to invest remained low until recent years. Companies concentrated on bolstering their financial structures while households tried to reduce their debt burden. Bank lending to the general public only picked up in 1997. Adjustment took place over a long period of time, but now the financial position of both companies and households is good. In 1999, the real disposable income of households was 23% higher than in 1994. On the other hand, income differences have clearly increased.

Together with the economic policy lessons learned during the 1990s crisis, the most crucial factors in implementing structural reform derive from the existence of a sound infrastructure, market deregulation, stable conditions in the society, high-quality basic social services, such as education, transport and telecommunications, and so on. Moreover, companies have not only invested heavily in research and development but have also adopted the newest technology.

Finland has a long-standing history of budgetary balance in general government finances, and public debt remained for decades 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 strongly increased in the early years of the 1990s, and the debt-to-GDP ratio as defined in EMU terms escalated to almost 60% in 1994.

Over the course of the 1990s, fiscal policy has been characterised by endeavours to overhaul the imbalance in central government finances. By promoting growth and employment, the tax base has been improved and pressure in social expenditure has eased. Moreover, over the past decade government expenditure has been reduced by almost one-tenth in relation to GDP.

The programme of the present Government aims to safeguard government expenditure at the 1999 level in real terms over the whole of the election period (1999–2003). This would mean that the debt-to-GDP ratio in government finances would fall below 50% in the course of the election period and overall public sector consolidated debt would decrease to roughly one-third of GDP. The Government also intends to decrease the unemployment rate to 7–8% by the end of the election period.

2.8. INDUSTRY

Finland's road to industrialisation started in the 19th century with the harnessing of forest resources. Forests are still Finland's most crucial raw material resource, although the engineering and high technology industries, led by companies like Nokia, are now very important branches of manufacturing (Fig. 2-2). Finland is one of the few European countries whose exports exceed imports in data and communications technology.

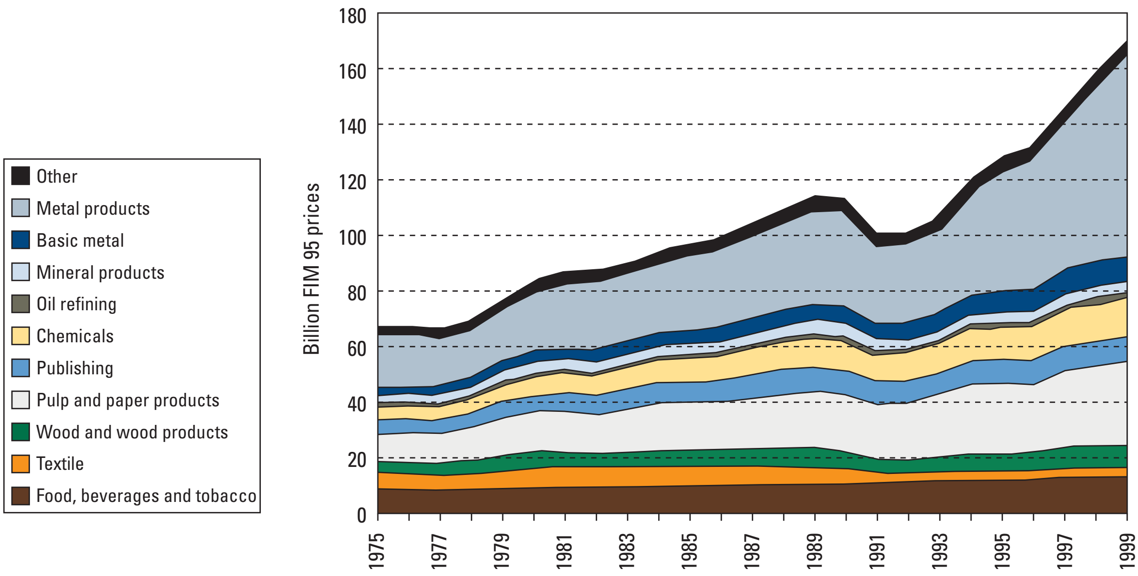


Figure 2-2
The output of Finnish industry in 1975–1999, expressed at constant prices of 1995. Following the economic recession of the early 1990s, very rapid expansion in the metal products industry – especially in electronics – ha changed the traditional structure of Finland's industry (1 FIM= 0.1682 EUR).

When the EC's enlargement extended to the former EFTA countries of United Kingdom, Denmark and Ireland in 1973, Finland and the other EFTA countries concluded a free trade agreement with the EC called the EEC treaty. This treaty removed barriers to trade in goods on the common market. Finnish industry expanded abroad during the 1980s and paid a high price for its international apprenticeship through foreign acquisitions. In 1995, Finland, together with Austria and Sweden, joined the European Union, after a rather close vote in a national referendum.

The disintegration of the Soviet Union caused the collapse of the extensive Finnish-Soviet trade, which had been conducted on a bilateral basis via official channels as was customary for the Soviet system. This made the recession in the early 1990s in Finland substantially more severe than elsewhere. Today, the business with Russia takes the form of ordinary currency-based trading.

Nordic cooperation has also been vital to Finnish industry. Sweden has always been an important trading partner. It nevertheless became necessary to all the Nordic countries to broaden their horizons towards the end of the 20th century.

The Finnish export industry is highly competitive, and prospects look good in both the paper industry and electronics. Both sectors are part of the globalisation trend. Finnish forest industry enterprises, which are among the world's heavyweights, have recently strengthened their position through corporate acquisitions in North America and in Central Europe.

2.9. ENERGY

2.9.1. Finland's energy supply

About two-thirds of the energy used in Finland comes from imported primary sources. The main indigenous sources are hydropower and biomass residues from the forest industry, supplemented by peat.

As to the historical development, the main part of hydropower capacity was built before the end of the 1960s, half of it between the years 1945 and 1960. In the 1950s and 1960s oil captured market shares from coal and fire-wood. Combined heat and power production both in district heating plants and in the industry speeded up especially in the 1960s, and today this production covers almost one-third of electricity consumption and about half of the space heating demand. The next decade, the 1970s, brought two important new sources to the Finnish energy markets; natural gas and electricity generated by nuclear power.

In 1999, the gross consumption of primary energy in Finland amounted to 31.3 million tonnes of oil equivalent (Mtoe) or 1313 PJ (Fig. 2-3). The most notable decrease has taken place in oil consumption, which still accounts for 28% 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, the share of nuclear energy in Finland's diversified energy mix has increased.

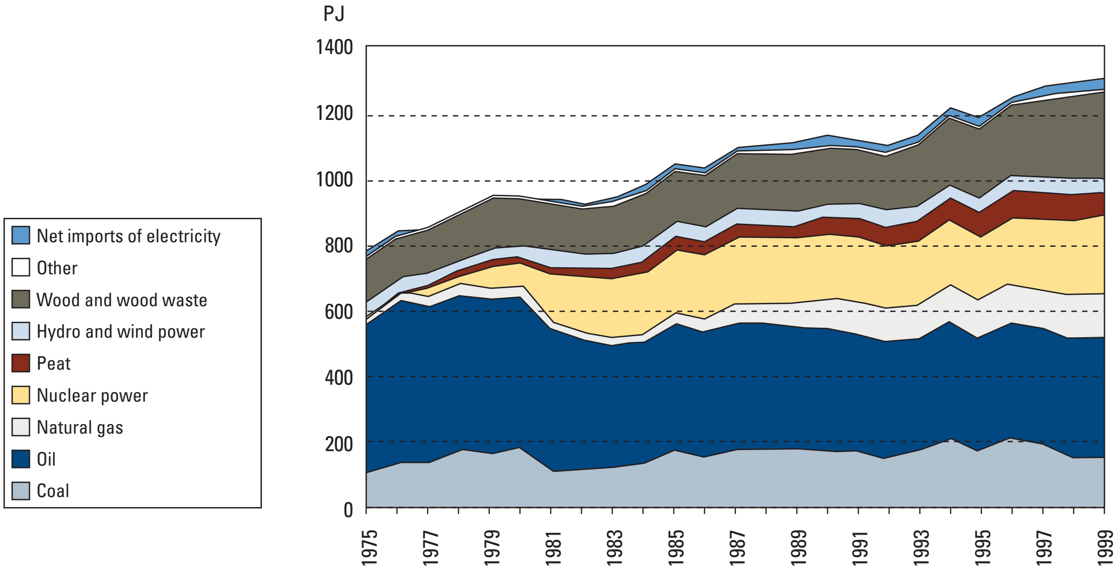


Figure 2-3
Gross consumption of primary energy in Finland in 1975–1999. The conversion of primary energy units into oil equivalent units follows the international methodology, recommended by the International Energy Agency.

The introduction of nuclear power in the early 1980s cut coal use for electricity generation dramatically (Fig. 2-4). Later, the exploitation of new sources, such as peat, biomass and natural gas increased. In 1999, as primary energy nuclear energy accounted for nearly half of all fuels used for electricity generation and in the electricity consumption the share of the nuclear power was 28%. In 1999, the total electricity consumption amounted to 77.8 TWh.

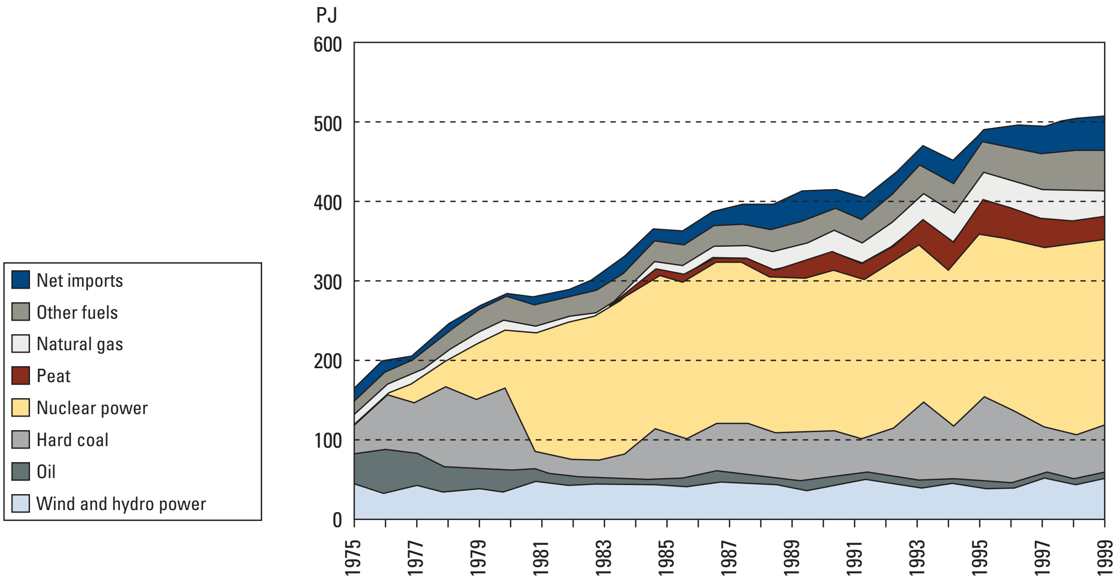


Figure 2-4
Energy sources in Finland's electricity generation in 1975–1999.

Renewable energy and slowly renewable biomass, peat, covered 28% of the total primary energy supply in 1999 (Fig. 2-5). The trend has been upwards, mainly owing to the increased use of black liquor and industrial wood wastes within the pulp and paper industry, and to the growth in other energy wood consumption. Industrial combined heat and power production (CHP), as well as CHP with district heating, provide good potential for cost-effective use of renewables.

The installed wind power capacity has increased rapidly in Finland in the 1990s as a result of the Government's support programme. Still in 1992 the capacity was only about 1 MW, but in 1999 it was around 40 MW. Finnish manufacturers have successfully developed technical solutions to prevent ice formation on the wings of wind power stations.

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

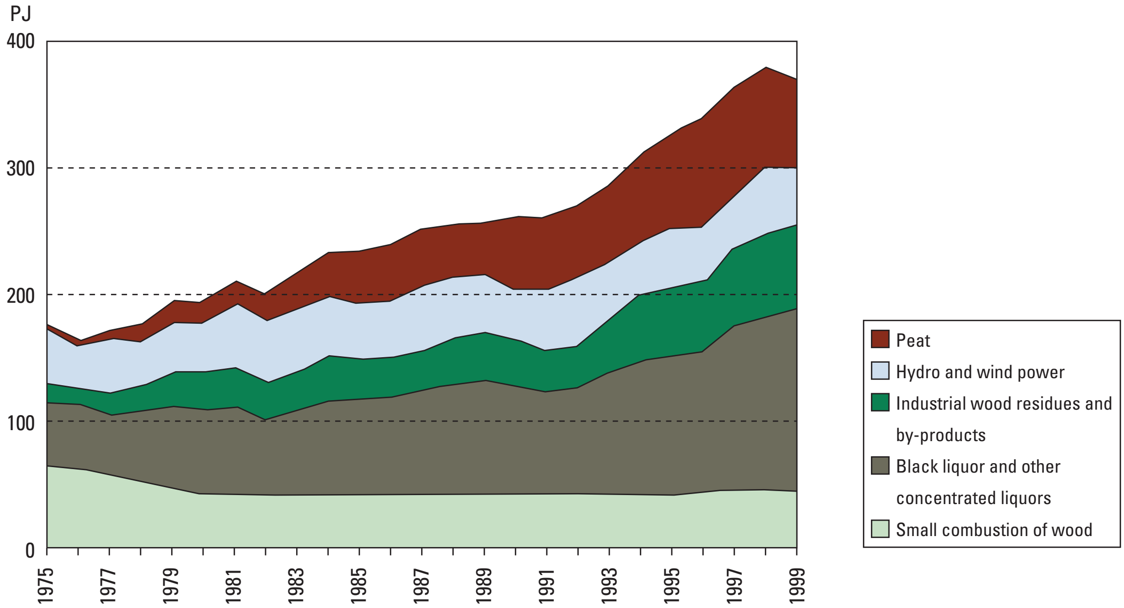


Figure 2-5
The use of renewable energy and peat in Finnish energy production in 1975–1999.

The energy intensity of the Finnish national economy, calculated as total primary energy supply per unit of GDP, has decreased slightly during the 25 years since the first energy crisis (Fig. 2-6). Structural changes in the GDP have recently led to the weaker connection between energy consumption and GDP. Electricity consumption per unit of GDP increased until 1993, which development reflected the shift in energy use to electricity at the expense of other fuels. Since then the growth of electricity consumption has remained lower than the GDP growth, which partly reflects the structural change in industry towards decreasing electricity and energy intensity.

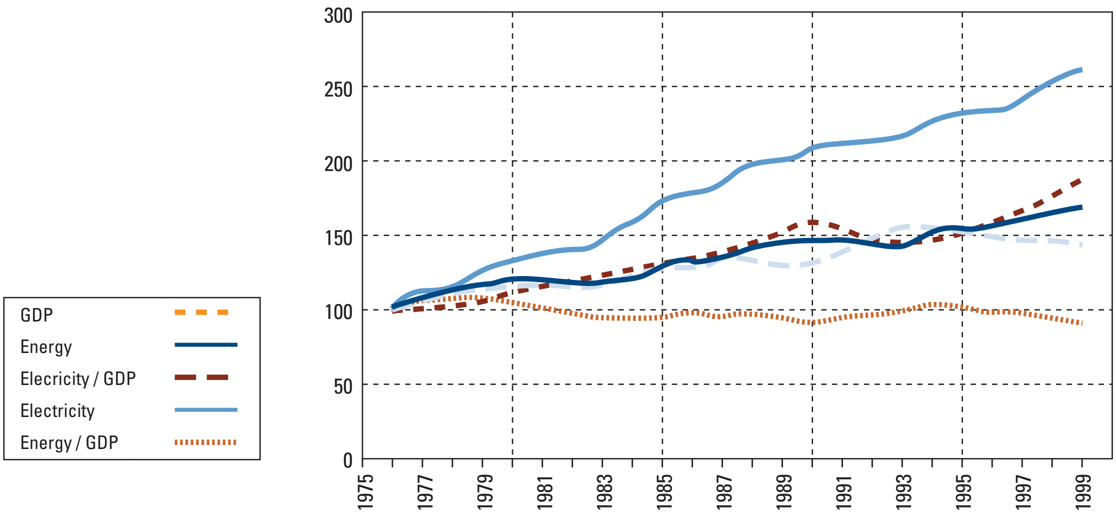


Figure 2-6
Energy and electricity intensity indices in Finland in 1975–1999.

2.9.2. Energy use in industry

The energy demand of industry is very high in Finland; in 1999 the industry used 50% of total primary energy and 54% of total electricity. (Fig. 2-7). A considerable part of energy-intensive industry is export-oriented. 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 used to supply other countries with energy-intensive products.

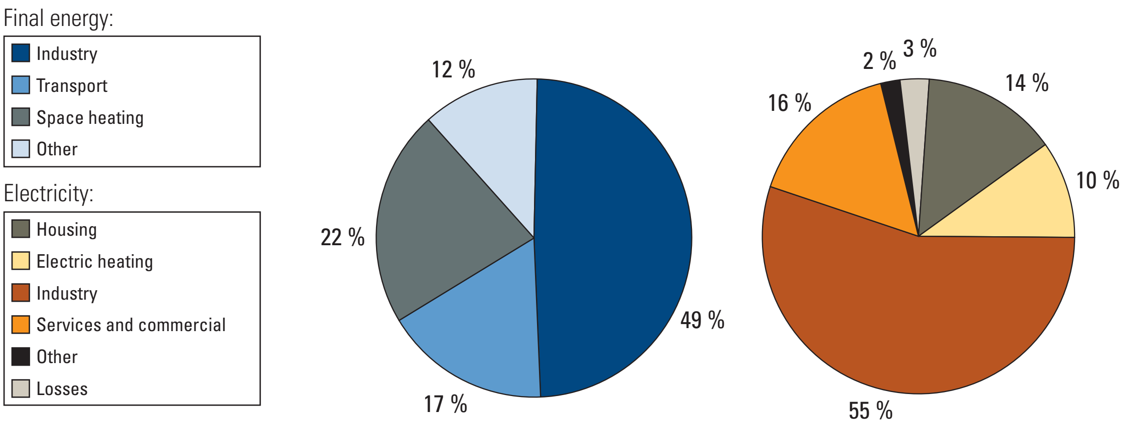


Figure 2-7
Final energy consumption and electricity consumption by sectors in 1999.

Because of 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; waste wood, pulping liquors and other biomass energy sources are effectively utilized.

In all, the forest industry produced about 16% of the country's total energy in 1999. All Finland's pulp mills are self-sufficient in heating energy and all the new chemical pulp mills produce energy in excess of their own requirements. In many industrial localities, the energy left over from the pulping process is channelled to the municipal district heating network.

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 most CO_2 emissions by households and by the public and tertiary sectors. However, during the past two 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 up 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.

The amount of heated space has increased steadily. In 1990–1999, the total increase in cubic metres was 13% in residential heating and 12% in heating of commercial and public buildings. During the first part of the decade, the specific energy consumption decreased in both cases by 15% and has remained practically constant after that.

The total energy use for space heating was slightly lower in 1999 as compared to 1990 (Fig. 2-8). The figure also shows the development of volume growth; that is activity effect and energy intensity effect for both residential heating and the heating of commercial and public buildings. The activity effect is calculated using constant (base year 1990) sectoral structure and constant energy intensities but actual aggregate activity for each year. The intensity effect is calculated using constant aggregate activity and constant sectoral structure but varying energy intensities.

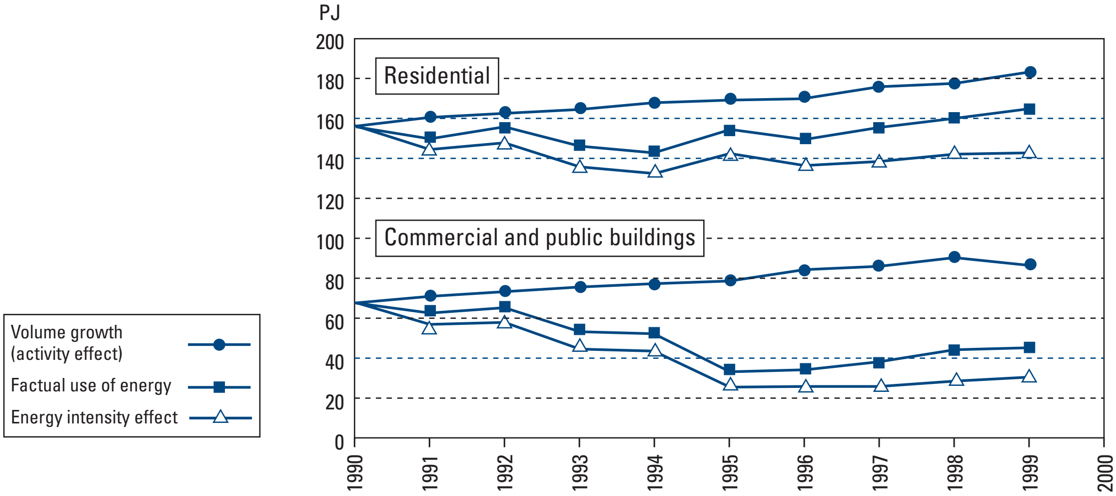


Figure 2-8
Energy use in residential heating and in heating of commercial and public buildings in 1990–1999. The impacts of activity and intensity are also shown (Kirjavainen and Tamminen 2001).

2.9.4. Energy production technology

Finland is a leading country in combined heat and power (CHP) production. In this production system, the heat produced by thermal electricity generation is utilized in industrial processes or for heating purposes, thus greatly boosting the overall efficiency and economy of energy production. In 1999, over 30% of all electricity produced in Finland was generated at CHP plants.

A wide range of fuels is used to produce district heating (Fig. 2-9). Coal and oil are being replaced by natural gas. Peat is competitive in district heating, especially in inland areas. The share of industrial wood residues and by-products has rapidly increased in the fuel mix, this being one target in the Government's energy strategy. The district heating network has reached most areas where there is cost-effective potential for district heating.

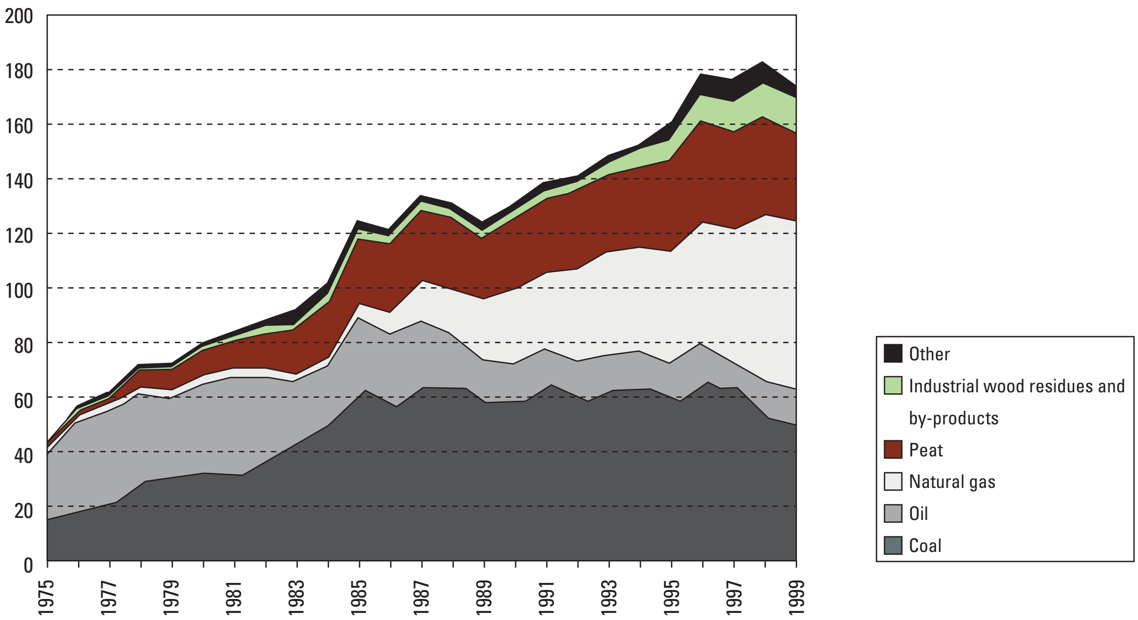


Figure 2-9
Fuels used in district heating and in combined district heating and electricity production.

2.10. TRANSPORTATION

2.10.1. Transport network

The Finnish transport network consists of the infrastructure needed for road, rail, water and air traffic (Table 2-2), parts of which belong to the Trans-European Network. The network of roads and streets comprises 78 000 km of public roads (65% paved) maintained by the National Roads Administration, 24 000 km of streets maintained by municipal and other local authorities, and 280 000 km of private roads. Finland has about 680 km of motorways, of which some 170 km are secondary. Of the rail network, less than half, 2 050 km, is electrified. The rail network is the densest in Europe if calculated per capita of population.

The capital value of public roads in Finland amounts to some EUR 20 billion. In 1999, GDP was EUR 121 billion.

Three-fourths of Finland's foreign trade is carried on by ship, and the harbours are its 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 on the Bothnian Bay require icebreakers for half the year, while these are needed in the Gulf of Finland for about three months.

Table 2-2

Transport network in Finland in 1999

Network	Kilometres
Public roads	77 900 km
Motorways (incl. secondary)	681 km
Other highways	8 902 km
Streets in urban areas	24 245 km
Private roads	280 000 km
Cycling paths	11 000 km
Railways	5 836 km
Metro line	21 km
Tramways	71 km
Waterways	9 338 km
Number of airports	22 airports (maintained by CAA)

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

The harsh winter conditions raise the costs of building, maintaining and operating the transport infrastructure in Finland. The penetration of the frost into the ground means that all constructions have 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 installed in the road structures in areas where the groundwater is used for domestic supplies. 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 on building and maintaining roads, railways and waterways, the 1999 budget for which was almost EUR 1.1 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 100 million euros per year.

The rail network degenerated in the 1980s, and financing for track maintenance has been increased during the present decade. About EUR 350 million was spent on this in 1998 as compared with only about a half of this sum ten years earlier. Some EUR 200 million were spent on the maintenance of airports and air routes in 1998, and about EUR 100 million on shipping channels.

2.10.2. Freight transport

In Finland more freight is transported per capita than anywhere else in Europe. Freight traffic kilometrage is almost double the EU average. This results mainly from the long haulage distances and the industrial structure. Finnish industry has traditionally been weighted towards heavy industries such as the timber, paper and metals 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. About two-thirds of all freight was transported by road in 1999 (Fig. 2-10); rail transport accounted for 25%, a distinctly greater proportion than the EU average, while the inland waterways' share was about eight per cent. Roundwood transports constitute a very essential part of all haulage on Finnish roads.

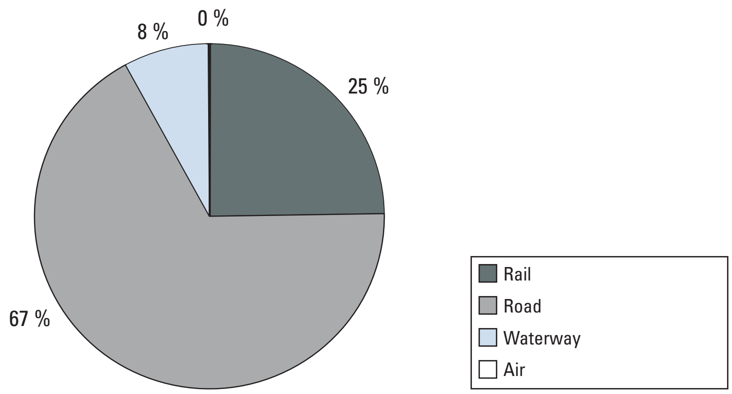


Figure 2-10
Percentual shares of different transport modes from domestic freight traffic in 1999.

The EU has taken Finland's special conditions into account by, for instance, allowing extra-long, 25-metre module combinations to be used in internal goods traffic. Long vehicle combinations can be made up in various ways from standard EU trucks and trailers. Transport firms in different EU member countries can thus compete for Finnish transport on an equal footing.

Motor gasoline alone accounts for almost half of traffic fuel consumption in Finland (Fig. 2-11). Consumption of diesel fuel began to rise in the late 1990s, following the increasing demand for freight transports.

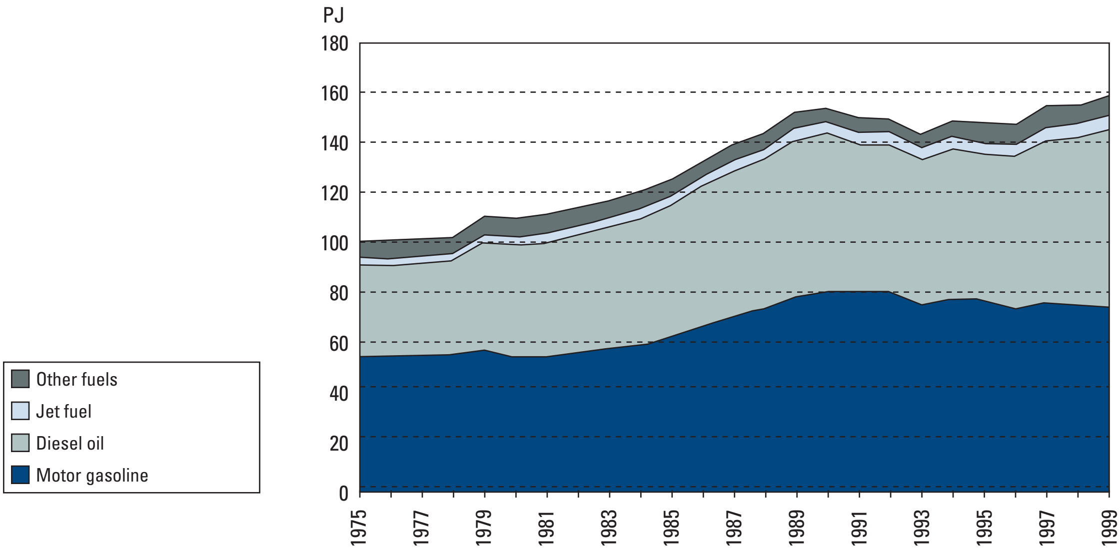


Figure 2-11
The consumption of transport fuels in Finland in 1975–1999.

Measured in euros, 60% of Finnish foreign trade deliveries are destined for western Europe and less than a quarter for Russia. Taking all the crossing points together, over 230 000 heavy goods vehicles and almost 930 000 private cars crossed from Finland into Russia in 1998.

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

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 aircraft. Growing exports of consumer goods and electronics, including mobile phones, are increasing the air transport share.

2.10.3. Passenger transport

An average Finn uses 83 minutes per day to travel, and covers a distance of 45 kilometres. Almost 80% of the distance travelled is by passenger car, 11% by bus and 5% by train. The shares of other transport modes are between 0.3% and 2% (Fig. 2-12).

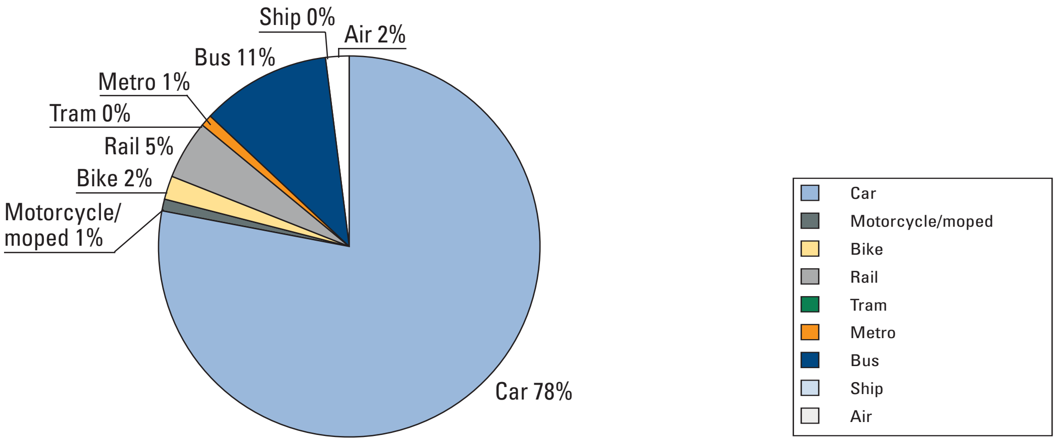


Figure 2-12
Percentual shares of different transport modes from domestic passenger traffic in 1999. The total volume of domestic passenger traffic in that year was 70.3 billion passenger-kilometres.

Finns travel more than people in other EU Member States. The reasons for this are the long distances, the dispersed settlement structure and trips to the holiday cottages. The total amount of passenger traffic is forecast to grow 30% as compared to the present situation by 2020.

Buses are the most popular form of public transport. Trains are preferred for long distance journeys from town to town and for commuter traffic in the Helsinki metropolitan area. Helsinki also has a metro and tram network. Travel between the south of Finland and Lapland is mostly by air.

Finland has 2.4 million automobiles; the number increased by 7.6% in the period 1990–1999. There are 2.1 million passenger cars in Finland, i.e. 403 per one thousand inhabitant. The average age of passenger cars in Finland is the highest in EU member countries. The energy efficiency of cars improved clearly in the 1990s, reaching the average level of 7.5 l/100 km (Fig. 2-13).

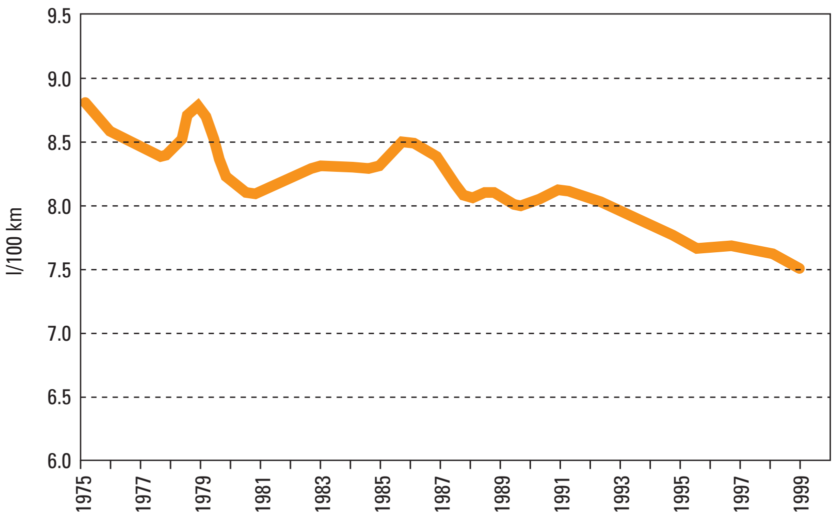
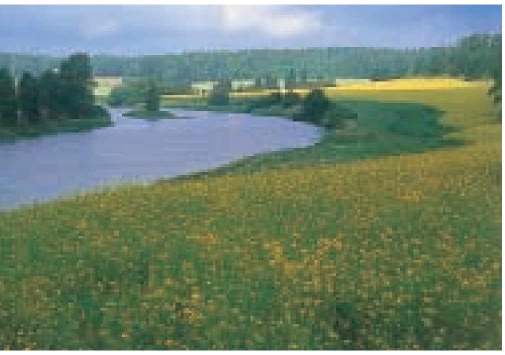


Figure 2-13
Specific consumption of gasoline by cars in 1975–1999.



The migration to population centres, especially to certain growth areas continues in Finland. In these areas, investments are made in public transport together with pedestrian and bicycle transport in order to manage the growing needs. Nowadays the adult population in Finland makes more than one-fifth of its journeys by bicycle or on foot. Cycling in wintertime is becoming more popular as well.

Public transport in Finland is, by and large, self-supporting. The State helps to fund public transport services 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 promotes traffic safety. In accordance with the Government resolution, the aim is to reduce the number of fatalities to less than 250 by 2005. In 1999, the number of fatalities in Finland was the fourth lowest within the EU in relation to kilometrage.

2.10.4. Telecommunication

Finland has made international headlines as an information society in recent years. There were 3.4 million mobile telephone connections in Finland at the end of 1999, equivalent to 652 per one thousand inhabitants. The number of Internet connections was 1.2 million, i.e. 121 per 1000 (Fig. 2-14). These figures were higher than in any other EU Member State.

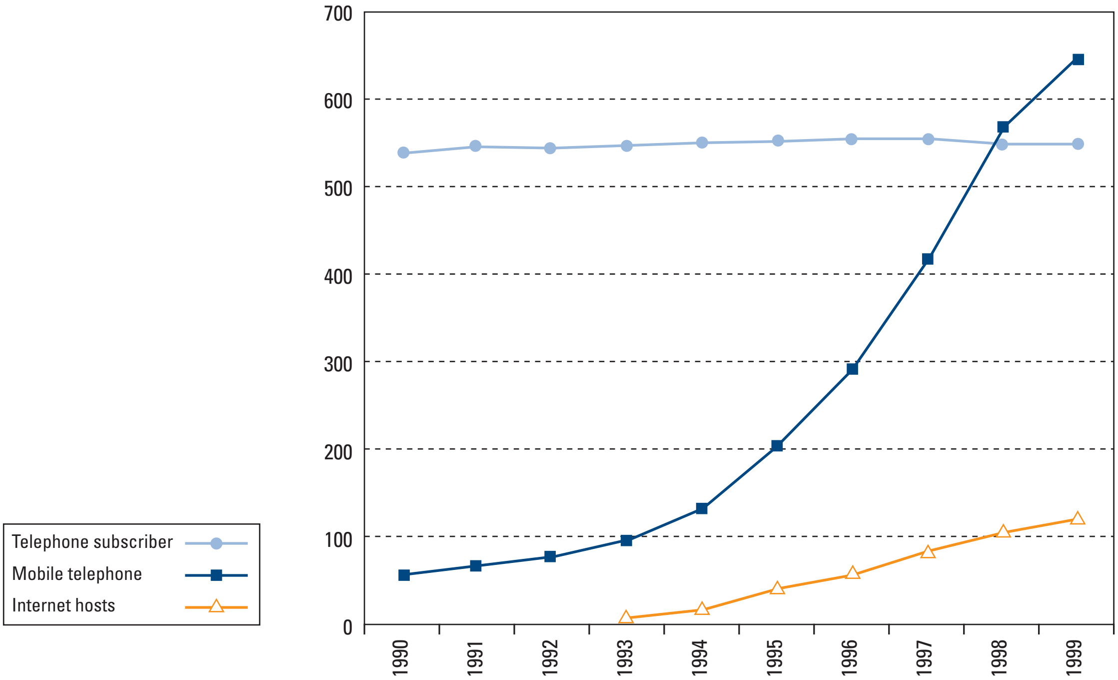


Fig. 2-14
The numbers of telephone subscribers, mobile telephones and Internet hosts in Finland in 1990–1999 (per 1000 inhabitants).

Finland was also the first country to grant licences for third generation mobile networks.

Four telecommunications companies received a licence to construct a 3G mobile network. Operations will be launched by 1st January 2002 at the latest.

In the next few years, the telecommunications and information technology sectors might continue to grow in Finland. During the next few years, a major change in mass media will be digital radio and television transmissions. A test network for digital radio transmissions will be built in the areas of Helsinki, Lahti and Tampere. Digital television transmissions started in autumn 2001.

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 very high rate for many years. Between 1990 and 1999, the number of active farms fell from 130 000 to 90 000. At the same time, the average farm size increased considerably. Though declining in number and increasing in size, Finnish farms should be in fact bigger still if they are to compete successfully with farms in other EU member states.

Though the number of farms is declining and farms are employing fewer and fewer people, agriculture remains by far the most important source of livelihood in rural areas. Moreover, as productivity is set to rise further, there will be little change in the level of agricultural production. In 1997, rural businesses provided jobs for nearly ten per cent of the employed work force, with agriculture accounting for six per cent and other small rural enterprises related to primary production for four per cent. At the same time, the income structure of farming families is changing, with more and more of their members having outside jobs.

In 1980, agriculture accounted for eleven per cent of the employed work force, providing 250 000 people with a livelihood. In 1999, the figures were five per cent and 120 000 people, respectively.

There are three kinds of rural business: primary production farms, rural enterprises and diversified farms. Primary production farms engage in traditional farming (agriculture, forestry and small-scale specialist farming). Specialist farming includes horticulture, fur farming, fish farming and small-scale further processing of agricultural products. Rural enterprises are small businesses in rural areas. Diversified farms engage in both traditional farming and small-scale entrepreneurship.

Agriculture is important throughout Finland, though in northern part of Lapland it mostly takes the form of reindeer husbandry. As

Finland is nearly 1 100 kilometres long from north to south, there are considerable regional variations in climate. The thermal growing season (the period with an average daily temperature in excess of +5°C) varies from 180 days in the south to less than 100 days in the north. In southern Finland, the growing season starts in late April and lasts until mid-October. The effective temperature sum varies between 300°C and 1 400 °C (Fig. 2-15). For comparison, in Central Europe the growing season is 260 days long and in southern parts of the continent more than 300 days.

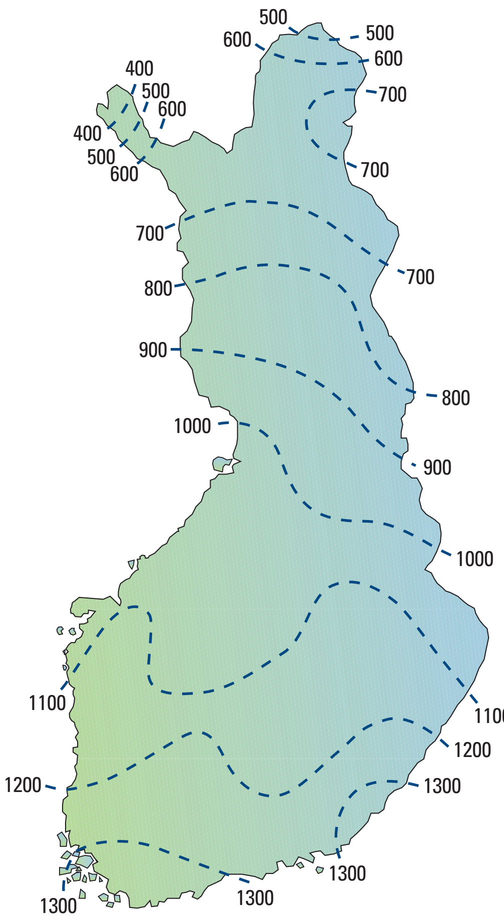


Figure 2-15
Effective temperature sum (°C) in Finland in 1961–90 (Finnish Meteorological Institute, Internet pages)

Most of Finland's agricultural production comes from family farms: 87% of active farms belong to private individuals and 12% to estates and family enterprises. The average age of farmers is 46 years, full-time farmers being younger than those farming part-time. Nearly one-third of all active farms are dairy farms, eight per cent beef cattle or other types of cattle farms, six per cent pig farms and two per cent poultry farms. Grain is cultivated on 31% of all active farms and 15% engage in horticulture or other crop production.

2.12. FORESTRY

2.12.1. A land of forests

A total of 262 300 km^2 or 86.1% of Finland's land area is classified as forestry land. As compared to the area of forest and other wooded land Table 2-1, this also includes 31 200 km^2 of treeless wasteland. Some 200 000 km^2 of forests have an annual growth of at least 1.0 m^3 per hectar. Thanks to the influence of the Gulf Stream, there are forests even in the northernmost parts of Finland.

Various kinds of peatlands are a fundamental element of the Finnish landscape. In fact, the Finnish name of the country, Suomi, might have originated from the word "suo", i.e. mire. In the cool and humid climate the soil becomes waterlogged, which creates the right conditions for peatland vegetation and the formation of peat. Originally, about one-third of Finland was covered by peatlands. Half of this area has been drained for farming, forestry and peat extraction purposes, while the other half has been preserved in its natural state.

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

A 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 almost all mature trees from the site. A new stand is established on the clear-felled area, either through direct seeding or planting.

2.12.2. Forest resources and management

The total volume of stock in Finnish forests amounts to about two billion cubic metres. For over thirty years, the increment of stock has exceeded harvesting volumes and natural drain. Today, the annual increment is about 75 million cubic metres, whereas less than 70 million cubic metres or less are harvested or die of natural causes. Of the total logged area, regeneration felling accounts for roughly one-third and thinnings two-thirds.

Thanks to increasing increment, it has been possible to continuously increase the harvesting. This is a result of improved forest management practices and forest improvement measures, for instance, drainage ditching. The annual increment of stock has been increased by about 15 million cubic metres. Today, natural peatlands are no longer subjected to drainage ditching; the activities are now concentrated on maintaining previously drained areas and forests established there.

In the 1990s, the area of forests strictly protected from fellings totalled 1.5 million hectars. These forests correspond closely with IUCN categories I and II. Otherwise, protected forests and forests in restricted forestry use together totalled just under one million hectars. Good one-half of all protected forests is productive forest land, while the rest is scrub land of low productivity.

Approximately 6.5% of the productive forest land and close to 40% of the scrub land is protected in Finland. Most of the protected forests are located in northern Finland.

Forests play an important part in Finnish economy as producers of renewable raw material, i.e. wood. The raw-material value of the volumes harvested annually varies from EUR 1.0 to 1.7 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 the forest ownership as well. An increasing number of forest owners are city or town inhabitants and live on paid wages or a salary. The number of women among them is also growing.

Finnish forest owners have easy access to expert advice related to the management of their forests. There are about 200 forest management associations which provide the forest owners with advisory services relating to forest management and felling as well as other types of related services. The associations' task, stipulated by 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, carrying out 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 i.e. cut-to-length-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 constitute 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 includes forest management and improvement work. About EUR 200 million are invested every year in forest regeneration, young stand management, fertilising, improvement ditching and constructing forest roads. About three-quarters of this is financed by the forest owners themselves and the rest is covered by State subsidies.

2.12.3. The forest industry

For decades, the forest industry has been the backbone of Finland's national economy. The solid foundation of the Finnish industry is the industrial manufacture of forest-based products, which has its roots in the 19th century. The export income of the wood processing industry and the employment which it offers have maintained a fairly constant economic growth.

The industries' annual consumption of domestic roundwood amounts to more than 50 million cubic metres; of this 30 million cubic metres are used in chemical and 20 million cubic metres in mechanical processes. Furthermore, a considerable amount of wood is imported, mainly from Russia. Today, the rapidly internationalised Finnish forest industries have also taken operations outside their home country. The major Finnish forest industry companies, UPM-Kymmene, Stora Enso and Metsäliitto Group, are among the leaders in their field.

The wood-processing industry makes efficient use of the raw material. Timber logs are either sawn or veneered to make plywood. Pulp wood is processed into pulp and paper. The topmost part of the tree trunk is chipped for energy production or left to decay in the forest where the nutrients are released back into the ground to fertilise the remaining trees. Sawmills and plywood factories turn about half of the raw material into final products; sawmill waste, i.e. chips, is sold to pulp and paper mills, whereas bark and sawdust are used for energy recovery.

In 1999 the export value of forest industry products was EUR 11.5 billion. About 80% of this sum was brought in by pulp, paper and paper products, and 20% by timber and wood products. Production has become more diversified, and the degree of processing is higher. The export of printing and writing paper has grown rapidly since the mid-1970s, while the export of newsprint has remained more or less at the same level.

Finns have recycled paper waste since the 1920s. Today more than 60% of paper domestically consumed is recovered and recycled. As only one tenth of the production of the chemical wood processing industry is consumed domestically and most is exported to Europe, Finnish forest industry companies have founded plants using recycled fibre pulp in various European countries.

2.13. WASTE

The annual waste generation in Finland from various activities amounts to about 110 million tonnes (Table 2-3). Waste statistics cover all materials starting with primary production, except logging residues left in the forest. Wastes may be liquid, sludge or solid form.

Municipal waste and sludge account for about 5% of total waste produced. Production processes generate the bulk of the waste, with the greatest amounts originating from industrial activities and agriculture. About half of all waste originate from mining activities, industry and energy and water supply. Construction wastes, including earth and water construction wastes, also represent considerably greater amounts than municipal wastes.

Table 2-3.

Waste amounts and recovery in Finland in 1997

Type of waste	Total waste (Tg/a)	Percentage recovered
Mining waste (dry weight)	29.6	
Agricultural waste	25.5	76
Industrial waste	15.9	64
Construction waste		
construction and demolition waste	1.69	20
surplus soil	33.5	54
Waste from energy and water supply	1.35	65
Municipal waste	2.2	36
Sewage sludge	0.136	61
Hazardous waste	0.485	
TOTAL	**110.4**	
excluding mining waste	80.8	

Recovery rates vary according to the type of waste. Agricultural waste has the highest recovery level, while the lowest recovery levels are those for solid municipal waste, construction waste, waste from energy and water supply, and hazardeous waste, i.e. some 20–30% each.

Wastes may be recovered in two ways: as raw material and as energy. The wastes from agriculture and mining as well as municipal sewage sludge are almost exclusively utilized as raw material; this includes use for soil improvement and as filling material. However, just over half of the recovered wastes from industry are recovered as raw material, the rest as energy. The use of industrial wastes for energy generation has considerable economic importance, not only for industry but for the country as a whole. Most of the utilized construction waste and municipal waste are used as raw material. Only in the town of Turku are municipal wastes used for energy generation to any great extent.

Wastes that are not recovered are mainly disposed of in landfills, or, in the case of waste from major industries and from mining, the waste is delivered to special waste basins. It is generally the waste holder who is in charge of organizing waste management; the local authorities are responsible for the management of household waste. In the 1990s, local authorities have increasingly cooperated in waste management. There are now more than 20 regional cooperation organizations, and new companies are being set up. At the same time, the number of active landfills has dramatically decreased: from almost one thousand in 1990 to about 300 in 1999.

The National Waste Plan, which came into effect in August 1998, addresses, e.g. the following problems:

– *increased amounts of waste generated*
– *low recovery levels for some types of waste*
– *inadequate disposal of wastes*
– *to some extent, inadequate waste management infrastructures*
– *insufficient use of guidance instruments*
– *incomplete follow-up and mastery of waste issues.*

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3 GREENHOUSE GAS INVENTORY INFORMATION

3.1. SUMMARY OF EMISSIONS

The total anthropogenic greenhouse gas emissions without land-use change and forestry in Finland were 76.2 Tg of CO_2 equivalent in 1999 (Pipatti 2001). This was 0.8% under the greenhouse gas emissions for the year 1998 and 1.1% under the 1990 baseline level. The land-use change and forestry sector (LUCF) has constituted a net sink during the whole of the 1990s. In 1999 the size of this net sink was estimated to be 10.8 Tg. Figures 3-1 through 3-4 illustrate the overall trends in total Finnish emissions by sector and gas, as well as the absolute changes in the emissions since 1990. The same and some additional information in numerical form can be found in the summary CRF tables in Annex 1 of this report.

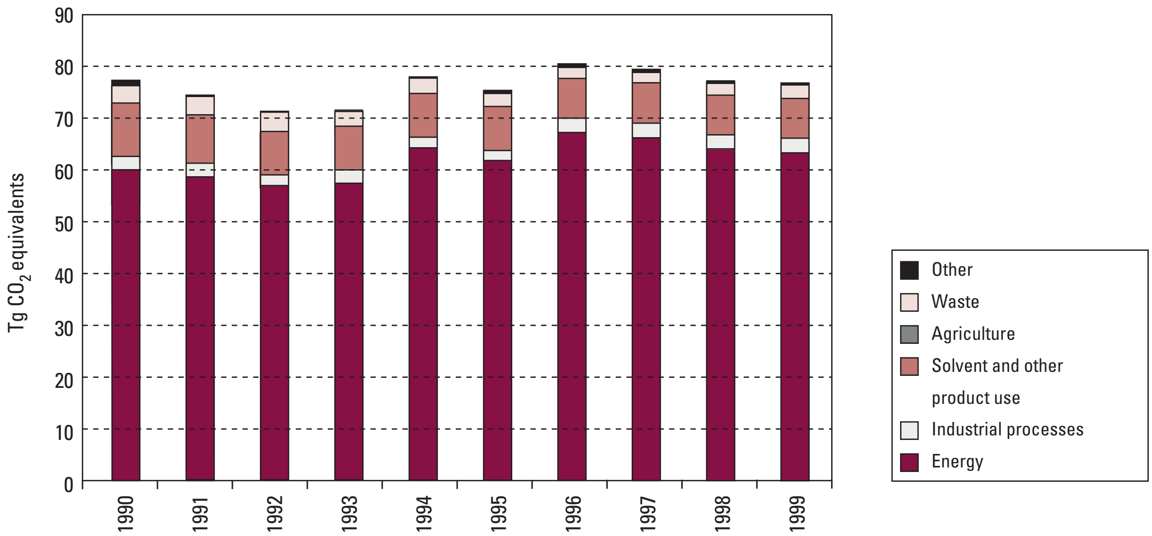

Figure 3-1
Finnish greenhouse gas emissions (excluding land-use change and forestry) by sector in 1990–1999.

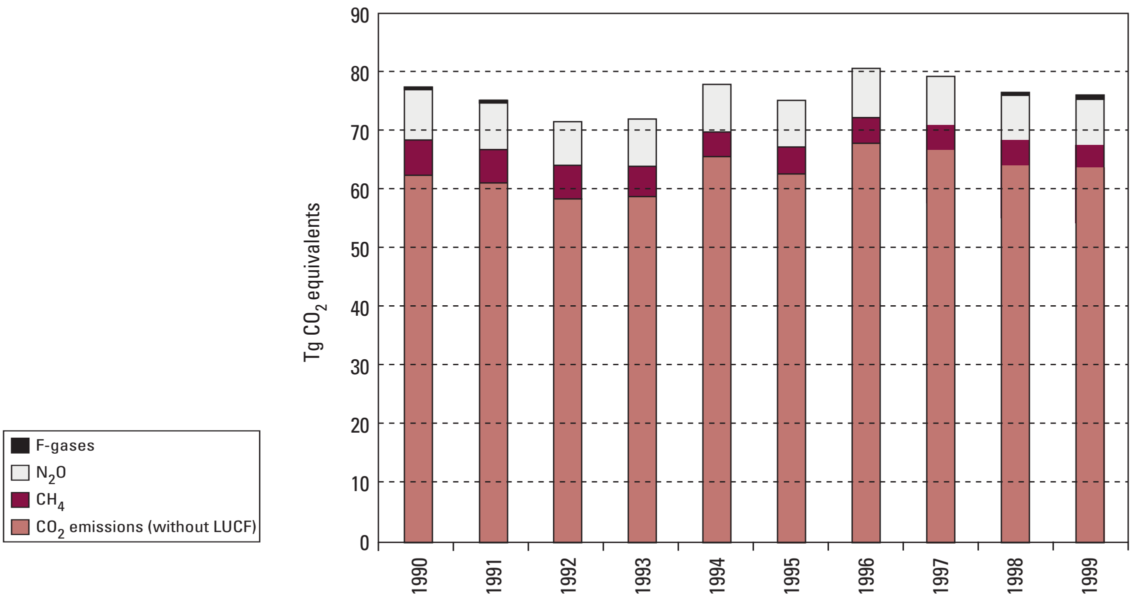

Figure 3-2
Finnish greenhouse gas emissions (excluding land-use change and forestry) by gas 1990–1999.

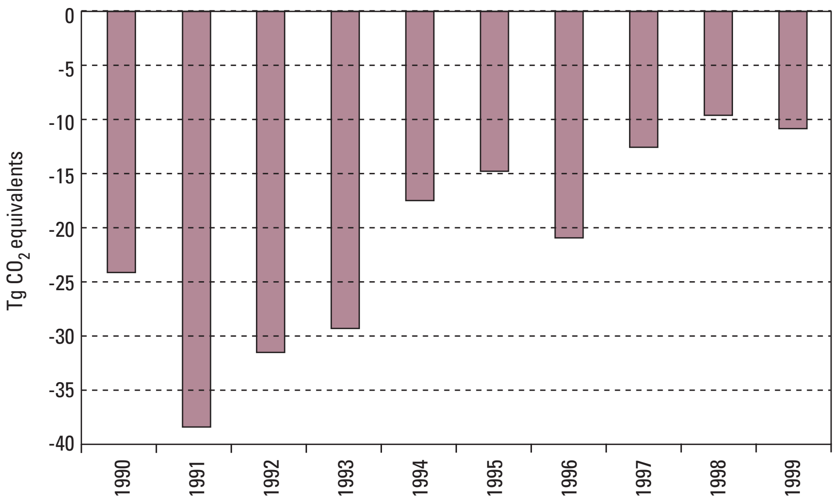

Figure 3-3
Greenhouse gas removals by sinks in Finland 1990–1999.

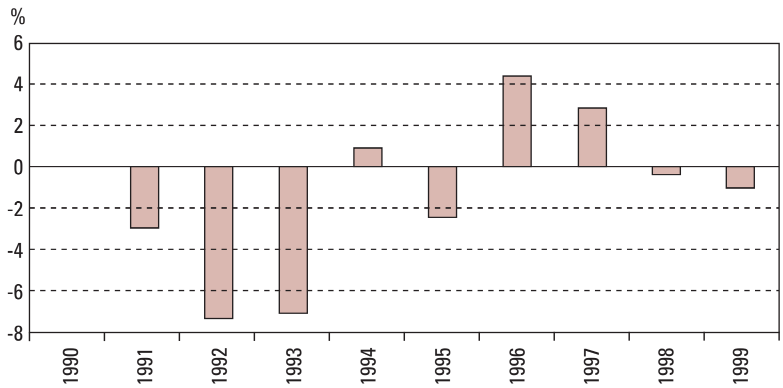

Figure 3-4
Per cent variation in Finnish greenhouse gas emissions (excluding land-use change and forestry) since 1990.

The annual change in Finland's greenhouse gas emissions per capita has varied somewhat during the 1990s (Fig. 3-5). Emissions per capita were lowest during 1991 to 1993 when Finland's economy was struggling with a severe recession that started around the turn of the decade. Current per capita emissions are slightly lower than in 1990. The level of the emissions is approximately the same, but the population has grown. Emissions per gross domestic product (GDP) have decreased approximately 16% since 1990.

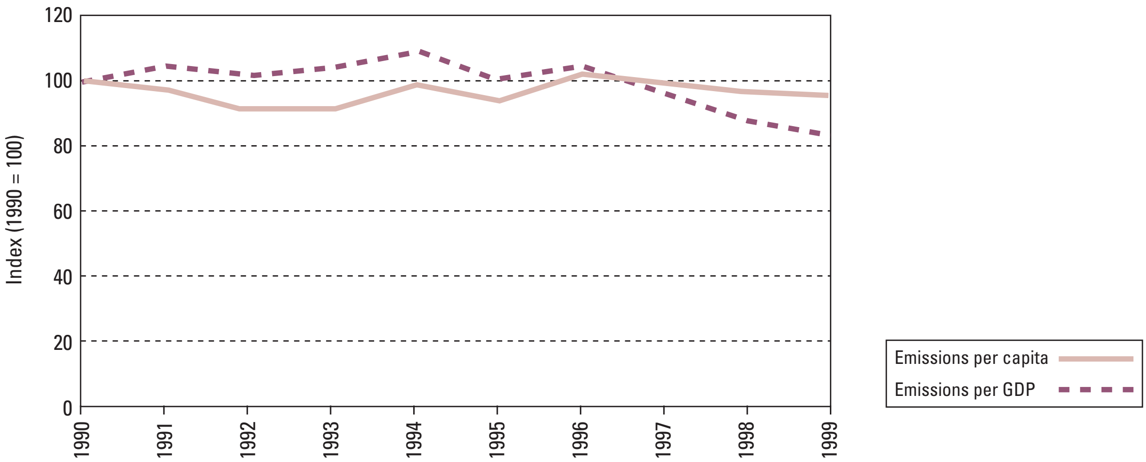

Figure 3-5
Finland's greenhouse gas emissions (excluding land-use change and forestry) per capita and per gross domestic product.

3.2. METHODOLOGY AND UNCERTAINTIES

Finland's greenhouse gas inventory is compiled in accordance with UNFCCC Reporting Guidelines on annual inventories, to the extent possible. Emissions and removals by sinks of greenhouse gases from various sources have been estimated using methodologies that are consistent with the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.

Finland has started incorporationg the IPCC report on Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (Penman et al. 2000) into the compilation of its annual inventories. All aspects of the report have, however, not yet been implemented. The approach to estimate the uncertainties of the Finnish inventory is at present based entirely on expert judgement. The total uncertainty of the inventory for the year 1999 has in this preliminary assessment been estimated to be around ±7%. In the future more resources will be allocated to the development of better quantitative uncertainty estimates.

As to the key emission sources in Finland, altogether 26 such sources were identified with the Tier 2 method, either based on the level or trend analysis. The majority of the identified key sources are energy related (17 key sources); in addition, five agricultural, two industrial, one waste and one other key source were identified in the analysis.

Each year Finland attempts to improve the inventory estimates through the use of better methods and data, taking into account the development in the IPCC methodologies and UNFCCC reporting requirements. The required changes and improvements mean that recalculations and revised estimates on historical inventory data are needed in order to maintain the consistency in the time series.

3.3. EMISSIONS BY SECTORS

3.3.1. Energy

Energy-related activities are the primary source of anthropogenic greenhouse gas emissions in Finland. In 1999 the emissions from the energy sector (including transport) were 63.3 Tg CO_2-eq., which accounted for about 83% of the total national emissions.

The largest emission source in the energy sector, CO_2 from fossil fuel combustion (56.8 Tg in 1999) accounted for 75% of the total national emissions. Fugitive CO_2 emissions from fuels, mainly associated with peat production, are also significant in Finland. The estimated emissions for 1999 are 3.5 million tonnes CO_2-eq. or about 4.5% of total greenhouse gas emissions. The estimated N_2O emissions from the energy sector account for 3.2% of the total emissions in 1999. These emissions come mainly from fluidized bed combustion and transportation. Energy-related CH_4 emissions are mainly due to incomplete combustion and accounted for only 0.7% of the total national emissions in 1999.

Energy industries caused most of the emissions in the energy sector, 34% in 1999. Manufacturing industries and construction produce much energy themselves, and their share of the emissions was also significant, 27%. Transportation accounted for about one-fifth of the energy-related emissions in 1999. Nearly three quarters of the CO_2 emissions in the transport sector originate from road transport, mainly private passenger cars. The growth of emissions, however is fastest in domestic air traffic.

Liquid fuels accounted for about 47%, solid fuels (coal and peat) almost 39% and gaseous fuels about 14% of the energy-related CO_2 emissions in 1999.

Energy consumption has grown steadily in Finland since the energy crisis in the mid-1970s. This growth has continued in the 1990s with the exception of the first few years of the decade when Finland experienced a severe recession. The growth in energy consumption has only partly been reflected in the CO_2 emissions from fuel combustion because the use of renewable energy has increased. A shift from coal and peat to natural gas, upgrading of the existing nuclear power plants, improved energy efficiency and the good availability of hydropower in the Nordic electricity markets have also contributed to this development. The CO_2 emissions from fossil fuel combustion in 1999 were about 5% higher than in 1990 (Fig. 3-6).

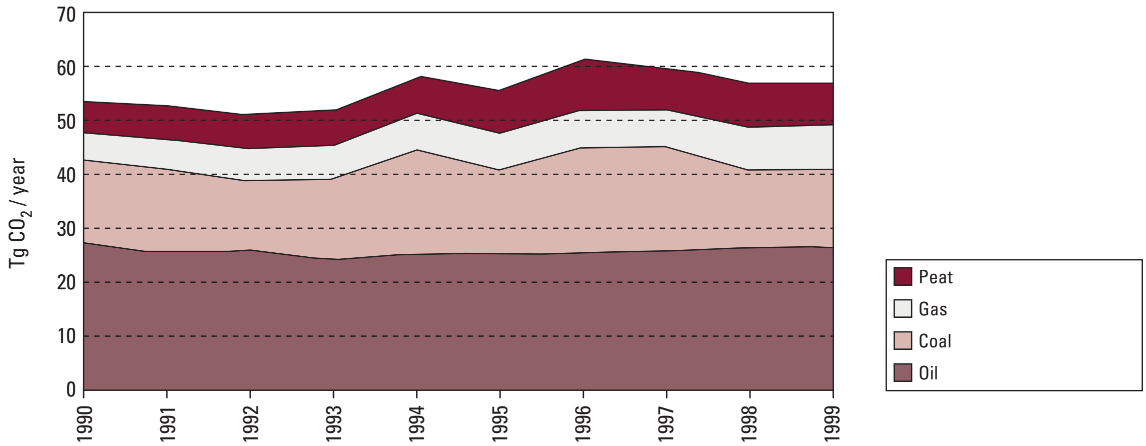

Figure 3-6
CO_2 emissions by fuel combustion in 1990–1999.

3.3.2. Industrial processes

Industrial greenhouse gas emissions contribute less than 4% to the total anthropogenic greenhouse gas emissions in Finland (Fig. 3-7). The most important industrial greenhouse gas emissions are the N_2O emissions from nitric acid production, and CO_2 emissions from cement and lime production. HFCs, PFCs and. SF_6 are together only about 0.5% of the total greenhouse gas emissions in Finland. Coke and ethylene production release small amounts of CH_4.

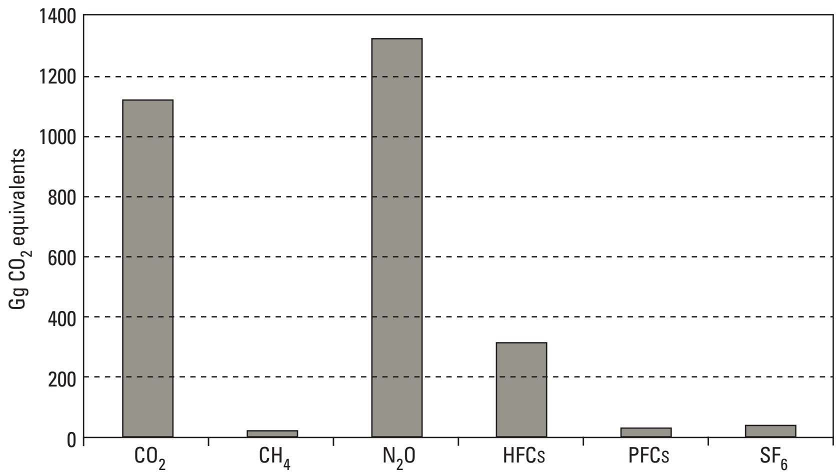

Figure 3-7
Greenhouse gas emissions from industrial processes in 1999.

PEAT IN FINLAND'S GREENHOUSE GAS INVENTORY

Greenhouse gas emissions from peat occur in Finland's inventories in three different classes:

- energy sector: CO_2, CH_4 and N_2O emissions
- energy sector: fugitive emissions
- agriculture sector: CO_2 and N_2O emissions

In the 1999 inventories, the emissions from these three sources amounted to 7.5, 3.5 and 2.5 Tg CO_2 eq, respectively. Thus, the total amount of peat-based emissions was 13.5 Tg CO_2 eq. almost one-fifth of all greenhouse gas emissions in Finland. – Emissions from peatlands in their in their natural state are not reported.

Peat produced a total of 19.5 TWh of energy in Finland in 1999. Of this total amount, 45% was for electricity generation, and the rest for heat production. The largest peat-fired plants are located near the cities of Tampere, Oulu, Jyväskylä and Joensuu. Only one power-plant in Central Ostrobothnia is far from a major urban area.

The peat production area in Finland is around 50 000 – 60 000 hectares. It has been estimated (Nykänen et al. 1996) that annual greenhouse gas fluxes from these areas are about five per cent of emissions caused by peat combustion. These fluxes are mainly CO_2 emissions, including the loss of natural carbon accumulation and emissions from stockpiles and ditches. Most of the present peat production occurs in forestry-drained peatlands, and some more recent studies indicate that the loss of carbon accumulation can be even higher than the value cited above. Thus, an estimate of 1.0 Tg CO_2 annually has been presented for the total greenhouse gas emissions from peat production areas.

Additionally, the CO_2 emissions from arable peatlands that are classified as reservoirs for future peat production (and that are no longer used for agricultural purposes) are estimated. According to Laine et al. (1998) some 100 000–150 000 hectares of arable peatland will be available in future for peat production purposes. The upper range of this estimate has been used as the basis for the emission estimate in the Finnish inventory. By using the emission factor of 450 g C /m^2 year, the annual emissions amount to 2.5 Tg CO_2. Together with the emissions from active peat production areas, the total losses reach 3.5 Tg CO_2.

This estimate for the fugitive CO_2 emissions related to peat production is still very uncertain. Especially the emissions from the arable peatland reservoirs are very rough: the emission factors are poorly known and future research is needed. Furthermore the emission factor of the fuel use of peat should be further investigated.

The cultivation of organic soils is the most important source of agricultural CO_2 emissions. In 1999, the emissions from this source were estimated to be 1.3 Tg CO_2 eq. There has been a slightly declining trend in these emissions in the 1990s.

The cultivation of soils with high organic content also leads to considerable N_2O emissions. By applying an emission factor of 8 kg N_2O-N/ha per year (IPCC Good Practice report; Klemedtsson et al. 1999) to an area of 303 000 ha, an estimate of 1.2 Tg CO_2 eq. annually is obtained, bringing the total emissions from the agriculture sector to 2.5 Tg CO_2 eq.

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Laine, J., Selin, P. & Nyrönen, T. 1998. *The role of peat and peat utilization in carbon balance.* Peat Memorandum, University of Helsinki, 11 p.

Nykänen, H., Silvola, J., Alm, J. & Martikainen, P. 1996. *Fluxes of greenhouse gases on some peatmining areas in Finland.* Proc. of the Int. Workshop, Hyytiälä, Finland, Oct. 812, 1995, pp.14 – 14.

Total industrial greenhouse gas emissions have fluctuated somewhat during the 1990s, but the 1999 emissions are almost the same as the emissions in the base year 1990. The most significant change is the increase in the emissions of F-gases, which are now more than five-fold compared to 1990 emissions. The N_2O emissions from nitric acid have decreased by almost 20%, which almost equals in amount the increase of the F-gases. The CH_4 emissions have increased more than 30%, but their contribution to total industrial emissions is very small. Industrial CO_2 emissions decreased considerably at the beginning of the 1990s, but have now almost reached the level of the 1990 emissions.

In 1999 the CO_2 emissions from cement production were some 25% lower than in 1990, whereas the CO_2 emissions from lime production were higher. In total the industrial CO_2 emissions are some 5% below the 1990 level. The CH_4 emissions from coke and ethylene production have increased much during the 1990s. Coke production has almost doubled during this time, and the increase in ethylene production has also been significant. Because of the small absolute amounts, the contribution to the total emissions has, however, been small.

Emissions from the fuel used as a raw material in the industrial processes (about 10 Tg CO_2) are calculated into the emissions from energy production.

Nitric acid production and, consequently, also the N_2O emissions have decreased by almost 20% during the 1990s. Nitric acid is used for nitrogen fertiliser production and the decrease in production can partly be attributed to declining nitrogen fertiliser use in Finland.

HFCs, PFCs and SF_6 are not produced in Finland; all consumption is based on imports. Identified emission sources are refrigeration and air conditioning systems, aerosols, foam blowing, electrical equipment, fixed fire fighting systems and electronics manufacturing. Two major global sources of these gases are also absent in Finland: HFC-23 emissions from HCFC-22 manufacturing and PFC emissions from primary aluminium production (Oinonen 2000).

The emissions of HFCs, PFCs and SF_6 are about 0.5% of the total greenhouse gas emissions in Finland. The most important of these emissions (in CO_2 equivalent) is HFC emissions (about 84%), the contributions of PFCs (8%) and SF_6 (9%) in 1999 were almost equal. The relative growth in the HFC emissions is large; the 1999 emissions are about thousand times higher than the 1990 emissions. PFC emissions have increased by a factor of about 50, while SF_6 emissions have, on the contrary, decreased by a factor of two.

3.3.3. Solvent 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 the medical use, N_2O is used also for other purposes, but no specific data are available on this.

All delivery is currently based on import of the gas to Finland. These N_2O emissions have been fairly constant during the whole of the 1990s, around 0.2 Gg per year (less than 0.1% of the total national emissions). The Finnish NMVOC emission inventory for the years 1988–1999 was revised due to a request by the UNECE secretariat. The revised inventory from the 15th of August 2001 will be used in the future UNFCCC reporting.

3.3.4. Agriculture

In 1999 Finnish agricultural greenhouse gas emission were 7.6 Tg CO_2 equivalents, which is around 10% of the total Finnish anthropogenic greenhouse gas emissions (Fig. 3-8). The most important of the agricultural emissions is the nitrous oxide emissions from agricultural soils; smaller amounts of N_2O are emitted from manure management.

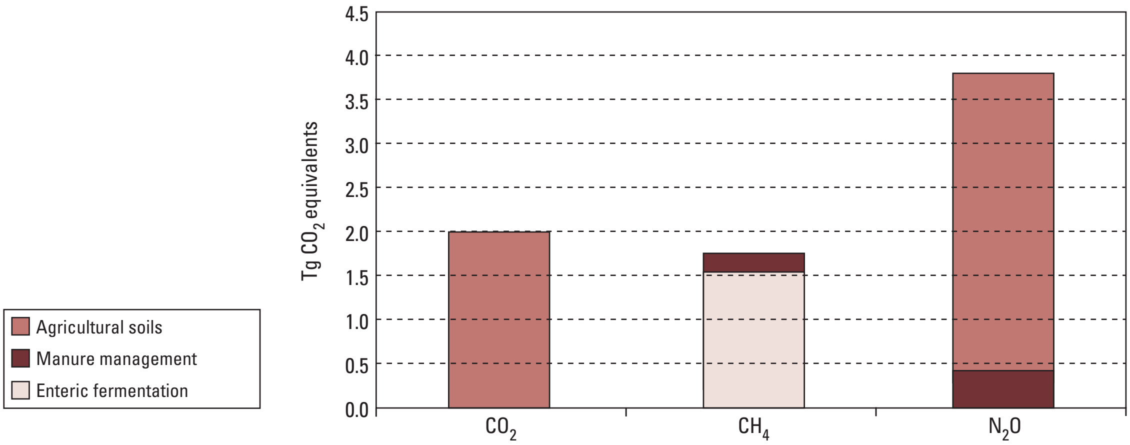


Figure 3-8
Agricultural greenhouse gas emissions in Finland in 1999 by main source category and gas.

The carbon dioxide emissions from cultivation and liming of agricultural soils are also important. These emissions are estimated for three subcategories: cultivation of mineral soils, cultivation of organic soils and liming (all soil types). Cultivation of organic soils causes most of the reported agricultural CO_2 emissions, about 65% in 1999.

Enteric fermentation and manure management are the main sources of agricultural methane emissions in Finland. Agricultural soils can also act as sources or sinks of methane. Quantitative information on methane emissions or removals from agricultural soils is scarce, and estimates of these have therefore not been included in this inventory.

The trend in the agricultural emissions has been declining in 1990–1999 (Table 3-1). Finland's agriculture sector has gone through many changes in the 1990s. Finland's membership in the European Union since 1995 has changed the economy of agriculture. The farm size in Finland has grown as many smaller farms have stopped production. This has enabled improved production efficiencies, and led to decreases in the number of livestock. At the same time, more weight has been put on environmental issues in developing the agricultural practices. This can be seen, e.g. in declining nitrogen (and phosphorus) fertilisation figures. The interaction between various environmental agricultural greenhouse gas emissions is complex. Measures that reduce one type of emissions can lead to an increase in another type (Kulmala and Esala 2000; Pipatti et al. 2000). The measures that have been undertaken in Finland have decreased the total agricultural greenhouse gas emissions, although some specific emissions (methane from manure management) have also increased.

Table 3-1

Agricultural greenhouse gas emissions (in Tg CO_2 equivalents) in Finland in 1990–1999

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2										
Agricultural soils	3.2	2.8	2.3	2.2	2.0	1.7	1.8	2.1	2.0	2.0
CH_4										
Enteric fermentation	1.8	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.6	1.6
Manure management	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
N_2O										
Manure management	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4
Agricultural soils	4.4	4.1	3.7	3.7	3.7	3.8	3.7	3.6	3.5	3.4
Total	**10.2**	**9.3**	**8.4**	**8.4**	**8.2**	**7.8**	**7.8**	**8.0**	**7.8**	**7.6**

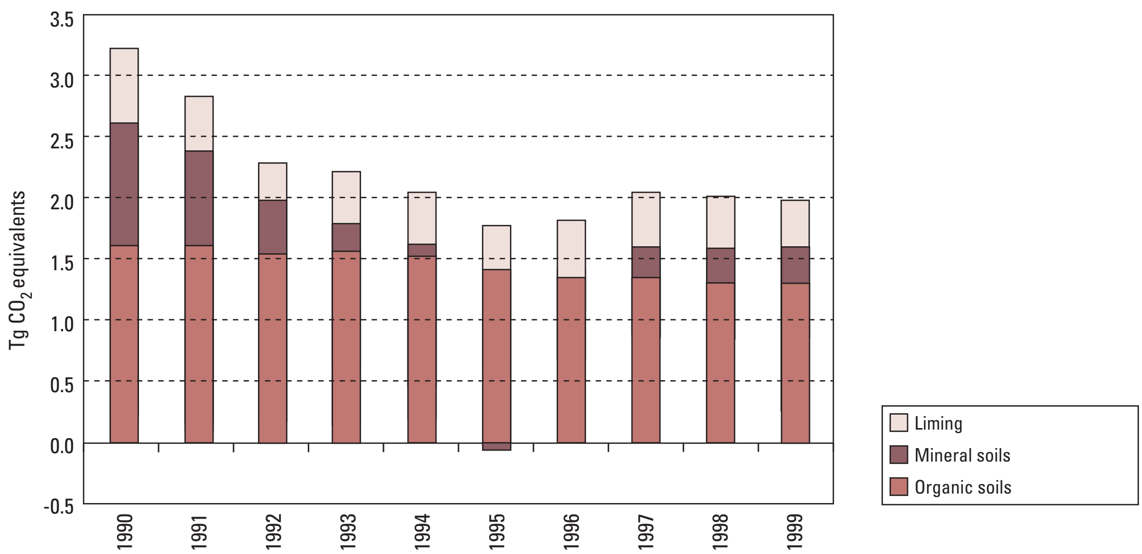
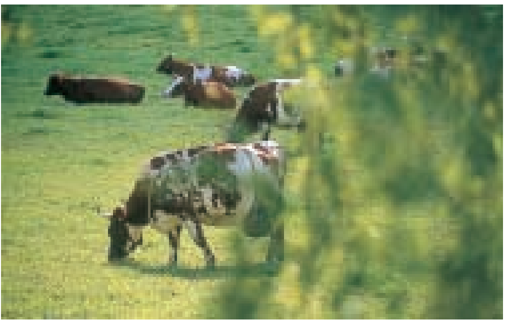


Figure 3-9

CO_2 emissions from agricultural soils in 1990–1999.

Agricultural CO_2 emissions have been estimated for 1) net changes in carbon stocks in mineral soils due to changes in land use and management, 2) cultivation of organic soils and 3) liming. The most important of the agricultural CO_2 emissions comes from cultivation of organic soils. The total estimated emissions have decreased in the 1990s by about one-third (Fig. 3-9).



The uncertainties in the emissions from mineral and organic soils are considerable. The uncertainties in emission factors contribute most to the total uncertainty. The uncertainties in the land areas have been greatly decreased by the estimates done by MTT Agrifood Research Finland.

Agricultural CO_2 emissions have been identified as a key source in Finland. The importance of these emissions was recognised even before, and the improvements done in the current inventory are considerable. Further improvements are, however, still needed. Especially the emission factors used in the calculation of the emissions from mineral and organic soils need more research.

Methane emissions from enteric fermentation in livestock are also identified as a key source category in the Finnish inventory. However, only one animal category (cattle) contributes more than 90% to the emissions.

The Finnish CH_4 emissions from manure management are rather small due to the cold climate and the large share of solid manure management. The emissions have, however, grown somewhat in Finland during the 1990s due to increased utilisation of liquid manure treatment methods. This has outweighed the effect of declining animal numbers on the emissions.

All main agricultural N_2O emission sources, the direct and indirect N_2O emissions from agricultural soils and the N_2O emissions from manure management, have been defined as key sources in the Finnish inventory. This in mainly based on the large uncertainties in the emission factors. Concerning direct N_2O emissions from agricultural soils, five sources have been considered. In addition, agricultural NH_3 emissions and nitrogen leaching to waterways have been considered in the estimation of the indirect N_2O emissions.

3.3.5. Land use change and forestry

Tree growth has been rather steady in Finland during the 1990s and the increment in the stem volume has varied between 73.4 and 78.0 million m^3. The annual changes in tree harvesting and cutting have been larger and the drain has varied from 44.6 to 69.4 million m^3. Hence also the annual net removals of CO_2 from the atmosphere have varied much during this period (9.7 – 38.2 Tg CO_2/year; Table 3-2).

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

Table 3-2.

Stem volume increment and drain, as well as CO_2 uptake and release by trees in Finland in 1990–1999

Year	Volumes (million m³)			Tg CO_2		
	Incre-ment	Drain	Balance	Uptake	Release	Balance
1990	73.4	55.1	18.3	95.9	72.1	23.8
1991	74.3	44.6	29.7	96.8	58.6	38.2
1992	75.8	51.0	24.8	98.6	66.7	31.9
1993	76.6	53.8	22.8	99.5	70.4	29.1
1994	75.4	61.6	13.8	97.8	80.6	17.3
1995	75.4	63.6	11.8	97.8	83.1	14.7
1996	75.5	59.0	16.5	98.0	77.0	21.0
1997	75.9	65.8	10.1	98.6	85.9	12.6
1998	77.2	69.4	7.8	100.1	90.4	9.7
1999	78.0	69.4	8.6	101.3	90.4	10.8

The volume increment of the growing stock of trees is estimated using field measurements on the sample plots of the FNFI. The measurements concern the increment of the tree stem volume. An average increment of five years preceeding the measurement time is applied. The measurements of the FNFI progress by regions and thus the data for the whole country comes from different parts of the country for different years (Tomppo 2000).

CARBON IN WOOD PRODUCTS

Increased use of wood-based products is one potential, although limited, option for increasing carbon sequestration and mitigation of greenhouse gas emissions. An additional benefit is achieved when wood products replace other, more fossil fuel and energy-intensive products, or when the energy of wood residues in the production chain is recovered and used to replace fossil fuels.

The carbon reservoir of wood products in Finnish construction and civil engineering was estimated by three inventories including the years 1980, 1990 and 1995. The inventory method was mainly based on the statistics of the Finnish building stock. The carbon reservoir was calculated on the basis of the dry matter content of wooden construction materials (Pingoud et al. 2001).

According to the inventories, the carbon pool of the Finnish building stock was 8.7 Tg C in 1980, 10.7 Tg C in 1990 and 11.5 Tg C in 1995. When also the construction not subject to permission, and civil engineering works were taken into account, the estimated C stock of wood products in Finland was 16.5 Tg C, equivalent to 61 Tg CO_2, in 1995. This is about 3.3 Mg C per capita and 2.4% of the carbon reservoir in the Finnish forest biomass.

If exported wood products are also included, the total carbon reservoir of wood products (excluding wood waste and paper products) coming from Finnish forests might be as much as 7% of the standing biomass. The average lifetime of sawn wood in Finnish construction is less than 40 years.

Pingoud, K., Perälä, A-L. & Pussinen, A. 2001. Carbon dynamics in wood products. Submitted for publication in Mitigation and Adaptation Strategies for Global Change, March 2001, 12 p.

3.3.6. Waste

Solid waste disposal on land (landfills and dumps) causes relatively large CH_4 emissions in Finland: about 2% of total emissions in 1999. The emissions from wastewater treatment are much smaller (Fig. 3-10).

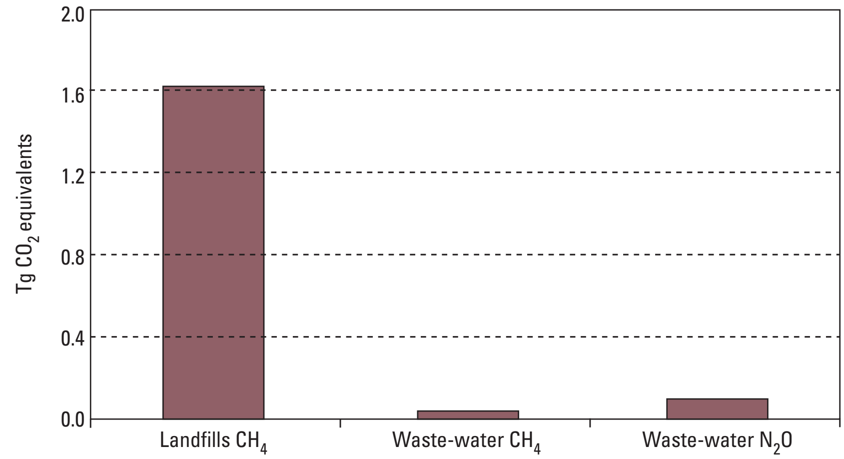


Figure 3-10
Greenhouse gas emissions from the waste sector in Finland in 1999 and their share of the total emissions.

CH_4 emissions from landfills are the most important greenhouse gas emissions in the waste sector. During the 1990s, these emissions have decreased by more that 50%. The decrease has been mainly due to the implementation of the new waste law in Finland in 1994. At the beginning of the 1990s, around 80% of the generated municipal waste was taken to solid waste disposal sites (landfills). After the implementation of the new waste law, minimisation of waste generation, recycling and reuse of waste material and alternative treatment methods to landfills have been endorsed. Similar developments have occurred in the treatment of industrial waste, and municipal and industrial sludges (Dahlbo et al. 2000).

Landfill gas recovery was practised on a minor scale at the beginning of the 1990s, but is now increasing rapidly. In 1990 the impact of recovery was estimated to be null, in 1995 about 3 Gg CH_4 and in 1999 already almost 9 Gg CH_4 (Leinonen and Kuittinen 2000).

The uncertainties in the CH_4 emissions from solid waste disposal are estimated to be considerable. These can, however, be mainly attributed to the nature of the source. The uncertainties in activity data are estimated to be 30%, uncertainties in emission factors are estimated to be somewhat larger, around 40%. The accuracy of the activity data has improved much during the last years, as many of the landfills have been equipped with scales to weigh the amounts landfilled.

CH_4 emissions from solid waste disposal on land have been identified as a key source in Finland. The emissions have been estimated with the IPCC default method, whereas the IPCC good practice report recommends use of the first order decay model. The change of model is under consideration.

The amount of greenhouse gas emissions (CH_4 and N_2O) from wastewater treatment is small in Finland, annual emissions being around 0.1 Tg CO_2 equivalents. Emissions of both gases have declined during the 1990s, CH_4 emissions by about 6% and N_2O emissions by 25%. The large decline in the latter is attributed mainly to more effective nitrogen removal during wastewater treatment.

3.3.7. International bunkers

Emissions from international bunkers amounted to about 4% of total anthropogenic greenhouse gas emissions in Finland in 1999. About two-thirds of the emission come from marine bunkers and one-third from aviation. The total emissions from international bunkers have fluctuated somewhat during the 1990s, but no fast growing trend has been noticed (Fig. 3-11).

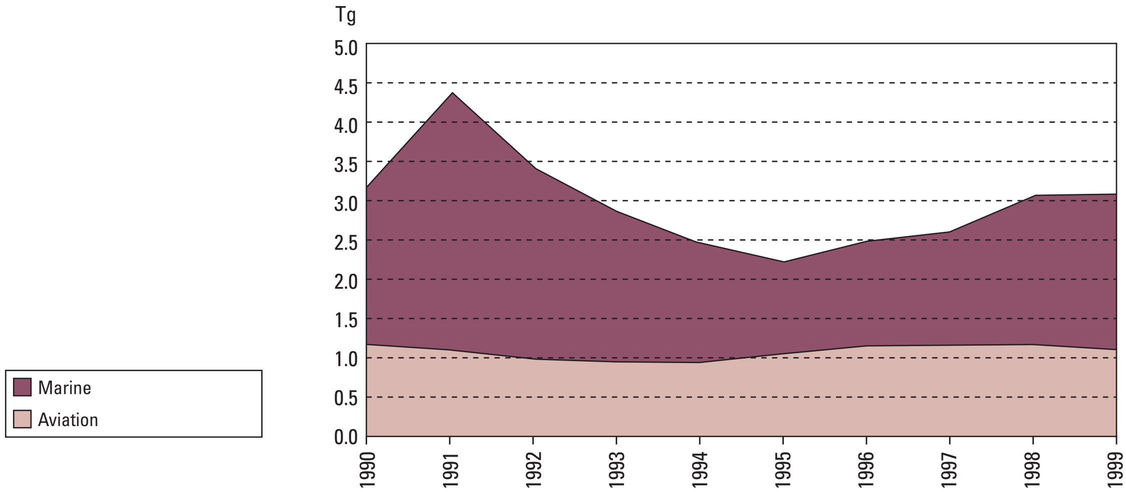


Figure 3-11
Trend in greenhouse gas emissions from international bunkers in 1990–1999.

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4 POLICIES AND MEASURES

4.1. POLICY-MAKING PROCESS

4.1.1. Global level

UNFCCC AND THE UNITED NATIONS

Climate change mitigation is one of the top environmental policy priorities in Finland. Finland ratified the UN Framework Convention on Climate Change (UNFCCC) on May 3, 1994. According to the burden sharing of the Kyoto target within the EU, Finland is committed to maintain the 1990 emissions level by 2008–2012. Finland signed the Kyoto Protocol on May 29, 1998. The ratification will take place in line with the other EU Member States.

Finland has signed numerous international environmental declarations and agreements within the United Nations. Among the most important regarding climate change mitigation are the Rio Declaration on Environment and Development, the action plan Agenda 21, and the Statement of Principles for the Sustainable Management of Forests that were adopted at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, June 1992.

The Rio conference also led to the conclusion of the UNFCCC and two other conventions that interact with climate change mitigation: the Convention on Biological Diversity: Finland has accepted the Convention on 27.7.1994 and signed its Protocol on Biosafety on 24.5.2000 and the Convention to Combat Desertification: Finland has accepted the Convention on 20.9.1995.

Finland was also among the first countries to sign and ratify the Convention for the Protection of the Ozone Layer, which was signed in Vienna in 1985, and the Montreal Protocol in 1987. Finland has been active in international co-operation within the UNECE Convention on Long-range Transboundary Air Pollution since 1979.

PARTICIPATION IN OTHER INTERNATIONAL ACTIVITIES AND ORGANISATIONS

Finland has been a member of the Organisation for Economic Co-operation and Development (OECD) since 1969. The OECD groups 30 member countries in an organisation that provides governments a setting in which to discuss and develop economic and social policy.

The OECD has a horizontal programme on sustainable development, in which climate change policy assessment is an integral part.

Finland participates in the work of the International Energy Agency (IEA), founded in 1974. The IEA's objectives include improvement of the world energy supply and demand structure, more efficient use of energy, development of alternative energy sources to reduce dependence on any one source, assistance in the integration of environmental and energy policies, and the promotion of co-operative relations between oil-producing and oil consuming countries. The IEA also maintains an emergency system to help member governments alleviate the effects of oil supply disruptions by various measures, including sharing available supplies.

Finland is a member of the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO). Both are sub-organisations of the United Nations. Finland participates actively in these organisations with the aim at preparing 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. Finland finances climate change mitigation through the Global Environment Facility (GEF). The Global Environment Facility was established to forge international co-operation and finance actions to address four critical threats to the global environment: biodiversity loss, climate change, degradation of international waters, and ozone depletion. For more information, see Chapter 7.

Finland has also contributed to the Prototype Carbon Fund (PCF) of the World Bank (see Chapter 4.6) The government of Finland has launched a pilot programme in order to prepare for the joint implementation (JI) as well as the clean development mechanism (CDM) of the Kyoto Protocol.

Finland is a member of the World Meteorological Organization (WMO). Finland participates actively in this organisation e.g. by supporting the Global Climate Observing System in ensuring that observations needed in global climate monitoring and modelling are available.

Finland's relations with developing countries are aiming at coherent goals in foreign and security policy, trade policy and development co-operation. Development co-operation's role as a significant part of foreign policy is underlined. Within the development policy objectives, reduction of poverty, prevention and mitigation of environmental problems, and promotion of equality, democracy and human rights constitute the basic elements in the promotion of global peace and security. For more information, see Chapter 7.

There is also an intensive co-operation with the other European countries e.g. under the auspices of the Ministerial Conferences on the Protection of Forests in Europe special emphasis has been focused on Nordic countries and the countries in the Baltic Sea region in the field of environmental protection and climate change mitigation. The Baltic Sea region offers some very specific advantages to regional co-operation in climate change mitigation including opportunities for energy trade and emissions reductions. The Ministers of these countries have recommended that further work should be done with a view to make a decision on a Baltic Sea region testing ground for international co-operation in the use of flexible mechanisms.

The Baltic Sea region is the first region in the world to adopt common goals for sustainable development. In 1996, the Prime Ministers of the region took the initiative to develop an Agenda 21 for the region. This was the start of the Baltic 21 process, and sustainable development in the Baltic Sea region. In 1998, the Foreign Ministers adopted the Agenda 21 for the region, which includes agreed overall goals and sectoral goals and an action programme for sustainable development.

Finland has supported environmental protection in its neighbouring areas since 1991 through bilateral and multilateral co-operation projects. Two important goals are improving the state of the Baltic Sea and reducing emissions in neighbouring countries that have a harmful effect on the Finnish environment.

4.1.2. EU level

Finland joined the European Union at the beginning of 1995. Under the burden-sharing agreement of the EU, Finland will have to maintain the 1990 level in its greenhouse gas emissions by 2008-12. The EU commitment under the Kyoto Protocol is to reduce GHG emissions by 8% from the 1990 level. The EU has expressed its commitment to ratify the Kyoto Protocol by 2002.

The European Commission has taken many climate-related initiatives since 1991, when it issued the first Community strategy to limit CO_2 emissions and improve energy efficiency. These include a proposed directive to promote electricity from renewable energy sources, voluntary commitments by car makers to improve fuel economy, a White Paper on increased use of renewable energy sources, the Sixth Environment Action Programme of the European Community 2001-2010, energy efficiency measures, and increase of CHP. In addition, several Directives are climate relevant in the areas of horizontal legislation, air quality, waste management, water quality, nature protection, and industrial pollution control and risk management as well as the whole Energy Acquis (European Commission 2001). Measures related to sustainable development also affect GHG emissions.

The Commission launched the European Climate Change Programme (ECCP) in June 2000. The goal is to identify and develop all the necessary elements of an EU strategy to implement the Protocol. Taking a 'twin-track' approach, the ECCP is preparing a range of additional EU-level policies and measures to cut greenhouse gas emissions as well as a proposal for emissions trading scheme that could start operating within the EU by 2005.

The introduction of harmonised energy taxes in the European Union has been discussed since the beginning of the 1990s. In 1997, the Commission presented a draft directive. This proposal seeks to introduce EU-wide minimum levels of taxation for a broad range of fuels and other energy products, including those products that have been tax-exempted in some member countries so far (gas, electricity, coal). Parallel to this, the member countries are encouraged to reduce other taxes, in particular the charges on labour. The European Parliament has welcomed the draft directive. Up to now it has not been approved by the Council, because a unanimous decision needed has not yet been achieved.

CARDIFF PROCESS

The adoption of the Amsterdam Treaty in 1997 was an important milestone when aiming at integrating environmental aspects into other Community policies. Article 6 of the Treaty of the European Communities requests the Member States to promote sustainable development and to integrate environmental aspects into all Community policies. The Commission Communication "Partnership for Integration" was welcomed by the Cardiff European Council in June 1998 and the ideas of this Communication were developed into practical requirements for the Commission and for the Council. In this respect, all relevant formations of the Council were invited to establish their own strategies for giving effect to environmental integration and sustainable development within their respective policy areas. The Transport, Energy and Agriculture Councils were invited to start this process. At subsequent European Council meetings, more Council formations were invited to join (i.e. Development, Internal Market, Industry, General Affairs, Ecofin and Fisheries). The EU forest strategy from 1998 also addressed climate issues.

The Helsinki Summit in December 1999 reaffirmed the commitment to sustainable development and to integration. Three Council formations (Transport, Agriculture and Energy) submitted their strategies to the Summit. In all of these strategies, the aim to reduce greenhouse gas emissions is one important objective when aiming at reducing negative environmental impacts caused by these economic activities.

Since the Helsinki Council meeting the sector integration strategies in the field of transport, agriculture and energy have been further developed and the work has continued to develop other strategies in the other fields of Community policies. In addition to sector specific integration strategies, the European Council has invited the Commission to submit a proposal for a comprehensive and long-term sustainable development strategy. Such a strategy was adopted at the Gothenburg Summit in June 2001.

4.1.3. National level

INSTITUTIONAL FRAMEWORK

Finnish regulations, policies and measures are nowadays affected by the EU directives, policies and measures in several ways. The current government has committed itself in Government Programme in 1999 to meet the target of the Kyoto Protocol and of the burden-sharing within the European Community. With that in mind, the Government appointed a ministerial working group to prepare a national action plan for meeting these targets. The National Climate Strategy was accepted in 2001 (see Chapter 4.2.1).

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, an agency of the ministry, monitors and assesses the state of the environment and provides information to the public. The Ministry of the Environment is also responsible for housing, building and spatial 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 is a major player in climate change policy and it has also been responsible for co-ordination of the development of the National Climate Strategy. In addition, the Ministry for Foreign Affairs and the Ministry of Finance are important parties in climate change mitigation.

Two national organisations are especially relevant to climate change: Motiva Oy is an independent, non-profit company that gets primary funding through state budget and is directed mainly by the Ministry of Trade and Industry. Motiva's main task has been the implementation of the government's Energy Conservation Programme, and it has also got the task to promote renewable energy. TEKES, the National Technology Agency is the main financing organization for applied and industrial research and development (R&D) in Finland. The funds for financing are awarded from state budget via the Ministry of Trade and Industry.

LEGISLATION AND REGULATIONS

The Environmental Protection Act (86/2000) regulates substances indirectly relevant to climate change although basically addressing other aims. The law also incorporates the EU Directive on Integrated Pollution Prevention and Control (96/61/EY).

The Land Use and Building Act (132/1999) does not explicitly promote climate change mitigation. However, its main principles, i.e. economically efficient land use and settlement structure, economical use of natural resources and promotion of the functionality of settlements and good practices in building, contribute to the aims of climate change mitigation. Based on the Act, national targets for spatial planning were adopted in 2000 especially affecting the spatial planning and urban structure. The Act on Environmental Impact Assessment Procedure has an indirect effect on GHG emissions.

The Finnish forest and nature conservation legislation were revised during the 1990s and it is now being implemented. The reform of forest legislation was based on the broadened concept of sustainable forest management, where enhancing biodiversity is one of the key concepts. Forest legislation now focuses on promoting the economic, social, ecological and cultural aspects of sustainable management of forests, and thus to sustainable development.

Regulations especially in the energy sector have clear influence on climate change mitigation (see Chapters 4.2.2 and 4.3 for details) due to economic steering. The Waste Act is also important as it regulates the planning, establishment, construction, use, management, closure and aftercare of landfills with effect on CH_4 emissions. Several other regulations and legislation affect GHG emissions mainly indirectly.

4.1.4. Regional level

Regional and municipal environmental administrations have been created in the past two decades, and are taking increased responsibility in managing local problems. They are also involved in land use planning and environmental education as well as in campaigns to reduce greenhouse gas emissions. Other important regional bodies are the regional environment centres (supervised by the Ministry of the Environment), with a prominent role in the collection of information on environmental issues, and the regional forest centres (supervised by the Ministry of Agriculture and Forestry), with responsibility for biodiversity management, among other tasks.

Three permit authorities and 13 regional environment centres give the environmental permit decisions for large and medium-sized industrial enterprises. The municipal authorities handle permits for smaller plants. Energy efficiency and BAT are considered. Regional environment centres also prepare regional programmes, which give guidance for planning process.

Finnish law requires regional planning by regional councils. 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 a guideline for municipal-level plans and other detailed planning of land use. For instance, the Regional Council of Häme concluded in the year 2000 the first regional inventory of GHG gases and sinks.

4.1.5. Municipal level

The political decision-making system in Finland is widely decentralized. The 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.

In Finland the municipal sector works in many different ways to reduce the greenhouse gases. Some of these functions are, for example, the municipalities' own energy consumption reduction programmes and agreements, the local or regional energy agencies for energy saving and renewables partly financed by the EU as well as the local agenda processes.

The Association of Finnish Local and Regional Authorities (AFLRA) promotes and co-ordinates the climate protection campaign of municipalities, The Cities for Climate Protection Campaign (CCP Finland). The purpose of the campaign is for cities and municipalities to plan and initiate their own actions to reduce local greenhouse gas emissions (see Chapter 9.2). Approximately 20 municipalities and two regions have calculated their GHG emissions. A wide array of national and local workshops and conferences are being arranged covering such issues as energy, land use, traffic and waste management.

4.1.6. Role of industry, NGOs, and other interest groups

Industry, environmental and other interest groups play an important part in the Finnish policy-making process. NGOs are involved in different working groups, seminars and official delegations including the Climate Committee. Especially the Finnish Association for Nature Conservation, Greenpeace, Friends of the Earth, WWF Finland, Dodo and Natur och Miljö are active in this field. Agricultural producers and forest owners are particularly interested in issues related to agriculture and forestry.

Industry participates and co-operates actively in climate change mitigation. Particularly, voluntary agreements between government and industry are considered an important instrument. They cover the use, production, transfer and distribution of energy. Companies joining 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 moment, the agreement covers approximately 80% 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 system based on ISO 14 000 standards. Important parts of the agreement system are mid-term and final evaluations. The results of the evaluations are used for further development of the agreements. The agreements signed in 1997 will be evaluated in 2001–2002.

A visible Finnish company in activities reducing GHG emissions has been Fortum Corporation. The company has published a Climate change initiative in 2000 that will reduce GHG emissions and joined the Prototype Carbon Fund (PCF) of the World Bank. Fortum's voluntary Climate Initiative includes immediate measures, targets for 2005 as well as long term objectives up to 2010. As an immediate action Fortum has established a corporate Climate Fund to facilitate early emissions reduction projects.

Several other companies are also activating themselves in climate change mitigation. For example, the power company Pohjolan Voima is actively increasing the use of biomass and studying the use of large scale wind power and recycled fuels. Rautaruukki and the City of Helsinki have been among the most visible in the area of energy conservation.

In general, Finnish industry has expressed its readiness to the implementation of the energy conservation programme and to the increased energy use of wood, both included in the National Climate Strategy. The industry presupposes, however, that Government does not impose other obligations on industry, such as binding requirements relating to energy consumption or emission quotas for carbon dioxide. The industry has also expressed the view that Government would abstain from increases in industrial energy taxes and from imposing possible carbon dioxide taxes on industries.

4.1.7. Monitoring and evaluation

The institutional framework for monitoring and evaluation of climate change mitigation is mainly based on the following elements, which have been necessary first steps in the policy formulation:

- *The implementation process of the National Climate Strategy is monitored by the Kyoto Ministerial Working Group.*
- *On the EU level the monitoring and evaluation is based on the Monitoring Mechanism of Community CO_2 and other greenhouse gas emissions (Council Decision 1999/296/EC)*
- *Finland's national greenhouse gas inventory has been based on the work of an inter-ministerial working group led by the Ministry of the Environment in consultation with the relevant ministries, institutes and experts in accordance with the provisions of the*

COP/SBSTA/SBI decisions. The annual inventory report has been compiled by he Finnish Environment Institute (SYKE) and Statistics Finland, and the collaboration with the Ministry of the Environment, the Technical Research Centre of Finland (VTT), and MTT Agrifood Research Finland and the Finnish Forest Research Institute (METLA).

In addition, several programmes at different levels, indicators and reports related to sustainable development contribute to monitoring and evaluation. Finland's indicators for sustainable development include indicators related to climate change. These are Finland's greenhouse gas emissions, mean temperature and ice break-up date of the river Tornio.

4.2. SECTORAL POLICIES AND MEASURES

4.2.1. National Climate Strategy

INTRODUCTION

The government started the preparations for the National Climate Strategy in 1999 in order to meet Finland's Kyoto commitment. According to the burden sharing agreement within the EU, Finland will have to maintain the 1990 emissions level by 2008-2012. The ratification of the Kyoto Protocol will take place together with the other EU member states. Pursuant to the Constitution of Finland, the Kyoto Protocol has to be approved by the Finnish Parliament. The final decision to ratify the Protocol is taken by the President of the Republic after the approval of Parliament.

As a member of the European Community, Finland will, pursuant to Article 4 of the Kyoto Protocol, fulfil its commitments under Article 3 jointly with the European Community and other member states. Finland will notify the UNFCCC Secretariat of the terms of the burden-sharing instrument simultaneously with the Community and other member states in connection with the deposition of the instrument of the ratification.

The ministries the most actively involved in the preparations for the National Climate Strategy were the Ministry of Trade and Industry, the Ministry of the Environment, the Ministry of Transport and Communications and the Ministry of Agriculture and Forestry. In addition, the Ministry for Foreign Affairs and the Ministry of Finance are important parties in climate change mitigation.

The Ministry of Trade and Industry has been responsible for coordinating and collecting the sector-specific programmes into a National Climate Strategy (Ministry of Trade and Industry 2001) and a background document (Kauppa- ja teollisuusministeriö 2001) in wide co-operation with the various ministries and other stakeholders. For this co-operation, a Kyoto Ministerial Working Group and an inter-ministerial Kyoto network was set up.

The National Climate Strategy was adopted by the Finnish Government on March 15, 2001, and it was submitted to Parliament. The Parliament supported the strategy in its statement on 19.6.2001.

Finland's Third National Communication under the Framework Convention on Climate Change is largely based on the National Climate Strategy and the background document as well as the research and sectoral reports of strategy formulation (e.g. Liikenne- ja viestintäministeriö 2000; Maa- ja metsätalousministeriö 1999, 2000a, 2000b, 2001; Ympäristöministeriö 2001), and on the work of the inter-ministerial committee for preparing the Third National Communication. In addition, the latest data was used in order to update the information.

POLICY INSTRUMENTS OF THE CLIMATE STRATEGY

The basis of the climate strategy is that the Kyoto target would be met as cost-effectively as possible by domestic measures. Possibilities offered by the Kyoto flexible mechanisms are discussed in Chapter 4.6.

Research and Development

More research will be needed in order to understand the greenhouse effect resulting from many different factors and its consequences. A special research area in this field is composed of studies of the society, urban structure and the behaviour of organisations and consumers. Development of technology is one of the most important measures by which greenhouse gas emissions can be reduced, and technological solutions bring long-term, permanent changes.

Taxation

Taxation has become more important in prevention of climate change. The use of taxation is limited e.g. by competition, regional or socio-economic facts, and to a certain degree, by the EU membership. Due to the membership, many taxation models, like tax refund or production subsidy for electricity generated by the renewable sources of energy, must be approved by the European Commission.

Subsidies

Various subsidies are already widely used today. The subsidies are allocated for non-recurrent investments of the operators and are thus operational subsidies of a permanent nature. The energy subsidy is an investment aid that can be granted to companies and municipalities for environment-friendly energy investments that are made particularly in new technology. There is also a proved need in the introduction of renewable energy sources for a substantial non-recurrent demonstration aid for new technology.

Renovations improving the energy efficiency of buildings can be supported by financial aid and interest subsidies. In agriculture, it is possible to support by financial aid and interest subsidies investments that also have implications on environmental protection.

Operational tax subsidy is paid for electricity generated by wind, wood-based fuel and small-scale hydropower reducing greenhouse gas emissions. The logging and chipping of energy wood obtained from management of young forests are subsidised in the forest sector. The environmental aid for agriculture co-financed by the EU is also used to influence greenhouse gas emissions. All criteria for allocating national subsidies must be approved by the Community. However, the Community takes generally, a positive stand to the aid required for preventing climate change.

Statutes, regulations and guidelines

The use of norms is a straightforward and efficient method in those sub-sectors where it is easily applicable, such as the energy regulations of new buildings, refrigeration apparatus and of ventilation equipment. New norms often lead to intensive technological development work. Furthermore, statutes can change production structures considerably.

Due to the internal market in the Community and international trade, some of the norms must apply at least on Community. Such norms are the energy labelling and energy efficiency requirements placed on certain equipment and vehicles. In contrast, building norms, for example, can be drawn up on purely national basis

Voluntary agreements

Voluntary agreements constitute a new way of promoting environment-friendly issues. The agreements are most often concluded between the government and the trade organisations. They are flexible and may concern efficiency improvements, change activities or producing products that meet certain requirements.

The energy conservation agreements are the most significant ones in Finland. The energy conservation agreement scheme can be extended over to new fields of action, e.g. to increasing the use of the renewable energy sources. In some countries, the agreements are connected with various incentive schemes, like tax reliefs. On the Community level, voluntary agreements on the energy efficiency of products have been concluded for instance with car manufacturers (see Chapter 4.1.6).

Information dissemination, advisory services and training

Information dissemination and advisory services will be needed for influencing attitudes. In all sectors of activity, studies will be needed to develop especially new measures and to assess the effectiveness of the measures taken. Information on climate change will be included in the various stages of education and training. The climate protection campaign of municipalities serves as a good example of spontaneous activity.

4.2.2. Energy

The general objective of Finland's energy policy has been to ensure a reliable supply of energy 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 nuclear energy, wood-based fuels, peat and natural gas. Finland also imports a considerable proportion of its electricity (5-17% in the 1990s). 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 needs from waste wood and other by-products (i.e. black liquor). The proportion of wood and derived products of total energy supply is the highest in Europe.

Direct government intervention to guide the choice of energy sources is rare, apart from decisions regarding the use of nuclear power. However, economic instruments, taxation and subsidies, have been used to improve energy efficiency and to favour the development of domestic energy sources such as peat and biomass. Peat, in particular, as one of the few indigenous energy resources, was given substantial support in the form of R&D and investment subsidies, and tax exemptions. The use of peat has, however, declined in the late 1990s mostly due to increased wood-based fuel subsidies and liberalization of the electricity market.

Finland was the first country to introduce a CO_2 tax in 1990. This tax was based on the carbon content of fuels. Since its introduction the tax system has been modified and tax rates adjusted several times in the 1990s. The present energy taxation consists of three tax components: A basic excise tax is levied on transport and heating fuels, an additional CO_2-based excise tax is levied on fossil fuels and peat and an additional differentiated (industrial and other use) excise tax is levied on electricity consumption (see Chapter 4.3).

The Finnish electricity market has been gradually liberalised since 1995. Finland has been effectively part of the Scandinavian electricity market together with Denmark, Norway and Sweden and since 1997.

Increased competition and improved overall efficiency have lowered the price of electricity for large consumers and since 1998 also for small consumers. This trend may result in an increase in electricity consumption and, therefore, may have important unintended side-effects on greenhouse gas emissions. The price of electricity is, however, expected to rise in the future from the current level.

POLICIES AND MEASURES

Concrete policies and measures (P&Ms) affecting CO_2 emissions were defined for the energy sector already in the 1990s, so the effect of policies and measures in the energy sector in the 1990s can be compared with the base scenario of the First National Communication of Finland. This Communication presented a scenario that originated from the strategic work of the government in the early 1990s concerning future development. The base or reference scenario was defined for the years 1990–2010 (CO_2 emissions from fuel combustion). This scenario is not considered to be a 'without measure scenario' and assumptions behind this base scenario are considered irrelevant after 1999. See Chapter 5.2 for detailed discussion in this subject.

Discussions on policies and measures in the energy sector are therefore divided in three sections:

First, policies and measures in the 1990s are discussed as mitigation impact compared with the original base scenario can be estimated only for CO_2 during the 1990s. The mitigation impact of individual policies and measures is not quantified. Emissions trends in the 1990s are discussed in general in Chapter 5.2.

Second, policies and measures in the 'with measures' scenario are presented for the years 2000–2020. No mitigation impact is calculated as no comparable 'without measures' scenario is defined. Policies and measures in the base scenario and in the 'with measures' scenario are combined in Table 4–1 as P&Ms are basically the same.

Third, policies and measures in the 'with additional measures' scenario are presented in Table 4–2 for the years 2000–2010. Policies and measures in this scenario are basically intensified and updated versions of the ones in the previous scenarios. Energy conservation programme was revised in 2000 and new Action plan for renewable energy was accepted in 2000. Additional measures concerning electricity supply have also been defined and two main alternatives have been presented: a shift from coal to natural gas in the generation of electricity and heat or a new nuclear power plant unit replacing coal in electricity generation.[1] Policies and measures are defined until the end of the first commitment period.

The mitigation impact of individual policies and measures is not estimated in Table 4–2. The aggregate effect of additional policies and measures in the energy sector is approximately 11 Tg by 2010 compared with the 'with measures' scenario.

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[1] *Natural gas alternative is called KIO1 and nuclear alternative is called KIO2 in the National Climate Strategy.*

Table 4-1.

Major policies and measures affecting GHG emissions in the energy sector in 1990–1999 and in the 'with measures' scenario in the energy sector in 2000–2010. Policies and measures are basically the same in the 1990s and in the 'with measures' scenario

Policy or measure	Objective[2]	GHG affected (mainly)	Type of instrument	Status	Implementing entity
Electricity market act	To increase competition	CO_2	Regulatory	Came into force in 1995, modified in 1997 (small consumers included)	Ministry of Trade and industry
Energy taxation	To reduce energy consumption and and to improve competitiveness of renewables	CO_2	Fiscal	Several changes in tax structure in 1990s. Latest change in 1998. Revisions have raised taxes and introduced subsidies on renewables	Ministry of Finance
Energy conservation programme	To reduce energy consumption	CO_2	Technical, regulatory, economic, information, education	Adopted in 1995, new energy conservation programme proposed in 2000	Ministry of Trade and Industry, Motiva Oy
Voluntary agreement on energy conservation and energy auditing	Agreements on monitoring, conservation plans, energy audits, energy investment, new technology	CO_2	Voluntary agreements since 1997	Currently 80% of industry, 90% of power production, 75% of power distribution, 70% of DH sales, 95% of government and 55% municipally owned buildings etc.	Ministry of Trade and Industry, Motiva Oy, industry, municipalities
Action plan for renewable energy	To reduce CO_2 and non-GHG emissions	CO_2	Fiscal, technical, information, education, economic	Several programmes in 1990s, important aspect in 1997 Finnish energy strategy, new action plan was accepted in 2000	Ministry of Trade and Industry
Energy and climate technology R&D	To reduce CO_2 emissions	CO_2	Technical	Continuous	Ministry of Trade and Industry, TEKES

[2] *Related to GHG mitigation (there are also other objectives)*

ENERGY CONSERVATION

The 1995 Energy Conservation Programme has been revised in 2000 to meet the needs of the National Climate Strategy and has now been integrated into the Strategy.

The proposed energy conservation measures can be divided into seven categories:

1) funding the development and commercialisation of energy-efficient technology
2) using economic steering methods, e.g., taxation
3) improving the efficient use of control by norms
4) further enforcing voluntary energy conservation agreements
5) further developing energy audits and analyses
6) supporting energy conservation measures with information services, training and motivation
7) supporting energy conservation activities of the EU and international organisations.

Implementing the proposed measures can reduce energy consumption by approximately 3% from the 1999 level by 2010. GHG emissions would be reduced by 3–4 Tg CO_2 equivalent, or 4–5%. Energy conservation measures have already contributed to a reduction in the electricity intensity in the service sector.

RENEWABLE ENERGY SOURCES

A national programme for enhancing the use of RES – Action Plan for Renewable Energy Sources – was approved in 1999. It was in line with the 1997 Finnish Energy Strategy and the 1998 EU White Paper (Community Strategy and Action Plan on RES). The Action Plan is now being implemented, and it has also been integrated into the National Climate Strategy.

The main objective of the Action Plan is to foster the competitiveness of RES on the open energy market. The measures can be divided into four categories:

1) development and commercialisation of new technologies
2) financial measures, especially taxation and investment subsidies
3) additional administrative measures
4) education and information dissemination.

The promotion of wind power is one element in the Action Plan. Wind power plants are already entitled to investment grants and they get a tax subsidy, the amount of which corresponds to the tax levied on electricity in the lower tax class. Exploitation of wind power is on the rise, but is still on a very low level. In 1999, the electricity output of wind power plants totalled 49 GWh (installed power at year end 38 MW). The strategic goal is an annual increase of over 10% in wind power production in the period 2000–2020.

The quantitative objective of the Action Plan is to increase energy production from RES between 1995 and 2010 by 125 PJ, or by 50%. So far, the promotion of RES use has been successful. The long-term objective is to double the use of RES by the year 2025. Furthermore, implementing the Action Plan is expected to reduce GHG emissions by 4–5 Tg CO_2 eq., or 5–7%, between 1999 and 2010.

Table 4-2.

Major additional policies and measures included in the 'with additional measures' scenarios in the energy sector in 2000–2010

Policy or measure	Objective[3]	GHG affected (mainly)	Type of instrument	Status	Implementing entity
Revised conservation energy	To reduce energy comsumption	CO_2	Technical information, education, fiscal	New energy conservation programme proposed in 2000	Ministry of Trade and Industry, Motiva Oy, Ministry of Finance, Ministry of the Environment
New action plan for rene-wable energy	To reduce CO_2 consumption and non GHG emissions	CO_2	Fiscal, technical, information, education, economic	Accepted in 2000	Ministry of Trade and Industry
Supply of electricity[4]	To reduce CO_2 emissions	CO_2	Regulatory	Pending on Parliament	Ministry of Trade and Industry

[3] *Related to GHG mitigation (there are also other objectives)*

[4] *Either natural gas (KIO1) or nuclear (KIO2) alternative. The Government is at present processing an application, submitted by Teollisuuden Voima Oy, for a Decision-in-Principle on its plan to build a new nuclear power plant unit. A decision is foreseeable in the autumn of 2001 at the earliest.*

4.2.3. Transport

In the transport sector the climate change policy has become an integrated part of the transport policy in the 1990s both at the national level and within the European Union. The aim is to restrain the growth of transport and thereby to reduce the environmental effects of transport, including greenhouse gas emissions.

The Commission has recently published a new White Paper on the Common Transport Policy with the aim to find new measures to reduce traffic congestion and to maintain and promote the share of sustainable modes of transport in modal split. This should also support reduction of greenhouse gas emissions.

Promotion and development of inter-modal transport, rail transport and public transport have traditionally played an important role in the Finnish transport policy. Finland has also had a national cycling policy programme since 1992.

Cities and towns sell convenient regional bus cards valid for one month in all major urban areas, and they also subsidise the ticket prices. The government funds half of the bus ticket prices in small urban agglomerations, but does not subsidise the bus tickets in large cities or towns. In freight transport the logistical efficiency of traffic chains has been an important objective already because the traffic distances are long and volumes rather small in a large country with low population density.

Following the relatively high level of vehicle and fuel taxation in Finland compared to several other countries, the market share of public transport has remained relatively high, around 20%, of all passenger transport.

Because of the transport and fiscal policy objectives and measures, and economic recession in the early 1990s, there has been only a slight increase in GHG emissions caused by transport in the 1990s (Figure 4-1). There is some cautious optimism that to a certain extent there might be some decoupling of traffic volumes from economic growth (Figure 4-2).

Greenhouse gas emissions from transport shall be reduced by decreasing the fuel consumption of vehicles and by disseminating information on the effects of the transport mode and the manner of driving on fuel consumption.

The agreement between the European Commission and the motor industry to reduce the average fuel consumption of new motor vehicles plays a key role in attempts to reduce emissions from transport.

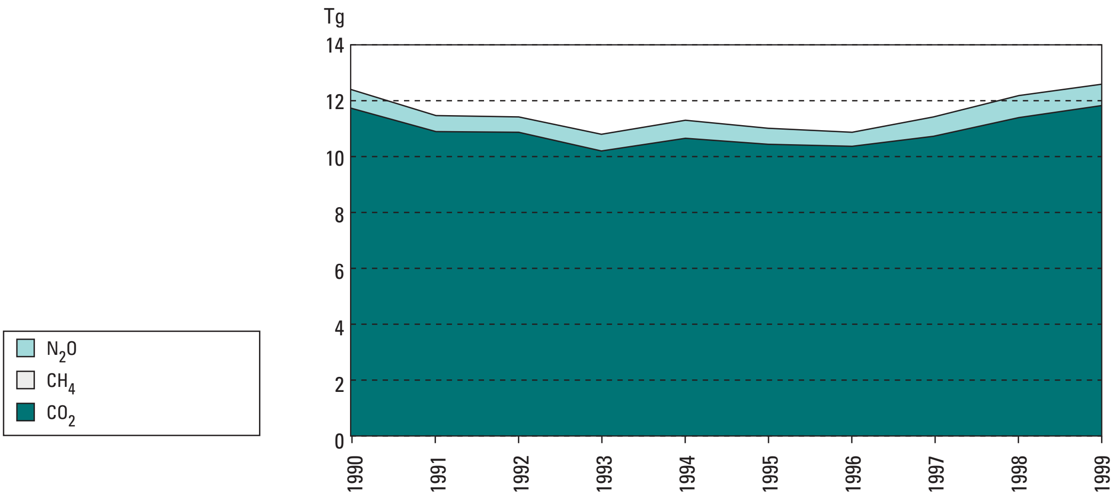

Figure 4-1.
Greenhouse gas emissions from transport in 1990–1999.

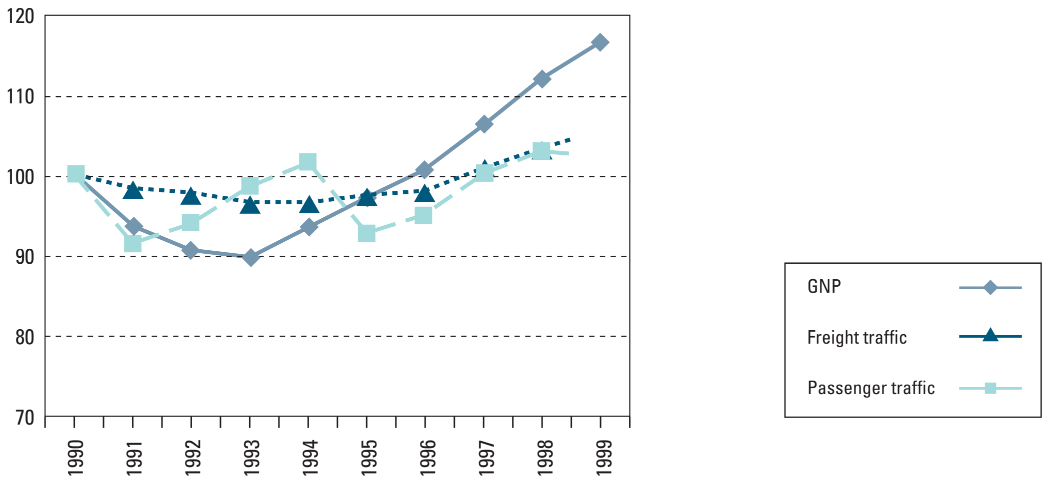

Figure 4-2.
Trends in GNP and volume of passenger and freight transport in 1990–1999.

The environmental management programme of the transport sector has clear links with climate change mitigation. The Ministry of Transport and Communications has had an environmental management programme of transport policy since 1994. This first programme "Action Programme for Reducing the Adverse Effects of Transport on the Environment" already contained the objective that the greenhouse gas emissions caused by transport should not exceed the 1990 level.

The new programme was adopted in July 1999 when "Environmental Guidelines for the Transport Sector" was published (Ministry of Transport and Communications 1999). The new programme is based on ISO standard 14001 and it provides a practical tool for the environmental management of transport policy. As to greenhouse gas emissions, the aim is that the greenhouse gas emissions in the year 2010 should not exceed the 1990 level. Under the programme, the different stakeholders share responsibility and monitoring and follow-up procedures are set up.

POLICIES AND MEASURES FOR THE YEARS 2000–2020

In the Environmental Management Programme of the Ministry of Transport and Communications the Ministry sets policy targets and measures also in the area of climate change policy of the transport sector. The measures defined in the programme "Environmental Guidelines for the Transport Sector" are much the same that are included in the National Climate Strategy. Such measures are:

– *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 Green Commuter Plans.*

- *Fiscal measures with the aim to reform vehicle taxation to encour age purchase of low-consumption and energy-saving cars and to promote and subsidize public transport.*
- *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 acilities.*
- *Voluntary energy saving agreements with the transport carriers.*
- *Information, education and motivation, such as eco-driving, campaigns aiming at awareness raising and changing transport behaviour.*

The Ministry of Transport and Communications (2000) has also published a long-term strategic programme called "Towards a sustainable and intelligent transport sector". The aim of this programme is to provide a vision of the transport system that could be reached by the year 2025. Such a transport system should take into account economic, ecological, social and cultural viewpoints. The strategy aims at reaching a transport system in which the demand for road transport (passenger car traffic and road freight traffic) should peak by the year 2020 and gradually start to decrease.

In accordance with the National Climate Strategy and the Environmental Management Programme, the Ministry of Transport and Communications (2001a, 2001b, 2001c) has adopted the following three programmes:

- *National Cycling Policy Programme with the aim to double cycling use from the 1998–99 level up to the year 2020.*
- *National Walking Policy Programme with the aim to incorporate walking into transport policy and planning.*
- *Public Transport Strategy with the aim to increase the attractiveness and competitiveness of public transport, e.g. with the help of estab lishing door-to-door travel chains and introducing travel centres.*

The annual funding in public transport is around EUR 0.4 billion. The funding in public transport is shared between the government (around 2/3) and municipalities (1/3). Even though in the National Climate Strategy the promotion of public transport is emphasised as an important measure to reduce the transport-related greenhouse gas emissions, it is not expected that the annual governmental funding in public transport will increase but funding will be directed differently aiming at increasing its efficiency: reducing the taxation rate set for the employment-bound public transport tickets lower than their nominal value and funding the development of passenger information services and establishing travel centres.

At the European Union level the reduction of transport related greenhouse gas emissions continues to be an important goal of the Common Transport Policy. One of the most important and efficient measures is the voluntary agreements with the car manufacturers (ACEA, JAMA and KAMA), which aim at reducing CO_2 emissions of new cars by 2008 (or by 2009 of Japanese and Korean cars). The aim is that average CO_2 emissions of new cars should not exceed 140 g/km by 2008. This means that average energy consumption of petrol fuelled cars should be less than 6 litres in 100 km and that of diesel cars less than 5.5 litres in 100 km. Additional measures will need to be developed to meet the EU target of 120 g/km for new cars by 2010.

Reduction of greenhouse gas emissions is an essential part of the Cardiff process (see Chapter 4.1.2). The Council strategy for integrating environment and sustainable development into transport policy was adopted in October 1999. Also various other EU initiatives, such as the revision of the Common Transport Policy, the forthcoming Green Paper on Clean Urban Transport as well as initiatives revitalising rail traffic and promoting short sea shipping, aim at promoting sustainability, restricting growth of transport and reducing greenhouse gas emissions.

Moreover, Finland will actively participate in other international co-operation (e.g. within ICAO, IMO) with the aim to prepare mechanisms to reduce greenhouse gas emissions from international aviation and shipping.

Table 4-3.

Major policies and measures affecting GHG emissions in the transport sector in the 'with measures' scenario, 2000–2020

Policy or measure	Objective[5]	GHG affected (mainly)	Type of instrument	Status	Implementing entity
Voluntary agreement with European, Japanese and Korean industries	Reduction of CO_2 emissions from passenger cars: 140/120 g/km by 2008/ 2010	CO_2	Voluntary agreement/ technical	Existing	EU with car industry
Differentiation of vehicle taxation	Promoting purchase and use of energy-efficient vehicles	CO_2	Fiscal	Proposed	Government
Promotion of public and non-motorised transport	Increasing share of public and non-motorised transport	CO_2 N_2O	Information, education, economic	Existing, new measures proposed	Government in co-operation with local authorities
Eco-driving	Adoption of ecoefficient driving skills and habits	CO_2	Information, education, economic	Proposed	Government in co-operation with driving schools
Energy-saving	Adoption of energy saving agreements between administration and transport operators	CO_2	Voluntary	Existing, new agreements under preparation	Government in co-operation with transport operators
Transport planning and land use planning	Maintaining compact urban structure	CO_2	Zoning, transportation system plans, information and education	Existing	Government and municipalities

[5] *Related to GHG mitigation (there are also other objectives)*

The mitigation impact of individual policies and measures is not quantified in Table 4-3, as there is no 'without measures' scenario available for the years 2000–2020. Policies and measures included in the 'with measures' scenario are, however, very ambitious and their mitigation effect is approximately 1.4–3.7 Tg compared to what would otherwise occur based on different assumptions.

ADDITIONAL MEASURES

Only a few additional measures are identified in addition to those included already in the 'with measures' scenario. Such measures are: increase of fuel taxation and wider implementation of those measures that were presented already above. However, these additional measures do not have any major additional effect compared to those measures that were presented in Table 4-3.

Table 4-4.

Major additional policies and measures included in the 'with additional measures' scenario in the transport sector, 2000–2010

Policy or measure	Objective[6]	GHG affected (mainly)	Type of instrument	Status	Implementing entity
Increase of fuel taxation	To reduce traffic volume and GHG emissions	CO_2	Fiscal	Planned	Ministry of Finance
Additional promotion of public transport	To promote public transport	CO_2	Information, education, economic	Planned	Government in co-operation with local authorities
Broader energy saving agreements	To broaden the scope and effecttiveness of energy	CO_2	Voluntary agreement	Planned	Ministry of Transport and Communications
Additional measures to maintain urban structure	Concentration of urban structure	CO_2	Information, education, economic	Planned	Government in co-operation with regional and local authorities

[6] *Related to GHG mitigation (there are also other objectives)*

The mitigation impact of individual policies and measures is not quantified in Table 4-4. The aggregate effect of policies and measures in the transport sector is approximately 0.3 Tg by 2010 compared to the 'with measures' scenario (see Chapter 5.3).

4.2.4. Industrial processes

GHG emission levels from industrial processes are fairly low in Finland and emissions have been quite stable during the 1990s. About half of the total emissions from this sector are N_2O emissions from nitric acid production. The CO_2-emissions come from cement and lime production. Emissions from the fuel used as a raw material in the industrial processes (about 10 Tg CO_2) are calculated into the emissions from energy production.

The level of the F-gases grew rapidly during the 1990s to 10% of the emissions from industrial processes. Without further measures their share will be about 40% by 2010.

The main policies and measures related to industrial processes aim at reducing N_2O emissions from nitric acid production and slowing down the increase of F-gases with the use of leakage control and alternative technologies and substances.

The role of industry in general as an energy user is, however, significant, and the climate strategy, especially the electricity procurement choices, would affect primarily the development of traditional energy-intensive industries. These include forestry products, the chemical industry, metallurgical manufacturing and building material industries. Therefore, policies and measures relevant for industry are mainly discussed in the energy sector.

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 a short growing period, temperature, frost 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.

PROGRAMMES

When Finland joined the EU in 1995, an environmental aid system part-financed by the EU, the agri-environmental programme for 1995–1999 was introduced. Environmental protection was adopted as a criterion for the allocation of agricultural subsidies. The objectives of the Finnish environmental programme for agriculture included improving water protection by farms, reducing harmful emissions into the air, and maintaining and developing the agricultural landscape and biodiversity. The agri-environmental programme for 1995–1999 also provided aid for conversion to organic production.

In 2000 a new kind of agricultural policy became fully effective in Finland as the five-year EU transitional period came to an end in 1999. The new support measures do not differ from the transitional arrangements in any essential way. The objective of the Horizontal Rural Development Programme is to secure the income level of farms, and develop the profitability and efficiency of the production of farms taking into account the environmental considerations and expansion of the industrial basis of the countryside, which maintains the viability and contributes to the better management of the 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 these actions together with the structural change in the Finnish agriculture sector have enabled a significant reduction of greenhouse gas emissions in agriculture from 9.2 Tg CO_2 eq.[7] in 1990 to 7.3 Tg CO_2 eq.[8] in 1999.

The agri-environmental support is an essential tool to promote 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 the agricultural land.

There are no major differences between the 'with measures' and the 'with additional measures' scenarios from the GHG emissions point of view in agriculture as the main policies and measures are already included in the 'with measures' scenario.

4.2.6. Forestry

The climate strategy measures concerning forestry are based on the National Forest Programme (Maa- ja metsätalousministeriö 1999), which was adopted by the Government in 1999. International agreement is still pending on the calculation rules for carbon sinks e.g. how changes in the soil are taken into account. In the climate strategy, inputs of forestry-related activities were not taken into account, even through sustainable forest management practiced in Finland has a significant contribution to forest sink.

The basic framework for forest management is set by forest legislation. In recent years forest policy has continued to emphasise other than legislative means (e.g. extension, education, forest management

[7] *10.2 Tg including CO_2 emissions from mineral soils*
[8] *7.6 Tg including CO_2 emissions from mineral soils*

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. As a result of all these policies and measures the forests in Finland have maintained their vitality and have provided multiple benefits including carbon sequestration between 10 to 38 Tg of CO_2 during 1990–1999.

PROGRAMMES

The Environmental Programme for Forestry in Finland (1994) includes the strategy for sustainable forestry, together with the targets for the year 2005. Conservation programmes approved by the Council of State improved Finland's possibilities to preserve biological diversity. EUR 550 million have been reserved for implementing the conservation programme of privately owned land for the years 1996–2007.

All thirteen Forestry Centres have compiled the 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 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.

In March 1999 the Government approved Finland's National Forest Programme (NFP) 2010. The comprehensive idea behind the programme 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 based on the Environmental programme for forestry of 1994. 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.*

PROMOTING THE USE OF WOOD AS AN ENVIRONMENTALLY FRIENDLY PRODUCT

The government and different stakeholders have 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 kind of campaign will continue to be implemented in 2001–2005.

FOREST CERTIFICATION AS A VOLUNTARY MARKET-BASED INSTRUMENT

Forest certification is a market-based instrument that is used to improve consumer awareness of the environmental qualities of sustainable forest management and to promote the use of wood and forest products as environmentally friendly and renewable raw materials. In April 1997 the wide working group on forest certification agreed upon a proposal for a standard for sustainable forest management and its implementation in Finland. The aim was to create a national standard compatible with the international forest certification systems and the environmental management systems.

In 1997–1999 the Finnish Forest Certification System (FFCS) was finalised. The FFCS is endorsed by the Pan-European Forest Certification (PEFC) council. The PEFC aims at establishing an internationally credible forest certification framework for forest certification schemes and initiatives. At the end of 2000 about 95% of the Finnish forests, altogether approximately 22 million hectares were certified pursuant to the FFCS.

4.2.7. Waste management

Measures in waste management have reduced GHG emissions. Government decisions on landfills and the collection and recovery of waste paper, the waste tax and the adoption of the National Waste Plan have lowered GHG emissions by 2 Tg CO_2 eq from 1990 to 1999 (Table 4-5). The mitigation impact of individual policies and measures is not calculated as there is no 'without measures' scenario available for waste management.

According to the National Climate Strategy, efforts will be made to utilise source-separated waste fractions as materials and to utilise combustible, unusable waste separated at source or at a processing utility as energy in existing energy production plants. Furthermore, more efforts are being made in waste minimization technologies. The objective is to limit more effectively than at present the quantity of biodegradable, methane-producing waste ending up at solid waste disposal sites.

The effect of additional policies and measures in waste management is approximately 0.8 Tg by 2010 compared to the 'with measures' scenario (Table 4-6).

Table 4-5.

Major policies and measures included in the 'with measures' scenarios in the waste management sector

Policy or measure	Objective[9]	GHG affected (mainly)	Type of instrument	Status	Implementing entity
Government decisions on landfills	To reduce CH_4 emissions	CH_4	Regulatory	Implemented	Ministry of the Environment
Waste minimisation, the 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
The waste tax	To reduce CH_4 emissions	CH_4	Fiscal	Existing	Ministry of Finance

[9] *Related to GHG mitigation (there are also other objectives)*

Table 4-6.

Major additional policies and measures included in the 'with additional measures' scenarios in the waste management sector

Policy or measure	Objective[9]	GHG affected (mainly)	Type of instrument	Status	Implementing entity
Landfill gas recovery and utilization	To reduce CH_4 emissions	CH_4	Regulatory, fiscal	Planned	Ministry of the Environment, Ministry of Finance
Waste minimisation, the utilisation of source-separated waste fractions as material and energy	To reduce CH_4 emissions	CH_4	Regulatory, fiscal	Planned	Ministry of the Environment, Ministry of Finance
Development of waste taxation	To reduce CH_4 emissions	CH_4	Regulatory, fiscal	Planned	Ministry of Finance

[9] *Related to GHG mitigation (there are also other objectives)*

4.2.8. Combined effects of policies and measures

The combined effects of sectoral policies and measures in the 'with additional measures' scenario in 2000–2010 are presented in Table 4-7.

If energy is utilised more efficiently, as assumed in the energy conservation programme and the present strategy, emissions can be reduced by the equivalent of a further 3-4 Tg of CO_2 eq. Implementing all the measures included in the programme promoting renewable sources of energy could result in the reduction of emissions to 4-5 Tg of CO_2 eq maximum in 2010. A reduction in emissions equivalent to a one Tg of CO_2 eq can be achieved with measures concerning methane and other greenhouse gases. Meeting these objectives calls for highly intensified economic control measures and success in their focusing. In electricity procurement, a reduction in emissions equivalent to 6-10 Tg of CO_2 eq minimum should be achieved by the year 2010. This reduction in emissions can be achieved either by allowing the construction of additional nuclear power generation capacity, or by limiting coal consumption.

Table 4-7.

Combined effects of policies and measures in the 'with additional measures' scenario in 2000–2010 (Tg CO_2 eq)

Set of policies and measures	Reduction in emissions by 2010 (Tg CO_2 eq.)
Energy conservation	3–4
Promotion of renewable sources of energy	4–5
Measures concerning other greenhouse gases	More than 1
Action concerning electricity production	6–10
Total of necessary emissions reduction	**14**

4.3. TAXATION

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. After a number of increases in the CO_2 tax rate in the early 1990s, the first major change occurred in 1994, when an additional component based on the energy content of the fuels was introduced, as well as special taxes on nuclear power and hydropower. Imported electricity was taxed at the average rate applied to domestically produced electricity.

The second important revision of energy taxation took place in 1997, prompted by the opening of the Nordic electricity market. Domestic industries, and in particular the electricity sector, felt disadvantaged by the fact that energy-intensive sectors were exempted from the CO_2 tax in the other Nordic countries while electricity imports could not be taxed according to their carbon content. At the same time, the border tax on imported electricity was found to be out of line with the EU single market legislation. Therefore, to avoid harming the competitiveness of domestic industries, the carbon/energy tax based on fuel inputs in the electricity sector was scrapped and an electricity consumption tax was introduced, with a lower rate for industry and greenhouse cultivation (slightly above half the rate on households and service sectors). Source fuels for heating and transport continued to be taxed, but only on their carbon content, with a reduced rate for natural gas and peat. Since then, tax rates have been raised on several occasions and further exemptions added. In addition, some taxes paid by energy-intensive industries are refunded since 1998.

The present energy taxation consists of three tax components:

- *a basic excise tax is levied on oil products,*
- *additional CO_2 based excise tax is levied on transport and heating fuels,*
- *additional differentiated (industrial and other use) excise tax is levied on electricity consumption.*

To improve the competitiveness of renewables in electricity production, wood based electricity production, wind power, small hydropower and small CHP plants using peat as fuel get a tax subsidy. This subsidy is equal to the industrial electricity tax, except for wind power the subsidy is paid according to the higher tax rate.

An energy intensive industry is entitled to a tax refund under certain conditions. A company which has paid energy taxes more than 3.7% of its value added has a right to a refund. The amount of the refund is 85% of the taxes paid over the 3.7% limit. However, refund is paid only for the part exceeding the limit of EUR 50 500.

The present tax rates came into force in September 1998. The basis for the additional tax on transport and heating fuels is EUR 17.2/t CO_2. The tax on electricity is EUR 4.2/MWh for industrial users and EUR 6.9/MWh for other users.

Vehicle and fuel taxation have traditionally been at a relatively high level in Finland by international comparison. The state receives an income from vehicle taxation of about EUR 1.2-1.3 billion (Table 4-8). In 1999 the state received EUR 1.2 billion through the vehicle taxation (4.6% of total incomes). Moreover, each passenger car owner has to pay annually a user charge of EUR 117, if the car is registered after 31 December 1993 or EUR 84 if the car is registered before 31 December 1993. The state receives an income annually of around EUR 200-220 million.

The fuel taxation in Finland contains differentiation scheme according to which the price of diesel fuels is differentiated taking into account the sulphur content. The differentiation of petrol fuels is implemented between the reformulated and non-reformulated fuels.

The waste tax is EUR 15.1/t and it is applied to wastes excluding soils disposed to municipal landfills. The annual energy and other environment-related tax revenues between 1980 and 1999 are illustrated in Figure 4-3. The Figure includes also other environment-related taxes and charges.

Table 4-8.

Environmentally-related taxes, fees and charges in Finland in 1999, EUR million

MOTOR FUELS, total		**1 967**
Unleaded petrol	Basic tax	1 253
	Surtax	98
Diesel oil	Basic tax	523
	Surtax	93
OTHER ENERGY PRODUCTS, total		**313**
Light fuel oil	Basic tax	50
	Surtax	125
Heavy fuel oil	Surtax	52
Coal	Surtax	47
Peat	Surtax	15
Natural gas	Surtax	25
ELECTRICITY		**369**
Electricity consumption		369
VEHICLE-RELATED TAXATION, total		**1 422**
Car sales tax		1 028
Vehicle tax ("sticker tax")		209
Motor vehicle tax ("diesel tax")		185
AGRICULTURAL INPUT, total		**2**
Pesticides		2
OTHER GOODS, total		**23**
Beer surtax		12
Soft drink surtax		1
Oil waste tax		3
Oil pollution control fee		6
WATER AND WASTEWATER CHARGES, total		**636**
Water charges		275
Wastewater charges		360
Water protection fee		1
WASTE DISPOSAL AND MANAGEMENT CHARGES, total		**141**
Waste tax		34
Municipal Waste Charges		107
TOTAL		**4 503**
Charges		742
TOTAL, TAXES AND FEES		**3 761**
Total tax revenue (OECD)		56 180
– Central Government		29 699
– Local Government		12 131
– Social Security Funds		14 208
– Supra-national Authorities (EU)		142
Total tax revenue (OECD)*		**41 830**
Share of the environmental taxes and fees (%)		**2**

* *social security contributions not included*

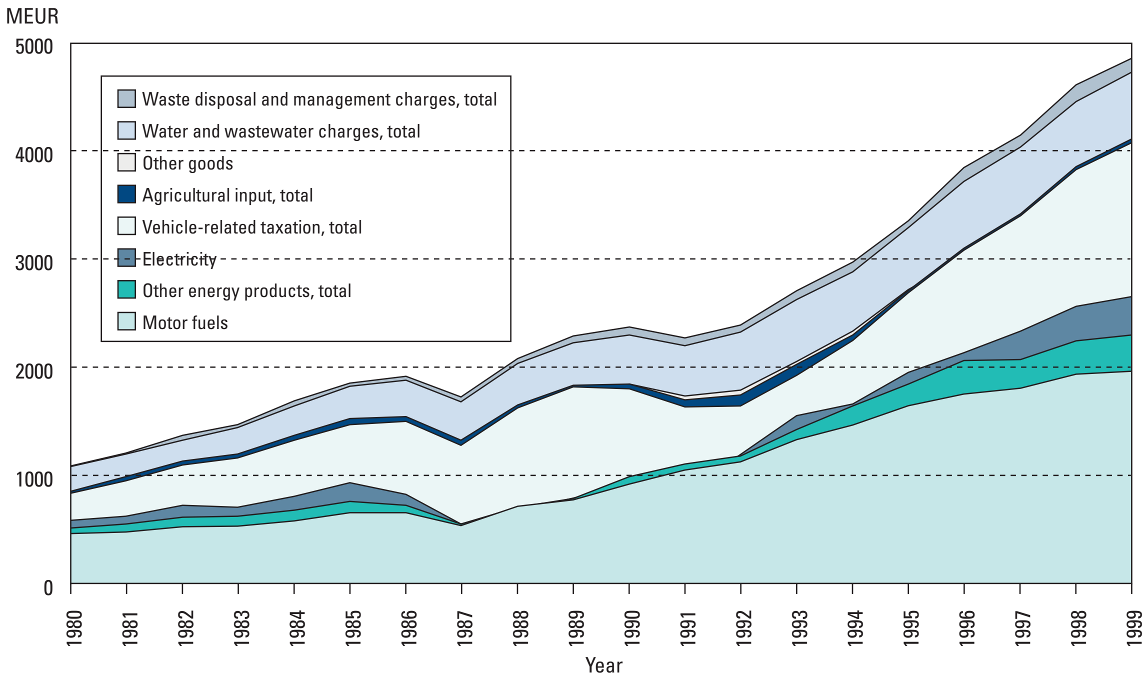

Figure 4-3.
Trends in energy tax and other environment-related tax revenues between 1980 and 1999.

4.4. OTHER CROSS-SECTORAL POLICIES AND MEASURES

Several cross-sectoral policies and measures also affecting GHG emissions can be identified including national programmes and policies related to biodiversity, regional structure, ecologically sustainable construction, protection of the ozone layer, transboundary air-borne pollution and co-operation in environmental protection in neighbouring areas. Especially important are UNCSD, Agenda 21 and Rio +10. In Finland, the promotion of sustainable development has been comprehensively adopted as the goal of broad cooperation between the government, the private sector, interest groups and other NGOs, the scientific community, the education system and the media. The Finnish National Commission on Sustainable Development (FNCSD) was set up in 1993 to promote cooperation for this purpose. The mandate of the FNCSD is extended to the end of year 2002.

Other policies and measures affecting GHG emissions include environmental management systems and environmental labels and declarations. In accordance with EC Directive 1999/94 relating to the availability of consumer information on fuel economy and CO_2 emissions in respect of the marketing of new passenger cars, a decree has been adopted on providing information on fuel economy and CO_2 emissions of new passenger cars. This decree came into force on 18 January 2000.

URBAN AREAS, REGIONAL STRUCTURE AND TRANSPORT SYSTEMS

Developments in the urban structure have a long-term effect 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 hand, concentration of the population in a few urban regions, mainly the Helsinki metropolitan area, Tampere, Turku and Oulu, including the cities themselves as well as their surrounding communities. This means increasing challenges for the co-ordination of transport and land use planning in the future. These challenges should be met, on the one hand, by increasing the co-operation between the authorities responsible for transport and land use planning, and on the other hand, by producing research information 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 possible to maintain a high level of public services even though passenger car traffic has continued to increase.

Since 1996 Finnish municipalities have implemented the so-called transportation system plans. These are long-term strategic plans, which are aimed at developing an 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 the urban areas. The municipalities are responsible for maintaining and developing the transport system and transport infrastructure inside the 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 to guide the transport planning of the municipalities which otherwise can autonomously decide on transport planning at the local level. So far 15 intention agreements have been agreed between the government, municipalities and regional councils.

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 reduction in energy use and emissions. Furthermore, the goal is to increase the export of energy technology.

The government contributes to the determined development of new technology for energy generation and use. Supporting energy technology R&D with governmental funds serves 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 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. Government energy research, development and demonstration expenditure was approximately EUR 100 million in 1999.

The government's support for research and development work is channelled via the Technology Development Centre (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. Funding by the Ministry of Trade and Industry covers the first full-scale applications (demonstrations) resulting from the research and development activities.

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. VTT carries out both its own technical research work and testing as well as 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 first, broad package of 11 research programmes were carried out in 1993–1998 with the total funding of EUR 250 million. Most of the programmes that are active now have started in 1999. New programmes are being planned and implemented continuously as the need for a new one arises.

Energy technology programmes active in 2000 were:

- *Engine Technology Programme ProMOTOR, 1998–2003*
- *Energy and the Environment in Transportation MOBILE[2], 1999–2003*
- *Fusion Energy Research Programme FFUSION 2, 1999–2003*
- *Information Technology and Electric Power Systems Technology Programme TESLA, 1998–2000*
- *Materials for Energy Technology KESTO, 1997–2001*
- *Modelling Tools for Combustion Process Development CODE, 1999–2002*
- *Process Integration Technology Programme, 2000–2004*
- *Technology and Climate Change Programme CLIMTECH, 1999–2002*
- *Waste to REF & Energy, 1999–2001*
- *Wood Energy, 1999–2003*

The total funding of the above-mentioned programmes is estimated to be EUR 170 million. VTT has also launched energy technology programmes that are established to pool the wide resources of VTT Energy in order to enhance internal collaboration.

The Technology and Climate Change Programme (CLIMTECH), investigates the development needs and possibilities of the technologies which can be applied to control greenhouse gas emissions and climate change. The programme includes both the control and limitation of emissions within Finland as well as the use of Finnish technology to limit emissions elsewhere. CLIMTECH is discussed in more detail in Chapter 8.

The development of bioenergy technologies is given a high priority within overall energy R&D work. New energy technology for growing markets of waste management is being developed under the Waste to REF & Energy Technology Programme launched by TEKES. During the period 1993–1998, TEKES also had a specific technology programme for wind and solar energy called NEMO, Advanced Energy Systems and Technologies.

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

- *Raket*
- *Environmental Technology in Construction 1994–1999*
- *Healthy Building 1998–2002*
- *Nordic Wood 2*
- *Progressive Building Process – ProBuild 1997–2001*
- *Wood in Construction 1995–1998*

The Ministry of Trade and Industry has financed a research programme on energy conservation decisions and behaviour (Linkki 2) in 1997–2001. The programme aims at promoting the implementation of the energy saving programme.

The Ministry of Transport and Communications, the Ministry of the Environment and various agencies and offices, transport enterprises and companies have established a research programme which is aimed at producing information that should facilitate implementation of integrated and sustainable policies and planning (the so-called LYYLI programme). Useful background information on the interaction between the transport and community structure has been produced for preparation of the National Climate Strategy. Some of the recent studies that have been conducted in the context of this programme are:

- *Interaction between transport and land use in the Helsinki metropolitan area*
- *Modelling of urban sprawl and fragmentation*
- *Long-term impacts of fuel price changes and removal of tax reduction based on commuting costs.*
- *Changes in the urban form and transport demand in Finnish cities by the year 2020.*
- *Impacts of the telecommunications sector on transport and the environment.*
- *The travel behavioural effects of changes in the transport system and the location of housing, working places and services.*

In addition to the LYYLI programme, there are several other research programmes that aim at promoting sustainable transport with reduced energy consumption and emissions. Such programmes, in addition to the above-mentioned MOBILE and ProMotor programmes, are:

- *Väylät 2030 is a research programme with the aim to increase knowledge on how the transport infrastructure should be developed in the future in order to respond to the challenges and needs of other factors (such as environment, industry, etc.).*
- *Ketju is a research programme that provides information on means of increasing transport efficiency and logistics.*

4.6. THE USE OF THE KYOTO MECHANISMS

The use of the Kyoto Flexible Mechanisms has been excluded from the National Climate Strategy for the present due to the uncertainties concerning the final rules. The Report by the Committee on the Kyoto Mechanisms, however, has suggested that the use of flexible mechanisms should be further promoted in Finland.

The government of Finland has launched a pilot programme in order to prepare for the implementation of joint implementation (JI) as well as the clean development mechanism (CDM) of the Kyoto Protocol. The Ministry for Foreign Affairs is in charge of the implementation of the programme in co-operation with other relevant ministries. The aim of the programme is to gain experience in the issues specific to the JI/CDM project cycle. The government has reserved around EUR 8.4 million the implementation of the projects during 2000-2002. It is expected that the pilot projects implemented under the programme will result in high-quality emissions reductions or carbon removals by sinks. So far, one project is being implemented and several are in the pipeline.

The Finnish government has signed Memorandums of Understanding about Joint Implementation with Estonia, Latvia, Lithuania, Poland and Ukraine. The government has also invested approximately EUR 9 million in the Prototype Carbon Fund of the World Bank in order to obtain around 2 Tg CO_2eq in emission credits for the first commitment period.

4.7. CAPACITY-BUILDING, EDUCATION, TRAINING AND AWARENESS-RAISING

Capacity-building, education, training and awareness-raising are discussed in detail in Chapter 9. There are, however, a few activities that have a more direct impact on GHG emissions. Motiva Oy'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 economical 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.

Eco-driving is one instrument that has been identified in the National Climate Strategy. Since 1997 eco-driving has been increasingly integrated into the general driving education that is given in Finland. European Car Free Day was organised in Finland for the first time in 2000 and the aim is that it will become a tradition also in Finland. Seventeen cities participated in events related to Car Free Day.

Promotion of public and non-motorised transport is an integrated part of the Finnish transport policy, which is continuously aimed at increasing the attractiveness and market share of these transport modes. An annual cycling week is held at the beginning of May. The new cycling and walking programmes also contain new proposals for specific campaigns and awareness raising.

4.8. THE EFFECT ON LONGER-TERM TRENDS OF POLICIES AND MEASURES

There is no quantitative integrated analysis available yet on longer-term trends of policies and measures on GHG emissions. Since the National Climate Strategy is defined until 2010, no mitigation impacts are presented here beyond 2010.

The National Climate Strategy formulation process and recent research work has, however, indicated that for example changes in the building stock and urban structure have especially a longer-term effect on energy consumption and GHG emissions. Some calculations for mitigation impacts are available until 2020 and beyond.

4.9. POLICIES AND MEASURES NO LONGER IN PLACE

Major policies related to GHG emissions have been maintained in recent years with some modifications.

However, the peat support has been considerably decreased when the energy investment grants have been limited only to renewable energy sources and energy efficiency, as well as to new technology investments. In this connection peat fired power plants are no more relevant.

4.10. NON-GHG MITIGATION BENEFITS

The measures covered by the 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 energy production alternative chosen, for example, on 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.

4.11. COSTS

4.11.1. Impacts on the central government finances

In 1999, a little less than EUR 100 million was spent as government expenditure for development of the technology of energy production and use, for energy conservation and for promotion of renewable energy modes. Of this total sum, around EUR 10 million was spent for auditing, investments, renovation subsidies of buildings and for information dissemination in order to encourage energy savings. Around EUR 20 million of investment subsidies and operational aid was used to promote renewable energy sources. In addition, EUR 35 million of tax subsidies was granted for electricity generated by renewable energy sources (Table 4-9).

Table 4-9

Estimate on the Government's financing need and financing to be channelled through the energy taxation scheme, EUR million (at the currency value of 1999)

Object of Financing	In 1999	Average need by 2010
R&D, energy use and conservation	35	35
R&D, energy production	28	33
Promotion of energy conservation	5	13
Investment aid for renewable energy sources	20	33
Total of financing	**88**	**115**
Renovation of energy and heating systems of residential buildings	5	17
Total of financing from the Budget and funds	**93**	**131**
Tax subsidy for electricity generated by renewables	35	60
Total of financing and tax subsidies	**128**	**190**

Furthermore, if the use of coal was limited in energy production by administrative measures, additional expenses might incur for the Government in the form of a compensation obligation concerning the so-called frustrated costs. According to a certain estimate, such costs could amount to a fixed compensation of at least EUR 115–130 million, but energy producers have made considerably higher estimates on the possible compensation claims.

The government has agreed on the spending limits of central government finances for the period 2002-2005, in which the appropriations required by the improvement of the efficiency of the climate strategy have been taken into account.

In addition, there are smaller items, such as the ministries' own R&D funds, the felling and chipping subsidy for wood material obtained from management of young forests and part of the funds of co-operation with neighbouring areas, which amount to approximately to few million euros. The impacts on the government financing are shown in Figure 4-4.

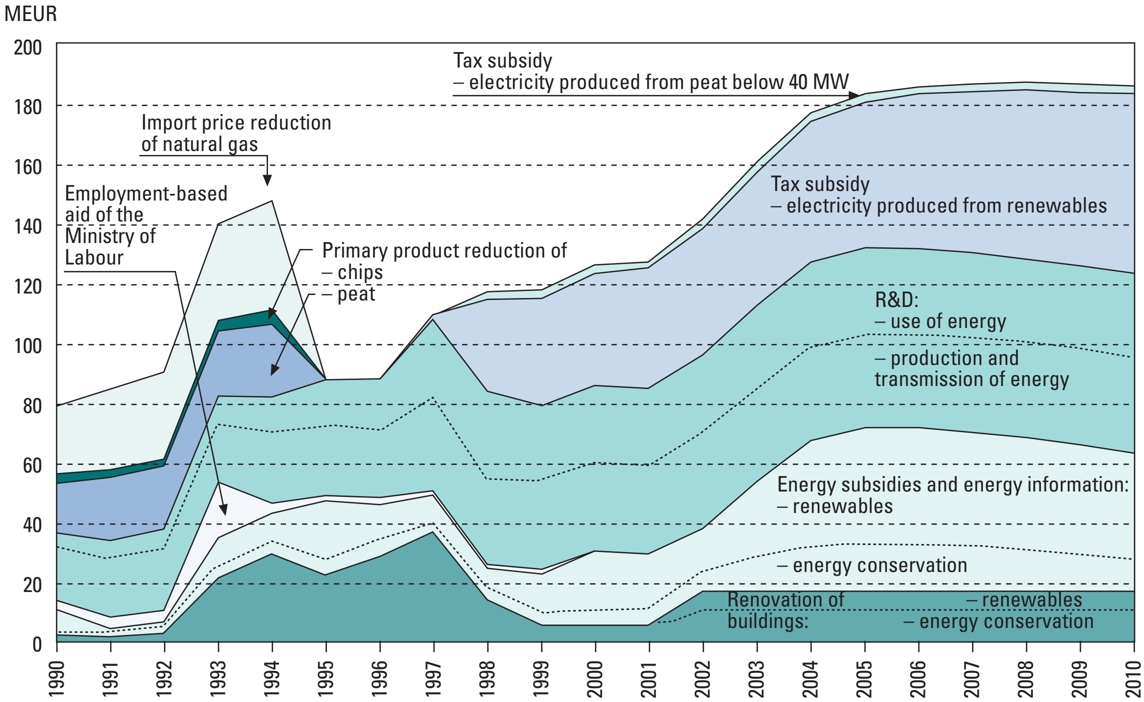

Figure 4-4.
Government subsidies for energy economy in the 1990s and the need for subsidies up to 2010, EUR million. The figures do not include loans, the future amounts at the 1999 currency value, history at the currency value of the year concerned.

In 1999, the revenue from energy taxes totalled around EUR 2.6 billion, of which taxation on traffic liquid fuels accounted for about EUR 2 billion, electricity taxation about EUR 0.3 billion, as was the case with carbon dioxide taxation: approximately EUR 0.3 billion.

The use of energy taxation as a major steering mechanism of the National Climate Strategy would lead to an increase of the energy tax accrual by EUR 0.6-0.8 billion by the year 2010. If the taxation on traffic liquid fuels is not tightened, the growth of the revenue from energy taxes would be of the order of EUR 0.15 to 0.5 billion.

4.11. 2. Impacts on the economy as a whole

ENERGY EXPENDITURE OF ENERGY CONSUMERS

The energy expenditure of energy consumers will rise, as energy taxation becomes more stringent, the price of energy excluding tax will go up along with the costs and because the energy conservation investments will bind more resources than before. Lower consumption due to energy savings will, naturally, bring down the costs of energy.

Two research projects (Forsström and Honkatukia 2001; Kemppi et al. 2001) compared to changes in the energy expenditure of energy consumers. The costs will be highly dependent on the energy taxation alternative[10] chosen and on the electricity supply decisions[11].

According to both research projects, the annual direct energy costs of energy consumers would rise, depending on the electricity supply alternatives, by EUR 0.8-1.25 billion by 2010 compared with the 'with measures scenario'.

IMPACTS ON THE NATIONAL ECONOMY

If energy taxes will be used considerably more in implementing the climate strategy, other taxation can be alleviated by using the increasing energy tax revenue for e.g. bringing down the income tax and social security contributions. The studies showed that the choice of the redistribution procedure did not have any significant impact on the final outcome with the tax levels studied.

The both research projects (Forsström and Honkatukia 2001; Kemppi et al. 2001) indicate, that implementation of the strategy would impair the development of national economy. However, the intensity of the effects will mainly depend on the structure of electricity procurement chosen and, to a lesser degree, on the energy taxation alternatives.

The climate strategy would lead to a decrease in employment by 6 000–11 000 persons/year by 2010. The KIO1 alternative based was in all the cases studied weaker. The climate strategy, especially the electricity supply choices, would most affect the development of the traditional energy-intensive industries, such as the forest products industry, chemical industry, metal manufacturing and the building material industry.

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[10] Three alternatives were studied: a) Energy taxes will be raised considerably, b) Energy taxes will be raised except taxes on traffic liquid fuels c) Energy taxes will not be raised.

[11] KIO1 alternative is mainly based on the use of additional natural gas in electricity generation, while KIO2 is based on construction of additional nuclear power capacity.

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5 PROJECTIONS AND ASSESSMENT OF POLICIES AND MEASURES

5.1. INTRODUCTION

Total CO_2 eq emissions in the base year 1990 were 77.1 Tg according to the latest inventory (excluding land-use change and forestry). Emissions in 1999 were 76.2 Tg, a 1% reduction compared with the base year of 1990. Finland has to maintain its emissions at the 1990 level by 2008–2012 under the burden-sharing agreement of the EU.

The major source of GHG emissions is the energy sector followed by transport, agriculture, industrial processes and waste management. In the 1990s, CO_2 emissions from fuel combustion have grown from 53.9 Tg to 56.8 Tg in 1999, whereas CH_4 emissions from waste management and all GHG emissions from agriculture have been reduced. The following analysis first gives an overview of fuel combustion related to CO_2 emissions in the 1990s with the background of the Government's energy and climate policies. Subsequently, projections of all GHGs based on the National Climate Strategy are presented.

5.2. CARBON DIOXIDE EMISSIONS IN 1990–1999

The First National Communication 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 concerning the possibilities of future electricity imports was taken. It was seen that in certain circumstances the demand for electricity would have to be wholly covered by indigenous production and the 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 natural that these assumptions lead to high emission levels (CO_2 emissions from fuel combustion), as can be seen in Fig. 5-1. Assumptions behind this scenario are considered irrelevant after 1999.

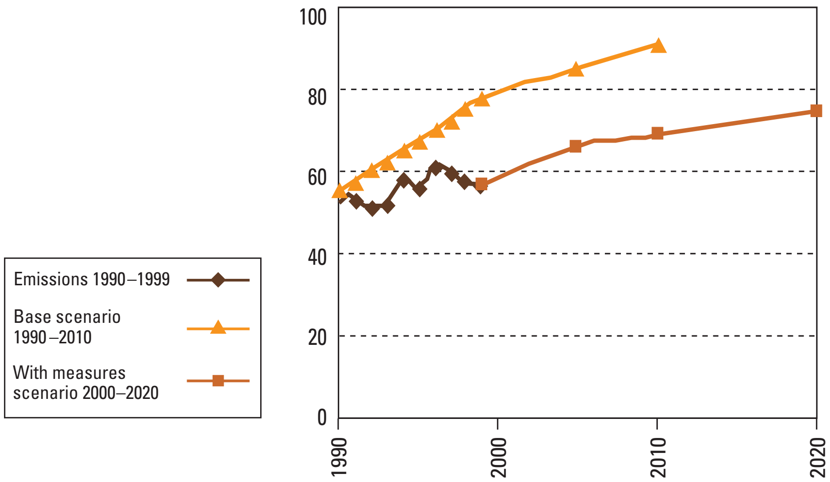


Figure 5-1.
Comparison of the base (reference) scenario of Finland's First National Communication with the 'with measures' projections (CO_2 emission from fuel combustion).

The increase of emissions of the base scenario never materialized, owing to an active energy policy, favourable trends in the Nordic electricity markets and milder than normal weather conditions, among other things. In 1999 the actual CO_2 emissions from fuel combustion were approximately 57 Tg, which is significantly lower than the emission level of the base scenario.

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 in the Nordic market was in most years high in comparison with electricity demand. Therefore, production of coal-fired condensing power in Finland remained on a relatively low level. One-quarter of the difference between the base scenario and the actual emissions is due to a change in the fuel mix in the 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 have also been important in this positive development (see Table 4-1), but their mitigation impact in relation to the base scenario has not been quantified in detail.

5.3. PROJECTED GREENHOUSE GAS EMISSIONS FOR 2000–2020

5.3.1. Scenario formulation

The preparations for the National Climate Strategy were started by sector in 1999. The ministries most involved were the Ministry of Trade and Industry, the Ministry of the Environment, the Ministry of Transport and Communications, the Ministry of Agriculture and Forestry. The Ministry of Trade and Industry has coordinated the preparation process and a Kyoto Ministerial Working Group has formulated policy options.

The process of scenario formulation is described in Figure 5-2. The background material for the National Climate Strategy was compiled of sector-specific reports made by the ministries. In order to make economic assessments of various policy options, two separate model projects was used (ETLA-VTT Energy and VATT-VTT Energy). By the help of model calculations the emissions were finetuned to the target level in the years 2008–2012. This was not exactly the result of the sectoral programmes.

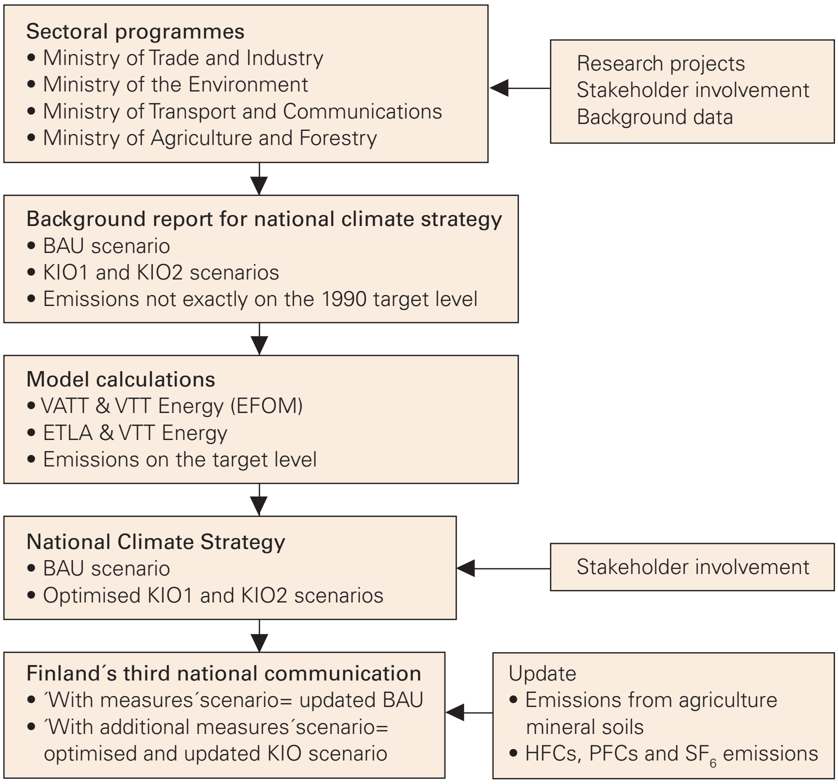


Figure 5-2
Scenario formulation. Two scenarios are discussed in this context: a 'with measures' scenario for the years 2000–2020 and a 'with additional measures' scenario for the years 2000–2010. Both scenarios are based on the National Climate Strategy. Basic assumptions are given in Table 5-1. The methodology of scenario formulation is described in Chapter 5.3.5.

Emissions from agriculture and HFCs, PFCs and SF_6 emissions are updated in both scenarios for this Communication according to the most recent findings.

Table 5-1
Basic assumptions and features for the scenarios. No policies and measures are defined for the 'with additional measures' scenario for the years 2010–2020.

	Scenario	2000–2005	2005–2010	2010–2020
Global operational environment	Stable	Stable	Stable	Stable
Population	Both scenarios	Slow growth	Slow growth	Slow growth
Regional structure	Both scenarios	Urbanization continues	Urbanization continues	Urbanization continues
Transport policy	With measures	Current P&Ms	Current P&Ms	Current P&Ms
	With additional measures	Some additional P&Ms	Some additional P&Ms	Some additional P&Ms
Agricultural policy	With measures	Agenda 2000	Agenda 2000	Agenda 2000
	With additional measures	Renewed Agenda 2007 onwards	Renewed Agenda 2007 onwards	Agenda 2007
Economic growth	Both scenarios	> 3%/a	> 2%/a	2%/a
World-market prices of fuels	Both scenarios	Stable	Stable	Stable
Energy taxation	With measures	Current level	Current level	Current level
	With additional measures	Stricter, same structure	Clearly stricter increase, same structure and development within EU	Clearly stricter increase, same structure and development within EU
Development of technology	With measures	Current rate	Current rate	Current rate
	With additional measures	Faster rate	Faster rate	Faster rate
Norms	With measures	Current	Current	Current
	With additional measures	Increase	Major increase	Some increase
Hydropower	Both scenarios	No major addition	No addition	No addition
Competitiveness of bioenergy	With measures	Slight improvement	Slight improvement	Slight improvement
	With additional measures	Improvement	Improvement	Improvement
Use of other renewables	With measures	Current growth	Current growth	Current growth
	With additional measures	Major increase	Major increase	Major increase
Natural gas grid	With measures	Current	Extended in Southern Finland	No further extensions
	With additional measures	Current	Extended in Southern Finland	No further extensions
Nuclear power	With measures	Current	Current	Current
	With additional measures (natural gas alternative)	Current	Current	Current
	With additional measures (nuclear alternative)	Current	1300 MW increase in 2010	No further increase
Use of coal	With measures	Increase	Increase	Increase
	With additional measures (natural gas alternative)	Clear decrease	Phase out within gas grid area and in condensing plants	No use within gas grid area and in condensing plants
	With additional measures (nuclear alternative)	Decrease	Displaced partly by nuclear power	Displaced partly by nuclear power
Imports of electricity	Both scenarios	8 TWh/a	6 TWh/a	6 TWh/a

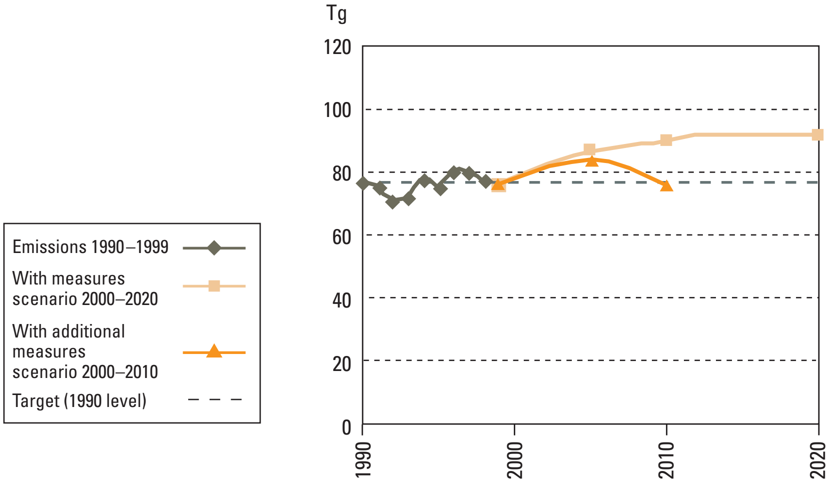


Figure 5-3
Comparison of the 'with measures' scenario for the years 2000–2020 with the 'with additional measures' scenario based on the National Climate Strategy for the years 2000–2010. All GHG emissions.

The main characteristic of the 'with measures' scenario is the assumption of unchanged energy and climate policy. The prevailing measures would be kept in force in real terms but no new additional measures would be taken. Under these assumptions the emissions would increase from 77.1 million tonnes (Tg) equivalent of CO_2 in 1990 to close to 90 million tonnes in 2010 (Fig. 5-3; Tables 5-2 and 5-3).

In order to meet the climate strategy targets, the Government finds it necessary to implement a new energy conservation programme, and a programme for promoting renewable sources of energy. Together these programmes may account for about half of the targeted annual emissions reduction. A reduction in emissions equivalent to a one Tg of CO_2 may be achieved with measures concerning methane and other GHGs.

Table 5-2

Greenhouse gas base year emissions, current emissions and projected emissions (Tg CO_2 eq) in Finland

Greenhouse gas	Base year (1990)	1999	2005	2005	2010	2010	2020
			With measures	With add. measures	With measures	With add. measures*	With measures
CO_2	62.5	64.2	73.3	71.5	76.4	64.7	81.7
CH_4	6.1	3.9	3.7	3.8	3.5	2.8	3.1
N_2O	8.4	7.7	8.3	7.8	8.3	7.4	8.4
HFCs+PFCs	0.001	0.35	1.1	0.6	1.7	0.9	2.2
SF_6	0.07	0.03					
Total CO_2 eq	**77.1**	**76.2**	**86.3**	**83.8**	**89.9**	**75.8**	**95.4**

* *The base year (1990) figures have recently been revised. Therefore the target figure for 2010 (75.8 Tg) differs from the revised 1990 emissions (77.1 Tg).*

The rest of the targeted emissions reductions would also be achieved in the heat and electricity supply sectors, where the use of coal must be reduced considerably by increasing the utilisation of natural gas, or by building more nuclear power capacity, or by a combination of these two measures.

Table 5-3

Greenhouse gas base year emissions, current emissions and projected emissions (Tg CO_2 eq) in Finland by sector

Sector	Base year (1990)	1999	2005	2005	2010	2010	2020
			With measures	With add. measures	With measures	With add. measures ***	With measures
Energy*	46.4	49.7	59.0	57.3	62.3	51.3	67.6
Transport	13.2	13.5	13.8	13.7	13.9	13.7	13.8
Industrial processes	2.9	2.8	3.6	3.0	4.5	2.6	5.2
Solvents**	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Agriculture	10.2	7.6	7.4	7.4	6.8	6.7	6.8
Waste	3.8	1.7	1.7	1.7	1.6	0.8	1.2
Other	0.6	0.8	0.7	0.7	0.7	0.7	0.7
Total CO_2 eq	**77.1**	**76.2**	**86.3**	**83.8**	**89.9**	**75.8**	**95.4**

**Excluding transport, **Solvents and other product use, ***The base year (1990) figures have recently been revised. Therefore the target figure for 2010 (75.8 Tg) differs from the revised 1990 emissions (77.1Tg).*

5.3.2. Indirect greenhouse gas emissions

Changes in indirect greenhouse gas emissions (Table 5-4) are based on the Strategic Environmental Impact Assessment of the National Climate Strategy (Hildén et al. 2001). SO_2, NO_x and particle (PM) emissions decrease from the current level already in the 'with measures' scenario. Further reductions are achieved with additional measures, but differences between the two 'with additional measures' scenarios are minor.

Emissions of volatile organic compounds (NMVOC) are projected to decrease regardless of the GHG scenarios. Additional measures are, however, needed for targeted sources in order to reduce NMVOC emissions at internationally agreed levels. The GHG scenarios have no effect on carbon monoxide (CO) emissions.

Table 5-4

Indirect greenhouse gas emissions (NO_x and SO_2) 1998–2020, Gg/a

Pollutant	Emissions in 1998	With additional measures in 2010	With additional measures in 2020 (natural gas alternative)	With additional measures in 2020 (nuclear alternative)
NO_x	252	187	170	172
SO_2	90	114	91	88
PM	48	42	41	41

5.3.3. Sectoral data

Introduction

Sectoral data are based on the common reporting format (CRF) of the Framework Convention on Climate Change (UNFCCC) with the exception of the transport sector. Transport is separated from the energy category because its policies and measures differ from the general ones in the energy sector. The 1990 and 1999 data are based on the official latest UNFCCC reporting (March 2001), whereas projections are based on the National Climate Strategy (see Chapter 5.3.1 for details). Emissions from international bunkers are reported in accordance with the UNFCCC requirements.

Energy

Carbon dioxide emissions associated with energy generation and utilisation are key factors in meeting our national target. The government's climate strategy is based on a commitment to continued improvements in the efficient use of energy. The use of renewable sources of energy will be boosted. The actions in these fields will be taken regardless of the measures implemented in electricity production.

Despite improved energy conservation measures, total energy and electricity consumption is estimated to continue rising, albeit clearly slower than in the past decades. Because of the rise in electricity consumption and phasing out of ageing power plants, new power plants should be built. Basing the climate strategy on large imports of electricity is not justified. The measures concerning electricity production are based on the assumption that electricity imports will diminish from their record high levels of recent years.

In addition to the principles and actions concerning electricity supply outlined above, other measures are required to provide further electricity that is less GHG intensive. To achieve this, there are two main approaches to choose from: allowing the construction of additional nuclear power production capacity, or banning the combustion of coal in the power-only and in CHP generation.

Table 5-5

Primary energy sources in 1990–2020 (PJ), 'with measures' and 'with additional measures'

Source	1990	1999	2010		2020
			With measures	With add. measures**	With measures
Oil	375	364	348	327	343
Coal *	167	151	247	84	281
Natural gas	91	138	218	301	268
Nuclear	198	241	239	239	230
Imports of electricity	39	40	21	21	21
Hydro	39	45	46	50	46
Wind	0	0.2	2	4	3
Wood and peat ***	231	335	373	368	394
Total	1 140	1 315	1 495	1 394	1 585

**coal, coke, blast furnace and coke oven gases*
***data is based on original KIO1 scenario of the background report of the National Climate Strategy, not EFOM optimised 'with additional measures' scenario.*
**** includes small amounts of municipal solid waste and reaction heat of industry.*

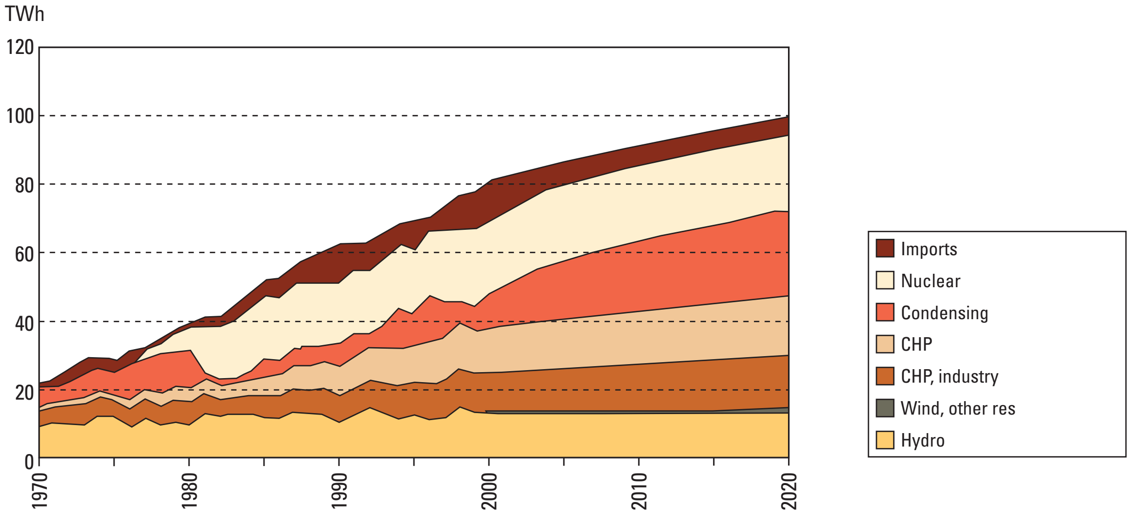


Figure 5-4
Electricity production by source in 1970-2020 (TWh), 'with measures' scenario.

Table 5-6

Base year emissions, current emissions and projected emissions (Tg CO_2 eq) from energy (excluding transport)

Greenhouse gas	Base year (1990)	1999	2005	2005	2010	2010	2020
			With measures	With add. measures	With measures	With add. measures	With measures
CO_2	45.0	47.6	56.5	54.8	59.8	48.2	64.9
CH_4	0.4	0.4	0.4	0.5	0.4	0.5	0.3
N_2O	1.1	1.8	2.1	2.0	2.1	2.6	2.4
Total CO_2 eq	**46.4**	**49.7**	**59.0**	**57.3**	**62.3**	**51.3**	**67.6**

Transport

The long-term vision and strategy of the Ministry of Transport and Communications called "Towards a sustainable and intelligent transport sector" contains projected trends of passenger and road transport volumes until 2025. Behind these trends is the vision of a future transport system that should be based to an increasing extent on sustainability and increasing use of information technologies. Such a transport system should take into account economic, ecological, social and cultural viewpoints. The strategy aims at reaching a transport system in which the demand for road transport (passenger car traffic and road freight traffic) should peak by the year 2020 and start gradually to decrease (Fig. 5-5; Fig. 5-6).

The 'with additional measures' scenario based on the EFOM optimised KIO scenario related to traffic emissions leads to a conclusion that the CO_2 eq emissions caused by transport would slightly increase by the year 2010 compared to the base year level (Table 5-7). This is somewhat contrary to those projections that have been calculated using the LIPASTO model and which have been used when preparing transport sector specific measures for the National Climate Strategy. This is due to the fact that the EFOM optimisation suggests emissions reductions to be more cost-effective in other sectors compared to transport. According to the LIPASTO projections, transport sector policies and measures are considered to be sufficient to guarantee that emissions levels in 2010 do not exceed the 1990 level.

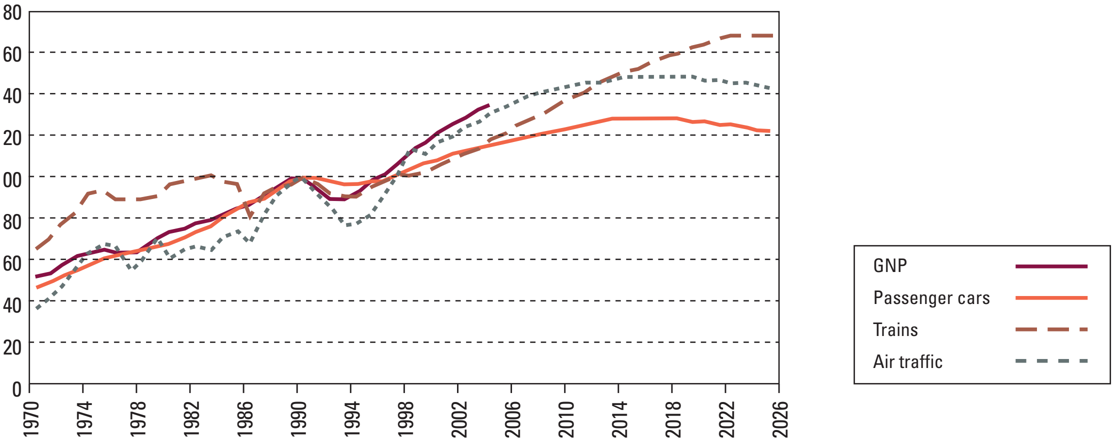


Figure 5-5

Volume of passenger transport (number of passengers) according to the Strategy of "Towards a Sustainable and intelligent transport system" (1990=100).

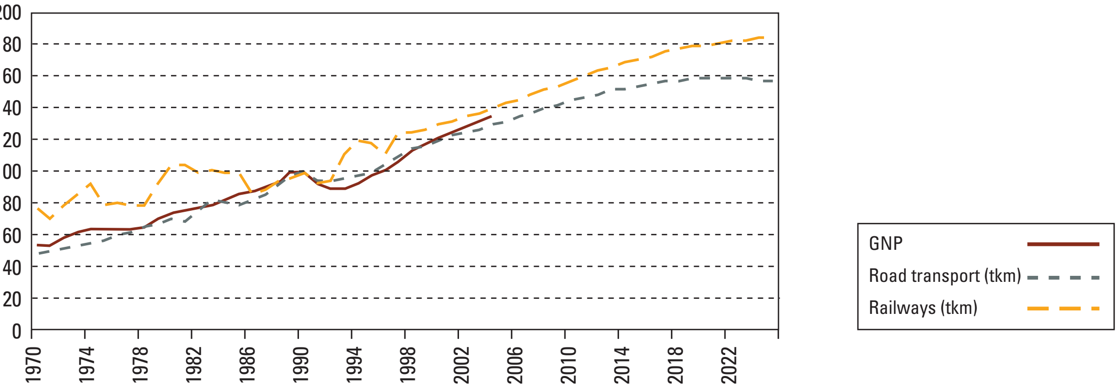


Figure 5-6

Volume of freight transport according the Strategy of "Towards a Sustainable and intelligent transport system" (1990=100).

Table 5-7.

Base year emissions, current emissions and projected emissions (Tg CO_2eq) from transport

Greenhouse gas	Base year (1990)	1999	2005	2005	2010	2010	2020
			With measures	With add. measures	With measures	With add. measures	With measures
CO_2	12.5	12.7	12.8	12.7	12.8	12.7	12.8
CH_4	0.07	0.07	0.04	0.06	0.03	0.06	0.03
N_2O	0.6	0.7	0.9	0.9	1.1	0.9	1.0
Total CO_2 eq	**13.2**	**13.5**	**13.8**	**13.7**	**13.9**	**13.7**	**13.8**

Industrial processes

Greenhouse gas emissions for the industrial sector have been quite stable during the 1990's. The biggest share, about half the sectors emissions, come from N_2O emissions, as can be seen in Table 5-8. Nitric acid production by the chemical industry is the sole cause of N_2O emissions. Emissions are expected to decrease in the 'with additional measures' scenario. The CO_2-emissions originate from cement and lime production. The amount of the F-gases grew rapidly during the 1990s from practically zero to 10% of the industry's emissions. Without additional measures, their share will be about 40% by 2010. The increase comes mainly from hydrofluorocarbons (HFCs). No major changes in emissions from solvents and other product use (Table 5-9) and emissions from fuels used as feedstocks are expected (Table 5-10).

Table 5-8

Base year emissions, current emissions and projected emissions (Tg CO_2 eq) from industrial processes

Greenhouse gas	Base year (1990)	1999	2005	2005	2010	2010	2020
			With measures	With add. measures	With measures	With add. measures	With measures
CO_2	1.2	1.1	1.0	1.1	1.2	1.1	1.4
CH_4	0.01	0.01	0.02	0.02	0.02	0.02	0.02
N_2O	1.6	1.3	1.5	1.2	1.5	0.5	1.6
HFCs+PFCs	0.001	0.3	1.1	0.6	1.7	0.9	2.2
SF_6	0.1	0.03					
Total CO_2 eq	**2.9**	**2.8**	**3.6**	**3.0**	**4.5**	**2.6**	**5.2**

Table 5-9

Base year emissions, current emissions and projected emissions (Tg CO_2 eq) from solvents and other product use

Greenhouse gas	Base year (1990)	1999	2005	2005	2010	2010	2020
			With measures	With add. measures	With measures	With add. measures	With measures
CO_2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total CO_2 eq	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**

Table 5-10

Base year emissions, current emissions and projected emissions ($Tg\ CO_2$ eq) from other sources (emissions from fuels used as feedstocks)

Greenhouse gas	Base year (1990)	1999	2005	2005	2010	2010	2020
			With measures	With add. measures	With measures	With add. measures	With measures
CO_2	0.6	0.8	0.7	0.7	0.7	0.7	0.7
Total CO_2 eq	**0.6**	**0.8**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**

Agriculture

Greenhouse gas emissions from agriculture have diminished since 1990. This trend will be safeguarded in the common agricultural policy of the EU by adopting support measures encouraging such production that minimises the burden on the greenhouse gas balance, besides other objectives.

Action designed to reduce methane emissions from livestock farms will continue to be taken, and the use of field biomasses for energy production will be developed.

The estimated development of agriculture covers the changes in agricultural production and structure since 1990 and their impacts on the greenhouse gas emissions, and also on the agri-environmental measures for 2000–2006 based on the Agenda 2000 reform. The 'with measures scenario' of the development of agricultural production and emissions of greenhouse gases in the first commitment period 2008–2012 and after this until 2020 has the same basic assumptions (Fig. 5-7, Table 5-11).

Figure 5-7
Emissions from agriculture according to the 'with measures scenario' in 1990–2020 by sources (excluding CO_2 emissions from mineral soils)[2].

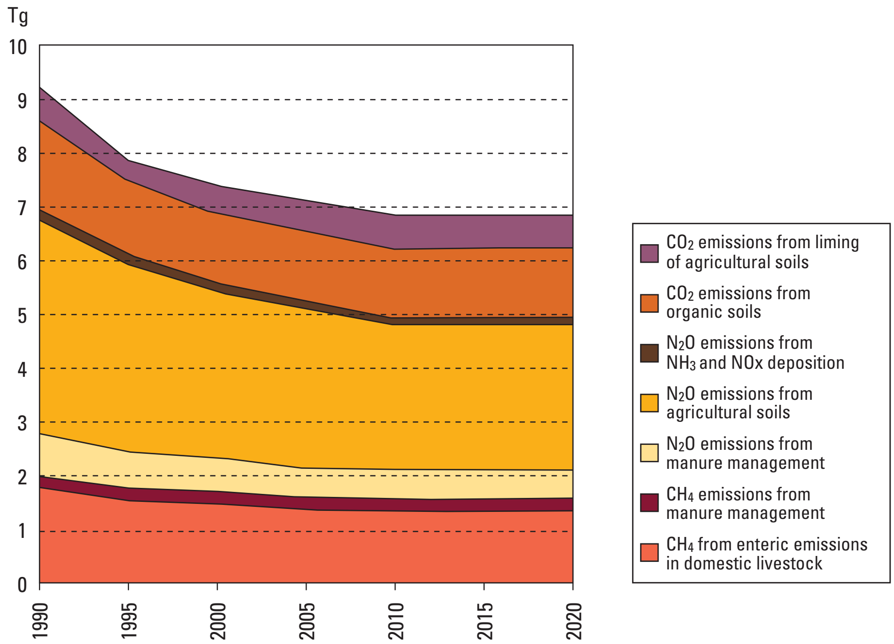


Table 5-11

Base year emissions, current emissions and projected emissions (Tg CO_2 eq) from agriculture[2]

Greenhouse gas	Base year (1990)	1999	2005	2005	2010	2010	2020
			With measures	With add. measures	With measures	With add. measures	With measures
CO_2	3.2	2.0	2.2	2.2	1.9	1.9	1.9
CH_4	2.0	1.8	1.6	1.6	1.6	1.5	1.6
N_2O	4.9	3.8	3.6	3.6	3.3	3.3	3.3
Total CO_2 eq	**10.2**	**7.6**	**7.4**	**7.4**	**6.8**	**6.7**	**6.8**

[2] Inclusion of CO_2 emissions from agricultural soils is not yet fully agreed upon internationally. They are currently included in the inventory as well as in projections. Exclusion of them would decrease CO_2 emissions from agriculture by 1 Tg in 1990, 0.3 Tg in 1999 and 0.3 Tg in 2005. Depending on the accounting system to be agreed upon, and on the development of land management practices, CO_2 emissions from mineral soils due to land use change may turn out to be a net sink and not a source by 2020. A net sink estimate for 2020 ranges between 0.1 and 0.6 Tg CO_2.

Furthermore, an alternative and illustrative scenario was elaborated in order to estimate the sensitivity of the possible review in the common agricultural policy of the EU. In this alternative, the 'with additional measures' scenario, further emphasis is put on environmental, social and cultural aspects and non-marketable benefits. According to this hypothetical scenario, greenhouse gas emissions are slightly lower compared to the 'with measures scenario'.

Forestry

According to Finland's National Forest Programme (NFP) 2010, total production in 2010 is expected to be between 63 - 68 million m^3. Based on a number of studies made for the preparation of the National Climate Strategy, net removals from forests (excluding soils and subject to level of total production) are estimated to be between 3 and 10 Tg CO_2 in 2010. Provided that total production would be 65 million m^3, annual increment in forests is estimated to be 102 Tg CO_2 and drain 94 Tg in 2010, In 2020, annual increment would be 110 Tg CO_2 and drain 91 Tg (Figure 5-8).

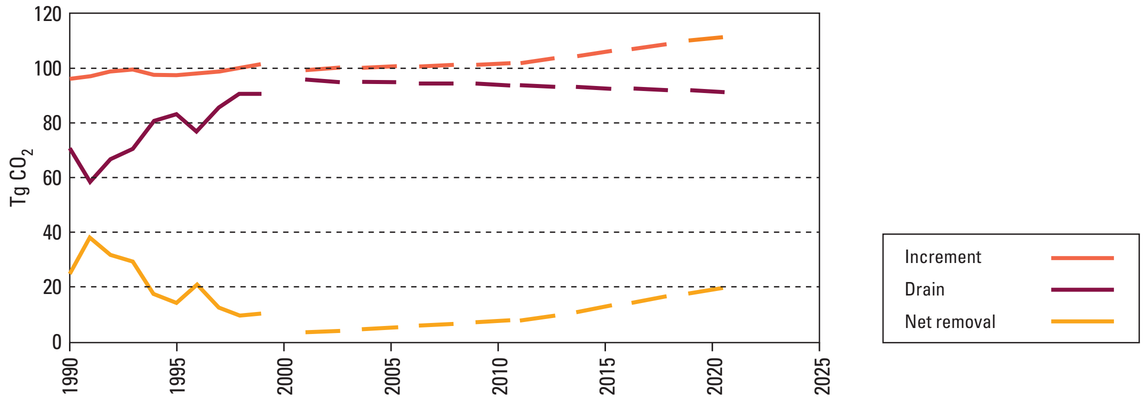


Figure 5-8
An estimation of the 'with measures scenario" of increment and drain of forests in Finland in 1990-2020 (according to the National Forest Programme 2010), Tg CO_2/a.

Waste management

In waste management, efforts will be made to utilise source-separated waste fractions as materials, on the one hand, and to utilise combustible, unusable waste separated at source or at a processing utility as energy in existing energy production plants, on the other hand. Furthermore, more and more efforts are being made to reduce the generation of waste. The objective is to limit more effectively than at present the quantity of biodegradable, methane-producing waste ending up at solid waste disposal sites.

Table 5-12

Waste disposal on land (Gg)

Type of waste	1990	1999	2005	2005	2010	2010	2020
			With measures	With add. measures	With measures	With add. measures	With measures
Municipal solid waste	2450	1488	1537	1178	1377	643	1222
Municipal sludge (d.m.)*	62	7	4	4	2	2	0
Municipal sludge (d.m.)*	210	152	140	128	122	100	108
Industrial solid waste	2618	2479	905	862	773	694	671
Constr. and demolition waste**	1262	457	572	564	530	514	427

**dry matter, **without soil and stones*

CH_4 emissions from waste disposal on land (Table 5-12) are estimated using the IPCC default method. If the IPCC first order decay method had been used the emission reductions would have been considerably smaller. The summary of emissions in the waste sector is given in Table 5-13.

Table 5-13

Base year, current emissions and projected emissions (Tg CO_2 eq) of the waste sector

Greenhouse gas	Base year (1990)	1999	2005	2005	2010	2010	2020
			With measures	With add. measures	With measures	With add. measures	With measures
CH_4	3.7	1.7	1.6	1.6	1.5	0.7	1.1
N_2O	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total CO_2 eq	**3.8**	**1.7**	**1.7**	**1.7**	**1.6**	**0.8**	**1.2**

International bunkers

Emission projections from international bunkers are based on estimates by Statistics Finland. A slight increase of emissions from international bunkers is expected (Table 5-14), and no policies and measures are currently defined for this sector.

Table 5-14

Base year emissions, current emissions and projected emissions (Tg CO_2 eq) from international bunkers (aviation and marine)

Greenhouse gas	Base year (1990)	1999	2005	2005	2010	2010	2020
			With measures	With add. measures	With measures	With add. measures	With measures
CO_2	2.8	2.8	3.0	3.0	3.2	3.2	3.2
CH_4	0.026	0.002	0.002	0.002	0.002	0.002	0.002
N_2O	0.4	0.2	0.2	0.2	0.2	0.2	0.2
Total CO_2 eq	**3.2**	**3.1**	**3.3**	**3.3**	**3.4**	**3.4**	**3.4**

5.3.4. Sensitivity Analysis

Depending on the assumptions put forward in the studies – for example, what is the volume of electricity imports to Finland – the findings of the scenarios vary considerably. These sensitivity analyse are described in more detail in the publication by the Ministry of the Trade and Industry (MTI) publication on the Background Report to the National Climate Strategy (Kauppa- ja teollisuusministeriö 2001). However, the calculations come clearly to the conclusion that Finland's greenhouse gas emissions cannot be brought down to the target level during the period 2008–2012 unless energy consumption intensity can be made clearly even more efficient than today and unless energy supplies can be based on modes of energy with low or zero emission levels.

There are many activities causing GHG emissions on which government actions have little if any effect, for example, activities such as net electricity import, domestic hydropower production and the growth of the energy-intensive industry. The treatment of the carbon sinks can have a very large effect on the Finnish greenhouse gas balance. Many other assumptions also affect also the scenarios.

If the growth of the energy-intensive industrial branches of the industry is only moderate and the competitiveness of indigenous electricity production insufficient in relation to imports, the carbon dioxide emissions from combustion would clearly remain at a lower level than predicted. On the other hand, the levels of emissions can also rise higher than expected, if the production conditions of the energy-intensive industry are better than anticipated or if there are only a few possibilities of importing electricity.

The trend will decisively depend on a few factors that are difficult to predict. The general economic development is one of the main factors, but the assumptions on the production growth rate of the energy-intensive branches, such as the pulp and paper industry, manufacture of metals and the chemical industry, will play a special role. The sensitivity analyses presented in the background report to the strategy indicate that carbon dioxide emissions can vary quite widely within the next few decades.

Assumptions on which forms of production should be used to cover the growth of electricity consumption are also in a central position. On the other hand, it must be taken into account that the national energy or climate policy can be used to influence those factors of competitiveness that affect both the development conditions of industry and the relationship between indigenous electricity generation and imported electricity.

Uncertainty as to economic development will also be reflected on a wider scale (vehicle stock, demand for services, etc.) on the development of emissions, but it will have minor effects compared to the factors mentioned above. Meeting the wood-felling targets will also be directly reflected in the utilisation potential of energy from wood and thereby on achieving the targets set for greenhouse gas emissions.

5.3.5. Methodology

Sectoral programs

The Ministry of Trade and Industry has combined the results of sectoral programmes (see chapter 5.3.1), which were based on several other models (Ministry of Trade and Industry 1997). Emissions from waste management were based on a sectoral report by the Ministry of the Environment. The Finnish Environment Institute has made the calculations using the mass balance method (Dahlbo et al. 2000). The energy consumption of buildings has been estimated partly with the REM model (Nippala et. al. 1995) developed by VTT and Tampere University of Technology in collaboration with MTI.

Projections related to traffic emissions are included in the sectoral report of the Ministry of Transport and Communications. The results have been calculated using the LIPASTO model developed by VTT (2000). Emissions from international bunkers are based on data provided by Statistics Finland

Emission projections from agriculture are based on the sectoral report of the Ministry of Agriculture and Forestry . The methods were developed by VTT Energy (Pipatti et al. 2000). The climate strategy measures concerning forestry are based on the National Forestry Programme (Maa- ja metsätalousministeriö 1999). Calculations related to HFCs, PFCs and SF_6 are based on work by Finnish Environment Institute and VTT Energy (Oinonen & Soimakallio 2000, Oinonen 2000).

Pipatti (2001) has recently summarized the methodologies used for compilations of the Finnish inventories.

Economic and environmental impacts

In order to study the effects of the climate strategy two major research projects were launched at the beginning of 1999. In one project the Government Institute for Economic Research (VATT) studied the effects in collaboration with the Technical Research Centre of Finland (VTT), and in the other project, the Research Institute of the Finnish Economy (ETLA) and VTT produced joint estimates of the effects (Kemppi et al. 2001, Forsström & Honkatukia 2001).

The prime aim of both studies was the assessment of the climate policy packages set up by the ministerial group. The balanced budget principle was an important premise for the projects. The principle implies that extra tax revenues should be recycled and a fall-back in tax revenues should be recouped. Concerning the economic effects of different scenarios see also Chapter 4.

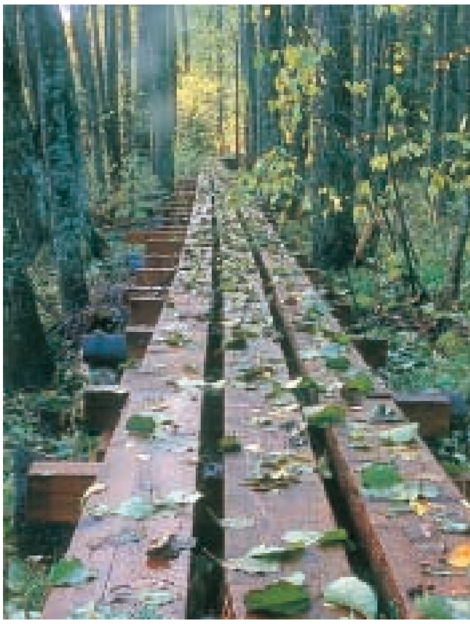
ETLA/VTT model

ETLA and VTT have developed a computable general equilibrium model that combines a top-down approach of economic behaviour with a bottom-up description of energy and paper industries. The model facilitates a simultaneous analysis of both economic and technological choices.

The energy sector comprises separate electricity generation, district heat generation, and combined heat and electricity generation. Each of these is further divided according to production technologies, following an engineering approach. The model takes into account fuel switching and improvement of fuel efficiency.

Forest industries are modelled separately for the mechanical and chemical forest industries. The former comprises the manufacture of wood products and timber and, as a by-product, wood waste that is used as a fuel or a fibre source in chemical paper industries. Chemical paper industries consist of the six most important product lines ranging from pulp to fine graded papers.

It is assumed in the model that imports and exports are imperfect substitutes. This substitutability differs both between industries and products.



Consumers are modelled with a representative consumer. The consumer receives wages and rental for capital from firms and income transfers from the public sector, and uses its income optimally for consumption, taxes, and savings. Investment is determined both by the demand for capital by firms as well as supply of savings by the firm. The rental for capital depends on the time-span under study and also on the assumptions concerning the rest of the world. In the short run, a balance-of-payments restriction is imposed, but this can be modified in a longer-run treatment. World demand and world market prices are taken to be exogenous.

The public sector produces a public good that does not improve the consumer's utility. This assumption can easily be lifted and is made only to keep the public sector as exogenous as possible. The public sector nevertheless affects the economy via its decisions on taxation.

VATT/VTT models

In the VATT/VTT project two large models were used in an iterative manner. The energy sector calculations are carried out by means of the EFOM model, managed by VTT Energy. The economic evaluation is largely based on calculations with KESSU, which is owned by the Ministry of Finance but deployed in VATT.

EFOM is an optimisation energy model. Its original design is rooted in an initiative of the European Commission to obtain a model standard for energy system modelling throughout Europe. The Finnish version has been extended and tuned to the Finnish circumstances.

The model looks for the cheapest combination of energy carriers and energy technologies, given the indicated boundaries on emissions, price levels of primary and secondary energy sources, costs of energy saving technologies, the potentials of energy saving technologies, the default improvement of energy efficiency by type of use, the current structure and age distribution of (main) energy conversion and energy using technologies, the economic growth by sector, growth of the buildings stock, growth of the vehicle stock and annual mileage.

Next to energy use per fuel type per sector and emission by type of greenhouse gas, the output from EFOM concerns annualised costs per sector distinguished by:

- *investment in energy conversion capacity (both utilities and heavy industry)*
- *extra use cost due to switches in fuels and/or energy technology*
- *extra investments in energy efficiency*
- *extra energy/carbon tax levied*
- *extra subsidies (mostly on renewables) received*

In addition, the model also gives output on total incited investment by period and by sector as well as the marginal cost levels for energy use and abated emissions.

KESSU is an econometric model of the Finnish economy developed and used by the Ministry of Finance (Hetemäki and Kaski, 1992; Kaski et al. 1998). The latest version of the model (KESSU V) is deployed in VATT and at several places adapted to be able to absorb energy cost information better than in the standard KESSU. KESSU is meant for medium-term forecasts, which implies that the interpretation of results preferably focuses on forecast years between 3 and 10 years. In the study of concern, policy impulses were set to start in 2005, which means that the results for the years 2008, 2010 and 2015 were in focus.

KESSU V has separate blocks for commercial production sectors, households, the public sector and taxation and foreign trade. Important exogenous variables (i.e. can be set 'freely' by the model user) are among others:

- *demand developments on export markets;*
- *international trade prices (import and export) such as the oil price;*
- *technical development;*
- *public sector consumption and investment (volumes);*
- *demographic variables (employable population by age cohort, migration, under aged and retired population, number of house holds/homes).*

Fig. 5-9 gives an overview of the information flow from the policy packages through the models. The policy programmes are first translated into EFOM input. The results from EFOM are fed into KESSU. In case of large macro-economic impacts, the production levels pictured in KESSU's output have to fed back into EFOM in order reassess the energy and emission levels.

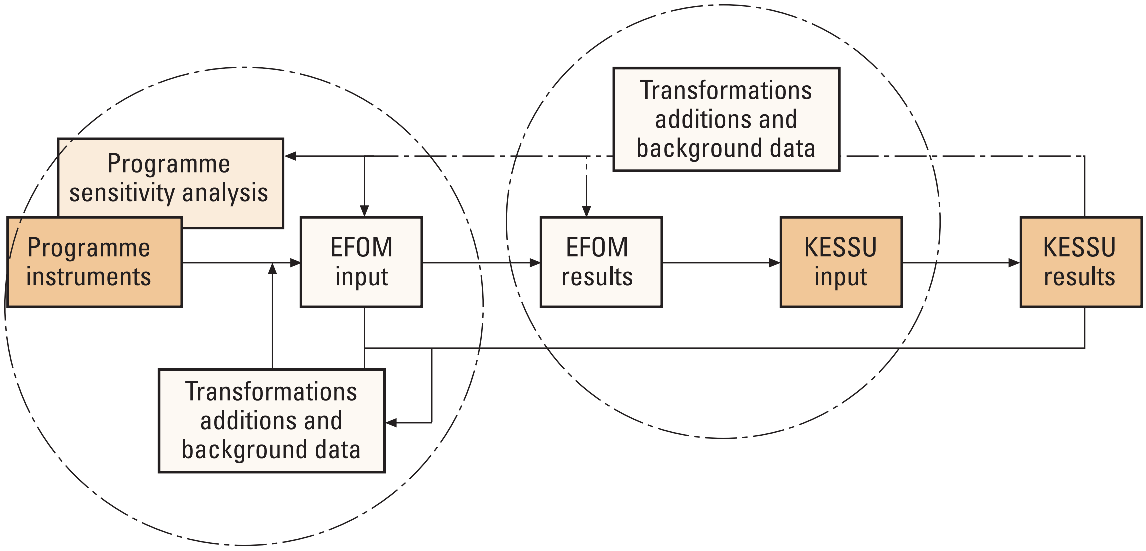


Figure 5-9
Overview of the linked model evaluation system.

Strategic EIA has been conducted by the Finnish Environment Institute (Hildén et al. 2001) based on the input of the various abovementioned models.

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6 CLIMATE CHANGE IMPACTS, ADAPTATION AND VULNERABILITY

6.1. FINLAND'S CLIMATE IN THE FUTURE

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 uncertainty range.

The central temperature scenario gave a mean annual warming of 2.4°C by 2050 and 4.4°C by 2100. This was about one and a half times greater than the average global warming expected in the scenarios of the First IPCC Assessment over the same period. Under the low scenario for Finland the corresponding values were 0.6°C and 1.1°C, and under the high scenario, 3.6°C and 6.6°C, respectively. Warming was expected to be greater in winter than in summer.

The SILMU central scenario for annual precipitation was an increase of 1% per decade (2% per decade in winter and 0.5% per decade in summer). This represented an annual increase of about 30–40 mm by 2050 and 60–70 mm by 2100 in southern Finland. Under the low scenario the increase was 0.5% per decade and under the high scenario, 1.5% per decade.

Scenarios of future atmospheric carbon dioxide concentrations were also provided. The central scenario gave concentrations of 523 ppm by 2050 and 733 ppm by 2100. The corresponding values were 456 ppm and 485 ppm for the low scenario and 555 ppm and 848 ppm for the high scenario.

The recent scenarios developed in the Swedish SWECLIM programme cover also the whole of Finland (Bergström and al. 2001). With the HadCM2 model and a 150% increase in atmospheric CO_2, the mean annual temperature in Finland is predicted to be around 3°C higher than in the present climate. With the ECHAM4 model and a doubling of atmospheric CO_2, the temperature increase is 3–4°C. Thus, the latter model has a higher sensitivity than the former one. The corresponding increases in mean annual precipitation are 15–30% and 10–25%, respectively.

A new, more comprehensive set of scenarios for Finland's future climate and its impacts will be developed in the FINSKEN project. This project, "Developing Consistent Global Change Scenarios for Finland" is a part of the FIGARE programme of the Academy of Finland.

The FINSKEN project aims to develop state-of-the-art projections of changes in environmental and related factors in Finland during the 21st century and beyond. FINSKEN will consider both changes in average conditions as well as in the types of extreme events that can have important impacts.
The scenarios to be developed include:

– *Socio-economic and technological scenarios (population, economic growth, human welfare, emissions)*
– *Atmospheric composition scenarios (carbon dioxide, ozone, sulphur and nitrogen compounds)*
– *Acid deposition scenarios*
– *Climate scenarios (temperature, precipitation, atmospheric circulation)*
– *Sea-level scenarios*

One of the key objectives of FINSKEN is to develop scenarios that are mutually consistent. Many environmental changes tend to be studied independently when actually they have a close dependence on other changes (Fig. 6-1). One method of encouraging consistency is for all scenarios to be based on the same underlying socio-economic driving factors. Given the global or transnational scope of environmental changes, they should also be consistent with projections widely accepted internationally. To achieve this, a number of global emissions scenarios developed by the IPCC are being adopted.

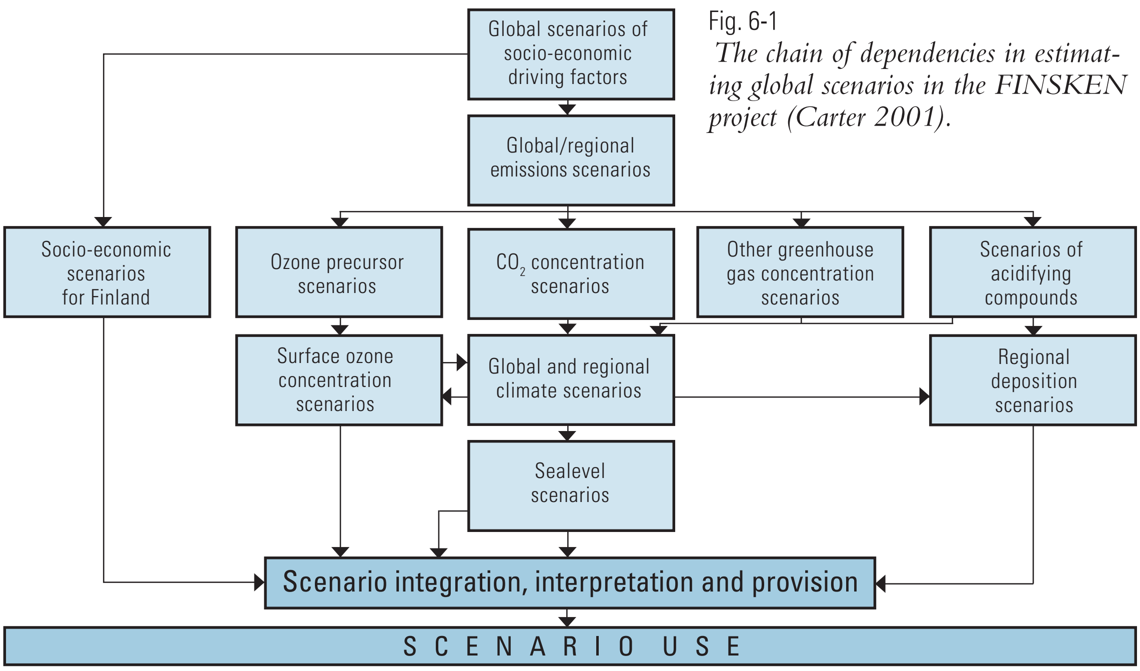


Fig. 6-1
The chain of dependencies in estimating global scenarios in the FINSKEN project (Carter 2001).

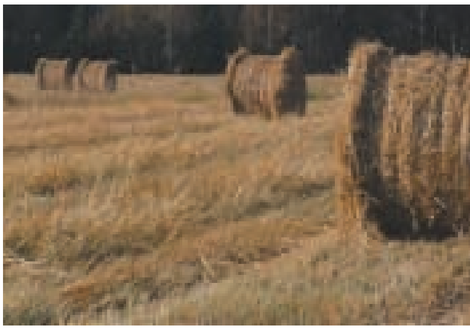
A wide range of mathematical models will be used under FINSKEN – from very simple to highly complex. In addition, elements of expert judgement will be needed. A further class of models that attempt to account for the interactions and feedbacks between many different environmental changes – integrated assessment models – will also be used to help ensure consistency in the scenarios.

FINSKEN runs from October 1999 to September 2002. It is jointly funded by the Academy of Finland and the Ministry of Transport and Communications. Results from a questionnaire survey of potential scenario users indicated substantial interest in scenarios and revealed some differences between various user groups (Bärlund and Carter 2001). For example, relatively short time horizons were of interest to planners and decisionmakers, while researchers preferred long time horizons.

6.2. IMPACTS OF CLIMATE CHANGE

6.2.1. Agriculture

In Finland climate conditions impose a significant constraint on agriculture. Low temperatures in winter and transition seasons limit the growing season to about six months in southern Finland and only three months in the far north of Lapland. In addition, night frosts decrease production and wet harvest conditions often reduce the quality and increase the need for artificial drying of cereal grain.



Estimates of possible effects of climate change on Finnish crop production have been obtained from experiments (e.g. Hakala 1998), from empirical-statistical crop climate models, from mechanistic crop models applied at sites (Kleemola and Karvonen 1996) and from regional mapping exercises (Carter et al. 1996). Also climate effects on some pests and diseases have been studied (Tiilikkala et al. 1995).

The growing season is conventionally defined in Finland to cover the period when daily mean temperature exceeds +5°C. This period is estimated to lengthen by 9–11 days for each one degree warming in the annual mean temperature (Carter et al. 1996). The effect would be greatest in the coastal regions and less in the north and east of Finland. In all parts except northern Finland, the growing season would lengthen more in autumn than in spring.

With global warming the growing season would become more intense, i.e. crops would be growing under higher temperatures than today. This would enable a wider selection of crops to be cultivated. For example, maize could be cultivated reliably in many parts of southern Finland under the SILMU central scenario in 2050 (Carter et al. 1996).

Also the year to year variability in spring cereal yields has been estimated to decrease. This is mainly attributable to fewer cool summers with poor yields. However, as already observed in the current climate, warm summers enhance crop development and the shorter growing time would reduce the harvestable yield of crops with a determinate growth habit (Hakala 1998). New, better adapted crop varieties are required to replace the currently grown varieties, to take advantage of the longer and intensified growing seasons and increased CO_2 concentrations.

In an extensive study of spring wheat, Saarikko (1999) estimated that the northern limit for the cultivation of this crop would shift 160–180 km per 1°C increase of mean annual temperature. Average grain yield of present-day cultivars was estimated to increase only slightly due to the shortening of the development phase. The regional year to year variation of yield was estimated to decrease markedly, while significant multi-decadal variations can occur simply as a result of natural variations in climate.

New challenges and risks are likely to appear with a changing climate. The range and damage potential of pests and diseases are expected to change (Kaukoranta 1996). For example, the potential distribution of nematode species is expected to expand northwards and some species are likely to produce more generations. Furthermore, increased precipitation is often predicted for the Finnish region and this may have implications for farm operations, quality of the harvest and overwintering of crops.

6.2.2. Forestry

Forest boundaries and productivity

Climate changes are likely to modify substantially the boreal forests in Finland. The two most important coniferous trees, Scots pine *(Pinus sylvestris)* and Norway spruce *(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 (IPCC 1996). 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 (Kellomäki 2000).

The climate change impacts on tree growth are closely related to stomatal functions and transpiration. The elevated CO_2 results in a partial closure of stomata with a consequent reduction in transpiration. For example, in *Pinus sylvestris* the water-use efficiency increased by 50% under the CO_2 elevation but decreased by 30% under the temperature elevation. The combined elevation of CO_2 and temperature improved the water-use efficiency only slightly (Wang and Kellomäki 1997).

In Finnish climatic conditions, regeneration of trees is mainly limited by low summer temperatures. Model computations (Kellomäki and al. 1997) show that at the northern timberline in Finland the temperature rise alone may enhance the 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 (Talkkari 2001). 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.

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. However, there might be some counteracting effects, especially through changes in the activity of natural enemies. Moreover, the risk of damages 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 preceeded 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 (e.g. Linkosalo 2000).

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.

Timber yield

Forests are an important 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 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 40% in the period 1990–2100, with the main increase north of the 63rd latitude (Kellomäki and Kohlström 1993). In these calculations, the current management and a gradual increase of annual mean temperature by 4°C with a 10% increase in precipitation were assumed. The same calculations showed that the sustainable cuttings allowed 22% more timber to be harvested. The share of hardwood timber would increase from the current 10% up to 30%. At the same time, the stem wood stock would increase by 30%. It is estimated that the value of increasing growth would be one billion euros by 2040 (Kuoppamäki 1996).

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, like a shorter soil frost period (Peltola et al. 1999). To avoid these problems, there is a need to develop logging systems to match the changing conditions.

6.2.3. Peatlands

In Finland several environmental stressors influence wetland systems. Climate change may be or become one of the most prominent of them. Changes in temperature, precipitation and evapotranspiration will affect the hydrology of wetlands and consequently the load of organic and inorganic matter from the catchment. Furthermore, the continued increase in atmospheric CO_2 will affect the quantity and quality of the primary production as the photosynthesis of most submerged macrophytes and the emergent littoral vegetation (C3 plants) is limited by CO_2.

The present area of undisturbed peatlands in Finland is about 4 million hectares. These peatlands sequester CO_2 at an average rate of 75 g/m^2 per year. Variation between different site types, grouped by ecosystem physiology and structure, is quite small. Methane is emitted at an average rate of 14 g/m^2 per year, but the variation between site types is large, i.e. from close to zero to twice the average. Emissions of N_2O from undisturbed peatlands have been observed to be small, only 0.005 g/m^2 per year on average (Crill et al. 2000).

Approximately 5.7 million hectares of peatlands have been drained for forestry in Finland. These peatlands are estimated to sequester CO_2 at the rate of 164 g/m^2 per year. The variation between different site type groups is large; from annual losses of 168 g/m^2 from peat to atmosphere to gains of 670 g/m^2. Methane is emitted at an average rate of about one tenth of the corresponding rate for undisturbed peatlands, whereas the emissions of N_2O exceed those of natural sites.

Some 0.7 million hectares of peatlands have been drained for agriculture, with most of the drainage occurring soon after World War II. Today the area of drained peatlands in cultivation is estimated to be about 250 000 hectares. From this area, the CO_2 emissions have been estimated at 3 200–7 800 Gg (Maljanen et al. 1999). The CH_4 fluxes are small, because the agricultural peatlands are not only drained but often also fertilised.

Changes in peatlands as a consequence of increased atmospheric CO_2 levels have been studied in Finland e.g. in the BERI programme (Saarnio et al. 2000a). Elevated CO_2 levels seemed to moderately increase CH_4 fluxes from the 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. 2000b).

6.2.4. Inland waters

Under climate change the winter in southern Finland may be much milder than today; the present accumulation of seasonal snow cover is likely to be an exception in the mid-21st century. Snowmelt and rainfall may cause winter floods, warning signs of which have already been observed in recent years.

In small catchments of central Finland, the spring flood will attenuate and occur earlier. In the large basins of the Lake District, the abundant winter flows will raise the levels of major downstream lakes to flood stages in spring; for example, increasing the outflow from Lake Saimaa by 15–20% in April–May by the year 2050.

In northern Finland the spring flood will also occur earlier and the peak will usually be lower than under the present climate. However, the risk of large spring floods is still obvious, because winter precipitation may increase and it mainly falls as snow.

The production of hydropower is expected to increase slightly (Saelthun et al. 1998). The changes in seasonal distribution of flows may lead to higher valued hydropower, even if the total production would not increase at all. 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 be raised by 35−65% by the end of this century compared to 1961–1990 (Tuomenvirta et al. 2000). The increase is largest in the period from January to June. This would lead to dramatic increase of design flood; e.g. for a 2000 km^2 subcatchment of the Kyrönjoki River in Ostrobothnia, the increase of peak discharge was estimated to be 70% (Vehviläinen 2001).

Winter floods and the 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 large. 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 shortened around ten days in Finnish lakes during the 20th century, 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 increase 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. 1996).

The habitats of many warmwater fish species are likely to expand, especially in northern Finland. Unfortunately, most of these species have little or no commercial or recreational value. Many coldwater species will suffer from warming, for example, salmon, brown trout, arctic char and whitefish. However, the larvae and juveniles of most Finnish fish species will grow faster.

6.2.5. The Baltic Sea

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 maximum ice thickness is estimated to decrease by 20 cm. In 2100, only the Bothnian Bay will have an ice cover in a normal winter and ice thickness may be about 30 cm. Ice conditions may still be difficult, however, as drift ice and ridged ice create rapidly changing conditions.

According to the Rossby Centre regional climate scenario (Meier 2001), the mean annual surface temperature in the Baltic would increase by 2.3°C with a 150% increase of atmospheric CO_2. The decrease of mean ice extent in the scenario compared to the control run is dramatic, from 210 000 km^2 to 82 000 km^2. However, in all years ice can still be found in the Bothnian Bay. In the fast ice zone of the Bothnian Bay, the mean ice season will shorten by 40 days, and the ice thickness in the central Bothnian Bay will decrease from 54 cm to 29 cm.

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.

Sea level rise may not be a problem on the coastal areas of Finland, because the post-glacial rebound will probably compensate for it. However, there is a slight risk of unfavourable changes in storm occurrence and wave climate (Parry 2000).

6.2.6. Economic impacts

Because of the long time periods and many uncertainties involved, estimation of the economic effects of climate change is very difficult. In SILMU, some estimates were made on a sector-by-sector basis. These estimates indicated that the Finnish economy might benefit by about one per cent of GNP by 2050. However, it should be noted that detailed evaluations could not be made for all sectors, and many effects cannot easily be valued in economic terms.

Moreover, international agreements and responsibilities as well as negative effects of climate change in other parts of the world may result in significant costs for Finland. Thus, even if we may see no emergency coming in Finland, as a small and open economy we are very dependent on nations more vulnerable to a changing climate.

6.3. VULNERABILITY ASSESSMENT

Considering the implications of climate change in Finland, no systematic vulnerability assessment has been made. Some research has been made and estimates presented, particularly in those sectors where harmful consequences are potentially high.

Silviculture is a very important climate sensitive part of the Finnish economy. Finnish forestry researchers say that the genetic adaptability of our most important tree species – pine, spruce and birch – is exceptionally good, because Finland is located between continental and maritime climates. However, the risk of new pests and insects in a warmer climate should be considered. Similar risks will occur in agriculture, although this sector may otherwise benefit considerably because of longer growing seasons and higher temperatures.

Forests in Finland today are most vulnerable at the timberline (Parry 2000). The functioning, structure and tree species composition of these forests may undergo a thorough modification with a loss in their value for conservation, recreation and reindeer husbandry. On the other hand, the timber-producing capacity of these forests may increase substantially.

The vulnerability of the Finnish coastline to sea level rise is essentially cancelled out by land uplift, which more than compensates for the IPCC forecasts along most of our coastlines during this century. More severe storms or other direct climate hazards are not considered serious in Finland.

As to the long-term risks involved with climate change in Finland, the possibility of lower activity of the Gulf Stream has been discussed. According to the Third Assessment Report of IPCC, it could lead to a considerable cooling of climate in the whole northern Europe. The probability of this cooling is negligible in this century, but it might increase thereafter.

6.4. ADAPTATION MEASURES

Adaptation offers means to reduce the possible effects of future climate change. Measures to adjust to climate change can be taken both on an individual level and by society as a whole.

In the SILMU programme, some possible means of adaptation to climate change in Finland were studied, but they were mainly related to forestry and agriculture (Table 6-1). For issues such as extreme weather events, water supply, sea level rise, biodiversity or human health very little discussion of the need for adaptation has thus far taken place.

The Finnish economy is deeply dependent on the forest sector. Because of the long time periods involved, the forest might be more sensitive to climate change than other ecosystems or agriculture. Over the next few decades warming could enhance forest growth. However, Finland should also be prepared for a greater risk of forest damage. The adaptation of agriculture to climate change depends – in addition to the farmer – on technological progress and agricultural policies at the regional, national and international level. One challenge will be the development of new crop varieties, which are able to exploit the future conditions optimally. Maintaining soil properties suitable for crops might also require considerable efforts in the future.

As to water resources, changes in hydrological regimes and leaching should be anticipated. An increase of winter flows can also alter considerably the conditions for hydropower production. Some research has been already done to guarantee dam safety also in the changed hydrological regime.

Table 6-1

Some means of adaptation to climate change in Finland

Sector	Means of adaptation
Forest	– preparedness for increased damage – maintainance of biodiversity – changes in the proportions of tree species – introduction of new species – improved risk control in forestry
Agriculture	– plant breeding, changes in crop species and varieties – timing of cultivation practices – maintainance and improvement of soil properties – lengthening of the grazing season – modified and improved pest/disease control
Watercourses	– preparedness for changes in precipitation and runoff – preparedness for increased dimensioning of flood gates – preparedness for changes in leaching and eutrophication
Energy sector	– preparedness for changes in hydropower production
Transport	– preparedness for changes in transport conditions (especially ice and soil frost, salting and prevention of slippery conditions on major roads, prevention of floods)

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7 FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

7.1. PROVISION OF NEW AND ADDITIONAL RESOURCES

The general objectives of the Finnish development cooperation are formulated in the governmental strategy for development cooperation. Finland supports development efforts which aim at reducing widespread poverty in developing countries, combatting global threats to the environment by helping the developing countries to solve their environmental problems, and promoting social equality, democracy and human rights. (Decision-in-principle on Finland's Development Cooperation from 1996 and Finland's Policy on Relations with Developing Countries from 1998).

As new and additional resources for solving global environmental problems, Finland contributed in 1997-2000 altogether USD 18.3 million to the Global Environment Facility, GEF (Table 7-1). This contribution brings forward Finland's aims to promote the environmental agreements and develop their monitoring.

Table 7-1

Financial contributions to the Global Environment Facility (GEF)

Disbursements	Contribution (millions of current US dollars)			
	1997	1998	1999	2000
Global Environment Facility	7.6	3.6	5.4	1.7

7.2. PROVISION OF FINANCIAL RESOURCES

In multilateral cooperation Finland has firmly pursued environmental aspects of development (Table 7-2). Finland has actively participated in the UN Conference on Environment and Development (UNCED) process and supported the implementation of Agenda 21 through various channels.

Table 7-2

Financial contributions to multilateral institutions (ODA) **

Disbursements	Contribution (millions of current US dollars)		
	1997	1998	1999
Multilateral institutions			
1. World Bank/IDA	13.7	10.0	13.0
2. African Development Bank and Fund	4.2	5.6	11.5
3. Asian Development Bank and Fund	3.9	3.7	4.0
4. European Bank for Reconstruction and Development	0.1	4.8	3.8
5. Inter-American Development Bank	1.8	1.6	1.8
6. United Nations Development Programme	13.9	13.4	12.5
7. United Nations Environment Programme	3.3	3.2	3.5
8. UNFCCC*			
9. Other	138.0	150.0	129.6
of which			
– EC	48.2	64.9	56.8
– NDF	14.3	14.4	5.9
– Montreal Protocol	0.9	1.0	0.9
– CGIAR	1.5	1.5	1.4
– WIDER	0.3	0.3	0.2
Total	**178.8**	**187.5**	**175.8**

*Finnish support to UNFCCC has been thematic in nature and therefore registered under bilateral aid (support to participation of developing country officials at meetings) as follows:

	1997	1998	1999
– UNFCCC meeting participation			0.2

**Non-ODA items related to the convention as follows:

	1997	1998	1999
– PCF			3.7
– CDM/JI***			

***The CDM/JI programme was initiated in 1999 with annual appropriations of 0.9 million USD in 2000–2002.

7.3. ASSISTANCE TO DEVELOPING COUNTRIES

Official development assistance (ODA) is one of the major tools Finland can provide to assist developing countries to enhance the objectives of the FCCC. The most significant channels of Finnish ODA are bilateral project and programme funding and the concessional credits. Other funding channels in the Finnish ODA system are multilateral funding and funding through NGOs.

During the reporting period the most important ODA sectors contributing to the mititgation of climate change have been forestry, agriculture and energy (Table 7-3). In support to the adaptation capacities the most important lines of action have been capacity building and vulnerability assessments. It is notable that the annual fluctuations within each category are considerable, resulting from the rather wide range of countries where Finland is involved through ODA during the reporting period. Also the fact that Table 7–3 refers to annual commitments and not disbursements does have its effect on the annual variation. For example, the year 1998 shows a large commitment to the forestry sector in the Central American countries, because this is the year when the commitment for a large regional forestry programme of four years was made.

Promotion of sustainable forest management can result in slowing deforestation rates, which is a direct contribution to the permanence of greenhouse gas sinks and reservoirs. In order to enhance the objectives of the UNFCCC, Finland has during the reporting period provided assistance to various developing countries to promote sustainable management of forests. These activities include community forestry programmes, forest sector planning and forest fire management.

The sector planning process has been supported e.g. in Zambia under the Zambia Provincial Forestry Action Programme, which aims at operationalisation of the National Forestry Action Plan at the provincial level. National level sector planning involves often national forest inventory, which enables the stocktaking of sinks and reservoirs at the national level. During the reporting period this has been supported e.g. in Namibia.

Community forestry is an important part of promoting sustainable forest management and has been assisted during the reporting period in Central American countries, Namibia, Tanzania, Zambia, Kenya, Vietnam and Malawi. Community involvement in forest management is particularly important in the current conditions where an increasing number of government organisations, including forest administration, are facing downsizing and budgetary restrictions.

Community-based forest fire management is perhaps the most innovative part of Finnish ODA activities in relation to the mitigation objectives of the FCCC. During the reporting period, two pilot programmes on controlling and managing forest and bush fires have been supported, one in north-eastern Namibia and other in Burkina Faso. Both initiatives 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. The results have been promising, for example in Namibia fires have been reduced by up to 50%.

During the reporting period, Finland has also supported two forestry training programmes to promote sustainable forest management, one of these in the SADC region forestry colleges.

Cross sectoral linkages between sustainable forest management and climate change require study and research. Finland is one of the major donors to the United Nations University WIDER Institute, located in Helsinki, which has, in cooperation with the European Forest Institute (EFI), carried out research projects on the role of forests in the implementation of international conventions of climate change and biological diversity.

During the reporting period the contribution towards the objectives of FCCC through energy sector ODA has been rather limited. The most notable initiatives have been the financing of the improvements to the Sarajevo district heating system, and the Asian alternative energy programme.

In summary, Finland has had in the 1990s altogether 27 official grant projects related to climate change assistance. Four of them have been directly in the climate sector: the support to the Government of Nicaragua to implement the UN Framework Convention on Climate Change and meteorology development programmes in the Central American Isthmus, in the Caribbean and in Mozambique. Altogether 19 projects have been in the forestry sector, some of them having also agricultural or rural development aspects. Three projects have belonged to the environmental sector, three to the energy sector.

Tables 7-3a, b and c

Bilateral and regional financial contributions related to the implementation of the Convention, 1997

Commitments (millions of current US dollars, USD/FIM rate 5.1872)									
	Mitigation						Adaptation		
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity-building	Coastal zone management	Other vulnerability assessments
AFRICA UNSPECIFIED			0.13						0.19
ASIA UNSPECIFIED				0.29					0.31
BURKINA FASO			0.62						
ETHIOPIA							0.09		0.77
KENYA				3.86					
LDC'S UNSPECIFIED	0.19		0.48						
MOZAMBIQUE								0.19	0.39
N. & C. AMERICA UNALLOCATED			0.10						
NAMIBIA			0.32						1.06
NICARAGUA				1.54					5.78
SOUTH AMERICA UNALLOCATED						0.77			
SOUTH OF SAHARA UNALLOCATED			2.12						
SUDAN				0.02					
TANZANIA			0.77						
ZAMBIA			1.38	0.29					
TOTAL	0.19	0.00	5.93	6.00	0.00	0.77	0.09	0.19	8.50
GRAND TOTAL									21.68

Bilateral and regional financial contributions related to the implementation of the Convention, 1998

Commitments (millions of current US dollars, USD/FIM 5.3453)

	Mitigation						Adaptation		
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity-building	Coastal zone management	Other vulnerability assessments
AFRICA UNSPECIFIED							0.03		
ASIA UNSPECIFIED	0.56								1.68
BOSNIA-HERZEGOVINA	1.87								
INDONESIA			0.01						
KENYA			0.47						
LDC'S UNSPECIFIED							1.12		
MALAWI			2.24						
MOZAMBIQUE							1.40	0.69	
N. & C. AMERICA UNALLOCATED			9.35						
NAMIBIA									0.19
NICARAGUA				4.30					
TANZANIA			2.81						
VIETNAM			2.90	4.75					
ZAMBIA			3.74						
TOTAL	**2.43**	**0.00**	**21.52**	**9.05**	**0.00**	**0.00**	**2.56**	**0.69**	**1.87**
GRAND TOTAL									**38.11**

Bilateral and regional financial contributions related to the implementation of the Convention, 1999

Commitments (millions of current US dollars, USD/FIM rate 5.5804)

	Mitigation						Adaptation		
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity-building	Coastal zone management	Other vulnerability assessments
BOSNIA-HERZEGOVINA	0.99								
CHINA	3,82								
LDC'S UNSPECIFIED	0.18		0.05				0.11	0.54	1.26
MALAWI			0.90						
MOZAMBIQUE			0.45						
N. & C. AMERICA UNALLOCATED							3.76		
NEPAL							0.65		
NICARAGUA									1.43
SOUTH AFRICA							0.18		
TANZANIA		2.42							
TOTAL	**4.98**	**2.42**	**1.59**	**0.00**	**0.00**	**0.00**	**4.70**	**0.54**	**2.69**
GRAND TOTAL									**16.92**

7.4. ACTIVITIES RELATED TO TRANSFER OF TECHNOLOGY

Finland has specific programmes and financial arrangements for transferring environmentally sound technology to developing countries. Finland also supports cleaner power and heat generation options and sustainable forestry with grants, concessional credits and development credit financing.

Although energy-related pollution is still rather minor in many parts of the developing world, it is rapidly increasing. Thus a great deal of attention must be paid to counteract this trend. To this effect Finland has supported energy efficiency and conservation projects related to the problems of power transmission and distribution. Finland has also supported national policies that promote energy conservation and efficiency.

Over the long term, it is important to gradually introduce renewable energy sources. Finland's involvement in this field has mostly been directed at developing the use of biomass. Finland has also supported the establishment of appropriate data records of wind and solar energy through the meteorological development programmes in the southern Africa region and the Caribbean.

With regard to the use of biomass, an enhancement in fuel wood production through sustainable forest management and community participation is currently emphasised in a number of forestry projects. Innovative ways of using biomass are promoted and have been supported through research. A good example of this is the introduction of improved stoves and fireless cookers to rural households, which has been done in a forest conservation project in the Usambara Mountains of Tanzania. The use of self-constructed mud stoves or clay stoves has decreased the consumption of fuelwood in the pilot households by up to 50%.

7.5. NEIGHBOURING REGIONS

Finland has promoted and supported joint environmental and other programmes in its neighbouring regions since 1991. The focal areas are the southern neighbours – Estonia, Latvia and Lithuania – and northwestern Russia, particularly the St. Petersburg region, the Republic of Karelia and the Murmansk Region. The cooperation with Poland, the so-called eco-conversion, is particular in nature, involving partial waiving of Poland's debts to Finland. Polish authorities support an environmental investment by local funding and Finland reduces Poland's debt to Finland by a corresponding sum. The cooperation with Russia, the Baltic countries and Poland is directed by Finland's

Strategy for Cooperation in the Neighbouring Areas, updated by the Ministry for Foreign Affairs of Finland in May 2000.

During the 1990s, Finland channelled EUR 110 million into environmental cooperation in the Neighbouring areas. Four-fifths of the funds have been allocated to investment projects, one-fifth to technical assistance.

The primary aim of the cooperation is to prevent transboundary air and water pollution. Relative to the costs involved, cooperation with the neighbouring regions is a very efficient way of protecting the Finnish environment. Finland has also been active in improving the safety of nuclear power plants in Russia, Lithuania and Ukraina.

The strategic objectives of the environmental cooperation are 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 the implementation of the EU's environment acquis in the Baltic republics*
- *Promotion of joint implementation projects under the UNFCCC*

The main sectors of cooperation are air protection, Baltic Sea protection and hazardous waste management. The local partner – i.e. the recipient of the support for the project – has the main responsibility for the financing and implementation of the project. For example, the Finnish Ministry of the Environment's grant aid can cover at most 50% of the value of Finnish work in each project. In experimental projects the grant can be made up to 80%.

Some of the joint projects aim at or have already resulted in significant reduction of sulphur or dust emissions:

- *In northwestern Russia, the emissions from Kostamuksha Iron Pellet Combine and Svetogorsk Pulp and Paper Mill will be significantly reduced.*
- *In Estonia, Finland has supported the preparation of the investment and restructuring plan for the Narva power plants and oil shale mining in Estonia, a pilot-scale sulphur reduction device in the Narva Power Plant and modernisation of several power plants in order to convert the fuel burned from heavy heating oil to gas. At the Eesti Power Plant in Narva the instrumentation and process control have been modernised.*
- *In Tallinn, the Iru Power Plant has been converted to burn natural gas; this change yielded a 0.1 Tg annual reduction in CO_2 emissions.*

- *Delivery of electric filters to the Kunda Cement Plant has resulted in significant reduction of dust emissions*
- *Modernisation of the recovery boiler and evaporation plant in Kehra in Estonia will reduce the sulphur emissions 98% and the particle emissions 96%.*
- *District heating rehabilitation is proceeding in Tamsalu Municipality in Estonia. In Lithuania, a Finnish district heating expert is a consultant with the Lithuanian Municipal Development Project.*
- *In Poland, Finland has assisted in the modernisation of, the reduc tion of sulphur emissions, and the improvement of energy efficiency in altogether 15 power or industrial plants, of which the Jaworzno Power Plant has great regional significance. District heating systems have also been upgraded and modernised at some locations with Finnish support, which actions have also reduced air emissions.*

The environmental cooperation in Finland's neighbouring areas has been mainly successful according to the evaluation by PI Consulting OYJ, commissioned by the Ministry for Foreign Affairs of Finland. There have been a few failures but in most cases the individual projects have been successful and the cooperation as a whole is highly appreciated by the partner countries. This is especially noteworthy with regard to all the changes that have taken place in neighbouring areas; e.g. the cooperation started with the Soviet Union, which soon broke up into separate nations. The political, economic and social circumstances in most new partner countries remained very difficult especially in Russia. In the Baltic countries the attitude towards environmental issues remained positive even in the economically worst years. At the same time, Finnish enterprises and organisations were active in seeking out projects in neighbouring areas.

The cooperation will continue and its forms and focus will also develop. For example, the consideration of the Kyoto mechanisms may be one alternative in the future (see Chapter 4.6). As to the Baltic countries, the preparation for EU accession is a priority when identifying new projects.

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8 RESEARCH AND SYSTEMATIC OBSERVATION

8.1. GENERAL POLICY ON RESEARCH AND SYSTEMATIC OBSERVATION

8.1.1. Policy statement

The climate strategy of the Finnish Government 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.

Climate-related research is carried out in several research institutes, universities and organizations. The Finnish Meteorological Institute and the Department of Meteorology at the University of Helsinki have research programmes in climate processes, modelling and prediction. The impacts of climate change, socio-economic analyses, and mitigation and adaptation technologies are studied at a variety of sites, most of which will be mentioned later.

Climate change research is one of the priority areas of the Finnish Meteorological Institute. The Institute is responsible for the production of reliable information on the state of the atmosphere, its characteristics and phenomena with the aim of serving the needs of the general public, industry and commerce, and other branches of science. Funding is divided between the governmental portion, usually more than half, and a portion obtained from research funding organisations through a competitive process. The productivity and the international visibility of the research are measured.

As to the 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. 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 data that have been given out 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 data originators is secured.

8.1.2. Some important research programmes

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).

The SILMU programme was evaluated by an international committee in autumn 1996 (Hordijk et al. 1996). In general, the committee found the research performed in the programme to be of high quality and relevance. Critical remarks mainly concerned the insufficient integration of the subprogrammes.

FIGARE

In 1999, the Academy of Finland launched FIGARE, the Finnish Global Change Research Programme. The main objective of the programme is to find scientific, social, economic and technological solutions to help intervene in the process of global change or adapt to the ongoing changes. This objective is pursued by studying global change, its underlying causes and impacts at different times and in different regions and by analysing and predicting the environmental and socio-economic impacts of global change. The programme is expected to generate useful information for both national and international decision-making.

The purpose is to complement international research in issues that are particularly relevant to Finland in terms of their impacts or planning implications: these include questions concerning northern, Arctic and boreal issues, Finnish technological know-how and global change questions relating to developing countries.

The programme comprises 36 projects involving some 100 researchers in the following organisations: the University of Helsinki, the Helsinki School of Economics and Business Administration, the Geological Survey of Finland, the Finnish Meteorological Institute, the Finnish Forest Research Institute, the environmental administration, the Research Institute of the Finnish Economy and MTT Agrifood Research Finland.

The programme has a budget of EUR 6.7 million. Funding from the Academy of Finland amounts to EUR 4.2 million. Funding is also provided by the Ministry of Trade and Industry, the Ministry of Transport and Communications, the Ministry of Agriculture and Forestry, the Ministry of Foreign Affairs, and the Ministry of the Environment. The programme runs from 1999 to 2002.

The Finnish Biodiversity Research Programme (FIBRE) and the Research Programme on Sustainable Use of Natural Resources (SUNARE) also contain climate-related topics. The Academy of Finland is responsible for both programmes.

CLIMTECH

Under the Technology and Climate Change Programme (CLIMTECH) technologies that can be applied to control greenhouse gas emissions and climate change will be investigated. The programme includes both the control and reduction of emissions within Finland as well as the use of Finnish technology to limit emissions elsewhere.

The timescale for the technologies studied extends beyond the first commitment period of the Kyoto Protocol to about 2030. Within this timescale the emission limits for developed countries will most likely be tightened and the emissions for developing countries will most likely also be limited.

Under CLIMTECH, the control of climate change is being analysed against the background of the overall picture. Forecasts are made on the requirements and possibilities for controlling emissions and these are weighed against their economic consequences. The programme is helping to identify the most important development fields. Additionally, the implementation and commercialisation of Finnish technology is supported. The programme will also help to identify any restrictions on implementation.

CLIMTECH is run as a framework programme. The programme will be implemented from 1999 to 2002 and with a total budget of EUR 2.5 million financed by TEKES, the National Technology Agency. VTT Energy is responsible for the implementation of the programme and a steering group will guide and supervise the work.

8.2. RESEARCH

8.2.1. Climate process and climate system studies

At the Finnish Meteorological Institute emphasis has been put on homogenisation of observed station data in order to detect the real climatic or natural signal of the change in the observed variables, for example, surface air temperature, precipitation and snow cover (Heino 1994). 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 (Solantie 1990).

The longest data series of air temperature is from Helsinki, extending from 1830 to the present. This series was adjusted to account for the effects of urbanisation and other sources of measurement error to achieve a reliable indicator of climate change. The results show that the annual average temperature has risen by one degree Celcius, which is in keeping with climate models for Helsinki's latitude.

The Department of Meteorology at the University of Helsinki has analysed the most hazardous climate event in Finland, that is the catastrophic weather conditions of the year 1867, which led to the death of one-tenth of the population (Jantunen and Ruosteenoja 2000).

Finland is one of the few countries which lies within the influence of stratospheric polar ozone depletion. The Jokioinen and Sodankylä observatories have been involved in international ozone campaigns for the last ten years. The most important of these was a recent TESEO 2000 campaign.

Finland has extensive research 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 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

Under the strategy for climate change research, the Finnish Meteorological Institute (FMI) obtains results of model calculations from its international partners. Instead of direct climate modelling, the emphasis has been put on modelling of impacts.

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 Department of Meteorology at the University of Helsinki has participated in the climate modelling activities of the Rossby Centre in Sweden. This institute has also developed a linear climate model, which can be applied to the interpretation of the results of GCMs. Another area of interest of the Institute of Meteorology is the development of subgrid scale parameterisation methods.

8.2.3. Research on the impacts of climate change

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 ministries and foundations and the European Union.

AGRICULTURE

The research emphasis has been in recent years 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 land-area data of organic soils have been improved and a time series for the changes since 1990 has been developed by MTT Agrifood Research Finland.

The emission factors used in the calculation of greenhouse gas emissions from mineral and organic soils need more research. Under the Finnish Global Change Research Programme (FIGARE) an agricultural research project is aimed at improving this data by doing actual measurements on the emissions from different soil types under varying management practices. The results will be used, when available, to improve the emissions factors.

Finnish researchers have also participated in several international programmes, such as CHIP, which is aimed at determining the impact of future climatic change and associated stresses on potato growth, yield and quality across Europe (Ojanperä and Vorne 2000).

FORESTS

The Finnish Forest Research Institute (METLA) started in 2000 an extensive research programme "Pools and fluxes of carbon in Finnish forests and their socio-economic implications". This programme consists of three projects, scheduled for 2000–2005:

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 socioeconomic 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. The carbon dynamics in mineral soils (carbon input in litter and water, carbon output from the rooting layer in water, emissions of carbon) is not yet well understood. Of particular interest is the significance of understorey and fine roots in carbon cycling in forest soils. The effect of cutting and harvesting on carbon fluxes on peatland sites and the regional variation of methane emissions from ditched areas will also be studied.

The University of Joensuu established in 2000 the Centre of Excellence for Forest Ecology and Management. This Centre aims at enhancing the scientific research on functional and structural dynamics of the boreal forest ecosystem with management implications. Multidisciplinary studies integrate the basic and applied science for applications to manage the boreal forests in a sustainable way. The staff of the Centre consists of about 25 senior scientists and 15 junior scientists and post docs and 50 PhD students. Part of the staff works abroad.

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.

Finnish forest researchers have recently began using complex, multifaceted models to study the effects of climate change. They have found 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 into radiative transfer have been taken into account.

One model of this type is the FinnFor model, developed by Kellomäki and Väisänen (1996). In this model, the dynamics of the forest ecosystem are directly linked to the climate through photosynthesis, respiration and transpiration. Furthermore, hydrological and nutrient cycles indirectly couple the dynamics of the ecosystem to the climate change through soil processes. The computations cover an entire year representing active and dormant seasons (Fig. 8-1).

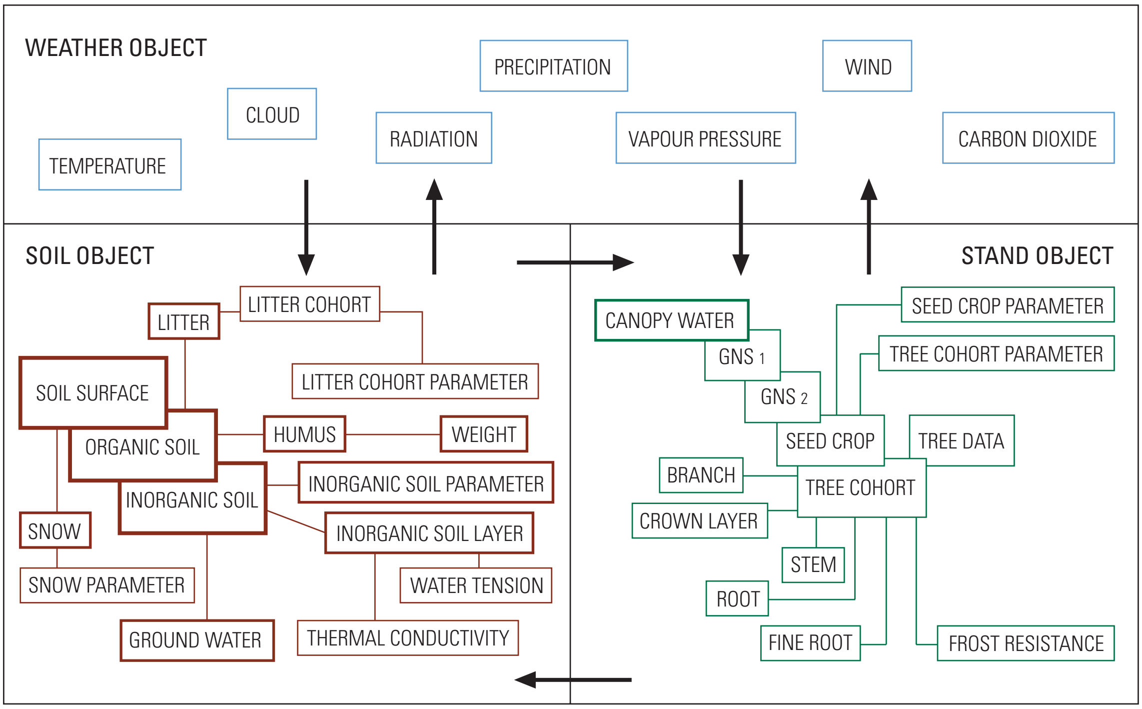

Fig. 8-1
Outlines of the effects of climate on the soil processes and the metabolism of trees, and the consequent dynamics of the forest ecosystem in the FinnFor model (Kellomäki et al. 1997).

Finnish forestry researchers are also involved in climate-related projects in Europe and globally. In the Philippines and Laos, for example, local and national forestry impacts of global climate and biodiversity policies are studied by researchers from the University of Joensuu. In Central America, under a project by the University of Helsinki land-use changes and options for carbon management are being analysed. Also the European Forest Institute, located in Joensuu, Finland, conducts research on climate change and forestry.

Peatlands

The role of peat in Finnish greenhouse gas balances has been extensively studied; a recent compilation of this work has been presented by Crill, Hargreaves and Korhola (2000). The authors were members of an international committee, commissioned by the Ministry of Trade and Industry in autumn 1999.

Key topics in climatic research of peatlands have been the following:

- *long-term average accumulation of carbon in natural peatlands*
- *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*

As an example of the last topic, Finland has participated in the BERI (Bog Ecosystem Research Initiative) of the European Union. The objectives of this programme have been 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.

More research is needed, for example, on the greenhouse gas exchange of peatlands in agricultural use, and on the GHG balances of cut-away peatlands.

INLAND WATERS AND MARINE AREAS

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.

The climate change impacts on runoff and hydropower were analysed in a Nordic coproject, funded by the Nordic Council of Ministers and the participating organisations. The Finnish Environment Institute (SYKE) and the Finnish Meteorological Institute did a study on the increase of design precipitation in Finland due to climate change. The results of this study will be utilised by the SYKE in the estimation of the changes in design floods.

Finnish lakes as a source of greenhouse gases were studied in the CARBO Project, funded by the Academy of Finland. In this project, the Geological Survey of Finland and the Finnish Environment Institute also performed a study on the total amount of carbon stored in the lake sediments in Finland. The result was 700–900 Tg, a slightly higher value than the amount of carbon stored in the growing stock in Finland's forests (Kortelainen and Pajunen 2000).

As to the quality of inland waters, several studies on the future changes of nitrogen and phosphorus leaching have been performed. One FIGARE project analyses solar UV-B actions on aquatic ecosystems.

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 VEINS Project has concentrated on the heat and moisture exchange between the North Atlantic and the Arctic Sea.

A Baltic Sea ice model has been developed at the Department of Geophysics in the University of Helsinki. This model takes into account the ice thickness redistribution and resolves the amount of the open water, the level and lead ice thickness, and three categories of deformed ice. This model will also be applied for the Barents and Kara seas.

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. The main BALTEX modeling and observational phase BRIDGE started in 1999 and will continue until early 2002.

Within the FINSKEN Programme, sea level scenarios will be developed (Kahma et al. 2001). 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 for the sea level variability will be presented.

TRAFFIC

The Ministry of Transport and Communications has had a research project "Regional Climatic Change and Impacts on Transport". In this project, models and indexes describing climatic impacts were developed and applied to transport. The results can be utilized in the planning and assessment of transport infrastructure as well as in the assessment of ice-breaking capacity. The consultant in this project was the Finnish Meteorological Institute.

The Finnish Institute of Marine Research and the Finnish Meteorological Institute have also studied the impact of the predicted climate change on ice cover in the Baltic Sea. The FMI has also studied the impact of climate change on the wintertime road conditions using regionalised model data from cooperative research institutions.

The FMI, the Finnish Road Administration, the Central Organization of Traffic Safety in Finland, the Ministry of the Interior and the Finnish Broadcasting Company have developed a system that warns main road users of poor and extremely poor conditions.

In addition to these specific research projects that concentrate on climate change there are several transport related research projects that have been utilised when defining the policies and measures in the transport sector to reduce the greenhouse gas emissions caused by transport (see in more detail Chapter 4.3).

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 the awareness of the Arctic and other issues related to northern regions. Finland's Arctic research strategy has four priority areas: natural resources, global change, man and communities, and the infrastructure. As to the global change, the strategic goal of the research is 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.

The Arctic Centre at Rovaniemi participates in national and international research projects, which include also climate change aspects. The Centre is host to the Global Change Programme Office (IASC/GCPO) of the Secretariat of the International Arctic Science Committee.

The Centre has participated in two extensive, EU-funded research programmes: BASIS (the Barents Sea Impact Study) in 1997–99 and TUNDRA (Tundra Degradation in the Russian Arctic) in 1998–2000.

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 hosts the secreteriat of the Nordic Arctic Research Programme (NARP). The goal of this programme is to enhance Nordic competence by building scientific cooperation within selected subject areas. This will happen through network building, training and mobility of researchers, workshops and pilot studies. The NARP programme was initiated by the Nordic Council of Ministers. The annual budget of the programme will be EUR one million during the five years' duration, 1999–2003.

In FIGARE, Arctic snow, sea-ice and glaciers in a changing climate are studied. Another FIGARE project focuses 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 is concentrating on physiological and ecological stress responses and recovery of wild subarctic plants.

The Sodankylä Geophysical Observatory has been a very important observation and research site in Lapland since 1949. To emphasise its importance in Arctic research the Observatory was renamed the Arctic Research Centre in 2000. A research professorship on arctic themes has also been set up at the centre in January 2001.

Within Arctic paleolimnology, there are several recently finished or ongoing research projects:

– *Holocene climatic variability in the Fennoscandian Arctic in ferred 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 inte grated study*

8.2.4. Socio-economic analysis

The international evaluation team of the SILMU programme noticed the small amount of socio-economic studies of climate change impacts. The situation has slightly improved in recent years, but research in this sector is still limited.

Under FIGARE, there are the following socio-economic research projects:

- *Global policies and Finland: environment, energy markets and forestry sector*
- *Global problems, knowledge, institutions and policies*
- *Climate change and decision-making*
- *Conditioning global and local climate, biodiversity and development policies*

Within the FINSKEN programme, socio-economic scenarios for Finland will be developed (Kaivo-oja & Wilenius 2001). 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.

8.2.5. Research and development on mitigation and adaptation technologies

Research on mitigation and adaptation technologies has not been very active in Finland. A major step forward is the CLIMTECH programme in 1999–2002, which has e.g. the following projects:

- *Abatement of new greenhouse gases*
- *Mitigation of greenhouse gases from waste management*
- *The development of Finnish energy system models within the IEA ETSAP agreement*
- *The possibilities of wind power for mitigating climate change*
- *A road map for solar energy technology and markets in Finland*
- *Increasing the use of biomass in energy production*
- *Hydrogen technology survey*
- *The impact of information technology and the Internet economy*
- *Decentralised energy systems*

8.3. SYSTEMATIC OBSERVATIONS

8.3.1. Atmospheric climate observing systems

In Finland, meteorological observations have been made at several stations for more than a hundred years. In May 2001, observations were made at three meteorological observatory stations, 45 synoptic stations, 49 climatological stations, 318 precipitation stations and 121 automatic stations.

Long climatological time series form a necessary basis not only for the actual climatological research but also for estimates on the impacts of climate change. Finnish climate observations have been included in the international North Atlantic Climatological Data Set (NACD) database, which is a collection of reliable long-term climatic observations for climate change research.

Finland also participates in the Global Atmosphere Watch (GAW) programme of the World Meteorological Organisation (WMO). The objective ot the GAW is to observe greenhouse gas concentrations and long-range transport of pollutants in the atmosphere. In 1994, the WMO accepted the Pallas-Sodankylä station in Finnish Lapland as a part of the global GAW network. The station measures air composition and measurable meteorological quantities, focusing on greenhouse gases such as CO_2, CH_4, N_2O and O_3. Considerable investments have been made to develop this station.

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 since1994, ultraviolet irradiance since 1994)*
- *Synop data*
- *Hourly values for solar radiation since 1971; sunshine hours since 1950*
- *Rawinsonde data*
- *Normal values (1931–1960 and 1961–1990)*
- *Automatic weather station data since 1996*
- *Automatic synop data since 1998*
- *Mast Data since 1986; 3 masts*

All these data are quality-checked and archived in a relational database at the Finnish Meteorological Institute.

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 coordinated by the ECE*

Under the Global Climate Observing System (GCOS) Programme, Jokioinen, Jyväskylä, and Sodankylä stations are included in both the GCOS Surface Network (GSN) and the GCOS Upper-Air Network (GUAN).

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 EUMETSAT's several research programmes. The Finnish Meteorological Institute is hosting the ozone research programme and participating in the satellite climate data programme.

The EUMETNET was established to promote the European co-operation in the development of a meteorological observation network and the basic weather services. The FMI is hosting the programme, which has been established to improve the observation technology for severe weather conditions.

The Finnish Environment Institute (SYKE) coordinates the collection and compilation of data on airborne emissions, the most significant of which are greenhouse gases, particles, volatile hydrocarbons (NMVOC), heavy metals, persistent organic pollutants (POP) and sulphur and nitrogen compounds. The data system contains information from different sources and computation methods. The system meets the requirements set for international reporting on air pollution and for providing information under EU directives concerning emissions.

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, the integrated use of new microwave satellite data for sea ice observations and improving measurement technologies for marine near-surface fluxes. All three studies were EU projects. The EURONODIM programme in 1998-2000 has 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, including, among other things, an extensive hydrological data bank. Finland has exceptionally long, homogeneous data series on some climatically interesting variables, like freezing and breakup dates of rivers and lakes.

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

Since the early 1970s, Finland has actively participated in the building up 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. Major programmes have been launched in cooperation with WMO. Under these programmes data is gathered on climate change, ozone depletion and transboundary dispersion of pollutants relevant to the implementation of UN global conventions. The purpose of the programmes is not just to collect information but also to contribute to the preparedness for natural disaster prevention.

During the last ten years, Finland's total contribution to cooperation projects concerning meteorological technology transfer and education/training has been about EUR 16.5 million (Table 8-1). Projects have been 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 these programmes.

A comprehensive Finnish programme to enhance systematic climatic observations in the developing world took place in 1987–1993 in SADC countries in southern Africa. The aim of this programme was to strengthen the national meteorological services in this region.

The project was implemented in two phases; the objective of the first phase was to create the conditions for basic weather services in the region, while the second phase was designed to guarantee the continuity of these services and establish the provision of applications of meteorology to the officials responsible for food production.

The total project budget of this programme amounted to EUR 11 million, of which 42% was for fellowships/expert services and 54% for equipment procurement and services. The programme, together with the meteorology programmes for Central America, was evaluated in 1999 as part of the thematic evaluation on environment and development in Finnish development cooperation. The findings proved favourable. Finland started a new project in Mozambique in 2000 with the aim of reconstructing the country's meteorological institute after the devastating floods earlier that year. Finland's allocation to this project will be around EUR 4 million.

Table 8-1

Some development projects in meteorology.

Programme	Countries involved	Partners	Duration	Finland's financial contribu-tion (euros)
PANIF Nicaragua "Support to Implemen-tation of International Convention on Climate Change and Montreal Protocol"	Nicaragua	MARENA, INETER, SYKE and FMI	1998–2000	2 million
IADB "Assessment of Ozone and UV-Radiation Monitoring in Latin America"	Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Hondu-ras, Mexico, Nicaragua, Panama, Peru, Uruguay, Venezuela	CRRH, IAI	1997–1999	130 000
SIDS-Caribbean "Preparedness to Climate variability and Global Change in Small Island Developing States, Caribbean Region"	Guyana, Trinidad and Tobago, Grenada, St. Vincent and the Grenadines, Barbados, Bahamas, Cuba, St. Lucia, Commonwealth of Dominica, Montserrat, Antigua and Barbuda, St. Christopher and Nevis, Anguilla, Dominican Republic, Haiti, Jamaica, Turks and Caicos Islands and Netherlands Antilles	CARICOM, CIMH, CMO, WMO	2001–2003	3.5 million
Central America "Rehabilitation and Improvement of the Meteorological and Hydrological Services"	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama,	CRRH, WMO	1990–2000	4.5 million
TRACECA "Hydrometeorological Safety to Transport Corridor Europe-Caucasus-Asia"	Georgia, Azerbaijan	WMO	2000	20 000
Mozambique "Post-Emergency Reconstruction Pro-gramme in the field of Meteorology, Phase I Immediate Actions"	Mozambique	INAM	2000–2001	1 million

IAI	Inter-American Institute for Global Change Research
IADB	Inter-American Development Bank
PANIF	Programa Ambiental Nicaragua-Finlandia
INETER	Instituto Nicaraguense de Estudios Territoriales
MARENA	Ministerio del Ambiente y Recursos Naturales
SYKE	Finnish Environment Institute
CRRH	Comite Regional de Recursos Hidraulicos
SIDS	Small Island Developing States
INAM	The Instituto Nacional de Meteorologia
TRACECA	Transport Corridor Europe-Caucasus-Asia
WMO	World Meteorological Organization
CARICOM	Caribbean Community
CIMH	Caribbean Institute for Meteorology and Hydrology
CMO	Caribbean Meteorological Organization
FMI	Finnish Meteorological Institute

In Nicaragua, the Finnish support has focused on the national FCCC activities for implementation and reporting, clean development mechanisms, strengthening of climatological and hydrological research and systematic observation. During the project, the meteorological and hydrological observation networks were modernised. A new database system was also created, into which a geographic information system was incorporated. A flood model was devised for Lake Managua, which will allow reliable forecasting of the water level.

Central America is characterised by difficult geophysical and socio-economic conditions. Finland's project in seven Central American countries was designed to support these countries through empowering their services to offer reliable and updated hydrological and climatological data to various user sectors, for example, agriculture, communications, industry, transportation and fishing. The main objective was to strengthen the basic weather-forecasting services, as well as hydrological networks in each country. The implementation of a new telecommunication system was considered the most important goal at regional level. The project included economic and technical support as well as training of personnel.

The project began in 1991, and was financially supported by the Ministry of Foreign Affairs of Finland within its development cooperation programme. The implementation period was prolonged from the originally planned five years up to the end of 1997.

After the destruction caused by hurricane Mitch, the Central American cooperation programme was continued and revised in January 1999. The support was mainly provided for extended maintenance services and training related to satellite-based meteorological telecommunication systems. A refresher course on the maintenance and service skills required for the weather observation systems was also organised.

The Finnish Environment Institute (SYKE) has also been involved in the enhancement of systematic observations in developing countries. In 2000, the SYKE concluded its extensive project on the development of the environmental monitoring in the Republic of Kyrgyzstan. The SYKE also participated the climate change project in Nicaragua.

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9 EDUCATION, TRAINING AND PUBLIC AWARENESS

9.1. CLIMATE CHANGE ISSUES IN FINLAND'S EDUCATIONAL SYSTEM

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

The National Strategy for Environmental Education (1991) states that the responsibility for sustainable development lies with all people, collectively and as individuals. The individual can influence sustainable development at work, home and during free time. Education, information and advice provide the contents for a world outlook favourable to sustainable development.

The strategy also highlights the importance of environmental education at different stages in life, from child 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 caretakers. In some other sectors, e.g. in waste handling, environmental education can be started much earlier.

In a recent study of educational plans, 72% of primary schools and 83% of secondary schools had intercurricular issues for environmental education (National Board of Education 2000). Environmental aspects, such as climate topics, can be included with other subjects, and even first-graders can be eager to learn about practical ways to conserve energy and to participate in value discussions.

The international GLOBE Programme was initiated at Finnish schools in 1995. With a wide interpretation, all four areas of the programme – atmosphere, hydrology, soil and land cover – are connected to climate change issues. From an environmental education point of view, the most valuable features of GLOBE are direct experiences, which the students get by doing regular field work. Many schools have e.g. a small meterological station.

Teachers' early interest in the GLOBE programme was high, but about half of the 200 schools represented at in-service training courses rejected this innovative programme before even trying to implement it. Teachers at 103 schools started the implementation; in 60 schools the measurements and observations were still made during 1999. The students at these schools were from 6 to 18 years of age (Kaivola 2000).

Four types of empowering identities were discovered: technical, cultural, scientific and environmental. Teachers generated innovative applications of GLOBE to improve their working conditions and to create small effective networks between colleagues from different schools in Finland and abroad. GLOBE also has subprogrammes for GPS (Global Positioning System) and arctic environmental issues.

All schools in Finland have fairly good computer facilities and access to the Internet. The possibilities of multimedia have also been utilised; e.g. the National Board of Education published in 2000 a CD-rom with the title "Weather, Climate and Climate Change". The Department of Geography at the University of Helsinki had earlier published a CD-rom "Globus" with a wide coverage of environmental education. "Facts from Finland's Nature", published by the Finnish Environment Institute, contains a large collection of climate change topics.

An Internet-based programme, the Virtual School 2000–2004, also has environmental and climate issues as an essential element. This programme utilises existing links and services as teaching aids and as a basis for study courses. The virtual school is also aimed at adult people, particularly those living far from universities and other educational facilities.

At least 30 institutes at a number of universities have courses related to sustainable development in their curricula, rather many of them also dealing with climate change. University continuing education and adult education also cover to some extent this topic.

9.2. INCREASING PUBLIC AWARENESS

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. For example, the information by the Ministry of Transport and Communications deals with economic and ecological driving, promotion of cycling and so on. The ministry has also started to organise European Car Free Days in Finland since the year 2000.

The ministries have environmental web-sites with up-to-date information about a variety of issues. New statistics and research results are made readily available to the public. However, 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.

A broad-based Climate Commission led by the Ministry of the Environment has a special task of promoting awareness on climate change issues. The members of the Committee represent different ministries, industrial and environmental NGO's and trade unions. The meetings are an opportunity for information sharing and exchange of views. The Climate Commission also organises public seminars, which deal with topics of climate negotiations. These seminars take place before SBSTA and/or COP meetings and they are well attended and also usually attract media interest. A number of working groups involved with climate specific tasks spread imformation and enable exchange of views between e.g. scientists, civil servants and NGOs.

Additionally, the Finnish National IPCC Committee organises public seminars. Themes of the seminars come from the work of the IPCC, e.g. the most recent seminars have dealt with land use, land use change and forestry and with the findings of the Third Assessment Report (TAR).

The National IPCC Committee also had the TAR summaries for policy-makers translated into Finnish. These texts are available through the web pages of several relevant institutions.

The collection and distribution of information is also an essential task of Motiva Oy, in its aims at increasing energy efficiency in households, transport, services and industry. Motiva has, for example, organised "energy saving weeks", exhibitions, seminars and campaigns. 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. The library of the FMI has by far the largest collection of climate-related publications and magazines in the country.

Climate issues are also included in the information distributed by FINERGY, the Finnish Energy Industries Federation. They give advice in household energy savings through Adato, which is the energy branch´s publishing, training and information company. Consumers can 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. One way is the Cities for Climate Protection campaign. In Finland there are 41 cities or municipalities participating in this worldwide campaign at the moment. They cover almost half of the population. During the campaign, the municipalities will proceed through five stages:

1) *Surveying emissions and sinks in their areas.*
2) *Compiling development prognoses for emissions for the year 2005 or 2010.*
3) *Setting individual goals for the reduction of emissions.*
4) *Making a plan for emission reductions.*
5) *Beginning the implementation of the plan.*

The responsibility of the municipalities in energy production, traffic, land use planning and waste management is significant in Finland. By collecting basic information in this campaign the municipality will be able to plan its actions which aim at reducing 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, intensification of energy production, and efficient waste management are easiest to introduce. Other ways include public procurements, promotion of new technology in small-area and district heating, combined heat and power production (CHP), energy audits, and energy services provided to real estate companies by heating contractors.

These measures have led to considerable reductions of greenhouse gas emissions, e.g. in the town of Mikkeli, located in eastern Finland and having some 50 000 inhabitants. The emissions per capita were in 1999 eight per cent lower than in 1990.

9.3. CLIMATE CHANGE AND THE FINNISH MEDIA AND CULTURE

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. In recent years, the media has extensively covered the topic particularly during COP events, and in cases of major natural catastrophes like floods and cyclones.

Several non-governmental organizations (NGOs) have been active in climate change issues. They have participated in national seminars, public discussions, TV debates and other events. Some NGOs have also sent representatives to Kyoto and other COPs. A coalition of environmental NGOs maintains an extensive joint website on climate, greenhouse gases and related topics. Some NGOs have their own climate-related www pages, which contain, among other things, criticism of official energy strategies and detailed formulations of alternative strategies.

In March 2001, three Finnish NGOs arranged a seminar on climate equity between the North and the South. This seminar was the outcome of the Whole Climate project of these NGOs; the results were also summarized by Lammi and Tynkkynen (2001).

The post-Kyoto climate discussion in Finnish newspapers was analysed by Luukkanen and others (2000). This discussion consisted of two phases: (i) the commitment to the zero-reduction objective, and (ii) the means to reach 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 a 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.

ALTERNATIVE VIEWS OF THE NATIONAL CLIMATE STRATEGY

(by Finnish Association for Nature Conservation, Greenpeace Finland, and Natur och Miljö)

Several of the underlying assumptions of the National Climate Strategy are unrealistic:

– The potential of energy saving and energy efficiency measures has been underestimated. The energy saving and energy efficiency measures included in the strategy would only reduce energy consumption by about 3%, while several energy efficiency programs and studies have shown the energy saving potential in Finland to be in the magnitude of 10–20%.

– The potential of renewable energy sources has been underestimated. According to the background report of the program for promotion of renewable energy sources, the use of biofuels in combined heat and power production could be increased to 175 PJ by the year 2010, instead of the 117 PJ target set in the Climate Strategy. Finland's wind power potential has also been underestimated.

– The strategy assumes that electricity imports from Scandinavia will end. The amount of electricity available for import from the other Nordic countries will decrease only if these countries do not implement climate programmes of their own, and their electricity consumption increases substantially.

– One of the most serious flaws of the climate strategy is that it assumes that the construction of a new nuclear power plant will not affect the increasing of renewable energy production capacity. The massive investment required for and large amount of electrical power generated by a new nuclear plant will, however, probably lead to a smaller amount of investors being interested in renewable energy projects even if state subsidies are available.

– No measures are taken to reduce emissions resulting from the use of international bunker fuels, which in the case of air traffic may have greater atmospheric effects than their percentage share of CO_2-equivalent emissions would indicate.

– The strategy does not contain serious efforts to reduce the fossil fuel dependency of transport systems. One of the greatest obstacles to the development of renewable transport fuels is the current fuel taxation system, which does not take into account the origin of the carbon content of the fuel.

The discussion about the means to reach the target was divided into two discourses. The competitiveness of the industry was a central concern in one discourse, while the other discourse saw renewable energy sources and structural change as a possibility.

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 across the whole of the programme's activities and results was published in Finnish (Kuusisto et al. 1996). This comprehensive integration of SILMU's results was aimed at the general public with particular interest in climate change issues. This book also received an award in the annual Science Book Competition. Several other books have recently dealt with climatic topics and alternative energy policies.

A climate change exhibition was arranged in the Finnish Science Centre Heureka near Helsinki in 1996. This impressive demonstration appeared at other venues in Finland in 1997.

WWF Finland arranged an international photo exhibition "Images Beyond the NAKED EYE" in Helsinki in 2000. This exhibition tried to demonstrate different aspects of climate change from the viewpoints of man and nature. Climate change issues, including extreme scenarios, have also been dealt with by Finnish artists and authors. For example, a novel describing the consequences of the run-away greenhouse effect in high latitudes aroused wide public interest.

9.4. INTERACTIONS AND INTERVIEWS

One of the aims of the SILMU programme was to produce information for decision-makers and for the general public. An integrative project for this purpose was PAATE (Tirkkonen 2000), an inquiry into the present state and future possibilities of interaction between researchers and decision-makers. This project started with a survey among more than one hundred people: researchers, officials of various ministries, politicians, representatives of the economy and non-governmental organizations.

The views of the respondents regarding climate change in the next 20 years varied considerably. A slight majority believed that significant changes would occur during that period. When asked to estimate climate changes during a longer period of time (100 years), almost all respondents were convinced that anthropogenic changes would occur to some extent.

When the respondents were asked to consider possible effects of climate change, they emphasised that these effects will be both negative and positive in Finland. Negative aspects mentioned included among other things the difficulties of forests adapting to rapidly changing conditions and the disappearance of "real winters". Possible positive effects included increased forest growth and savings in heating energy. On the other hand, it was recognised that the situation in Finland is affected critically by the global effects of climate change. The greatest cause of concern was the general increase of risks, as reflected, for example, in changed conditions for cultivation of the land or in migrations induced by environmental changes.

In the discussions between researchers and policy-makers several alternatives emerged for slowing down the growth of emissions in Finland. These included, first and foremost, investing in research and technology, joint implementation, technology transfer, and measures that serve also other social purposes. More disputed measures include energy and carbon taxes, the selection of appropriate forms of energy production, the preservation of carbon sinks and reservoirs, and solutions involving urban planning and transport policy.

One aim of the PAATE project was to bridge the information and communication gap between researchers and decision-makers. In the course of the project it became clear that while interaction may work well within individual sectors, problems tend to occur in the interaction between the scientific community and other societal actors. The participants generally welcomed all creative efforts to improve the integration of real-life decision-making and the knowledge of the various aspects of climate change (Wilenius 1997).

Experts working with climate change issues were also asked what would be the most important criteria in forming the national climate strategy (Hildén et al. 2001). The majority of the respondents emphasized criteria that cause only slight environmental impacts, and that enhance energy production and the use of raw materials, also in the global perspective. The promotion of the export of Finnish energy technology was also considered important. As to the economic impacts of the climate strategy, the international competitiveness of Finnish industry should not be lowered.

Ordinary citizens have also been interviewed in Finland on climate change issues. In general, the emphasis in their risk perceptions is on local environmental risks like air and water pollution. The most serious consequences of climate change are thought likely to occur elsewhere than in Finland. Most interviewees believe that global warming will lead to desertification and sea level rise. The number of environmental refugees is also assumed to increase.

In summary, it can be concluded that from the standpoint of the public in Finland, climate change is an integrated part of the overall ecological issue in the modern world. People anticipate that the pursuit of material well-being will lead to an accelerating future decline in the quality of life, unless strong protective measures are applied.

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 by ICLEI. Some Finnish projects in developing countries have also aimed at increasing public awareness in climate change issues, e.g. the PANIF project in Nicaragua. Likewise, most Finnish forestry projects in developing countries try to promote sustainable forest management practices through higher public awareness.

In spring 2001 Finland together with Sweden organised a seminar for Estonia, Latvia and Lithuania in order to enhance their capabilities in the preparation of National Communications and greenhouse gas inventories.

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ABBREVIATIONS

ACEA	European Automobile Manufacturers Association
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
EC	European Community
ECCP	European Climate Change Programme
EFI	European Forest Institute
EMAS	Eco-management and Audit Scheme
EMU	Economic and Monetary Union
ETLA	Research Institute of the Finnish Economy
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
HELCOM	Helsinki Commission
IASC	International Arctic Science Committee
ICAO	International Civil Aviation Organisation
ICLEI	International Council for Local Environmental Initiatives
IGBP	International Geosphere-Biosphere Programme
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
METLA	Finnish Forest Research Institute
MINTC	Ministry of Transport and Communications

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
NFP	National Forest Programme
NGO	Non-Government Organisation
NMVOC	Non-Methane Volatile Organic Hydrocarbons
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
PCF	Prototype Carbon Fund
PEFC	Pan-European Forest Certification
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
TUNDRA	Tundra Degradation in the Russian Arctic
UNCED	United Nations Conference on Environment and Development
UNCSD	United Nations Common Supply Database
UNFCCC	United Nations Framework Convention on Climate Change
VATT	Government Institute for Economic Research
VTT	Technical Research Centre of Finland
WCRP	World Climate Change Programme
WMO	World Meteorological Organisation
WWF	World Wildlife Fund

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 1 of 3)

Finland
1999
UN 2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs[1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
						P	A	P	A	P	A				
		(Gg)				CO_2 equivalent (Gg)				(Gg)					
Total National Emissions and Removals		**64 185,54**	**-10 820,88**	**187,20**	**25,00**	**883,65**	**316,89**	**28,55**	**28,55**	**0,001**	**0,001**	**248,23**	**544,86**	**177,10**	**85,03**
1. Energy		**60 305,76**		**23,71**	**7,95**							**248,23**	**544,86**	**134,99**	**68,28**
A. Fuel Combustion	Reference Approach [2]	56 845,35													
	Sectoral Approach [2]	56 781,40		22,36	7,95							248,23	544,86	100,49	68,28
1. Energy Industries		21 028,80		1,38	1,89							36,31	9,62	0,00	34,28
2. Manufacturing Industries and Construction		15 844,40		2,34	2,95							51,82	56,75	3,00	24,25
3. Transport		12 734,00		3,42	2,30							136,17	357,02	60,61	2,83
4. Other Sectors		6 368,80		15,11	0,78							23,26	121,22	36,82	5,95
5. Other		805,40		0,12	0,03							0,67	0,25	0,06	0,97
B. Fugitive Emissions from Fuels		3 524,36		1,35	0,00							0,00	0,00	34,50	0,00
1. Solid Fuels		3 500,00		1,00	0,00							0,00	0,00	0,00	0,00
2. Oil and Natural Gas		24,36		0,35	0,00							0,00	0,00	34,50	0,00
2. Industrial Processes		**1 114,08**		**0,71**	**4,27**	**883,65**	**316,89**	**28,55**	**28,55**	**0,001**	**0,001**	**0,00**	**0,00**	**9,01**	**16,75**
A. Mineral Products		1 114,08		0,00	0,00							0,00	0,00	1,20	0,00
B. Chemical Industry		0,00		0,26	4,27	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	5,80	7,35
C. Metal Production		0,00		0,45	0,00				0,00		0,00	0,00	0,00	0,51	3,20
D. Other Production [3]		NE/NZ										0,00	0,00	1,50	6,20
E. Production of Halocarbons and SF_6							0,00		0,00		0,00				
F. Consumption of Halocarbons and SF_6						883,65	316,89	28,55	28,55	0,00	0,00				
G. Other		0,00		0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

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

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

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

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

[3] Other Production includes Pulp and Paper and Food and Drink Production.

Note: The numbering of footnotes to all tables containing more than one sheet continue to the next sheet. Common footnotes are given only once at the first point of reference.

Note: CO2 emissions from coke and residual fuel oil used in the blast furnaces have been included in ì1.A 2 a Fuel combustion in Iron and steel Industryî

Note: NO2 and SO2 emissions from Industrial processes have been included in ì1.A 2 Fuel combustion in Manufacturing industrie s and constructionî

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 2 of 3)

Finland
1999
UN 2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs [1]		PFCs [1]		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
	(Gg)				CO_2 equivalent (Gg)						(Gg)			
3. Solvent and Other Product Use	**0,00**			**0,20**							**NO**	**NO**	**31,10**	**NO**
4. Agriculture	**2 015,71**	**0,00**	**84,02**	**12,30**							0,00	0,00	0,00	0,00
A. Enteric Fermentation			74,01											
B. Manure Management			10,01	1,32									0,00	
C. Rice Cultivation			0,00										NO	
D. Agricultural Soils	[4] 2015,71	[4] 0,00	0,00	10,98									NE	
E. Prescribed Burning of Savannas			0,00	0,00							NO	NO	NO	
F. Field Burning of Agricultural Residues			0,00	0,00							0,00	0,00	0,00	
G. Other			0,00	0,00							0,00	0,00	0,00	NO
5. Land-Use Change and Forestry	[5] **0,00**	[5] **-10 820,88**	**0,00**	**0,00**							**0,00**	**0,00**	**0,00**	**0,00**
A. Changes in Forest and Other Woody Biomass Stocks	[5] 0,00	[5] -10 820,88												
B. Forest and Grassland Conversion	0,00		0,00	0,00							0,00	0,00	NO	
C. Abandonment of Managed Lands	[5] 0,00	[5] 0,00												
D. CO_2 Emissions and Removals from Soil	[5] 0,00	[5] 0,00												
E. Other	[5] 0,00	[5] 0,00	0,00	0,00							0,00	0,00	NO	NO
6. Waste	**0,00**		**78,76**	**0,27**							**0,00**	**0,00**	**2,00**	**0,00**
A. Solid Waste Disposal on Land	[6] 0,00		77,15									0,00	0,75	
B. Wastewater Handling			1,60	0,27							0,00	0,00	1,25	
C. Waste Incineration	[6] IE		IE	IE							IE	IE	IE	IE
D. Other	0,00		0,00	0,00							0,00	0,00	0,00	0,00
7. Other *(please specify)*	**750,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
Emissions from fuels used as feedstock	750,00	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

[4] According to the IPCC Guidelines (Volume 3. Reference Manual, pp. 4.2, 4.87), CO_2 emissions from agricultural soils are to be included under Land-Use Change and Forestry (LUCF). At the same time, the Summary Report 7A (Volume 1. Reporting Instructions, Tables.27) allows for reporting CO_2 emissions or removals from agricultural soils, either in the Agriculture sector, under D. Agricultural Soils or in the Land-Use Change and Forestry sector under D. Emissions and Removals from Soil. Parties may choose either way to report emissions or removals from this source in the common reporting format, but the way they have chosen to report should be clearly indicated, by inserting explanatory comments to the corresponding cells of Summary 1.A and Summary 1.B. Double-counting of these emissions or removals should be avoided. Parties should include these emissions or removals consistently in Table8(a) (Recalculation - Recalculated data) and Table10 (Emission trends).

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

[6] Note that CO_2 from Waste Disposal and Incineration source categories should only be included if it stems from non-biogenic or inorganic waste streams.

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 3 of 3)

Finland
1999
UN 2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 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: [7]														
International Bunkers	**2 822,00**		**0,09**	**0,77**							**43,38**	**6,57**	**1,61**	**14,25**
Aviation	1 058,00		0,05	0,05							3,74	4,24	0,49	0,28
Marine	1 764,00		0,05	0,72							39,64	2,33	1,12	13,97
Multilateral Operations	**0,00**		**0,00**	**0,00**							**NO**	**NO**	**NO**	**NO**
CO_2 Emissions from Biomass	**28 986,70**													

[7] Memo Items are not included in the national totals.

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

Finland
1999
UN 2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**53 364,66**	**3 931,13**	**7 748,75**	**316,89**	**28,55**	**32,33**	**65 422,31**
1. Energy	**60 305,76**	**497,89**	**2 464,36**				**63 268,01**
A. Fuel Combustion (Sectoral Approach)	56 781,40	469,50	2 464,36				59 715,26
1. Energy Industries	21 028,80	28,98	585,99				21 643,77
2. Manufacturing Industries and Construction	15 844,40	49,06	914,42				16 807,87
3. Transport	12 734,00	71,74	713,82				13 519,56
4. Other Sectors	6 368,80	317,21	241,69				6 927,70
5. Other	805,40	2,52	8,44				816,36
B. Fugitive Emissions from Fuels	3 524,36	28,39	0,00				3 552,75
1. Solid Fuels	3 500,00	21,00	0,00				3 521,00
2. Oil and Natural Gas	24,36	7,39	0,00				31,75
2. Industrial Processes	**1 114,08**	**14,91**	**1 325,08**	**316,89**	**28,55**	**32,33**	**2 831,84**
A. Mineral Products	1 114,08	0,00	0,00				1 114,08
B. Chemical Industry	0,00	5,46	1 325,08	0,00	0,00	0,00	1 330,53
C. Metal Production	0,00	9,45	0,00		0,00	0,00	9,45
D. Other Production	NE/NZ						0,00
E. Production of Halocarbons and SF_6				0,00	0,00	0,00	0,00
F. Consumption of Halocarbons and SF_6				316,89	28,55	32,33	377,78
G. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00
3. Solvent and Other Product Use	**0,00**		**62,00**				**62,00**
4. Agriculture	**2 015,71**	**1 764,42**	**3 814,05**				**7 594,18**
A. Enteric Fermentation		1 554,12					1 554,12
B. Manure Management		210,30	409,33				619,63
C. Rice Cultivation		0,00					0,00
D. Agricultural Soils[2]	2 015,71	0,00	3 404,73				5 420,43
E. Prescribed Burning of Savannas		0,00	0,00				0,00
F. Field Burning of Agricultural Residues		0,00	0,00				0,00
G. Other		0,00	0,00				0,00
5. Land-Use Change and Forestry[1]	**-10 820,88**	**0,00**	**0,00**				**-10 820,88**
6. Waste	**0,00**	**1 653,90**	**83,26**				**1 737,16**
A. Solid Waste Disposal on Land	0,00	1 620,21					1 620,21
B. Wastewater Handling		33,70	83,26				116,96
C. Waste Incineration	IE	0,00	0,00				0,00
D. Other	0,00	0,00	0,00				0,00
7. Other *(please specify)*	**750,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**750,00**
Emissions from fuels used as feedstock	750,00	NO	NO	NO	NO	NO	750,00
							0,00
Memo Items:							
International Bunkers	**2 822,00**	**1,93**	**237,77**				**3 061,70**
Aviation	1 058,00	0,95	13,95				1 072,90
Marine	1 764,00	0,99	223,82				1 988,81
Multilateral Operations	**0,00**	**0,00**	**0,00**				**0,00**
CO_2 Emissions from Biomass	**28 986,70**						**28 986,70**

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

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	90 447,42	-101 268,30	-10 820,88			-10 820,88
B. Forest and Grassland Conversion	0,00		0,00	0,00	0,00	0,00
C. Abandonment of Managed Lands	0,00	0,00	0,00			0,00
D. CO_2 Emissions and Removals from Soil	0,00	0,00	0,00			0,00
E. Other	0,00	0,00	0,00	0,00	0,00	0,00
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	90 447,42	-101 268,30	-10 820,88	0,00	0,00	-10 820,88

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry[a]	76 243,19
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry[a]	65 422,31

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

Note: CO2 emissions from coke and residual fuel oil used in the blast furnaces have been included in ì1.A 2 a Fuel consumption in Iron and steel Industryî

TABLE 10 EMISSIONS TRENDS (CO_2)
(Sheet 1 of 5)

Finland
1999
UN 2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[(1)]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
					(Gg)						
1. Energy	**57 435,10**	**57 435,10**	**56 604,38**	**54 805,26**	**55 593,19**	**61 870,68**	**59 421,36**	**64 743,88**	**63 341,16**	**60 928,06**	**60 305,76**
A. Fuel Combustion (Sectoral Approach)	53 893,20	53 893,20	53 070,22	51 258,62	52 035,04	58 330,70	55 881,80	61 220,10	59 814,70	57 403,70	56 781,40
1. Energy Industries	18 517,20	18 517,20	19 107,22	17 509,92	19 945,04	24 644,80	22 455,60	27 508,80	24 672,50	21 394,50	21 028,80
2. Manufacturing Industries and Construction	14 357,80	14 357,80	13 840,40	13 504,70	13 204,80	13 986,60	13 866,30	13 533,80	15 194,10	15 281,80	15 844,40
3. Transport	12 475,20	12 475,20	11 609,70	11 583,30	10 963,40	11 366,10	11 125,10	10 994,10	11 531,30	12 299,00	12 734,00
4. Other Sectors	7 570,80	7 570,80	7 205,90	7 353,70	6 607,60	6 882,50	6 679,40	6 483,30	6 597,50	6 658,60	6 368,80
5. Other	972,20	972,20	1 307,00	1 307,00	1 314,20	1 450,70	1 755,40	2 700,10	1 819,30	1 769,80	805,40
B. Fugitive Emissions from Fuels	3 541,90	3 541,90	3 534,16	3 546,64	3 558,15	3 539,98	3 539,56	3 523,78	3 526,46	3 524,36	3 524,36
1. Solid Fuels	3 500,00	3 500,00	3 500,00	3 500,00	3 500,00	3 500,00	3 500,00	3 500,00	3 500,00	3 500,00	3 500,00
2. Oil and Natural Gas	41,90	41,90	34,16	46,64	58,15	39,98	39,56	23,78	26,46	24,36	24,36
2. Industrial Processes	**1 175,46**	**1 175,46**	**1 036,92**	**936,92**	**793,07**	**836,25**	**836,39**	**862,61**	**946,88**	**921,37**	**1 114,08**
A. Mineral Products	1 175,46	1 175,46	1 036,92	936,92	793,07	836,25	836,39	862,61	946,88	921,37	1 114,08
B. Chemical Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
C. Metal Production	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	NE
D. Other Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Production of Halocarbons and SF_6											
F. Consumption of Halocarbons and SF_6											
G. Other											
3. Solvent and Other Product Use											
4. Agriculture	**3 214,94**	**3 214,94**	**2 815,18**	**2 320,68**	**2 229,85**	**2 069,12**	**1 726,47**	**1 825,07**	**2 064,96**	**2 031,25**	**2 015,71**
A. Enteric Fermentation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Manure Management	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils [(2)]	3 214,94	3 214,94	2 815,18	2 320,68	2 229,85	2 069,12	1 726,47	1 825,07	2 064,96	2 031,25	2 015,71
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other											
5. Land-Use Change and Forestry [(3)]	**-23 797,73**	**-23 797,73**	**-38 206,89**	**-31 893,52**	**-29 116,33**	**-17 259,44**	**-14 687,35**	**-21 032,44**	**-12 637,13**	**-9 712,58**	**-10 820,88**
A. Changes in Forest and Other Woody Biomass Stocks	-23 797,73	-23 797,73	-38 206,89	-31 893,52	-29 116,33	-17 259,44	-14 687,35	-21 032,44	-12 637,13	-9 712,58	-10 820,88
B. Forest and Grassland Conversion	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
C. Abandonment of Managed Lands	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. CO_2 Emissions and Removals from Soil	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Other											
6. Waste	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
A. Solid Waste Disposal on Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Waste-water Handling	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other											
7. Other *(please specify)*	**640,29**	**640,29**	**614,76**	**607,51**	**555,98**	**691,52**	**699,49**	**698,46**	**557,64**	**720,05**	**750,00**
Emissions from fuels used as feedstock	640,29	640,29	614,76	607,51	555,98	691,52	699,49	698,46	557,64	720,05	750,00
Total Emissions/Removals with LUCF [(4)]	**38 668,06**	**38 668,06**	**22 864,35**	**26 776,85**	**30 055,76**	**48 208,14**	**47 996,36**	**47 097,58**	**54 273,50**	**54 888,13**	**53 364,66**
Total Emissions without LUCF[(4)]	**62 465,79**	**62 465,79**	**61 071,24**	**58 670,36**	**59 172,09**	**65 467,58**	**62 683,70**	**68 130,02**	**66 910,63**	**64 600,72**	**64 185,54**
Memo Items:											
International Bunkers	**2 774,00**	**2 774,00**	**3 815,00**	**2 975,00**	**2 457,00**	**2 120,00**	**1 911,00**	**2 138,00**	**2 251,00**	**2 648,00**	**2 822,00**
Aviation	974,00	974,00	917,00	811,00	762,00	802,00	867,00	957,00	965,00	990,00	1 058,00
Marine	1 800,00	1 800,00	2 898,00	2 164,00	1 695,00	1 318,00	1 044,00	1 181,00	1 286,00	1 658,00	1 764,00
Multilateral Operations	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
CO_2 Emissions from Biomass	**18 452,20**	**18 452,20**	**17 690,75**	**16 932,05**	**19 961,00**	**20 985,00**	**23 051,10**	**22 926,70**	**26 524,00**	**27 224,80**	**28 986,70**

(1) Fill in the base year adopted by the Party under the Convention, if different from 1990.

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

(3) Take the net emissions as reported in Summary 1.A of this common reporting format. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

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

TABLE 10 EMISSIONS TRENDS (CH_4)
(Sheet 2 of 5)

Finland
1999
UN 2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)										
Total Emissions	**292,45**	**292,45**	**275,15**	**256,08**	**237,52**	**221,83**	**221,13**	**212,66**	**203,96**	**193,39**	**187,20**
1. Energy	**20,52**	**20,52**	**20,01**	**16,88**	**16,30**	**17,29**	**22,87**	**24,01**	**23,31**	**23,57**	**23,71**
A. Fuel Combustion (Sectoral Approach)	19,35	19,35	18,81	15,68	15,10	16,09	21,67	22,42	21,90	21,96	22,36
1. Energy Industries	1,19	1,19	1,34	1,27	1,44	1,79	1,65	1,89	1,72	1,60	1,38
2. Manufacturing Industries and Construction	1,93	1,93	1,89	1,88	2,42	2,43	2,61	2,61	2,27	2,26	2,34
3. Transport	3,33	3,33	3,28	3,21	3,12	3,06	2,98	2,93	2,96	2,93	3,42
4. Other Sectors	12,78	12,78	12,19	9,21	8,01	8,71	14,30	14,67	14,76	14,91	15,11
5. Other	0,12	0,12	0,12	0,12	0,10	0,10	0,14	0,31	0,19	0,26	0,12
B. Fugitive Emissions from Fuels	1,17	1,17	1,20	1,20	1,20	1,20	1,20	1,59	1,41	1,60	1,35
1. Solid Fuels	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2. Oil and Natural Gas	0,17	0,17	0,20	0,20	0,20	0,20	0,20	0,59	0,41	0,60	0,35
2. Industrial Processes	**0,43**	**0,43**	**0,46**	**0,47**	**0,63**	**0,64**	**0,69**	**0,69**	**0,62**	**0,71**	**0,71**
A. Mineral Products	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
B. Chemical Industry	0,19	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	0,24	0,25	0,44	0,46	0,46	0,46	0,44	0,46	0,45
D. Other Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Production of Halocarbons and SF_6											
F. Consumption of Halocarbons and SF_6											
G. Other											
3. Solvent and Other Product Use											
4. Agriculture	**96,32**	**96,32**	**91,71**	**89,56**	**89,61**	**89,54**	**86,29**	**86,52**	**87,77**	**85,66**	**84,02**
A. Enteric Fermentation	86,85	86,85	82,72	80,78	80,88	80,72	75,94	76,21	77,08	75,28	74,01
B. Manure Management	9,47	9,47	8,99	8,78	8,73	8,82	10,35	10,31	10,69	10,39	10,01
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	NE/NZ	NE/NZ	NE/NZ	NE/NZ	NE/NZ	NE/NZ	NE/NZ	NE/NZ	NE/NZ	NE/NZ	NE/NZ
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NZ	NZ	NZ	NZ	NZ	NZ	NZ	NZ	NZ	NZ	NZ
G. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5. Land-Use Change and Forestry	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
A. Changes in Forest and Other Woody Biomass Stocks	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
B. Forest and Grassland Conversion	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
C. Abandonment of Managed Lands	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. CO_2 Emissions and Removals from Soil	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Other											
6. Waste	**175,19**	**175,19**	**162,97**	**149,19**	**130,98**	**114,36**	**111,28**	**101,45**	**92,26**	**83,45**	**78,76**
A. Solid Waste Disposal on Land	173,48	173,48	161,40	147,69	129,41	112,73	109,66	99,85	90,71	81,86	77,15
B. Waste-water Handling	1,71	1,71	1,57	1,50	1,56	1,62	1,62	1,60	1,56	1,59	1,60
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other											
7. Other *(please specify)*	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
Memo Items:											
International Bunkers	**1,26**	**1,26**	**1,22**	**1,07**	**0,99**	**1,03**	**1,11**	**1,22**	**1,23**	**1,28**	**0,09**
Aviation	1,21	1,21	1,14	1,01	0,95	1,00	1,08	1,19	1,20	1,23	0,05
Marine	0,05	0,05	0,08	0,06	0,05	0,03	0,03	0,03	0,03	0,04	0,05
Multilateral Operations	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
CO_2 Emissions from Biomass											

TABLE 10 EMISSIONS TRENDS (N_2O)
(Sheet 3 of 5)

Finland
1999
UN 2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)										
Total Emissions	**27,14**	**27,14**	**25,52**	**23,51**	**24,13**	**24,49**	**25,15**	**25,31**	**26,02**	**25,52**	**25,00**
1. Energy	**5,54**	**5,54**	**5,67**	**5,41**	**5,63**	**5,89**	**6,33**	**6,91**	**7,89**	**8,00**	**7,95**
A. Fuel Combustion (Sectoral Approach)	5,54	5,54	5,67	5,41	5,63	5,89	6,33	6,91	7,89	8,00	7,95
1. Energy Industries	1,19	1,19	1,31	1,24	1,40	1,61	1,61	2,06	1,93	1,88	1,89
2. Manufacturing Industries and Construction	1,41	1,41	1,49	1,32	1,32	1,36	1,81	1,75	2,78	2,83	2,95
3. Transport	2,03	2,03	1,75	1,74	1,84	1,87	1,80	1,94	2,02	2,45	2,30
4. Other Sectors	0,88	0,88	0,77	0,76	0,73	0,68	0,72	0,73	0,77	0,77	0,78
5. Other	0,03	0,03	0,35	0,35	0,34	0,37	0,38	0,44	0,38	0,07	0,03
B. Fugitive Emissions from Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
1. Solid Fuels	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2. Oil and Natural Gas	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2. Industrial Processes	**5,15**	**5,15**	**4,52**	**4,05**	**4,20**	**4,35**	**4,50**	**4,50**	**4,52**	**4,26**	**4,27**
A. Mineral Products	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
B. Chemical Industry	5,15	5,15	4,52	4,05	4,20	4,35	4,50	4,50	4,52	4,26	4,27
C. Metal Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Other Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
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**	**0,20**
4. Agriculture	**15,89**	**15,89**	**14,78**	**13,52**	**13,78**	**13,73**	**13,81**	**13,40**	**13,11**	**12,78**	**12,30**
A. Enteric Fermentation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Manure Management	1,79	1,79	1,70	1,68	1,68	1,69	1,50	1,49	1,49	1,42	1,32
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	14,11	14,11	13,08	11,84	12,10	12,04	12,31	11,91	11,62	11,36	10,98
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NZ	NZ	NZ	NZ	NZ	NZ	NZ	NZ	NZ	NZ	NZ
G. Other	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
5. Land-Use Change and Forestry	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
A. Changes in Forest and Other Woody Biomass Stocks	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
B. Forest and Grassland Conversion	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
C. Abandonment of Managed Lands	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. CO_2 Emissions and Removals from Soil	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Other											
6. Waste	**0,36**	**0,36**	**0,34**	**0,33**	**0,32**	**0,32**	**0,32**	**0,30**	**0,30**	**0,28**	**0,27**
A. Solid Waste Disposal on Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Waste-water Handling	0,36	0,36	0,34	0,33	0,32	0,32	0,32	0,30	0,30	0,28	0,27
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other											
7. Other *(please specify)*	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
Memo Items:											
International Bunkers	**1,18**	**1,18**	**1,59**	**1,25**	**1,04**	**0,91**	**0,82**	**0,92**	**0,97**	**1,13**	**0,77**
Aviation	0,44	0,44	0,42	0,37	0,34	0,36	0,39	0,43	0,44	0,45	0,05
Marine	0,74	0,74	1,18	0,88	0,69	0,54	0,43	0,49	0,53	0,68	0,72
Multilateral Operations	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**
CO_2 Emissions from Biomass											

TABLE 10 EMISSION TRENDS (HFCs, PFCs and SF_6)
(Sheet 4 of 5)

Finland
1999
UN 2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)										
Emissions of HFCs[5] - CO_2 equivalent (Gg)	**0,31**	**0,31**	**0,34**	**0,39**	**0,38**	**6,81**	**30,02**	**77,99**	**167,93**	**246,45**	**316,89**
HFC-23	0,00003	0,00003	0,00003	0,00002	0,00003	0,00002	0,00006	0,00006	0,00004	0,00003	0,00026
HFC-32	NO	NO	NO	NO	NO	NO	0,000	0,000	0,002	0,001	0,009
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-125	NO	NO	NO	NO	NO	0,000	0,002	0,005	0,008	0,018	0,034
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	NO	NO	NO	NO	NO	0,005	0,015	0,038	0,089	0,092	0,126
HFC-152a	0,0001	0,0001	0,0003	0,0007	0,0007	0,0004	0,017	0,041	0,037	0,031	0,027
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-143a	NO	NO	NO	NO	NO	0,000	0,001	0,002	0,006	0,019	0,012
HFC-227ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of PFCs[5] - CO_2 equivalent (Gg)	**0,53**	**0,53**	**0,61**	**0,68**	**0,75**	**0,83**	**0,90**	**1,05**	**1,35**	**0,90**	**28,55**
CF_4	0,00003	0,00003	0,00003	0,00003	0,00003	0,00003	0,00003	0,00003	0,00003	0,00003	0,00012
C_2F_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00001
C_3F_8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00362
C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C_4F_8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_6F_{14}	0,00005	0,00005	0,00006	0,00007	0,00008	0,00009	0,00010	0,00012	0,00016	0,00010	0,00032
Emissions of SF_6[5] - CO_2 equivalent (Gg)	**71,07**	**71,07**	**47,78**	**32,47**	**26,28**	**26,21**	**13,93**	**13,93**	**16,07**	**11,82**	**32,33**
SF_6	0,0030	0,0030	0,0020	0,0014	0,0011	0,0011	0,0006	0,0006	0,0007	0,0005	0,0014

[5] Enter information on the actual emissions. Where estimates are only available for the potential emissions, specify this in a comment to the corresponding cell. Only in this row the emissions are expressed as CO_2 equivalent emissions in order to facilitate data flow among spreadsheets.

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

Finland
1999
UN 2001

GREENHOUSE GAS EMISSIONS	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)										
Net CO_2 emissions/removals	38 668,06	38 668,06	22 864,35	26 776,85	30 055,76	48 208,14	47 996,36	47 097,58	54 273,50	54 888,13	53 364,66
CO_2 emissions (without LUCF) [6]	62 465,79	62 465,79	61 071,24	58 670,36	59 172,09	65 467,58	62 683,70	68 130,02	66 910,63	64 600,72	64 185,54
CH_4	6 141,48	6 141,48	5 778,10	5 377,74	4 987,93	4 658,36	4 643,65	4 465,91	4 283,23	4 061,24	3 931,13
N_2O	8 413,60	8 413,60	7 911,05	7 286,87	7 480,01	7 591,34	7 796,28	7 846,77	8 066,60	7 911,92	7 748,75
HFCs	0,31	0,31	0,34	0,39	0,38	6,81	30,02	77,99	167,93	246,45	316,89
PFCs	0,53	0,53	0,61	0,68	0,75	0,83	0,90	1,05	1,35	0,90	28,55
SF_6	71,07	71,07	47,78	32,47	26,28	26,21	13,93	13,93	16,07	11,82	32,33
Total (with net CO_2 emissions/removals)	**53 295,04**	**53 295,04**	**36 602,22**	**39 474,99**	**42 551,12**	**60 491,69**	**60 481,14**	**59 503,23**	**66 808,67**	**67 120,46**	**65 422,31**
Total (without CO_2 from LUCF) [6]	**77 092,77**	**77 092,77**	**74 809,11**	**71 368,51**	**71 667,45**	**77 751,13**	**75 168,48**	**80 535,67**	**79 445,80**	**76 833,05**	**76 243,19**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)										
1. Energy	59 584,38	59 584,38	58 783,07	56 836,63	57 679,75	64 058,57	61 862,91	67 391,26	66 276,55	63 901,47	63 268,01
2. Industrial Processes	2 851,75	2 851,75	2 496,80	2 234,66	2 136,97	2 232,55	2 289,63	2 364,13	2 548,01	2 516,34	2 831,84
3. Solvent and Other Product Use	62,00	62,00	62,00	62,00	62,00	62,00	62,00	62,00	62,00	62,00	62,00
4. Agriculture	10 164,61	10 164,61	9 323,51	8 392,07	8 383,36	8 206,13	7 819,55	7 795,16	7 971,84	7 793,46	7 594,18
5. Land-Use Change and Forestry [7]	-23 797,73	-23 797,73	-38 206,89	-31 893,52	-29 116,33	-17 259,44	-14 687,35	-21 032,44	-12 637,13	-9 712,58	-10 820,88
6. Waste	3 789,75	3 789,75	3 528,96	3 235,65	2 849,40	2 500,35	2 434,90	2 224,66	2 029,77	1 839,72	1 737,16
7. Other	640,29	640,29	614,76	607,51	555,98	691,52	699,49	698,46	557,64	720,05	750,00

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