Finland's Fifth
National Communication
under the United Nations
Framework Convention on

Climate Change

Finland's Fifth
National Communication
under the United Nations
Framework Convention on

Climate Change

Committee for Preparing the Fifth National Communication

Riitta Pipatti, Statistics Finland (Chair)
Martti Esala, MTT Agrifood Research Finland
Saara Jääskeläinen, Ministry of Transport and Communications
Leo Kolttola, Statistics Finland
Esko Kuusisto, Finnish Environment Institute
Sanna Luhtala, Ministry of Agriculture and Forestry
Irmeli Mikkonen, Motiva Oy
Markku Niinioja, Ministry for Foreign Affairs
Sini Niinistö, Finnish Forest Research Institute (Metla)
Marjo Nummelin, Ministry of the Environment
Paula Perälä, Ministry of the Environment
Kim Pingoud, VTT Technical Research Centre of Finland
Hannele Seitsonen, Ministry of Education
Markku Stenborg, Ministry of Finance
Pekka Tervo, Ministry of Employment and the Economy
Outi Tolonen-Kivimäki, Finnish Meteorological Institute
Heikki Tuomenvirta, Finnish Meteorological Institute
Jussi Uusivuori, Finnish Forest Research Institute (Metla)
Leena Raittinen, Statistics Finland (Secretary)
Kai Skoglund, Statistics Finland (Secretary)

Editor: Merimari Kimpanpää, Earth Pen, the Netherlands

Reference recommendation: Finland's Fifth National Communication under the United Nations Framework Convention on Climate Change. 2009. Ministry of the Environment and Statistics Finland, Helsinki. 280 p.

English Language Consultant: Peter Ovell

Cover Design and Layout: Hilkka Lehtonen, Statistics Finland

Cover Photo: Jouko Lehmuskallio/YHA-kuvapankki

Photos:
Markku Aikioniemi/YHA kuvapankki, page 132
Jukka Alm/METLA, page 223
Marita Björkström/YHA kuvapankki, page 82, 171
Pirjo Ferin-Westerholm/YHA kuvapankki, page 46
futureimagebank.com, pages 13, 33, 38, 46, 48, 52, 62, 73, 75, 80, 141, 142, 143, 164, 184
Pradipta Halder, page 244
Pentti Hokkanen/YHA kuvapankki, page 81, 246
Anja Holmsten/YHA kuvapankki, page 124
iStockphoto, page 161
Jyri Juujärvi, pages 31, 35, 163
Vesa Kaarakka/VITRI, University of Helsinki, page 243
Nina Kokko/YHA kuvapankki, page 55
Frank Koumolou, pages 25, 202, 205
Vesa Kuusava/YHA kuvapankki, page 11
Esko Kuusisto, pages 9, 20, 45, 65, 137, 167, 185, 213, 230
Käpylän koulu, Helsinki, page 237
Jouko Langen/YHA kuvapankki, page 121
Riku Lumiaro/YHA kuvapankki, pages 191, 217
Kerttu Malinen/YHA kuvapankki, page 122
Raili Malinen/YHA kuvapankki, page 177
Marja-Leena Nenonen/YHA kuvapankki, page 128
Mervi Nieminen/MTT, page 226
Esa Nikunen/YHA kuvapankki, page 79
Markku Nurmi/YM, page 197
Erkki Oksanen/METLA, pages 60, 157, 172, 175, 220, 221, 233, 234
Marita Potila, page 39
Ilmo Pylkkänen, Viherjuuri, page 28, 239
Kalaimani Supramaniam, page 199, 242
Päivi Tahvanainen/YHA kuvapankki, pages 97, 102, 116
Unto Tapio/YHA kuvapankki, page 166
Aarno Torvinen/YHA kuvapankki, pages 173,175,189
Maria Uotinen/YHA kuvapankki, page 50
YHA kuvapankki, page 42
Ping Zhou/VITRI, University of Helsinki, page 243

Figures and Tables:
Statistics Finland, the Long-term Climate and Energy Strategy and the ministries, unless otherwise indicated.

ISBN 978–952–244–184–3 (pdf)
ISBN 978–952–244–185–0 (print)

Multiprint Oy, Helsinki 2010

Contents

Foreword

Climate change is among the most critical challenges of our time. As a response to this challenge, one of Finland's top environmental policy priorities is mitigation of climate change. Finland is active in implementing climate change policies in order to work towards this objective and reduce its greenhouse gas emissions further in the future.

Finland signed the United Nations Framework Convention on Climate Change (UNFCCC) in June 1992 and the respective legislation entered into force in 1994. In 2002, Finland ratified the Kyoto Protocol of the UNFCCC. Finland is working actively towards fulfilling its commitments under these treaties. In this report, Finland's Fifth National Communication under the UNFCCC, Finland describes its efforts towards fulfilling its obligations as a member of the European Union and within international cooperation.

The European Union is committed to a legally binding commitment to reduce its emissions by eight per cent on average during the first commitment period of the Kyoto Protocol 2008–2012. Under the burden sharing agreement, Finland as a Member State of the European Union is committed to bringing its average annual emissions down to the 1990 level in this first commitment period. Finland is meeting this goal and is fulfilling its commitment.

The European Union is also committed to reducing its greenhouse gases by at least 20 per cent by 2020. In addition, the European Union has set for itself a mandatory target of 20 per cent renewable energy use and a 10 per cent biofuels target by 2020. To enhance these efforts in combating climate change, the European Union adopted a legislative Climate and Energy package in 2008. The package includes e.g. an amendment of the EU Emission Trading Directive and a decision concerning burden sharing in the sectors outside the emissions trading scheme (transport, buildings, services, smaller industrial installations, agriculture and waste). Finland's obligation for the sectors outside the emissions trading scheme is a 16 per cent reduction of emissions by 2020 compared to the 2005 emissions. The European Union has also agreed to further reductions of its emissions, that is, 30 per cent by 2020, if a new global climate change agreement is reached.

Finland has prepared a new, comprehensive Long-term Climate and Energy Strategy in 2008. The previous strategy was adopted in 2005. The new Strategy outlines the policies and measures that Finland is pursuing to achieve its emission reduction goals. In addition, the Government prepared in 2009 a Foresight Report on Climate and Energy Policy which focuses on long-term development of climate policy up to 2050. The objective is an 80 per cent reduction in the emissions by 2050 compared to the 1990 level.

In Finland greenhouse gas emissions exhibit typically large fluctuations between years. The main reason for this is changes in the energy related emissions. These emissions make up around 80 per cent of the total greenhouse gas emissions. Most of the energy sector emissions are included in the EU Emission Trading Scheme (ETS). Finland is also participating in the Kyoto Mechanisms and purchasing emission allowances through the Clean Development Mechanism and Joint Implementation. Finland be-

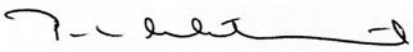
came eligible for international emissions trading and Track I joint implementation on 22 April 2008.

In 2005 Finland established the National System for estimating greenhouse gas emissions and removals in accordance with Article 5.1 of the Kyoto Protocol. Statistics Finland functions as the National Authority with overall responsibility for compiling the greenhouse gas inventory. Several organizations participate in preparing the inventory. The national registry system under the Kyoto Protocol and the EU Emission Trading Scheme was connected to the international transaction log (ITL) of the UNFCCC secretariat in October 2008.

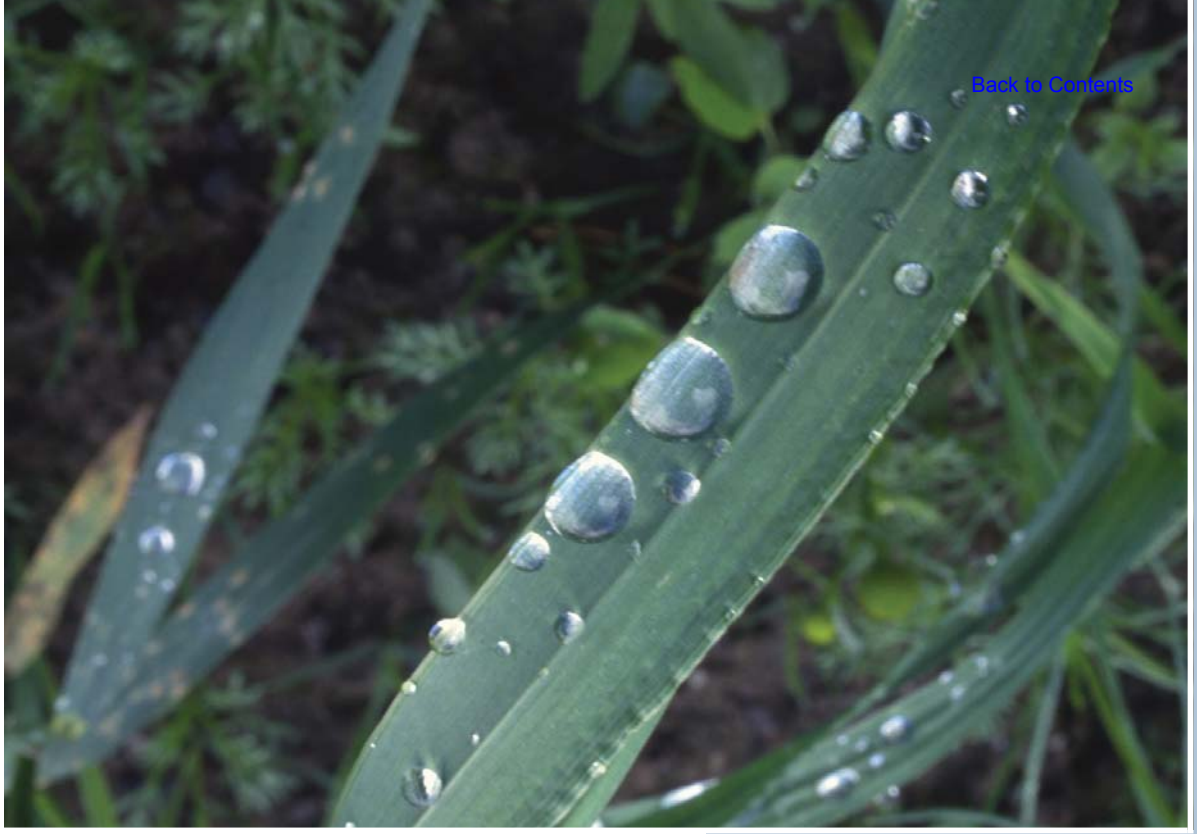
The Fifth National Communication of Finland was prepared through wide cooperation between various governmental bodies and organizations. The preparation committee was composed of the Ministry of the Environment, the Ministry for Foreign Affairs, the Ministry of Finance, the Ministry of Education, the Ministry of Agriculture and Forestry, the Ministry of Transport and Communications, the Ministry of Employment and the Economy, the Finnish Environment Institute, the Finnish Forest Research Institute, the Finnish Meteorological Institute, MTT Agrifood Research Finland, VTT Technical Research Centre of Finland and Motiva. Statistics Finland had the responsibility for coordinating the work. Finland hopes that the report will also prove useful to the public at large and help to increase the general awareness of climate change among interested readers.

This report describes Finland's efforts in implementing policies and measures aimed at responding to the challenge of climate change. Moreover, it shows that Finland is achieving its obligations under the Kyoto Protocol. It also shows that Finland has the long-term goal of further reducing its emissions in the future. Finland will work actively to achieve this goal.

Helsinki, December 2009



Ms Paula Lehtomäki
Minister of the Environment, Finland



Back to Contents

1 Executive summary

Back to Contents

Photos

futureimagebank.com, page 13
Frank Koumolou, page 25
Vesa Kuusava/YHA kuvapankki, page 11
Esko Kuusisto, pages 9, 20
Ilmo Pylkkänen, Viherjuuri, page 28

1 Executive summary

1.1 National circumstances relevant to greenhouse gas emissions and removals

The population of Finland was 5.3 million at the end of 2007 and according to projections it will rise to 5.7 million by 2040. The population density averages 17 inhabitants per km². As a result of the low population density and the geographical extent of the country, average distances travelled for different purposes are long.

Finland is situated at a latitude of between 60 and 70 degrees north, with a quarter of the country extending north of the Arctic Circle. With a total area of 338,418 km², it is Europe's seventh largest country.

Nearly all of Finland is situated in the boreal coniferous forest zone, and 73 per cent of the total land area is classified as forest land, while only some 7 per cent is farmed. Finland has over 34,300 km² of inland water systems, which is about 10 per cent of its total area. There are some 190,000 lakes and 180,000 islands.

The climate of Finland displays features of both maritime and continental climates, depending on the direction of air flow. Considering the northern location, the mean temperature in Finland is several degrees higher than in most other areas at these latitudes. The temperature is raised by the Baltic Sea, inland waters and, above all, by air flows from the Atlantic, warmed by the Gulf Stream. The mean annual temperature is about 5.5°C in southwestern Finland, decreasing towards the northeast. The average annual temperature has increased during the last 150 years by slightly more than one degree.

Finland has an open economy with a large service sector. The main manufacturing industries are the electrical and electronics, forest, metal and engineering industries. Foreign trade is important, with exports accounting for about 40 per cent of the gross domestic product.

In 2007, the gross consumption of primary energy was 1,469 PJ. Finnish industry used 50 per cent of the country's total primary energy and 53 per cent of the total electricity. For decades the demand and supply of electricity were rising more rapidly than the GDP. Since 1994, parallel with the structural change in the economy, the situation has reversed and the electricity intensity of the economy has decreased.

The relatively large dependence on fossil fuels and peat has resulted in considerable CO_2 emissions. Nevertheless, the CO_2 emissions per total primary energy unit are lower than in many other European countries. This is due to the use of hydro, nuclear and biomass as primary energy sources.

Emissions trading in the EU has become a significant factor on the energy market. In Finland, the number of installations needing a emissions permit under the EU scheme is around 600.

Domestic passenger transport, measured in terms of passenger-kilometres, has increased by approximately 19 per cent since 1990. Cars account for around 82 per cent of the total passenger-kilometres. The total number of freight tonne-kilometres in Finland is almost double the EU average, mainly because of the long distances and the industrial structure.

Indoor heating is the biggest source of CO_2 emissions by households and by the public and service sectors.

Forests (trees and soil) absorb a significant proportion of the carbon dioxide (CO_2) emissions. The forest sink varied between 22.4 and 40.7 million tonnes CO_2 eq. during 1990–2007, which represents 20–40 per cent of Finland's total emissions. The proportion has varied considerably due to fluctuating trends in emissions and forestry activity. Since the last ice age, Finnish peatlands are estimated to have accumulated some 5,400 million tonnes of carbon, forming the largest soil carbon stock in Finland.

1.2 *Greenhouse gas inventory information, including information on the national system and the national registry*

Finland's greenhouse gas emissions in 2007 totalled 78.3 million tonnes CO_2 equivalent (CO_2 eq.). The emissions were some 10 per cent (7.3 million tonnes) higher than in 1990 (71 million tonnes CO_2 eq.), which is the level to which Finland should reduce its emissions during 2008–2012 (see Table 1.1).

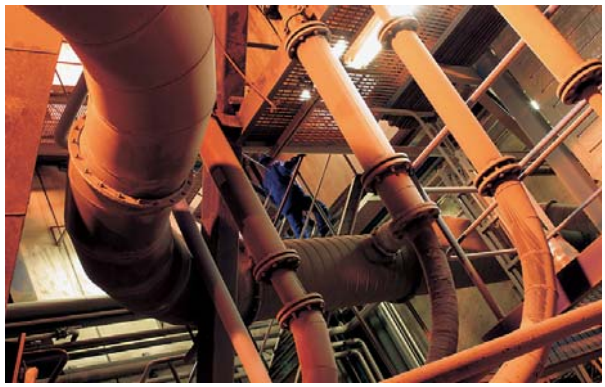
The most significant greenhouse gas of Finland's inventory is carbon dioxide (CO_2). Its share of the total emissions ranged between 80 and 85 per cent in 1990–2007. CO_2 emissions have increased by some 17 per cent compared with 1990. Nitrous oxide (N_2O) accounted for over 8 per cent of the total emissions in 2007, down by some 13 per cent from 1990. Methane (CH_4) emissions were close to 6 per cent of the total emissions, having decreased by almost 30 per cent from the 1990 level. F-gases

Table 1.1
Greenhouse gas emissions (+) and removals (–) by sector, 1990, 1995 and 1997–2007 (million tonnes CO_2 eq.)

Sector	1990	1995	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Energy	54.6	56.3	60.3	57.2	56.6	54.6	59.9	62.5	70.0	65.9	54.3	65.6	63.6
Industrial processes[1]	4.9	4.5	5.0	4.9	4.9	4.9	4.9	4.9	5.2	5.4	5.3	5.3	5.7
F-gases[2]	0.1	0.1	0.2	0.3	0.4	0.6	0.7	0.5	0.7	0.7	0.9	0.8	0.9
Use of solvents and other products	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Agriculture	7.1	6.3	6.2	6.1	5.9	6.0	5.9	5.8	5.7	5.6	5.6	5.6	5.5
Waste	4.0	3.9	3.8	3.6	3.5	3.3	3.2	3.0	2.8	2.7	2.5	2.5	2.4
Total	**70.9**	**71.2**	**75.7**	**72.1**	**71.5**	**69.5**	**74.7**	**76.8**	**84.5**	**80.5**	**68.7**	**79.9**	**78.3**
Land use, land-use change and forestry[3]	–17.8	–16.6	–19.7	–16.6	–18.5	–18.4	–21.5	–22.5	–22.5	–23.3	–28.3	–32.2	–25.3

1 Excluding F-gases
2 F-gases refer to fluorinated greenhouse gases (HFC compounds, PFC compounds and SF_6)
3 A negative figure denotes a net sink, which means that in this sector more greenhouse gases are absorbed from the atmosphere than are released into it.

(HFCs, PFCs and SF_6) accounted for roughly 1 per cent of all greenhouse gas emissions, but their share has been growing continuously. F-gas emission volumes are nearly tenfold higher than in 1990.



Similarly to other industrialised countries, Finland's biggest source of greenhouse gas emissions is the energy sector. The cold climate, long distances and energy-intensive industries are apparent in the high emissions volumes of the energy sector. In 2007 its share of the total greenhouse gas emissions was 81 per cent (63 million tonnes CO_2 eq.). The emissions show strong annual variation in accordance with the amount of energy used and the proportion of imported electricity. This variation has been the principal feature of the overall trend in emissions over the period since 1990. The emissions of the energy sector are strongly affected by the availability of hydro power in the Nordic electricity market. If the annual precipitation in the Nordic countries is lower than usual, hydro power becomes scarce and Finland's net imports of electricity decrease.

Greenhouse gas emissions generated by transport amounted to 14.7 million tonnes CO_2 eq. in 2007. Transport emissions made up 19 per cent of all greenhouse gas emissions and 22 per cent of the energy sector greenhouse gas emissions. Road transport accounted for 88 per cent of the total domestic transport emissions. During the period 1990–2007, transport emissions increased by 15 per cent due to the growth in traffic volume.

Greenhouse gas emissions generated in industrial processes amounted to roughly 6.7 million tonnes CO_2 eq. in 2007. They made up roughly 9 per cent of Finland's total emissions. Emissions from the agriculture sector were some 5.5 million tonnes CO_2 eq. or approximately 7 per cent of Finland's total greenhouse gas emissions in 2007. Waste sector emissions amounted to 2.4 million tonnes CO_2 eq. in 2007, which is some 3 per cent of Finland's total emissions. Landfill emissions accounted for some 85 per cent of all waste sector emissions.

Greenhouse gas inventory system

Statistics Finland is the national entity with the overall responsibility for compiling and finalising inventory reports and submitting them to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC) and the European Commission. It bears the responsibility for the general administration and quality management of the inventory and of communication with the UNFCCC, coordinates participation in the inventory review, and publishes and archives the inventory results.

The legal basis of Finland's national system under the Kyoto Protocol is defined by the Resolution of the Finnish Government of 30 January 2003 on the organisation of climate policy activities of Government authorities. The legal framework of the national system is further defined by the agreement between the Ministry of the Environment and Statistics Finland on operating the national system for estimating greenhouse gas emissions under the Kyoto Protocol and on the reporting requirements under the UNFCCC, and by the regulations concerning Statistics Finland (the Statis-

tics Finland Act (48/1992) and the Statistics Act (280/2004). Various expert organisations acting as parties to the inventory system are responsible for the inventory data of the different reporting sectors.

The UNFCCC, the Kyoto Protocol and the EU greenhouse gas monitoring mechanism require Finland to submit annually a National Inventory Report (NIR) and Common Reporting Format (CRF) tables. The annual submission contains emission estimates for the year prior to the previous year. The methodologies, activity data collection and choice of emission factors are consistent with the guidance in the Revised 1996 IPCC Guidelines and the IPCC Good Practice Guidance reports.

The quality requirements set for the annual inventories – transparency, consistency, comparability, completeness, accuracy and timeliness – are fulfilled by implementing the QA/QC plan and procedures consistently.

National registry

The EU Emissions Trading Scheme (EU ETS) began in January 2005 and is mandatory for specific industries in the European Union with emissions above a certain threshold. The EU ETS and wider international emissions trading under the Kyoto Protocol have operated in parallel with each other since mid-October 2008. Both trading schemes are underpinned by a system of electronically linked national registries, which are intended to keep track of national and international transactions involving EU allowances and Kyoto units.

Every EU member state has been required to establish a national registry for the EU ETS and for emissions trading under the Kyoto Protocol. National registries are required to meet the technical and functional specifications issued by the European Commission and the UNFCCC Secretariat. Finland used the Greta registry until summer 2009, when it replaced this with the CR registry software, which was developed by the Commission. In Finland the Energy Market Authority is the competent authority and the registry administrator of the national emissions trading registry.

1.3 Policies and measures

Policy framework and policy making process

Finnish climate policy is formulated within the framework of the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol as well as policies set by the European Community (EC).

As a result of the burden sharing agreement in the European Union (EU), Finland is committed to bringing its national average annual emissions down to their 1990 level in 2008–2012. Under the EU Climate and Energy Package the EU is committed to reducing its greenhouse gas emissions by 20 per cent by 2020 from the 1990 level, or by 30 per cent if a comparable international agreement is reached. The majority of the reduction will be reached within the EU emissions trading scheme (EU ETS).

Finland's reduction obligation under the Climate and Energy Package for sectors not covered by the EU ETS is 16 per cent. The package also requires Finland to increase its use of renewable energy sources to 38 per cent of final energy consumption and the share of biofuels in gasoline and diesel to 10 per cent by 2020.

The Government and Parliament make the most important decisions concerning climate policy. Parliament approves Finland's international commitments and decides on their implementation according to the constitution. The Ministry of the Environment bears the administrative responsibility for the climate negotiations.

Municipal authorities have a significant role in climate policy and emission reductions because of their responsibilities in land-use and traffic planning and waste management, and their own energy production and the energy consumption of local services.

Legislation

Finland is implementing at national level various EU-wide legislative arrangements and programmes affecting greenhouse gas emissions (e.g. the EU ETS).

Finland has also implemented national legislation and strategies to ensure the fulfilment of its commitments under the Kyoto Protocol. An administrative framework for participation in Joint Implementation (JI) and Clean Development Mechanism (CDM) project activities and in emissions trading under the Kyoto Protocol, is provided by an act.

The sustainable management of forests in Finland is based on legislation and good practices. Forest legislation is the most important means of forest policy for ensuring sustainable forestry.

Energy and climate strategies

In 2008, the Government approved the new Long-term Climate and Energy Strategy, with detailed proposals on climate and energy policy measures up to 2020, and suggestions up to 2050. The strategy clearly demonstrates that the objectives in the EU Climate and Energy Package for Finland regarding the reduction of emissions, promotion of renewable energy and enhancing the efficiency of energy consumption cannot be attained without new, prominent climate and energy policy measures.

The 'with measures' (WM) scenario in the most recent strategy includes the implemented and adopted policies and measures with which the emission limitation target under Kyoto Protocol will be achieved (Table 1.2). The 'with additional measures' (WAM) scenario aims at meeting the objectives of the EU Climate and Energy Package.

In the WM scenario, the main instrument to be used for emission reduction is the EU ETS. Other domestic policies and measures include promoting energy conservation and use of renewable energy sources.

As a result of the domestic targets and measures, Finland's greenhouse gas emissions are forecast to decline by an estimated 23 per cent in 2020 compared to a situation without the new measures.

The Government adopted on 15 October 2009 the Foresight Report on Long-term Climate and Energy Policy. It set a target to reduce Finland's greenhouse gas emissions by at least 80 per cent from the 1990 level by 2050 as part of an international effort.

Table 1.2
Projected average annual emissions and the effect of policies and measures (PAMs) in the WM scenario with which the Kyoto Protocol target will be achieved in the first commitment period 2008–2012 (million tonnes CO_2 eq.)

	million tonnes CO_2 eq.	
Emissions in the EU ETS sector	46.4	37.6 *
Emission reductions or acquired AAUs, ERUs or CERs by EU ETS entities to meet their allowed emissions	−8.8	
Emissions in the non-trading sector	35.2	
Total projected emissions	**72.8**	
Finland's assigned amount (annual average value)	71.0	
RMUs from Article 3, paragraphs 3 and 4	0.6	
Governmental use of Kyoto mechanisms	1.4	
Sum of Finland's assigned amount, RMUs and units acquired from flexible mechanisms	**73.0**	
Difference between the projected emissions and the above sum	−0.2	

*emission cap for EU ETS installations

Energy sector as an example of sectoral policies and measures

The 'with measures' (WM) scenario includes all energy policy measures in use at the beginning of 2007 (see Table 1.3). No 'without measures' scenario has been developed in Finland. Therefore, mitigation impacts of the policies in the WM scenario are not available in the table.

Table 1.4 shows the major policies and measures included in the 'with additional measures' (WAM) scenario in the energy sector. The measures are designed to achieve the EU targets for emissions reduction, increasing renewable energy sources and energy efficiency by 2020.

Table 1.3
Major policies and measures affecting greenhouse gas emissions in the energy sector in the 'with measures' (WM) scenario, 2007–2020

Policy	Objective	Type of instrument	Status	Estimated mitigation impact		
				2010	2015	2020
EU ETS	To reduce emissions, renewables	Economic	Implemented	na	na	na
Nuclear power	Supply of electricity	Regulatory, economic	Under construction, in use in 2013	0	About 8 Tg	About 8 Tg
Energy taxation	Energy saving, renewables	Fiscal	Implemented	na	na	na
Voluntary agreement scheme	Energy saving	Agreements	Implemented	4 Tg	na	na
Subsidies	Renewables, energy saving, R&D	Fiscal	Implemented	na	na	na
Regulatory measures	Energy efficiency, buildings	Regulatory	Implemented	na	na	na

na = Not available

Table 1.4
Major policies and measures affecting greenhouse emissions in the energy sector in the 'with additional measures' scenario, 2007–2020

Policy	Objective	Type of instrument	Status	Estimated mitigation impact		
				2010	2015	2020
Common EU target for ETS sector	To reduce emissions, renewables	Economic	Target set	na	na	na
Feed-in tariffs for renewables	To reduce emissions	Economic	Under implementation	na	na	na
Energy efficiency measures	Energy consumption	Economic, regulatory	Planning stage	na	na	na

na = not available

Taxation and subsidies

Energy taxation is a substantial source of revenue for the state, generating about 8 per cent of the total tax revenue annually. Energy taxation is an excise duty levied on transport and heating fuels and electricity. Energy taxation is also a central instrument in energy and environmental policy. The current energy taxation scheme has been in force since 1997. Some modifications to the scheme have been made in order to alleviate the impact of the EU ETS, which started in 2005.

Energy taxation is divided into a basic tax and a surtax. The basic tax is fiscal by nature and is collected on oil products only. It is graded according to the quality and environmental characteristics of gasoline and diesel oil. The surtax is collected on oil products, other fossil fuels and electricity. The surtax on fuels is determined according to their carbon content.

Fuels used for power production are tax-free. Electricity is taxed at the consumption stage.

The energy taxation scheme also encompasses other elements aimed at promoting the goals of energy and climate policy. In a broad sense, these can be called tax subsidies. Subsidies for power production were introduced in 1997.

Use of Kyoto mechanisms

Under the EU emissions trading scheme, companies may meet part of their emission reduction obligation by engaging in the CDM and the JI. These are projects in developing countries and in other Annex I countries which will cost-efficiently reduce emissions and create tradable emission units (CERs and ERUs). The Government may also use these project mechanisms or acquire assigned amount units through international emissions trading in accordance with the Kyoto Protocol in order to meet Finland's national emission commitments. In 2008–2012 Finland may allow its operators in the EU ETS to use CERs and ERUs up to a maximum relative threshold of 10 per cent. The use of the Kyoto mechanisms is supplementary to domestic actions for cutting greenhouse gas emissions.

Effect of policies and measures on longer term trends

Table 1.5 shows emissions in the WM and WAM scenarios in 2020 (million tonnes CO_2 eq.)

Table 1.5
Effect of policies and measures on longer term trends: The estimated emissions in the WM and WAM scenarios in 2020 (million tonnes CO_2 eq.)

Sectors	2005	2006	2007	2020	
				WM	WAM
Transport	13.4	13.6	14.0	14.2	11.4
Space heating	3.1	3.0	3.1	2.6	1.2
Agriculture	5.6	5.6	5.5	5.7	5.1
F-gases	0.9	0.8	0.9	0.6	0.3
Waste management	2.4	2.5	2.4	1.8	1.7
Machinery	2.6	2.6	2.6	2.7	2.5
Other sources, of which:	7.7	7.2	7.5	8.4	7.5
• Non-ETS industry CO_2	1.6	1.6	1.6	1.5	1.1
• Combustion, N_2O	0.9	1.0	1.0	1.1	1.0
• Hydrogen production, CO_2	0.07	0.07	0.07	0.8	0.8
Non-ETS total	**35.7**	**35.3**	**36.0**	**36.0**	**29.7**
Emissions in the ETS sector	**33.1**	**44.6**	**42.5**	**52.6**	**38.8**
Total emissions	**68.8**	**79.9**	**78.5**	**88.6**	**68.5**

Economic impacts

It is not possible to achieve the targets for emissions, renewable energy and energy efficiency without economic costs. Gross domestic product (GDP) in 2020 under the WAM scenario would be 0.8 per cent lower than under the WM scenario. Private consumption would be 1.8 per cent below the WM scenario.

1.4 Projections and assessment of policies and measures

With Measures scenario

Figure 1.1 shows Finland's greenhouse gas emissions in the with measures (WM) scenarios for the last two national climate and energy strategies (published in 2005 and 2008). The main difference between the two scenarios is the assumed period for start-up of the fifth nuclear plant. In the 2005 WM scenario power production was assumed to start in 2009–2010, whereas the 2008 WM scenario takes into account the new estimated start-up year, 2012.

The EU ETS and use of the Kyoto mechanisms have been included in the scenario.

In the WM scenario total consumption of primary energy will grow from approximately 1,469 PJ in 2007 to 1,725 PJ by 2020. The growth will clearly slow down compared to 1990–2006. The average annual growth in 2006–2020 will be only 1 per cent, whereas in 1990–2006 it was over 2 per cent.

Table 1.6 shows the structure of electricity supply. The new nuclear power unit is assumed to start operation in 2012, which can be seen in the significant growth in nuclear power production at the beginning of the next decade.

Figure 1.1
Greenhouse gas emissions in the WM scenarios for the climate and energy strategies published in 2005 and 2008 (million tonnes CO_2 eq.)

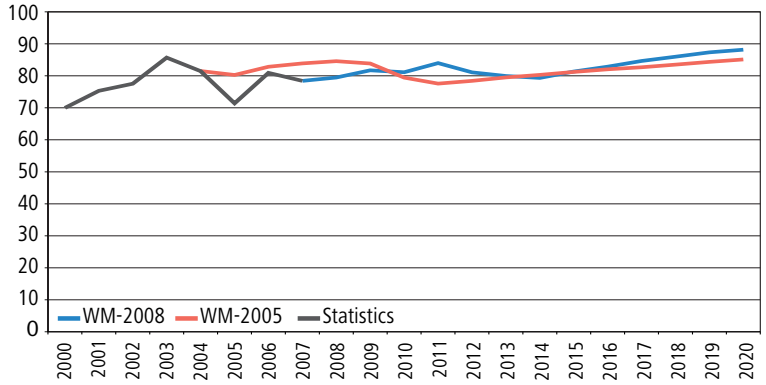


Table 1.6
Structure of electricity supply in the WM scenario 2005–2020, TWh

	2005	2006	2007	2010	2015	2020
Hydropower	13.4	11.3	14.0	13.4	14.0	14.2
Wind power	0.2	0.1	0.2	0.5	0.8	1.0
CHP, industry	10.6	11.9	11.4	12.5	13.6	14.2
CHP, district heating	15.8	15.7	15.3	17.3	18.0	18.3
Nuclear power	22.4	22.0	22.5	22.0	34.9	34.9
Condensing power	5.3	17.6	14.3	16.4	13.8	21.3
Net imports	17.0	11.4	12.6	10.5	4.5	–1.0
Total	**84.8**	**90.0**	**90.4**	**92.5**	**99.6**	**103.1**

In the EU's burden sharing agreement Finland agreed to cut its emissions in 2008–2012 to the level of 1990, that is an average of 71.0 million tonnes CO_2 eq. per year. Calculations show that with the assumptions of the WM scenario, emissions would be above the target level in 2008–2012.

However, in accordance with a decision of the European Commission in 2008, sectors under the ETS will be granted emissions allowances averaging 37.6 million tonnes CO_2 eq. per year during the Kyoto period. Emissions from non-ETS sectors are estimated to be an average of around 35.2 million tonnes CO_2 eq. per year in the same period. The total volume of emissions would therefore amount to 72.8 million tonnes CO_2 eq. per year. The number of available assigned amount units, 71 million tonnes CO_2 eq. per year, the removal units from forest management of 0.6 million tonnes CO_2 eq. per year, and the emissions units that the Government will require using project mechanisms or through purchase of assigned amount units of 1.4 million tonnes CO_2 eq. per year, in total 73 million tonnes CO_2 eq. per year, would be sufficient to cover Finland's obligation even in the WM scenario during the Kyoto period.

With Additional Measures scenario

The assumptions made regarding the development of the national economy and international energy prices were identical in both the 'with additional

measures' (WAM) scenario and in the WM scenario. In addition, assumptions concerning nuclear power, hydropower, the natural gas network and the capacity of cross-border electricity transfer were similar. The differences between the scenarios were in the policy sector. The Finnish national goals in line with the EU Climate and Energy Package require that renewable energy should account for 38 per cent of final energy use by 2020, and that greenhouse gas emissions in the non-ETS sectors should fall by 16 per cent between 2005 and 2020. Under a further EU-wide goal, renewable energy sources should account for 10 per cent of road transport fuels by 2020. The WAM scenario should allow Finland to achieve these main goals.

The Energy Efficiency Committee proposed in June 2009 measures concerning all sectors of society. With the proposed measures, final energy consumption could be approximately 11 per cent lower in 2020 than without the measures. The annual amount of energy saved would correspond to a decrease of approximately 9.3 million tonnes in CO_2 emissions.

Due to higher electricity prices (influenced by EU ETS allowance prices) and electricity saving measures, the consumption of electricity in the WAM scenario would be 5 TWh lower compared with the WM scenario.

Finland can achieve its Kyoto targets with either the WM or the WAM scenario, because both scenarios contain almost the same measures up to the end of the Kyoto period in 2012. However, Finland's post-Kyoto targets to 2020 as specified at EU level can only be reached with the WAM scenario.

The calculations for the Long-term Climate and Energy Strategy were carried out before the current global economic downturn. This downturn will have a profound impact on many of the key assumptions. Also, the ongoing structural change in the forest industry is having a significant impact on the energy sector, including renewable energy production, energy consumption and greenhouse gas emissions.

1.5 *Climate change impacts, adaptation measures and vulnerability assessment*

Climate scenario information for impacts and adaptation research as well as policy making has been produced as part of a climate scenario and information service project called ACCLIM, which is part of the Climate Change Adaptation Research Programme (ISTO, 2006–2010). Table 1.7 below summarizes projected changes in the Finnish climate.

There are still considerable uncertainties and information gaps in assessing the potential costs of the impacts and adaptation measures. Preliminary estimates of the economic impacts in this century suggest that they could be slightly positive. At the same time, climate-related risks are projected to increase.

Table 1.7
Projected changes in the Finnish climate

Variable	Description
Temperature	Annual mean temperature increase of +3°C to +6°C between the periods 1971–2000 and 2070–2099. Greater increase in winter than in summer. Increase in mean minimum temperatures greater than increase in mean maximum temperatures. Decrease in number of frost days. Change in number and timing of days with temperatures around zero, depending on region and time interval considered
Precipitation	Increase of 10 to 25 per cent in annual precipitation between the periods 1971–2000 and 2070–2099. Greater increase in winter than in summer. Some models project no change in the summer. Increase in number of precipitation days in winter. Ratio of snow/rain decreases.
Ground frost	Less ground frost in snow-free areas (e.g. roads and yards). General decrease in number of ground frost days and depth of ground frost, modified regionally by snow cover changes.
Ice cover	Shorter ice period and decrease in ice strength.
Snow cover	Shorter and discontinuous snow season. Decrease in snow cover progressing from south to north.
Wind	Models give no clear indication of changes in mean windiness. Likely increase during wintertime over the Baltic Sea.
Cloud cover	Increase in cloud cover during winter.
Extreme events	Greater frequency and length of heat waves. Fewer and shorter periods of extreme cold. Greater intensity and frequency of heavy rainfall. No decrease in maximum snowfall. Longer periods of weak soil stability due to longer thaw. Risk of soil erosion.

Impacts of climate change on nature, society and the economy in Finland include:

- ***Biodiversity***
  Climate change will probably increase the total number of Finnish flora and fauna, but some species characteristic to Finland may become extinct.
- ***Water sector***
  The most important effect of climate change on hydrological regimes is the change in seasonal distribution of runoff. Winter runoff is expected to increase considerably due to an increase in snowmelt and rainfall, while spring floods are estimated to decrease.
- ***The Baltic Sea and its coastal areas***
  A warming of the mean annual air temperature in the order of 3°C to 5°C is projected for the Baltic Sea area during this century. The annual precipitation would increase especially in the northern parts of the Baltic Sea basin. There has been a general tendency towards milder ice conditions in the Baltic Sea.
- ***Pristine peatlands***
  Changes in temperature, precipitation and evapotranspiration may have a considerable impact on the hydrology of wetlands and, consequently, the load of organic and inorganic matter from catchments. Warming will probably cause mire vegetation zones to move further north.

- ***Agriculture***
  The effective growing season will be prolonged by about two weeks. Crop productivity will increase and the current main field crops could be cultivated further north. However, the predicted increase in the variability of growing conditions is likely to increase production risks.
- ***Fisheries and game***
  Changes in precipitation and temperature will probably affect the numbers, distribution and mutual relationships of fish populations. The disappearance of snow cover will be harmful for game species adapted to a snowy environment. The diversity of small game prey and predatory species will increase and should stabilise the present strong population fluctuations.
- ***Forestry***
  Climate change will have an influence on the distribution and growth of boreal forests. Increases in temperature, CO_2 concentration and precipitation together with a longer growing season are likely to increase tree growth. Climate change is, however, a risk for forest health and productivity.
- ***Energy***
  Demand for heating can be expected to decrease and demand for cooling to increase. The reliability of energy distribution and transmission will probably weaken, because the frequency of extreme weather conditions is likely to increase.
- ***Land-use planning and construction***
  The expected changes in precipitation and snow loads, wind velocity and temperature are a challenge for the construction sector. The most important impacts of climate change on land use are changes in flood risks, extreme weather events and groundwater conditions.
- ***Manufacturing***
  The indirect impact of climate change through mitigation measures and greenhouse gas reduction targets will be much more important to industry than direct impacts. Direct impacts have two main pathways: In some sectors available raw materials may change and the transport of industrial raw materials and products may become more vulnerable to adverse weather conditions.
- ***Transport and communications***
  Climate change is likely to affect the transport infrastructure and all modes of transport. Floods and heavy rainfall will increase erosion and risk of landslides along roads and railways. Sea transport may benefit from climate change. In telecommunications, the networks relying on cables may be vulnerable to storms and icy rain.
- ***Tourism and recreation***
  The reliance on nature and seasonal variation make tourism and recreation vulnerable to climate change. Increased uncertainty of snow conditions has already been a problem for winter tourism and recreation, particularly in southern Finland.
- ***Insurance***
  Climate change is likely to increase the damage caused by extreme weather. Insurance companies face higher uncertainties in their risk estimates, which may be reflected in the insurance premiums and coverage.

- ***Health***
  Increased intensity and frequency of extreme weather events may cause additional pressure in the health sector, particularly as the population ages.
- ***Cultural environment***
  Climate change may pose a threat to the preservation of the cultural and natural heritage. Climate and energy policies and energy-saving goals may also have significant effect on the cultural environment.
- ***Finnish Lapland***
  The projected climate change in Lapland indicates a particularly large warming trend, and a considerable increase in precipitation. The changes are likely to have pronounced effects on the distribution and productivity of boreal forests and arctic vegetation.
- ***Global impacts of climate change reflected in Finland***
  Climate change impacts on the world economy and on the development of poorer countries could have important repercussions for the Finnish economy and for Finland's international relations. The near-term adaptive capacity of Finland appears to be quite high. In the long run, external impacts could prove to be more significant for policy makers than domestic concerns.

The Ministry of Agriculture and Forestry published the National Strategy for Adaptation to Climate Change in 2005. Evaluation of the strategy in 2008–2009 resulted in an extensive compendium of planned and launched adaptation measures (presented fully in Chapter 6).

In all sectors, decision-makers have at least some understanding of the impacts of climate change and recognise the need for adaptation measures. Practical adaptation measures have been identified and plans made or even launced for implementation. The most advanced sector is water resources management. Good research on adaptation has been done in agriculture and forestry, but implementation of the measures is going to take some time. In fisheries, reindeer and game management, hardly any scenario-based research has been conducted, and adaptation measures are largely based on monitoring current climate conditions. Several research projects and strategy work have been started on biodiversity, but very few actual adaptation measures have been launched.

The need to adapt to climate change is being taken into account well in land-use and community planning, especially with regard to flood risks. In construction, planning the necessary adaptation measures calls for more research.

The transport sector is already well prepared for weather-related disturbances in traffic safety and maintenance of the transport infrastructure.

The industrial and energy sectors have focused on climate change mitigation rather than adaptation to it. However, the views concerning the extent of adaptation measures in these sectors may be incorrect, because measures in the private sector have not been evaluated. The same applies to the tourism and insurance sectors. Private companies in these sectors are capable of adapting to the risks posed by the changing climate quite rapidly.

In the health and social services sectors the need for adaptation has been recognised only in certain circles and there has been little research on the health impacts of climate change.

In 2006 and 2008 two Government Resolutions were adopted to prepare the national defence administration for the consequences of climate change.

In comparisons of the vulnerability of different countries to climate change, Finland has been among the least vulnerable. So far, there have been few risk analyses concerning the impacts of climate change in Finland. Implementation of Finland's adaptation strategy requires that risk assessment methods applicable to the impacts of climate change must be developed and applied further. Moreover, assessments that integrate different risks, such as those related to climate, cultural and natural environment, economy, health and insurance, will be needed.

In 2009 two major projects concerning vulnerability assessment were started: 'Map-based assessment of vulnerability to climate change employing regional indicators' and 'Vulnerability of ecosystem services for climate change impacts and adaptation'.

1.6 Financial resources and transfer of technology

Finland reaffirmed in the Bonn Declaration its strong political commitment to provide additional climate change funding for developing countries and has acted accordingly. Finland places particular emphasis on issues relating to climate change and the environment.

Finland provides funds for financial mechanisms of the Climate Convention and the funds under the Kyoto Protocol as well as through bilateral, regional and other multilateral channels.

Finland has also integrated the goals and objectives of the Climate Convention and the Kyoto Protocol to its development policy taking into account that economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties. It is steered by the Government Resolution on development policy adopted in October 2007. The main goal of the policy is to eradicate poverty and promote sustainable development in accordance with the UN Millennium Development Goals.

Finnish development aid disbursements in 2008 were EUR 790 million, which was 0.43 per cent of its gross national income (GNI). Finland is committed to reaching the 0.51 per cent minimum set by the European Council by 2010, and to reaching 0.7 per cent, the target set by the UN, by 2015. In a joint Political Declaration (Bonn 2001), Finland together with the European Community and its other member states and five other donor countries committed themselves to collectively providing USD 410 million annually as additional climate change funding for developing countries, starting in 2005. Finland's minimum share of this joint contribution is USD 6.4 million per year, but Finland has exceeded this figure: USD 7.4 million in 2005, USD 7.6 million in 2006, USD 9.4 million in 2007 and USD 28.5 million in 2008.

Finland has contributed additional resources to the Global Environment Facility (GEF) to prevent and mitigate global environmental problems in developing countries. During the 3rd replenishment period (2002–2006) the Finnish contribution was about EUR 30 million. During the 4th replen-

ishment period (2006–2010) the contribution will be about EUR 31.2 million, EUR 1.2 million more than during the previous period.

Finland attaches particular importance to assisting countries that are least developed, as they are among the countries most vulnerable to climate change. Finland's eight long-term partners in development cooperation are Ethiopia, Kenya, Mozambique, Nepal, Nicaragua, Tanzania, Vietnam and Zambia. Five of these are officially classified as least developed countries, and all are particularly vulnerable to climate change.

Finland's voluntary funding for the Least Developed Countries Fund and the Special Climate Change Fund under the GEF has increased from EUR 1.35 million in 2005 to EUR 2.5 million in 2008.

From a development cooperation point of view the UNFCCC is one of the most important conventions. Finland's funding for the UNFCCC has grown almost four fold over the period 2004–2008.

The energy sector accounts for the largest share of mitigation-related projects. Support for forestry projects and adaptation is also substantial. With regard to adaptation, the most important element has been capacity building and vulnerability assessments in partner countries. Furthermore, Finland supports mitigation and adaptation measures through NGOs.

Energy-related pollution is increasing rapidly in many parts of the developing world, and preventing such pollution is becoming an important factor in Finland's development cooperation. Finland has enhanced sustainable wood fuel production and community forestry projects in e.g. Laos, Kenya, Tanzania, Zambia, Namibia and Mozambique.

Table 1.8
Summary of the financial resources Finland has directed to development cooperation, especially related to climate change (EUR).

Official development assistance (ODA)	790 million in 2008 (0.43 per cent of gross national income (GNI))
Climate-related aid in bilateral ODA	14.76 million in 2008
Climate-related support programmes	Energy and Environment Partnership with Central America, VietAudit, Sustainable forestry for rural development project (SUFORD), Post-emergency reconstruction programme in the field of meteorology
Contributions to GEF	2006 7.8 million, 2007 7.8 million, 2008 7.8 million
Pledge for fourth GEF replenishment	31.2 million
Activities implemented jointly (AIJ)	After the JI/CDM pilot programme (1999-2006) the Finnish Carbon Procurement Programme (Finnder) was launched. Finnder's portfolio of contracted projects contains 14 projects: 9 CDM and 5 JI projects. Emission reductions are 3.3 million tonnes CO_2 eq.
JI and CDM under the Kyoto Protocol	Investments in the Prototype Carbon Fund, Testing Ground Facility, Multilateral Carbon Credit Fund, Asia Pacific Carbon Fund, Fine Carbon Fund, ADB' s Future Carbon Fund, Nefco's Future Carbon Fund
Other (bilateral/multilateral)	Support to World Bank' s Trust Fund for Environmentally and Socially Sustainable Development 27 projects for developing countries directly relating to climate change (2004–2008)

Forestry forms a significant sector in Finland's development cooperation. Finland has supported sustainable forest management in various countries by assisting partner countries in the preparation and implementation of national forest programmes as well as sector policies and strategies.

Community forestry is important in the promotion of sustainable forest management, and such forestry has been assisted in Mozambique, Namibia, Tanzania, Zambia, Vietnam and Laos. Finland has supported pilot activities in the REDD programme (Reduced Emissions from Deforestation and Forest Degradation), which is based on rewarding individuals, communities, projects and countries that prevent deforestation and forest degradation.

Finland has not provided funding for the adaptation fund established in accordance with decision 10/CP.7., except for EUR 0.1 million for supporting the participation of developing countries in meetings of the Adaptation Fund.

Finland has specific programmes and financial arrangements for transferring environmentally sound technology to developing countries. These activities comprise transfer of both "soft" technology, including capacity building, creating information networks and enhancing training and research, and "hard" technology, that is technology to control greenhouse gas emissions and for adaptation measures.

1.7 Research and systematic observation

In 2007 Finland's research and development expenditure was about EUR 6,200 million, or 3.5 per cent of the country's gross domestic product.

Climate change has become a priority area in many research programmes and projects. Large cross-sectoral climate change programmes have aimed at increasing understanding of the scientific basis of climate change as well as the impacts and options for mitigation and adaptation, including environmental and socio-economic questions. In addition, climate change has increasingly been integrated into other environmental, sectoral and technology research programmes and projects.

Finland emphasizes international collaboration in climate change research. Finland has participated or participates actively in, for example, climate change related research under the framework programmes of the European Union, the World Climate Research Programme (WCRP), the International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme (IHDP) and has also actively supported and participated in the work of the Intergovernmental Panel on Climate Change (IPCC).

Since 1990 climate change and its various effects have been studied in Finland in major overarching research programmes (SILMU and FIGARE). A new multidisciplinary research programme on climate change is under preparation. The programme, to be called the Finnish Climate Change Programme (FICCA), is to be launched in 2010.

The Finnish Meteorological Institute (FMI) has its own research programme entitled Climate Change, with a staff of around 65 scientists. The emphasis of the programme is on climate research and services, greenhouse gases and aerosols and climate.

The Universities of Helsinki and Kuopio and the FMI host the Finnish Centre of Excellence in Physics, Chemistry, Biology and Meteorology of Atmospheric Composition and Climate Change. Its main objective is to re-

duce the scientific uncertainties concerning global climate change issues, particularly those related to aerosols and clouds.

Finnish research institutes also have extensive activities in paleoclimatology.

Some examples of Finnish research on impacts of climate change, adaptation and mitigation are:

- The Climate Change Adaptation Research Programme (ISTO 2006–2010) implements the national adaptation strategy by providing funding for research aimed at producing information to support planning of the adaptation measures. The trend in adaptation research is from natural science towards comprehensive socio-economic studies.
- The Arctic Centre at the University of Lapland has various research activities related to climate change which provide support for decision-making and sustainable development in the Arctic.
- The Finnish Funding Agency for Technology and Innovation (TEKES) has coordinated major research programmes on the mitigation of climate change. The latest programme, ClimBus (2004–2008) helped to develop technologies, business concepts, products and services for reducing greenhouse gas emissions on a highly cost-effective basis.
- Many research activities of the Finnish Environment Institute, e.g. research on biodiversity, hydrology, water resources, environmental policies and production and consumption, provide information essential to understanding scientific and societal phenomena related to the mitigation of and adaptation to climate change and finding solutions to these.
- The VTT Technical Research Centre of Finland has several research programmes and projects on saving energy and improving energy efficiency for climate change mitigation.
- The Finnish Forest Research Institute (METLA) has recently initiated a new research programme entitled Functioning of Forest Ecosystems and Use of Forest Resources in a Changing Climate (2007–2011).
- A research programme at MTT Agrifood Research Finland, Climate Change and Agriculture, aims to assess and enhance the adaptive capacity of agrifood systems at various levels and to study alternatives of reducing greenhouse gas emissions from agriculture.
- The Government Institute for Economic Research (VATT), the Research Institute of the Finnish Economy (ETLA), the Pellervo Economic Research Institute (PTT) and the VTT Technical Research Centre of Finland have all been engaged in extensive research on the economic impacts of climate change mitigation and the economic impacts of adaptation

Meteorological observations have been made in Finland for more than 100 years. The prime source of atmospheric observations relevant to climate change are the routine surface and upper air weather observations made by the Finnish Meteorological Institute (FMI). Under the Global Climate Observing System (GCOS) programmes, the Jokioinen, Jyväskylä and Sodankylä stations are included in the GCOS Surface Network (GSN) and Sodankylä in the GCOS Upper-Air Network (GUAN). As part of the Global Atmosphere programme of the WMO, the FMI maintains a GAW station in Pallas-Sodankylä in Lapland, where greenhouse gas concentrations

have been measured since 1996. The FMI maintains networks of water level and water temperature observations in Finnish marine areas. The Finnish Environment Institute (SYKE) is the national centre for monitoring the physical, chemical and biological state of inland waters. Terrestrial essential climate variables and relevant metadata are included in several registers like the Hydrology and Water Resources Management Data System.

Finland has one of the densest snow survey networks in the world. Snow depth is measured at 50–80 points and snow density at ten points on each survey line.

For many years Finland has been operating extensive capacity building programmes around the world. Climate data management systems have been implemented in several developing countries through Finnish development agencies and with considerable financial and personnel support. The FMI is currently running capacity building activities e.g. in Peru, Oceania, Southern Africa, Croatia and Lithuania. It will also begin capacity building projects in Nepal, Vietnam, Sudan, Trinidad & Tobago, Barbados and elsewhere in the Caribbean region in the coming years, focusing on institutional capacity building of the national meteorological (and hydrological) services.

1.8 Education, training and public awareness

Climate change is already firmly anchored in the education and public awareness policies and practices of the government, and these policies and practices remain under continuous development.

Climate change issues are included in the education given on sustainable development in Finland's compulsory basic education system. Sustainable development and climate change are dealt with in many subjects and as a cross-curricular theme. In addition, all Finnish schools and educational establishments are required to have a sustainable development action programme by 2010.

Universities provide climate change education as a part of different degree programmes, including environmental studies, environmental technology, chemistry, chemical technology and energy technology. Some universities also offer postgraduate studies in climate change. Teaching related to climate change is closely tied to the research in this field.

Universities, polytechnics and several training institutes provide continuing education programmes and vocational training in climate change and related issues, e.g. energy efficiency and environmental technology, for individuals and companies.

Training of experts for developing countries in managing forests and other natural resources is an integral part of the agricultural and forest sciences programmes at the University of Helsinki. The Faculty of Forest Sciences at the University of Joensuu has participated in several international exchange programmes in forestry education. Many academic units in Finland also cooperate with universities, research institutes and governmental organisations in developing countries to support institutional development in various sectors.

Communication on climate change is performed by several different ministries, the Finnish Meterological Institute and other government research organisations. Since autumn 2008 there has been unofficial cooperation on climate change communication between them in order to ensure that actions are coordinated. Training of journalists is an area where the collaboration has been increased.

Extensive media coverage and campaigns by both the government and NGOs have increased the climate change related awareness of the public in Finland. Climate change has undergone a shift from the margins to the centre of media attention.

The Climate Change Communications Programme (2002–2007) formed an important part of Finland´s national climate strategy. The programme was aimed at increasing awareness on climate change, its impacts and mitigation. In five years the programme funded 62 projects with a total budget of about EUR 2.5 million.

Every year in October some 300 companies and organisations participate in the Energy Awareness Week, organised by a stateowned company MOTIVA. Half of Finland's school children aged around eight take part in the week by studying energy from its production and consumption to energy saving and by taking energy saving action at home and in school. The week is a means of getting people to think and act in favour of sensible use of energy and an environmentally conscious way of life – voluntarily.

Dozens of municipalities participate in a long-running campaign to reduce their own greenhouse gas emissions. Five municipalities have even committed to cutting their emissions faster than the EU targets would require. Another campaign in and around Finland´s second biggest city Tampere is trying to involve inhabitants in preparing mitigation measures.

Back to Contents

2 National circumstances

This chapter describes the national circumstances which are relevant to the Finnish greenhouse gas emissions and removals. The emphasis is on the present national circumstance including climate and its variations. Their influence is examined in relation to the economy in general, energy supply and consumption, transport, industry, building stock, urban structure, waste, agriculture and forestry.

Back to Contents

Photos

Pirjo Ferin-Westerholm/YHA kuvapankki, page 46
futureimagebank.com, pages 33, 38, 46, 48, 52, 62
Jyri Juujärvi, page 31,35
Nina Kokko/YHA kuvapankki, page 55
Esko Kuusisto, page 45
Erkki Oksanen/Metla, page 60
Marita Potila, page 39
Maria Uotinen/YHA kuvapankki, page 50
YHA kuvapankki, page 42

2 National circumstances

2.1 Government structure

Finland is a representative democracy, with 200 Members of Parliament elected every four years. The tasks of the Finnish Parliament include passing laws and approving national budgets. 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. The President of the Republic directs foreign policy in cooperation with the Government, deciding e.g. on joining or withdrawing from international organisations and on the signing, ratification and entry into force of international conventions. The Government, in its narrower sense, means the Cabinet, which runs the 12 ministries. The Prime Minister directs the activities of the Government and oversees the preparation and consideration of matters within the Government´s mandate. Each ministry is responsible for the preparation of issues within its mandate and for the proper functioning of the departments and agencies within its administrative domain. The Government must enjoy the confidence of Parliament. It has to implement parliamentary decisions, present legislative proposals to Parliament, direct state administrative activities and represent Finland in the European Union.

Matters related to the United Nations Framework Convention on Climate Change (UNFCCC) fall within the administrative responsibility of the Ministry of the Environment, which acts as the national focal point to the UNFCCC.

More information about the institutional framework of Finland's climate policy is presented in Chapter 4.

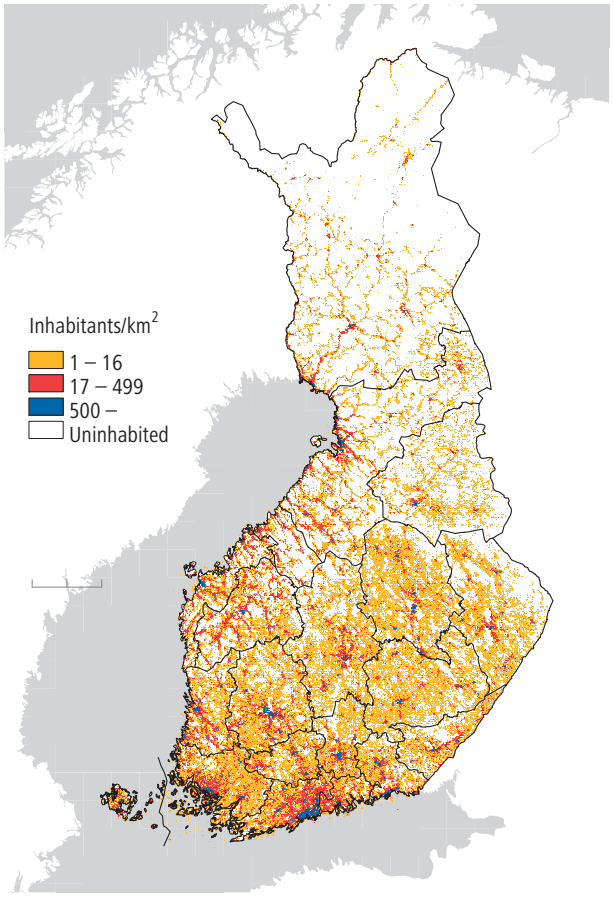
2.2 Population profile

The population of Finland was 5.3 million at the end of 2007. It has increased by an annual average of 0.35 per cent since 1990, when the population totalled just under five million. According to population projections made by Statistics Finland it is estimated that the Finnish population will rise to 5.7 million by 2040. The population density averages 17 inhabitants per km², but ranges from 2 inhabitants per km² in northern Finland to 72 inhabitants per km² in the south of the country. As a result of the low population density and the geographical extent of the country (Figure 2.1), average distances travelled for different purposes are high.

There is strong internal migration from rural to urban areas. In the period 1990–2007, net migration from rural to urban areas amounted to a total of 128,000 people. Many rural communities have a declining population, particularly in northern and eastern Finland.

In 2007, net migration to urban areas was 4,807 people, which was considerably lower than in the latter half of the 1990s, when it exceeded 10,000

Figure 2.1
Population density in Finland, 1.1.2008



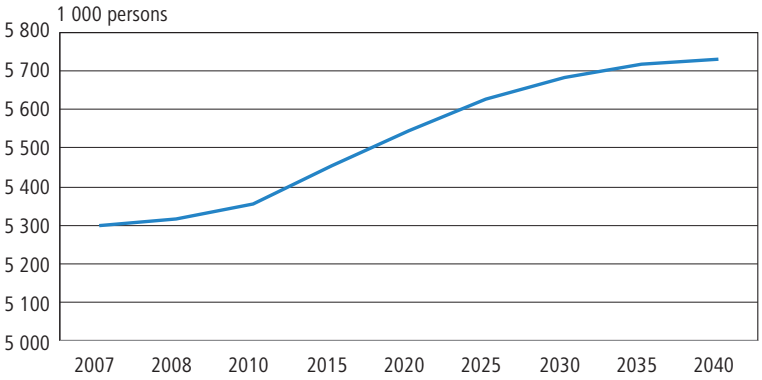
Regional division as on 1 January 2008

people per year. The urban population (3,444,620) made up 65.0 per cent of the total population (5,300,484) in 2007. The corresponding figure in 1990 was 56.9 per cent (2,846,220) of the total population (4,998,478).

The number of one person households has increased and the average household size has decreased. The total number of households at the end of 2007 was 2,476,500. 40 per cent, or 999,800, of them consisted of one person. The average size of a household was two people. As recently as 1970 the average household size was still three people. Finland's current average household size is low in comparison with other countries.

The population is ageing. In 2007 the proportion of people aged over 65 was 16.5 per cent, while in 1990 it was 13.5 per cent. This trend will accelerate in the coming years and decades. It is estimated that in 2040 over one quarter of Finland's population will be above the age of 65. The life expectancy has risen rapidly during the past 30 years. At present, women may expect to reach the age of 83 and men the age of 76. Despite this, the population growth has slowed down, and it is expected that the number of births will decrease slightly in the coming decades. The proportion of elderly people in the total population is increasing and so is the mortality rate. In the long run, the population is only likely to increase if there is a surplus of immigrants.

Figure 2.2
Population profile for 2007–2040



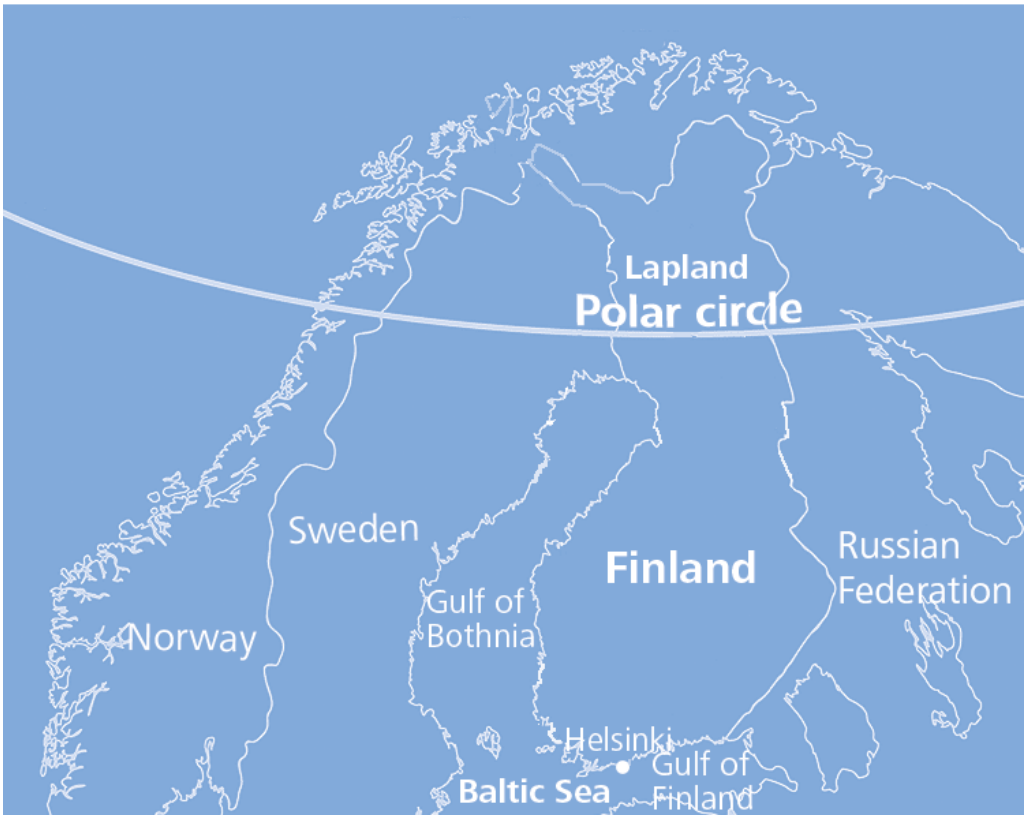
2.3 Geographical profile

Finland is situated at a latitude of between 60 and 70 degrees north, with a quarter of the country extending north of the Arctic Circle (Figure 2.3). In the west and south, it has a long coastline with numerous islands along the Baltic Sea. With a total area of 338,418 km^2, it is Europe's seventh largest country. The land boundary with Sweden is 614 km, with Norway 736 km and with Russia 1,340 km.

Finland lies between the Scandinavian mountains and northern Russian plains. Its terrain is a varying mosaic of low hills, broad valleys and flat, low-lying plains, with higher fells in the north. The landscape is a mixture of forests, lakes and mires. Much of the country is a gently undulating plateau of mostly ancient bedrock. Nearly all of Finland is situated in the boreal coniferous forest zone, and 73 per cent of the total land area is classified as forest land, while only some 7 per cent is farmed. Finland has over 34,300 km^2 of inland water systems, which is about 10 per cent of its total area. There are some 190,000 lakes and 180,000 islands, almost half of the latter along the Baltic Sea coast.

The Baltic Sea is the second largest brackish water basin in the world in terms of water volume. The water of the Baltic Sea is a mixture of ocean water and fresh water brought by numerous rivers. The salinity of surface water in the southern Baltic Sea is as high as 20 per mille, but in the northern

Figure 2.3
Finland's location



reaches it drops to 6 per mille. A severe problem affecting the Baltic Sea is eutrophication, which is the consequence of more than a century of nutrient loading caused by human activity (settlements, industry, agriculture and forestry) in the Baltic coast states.

The landscape in the northern part of Finland is characterised by high rounded fells. The Arctic region is especially vulnerable to the effects of climate change (more information in Chapter 6).

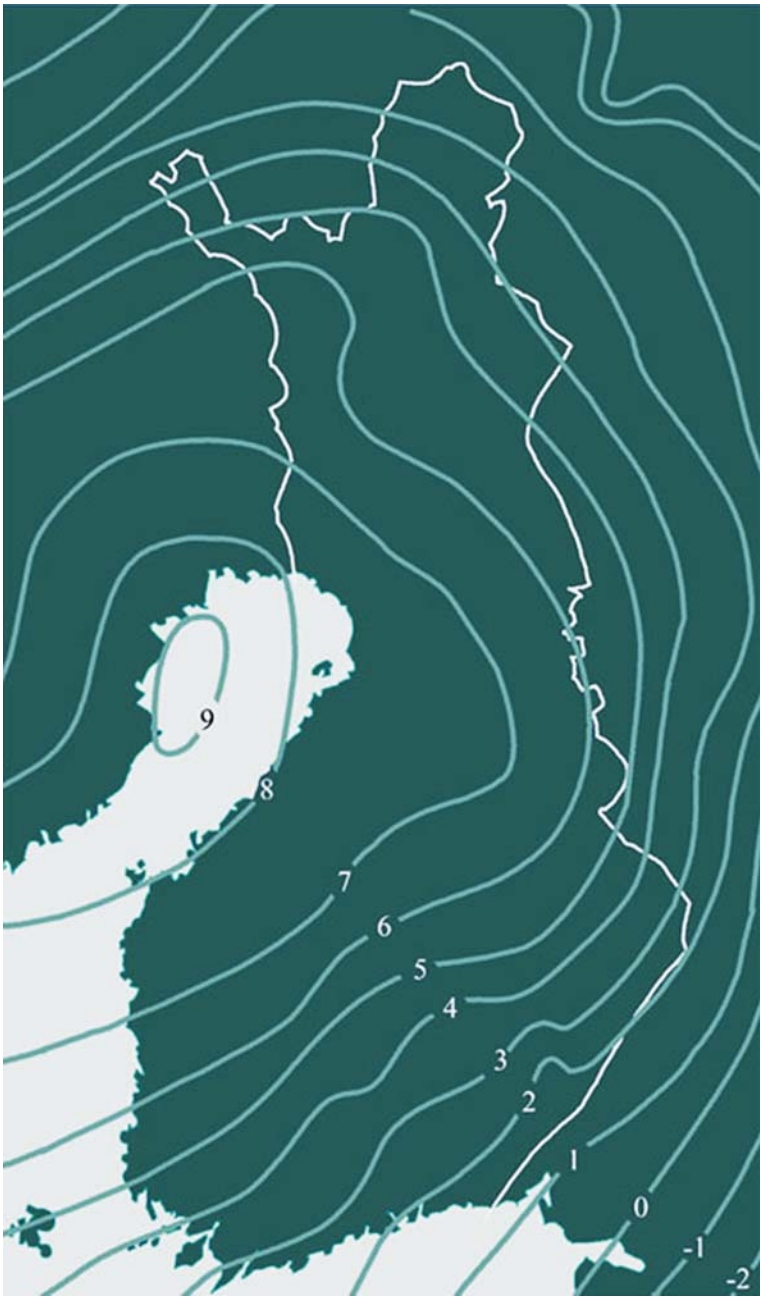
Changes in land use since 1990 are shown in Table 2.1. Areas of forest land and settlements have increased, while the areas of cropland and wetlands have decreased. During the period shown in the table (1990–2007), Finland's land

Table 2.1
Land use in 1990 and 2007. The classification is based on the IPCC Good Practice Guidance for land use, land-use change and forestry (LULUCF) (2004).
Source: the tenth National Forest Inventory (see Chapter 8)

Land use classification	1990 (km^2)	2007 (km^2)	Change (%)
Forest land	217,702	220,392	1.2
Cropland	22,710	22,553	–0.7
Grassland	6,768	3,919	–42.1
Wetlands	33,122	30,625	–7.5
Settlements	11,658	13,511	15.9
Other land	12,126	13,086	7.9
Total	**304,086**	**304,086**	**0.0**

area increased by about 100 km^2 due to land uplift as a result of the last ice age (Figure 2.4). This has not been taken into account in Table 2.1.

Figure 2.4
Land uplift as a result of the last ice, mm/year



Source: National Land Survey of Finland

2.4 Climate profile

2.4.1 Present climatic conditions and variations

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

The mean annual temperature is about 5.5°C in 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 the greatest in January, when the difference between southern and northern Finland is on average about 12°C. In June and July it is only about 5°C.

Finland enjoys long periods of daylight around midsummer, when the length of the day, including twilight, reaches 22 hours even at the latitude of the capital, Helsinki. North of the Arctic Circle (66½°N) it remains light throughout the night at this time of year, as the sun does not go below the horizon at all. In the far north there is a period around midsummer of more than two months during which the sun never sets. Conversely, in wintertime, the northernmost region has two months of uninterrupted night.

The Finnish climate is characterised by irregular precipitation and there are typically 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 it is slightly lower. In northern Finland the annual precipitation is 550–650 mm.

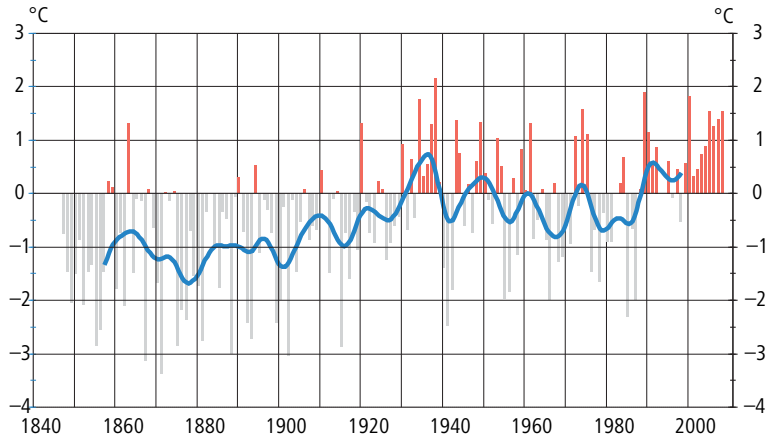
The seasonal variation in precipitation is similar throughout the country, the driest month being March. From then on, precipitation gradually increases until July and August, or until September and October on the coast, after which it decreases towards the winter and spring. The lowest annual precipitation recorded is less than 300 mm in northern Finland, while the country's maximum recorded precipitation has exceeded 900 mm. The highest daily precipitation recorded is almost 200 mm, but values above 50 mm are rare. In an average year more than half of the days have some precipitation, except the coastal regions. Even in southern Finland, some 30 per cent of the annual precipitation is in the form of snow, which remains on the ground for about four months. In Lapland 50–70 per cent of the annual precipitation is snow and remains 6–7 months on the ground. The lakes freeze over in October in Lapland and early December in southern Finland. In severe winters, the Baltic Sea may freeze over almost completely, but in mild winters it remains open except for the Gulf of Bothnia and the eastern part of the Gulf of Finland.

The wind direction in Finland is mainly from the southwest, and the least common

direction is 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 7m/s in maritime regions. Damage due to storms and strong winds occurs most often during autumn and winter, but also during summer in connection with thunderstorms. Cloud cover is especially abundant in the autumn and winter, increasing from the northwest towards the southeast. The long-term average of the monthly cloud cover ranges from about 50 per cent in May–June to about 80 per cent in September–November.

The average annual temperature has increased during the last 150 years by slightly more than one degree (Figure 2.5). The increase has been the greatest in spring. Winters have become about one degree and summers and autumns about half a degree warmer. Considerable fluctuations in the temperature have also occurred during this period. The winters of 1985 and 1987, for example, were very cold, and in the 1990s and during the present century there have been a number of warm years. Since winter 1989, nearly all winters have been warmer than the 20th century average. The culmination occurred in winter 2007, which was the warmest measured since the beginning of the 20th century. 20th century observations indicate that such a mild winter will occur only once every 200 years. However, climate change projections suggest that by 2050 one in five winters will be as warm as or warmer than the winter of 2007. Temperature records were also broken in 2008, which was the warmest year ever measured in southern part of Finland. For the country as a whole it was the sixth warmest year.

Figure 2.5
Annual mean temperature in Finland, 1847–2008, presented as anomalies of the reference period 1971–2000 mean temperature. The curve represents temperature variability per decade.



Source: Finnish Meteorological Institute

2.5 Economy

Finland has an open economy with a large service sector (Figure 2.6). Through the membership of the European Union and the European Economic and Monetary Union (EMU) the Finnish economy is integrated with the economies of other European countries. The main manufacturing industries are the electrical and electronics, forest, metal and engineering industries. Foreign trade is important, with exports accounting for about 40 per cent of the gross domestic product (GDP). The cold climate, energy-intensive industries and long distances have led to a high energy intensity and per capita greenhouse gas emissions.

For a number of decades, the Finnish economy was characterised by rapid growth combined with vulnerability to international cyclical fluctuations. As a result of the economic downturn in the early 1990s the GDP decreased in 1991–1993 by about 10 per cent. Between 1994 and 2007 the average annual GDP growth was nearly 4 per cent. In 2007 the GDP per capita was at EUR 31,044 compared with EUR 21,832 in 1990 (Figure 2.7). The global economy contracted very sharply in the latter half of 2008 and slid into a deep recession in early 2009. The recession in the real economy was triggered by a crisis in the financial market, which remains in a state of disequilibrium despite a slight improvement in bank balance sheets. The Ministry of Finance's forecast indicates that Finland's total output will decrease by 6 per cent in 2009 and grow by less than 0.5 per cent in 2010.

Private consumption, accounting for 50 per cent of the GDP, increased by 43 per cent between 1994 and 2007, representing an annual growth of over 3 per cent.

At the beginning of the 1990s, the value of both exports and imports was around EUR 20,000 million, reaching a little over 20 per cent of the GDP. 1992 marked the beginning of an export-led growth period, as the economic policy resulted in improved export competitiveness. Exports have grown nominally at around 10 per cent annually, whereas the growth in imports has remained at 7 per cent, resulting in account surplus. By 2007, exports accounted for more than 40 per cent of GDP; imports also accounted for around 40 per cent. Over the period 1990–2007, Finland's foreign trade increased both in absolute and relative terms (Figure 2.8).

Figure 2.6
Structural change in the economy

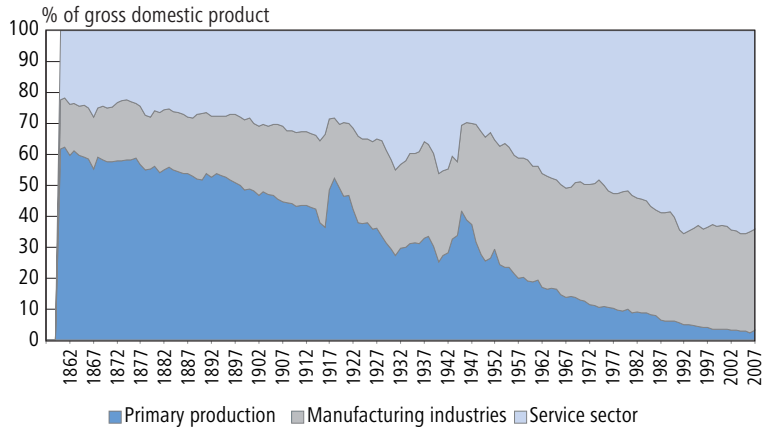


Figure 2.7
Gross domestic product 1975–2008 (at 2000 prices)

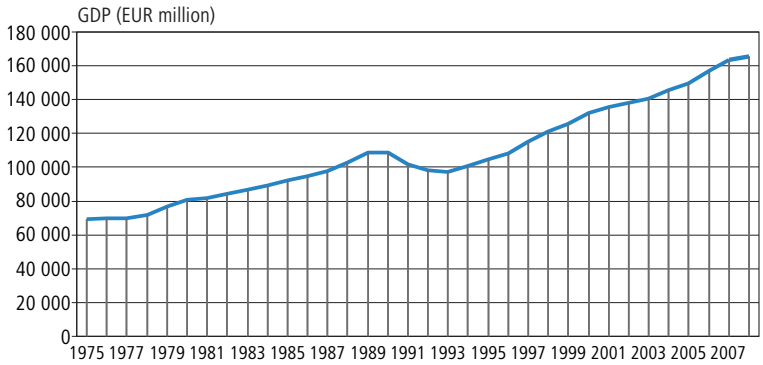
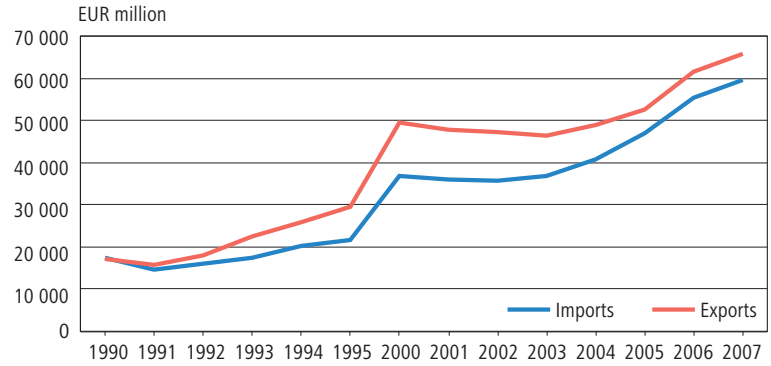


Figure 2.8
Finland's imports and exports (current prices)



Nearly 60 per cent of Finnish exports were to the EU countries (EU 27). However, this share is declining due to the low growth in Europe and expanding markets elsewhere. The composition of exports has also changed. Finland's pulp and paper industry accounted for nearly 25 per cent of exports at the end of the 1990s, but by 2007 this had fallen to about 15 per cent. Electronics industry exports have increased to 25 per cent of the total, and the metal and engineering industry has increased its share from 28 per cent to about 35 per cent. The share of other sectors has varied around 25 per cent.

The liberalisation of the capital markets and the opening up of national economies has increased capital movements between countries. Direct investments from Finland exceeded investments flowing into Finland during 1993–2001. In 2000, investments from Finland reached a record volume of nearly 20 per cent of the GDP. During 2002–2006 foreign direct investments in Finland exceeded direct investments from Finland. In 2007, the inflows and outflows of foreign direct investments were in about equal proportions.

Finland is part of the euro area, consisting of the EU Member States that have adopted the euro currency. The main objective of the European Central Bank's monetary policy is to maintain price stability in the euro area in order to safeguard the purchasing power of households. Price stability is defined as a year-to-year increase in consumer prices of below 2 per cent. The main monetary instruments are the key interest rates. The rates affect market prices and macroeconomic developments.

2.6 Energy

2.6.1 Energy supply

Finland is dependent on imported fuels. Accordingly, the cornerstones of Finnish energy policy are a diversified and reliable supply of energy and improved self-sufficiency. The energy-intensive basic industries, cold climate and long distances underline the significance of energy for the country's competitiveness and the wellbeing of its inhabitants. Until the 1960s, Finland's energy policy relied on the electricity produced by hydro power stations and extensive use of wood. Due to the limited hydro resources, the use of coal and oil started to increase rapidly, and the need to find new energy sources became clear. A gas pipeline from the Soviet Union to eastern Finland was completed in 1973 and later extended to the capital area and some other cities. The first nuclear power unit was taken into use in 1977, followed by three other units in 1979–1982. The 1970s also brought peat into the Finnish energy mix (Figure 2.9).

In 2007, the total energy consumption was 1,469 PJ. Finland's domestic energy sources are wood-based fuels, hydro power, wind power and peat. Domestic electricity generation was 77.8 TWh. This consisted of hydro power, wind power, combined heat and power production in district heating and also by industry for its own use, nuclear power and conventional condensing power. Net imports from the Nordic market and Russia vary considerably from year to year, mainly due to variations in hydro power production in the Nordic countries. In 1990–2007, maximum net imports were 17.0 TWh (in 2005) and the minimum 3.7 TWh (1996). Electricity exports averaged only 0.7 TWh in 1990–2002, but were high in 2003 (7.0 TWh) and 2004 (6.8 TWh) because Sweden and Norway had very scarce hydro resources in those years. In 2007 electricity exports were 2.9 TWh (Figure 2.10).

Figure 2.9
Total energy consumption, 1970–2007

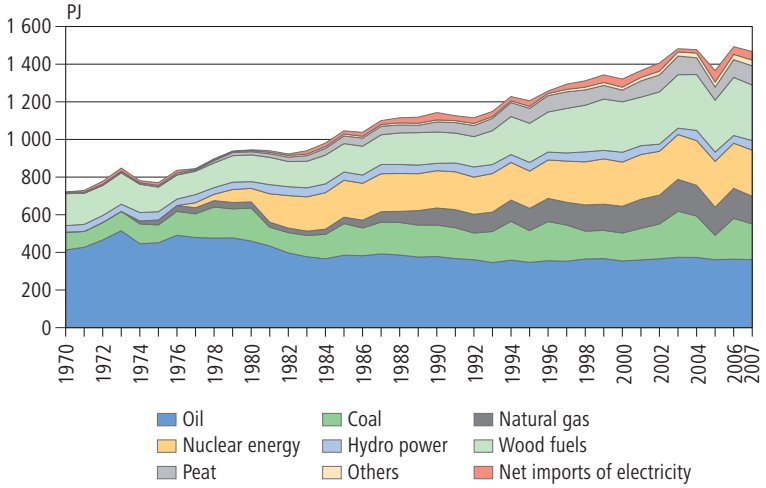
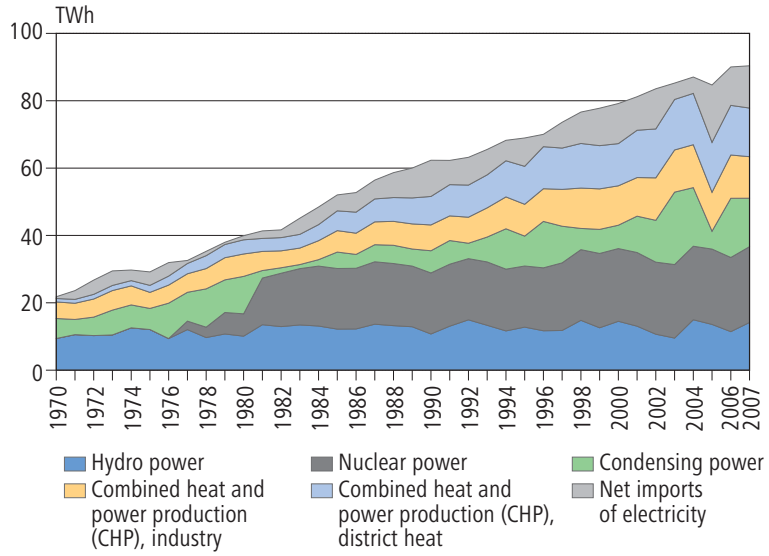


Figure 2.10
Electricity supply by production mode, 1970–2007



For decades the demand and supply of electricity were rising more rapidly than the GDP. Since 1994, parallel with the structural change in the economy, the situation has reversed and the electricity intensity of the economy has decreased.

The relatively large dependence on fossil fuels and peat has resulted in considerable CO_2 emissions. Nevertheless, the CO_2 emissions per total primary energy unit are lower than in many other European countries. This is due to the use of hydro, nuclear and biomass primary energy sources. The energy intensity of the Finnish economy decreased slightly in the 1980s, then increased for some years, but started to decrease again in 1994 (Figure 2.11). The decrease partly reflects the structural change in the industry.

In the EU, renewables account for an average of 9.2 per cent of final energy consumption. In Finland, the corresponding figure has consistently been about 29 per cent over the period 2000–2007 (Figure 2.11).

Figure 2.11
Energy and electricity intensity indices, 1970–2007

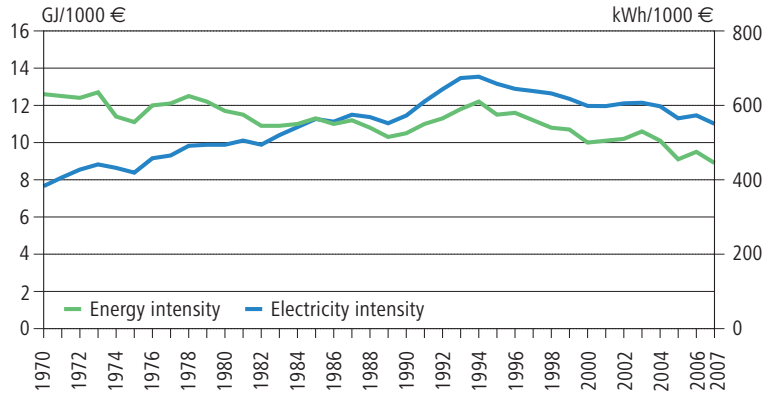
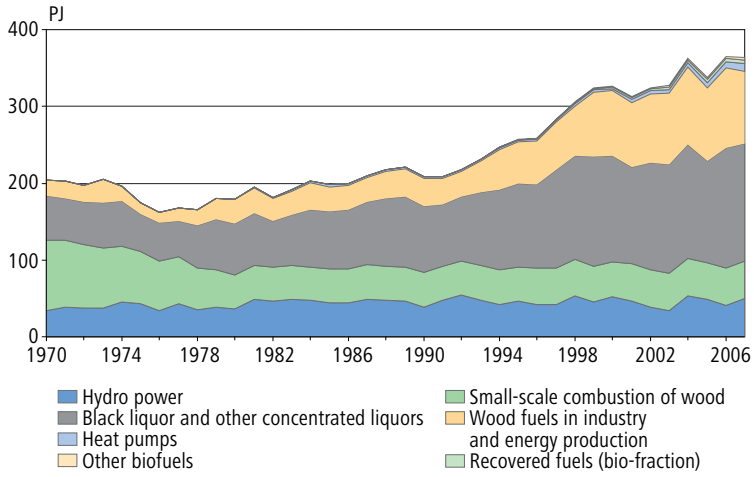


Figure 2.12
Renewable energy sources, 1990–2007



Combined heat and power production (CHP) provides opportunities for the cost-effective use of renewables, both by industrial producers and at district heating plants. The amount of energy Finland saves annually through CHP corresponds to approximately one tenth of all primary energy used in the country. CHP accounts for more than one third of all electricity production, compared with the EU average of 11 per cent. Installed wind power capacity increased rapidly in Finland since 1990 as a result of the Government's support programme. In 1992, the capacity was only about 1 MW, but in 2007 it was around 86 MW.

The use of wood-based fuels and natural gas has increased recently. The share of nuclear energy in the diversified energy mix has increased as well, owing to the upgrading of existing nuclear power plants in 1995–1998. Finland's energy dependence, calculated as the proportion of imported energy in the total primary energy supply (TPES), has decreased from 80 per cent in the late 1970s to 76 per cent today.

The introduction of four nuclear power units in the turn of the 1980s cut the use of coal in electricity generation. Later, with attention directed away from nuclear development, the exploitation of new sources such as peat, biomass and natural gas increased. Nuclear power nevertheless accounts for over 29 per cent of Finland's electricity production. In 2007 total electricity consumption amounted to 90.4 TWh, and nuclear power accounted for 25 per cent of this. The difference in the percentages is explained by the fact that Finland is a net importer of electricity, and electricity consumption is thus greater than electricity production.

In May 2002, Parliament voted in favour of constructing a fifth nuclear power plant. This is under construction on the island of Olkiluoto, in the municipality of Eurajoki in western Finland. The construction of the plant, owned by the private electricity producer TVO (Teollisuuden Voima Oy), has been delayed. The plant is expected to start operation in 2012.

2.6.2 Recent changes on the energy market

The Finnish electricity market was opened gradually to competition with the enactment of the Electricity Market Act in 1995. Since autumn 1998, it has been possible for all electricity consumers, including households, to invite tenders for their electricity purchases. The electricity market reform aimed to improve efficiency and achieve environmental benefits, as the new arrangements allowed Nordic hydro power capacity to play an important role in the integrated electricity market, and also allowed the emergence of trading in 'green electricity'.

The opening of the market has strongly influenced the electricity trade. Prior to this, electricity transmission companies and major consumers concluded long-term wholesale delivery contracts with electricity producers. Nowadays, most of the wholesale trade in electricity takes place at the Nordic Power Exchange, Nord Pool. Its ELSPOT market price sets the electricity price in the Nordic countries. Electricity is also traded on the so-called OTC market and directly between the buyer and the seller.

Major restructuring took place in the Finnish electricity market in 1997, when the transmission grids of two companies, IVO (Imatran Voima Oy) and TVO (Teollisuuden Voima Oy), were merged into a single national grid company, Finngrid. Finngrid is responsible for the national power balance management and ensures that the transmission system is maintained and used in a technically appropriate manner. Together with the other Nordic grid operators, Finngrid is also responsible for safeguarding the necessary reserves for the operation of the power system.

A long-term objective is to increase the alternatives for the supply of natural gas. This is important in terms of safeguarding both the supply and the functioning of the market. The potential for developing and diversifying the supply of natural gas has been studied, but no decisions have been made yet.

The energy department of the Ministry of Employment and the Economy monitors continuously the functioning of other energy markets, such as oil and heating, as well. The ministry monitors both the competitive situation and the security of energy supply. Where necessary, it presents initiatives for improving the functioning of the markets.

Emissions trading in the EU has become a significant factor on the energy market. Finland's Emissions Trading Act applies to the CO_2 from

combustion installations with thermal input of more than 20 MW, smaller combustion installations connected to the same district heating network, mineral oil refineries, coke ovens and certain installations and processes of the steel, mineral and forest industries. Any installation covered by the emissions trading system needs an emissions permit. In Finland, the number of installations needing a permit is around 600.

2.7 Transport

Transport demand and supply are influenced primarily by developments in the economy, demographic factors, employment patterns and infrastructure provision. Increased access to high-speed transport has increased the commuting distance between work and home.

The Finnish transport network consists of the road, rail, water and air traffic infrastructure, the main elements of which form part of the EU's Trans-European Networks. The Finnish road network has around 106,000 km of public roads. In addition, there are 224,000 km of smaller private roads, many of which are used for forestry purposes. Finland has about 700 km of motorways and 150 km of semi-motorways. The rail network amounts to a total of 5,900 km, of which 2,400 km is electrified.

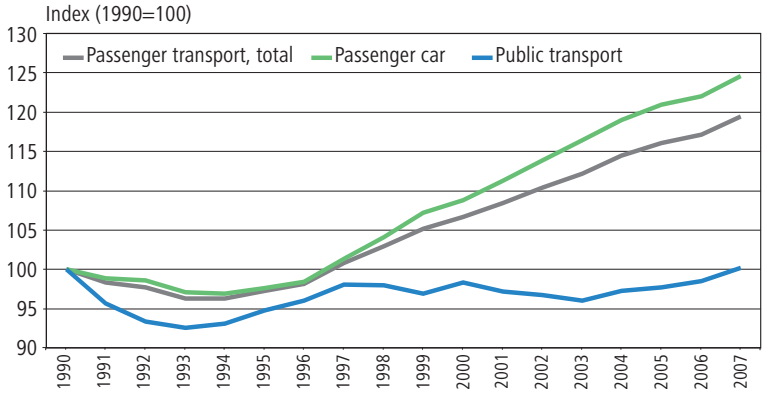
Three quarters of Finland's foreign trade goes by sea, most of it from the country's principal ports. Most of Finland's many ports and harbours are small, and the traffic flows vary considerably. Icebreakers have an important role to play, with eight of them being responsible for assisting freighters and passenger ships into the 23 ports and harbours that are kept open all year round. Given a normal winter, the harbours in the Bothnian Bay require icebreakers for half of the year, while in the Gulf of Finland they are needed for about three months.

Finland has a network of 28 airports, of which 25 are maintained by Finavia (formerly the Civil Aviation Administration). About 95 per cent of the country's international air traffic operates via Helsinki-Vantaa Airport.

2.7.1 Passenger transport

Domestic passenger transport, measured in terms of passenger-kilometres, has increased by approximately 19 per cent since 1990. Cars account for around 82 per cent of the total passenger-kilometres. Since 1990 the number of passenger-kilometres travelled by car has increased by 26 per cent, while the number of passenger-kilometres by public transport has remained unchanged. Rail and air travel have

Figure 2.13
Passenger-kilometres in domestic transport, 1990–2007



increased, whereas the use of buses has decreased in terms of passenger-kilometres (Figure 2.13).

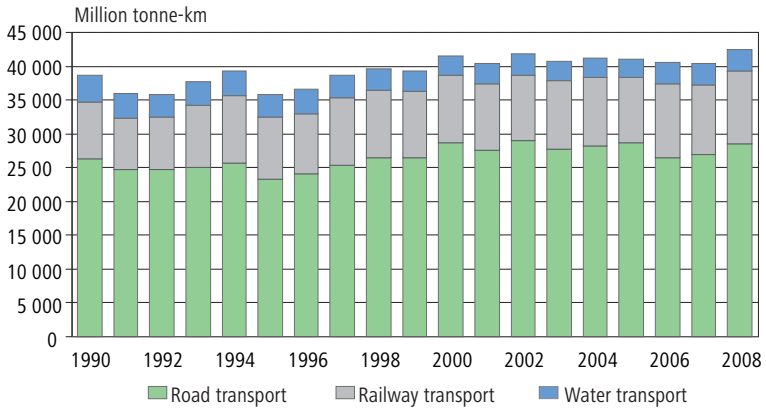
In international rail traffic, the number of passenger-kilometres has increased by 34 per cent, and in international air traffic the figure has more than doubled.

2.7.2 *Freight transport*

The total number of freight tonne-kilometres in Finland is almost double the EU average, mainly because of the long distances and the industrial structure. Heavy industries, such as timber, pulp and paper, and metal and engineering, have traditionally played a prominent role in the Finnish economy, and these all need transport for their raw materials and products. The structural change in manufacturing has reduced exports from the paper, pulp and wood-processing industries and increased exports from the electronics and metal and engineering industries.

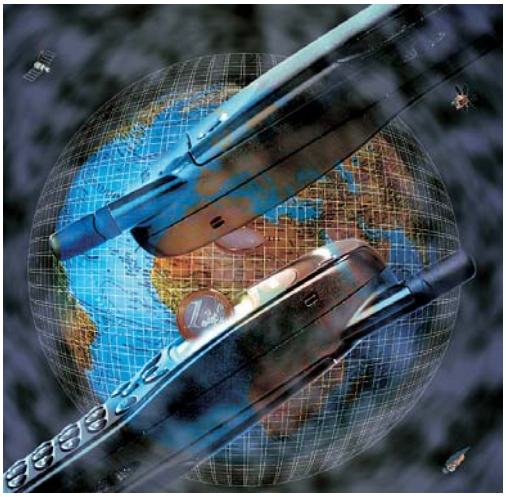
Road haulage is the most important form of transport for domestic goods traffic. More than 89 per cent of all freight is transported by road,

Figure 2.14
Tonne-kilometres in domestic goods transport, 1990–2008



while rail transport accounts for 7 per cent and inland waterways for just under 2 per cent. Air transport's share is almost negligible.

Since 2000 Finland's international freight transport has increased about 27 per cent, measured in terms of the tonnage of transported goods. More than 93 per cent of this overseas freight travels by sea, and under 7 per cent by road. Air freight is almost negligible in tonnage terms, whereas in terms of value it accounts for more than one tenth. Products with a high added value, such as electronics, are transported by air. The growth in exports of consumer goods and electronics, such as mobile phones, is increasing the role of air transport.

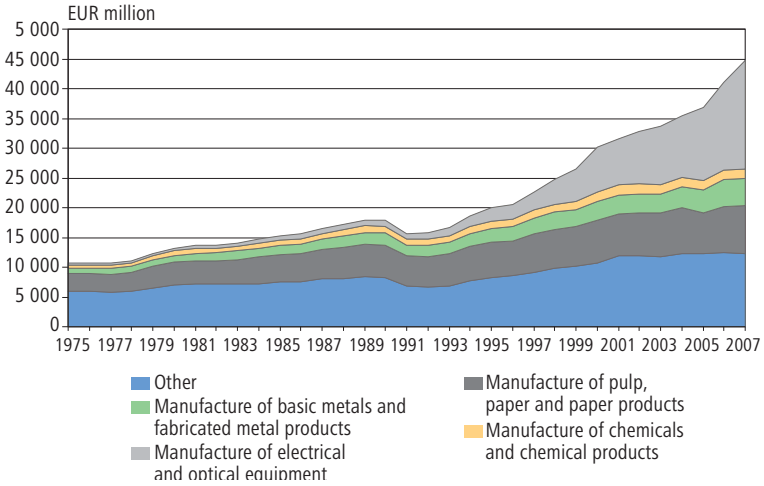


2.8 Industry

The electronics and electrical industry, the forest industry and the metal and engineering industry are the three strongest sectors in the national economy (Figure 2.15). Finland's industrial structure has recently undergone a profound change, and this has occurred at a very fast rate. Following the economic recession of the early 1990s, the very rapid expansion of the metal products industry – especially electronics – changed the traditional industrial structure. The increase in the technology-intensity of the country's manufacturing sector has been strong, driven mainly by the manufacture of communications equipment.

The proportion of the GDP accounted for by the forest industry, one of Finland's traditional industrial sectors, was still over 10 per cent in 2000, but by 2007 this had fallen to less than 5 per cent. This was despite the increasing proportion of higher value added products in this sector. Currently, the forest industry is undergoing a structural change, as the manufacturers downsize their capacity in Finland and shift new investments to regions with a high end-product consumption potential and low operating costs.

Figure 2.15
Output of manufacturing industries by sector (at 2000 prices)



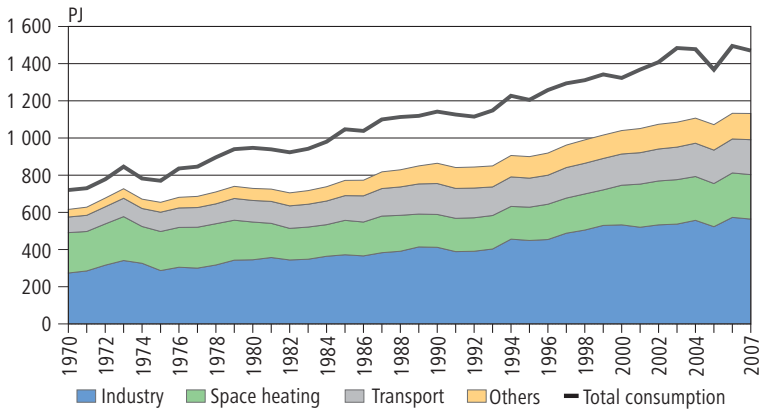
The impact of the high-tech industry, mainly communications, is significant. Its relative share is the highest in the OECD countries. On the other hand, the share of medium-high technology sectors is lower than the international average. In general, the trend in industrial output at constant prices is fairly similar to that of GDP.

Until the 1980s, Finnish industry was almost entirely domestically owned and the legislation placed strict limits on foreign ownership. For a long time, about one fifth of all industry was state-owned. The restrictions on foreign ownership were removed with Finland's accession to the EU in 1995. The state has also sold a considerable part of its industrial holdings.

2.8.1 Energy use in industry

In 2007 Finnish industry used 50 per cent of the country's total primary energy and 53 per cent of the total electricity (Figure 2.16). A considerable number of the energy-intensive industries are export-oriented. Almost 90 per cent of paper and board production is exported and the share of exports is also high in the basic metal industry. Because of their high energy demand, these energy-intensive industries have also worked hard to improve their energy efficiency. For example, in 1980–1990 industrial output rose by one third, while the consumption of energy rose by only about 20 per cent. Furthermore, the forest industry relies to a considerable extent on biomass to meet its energy needs: wood residues, black liquor and other biomass energy sources. All pulp mills are self-sufficient in heating energy and all of them produce energy in excess to their own requirements. At many industrial sites, the energy left over from the pulping process is channelled to the municipal district heating network. However, in search of higher profit margins, industrial installations have increasingly outsourced their electricity generation to the open electricity market.

Figure 2.16
Total energy consumption and final energy consumption by sector, 1970–2007

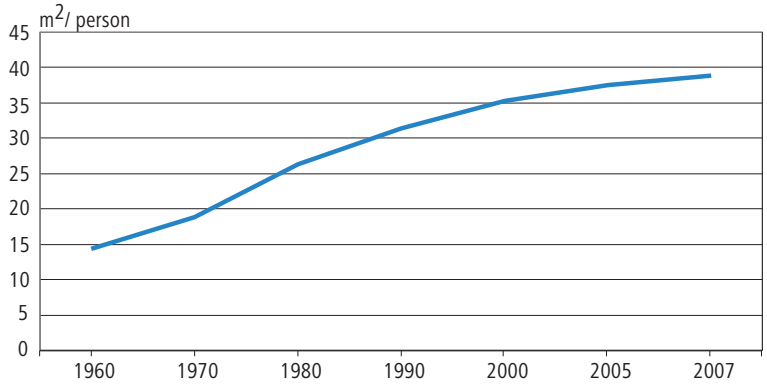


2.9 Building stock

Finland's largest cities are located in the south and west of the country, and the size of settlements tends to decrease towards the north and east. Outside these relatively few larger towns and cities, Finland is a land of small towns and rural communities. Most of the economically important cities are located on river estuaries on the coast or inland at the inters of the lake systems.

In 2007 the total heated building area amounted to 497 million m². Residential buildings accounted for about half of this, while office, commercial and industrial buildings made up almost 40 per cent. The remainder consists of free-time residences, agricultural buildings and other small outbuildings. There were 1,095,000 detached houses, 377,541 dwellings in attached houses (mainly semi-detached and terraced houses) and 1,204,000 dwellings in apartment blocks. The number of dwellings increased by 24 per cent between 1990 and 2007. As well as this increase in number, there has also been a gradual rise in the average size of dwellings. In 1990 the average residential floor space per dwelling was 74 m². In 2007

Figure 2.17
Development of floor space m^2/person in 1960–2007



it had increased by 5 m² to 79 m². This is driving up the energy requirement for heating.

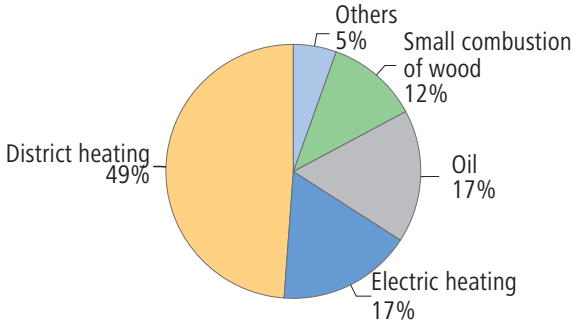
The figure for residential floor space per person has grown by more than the per dwelling figure. In 2007 it was 39 m^2 compared with 19 m^2 in 1970 and 31 m^2 in 1990 (Figure 2.17). On average, Finns spend one fifth of their disposable income on housing. The building stock is fairly new, with only 10 per cent having been constructed before 1940. More than 95 per cent of dwellings have flush toilets and over 98 per cent have a sewer and running water.

2.9.1 Energy use for indoor heating

Because of the country's northern location, Finland uses a lot of energy for indoor heating. It is the biggest source of CO_2 emissions by households and by the public and service sectors. However, during the past three decades the consumption of energy per unit of heated space has been successfully reduced by 40 per cent. This is largely due to the tightening of the building regulations, especially in the 1970s. The figure for heating degree days (HDD), calculated using a 17°C indoor temperature as the base, varies in Helsinki from 3,400 to 4,800 per year. In Rovaniemi, in northern Finland, the corresponding range is 5,500–7,000. HDD is a quantitative index designed to reflect the demand for energy needed to heat a building. Energy conservation has been aided considerably by technical advances in insulation and window design, and by developments in combined heat and power (CHP) production, district heating, heat-recovery, air-conditioning and ventilation systems. By comparison, the HDD figure in Belgium varies from 2,400 to 2,800 per year.

Since 1990, the composition of energy sources used for heating has changed markedly (Figure 2.18). The use of heavy fuel oil has decreased by 71 per cent and the use of light fuel oil by 34 per cent. At the same time, energy from natural gas has more than doubled and energy from ground source heat pumps is four times greater than in 1990, although still rather low. Small-scale combustion of wood has increased by 14 per cent, electric heating by 43 per cent and district heating by 36 per cent since 1990. The share of district heating was 49 per cent of the total heating energy in 2007. District heating is the primary heating system in apartment blocks,

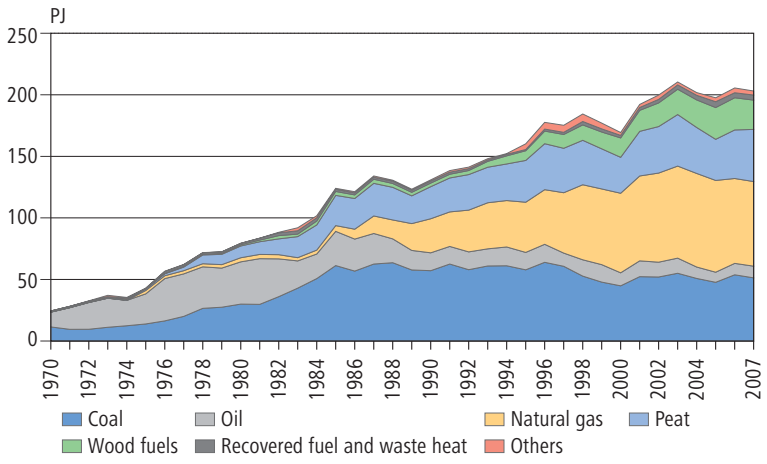
Figure 2.18
Heating energy used in residential, commercial and public buildings, 2007



and half of the country's total building stock relies on it. Since the 1980s, light fuel oil has lost some of its market share to electric heating and later also to ground source heat pumps in detached houses. Small-scale combustion of wood is often a secondary heating system, but in rural areas it is also used as the principal heating source. Heat pumps have recently become as common as oil heating, for economic and environmental reasons. Advances in technology have also been a contributing factor.

A wide range of fuels is used to produce district heat (Figure 2.19). Coal and oil are being replaced by natural gas. Peat, an indigenous fuel, remains competitive especially in inland areas. Government and industry efforts have helped to increase the use of wood fuel, mostly by-products from the forest industry. The district heating network now covers most areas with cost-efficient potential. CHP accounts for 72 per cent of the total heat produced in district heating, i.e. practically all of the potential for CHP has been exploited. CHP improves efficiency, especially when compared to separate condensing power production. CHP is also an efficient way to cut the level of CO_2 emissions from energy production.

Figure 2.19
Fuels used in district heating and CHP, 1970–2007



2.9.2 Urban structure

The deep recession of the early 1990s had an impact on the changes occurring in the country's settlement pattern and urban structure. In the 1980s the densely populated areas had expanded quickly, but during the 1990s construction diminished considerably for a number of years. Since then, differences have emerged in the pattern of development in the urban regions and other parts of the country. In the growing urban regions, principally Helsinki, Tampere, Turku, Oulu and Jyväskylä, the growth has mainly been based on the existing urban structure. In many other urban areas growth has occurred too, due to migration. In rural areas, however, population has been declining for many years. The population of remote villages has also been declining, wheareas villages closer to the growing urban regions have grown.

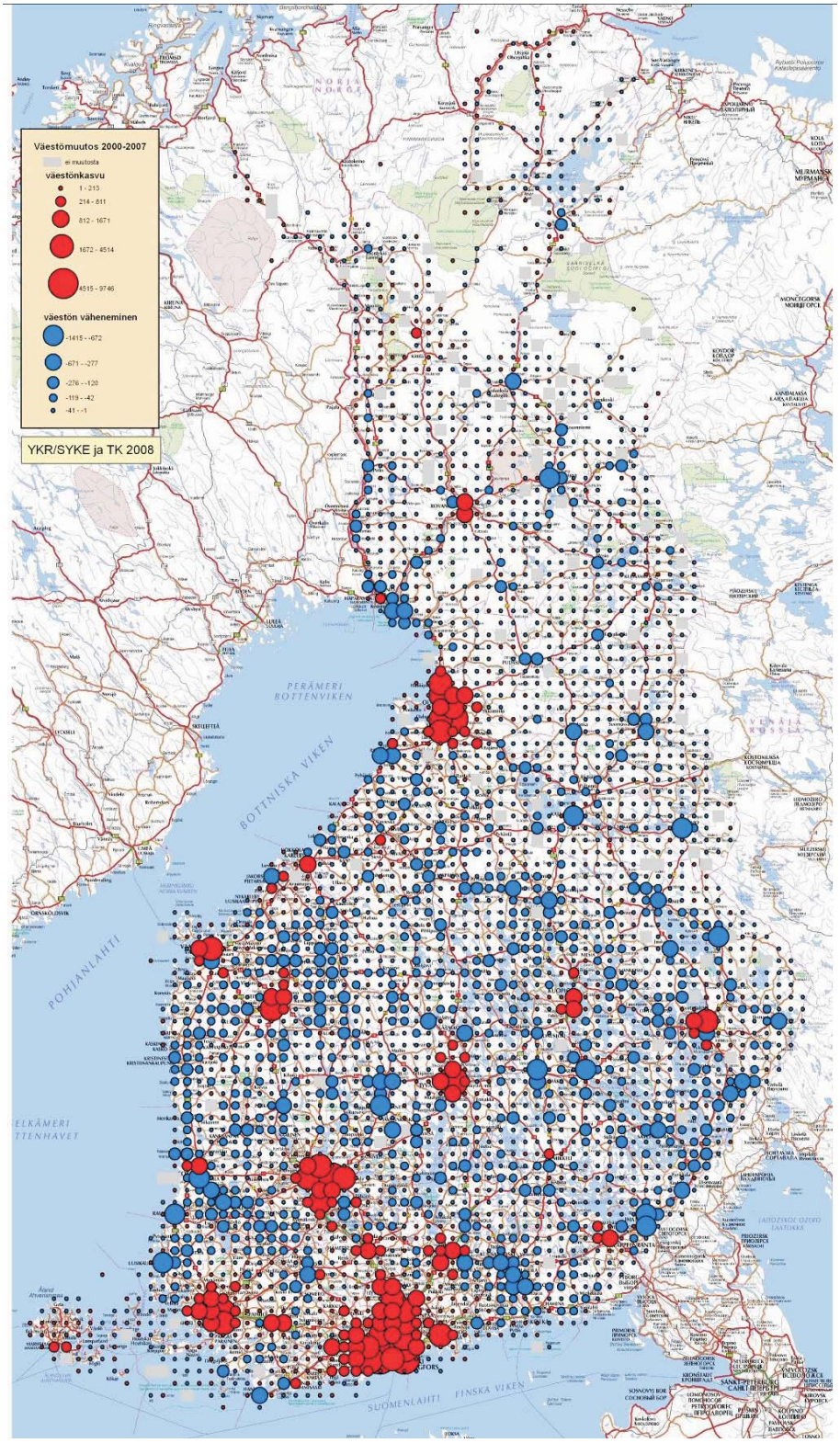
In 2005 the combined population of the 34 largest urban areas in Finland was 3.3 million, a rise of 740,000 since 1990. These urban areas contain 64 per cent of the total population (58 per cent in 1990), and have 74 per cent of the country's jobs. This means that more than two thirds of the population and jobs are located in areas that cover less than one per cent of the surface of the country. Population growth is concentrated very clearly in certain urban centres, as shown in Figure 2.20.

Finland became urbanised relatively late and the urbanisation process is still continuing. The share of the population in densely built-up areas has risen continuously, and these areas accounted for 83.4 per cent of the population in 2007. There are 742 built-up areas covering about 2 per cent of the land area. In 1990 the corresponding proportion was 1.6 per cent. The population density in these built-up areas was about 700 inhabitants per km² in 2007. However, the density has declined by 70 inhabitants per km² since 1990 as the lower density fringes of these built-up areas have grown (Figure 2.21). Compared with the other Nordic and European countries the population density of these built-up areas is very low. It is less than half of the comparable areas in Sweden or Norway.

Often there is no distinct boundary between urban and rural areas, as in many cases there are few tight restrictions on construction close to urban areas.This has led to a dispersed and fragmented urban structure. Urban areas have typically expanded inexorably outwards, leading to the creation of unstructured, low density built-up areas. These low density districts of built-up areas cover some 30–35 per cent of the land surface of the country's urban areas – even in the main growth centres. Arranging services for those low density urban areas is very difficult. Many of these households need more than one car to manage their daily lives (commuting, school trips, acquiring services, engaging in free-time activities).

Due to the changes in country's economic, regional and urban structure the average daily one-way commuting distance has more than doubled in just 25 years, to more than 13 km, as shown in Figure 2.22.

Figure 2.20
Population change, 2000–2007, in 100 km² grids (red increase/blue decrease)



Source:
YKR/Finnish Environment Institute and Statistics Finland 2008,

Figure 2.21
Population density (inhabitants per km²) in built-up areas, 1980–2007

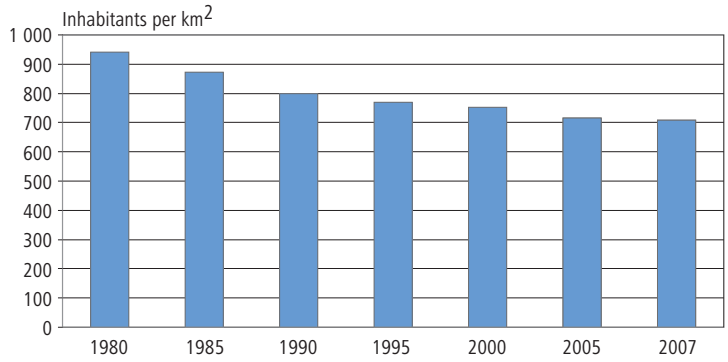
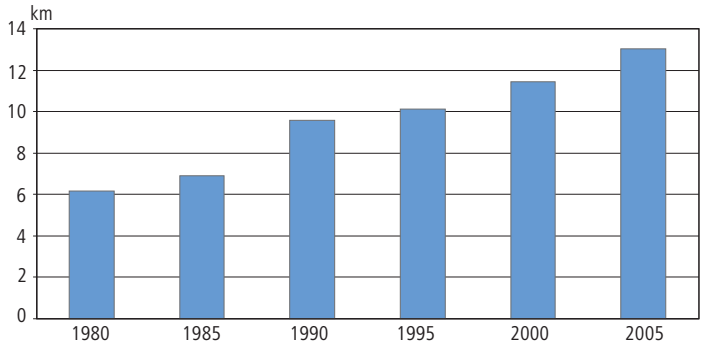


Figure 2.22
Average daily commuting distance, 1980–2005



2.10 Waste

The amount of waste deposited in landfill sites has been significantly reduced by effective waste regulation. Finland's waste policy is aimed at preventing waste, increasing re-use and recycling, reducing landfilling and reducing the environmental impact of various forms of waste management (see also Chapter 4).

Finland generated 74 million tonnes of waste in 2007, an increase of 7 per cent from the previous year. The largest quantities of waste came from mining and quarrying, construction and manufacturing and was primarily of mineral origin. The volume of mineral waste was 53.7 million tonnes, or 72.4 per cent of all waste. The amount of wood waste was 12 million tonnes.

The rest of the waste in the total waste figure is mixed waste, which comprises the solid municipal waste generated by households and services. Though accounting for less than 4 per cent of the country's total waste, this solid municipal waste is responsible for most of the greenhouse gas emissions from the waste sector. The amount of the solid municipal waste has continued to grow in recent years. In 2007, for example, the amount grew by 4.2 per cent on the previous year's figure. Mu-

Table 2.2
Generation of waste in 2007

	Chemical waste	Wood waste	Mineral waste	Other waste[1)]	Total
	1,000 tonnes per year				
Agriculture, forestry and fishing[2)]	0	1,584	1	169	1,754
Mining and quarrying	0	1	23,567	4	23,572
Manufacturing	1,410	10,542	4,276	2,490	18,719
Energy supply	5	1	1,518	51	1,574
Construction	0	650	24,349	478	25,478
Service activities and private households	42	49	2	2,859	2,951
Total	**1,458**	**12,283**	**53,713**	**6,051**	**74,050**
of which hazardous waste	462	51	1,500	233	2,246

1) Sludge, dry weight.
2) Excluding organic waste utilised in agriculture and logging waste left on site.

nicipal waste generation in total was just over 500 kg per capita in 2007, which was below the EU average.

Manufacturing industry generated 18.7 million tonnes of waste in 2007. The largest quantities of manufacturing waste were waste wood and bark, slag from the basic metal industry and various wastes, especially gypsum, from the chemical industry.

Table 2.2 shows the amount of waste generation by source category and waste category.

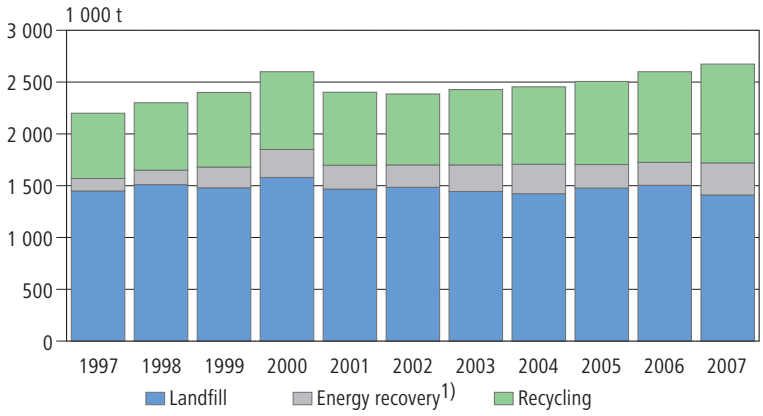
In 2007 the waste recovery rate was almost 40 per cent, at 29.2 million tonnes; altogether 20.5 million tonnes of waste was recovered as material and 8.7 million tonnes as energy. The latter comprises mostly wood waste (almost 8.3 million tonnes). The wood waste was almost fully recovered, as 4.1 million tonnes of wood waste was recovered as material in addition to the high energy recovery rate. A total of 13.2 million tonnes of mineral waste was recovered as material in 2007.

In 2007 almost half, or 44 per cent, of all municipal waste was recovered as material (35.6 per cent) or energy (8.8 per cent). Sorting and separate collection of municipal waste has been improved. Separate collection of biodegradable waste fractions has increased, raising the amount collected by almost 70 per cent since 2002. According to the Finnish Forest Industries Federation, 66 per cent of paper waste (e.g. newspapers and printed paper) is recycled, which is among the highest rates in Europe.

Almost 60 per cent of all waste was disposed in landfills. The proportion of municipal waste sent to landfills has decreased year by year since 2002 as a result of increased waste recovery rate. In 2002, the proportion was 62 per cent, and in 2007 53 per cent, or 1.4 million tonnes.

The residual waste not recovered or landfilled is incinerated. However, only a very small proportion of all waste is incinerated because the focus of waste policy in the early 1990s was on waste prevention and recycling, including composting and anaerobic digestion. Since then the policy focus has shifted and incineration has gained more support. The incineration of municipal waste has been increasing recently, with 75,000 tonnes (2.8 per cent) being incinerated in 2007, up by 38 per cent from the 2006 figure.

Figure 2.23
Municipal solid waste in Finland 2002–2007



1) Including waste incineration without energy recovery.

2.11 Agriculture

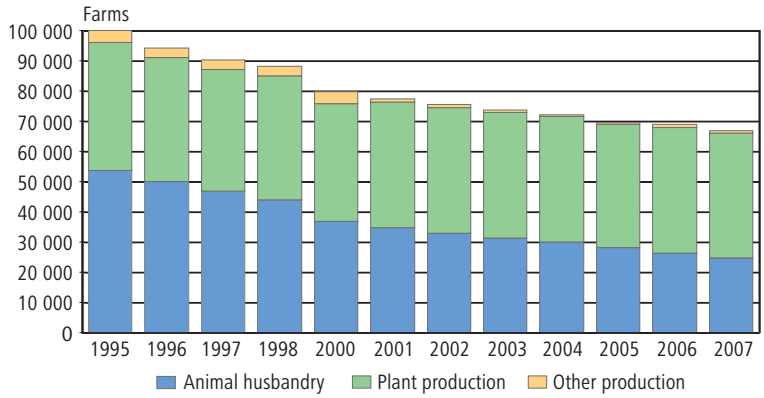
Farming in Finland is possible as a result of the warming effect of the Gulf Stream, which makes temperatures in Finland 3–4°C higher than would otherwise be expected at these latitudes. As Finland is nearly 1,100 kilometres long from north to south, there are considerable regional variations in the climate. The average total precipitation in the summer months is between 180 and 220 mm. The thermal growing season (the period with an average daily temperature of over +5°C) varies from nearly 6 months in the south to between 2 and 3 months in the north. The growing season in Finland is too short for the cultivars grown elsewhere and, therefore, frost-resistant varieties have been developed. Because of the short growing season, the yield levels of the field crop species are considerably lower in Finland than in central Europe. The harsh winters also reduce productivity as they restrict the cultivation of winter cereals.

Climatic conditions are a decisive factor for the feasibility of crop production. Cultivation of wheat and oilseed plants is restricted to southern Finland, whereas barley, oats, grass and potato can be cultivated in most parts of the country. In many parts of Finland, livestock farming, especially dairy farming, is the only profitable agricultural production form.

Finnish agriculture is based on family farms. In 2007 private persons owned 88.4 per cent of the farms, heirs and family companies 10.4 per cent, corporations, foundations and cooperatives 0.8 per cent and the state, municipalities and parishes 0.1 per cent.

In 1990–2007, the number of active farms fell from 130,000 to 67,000 (Figure 2.24). At the same time, the average farm size increased from 17 to 34 arable hectares. Total agricultural production has remained at almost the same level since 1990. The area cultivated as arable land has decreased about 10 per cent since 1990. Among the soils taken out of production are organic soils. In 2007 the cultivated arable land area was 22,553 km^2 or about 7.4 per cent of the total land area.

Figure 2.24
Number of farms by production sector, 1995–2007



Over 60 per cent of the active farms practice crop production as their main line. Most of these (68 per cent) produce cereals. A little under a third (32 per cent) cultivate other crops or practice horticulture. The share of grassland crops was 28 per cent, barley 24 per cent, oats 19 per cent and wheat 9 per cent. These shares have remained fairly stable since 1990. By comparison, the number of dairy cows decreased in this period from 490,000 to 296,000. Dairy production is the main production line at just over 20 per cent of the farms. About 6 per cent of farms specialise in beef production and 4 per cent in pig husbandry. The share of poultry farms, sheep and goat husbandry and reindeer herding is about 1 per cent each. About 6 per cent of all farms are organic.

In 2007 agriculture, forestry, hunting and fishing together accounted for 3.2 per cent of Finland's gross domestic product (GDP). The significance of the total food chain to the national economy is much greater than this percentage alone indicates. Transportation and processing increase considerably the role of food materials in the national economy. The food sector employs about 300,000 people (excluding the retail trade). By 2007 the agricultural labour force accounted for 5.8 per cent of the national labour force, compared with 7.8 per cent in 2000. This is still considerably higher than the percentage of the GDP accounted for by agriculture. Agriculture is the most important employer in the countryside and, alongside the forests, the dominating element of the rural landscape.

As a member of the EU, Finland follows the Common Agricultural Policy (CAP). The CAP is nationally implemented and aims to develop the agricultural production of the Union in a balanced way taking the environment and animal welfare into consideration. One important aim of the CAP is also to promote the vitality of rural areas.

2.12 Forestry

Land classified as forestry land in Finland consists of the subcategories forest land, poorly productive land and unproductive land. Forestry land covers 26 million hectares, or 78 per cent of total area of Finland (incl. inland waters). Of this, 20 million hectares is classified as forest land according to the na-

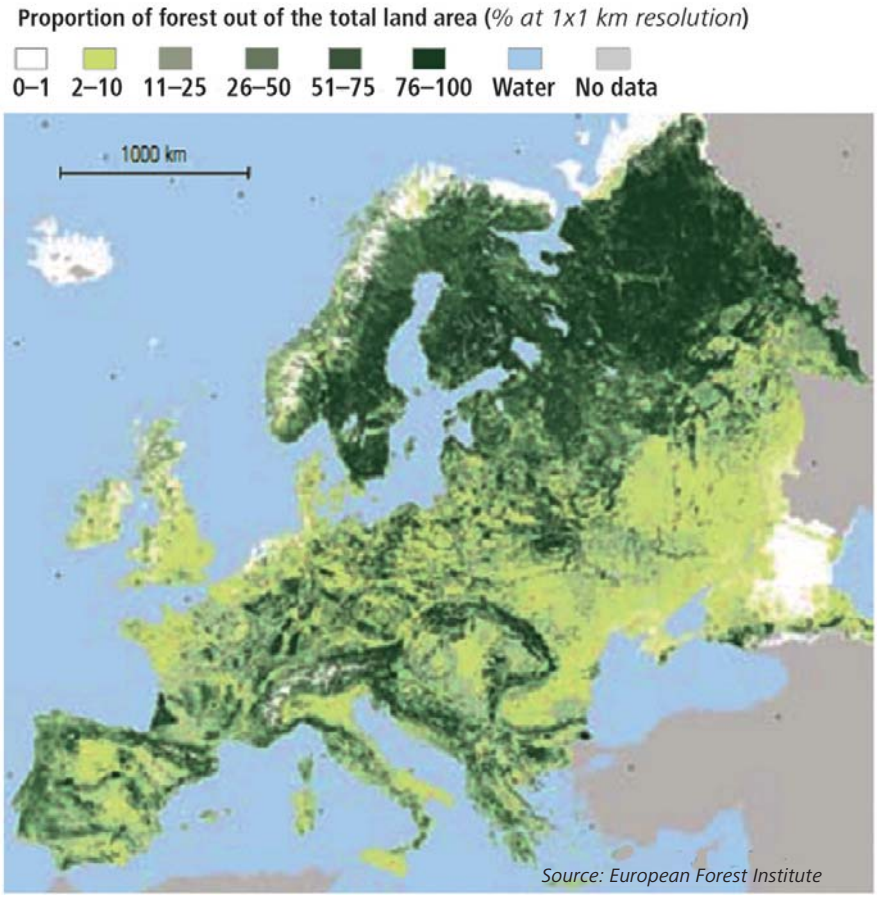
tional definition based on annual tree growth, or 22 million hectares according to the FAO definition, which is also used in the national greenhouse gas inventory. Within the EU, the impact of forests on the national economy and society at large has been at its greatest in Finland (Figure 2.25).

There are about twenty indigenous tree species growing in Finland. The most common ones are the Scots pine (*Pinus silvestris*), Norway spruce (*Picea abies*) and silver and pubescent birches (*Betula pendula* and *B. pubescens*). Usually, two or three tree species dominate a forest stand. More than half of the forest land area consists of mixed stands.

Finland's forest policy aims at sustainable forest management. The aim is to ensure the welfare founded on the use of forests and diversity of the forest nature. Policy measures include the Forest Act and other legislation, Finland's National Forest Programme 2015, financing and public forestry extension organisations (see Section 4.5 National forest legislation and programmes).

Finnish forests are managed in a sustainable manner. About one third of the forests are regenerated naturally and two thirds artificially. According to the Forest Act, a new seedling stand has to be established within three years after the end of felling. Natural regeneration is based on seeding from trees already growing on the site, usually by leaving a number of seeding trees standing at the time of felling. In artificial regeneration a new stand is established on a clear-felled area, either through seeding or planting. Every year, over 160 million seedlings are planted in the forests.

Figure 2.25
The forests of Europe



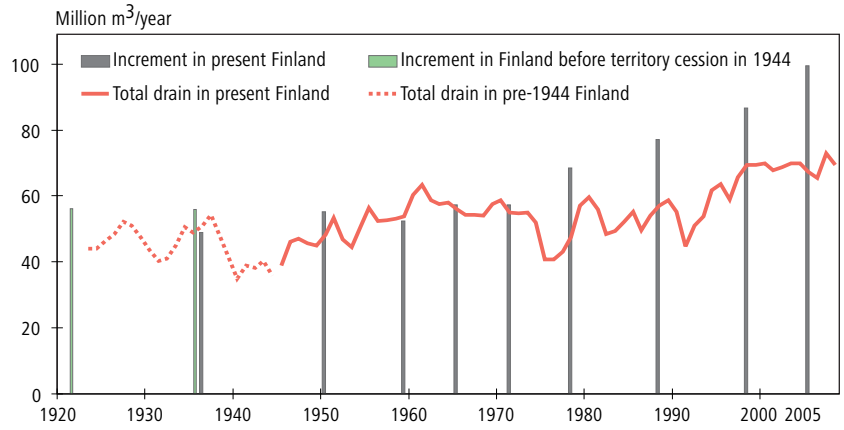
The total volume of Finland's forest stock amounts to 2,200 million m^3. The growing stock volume has been increasing for a long time, mainly because the growth of the forests in volume has exceeded the harvesting volumes and natural drain (Figure 2.26). In 2007 the total drain was 72.9 million m^3 and total increment of the growing stock 98.8 million m^3. The total drain includes cutting removals, harvesting losses and natural mortality. Of the total area undergoing felling annually, thinning accounts for roughly one half and other cutting, e.g. clear felling and seed and shelterwood felling, for the other half.

The growing stock has increased by 48 per cent since the 1960s. Pine has contributed most to the increase, due to the large number of young stands at the rapid growth stage. The draining of mires has also improved the growing conditions for trees in peatlands, which has added to the increase in the growing stock.

Over half of Finland's forests are owned by private individuals, 35 per cent by the state and about 13 per cent by private forest companies and other owners. The average size of a forest holding owned by private individuals is small, about 24 hectares. About one in every six Finns is a forest owner (920,000 owners and 440,000 holdings). The forest management associations provide the forest owners with advisory services on forest management and felling.

About EUR 200 million is invested every year in forest regeneration, young stand management and other silvicultural practices. About three quarters of this is financed by the private, non-industrial owners and the rest is covered by state subsidies. The raw material value of wood harvested annually was EUR 1,600–2,500 million in the period 2000–2007, of which approximately 85 per cent was paid to private forest owners as stumpage earnings. More than 95 per cent of Finland's forests are certified according to the national forest certification standard.

Figure 2.26
The total annual increment and drain of stemwood in Finland since the 1920s.



Source: National Forest Inventory/Finnish Forest Research Institute

In 2007 the total use of roundwood (raw, unmanufactured timber) in Finland was 81.4 million m³. Over 90 per cent (75.4 million m³) of this was used in the forest industry and 6.0 million m³ was used for energy production (Figure 2.27).

Forests (trees and soil) absorb a signicant proportion of the carbon dioxide (CO_2) emissions. The forest sink varied between 22.4 and 40.7 million tonnes CO_2 eq. during 1990–2007, which represents 20–40 per cent of Finland's total emissions. The proportion has varied considerably due to fluctuating trends in emissions and forestry activity.

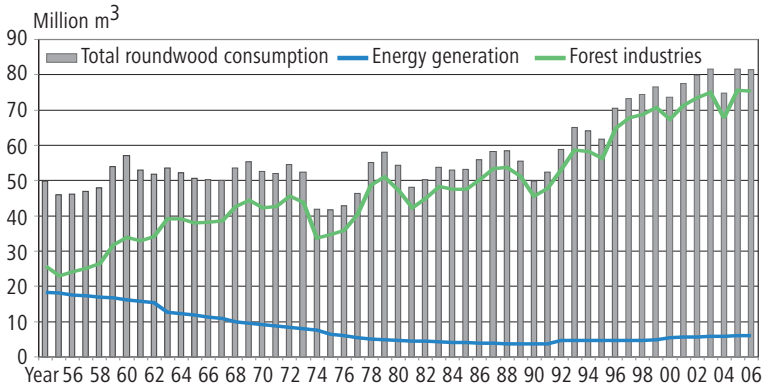
During the past few decades, forest protection and biodiversity in managed forests have received special attention. Numerous protection programmes and decisions have contributed to a three-fold increase in the area of protected forests over the last 30 years.

13 per cent of the forest area (forest and poorly productive land) or 2.9 million hectares, is protected or in restricted forestry use. Most of this, 2.5 million hectares, is in northern Finland, where the protected areas account for 22 per cent of the forest area. In the south the protected area is about 0.5 million hectares, which is 4 per cent of the forest area. Almost 70 per cent (2.0 million hectares) of the areas that are protected or in restricted forestry use are completely excluded from felling, i.e. under strict conservation. Their share of the total forest area is about 9 per cent. In addition, the Forest Act requires that certain parts of commercially used forests are left untouched or managed so that specific, biologically valuable habitats, such as surroundings of springs and certain types of mire habitats, maintain their characteristics.

The National Forest Programme 2015 and national policies on nature and biodiversity conservation are mutually supportive and coherent. The Forest Biodiversity Programme for southern Finland 2008–2016 (METSO) targets both private and state-owned lands. It combines the protection and commercial use of forests. Funding for the programme is EUR 180 million until 2012 (See also Section 4.5).

Chapter 4 describes Finland's National Forest Programme and forest protection in Finland.

Figure 2.27
Total roundwood consumption 1955–2007



2.13 Peatlands

Pristine peatlands are carbon accumulating ecosystems. The gas exchange and the resulting carbon balance are sensitive to varying weather conditions. According to measurements the annual carbon dioxide balance of a particular peatland can vary year to year from a net release to a net sink, depending on the weather conditions. Since the last ice age, Finnish peatlands are estimated to have accumulated some 5,400 million tonnes of carbon, forming the largest soil carbon stock in Finland. Of the original 10 million hectares of peatland, approximately 5.7 million hectares have been drained for forestry and about 0.7 million hectares for agriculture. Approximately 40 per cent of the original peatland still remains in a natural or semi-natural state.

The area of undrained peatlands is about 4 million hectares. All pristine peatlands are methane sources and the treeless "aapa" mires emit methane at especially high rates. Undrained peatlands sequester carbon dioxide (CO_2) in the long-term, even though they may sometimes be CO_2 sources, during exceptionally dry summers. Emissions of nitrous oxide (N_2O) from undrained peatlands are of minor importance.

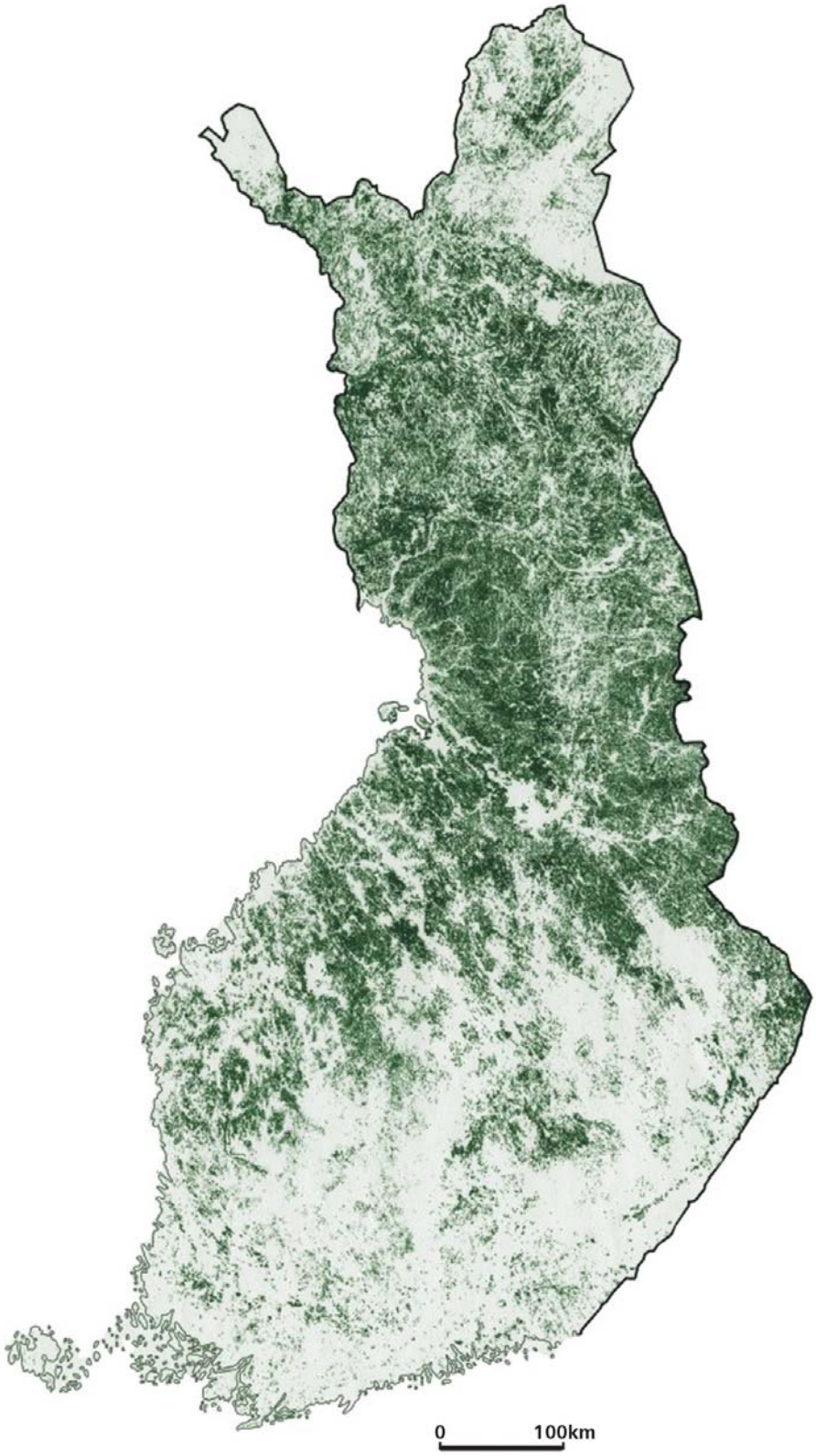
While undisturbed peatlands are net sinks, most of the peat soils drained for forestry are sources of CO_2. Nevertheless, drained peatlands that are subsequently forested become a sink because of the significant increase in sequestration into wood biomass, compensating for the soil CO_2 losses. However, the tree stand sink function saturates over time and continuous CO_2 losses from the soils transform these ecosystems into net sources of CO_2. Methane emissions may stop completely after drainage, while N_2O emissions may increase in some peatland types.

Most of the draining of peatlands for agriculture occurred soon after the Second World War, though some peatlands are still drained for cultivation today. Some of the drained peatland used for agriculture have since been abandoned. The area of drained peatlands in cultivation is estimated to be about 0.2–0.3 million hectares. Both abandoned and cultivated peatlands are considerable sources of N_2O and CO_2. These emissions may still be large 20–30 years after abandonment. A significant share of the emissions occurs in the winter.

Almost 13 per cent of Finland's mires, amounting to 1.13 million hectares, are protected. They consist mainly of areas under the national mire protection programme, in national parks and nature reserves and in old-growth forest conservation programme and wilderness areas.

Peat is a domestic fuel of national importance, and in view of its employment impact it also has a regional policy significance. The area used for the harvesting of energy and environmental peat is about 0.08 million hectares. In 2007 the emissions from peat extraction areas were a source of 1.4 Tg CO_2 eq. The emissions consist mostly of CO_2 emissions.

Figure 2.28
Distribution of peatlands (peatlands on green areas)



Source: National Land Survey of Finland

Literature

European Environment Agency (2009) Diverting waste from landfill. Effectiveness of waste-management policies in the European Union. EEA Report, No 7/2009, Copenhagen, Denmark

Finnish Environment Institute (2006) Tapio Lindholm and Raimo Heikkilä (eds.). Finland – Land of Mires. The Finnish Environment 23/2006, Vammala, Finland

Finnish Forest Research Institute (2008) Finnish Statistical Yearbook of Forestry 2008. Finnish Forest Research Institute Official Statistics of Finland, Agriculture, forestry and fishery, Vammala, Finland

Information Centre of the Ministry of Agriculture and Forestry (2008) Yearbook of Farm Statistics. Official Statistics of Finland, Agriculture, forestry and fishery, Helsinki, Finland

Intergovernmental Panel on Climate Change (2007) Fourth Assessment Report (AR4) Synthesis Report, Geneva, Zwitserland

Ministry of Agriculture and Forestry (2008) Greenhouse Impacts of the Use of Peat and Peatlands in Finland. Publication 11a/2007, Vammala, Finland

Ministry of the Environment (2008) Etelä-Suomen metsien monimuotoisuuden toimintaohjelma 2008–2016 METSO (The Forest Biodiversity Programme for Southern Finland (METSO) 2008–2016). Ympäristöministeriön raportteja 5/2008, Helsinki, Finland (In Finnish)

Statistics Finland (2008) Building, Free-time Residences, Dwellings and Housing Conditions. Official Statistics of Finland, Housing, Helsinki, Finland

Statistics Finland (2009) Greenhouse Gas Emissions in Finland 1990-2007, National Inventory Report under the UNFCCC and the Kyoto Protocol, Helsinki, Finland
http://tilastokeskus.fi/tup/khkinv/fi_nir_030409.pdf.

Statistics Finland (2009) National Accounts 1998–2007. Official Statistics of Finland, National Accounts, Helsinki, Finland

Statistics Finland (2008) Population Projection by municipality 2007–2040. Official Statistics of Finland, Population, Helsinki, Finland

Statistics Finland (2008) Population Structure and Vital Statistics by municipality Statistics Finland (2008). Official Statistics of Finland, Population, Helsinki, Finland

Statistics Finland (2008) Statistical Yearbook of Finland 2008. Official Statistics of Finland, Helsinki, Finland

Statistics Finland (2008) Transport and Communications Statistical Yearbook of Finland 2008. Official Statistics of Finland, Transport and Tourism, Helsinki, Finland

Internet links

ACCLIM Programme,
http://www.ilmatieteenlaitos.fi/research climate/climate 2.html

Finnish Statistical Yearbook of Forestry,
http://www.metla.fi/metinfo/tilasto/

National Land Survey of Finland,
http://www.maanmittauslaitos.fi/en/default.asp?id=225

Prime Minister' s Office,
http://www.vnk.fi/etusivu/en.jsp

Back to Contents

3 Greenhouse gas inventory information, including the national system and the national registry

This chapter describes Finnish greenhouse gas emissions and their development in 1990–2007 by sector. Thereafter there is an outline of how the national greenhouse gas inventory is compiled and how the high quality of the inventory is guaranteed. Finally, national registries and their functioning are explained.

Back to Contents

Photos

Marita Björkström/YHA kuvapankki, page 82
futureimagebank.com, pages 73, 75, 80
Pentti Hokkanen/YHA kuvapankki, page 81
Esko Kuusisto, page 65
Esa Nikunen/YHA kuvapankki, page 79

3 Greenhouse gas inventory information, including the national system and the national registry

3.1 Greenhouse gas emissions

Finland's greenhouse gas emissions in 2007 totalled 78.3 million tonnes CO_2 equivalent (CO_2 eq., Table 3.1). The emissions were some 10 per cent (7.3 million tonnes) higher than in 1990 (71.0 million tonnes CO_2 eq.), which is the level to which Finland should reduce its emissions during 2008–2012, the first commitment period under the Kyoto Protocol. The emissions in 2007 were 2 per cent lower than those in 2006. The emission trends by sector are given in Figure 3.1 and described in detail in Section 3.2.

The energy sector is by far the largest producer of greenhouse gas emissions. The energy sector includes emissions from all use of fuels to generate energy including fuel use in transport, and the fugitive emissions related to the production, distribution and consumption of fuels. In 2007 the energy sector accounted for 81 per cent of Finland's total greenhouse gas emissions (Figure 3.2). The second-largest source of emissions was industrial processes, with an emission share of some 9 per cent. Emissions from industrial processes refer to emissions that result from the use of raw materials during industrial processes. The emissions of the agricultural sector amounted to some 7 per cent and the waste management sector to 3 per cent of the total emissions.

The most significant greenhouse gas of Finland's inventory is carbon dioxide (CO_2). Its share of the total emissions ranged between 80 and 85 per cent in 1990–2007. CO_2 emissions have increased by some 17 per cent compared with the year 1990. Nitrous oxide (N_2O) accounted for over 8 per cent of the total emissions in 2007, down by some 13 per cent from

Figure 3.1
Finland's greenhouse gas emissions, 1990–2007, excluding the LULUCF sector

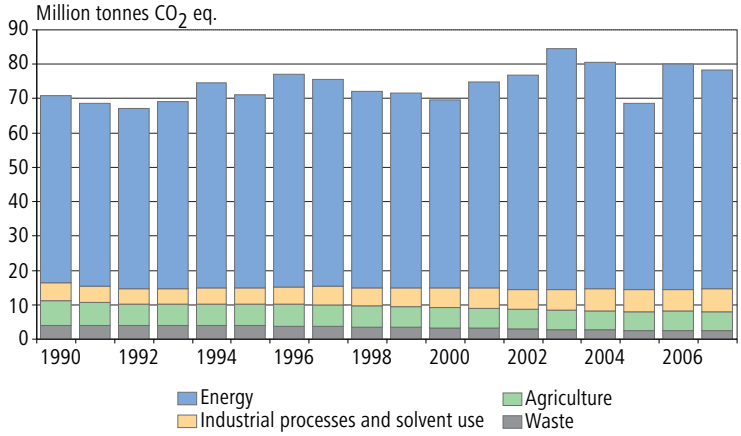
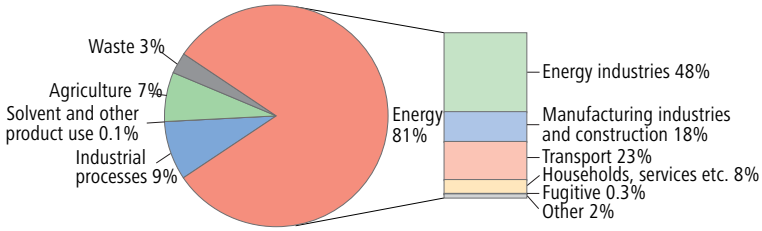


Figure 3.2
Greenhouse gas emissions by source, 2007, excluding the LULUCF sector (total emissions 78.3 million tonnes CO_2 eq.)



1990. Methane (CH_4) emissions made up close to 6 per cent of the total emissions, having decreased by almost 30 per cent from the 1990 level. F-gases (HFCs, PFCs and SF6) accounted for roughly 1 per cent of all greenhouse gas emissions, but their share has been growing continuously. F-gas emission volumes are nearly tenfold higher than in 1990.

In Finland the land use, land-use change and forestry sector (the LULUCF sector) is a net sink, that is, the volume of greenhouse gas emissions it removes from the atmosphere is higher than that it emits. This sector is not included in the total national emissions but is reported separately (Table 3.1, Figure 3.3). In 2007 the net sinks amounted to 25.3 million tonnes CO_2 eq.

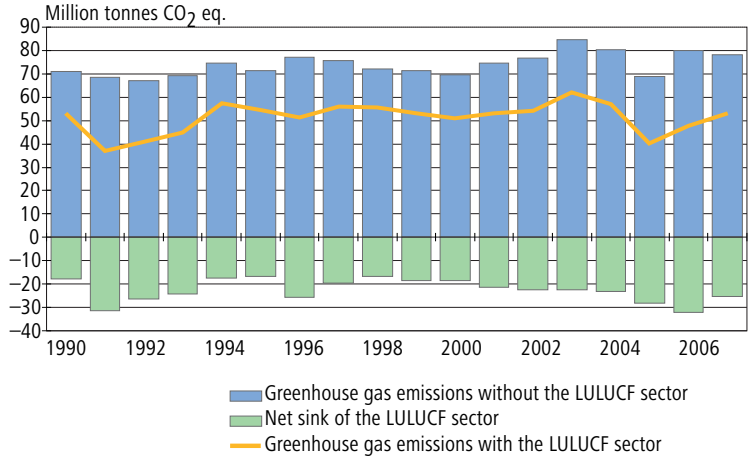
The energy sector produced 93 per cent of all carbon dioxide emissions in 2007. The majority of the CO_2 emissions were from energy production based on the combustion of fossil fuels and peat. Peat is not a fossil fuel as such, but lifecycle studies indicate that the climate effects of peat combustion are comparable with those of fossil fuels. The CO_2 emissions from wood combustion are not included in the CO_2 emissions resulting from combustion but are reported separately. Carbon dioxide emissions as a result of combustion in energy production totalled some 62 million tonnes in 2007. The production and use of energy also generate some methane and

Table 3.1
Greenhouse gas emissions (+) and removals (–) by sector, 1990, 1995 and 1997–2007 (million tonnes CO_2 eq.)

Sector	1990	1995	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Energy	54.6	56.3	60.3	57.2	56.6	54.6	59.9	62.5	70.0	65.9	54.3	65.6	63.6
Industrial processes[1]	4.9	4.5	5.0	4.9	4.9	4.9	4.9	4.9	5.2	5.4	5.3	5.3	5.7
F-gases[2]	0.1	0.1	0.2	0.3	0.4	0.6	0.7	0.5	0.7	0.7	0.9	0.8	0.9
Use of solvents and other products	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Agriculture	7.1	6.3	6.2	6.1	5.9	6.0	5.9	5.8	5.7	5.6	5.6	5.6	5.5
Waste	4.0	3.9	3.8	3.6	3.5	3.3	3.2	3.0	2.8	2.7	2.5	2.5	2.4
Total	**70.9**	**71.2**	**75.7**	**72.1**	**71.5**	**69.5**	**74.7**	**76.8**	**84.5**	**80.5**	**68.7**	**79.9**	**78.3**
Land use, land-use change and forestry[3]	–17.8	–16.6	–19.7	–16.6	–18.5	–18.4	–21.5	–22.5	–22.5	–23.3	–28.3	–32.2	–25.3

1 Excluding F-gases
2 F-gases refer to fluorinated greenhouse gases (HFC compounds, PFC compounds and SF6)
3 A negative figure denotes a net sink, which means that in this sector more greenhouse gases are absorbed from the atmosphere than are released into it.

Figure 3.3
Finland's greenhouse gas emissions, 1990–2007, excluding the LULUCF sector (blue bars) and including the LULUCF sector (orange line). The green bar shows the net removals in the LULUCF sector.



nitrous oxide emissions. The majority of the methane emissions originated from waste management and agriculture. The majority of the nitrous oxide emissions originated from agriculture. F-gases originate exclusively from industrial processes.

3.1.1 Emission trends 1990–2007

Finland's annual greenhouse gas emissions have varied considerably due to changes in electricity imports and production of fossil fuel based condensing power. In addition, the emissions are influenced each year by the economic situation in the country's energy intensive industries, the weather conditions and the volumes of energy produced with renewable energy sources (see trends by sector in Figure 3.4).

The trend in CO_2 emissions relative to Finland's gross domestic product (GDP) has been downward (Figure 3.5), although the annual variations have been large. In the early years of the 1990s the CO_2/GDP ratio rose almost 20 per cent above the 1990 base year level. This was largely due to

Figure 3.4
Greenhouse gas emissions by sector, 1990–2007, excluding the LULUCF sector

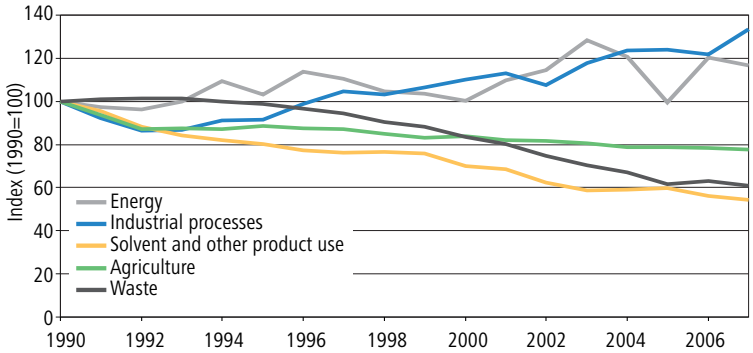
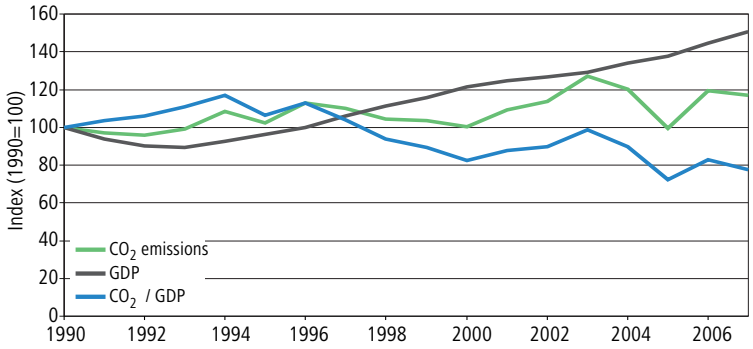


Figure 3.5
CO_2 emissions relative to GDP, 1990–2007, excluding the LULUCF sector



the economic recession, which led to a steeper fall in the GDP than in emissions. In 2007 the CO_2/GDP ratio was more than 20 per cent below the 1990 level, indicating that the greenhouse gas intensity of the economy has decreased.

More detailed information on emission trends by sector and gas can be found in the CRF Reporter Summary tables on emission trends included in Annex 1 of this communication.

3.2 Greenhouse gas emissions by sector

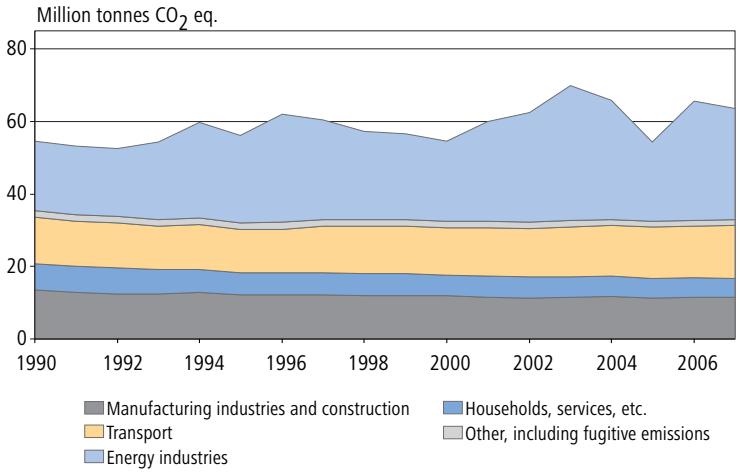
3.2.1 Energy

Similarly to other industrialised countries, Finland's biggest source of greenhouse gas emissions is the energy sector. The cold climate, long distances and energy-intensive industries are apparent in the high emissions volumes of the energy sector. In 2007 its share of the total greenhouse gas emissions was 81 per cent (63 million tonnes CO_2 eq.). Energy sector emissions can be divided into emissions resulting from fossil fuel combustion and fugitive emissions from fuels. The majority of the sector's emissions result from fuel combustion. Fugitive emissions make up only 0.3 per cent of the total emissions of the sector.

The energy sector emissions show strong annual variation in accordance with the amount of energy used and the proportion of imported electricity. This variation has been the principal feature of the overall trend in emissions over the period since 1990. The emissions of the energy sector are strongly affected by the availability of hydro power in the Nordic electricity market. If the annual precipitation in the Nordic countries is lower than usual, hydro power becomes scarce and Finland's net imports of electricity decrease. During such years Finland has generated additional electricity using coal and peat in condensing power production for its own needs and also to be sold on the Nordic electricity market. This can be seen directly in the emissions of the energy sector (Figure 3.6).

In 2007 the energy sector emissions were three per cent lower than in 2006, but were up by 17 per cent on the 1990 level. CO_2 emissions in the energy sector decreased slightly more than the total use of energy. The to-

Figure 3.6
Greenhouse gas emissions in the energy sector, 1990–2007

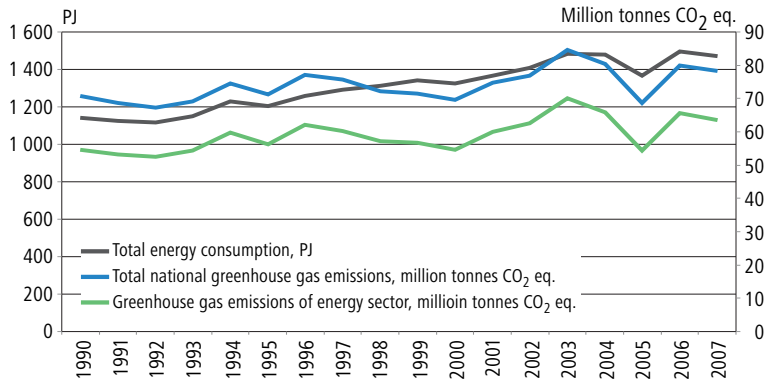


tal use of primary energy in 2007 was 1.47 million terajoules (TJ), which is nearly 2 per cent down from 2006. This reduction was due to a drop in Finland's condensing power generation as a result of the increase in domestically produced hydro power and electricity imports as well as warmer weather, which reduced the need for heating (Figure 3.7).

Of all fuels, the biggest decrease (12 per cent) was recorded in the consumption of coal (hard coal, coke and blast furnace gas). Among fossil fuels, the consumption of natural gas and oil decreased as well. By contrast, the consumption of peat increased by 9 per cent and reached its highest ever annual level.

Production of hydro power was up by nearly a quarter from the year before, as ample precipitation made it readily available. With a similar situation prevailing in Norway and Sweden, imports of electricity from these countries were up as well. In addition, the new power transmission line opened between Estonia and Finland at the end of 2006 facilitated imports of electricity from Estonia. Net imports of electricity increased by 10 per cent compared with 2006. A proportion of Finland's condensing power

Figure 3.7
Total energy use (PJ), total national greenhouse gas emissions and energy sector greenhouse gas emissions (million tonnes CO_2 eq.) 1990–2007



production was replaced with electricity imports and domestic hydro power, thus reducing the consumption of coal and other fuels in power production (Figure 3.8).

Renewable energy accounted for about 25 per cent of the total energy use in 2007. Among renewable energy sources, the consumption of wood fuels decreased by some 4 per cent compared to the previous year, but the consumption of hydro and wind power increased significantly (Figure 3.9).

Energy production, i.e. the production of electricity and district heat by main-activity producers, generates roughly half of the energy sector emissions and some 40 per cent of all greenhouse gas emissions. In 2007 the emissions from combustion of fossil fuels and peat in electricity and district heat production amounted to 30.8 million tonnes CO_2 eq. Other significant emission sources in the energy sector are transport fuels and energy production by industry primarily for its own needs.

Figure 3.8
Total energy use by energy source (PJ) and energy sector CO_2 emissions (million tonnes CO_2 eq.) 1990–2007

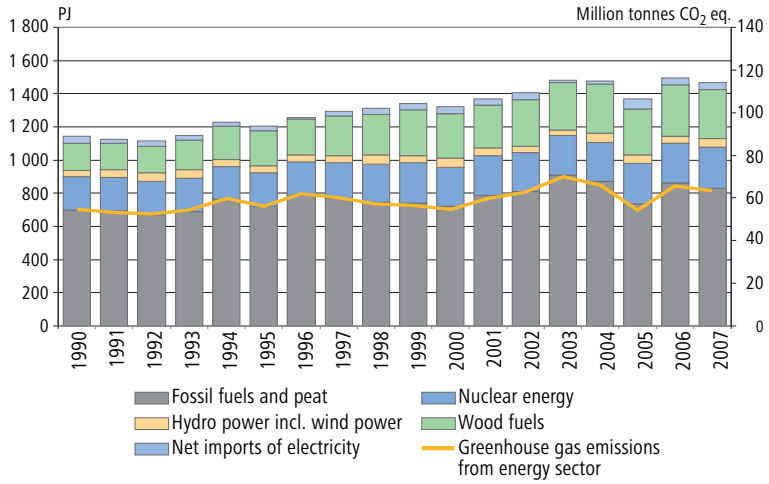
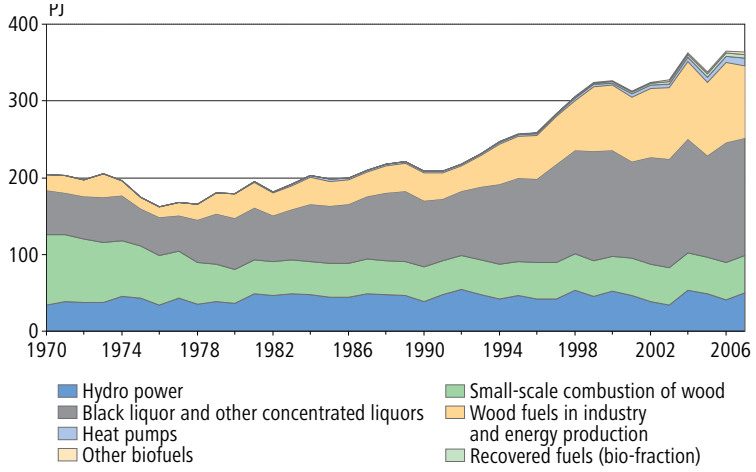


Figure 3.9
Use of renewable energy sources, 1970–2007



The forest industry is an example of the industries that produce a significant share of the energy they require. Greenhouse gas emissions from this type of energy production accounted for roughly 18 per cent (11.4 million tonnes CO_2 eq.) of energy sector emissions and some 15 per cent of all greenhouse gas emissions in 2007. Emissions from the fuels used by different industries have fallen by 15 per cent compared with the 1990 emissions. This is a result of the increased use of biofuels by the forest industry, in particular.

Emissions attributable to energy use by households and the service sector accounted to approximately 7 per cent of Finland's total emissions. These emissions are down significantly from 1990. The service sector's emissions have decreased by as much as 44 per cent and those of households by 28 per cent. This is a result of the changeover from oil heating to district or electric heating (in which case the emissions are allocated to energy production plants).

3.2.2 Transport

Greenhouse gas emissions generated by transport amounted to 14.7 million tonnes CO_2 eq. in 2007. Transport emissions made up 19 per cent of all greenhouse gas emissions and 22 per cent of the emissions of the energy sector. Road transport accounted for 88 per cent of the total domestic transport emissions. Cars make up the biggest share of road transport (Figure 3.10).

During the period 1990–2007, transport emissions increased by 15 per cent due to the growth in traffic volume (Figure 3.11). This increase was slower than in many other industrialised countries. The recession in the early 1990s also resulted in lower CO_2 emissions from transport and kept the growth in transport emissions in check during the 1990s as a whole.

However, Finland's per capita CO_2 emissions from transport are the second highest among the EU/EEA countries, after Norway, owing primarily to long distances, transport-intensive industries and travel to and from free-time residences.

Car use has been growing steadily as a proportion of all passenger traffic and already accounts for some 80 per cent of the total. The energy effi-

Figure 3.10
Road transport greenhouse gas emissions by vehicle type, 1990–2007

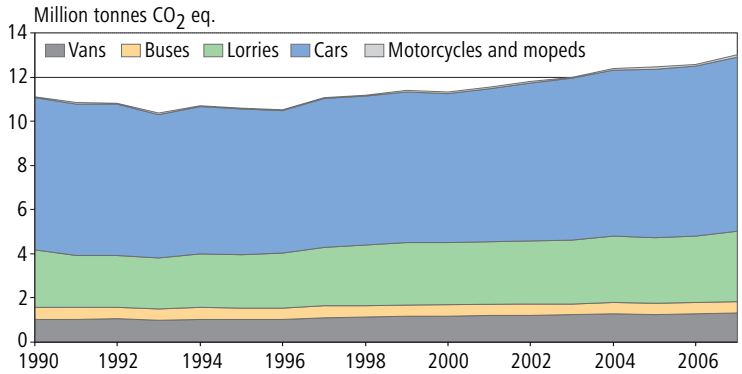
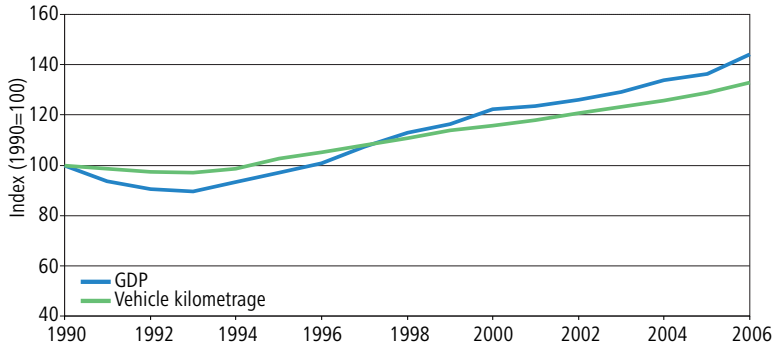


Figure 3.11
Traffic volume (vehicle-kilometres, all vehicles) and GDP, 1990–2006



ciency of new registered cars began to improve in the 1990s, and over the period 1990–2006 vehicle-specific CO_2 emissions of new registered passenger cars fell by 7.7 per cent. The downward trend levelled off after the year 2000 and may even have weakened slightly (Figure 3.12).

In recent years consumers have been increasingly opting for large diesel cars. As a result, the energy efficiency of the entire new vehicle stock has not improved (Figure 3.13). A vehicle tax amendment which entered into force in the beginning of 2008 is expected to guide consumers towards

Figure 3.12
Relative development of CO_2 emissions from cars (CO_2/km=carbon dioxide emissions per vehicle-kilometre), 1990–2007

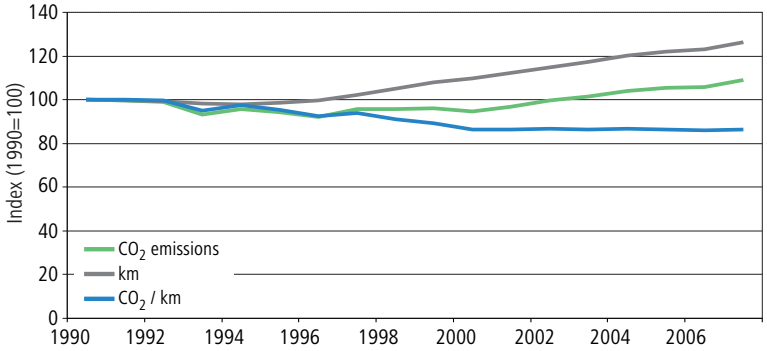
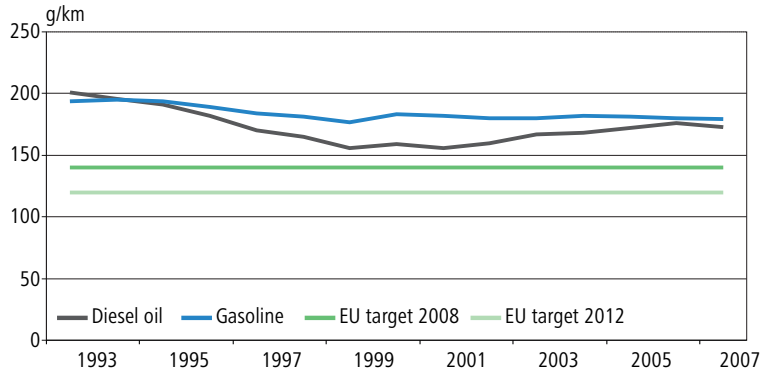


Figure 3.13
CO_2 emissions (g/km) of new registered cars (petrol and diesel)



choosing more energy-efficient vehicles. The market share of public transport in proportion to the total volume of passenger transport has decreased steadily since 1990, being 15 per cent in 2007.

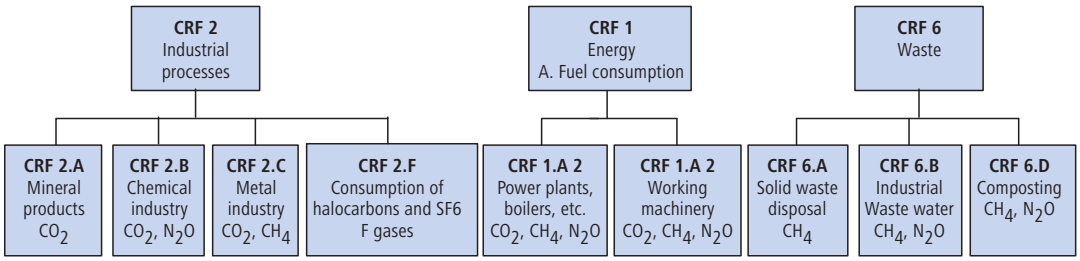
3.2.3 Industrial processes

Greenhouse gas emissions generated in industrial processes amounted to roughly 6.7 million tonnes CO_2 eq. in 2007. They made up roughly 9 per cent of Finland's total emissions. The most significant emission sources were the CO_2 emissions generated in iron and steel production (3 per cent of Finland's total emissions in 2007), the nitrous oxide (N_2O) emissions generated in the production of nitric acid (2 per cent) and the CO_2 emissions generated in the production of cement (1 per cent). CO_2 emissions were also generated in the production of lime and hydrogen as well as in the use of limestone and soda. In 2007 the CO_2 emissions accounted for 63 per cent of the emissions from industrial processes, the N_2O emissions from nitric acid production accounted for 22 per cent, and the methane (CH_4) emissions generated during the manufacturing process of coke, less than 0.5 per cent.

Fluorinated greenhouse gases, or F-gases, form a category of their own under industrial processes. They are used e.g. in refrigeration, air conditioning devices and as aerosols, and accounted for over 1 per cent of total national greenhouse gas emissions and 14 per cent of the greenhouse gas emissions of industrial processes in 2007.

Emissions from the production of electricity consumed by Finnish industry and from the electricity and heat produced by industries themselves, as well as from the use of off-road machinery and industrial transport are reported under the energy sector. Emissions related to industrial waste management are reported under the waste sector (Figure 3.14).

Figure 3.14
Reporting of industrial greenhouse gas emissions in different sectors (CRF = Common Reporting Format [1])



1 The Common Reporting Format is a standardised format for reporting estimates of greenhouse gas emissions and removals. Sources and sinks of greenhouse gases are categorised according to the format. The source/sink categories are grouped into the sectors: energy (CRF 1), industrial processes (CRF 2), solvent and product use (CRF 3), agriculture (CRF 4), land use, land use change and forestry (LULUCF, CRF 5), and waste (CRF 6).

The emissions of industrial processes are mostly affected by changes in production output, as they depend on the use of raw materials and production volumes (Figure 3.15). Emissions caused by industrial processes did not vary much during the 1990s. In the period from 1990 to 2005, the biggest change occurred in F-gas emissions, which increased ninefold. 1995 is the Kyoto Protocol base year for these gases (Figure 3.16). F-gases have been used to replace ozone depleting compounds in many refrigeration and cooling devices and applications, which is the main reason for the increase in F-gases.

Total CO_2 emissions from industrial processes decreased markedly in the early 1990s when a number of factories shut down their operations due to the recession, but emissions have been increasing since 1996. In 2007 they were 31 per cent above the 1990 level. N_2O emissions have been fairly steady, and have declined in recent years; in 2007 they were 11 per cent lower than in 1990. Methane emissions have grown continuously. In 2007 they were 78 per cent above the 1990 level, but their share of the sector's total emissions is still less than one per cent.

Figure 3.15
Greenhouse gas emissions from industrial processes, 1990–2007

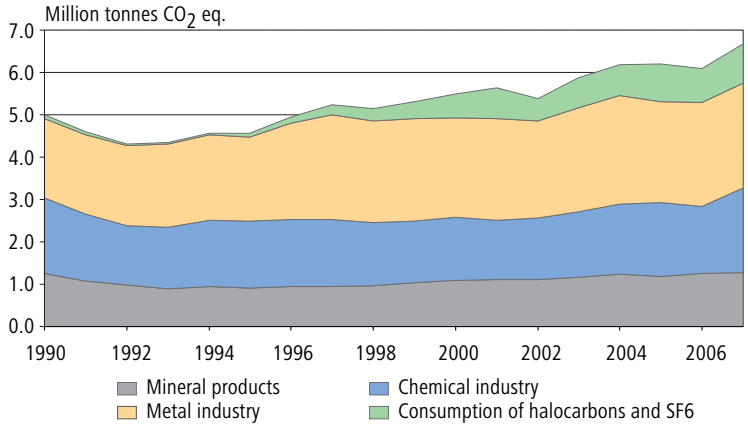
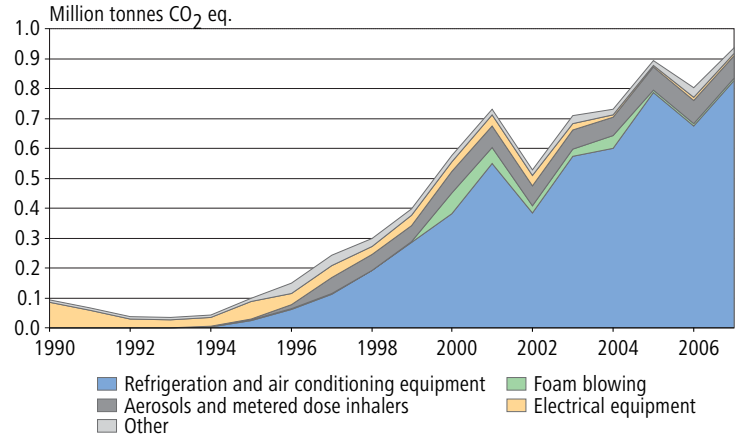


Figure 3.16
F-gas emissions, 1990–2007



3.2.4 Use of solvents and other products

This sector accounts for only a small proportion of the total emissions, amounting to only 0.1 per cent in 2007. These emissions are from the use of N_2O in industrial and medical applications and from indirect CO_2 emissions, which result from NMVOC (non-methane volatile organic compounds) emissions. NMVOC emissions are generated in the production and use of paints, in pharmaceutical, plastic, leather and textile manufacturing, in printing, timber preservation, use of pesticides, manufacturing of fibreglass, household solvent use and the extraction of fats and oils.

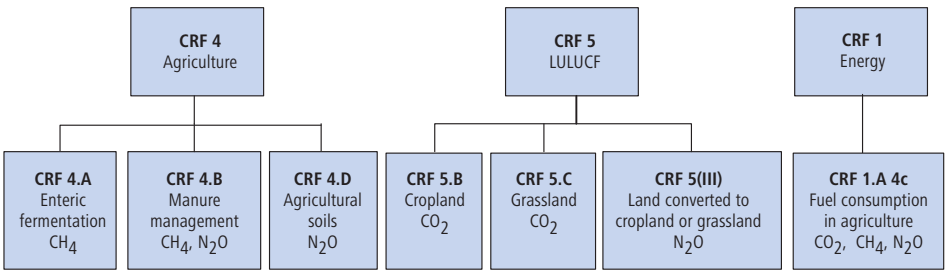
Total N_2O emissions in this sector have not varied much during 1990–2007. Indirect CO_2 emissions have decreased, as NMVOC emissions are decreasing.

3.2.5 Agriculture

Emissions from the agriculture sector were some 5.5 million tonnes CO_2 eq. in 2007. Agricultural emissions include methane (CH_4) emissions from enteric fermentation of domestic livestock, manure management and crop residue burning, as well as nitrous oxide (N_2O) emissions from manure management, cultivation of organic soils and crop residue burning. The agricultural sector accounted for approximately 7 per cent of Finland's total greenhouse gas emissions in 2007. Of the total agricultural emissions, methane emissions from enteric fermentation accounted for 28 per cent and from manure management 5 per cent, while nitrous oxide emissions from manure management accounted for 9 per cent and from soils 58 per cent.

In accordance with the UNFCCC, some of the greenhouse gas emissions from agriculture are reported under sectors other than agriculture (Figure 3.17). CO_2 emissions released from agricultural soils are reported in the land use, land-use change and forestry sector (LULUCF), while emissions from agricultural machinery and other energy use related to agriculture are reported in the energy sector. Greenhouse gas emissions from energy use in agriculture were 1.3 million tonnes CO_2 eq. and agricultural emissions reported in the LULUCF sector 7.4 million tonnes CO_2 eq. in 2007. The total of all these emissions from agriculture (i.e. including the energy and LULUCF sectors) was approximately 14.2 million tonnes CO_2 eq. in 2007 (18 per cent of Finland's total emissions).

Figure 3.17
Reporting of emissions generated by agriculture, in accordance with UNFCCC categories



Most of the CH_4 emissions from enteric fermentation are generated by cattle, but emissions generated by horses, pigs, sheep, goats, fur animals and reindeer are reported as well.

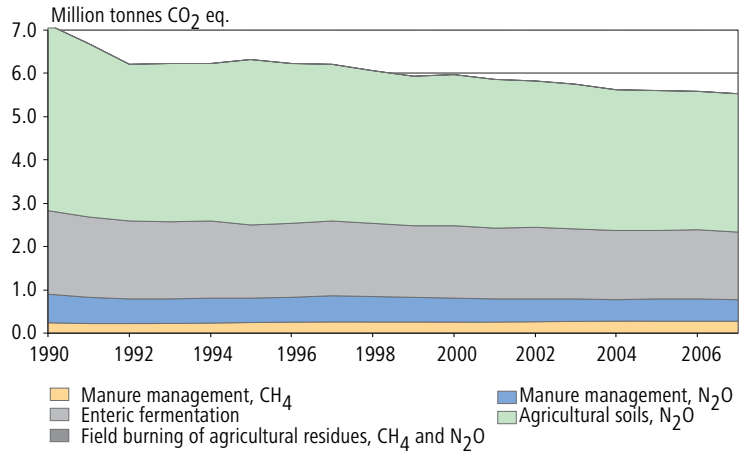
Most of the N_2O emissions from the agricultural sector are direct and indirect N_2O emissions from agricultural soils.

Emissions in the agriculture sector decreased by 22 per cent during 1990–2007. This was mainly due to structural changes in agriculture, which have resulted in an increase in farm size and a decrease in the numbers of domestic livestock. For example, the number of cattle was more than 30 per cent less in 2007 than in 1990. The decrease in number of livestock is visible in the lower CH_4 emissions from enteric fermentation and N_2O emissions from manure management (Figure 3.18). The emissions have not decreased in proportion to the drop in the number of livestock, however, because milk and meat output and emissions per animal have increased.

Although livestock numbers have decreased, methane emissions from manure management have increased slightly. This is due to the proliferation of manure management as slurry. CH_4 emissions from slurry are tenfold when compared with farm yard manure. However, the situation is the opposite for the N_2O emissions from manure management, that is, the emissions are significantly lower when manure is stored as slurry. As a result, the proliferation of the slurry systems has decreased emissions from manure management.

The decrease in emissions from the agriculture sector as a whole is also attributable to a significant degree to the drop in N_2O emissions from agricultural soils by a quarter compared with the 1990 level. The decrease in soil N_2O emissions has been caused by e.g. reduced use of nitrogen fertilizers and a decrease in the area of organic soils.

Figure 3.18
Greenhouse gas emissions from agriculture, 1990–2007



3.2.6 *Land use, land-use change and forestry*

Finland reports both greenhouse gas emissions and removals in the land use, land-use change and forestry (LULUCF) sector. Removals refer to the absorption of CO2 from the atmosphere by carbon sinks, such as plant biomass or soil.

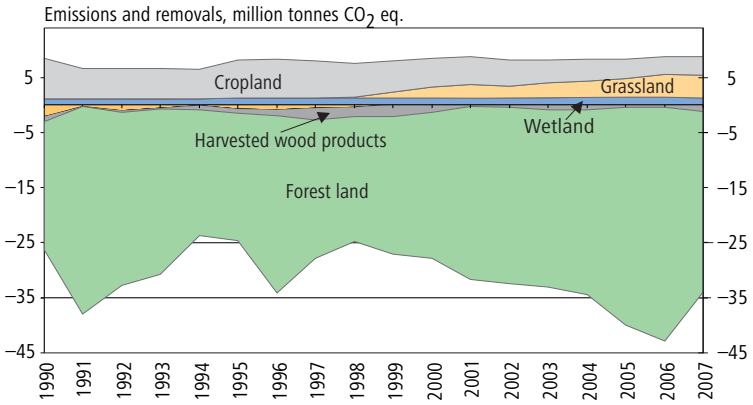
Changes in carbon stocks in six land use categories covering the whole of Finland are reported in this sector. In accordance with the IPCC guidelines, each land-use category reports the change in different carbon pools, which include the above- and below-ground biomass, dead wood, litter and soil. In addition, emissions originating from many other sources are reported in this sector, such as CO_2 emissions from liming as well as emissions from the burning of biomass (forest fires) and nitrogen fertilization of forest land. Emissions and removals are not reported for unmanaged wetlands.

Finland's largest carbon sinks are the forests. The most significant sink on forest land is the living biomass (–33 million tonnes CO_2 in 2007), and other contributors are the dead organic matter pool (–3.3 million tonnes CO_2) and mineral forest soils (–3.6 million tonnes CO_2). By contrast, organic forest soils are a fairly large source of emissions (6.7 million tonnes CO_2 in 2007). Other emission sources in the forest land category are nitrogen fertilisation (0.017 million tonnes CO_2 eq.) and biomass burning (0.006 million tonnes CO_2 eq.). Forest growth has increased steadily since 1990 owing to factors such as the large proportion of young forest at a strong growth phase, silvicultural measures and previous drainage. Felling volumes have varied according to the market situation and demand. In 2007 loggings were exceptionally large at 58 million m^3. In Finland, all forests are classified as managed forests. Consequently nature reserves are also included in the reporting.

Even though the LULUCF sector has clearly been a net carbon sink, the sector does also produce significant emissions. The largest emissions come from the soils of drained peatlands in forests and agricultural areas. Significant emissions have also been reported in grasslands. In addition, minor emissions are generated in peat production areas, from forest fires, from nitrogen fertilization of forests and from the liming of croplands.

The trend in emissions and removals from the different land-use categories reported in the LULUCF sector is presented in Figure 3.19.

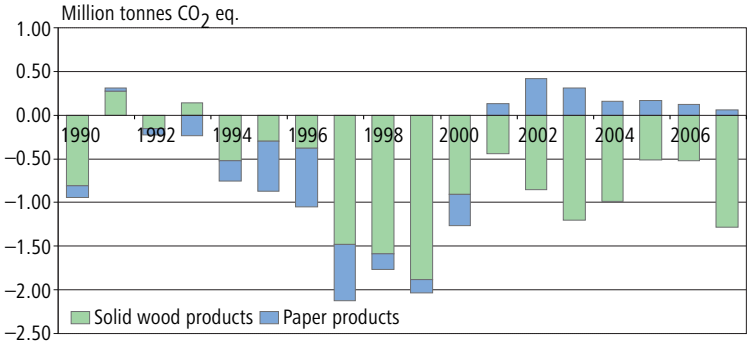
Figure 3.19
Greenhouse gas emissions (positive values) and removals (negative values) in the LULUCF sector, 1990–2007



Harvested wood products

Finland reported harvested wood products in its greenhouse gas inventory for the first time in the inventory submission 2008. Harvested wood products are divided in solid wood products (sawnwood, wood-based panels and round timber in long-term use, e.g. poles) and paper products (paper and paperboard). Changes in roundwood stocks or harvested wood products at landfill sites are not included in the calculation. The calculation does not include furniture or wooden packaging either, but fittings are included. Harvested wood products as a whole have served as a carbon sink, apart from 1991 when they were a minor carbon source (Figure 3.20).

Figure 3.20
CO_2 balance of harvested wood products (emissions positive and removals negatives), 1990–2007



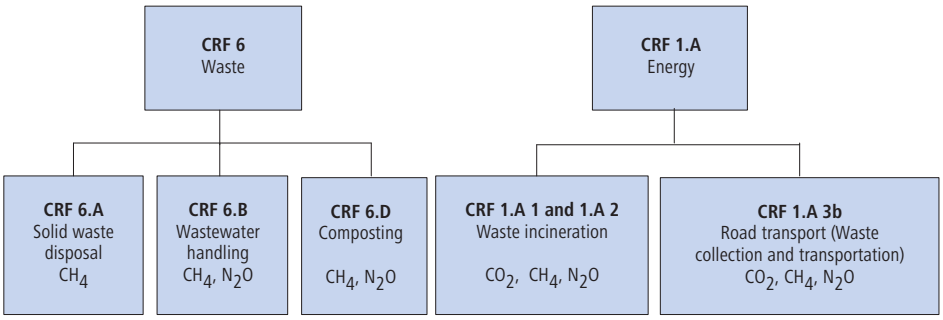
3.2.7 Reporting under Article 3, paragraphs 3 and 4, of the Kyoto Protocol

Emissions and removals in the LULUCF sector are included in their totality in the reporting under the UNFCCC. Only a subset of these emissions and removals is included in the reporting and accounting under the Kyoto Protocol. Removals and emissions resulting from forestry activities (afforestation, reforestation, deforestation) are addressed in Article 3.3 of the Kyoto Protocol. Reporting under this article is mandatory during the first Kyoto Protocol commitment period, 2008–2010. Article 3.4 includes the following activities: forest management, cropland management, grazing land management and revegetation. Reporting under this article is voluntary during the first commitment period. Parties may elect any of the Article 3.4 activities, but after this the reporting becomes mandatory. Finland has elected forest management under Article 3.4 and will start reporting in 2010.

3.2.8 Waste

Methane (CH_4) emissions from landfills and CH_4 and N_2O emissions from composting and waste water treatment are reported under the waste sector (Figure 3.21). Greenhouse gas emissions from the combustion of waste are

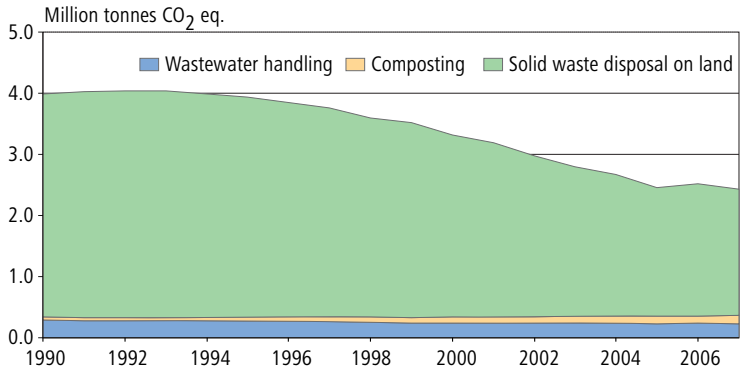
Figure 3.21
Reporting of waste sector emissions in the greenhouse gas inventory



reported fully in the energy sector, as the energy content of waste is mostly utilised through combustion. Waste sector emissions amounted to 2.4 million tonnes CO_2 eq. in 2007, which is some 3 per cent of Finland's total emissions. Landfill emissions accounted for some 85 per cent of all waste sector emissions. Landfill emissions cover the emissions from municipal waste, industrial waste and construction and demolition, as well emissions from municipal and industrial sludge. Emissions from waste water treatment made up some 10 per cent and composting some 6 per cent of waste sector emissions in 2007.

Waste sector emissions have decreased more than 40 per cent compared with 1990 (Figure 3.22). A new Waste Act entered into force in 1994, which has led to a reduction in methane emissions from landfill sites. The Waste Act has cut back the volume of waste deposited at landfills by promoting recycling and reuse, as well as energy use of waste materials. The recovery of landfill gases has also increased significantly since 1990. Currently nearly one third of the methane generated at landfills is recovered. The economic recession of the early 1990s also reduced consumption and waste volumes during that period.

Figure 3.22
Waste sector greenhouse gas emissions, 1990–2007



The implementation of the EU Landfill Directive is expected to reduce landfill CH_4 emissions even further. According to the directive the deposition of biodegradable waste at landfills must be restricted significantly. It requires that in 2006 a maximum of 75 per cent, in 2009 50 per cent and in 2016 35 per cent of the biodegradable municipal waste is deposited at landfills (calculated on the basis of the volume of biodegradable municipal waste generated in 1994). In addition, the directive includes tighter regulations on the pre-treatment of waste to be deposited at landfills and the recovery of landfill gas. Emissions from wastewater treatment have also been successfully reduced by some 20 per cent compared with the situation in 1990. The reduction in emissions has been affected by e.g. increasingly efficient treatment of wastewater (also in sparsely populated areas) as well as a lower nitrogen burden released from industrial wastewaters into bodies of water. Emissions from composting doubled in the period 1990–2007. The reason for this is the increased composting especially in semi-urban areas, due to separate collection of organic waste.

3.3 Greenhouse gas inventory system, under Article 5, paragraph 1, of the Kyoto Protocol

3.3.1 Institutional arrangements

Statistics Finland is the national entity with the overall responsibility for compiling and finalising inventory reports and submitting them to the UNFCCC Secretariat and the European Commission. Statistics Finland approves the inventory submissions to the European Community, the UNFCCC and the Kyoto Protocol independently.

The contact person at Statistics Finland is:
Dr Riitta Pipatti, Head of Greenhouse Gas Inventory Unit,
POB 6 A, FIN-00022 Statistics Finland
Tel: + 358-9-1734 3543
Fax: + 358-9-1734 3429
Email: riitta.pipatti@stat.fi

As the national entity Statistics Finland also bears the responsibility for the general administration and quality management of the inventory and of communication with the UNFCCC, coordinates participation in the inventory review, and publishes and archives the inventory results. In addition, Statistics Finland calculates the estimates for the energy and industrial processes (except for the so-called F-gases: HFCs, PFCs and SF6) sectors.

The legal basis of Finland's national system under the Kyoto Protocol is defined by the Resolution of the Finnish Government of 30 January 2003 on the organisation of climate policy activities of Government authorities. The legal framework of the national system is further defined by the agreement between the Ministry of the Environment and Statistics Finland on

operating the national system for estimating greenhouse gas emissions under the Kyoto Protocol and on the reporting requirements under the climate convention, and by the regulations concerning Statistics Finland (the Statistics Finland Act (48/1992) and the Statistics Act (280/2004)).

As a Member State of the European Union Finland participates in the compilation of the Community's greenhouse gas inventory and also has obligations to report to the European Commission (see Box 3.1).

Box 3.1

EC monitoring mechanism for greenhouse gas emissions and for implementing the Kyoto Protocol

Decision 280/2004/EC of the European Parliament and of the Council of 11 February 2004 contains provisions concerning a mechanism for monitoring greenhouse gas emissions and for implementing the Kyoto Protocol. The reporting requirements for the Member States are elaborated in Commission Decision 2005/166/EC, which lays down the rules for its implementation.

The monitoring mechanism is an instrument for accurate and regular assessment of the progress being made throughout the EU towards the Community's commitments under the UNFCCC and Kyoto Protocol. It includes provisions concerning the monitoring and reporting on the anthropogenic greenhouse gas emissions, implemented, adopted and planned policies and measures, and on the projections based on these.

The inventory of the EC is compiled on the basis of the national inventories of the Member States, and represents an aggregated total of the national emissions. According to the Decision 280/2004/EC Member States are required to submit their national inventories annually to the European Commission, DG Environment (DG ENV). The DG ENV bears the main responsibility for preparing the EC inventory.

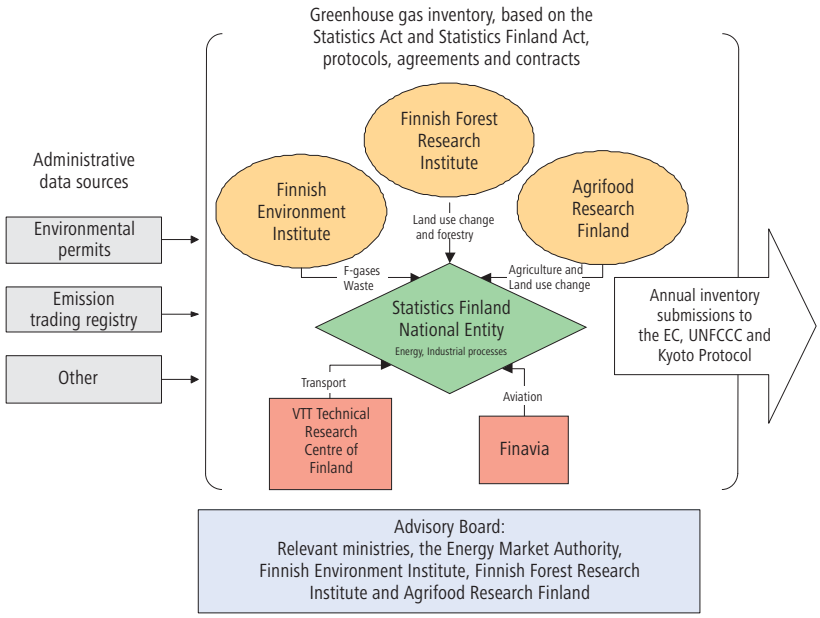
The quality of EC greenhouse gas inventory depends on the quality and the quality assurance and quality control procedures of the Member States' inventories and on the quality of the compilation process of the EC inventory.

Various specialist organisations acting as parties to the inventory system are responsible for the inventory data of the different reporting sectors (Figure 3.23).

The roles and responsibilities of the organisations participating in the preparation of the inventory are defined in agreements between Statistics Finland and the Finnish Environment Institute (SYKE), MTT Agrifood Research Finland, the Finnish Forest Research Institute (METLA), VTT Technical Research Centre of Finland and Finavia (formerly the Civil Aviation Administration). The resources for inventory preparation for the first three of these organisations are channelled via the relevant ministries' performance guidance arrangements (Ministry of the Environment, Ministry of Agriculture and Forestry). The contributions by VTT Technical Research Centre of Finland and Finavia are based on annual contracts with Statistics Finland. The continuance of these contributions is ensured with long-term framework agreements. In addition, all ministries participating in the preparation of the climate policy ensure that their data is available for use in the emission inventories.

The Finnish Environment Institute prepares the estimates of the F-gas and NMVOC emissions (excluding combustion sources) and for the waste

Figure 3.23
National system for the greenhouse gas inventory in Finland



sector. MTT Agrifood Research Finland estimates the agricultural emissions, including the CO_2 emissions reported in the LULUCF sector, while the Finnish Forest Research Institute has the overall responsibility for estimates in the LULUCF sector. VTT Technical Research Centre of Finland and Finavia provide transportation emissions data.

The agreements between Statistics Finland and the participating organisations confirm the division of responsibilities defined in the so-called reporting protocols. The protocols specify the procedures and tasks for the annual inventory process coordinated by Statistics Finland. The reporting sectors for which Statistics Finland is responsible are also defined in the protocols. They are annexed to the description of the national greenhouse gas inventory system in Finland, available on the Internet (see end of chapter).

All the participating organisations are represented in the inventory working group set up to support the process of producing annual inventories and the fulfilment of reporting requirements. The working group advances collaboration and communication between the inventory unit and the experts in charge of the different reporting sectors and ensures the implementation of the quality assurance/quality control (QA/QC) process of the inventory.

Statistics Finland has also set up an advisory board to which representatives from the participating organisations, the responsible ministries and the Energy Market Authority are invited. The advisory board functions as a higher level forum for collaboration and communication with the parties involved in the national greenhouse gas inventory system and decides on changes to the division of responsibilities. In addition, the advisory board coordinates longer term research programmes related to the development of the inventory and reporting, as well as international cooperation including participation in inventory reviews.

Both the inventory working group and the advisory board are appointed for a period of three years at a time.

In accordance with the Government Resolution referred to above, the ministries produce the data needed for international reporting on the content, enforcement and effects of the climate and energy strategy. Statistics Finland assists in the technical preparation of the policy reporting and in the technical compilation of the National Communications under the UNFCCC and the Kyoto Protocol. Separate agreements have been made on the division of responsibilities and cooperation between Statistics Finland and the relevant ministries.

The Energy Market Authority is the national emissions trading authority in Finland. Statistics Finland and the Energy Market Authority signed an agreement in 2006 on collaboration between the national inventory system and the national registry, including the division of reporting responsibilities.

3.3.2 Inventory process

The UNFCCC, the Kyoto Protocol and the EU greenhouse gas monitoring mechanism require Finland to submit annually a National Inventory Report (NIR) and Common Reporting Format (CRF) tables. The annual submission contains emission estimates for the year prior to the previous year.

The participating organisations produce their emission estimates in accordance with the pre-agreed responsibilities. Statistics Finland compiles national reports from this data and submits these reports to the UNFCCC Secretariat and to the European Commission.

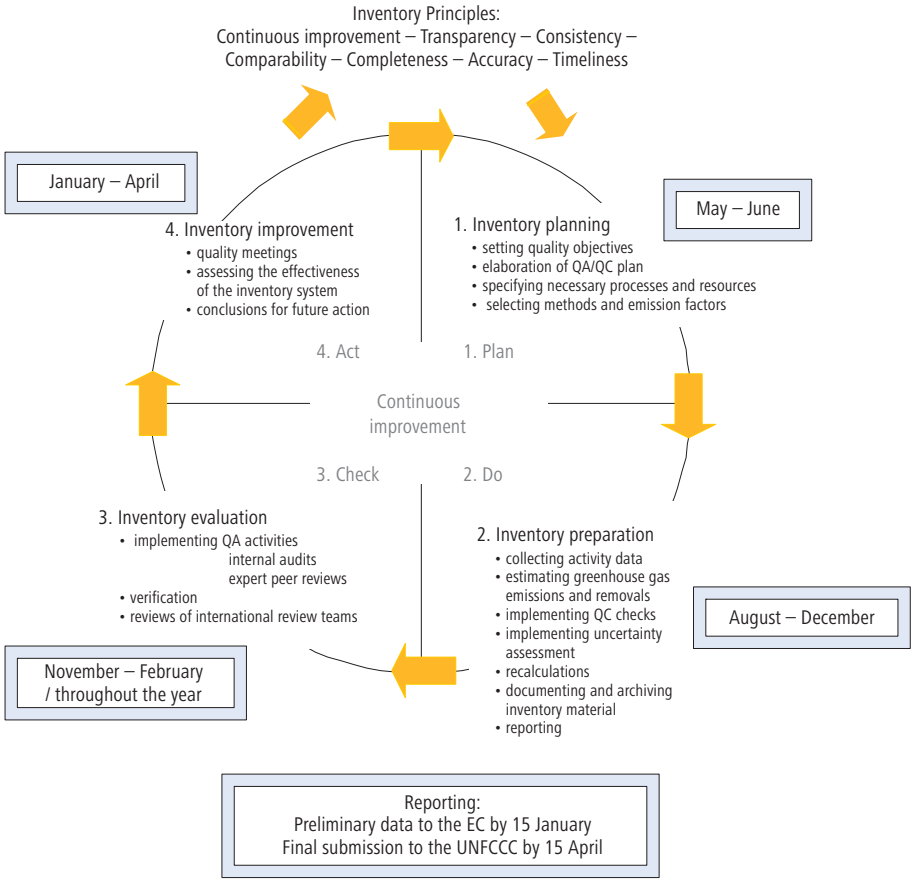
The preparation of the annual inventory follows a predefined reporting schedule. Under the EU monitoring mechanism the annual inventory must be submitted to the Commission by 15 January. The member states may then complement and update their submissions during the period to 15 March. The official greenhouse gas inventory is then submitted to the UNFCCC Secretariat by 15 April.

The annual inventory process set out in Figure 3.24 illustrates at a general level how the inventory is produced within the national system. The quality of the output is ensured by inventory experts during compilation and reporting, which consists of four main stages: planning, preparation, evaluation and improvement. The quality control and quality assurance elements are integrated into the inventory production system, which means that each stage of the inventory process includes relevant procedures for quality management.

The methodologies, activity data collection and choice of emission factors are consistent with the guidance in the Revised 1996 IPCC Guidelines and the IPCC Good Practice Guidance reports.

Advanced and country-specific approaches (Tier 2 and Tier 3 methods) are used wherever possible, as these are designed to produce more accurate emission estimates than the basic methods. Detailed activity data is used for most categories, and emission factors and other parameters are based on national research and other data. For large point sources in the energy and industrial processes sectors, the estimates are based on plant and process-specific data. The Compliance Monitoring Data System VAHTI, used by the Regional Environment Centres for processing and monitoring environmental permits, is the central data source for plant and process-specific

Figure 3.24
Annual inventory process



data. Detailed descriptions of the methodologies used can be found in the sector-specific chapters of the National Inventory Report.

Statistics Finland conducts a Tier 2 key category analysis annually, prior to the submission of inventory information to the EC. The Tier 2 methodology makes use of category-specific uncertainty analyses. The analysis covers all sources and sinks of the inventory and consisted of 127 categories at the time of writing.

The key category analysis functions as a screening exercise. The end result is a short list (20+) of important categories that are subjected to further, more detailed analysis. The goal of the detailed analysis is to pinpoint the factors that cause most of the uncertainty within each category. In the inventory the source and sink categories have been grouped into the following sectors: energy; industrial processes; solvent and other product use; agriculture; land use, land-use change and forestry (LULUCF); and waste. A key source category is prioritised within the national inventory system, and the estimate of this will have a significant influence on the total inventory of direct greenhouse gases in terms of the absolute level of emissions or the trend in emissions or both. The detailed analysis also gives rise to recommendations for the sector experts on how to improve the inventory.

The results of the key category analysis are included annually in the national inventory report and the common reporting tables. This information is archived following Statistics Finland's archival practices.

Recalculations are made for the purpose of implementing methodological improvements in the inventory, including changes in activity data collection and emission factors, or for including new source or sink categories in the inventory or for correcting for identified errors, omissions, overlaps or inconsistencies in the time series.

Greenhouse gas inventory recalculations are based on the annual evaluation of the inventory preparation and improvement needs, including input from the QA/QC activities. The driving forces in applying recalculations are the implementation of the guidance given in the IPCC Good Practice Guidance reports (IPCC 2000; IPCC 2003) and the recommendations in the UNFCCC inventory reviews.

Statistics Finland coordinates the development of the inventory. Each organisation participating in the inventory preparation bears the primary responsibility for the development of its own sector. The advisory board discusses and promotes horizontal development projects and resources needed for development.

Inventory development needs and projects that require additional resources are identified at bilateral quality meetings between the inventory unit and the participating organisations. Statistics Finland keeps a record of the development needs and planned or proposed improvement measures and uses this information to compile an annual inventory improvement plan. Methodological changes are discussed and evaluated by the advisory board before being implemented. Any changes made are documented in the CRF Reporter and the National Inventory Report in accordance with the IPCC Good Practice Guidance reports and the UNFCCC Guidelines. Changes in methodologies are implemented for the whole time series.

Finland has undertaken several research programmes and projects to improve the quality of the country-specific emission factors and other parameters as well as methods used in the greenhouse gas inventory (see Chapter 8). The results have been disseminated through e.g. articles in scientific journals and presentations at various national workshops and seminars. Some of the research results have also been used by the IPCC, for instance in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and the IPCC Emission Factor Database.

3.3.3 Quality management

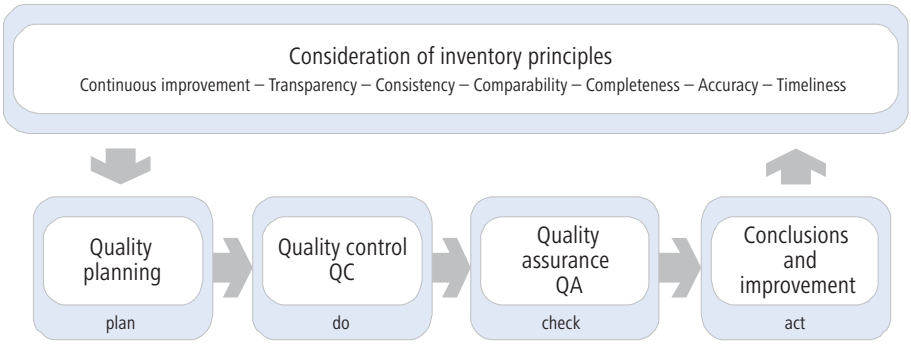
In the context of greenhouse gas inventories, high quality means that the structure of the national system (i.e. all institutional, legal and procedural arrangements) for estimating greenhouse gas emissions and removals and the content of the inventory submissions (i.e. outputs, products) comply with the requirements and principles.

The quality requirements set for the annual inventories – transparency, consistency, comparability, completeness, accuracy and timeliness – are fulfilled by implementing the QA/QC procedures consistently (Figure 3.25).

Statistics Finland steers and facilitates the QA/QC process. Experts on each inventory sector implement and document the QA/QC procedures.

The setting of quality objectives is based on the inventory principles. Quality objectives are specified statements about the quality level that is aimed at in the inventory preparation with regard to the inventory principles. The objectives aim to be appropriate and realistic while taking into

Figure 3.25
QA/QC process concerning preparation of the national greenhouse gas inventory



account the available resources and other conditions in the operating environment. Where possible, quality objectives should be measurable. The quality objectives regarding all calculation sectors for Finland's greenhouse gas inventory are presented in Table 3.2.

The quality objectives and the planned general quality control and quality assurance procedures regarding all sectors are set in the QA/QC plan. This is a checklist that specifies the actions, schedules and responsibilities in order to attain the quality objectives and to provide confidence in the Finnish national system's capability to deliver high-quality inventories.

The QC procedures used in Finland's greenhouse gas inventory comply with the IPCC Good Practice Guidance (GPG). General inventory QC

Table 3.2
Quality objectives for Finland's greenhouse gas inventory

Inventory principle	Quality objectives
1. Continuous improvement	1.1. Treatment of review feedback is systematic 1.2. Improvements promised in the National Inventory Report are carried out 1.3. Improvement of the inventory is systematic 1.4. Inventory quality control procedures meet the requirements 1.5. Inventory quality assurance is appropriate and sufficient
2. Transparency	2.1. Archiving of the inventory is systematic and complete 2.2. Internal documentation of calculations supports emission and removal estimates 2.3. CRF tables and the National Inventory Report include transparent and appropriate descriptions of emission and removal estimates and of their preparation
3. Consistency	3.1. The time series are consistent 3.2. Data have been used in a consistent manner in the inventory
4. Comparability	4.1. The methodologies and formats used in the inventory meet comparability requirements
5. Completeness	5.1. The inventory covers all the emission sources, sinks, gases and geographic areas
6. Accuracy	6.1. Estimates are systematically neither higher nor lower than the true emissions or removals 6.2. Calculation is correct 6.3. Inventory uncertainties are estimated
7. Timeliness	7.1. High-quality inventory reports reach their receivers (EC / UNFCCC) within the set time

checks (IPCC GPG 2000, Table 8.1 and IPCC GPG LULUCF 2003, Table 5.5.1) include routine checks of the integrity, correctness and completeness of the data, identification of errors and deficiencies and documentation and archiving of the inventory data and quality control actions. Category-specific QC checks including technical reviews of the source categories, activity data, emission factors and methods are applied on a case-by-case basis focusing on key categories and on categories where significant methodological and data revisions have taken place.

In addition, the quality control of member states' submissions conducted under the European Community GHG Monitoring Mechanism (e.g. completeness checks, consistency checks) produces valuable information on errors and deficiencies, and the information is taken into account before Finland submits its final annual inventory to the UNFCCC.

The QA reviews are performed after the implementation of QC procedures concerning the finalised inventory. The QA system comprises reviews and audits to assess the quality of the inventory and the inventory preparation and reporting process, to determine the conformity of the procedures taken and to identify areas where improvements could be made. Specific QA actions differ in their viewpoints and timing. The actions include basic reviews of the draft report, quality meetings, internal audits, peer reviews, UNFCCC inventory reviews and data verifications.

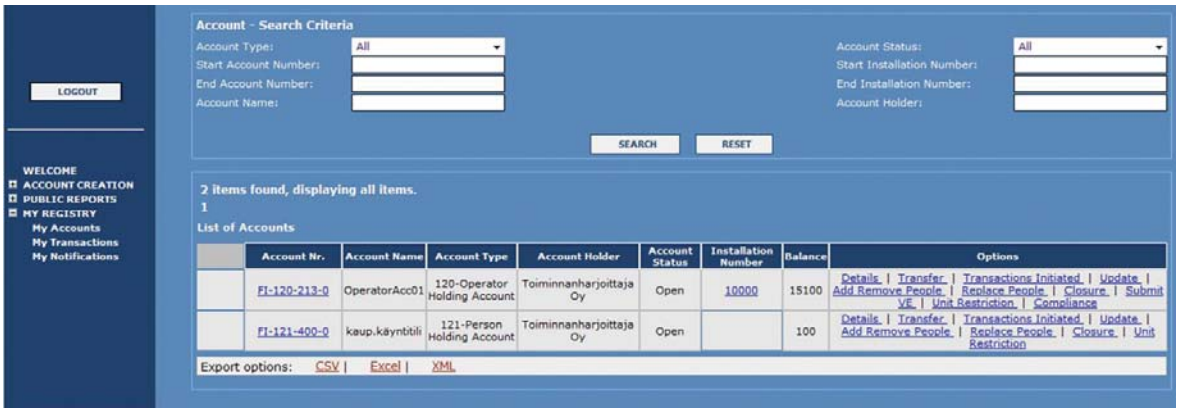
The ultimate aim of the QA/QC process is to ensure the quality of the inventory and to contribute to the improvement of the inventory. At the improvement stage of the QA/QC process, conclusions are made on the basis of the QA/QC measures taken and their results. The main findings and conclusions concerning the inventory's quality and improvement needs are considered by the advisory board and communicated to the parties to Finland's greenhouse gas inventory system for decision-making concerning the next inventory round.

3.4 National registry

3.4.1 Emissions trading schemes and the national registry

The EU Emissions Trading Scheme (EU ETS) began in January 2005 and is mandatory for specific industries in the European Union with emissions above a certain threshold. The EU ETS aims to ensure that large industrial emitters of CO_2 make a measurable contribution to the EU's emissions targets. The EU ETS and wider international emissions trading under the Kyoto Protocol have operated in parallel with each other since mid-October 2008. Both emissions trading schemes are underpinned by a system of electronically linked national registries, which in essence are intended to keep track of national and international transactions involving EU allowances and Kyoto units.

Every EU member state has been required to establish a national registry for the EU ETS and for emissions trading under the Kyoto Protocol. The CDM Executive Board has established a CDM registry, the EU Commission has established the Community Independent Transaction Log (CITL) and the UNFCCC Secretariat has established an Independent Transaction Log



User interface of the national registry's test environment.

(ITL). The CDM registry is being used for issuing certified emission reduction units (CERs) from registered CDM project activities and distributing these to national registries. The ITL and the CITL are not emissions trading registries but transaction logs which keep track of all issuances, transfers and cancellations of allowances and units in the national registries.

National registries are required to meet the technical and functional specifications issued by the European Commission and the UNFCCC Secretariat. Countries have had the option of developing their own registry, applying the Commission registry or purchasing the software from other countries or private companies. At the moment there are four types of registry software in use in EU countries (CR, Greta, Ecra and Seringas). Some Annex I countries, such as Japan, have their own registry systems. Finland used the Greta registry until summer 2009, when it replaced this with the CR registry software, which was developed by the Commission.

The registry is a web-based application. The website homepage must have a public area and a secure area. The public area allows visitors to view publicly available reports. The secure area permits existing account holders to access their accounts using a password and a login identification number. Countries also have the option of putting in place additional security measures. In Finland's national registry, the authentication is further strengthened by digital certificate access.

A national registry can be understood as being akin to an online banking facility. In this case, each account has the capability to hold different units at the same time. National registries are available to everybody, including individuals and organisations from other countries. In Finland there is a fee for opening an account in the registry and an annual fee based on the average amount of units kept in the account.

In Finland the Energy Market Authority is the competent authority and the registry administrator of the national emissions trading registry. A private company, Innofactor Ltd, is responsible for hosting the Finnish national registry production servers (network connectivity and VPN devices) and providing data communication services for the production environment. Innofactor Ltd. is also responsible for application-level management, including core software, localisation and environment and registry test/pre-production servers.

3.4.2 Registry users

Registry users are classified under the following categories, each only having access to specific registry menus and functions:

Registry administrator:
The role of the administrator is to carry out all the necessary administrative tasks, for example verifying new account applications, investigating any queries or problems with accounts, managing the registry website and providing reports. The administrator will be able to access and administer all accounts and menus in the registry. Each country must be able to demonstrate compliance with its national emissions target. The Party accounts are to be used for this purpose. In Finland the registry administrator (Energy Market Authority) is responsible for carrying out transactions on the Party accounts.

Operators:
Companies under the EU ETS have legally binding emission ceilings. These companies must use the registry to demonstrate compliance and therefore need accounts for each installation.

Organisations:
These are any private or public sector organisations with an interest in emissions trading under the EU ETS or the Kyoto Protocol.

Individuals:
As the name suggests, anyone with an interest in emissions trading can open an account in the registry.

Verifiers:
These are appointed by operators to validate their annual emissions for compliance under the EU ETS. In Finland the verified emission figure is transferred automatically to the registry from the FINETS (Finnish IT system for the EU ETS) for permitting, reporting, verification and monitoring. Therefore verifiers do not need to log into the registry.

3.4.3 Types of account

Broadly speaking there are two types of accounts in the registry. Operators use operator holding accounts (for each installation that has a mandatory emission ceiling under the EU ETS), while other individuals and organisations use person holding accounts. When account holders acquire or sell any units, the transfers will be made to and from their holding accounts. Verifiers do not have any accounts in the registry. The other main types of account in the registry are retirement and cancellation accounts, i.e. additional Party accounts that are used for demonstrating compliance with national emissions targets.

Registry transactions can be carried out on a single unit or a block of units. All units are differentiated by unique serial numbers from which the owner can obtain information such as unit type, originating registry, issue date and expiry date.

Each account must have a named primary authorised representative and a secondary authorised representative. Account holders are allowed to add an additional authorised representative to their accounts for viewing purposes, if desired. The registry assigns each account a unique account identification code.

3.4.4 Functions of the registry

The secure area of the registry can be used by different users to perform a variety of tasks on Kyoto Protocol units and EU ETS allowances. Broadly speaking the key functions can be categorised as follows:

Account management: allows operators and the registry administrator to create, update and close holding accounts as well as to record emissions.

Surrender and retirement: allows regulated companies (surrender) and national competent authorities (retirement) to demonstrate compliance with national emissions reduction targets.

Internal and external transfer: allows accounts holders within the same registry and those in other national registries to transfer units and allowances between their accounts.

Cancellation and replacement, and carry over of units and allowances in accordance with the emissions trading rules: allows the registry to comply with both the EU and Kyoto Protocol regulations as EU ETS units can be replaced with Kyoto Protocol units.

Reconciliation: with the CITL and the ITL on a periodic basis to ensure registry records are consistent.

A range of administrative functions.

Generation of reports and compliance status tables.

3.4.5 Roles of ITL and CITL

The ITL monitors all activity related to Kyoto Protocol units to ensure that transfers and other activities are consistent with the emissions trading rules under the Kyoto Protocol. The CITL is a supplementary transaction log used for monitoring all activities related to EU ETS, to ensure that they are consistent with the rules of that scheme. Each national registry automatically informs the ITL or the CITL of proposed transactions (for approval) before they can be finalized. If an inconsistency is detected or an invalid action is proposed by a registry, the CITL or the ITL will reject the proposal and cancel the request.

At least once every 24 hours, the ITL and the CITL will reconcile with national registries. This reconciliation process is intended to ensure that the account information held within the registries is consistent with that held by the transaction log. If an inconsistency is found during the reconciliation process, the administrator of the CITL or the ITL will communicate with the national registry administrator to trace the origins of the inconsistency and correct it. Until the inconsistency is corrected the registry will prevent any transactions involving the units or allowances that have been identified as affected.

3.4.6 Performance under the Kyoto Protocol

According to Decision 15/CMP.1 of the Kyoto Protocol, Parties need to provide a detailed description of how their registry performs the functions required in the relevant decisions, and of how it conforms with requirements on technical standards for data exchange (Data Exchange Standard (DES)).

These descriptions are provided in Table 3.3. A more detailed description of the registry can also be found on the Internet (see Internet links below).

Table 3.3
Descriptions of the functions of the national registry and its conformity with the Data Exchange Standard (DES) under the Kyoto Protocol

Registry Administrator	Jouko Hepola Energy Market Authority Address: Lintulahdenkatu 10, FIN-00500 Helsinki Tel.: +358 10 60 5000
Parties with which Finland cooperates by maintaining the registry in a consolidated system	The Finnish national registry is not a part of any consolidated registry system. However, the VPN connection to the ITL is shared with several countries using the same tunnel.
Database structure and capacity of the national registry	The registry system, based on CR software, uses an Oracle 9I relational database dedicated data model for supporting the registry operations. Current total capacity is 8 GB, and current database size is 808 MB.
Conformity with DES	The CR registry system was developed for the EU Emissions Trading Scheme by the European Commission. The scheme requires the Member States' registries to be compliant with the UN Data Exchange Standards (DES) specified for the Kyoto Protocol. The system contains the functionality to perform issuance, conversion, external transfer, (voluntary) cancellation, retirement and reconciliation processes using XML messages and web services as specified in the UN DES document. In addition, it also contains: 24-hour clean-up, transaction status enquiry, time synchronization, data logging requirements (including transaction log, reconciliation log, internal audit log and message archive) and the different identifier formats specified in the UN DES document. The registry development team has been in close contact with the ITL administrator and development team within the UNFCCC Secretariat during the development of the ITL functions.
Procedure to minimise discrepancies in issuance, transfer, cancellation and retirement of registry units	In order to minimise discrepancies between the registry and the transaction log, the following approach has been adopted for the registry system development under the EU ETS and UN DES: • Communication between the national registry and the ITL is via web services using XML messages – as specified in the UN DES document. These web services, XML message format and the processing sequence are as specified in the UN DES document; • As far as possible, the registry validates data entries against the list of checks that are performed by the ITL – as documented in Annex E of the UN DES Annexes document – before forwarding the request to the ITL for processing. This will help to minimise the sending of incorrect information to the ITL for approval. This also holds for any incoming transaction or message relating to a transaction. The registry validates all communication using checks described in the DES and the EC ETS regulation before processing the request further. If any check fails, the process is terminated and rolled back according to the requirements; • All units that are involved in a transaction shall be earmarked internally within the registry, thereby preventing the units from being involved in another transaction until a response has been received from the ITL and the current transaction completed; • The web service that sends the message to the ITL for processing will ensure that an acknowledgement message is received from the ITL before completing the submission of the message. Where no acknowledgement message is received following a number of retries, the web service will terminate the submission and roll back any changes made to the unit blocks that were involved; • Where a 24-hour clean-up message is received from the ITL, the web service will roll back any pending transactions and the units that were involved, thereby preventing any discrepancies in the unit blocks between the registry and the ITL; • Finally, if an unforeseen failure were to occur, the data discrepancies between the registry and the ITL can be corrected via a manual intervention function within the registry. Following this, reconciliation will be performed to validate that the data is synchronised between the registry and the ITL.

Table 3.3 Cont.

Overview of security measures (including maintenance of the measures) for un-authorised manipulations and to prevent operator error	For the CR registry the following security measures have been taken: • Access to the registry is via digital certificate access. This robust authentication system uses the Finnish banking system's authentication arrangements. Username and password authentication can also be acquired by contacting the registry administrator; • The actions that a user can perform are controlled by a permissions system, hence preventing unauthorised access to restricted actions; • All actions performed are recorded by audit; • Access to the servers and the database, as well as other related material, is limited to personnel members of Innofactor Ltd who have passed the security inspection; • Database manipulations can only be carried out by registry administrators from the user interface. A dedicated CR development team is available to make any further security enhancements as and when required. In order to prevent operator error, the registry software incorporates the following design: • Validation of all user inputs to ensure that only valid details are submitted for processing; the procedures are regularly reviewed and maintained where necessary. One example of the maintenance measures taken is the recent introduction of the safety inspection for personnel working with the registry and who have access to the registry servers.
List of information publicly accessible through the user interface of the registry	The following registry related information is publicly accessible through the Energy Market Authority's web site (http://www.emvi.fi/select.asp?gid=314&pgid=314): **Public information demanded by Decision 13/CMP.1:** Account information* JI projects in Finland* Holding and transaction information of units Account holders authorised to hold Kyoto units in their account **Public information demanded by Commission regulation (EC) No 2216/2004** (in addition to the above-mentioned public information) Installation and permit details* Information about verified emissions, surrenders and compliance status of installations National allocation plan for Finland (NAP) Registry fees Kyoto units that can be held in the accounts **Other public information:** Allocated allowances vs. verified emissions (in Finnish only) Approvals and authorisations concerning JI projects given by the Ministry of the Environment (in Finnish only) Approvals and authorisations concerning CDM projects given by the Ministry for Foreign Affairs of Finland (in Finnish only) ——— * Accessible through the user interface of the registry.
Internet address of the interface	https://www.paastokaupparekisteri.fi
Measures to safeguard, maintain and recover data to ensure the integrity of data storage and the recovery of registry services in the event of a disaster	In the event of a serious malfunction the following recovery procedures have been incorporated in the design of the registry system: • The database is physically stored on raid-array structure with automatic error detection and recovery. Therefore, any single database failure would be alerted and the registry would automatically switch over to use information from the remaining uncorrupted databases; • Data is also archived every 24 hours to an off-site recovery location, and this will also be used for taking over the live registry in the event that the main site becomes inoperable. This will then be followed by the reconciliation (with the ITL) and manual intervention processes in order to check for any inconsistencies that may exist in the registry and to restore data as needed. The recovery location for taking over the live registry is not yet operational but will be in the near future.

Literature

Commission Staff Working Document (2006) Annex to the Communication from the Commission / Fourth National Communication from the European Community under the UN Framework Convention on Climate Change (UNFCCC), Brussels, Belgium

Commission Staff Working Document (2009) Annex to the Communication from the Commission / Fifth National Communication from the European Community under the UN Framework Convention on Climate Change (UNFCCC), Brussels, Belgium

IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000) Penman, J., Kruger, D., Galbally, I., Hiraishi, T., Nyenzi, B., Emmanuel, S., Buendia, Martinsen, T., Meijer, J., Miwa, K. and Tanabe, K. (eds.), Hayama, Japan
http://www.ipcc-nggip.iges.or.jp/public/gp/english/

IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry (2003) Penman, J., Gytarsky, M., Hiraishi, T., Krug, T., Kruger, D., Pipatti, R., Buendia, L., Miwa, K., Ngara, T., Tanabe, K. and Wagner F. (eds.), Hayama, Japan
http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm

Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (1997) Houghton, J. T., Meira Filho, L.G., Lim, B., Treanton, K., Mamaty, I., Bonduki, Y., Griggs, D. J. and Callander, B. A. (eds.), London, UK
http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm

Internet links

A detailed description of Finland's national system and the national registry as well as greenhouse gas inventory data and submissions can be found on the website of the Greenhouse Gas Inventory Unit at Statistics Finland, http://www.stat.fi/greenhousegases.

Finland's annual national inventory submissions are also published on the UNFCCC website, http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/4771.php

For more detailed information on Finland's national registry, see, https://www.paastokaupparekisteri.fi (In Finnish)

The national climate and energy strategies for 2001, 2005 and 2008 approved by the Government are available on the website of the Ministry of Employment and the Economy, http://www.tem.fi/index.phtml?l=en&s=2542

Back to Contents

4 Policies and measures

This chapter describes the Finnish climate policy framework, the policy-making process and domestic and regional legislative arrangements and procedures to implement the Kyoto Protocol. These are followed by a description of the national climate and energy strategies for meeting the related targets. The policies and measures planned and implemented to achieve the emission reduction commitments under international agreements, including those under Articles 2 and 3.1 of the Kyoto Protocol, are presented by sector. Also, taxation and subsidies, use of Kyoto mechanisms, effect of policies and measures on long term trends and mitigation benefits other than greenhouse gas reduction are discussed. The end of the chapter examines the economic impacts and minimising adverse effects in other countries.

Back to Contents

Photos

Markku Aikioniemi/YHA kuvapankki, page 132
Anja Holmsten/YHA kuvapankki, page 124
Jouko Langen/YHA kuvapankki, page 121
Kerttu Malinen/YHA kuvapankki, page 122
Marja-Leena Nenonen/YHA kuvapankki, page 128
Päivi Tahvanainen/YHA kuvapankki, pages 97,102,116

4 Policies and measures

4.1 Climate policy framework in Finland

4.1.1 First commitment period of the Kyoto Protocol, 2008–2012

Finnish climate policy is formulated within the framework of the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol as well as policies set by the European Union (EU). In accordance with the Kyoto Protocol the EU is committed to reducing its emissions by 8 per cent in 2008–2012 compared to the base year emissions. This commitment is shared among the EU Member States through the Council Decision of 25 April 2002 (2002/358/EC) concerning the joint fulfilment of commitments pursuant Article 4 of the Kyoto Protocol. Under this burden sharing agreement, Finland is committed to bringing its national average annual emissions down to their 1990 level in 2008–2012. The emission levels in terms of tonnes of carbon dioxide equivalent (tonnes CO_2 eq.) allocated to the Community and to Member States were determined in 2006 in a Commission Decision (2006/944/EC). The Decision was in accordance with the opinion of the Climate Change Committee of the EU. Finland's 'assigned amount' of emissions for the first commitment period of the Kyoto Protocol (2008–2012) corresponds to 355,017,545 tonnes CO_2 eq. (or about 71 million tonnes CO_2 eq. per year).

4.1.2 Framework for climate policy after 2012

The EU legislative Climate and Energy Package adopted by the European Parliament in December 2008 forms the framework for the EU's climate policy after 2012. Under this Climate and Energy Package the European Union is committed to reducing its greenhouse gas emissions by 20 per cent by 2020 from the 1990 level, or by 30 per cent if a global and comprehensive agreement is reached. The majority of the reduction will be reached within the EU emissions trading scheme (EU ETS). Emissions from sectors not included in the EU ETS – such as transport, housing, agriculture and waste – will be cut by 10 per cent from the 2005 level by 2020 within the EU as a whole. Finland's reduction obligation for sectors not covered by the EU ETS is 16 per cent. It is up to each Member State to decide how these targets not covered by the EU ETS will be achieved. A Member State that fails to meet its targets will be penalised with a further 8 per cent emission reduction obligation.

The Climate and Energy Package also requires Finland to increase its use of renewable energy sources to 38 per cent of final energy consumption by 2020 and the share of biofuels in gasoline and diesel to 10 per cent by 2020.

Finnish climate policy beyond 2020 is outlined in the Government Foresight Report on Climate and Energy Policy (2009). The purpose of the report is to plan long-term climate and energy policies and propose measures for action. The timescale of the report extends to mid-century and covers both mitigation of climate change and adaptation to its effects.

4.2 Climate policy-making process in Finland

4.2.1 Government and role of ministries

The Government and Parliament make the most important decisions concerning climate policy. Parliament approves Finland's international commitments and decides on their implementation according to the constitution (see also Chapter 2). Parliament also actively participates in the debate on how EU decisions are implemented nationally. Finland's positions in the international climate negotiations are decided in the Cabinet Committee on EU Affairs, though in these negotiations Finland follows the common positions of the EU.

The Ministry of the Environment bears the administrative responsibility for the climate negotiations and acts as the national focal point to the UNFCCC. Preparatory work for the climate negotiations is carried out in a number of ministries.

In 2003 a Ministerial Working Group on Climate Change and Energy was established. Its work has included coordinating the preparation of the Government's Long-term Climate and Energy Strategy in 2008. Practical preparatory work for the strategy was carried out by representatives of various ministries. The strategy is described in Section 4.6.

In Finland, climate policy is being increasingly integrated with the decision-making processes in energy production, transport, agriculture, forestry and land-use and other planning. A strategy has been developed for reducing emissions from transportation, for instance. Finland is also one of the first countries to prepare a national climate adaptation strategy. In addition, the Finnish National Commission on Sustainable Development, led by the ministers of labour and the environment, promotes sustainable development in national policies and administrative practices and the special themes on its agenda for 2008–2012 include sustainable development in climate and energy policy.

Statistics Finland is the national entity responsible for compiling the Finnish greenhouse gas inventory. The national system under Article 5, paragraph 1 of the Kyoto protocol and the inventory preparation process are described in Chapter 3.

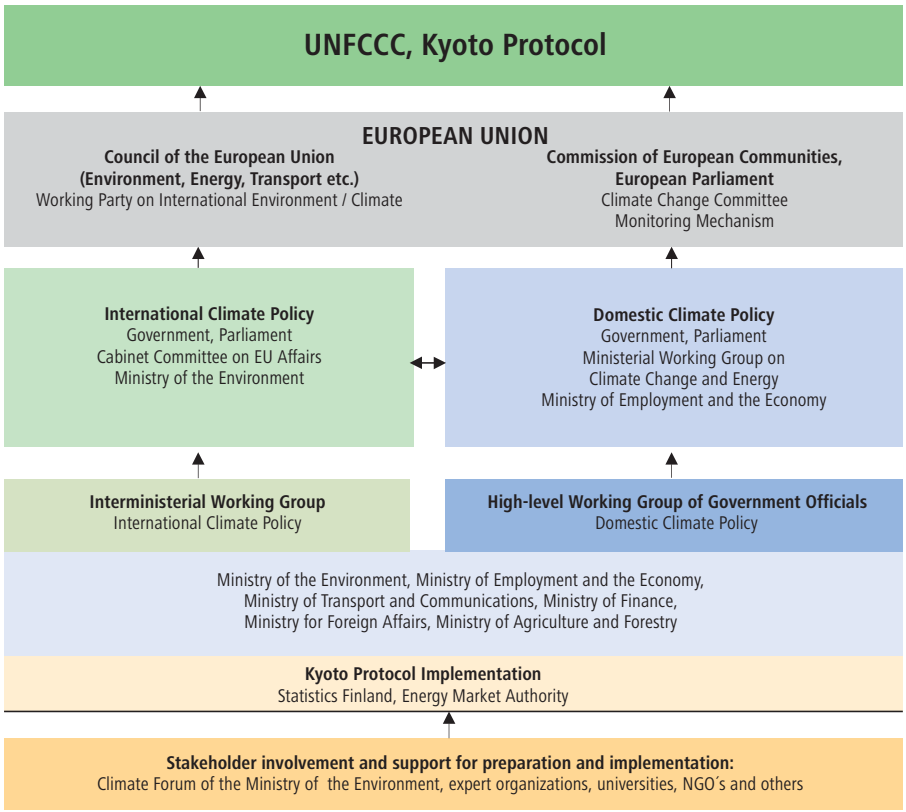
The Energy Market Authority is the competent authority and the registry administrator of the national emissions trading registry under the Kyoto Protocol (see Chapter 3), and also for EU ETS.

4.2.2 Other stakeholders

The Climate Forum of the Ministry of the Environment is a network for other ministries and stakeholders (e.g. industrial and environmental non-governmental organisations (NGOs), research institutes and labour unions), where they can present their views concerning issues related to climate policy. The Forum also allows background studies on climate policy to be presented and proposals made for new studies. It also aims to increase awareness of climate change and to promote the implementation of climate policies.

NGOs, including environmental, business, social and research organisations, participate in various governmental working groups, seminars and official delegations. Industrial enterprises and the general public also have a major role in providing information and views for the decision-making process.

Figure 4.1
Institutional arrangements concerning climate policy and its implementation



4.2.3 Public access to information

The right of access to information in official documents is a basic civil right protected by the Finnish constitution. Under the constitution, everyone has access to documents in the public domain. Documents in the possession of the authorities belong to the public domain unless access to them has been specifically restricted by an Act.

The Act on the openness of government activities (621/1999) ensures everyone the right to information on the activities of public officials. Access to documents is the main principle and secrecy an exception.

4.2.4 Regions and municipalities

Municipal authorities have a significant role in climate policy and emission reductions because of their responsibilities in land-use and traffic planning and waste management, and their own energy production and the energy consumption of local services.

Regional Environment Centres (RECs), operating under the Ministry of the Environment, prepare environmental strategies which guide regional environmental and land-use planning. Several RECs have included climate change mitigation as a priority in their environment strategies. Regions and Regional Councils (RCs) are responsible for compiling a Regional Land Use Plan, which defines the principles of urban structure and the use of areas needed for particular purposes. Climate change mitigation, use of renewable energy, energy and resource efficiency as well as coherent urban structure should be promoted in the plan. Regional Forestry Centres under the Ministry of Agriculture and Forestry, carry the responsibility for sustainable forest management.

The Association of Finnish Local and Regional Authorities (AFLRA) promotes and coordinates the Cities for Climate Protection (CCP) campaign in Finnish municipalities. The purpose of the campaign is to encourage cities and other municipalities to plan and initiate their own action to reduce local greenhouse gas emissions. By 2008, over 50 municipalities had joined the campaign. Several municipalities have also prepared their own climate strategies, and many have energy saving programmes and agreements. Since 2003 AFLRA has also published Climate Letters on its website, aiming to increase awareness on climate issues at local level.

Five municipalities have launched an ambitious project to set the first step in becoming carbon neutral (see Box 4.1).

Box 4.1

Canemu project for carbon neutral municipalities

In 2008, five Finnish municipalities launched a climate project that is unique not only in Finland but internationally too. Their objective is to reduce greenhouse gas emissions by more than that required by EU targets and more quickly than has been agreed. For the first time in Finland, the activities of municipal authorities and the businesses and inhabitants within them are examined in a single study from the perspective of reducing greenhouse gas emissions.

The project aims to create tools and procedures to enable Finnish municipalities to mitigate climate change and promote the adoption of climate-friendly technologies. Suitable solutions are being sought through close collaboration between researchers, the public sector and businesses. Successful tools and practices can then also be applied elsewhere in Finland and abroad.

The municipalities will define short-term goals and plan required measures together with experts. Consequently, it will be possible to achieve concrete results within just a few years. The project aims at greenhouse gas emission reductions both in the near future (2–5 years) and in the longer term (6–20 years). The ultimate goal is a carbon neutral municipality.

4.3 Legislative arrangements and programmes under the European Community

The European Climate Change Programme (ECCP), launched by the European Commission in 2000, provides the main framework for developing climate-relevant policies and measures in the European Union. The goal of the ECCP is to identify and develop all the necessary elements for an EU strategy to implement the Kyoto Protocol as well as to discuss and prepare the further development of the EU's climate policy. A number of key policies and measures, for instance the EU Emissions Trading Scheme, have resulted from the ECCP. The second phase of the programme, ECCP II, was launched in October 2005.

Finland is implementing at national level various EU-wide legislative arrangements and programmes known as Common and Coordinated Policies and Measures (CCPMs) affecting greenhouse gas emissions. These include i.a. the burden sharing agreement pursuant to Article 4 of the Kyoto Protocol[1], the EU Emissions Trading Scheme[2], the EU Climate and Energy Package for the post-2012 period and the Decision on the Monitoring Mechanism[3].

According to the treaty establishing the EC, the European Commission may start an infringement proceeding against a Member State which fails to fulfil its commitments and obligations under EU law. This also applies to commitments and obligations under the Kyoto Protocol and the internal EU burden sharing agreement.

Annex 2 lists EU CCPMs and their implementation in Finland. Most of the CCPMs described in the list have been developed within the ECCP.

4.3.1 Legislation implementing the EU Emissions Trading Scheme (EU ETS)

Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003, establishing a scheme for greenhouse gas allowance trading within the Community and amending Council Directive 96/61/EC, has been implemented in Finland by legislative arrangements described in Table 4.1.

The European Commission made its decision on Finland's National Allocation Plan for Emission Allowances for the trading period 2008–2012 on 4 June 2007. The Finnish Government made its decision on the allocation to installations on 14 February 2008.

1 (Decision 2002/358/EC)
2 (Directive 2003/87/EC)
3 (Decision 280/2004/EC)

Table 4.1
Legislation implementing the EU ETS

Domestic legislative arrangements implementing the EU ETS (Directive 2003/87/EC)	Description
Act on emissions trading (683/2004), which was amended in 2007 (108/2007 and 1468/2007)	The Act on emissions trading (683/2004) was amended (108/2007) as the Linking Directive (2004/101/EC) entered into force. The amended Emissions Trading Act enables the utilisation of Kyoto units within the EU ETS by companies participating in the scheme. The Act also specifies the emissions allowance allocation criteria included in Finland's National Allocation Plan for Emissions Allowances for the trading period 2008–2012.
Environmental Protection Act (86/2000), section 43 of which was amended in 2004 (684/2004)	If the activity falls under the scope of the Act on emissions trading (683/2004), the environmental permit may not set emission limits for the greenhouse gas emissions referred to in section 2 of the Act on emissions trading, unless they are necessary for ensuring the prevention of significant pollution at local level.
Act on the Energy Market Authority (507/2000), section 1 of which was amended in 2004 (685/2004)	The Act on the Energy Market Authority (507/2000) was amended by the Act of 30 July 2004. Pursuant to section 1(2) of the Act, the Energy Market Authority monitors compliance with the Emissions Trading Act.
Government Decree on emissions trading (194/2007)	The Decree regulates the content of a greenhouse gas emissions permit application for the trading period 2008–2012. It clarifies the regulations in the Emissions Trading Act on the contents of a greenhouse gas emissions permit. It also regulates the information required for the allowances.

4.4 National institutional and legislative arrangements under the Kyoto Protocol

In addition to implementing EU policies, Finland has also implemented national legislation and strategies to ensure the fulfilment of its commitments under the Kyoto Protocol. Key legislation is described below.

4.4.1 Act and Decree on the Kyoto Protocol

Finland ratified the Kyoto Protocol together with the EC and 15 EU Member States on 31 May 2002. Prior to the ratification the Kyoto Protocol was approved by the Finnish Parliament and the President of the Republic, as the Finnish constitution requires.

An Act[4] and a Decree[5] transposing provisions of the Kyoto Protocol into Finnish legislation entered into force at the same time as the entry into force of the Kyoto Protocol, on 16 February 2005. After the adoption of the Marrakech Accords in Montreal in 2005, the above-mentioned Decree was amended[6] in order to transpose into the Finnish legislation the decisions of the Conference of the Parties serving as the First Meeting of the Parties to the Kyoto Protocol.

4 (383/2002)
5 (13/2005)
6 (37/2006)

4.4.2 Legislation on the Kyoto Mechanisms

An administrative framework for participation in Joint Implementation (JI) and Clean Development Mechanism (CDM) project activities, and in emissions trading under the Kyoto Protocol (Articles. 6, 12 and 17), is provided by the Act on use of the Kyoto mechanisms[7]. Decrees on JI [8] and the CDM[9] include guidance on the contents of applications for project approvals and on authorisation for entities to participate in the projects.

The Ministry of the Environment decides on authorising legal entities to prepare for and participate in a JI project and approves the JI projects. The Ministry of the Environment may also participate in international emissions trading on behalf of the state. The Ministry for Foreign Affairs authorises preparations for and participation in CDM projects and approves the projects.

In accordance with Kyoto Mechanisms Act, it is possible to implement JI projects in Finland. The Act provides for the main elements of the national Track I procedures and authorises the Ministry of the Environment to enact more detailed regulations regarding further provisions on the monitoring of emissions, the report to be filed on the emissions, the verifier's statement, the approval procedure of the verifier, the evaluation of approval criteria and the implementation of the verification process. Authorisations for holding Kyoto units in a holding account in the national registry and making transfers under international emissions trading to and from the account are made by the Ministry of the Environment.

The Energy Market Authority is the competent authority for emission trading and the administrator of the national emission trading registry (see the section on the national registry in Chapter 3).

Table 4.2
Legislative arrangements related to the Kyoto Protocol mechanisms

Domestic legislative arrangements related to Articles 6, 12 and 17 of the Kyoto Protocol	Description
Act on the use of the Kyoto mechanisms (Act 109/2007)	The purpose of the Kyoto Mechanisms Act is to provide an administrative framework for participation in project activities and emissions trading under the Kyoto Protocol and to set provisions for the operation of the national registry required for the implementation of the Protocol and established under the Emissions Trading Act (683/2004)
Decree on Joint Implementation (913/2007)	This Decree expands on the provisions Kyoto Mechanisms Act and includes guidance on applications for JI project approvals and authorisations. In addition, the JI Decree includes regulations on Finland's national Track I procedures[10] related to applications for approvals of JI projects in Finland.
Decree on the Clean Development Mechanism (915/2007)	This Decree expands on the provisions of the Kyoto Mechanisms Act and includes guidance on applications for CDM project approvals and authorisations.

7 (109/2007)
8 (91372007)
9 (915/2007)
10 The presumption is that Finland will fulfil the eligibility criteria set out in paragraph 21 of Decision 9/CMP.1 and will therefore be eligible to verify emissions reductions independently (the verification procedure referred to as "Track I").

4.5 National forest legislation and programmes

The sustainable management of forests in Finland is based on legislation and good practices. The means for steering the use of forests include legislation, Finland's National Forest Programme 2015, financing, and public forestry extension organisations.

Forest legislation is the most important means of forest policy for ensuring sustainable forestry. The key acts include the Forest Act[11] and the Act on the financing of sustainable forestry[12]. There is also legislation on the prevention of forest damage and on trade in forest reproductive material, timber measurement, jointly owned forests and organisations in the forestry sector.

The Forest Act sets requirements for felling, regeneration and conservation of certain habitats. For instance, a new seedling stand has to be established within three years of the end of felling. The Forest Act is complemented with guidelines for good forest management and silviculture, compiled and promoted by public forestry extension organisations.

Finland's National Forest Programme (NFP) is designed to meet the demands set by international forest policy and will have far-reaching effects in Finland. It was prepared simultaneously with the national climate and energy strategy, and they are intended to complement each other.

The NFP sets a vision for sustainable forest management in 2015. It aims to:

- Generate operational preconditions for profitable forestry and for a viable forest industry
- Increase energy and climate benefits of forests
- Secure biodiversity and environmental benefits of forests
- Further develop the cultural and recreational use of forests
- Strengthen Finnish forestry know-how
- Participate actively in international forest policy

The NFP is implemented and monitored in broad cooperation between the public and private sectors. The Ministry of Agriculture and Forestry, supported by the Forest Council, carries the overall responsibility for the programme. The Forest Council has representatives from different administrative sectors, industries, NGOs and specialist organisations. For more information on the national measures of the NFP, see Section 4.7.7.

There is also a Regional Forest Programme, which is a development plan for the whole forest sector of the regions concerned. It defines the needs and objectives for the management of forests, forest-based business, and multiple use and protection of forests, and also proposes the measures and necessary funding to reach the objectives.

With regard to contributing to the conservation of biodiversity and sustainable use of natural resources the most important instruments are Section 10 of the Forest Act (preserving of diversity and habitats of special importance) and the policies and measures outlined in the Forest Biodiversity Programme for Southern Finland 2008–2016 (the METSO programme)

11 (1093/1996)
12 (1093/1996)

which are an integral part of the range of instruments in the NFP to protect biological diversity in the future.

The METSO programme is being implemented jointly by the Ministry of Agriculture and Forestry and the Ministry of the Environment. In southern Finland, 72 per cent of the forests are owned by private persons. METSO therefore targets both private and state-owned land. It covers the protection and commercial use of forests. The aim is to halt the decline in forest habitats and species and establish stable favourable conditions for forest biodiversity in southern Finland by 2016. The programme is being implemented through ecologically efficient, voluntary and cost-effective means.

Forestry is a significant income source for forest owners and provides benefits to society at large. Forest management associations provide forest owners with advisory services on forest management and felling. The task of the associations, prescribed by law, is to promote private forestry while securing its economic, ecological and social sustainability. A private forest owner may receive some assistance from the State for forest management and improvement work. State support encourages measures with long-term impacts. Management of the natural environment in commercial forests is promoted through environmental support and forest nature management projects. Public funding for forestry is based on the Act on the Financing of Sustainable Forestry.

Environmental aid may be granted for additional costs and income losses due to preservation and management of habitats of special value. The State also finances forest nature management projects. The works to be designed and implemented in these projects are defined in further detail in the legislation. Most of the forest nature management projects have special regional importance. Apart from habitats of special value, they may concern landscape management, preventing damage to waters and restoration of ditched areas.

Table 4.3
Key domestic forest legislation/programmes

Key domestic forest legislation/programmes	Description	Note
Forest Act (1093/1996)	Lays down provisions on the restrictions and preconditions for the use of forests.	Amendments under preparation.
	Section 10 of the Forest Act regulates the preserving of diversity and habitats of special importance.	
Act on the financing of sustainable forestry (1094/1996)	Promotes forest improvement and environmental management in private forests and the use of wood for energy	A new Act of the financing of sustainable forestry is under consideration.
Finland's National Forest Programme 2015	The objective is to improve national wellbeing and prosperity through diversified utilisation of forests, in full compliance with the principle of sustainable development.	The policies and measures outlined in the Forest Biodiversity Programme for Southern Finland 2008–2016 (METSO) are an integral part of the range of instruments in the NFP to protect biological diversity.
Regional Forest Programme 2015 (Government Resolution on 28 February 2008)	The development plan for the whole forest sector of the regions concerned.	The Programme is revised at least every five years. Revisions for 2006–2010 were made in 2005.

4.6 National energy and climate strategies

4.6.1 Meeting the Kyoto target

In 2001, the Government prepared a National Climate Strategy containing a programme of measures designed to meet Finland's emission reduction target in the period 2008–2012. This strategy was updated in November 2005, when the Government finalised a revised National Energy and Climate Strategy. The 2005 strategy was described in detail in Finland's Fourth National Communication.

In 2008, the Government approved the new Long-term Climate and Energy Strategy, with detailed proposals on climate and energy policy measures up to 2020, and suggestions up to 2050. The strategy clearly demonstrates that the objectives in the EU Climate and Energy Package for Finland regarding the reduction of emissions, promotion of renewable energy and enhancing the efficiency of energy consumption cannot be attained without new, prominent climate and energy policy measures.

The 'with measures' (WM) scenario in the most recent strategy includes the implemented and adopted policies and measures with which the emission limitation target under Kyoto Protocol will be achieved. The 'with additional measures' (WAM) scenario aims at meeting the objectives of the EU Climate and Energy Package, which is described in Section 4.6.2.

In the WM scenario, the main instrument to be used for emission reduction is the EU ETS. For the Kyoto period an emissions cap of 37.6 million tonnes CO_2 eq. has been set for the installations participating in the EU ETS in Finland. This cap is approximately 10 million tonnes or 22 per cent less than the estimated emissions of the emissions trading sector during the years 2008–2012 without the scheme. The ETS companies can fulfil the cap by reducing emissions and/or by acquiring more emissions allowances[13] from the market. Besides EU ETS, other domestic policies and measures include promoting energy conservation and use of renewable energy sources.

Emissions of sectors outside the ETS are estimated to be an average of around 35.2 million tonnes CO_2 eq. per year in the Kyoto period.

The impact from activities under Article 3, paragraphs 3 and 4 of the Kyoto Protocol are expected to result in credits (removal units (RMU)) equal to the cap set for Finland for forest management of 0.59 million tonnes CO_2 per year[14].

Finland as a Party to the Kyoto Protocol is also utilising the flexible mechanisms of the Kyoto Protocol, the Joint Implementation (JI) and the Clean Development Mechanism (CDM), to increase the cost-efficiency of climate policies. The use of flexible mechanisms is, however, minor compared to the emissions reductions using the EU ETS and other domestic measures. Thus the principle of supplementarity will be fulfilled during the Kyoto period.

The total emissions from the emissions trading sector based on the granted emission allowances (37.6 million CO_2 eq. tonnes per year) and for other sectors (35.2 million tonnes CO_2 eq. per year) would be 72.8 million tonnes CO_2 eq.. Finland's assigned amount for the period 2008–2012 has

13 Assigned amount units (AAU), certified emission reduction units (CER) and emission reduction units (ERU)

14 Decision 16/CMP. 1 Land use, land-use change and forestry. FCCC/KPCMP/2005/8/Add.3

been established at 355,017,545 tonnes CO_2 eq., i.e. an average of 71.0 million tonnes CO_2 eq. per year. The available assigned amount units (AAU), removal units (RMU) from activities under Article 3, paragraphs 3 and 4, and those units to be acquired by Finland using the flexible mechanisms, would amount to 73.0 million tonnes CO_2 eq., and be sufficient to cover Finland's obligation (see Table 4.4 below).

The compliance system of the EU ETS will ensure that the trading sector either cuts emissions or purchases the respective amount of emission units. It is the Government's responsibility, however, to attend to the emissions balance of the non-trading sector. There are uncertainties regarding the emissions trend i the non-trading sector, which the Government will mainly endeavour to cover with the Kyoto mechanisms.

Table 4.4
Projected average annual emissions and the effect of policies and measures (PAMs) in the WM scenario with which the Kyoto Protocol target will be achieved in the first commitment period 2008–2012 (million tonnes CO_2 eq.)

	million tonnes CO_2 eq.	
Emissions in the EU ETS sector	46.4	37.6 *
Emission reductions or acquired AAUs, ERUs or CERs by EU ETS entities to meet their allowed emissions	–8.8	
Emissions in the non-trading sector	35.2	
Total projected emissions	**72.8**	
Finland's assigned amount (annual average value)	71.0	
RMUs from Article 3, paragraphs 3 and 4	0.6	
Governmental use of Kyoto mechanisms	1.4	
Sum of Finland's assigned amount, RMUs and units acquired from flexible mechanisms	**73.0**	
Difference between the projected emissions and the above sum	–0.2	

*emission cap for EU ETS installations

4.6.2 The post-Kyoto period

In 2007 the EU heads of state agreed on ambitious targets to combat climate change, by a unilateral commitment to the reduction of greenhouse gas emissions by 20 per cent by 2020, from the emission levels of 1990. In the long term, or by 2050, the guideline target involves a reduction of emissions by as much as 80–95 per cent. In order to realise this, a binding target was set, prescribing that 20 per cent of the EU's total energy consumption must come from renewable energy sources by 2020. In addition, 10 per cent of the transport fuels consumed must be renewable fuels. In terms of energy efficiency, the improvement target was set at 20 per cent by 2020.

In accordance with the EU Climate and Energy Package Finland's national target for renewable energy is to increase the use of renewable energy sources to 38 per cent of final energy consumption by 2020. This means increasing the use of renewable energy by 9.5 percentage points above the corresponding figure for 2005. For transport fuels, the target concerns the year 2020 and requires that renewable energy sources account for at least 10 per cent of final energy consumption for transport. Under the Decision on the Effort Sharing of Member States to reduce their greenhouse gas emissions to meet the European Union's greenhouse gas emission reduction commitments up to 2020 (406/2009/EC), Finland is required to decrease green-

house gas emissions in sectors outside the EU emissions trading regime (EU ETS) – such as housing, agriculture and transport – and specifically to achieve a 16 per cent reduction by 2020 from the 2005 levels. Under the revised Directive on the EU ETS[15], companies within the emissions trading regime are covered by an EU-wide emission cap, with the cap for 2020 set at 21 per cent below the 2005 emission level. This represents a significant amendment to the existing emissions trading regime.

As a result of the domestic targets and measures, Finland's greenhouse gas emissions are forecast to decline by an estimated 23 per cent in 2020 compared to a situation without the new measures.

The Government adopted on 15 October 2009 the Foresight Report on Long-term Climate and Energy Policy. Setting a target to reduce Finland's greenhouse gas emissions by at least 80 per cent from the 1990 level by 2050 as part of an international effort, the report marks out the road to a low-carbon Finland in 2050 (more details on the report is presented in Annex 3).

4.7 Sectoral policies and measures

4.7.1 Energy

Policies and measures in the WM and WAM scenarios

'With measures' scenario

The general objective of Finland's energy policy is to ensure energy security at competitive prices and with the lowest possible environmental impacts. Finland uses a diversity of energy sources, and its energy imports cover about 70 per cent of total use. During the past two decades, energy supply has shifted away from oil and coal towards wood-based fuels, peat, natural gas and nuclear energy. Industry accounts for about half of total energy use and its share has increased over time. The forest industry is the largest energy consumer, but it produces more than 40 per cent of its energy needs from waste wood and other by-products, for example black liquor. The share of wood and wood-derived products in the total energy supply is the highest in Europe.

The 'with measures' (WM) scenario includes all energy policy measures in use at the beginning of 2007. Direct governmental intervention to guide the choice of energy sources is rare in Finland. However, economic instruments, i.e. taxation and subsidies, have been used to improve energy efficiency and promote the development of domestic energy sources such as peat and biomass. Table 4.5 shows the major policies and measures included in the WM scenario in the energy sector. Finland's fifth nuclear power reactor, currently under construction, represents the most efficient way, in quantitative terms, of reducing CO_2 emissions. Compared against generating the same amount of electricity using coal condensing power (a marginal production mode in Finland), the new nuclear plant's emissions will be lower by some 8 million tonnes CO_2 eq. The request to build a nuclear power reactor was presented by a consortium of private companies and required the approval of the Government and Parliament. The assumptions of the WM scenario are described in detail in Chapter 5.

15 (2009/29/EC)

Table 4.5
Major policies and measures affecting greenhouse gas emissions in the energy sector in the 'with measures' (WM) scenario, 2007–2020

Policy	Objective	Type of instrument	Status	Estimated mitigation impact		
				2010	2015	2020
EU ETS	To reduce emissions, renewables	Economic	Implemented	na	na	na
Nuclear power	Supply of electricity	Regulatory, economic	Under construction, in use in 2013	0	About 8 Tg	About 8 Tg
Energy taxation	Energy saving, renewables	Fiscal	Implemented	na	na	na
Voluntary agreement scheme	Energy saving	Agreements	Implemented	4 Tg	na	na
Subsidies	Renewables, energy saving, R&D	Fiscal	Implemented	na	na	na
Regulatory measures	Energy efficiency, buildings	Regulatory	Implemented	na	na	na

na = Not available

No 'without measures' scenario has been developed in Finland. Therefore, mitigation impacts of the policies in the WM scenario are not available in Table 4.5.

The EU ETS is included in the WM scenario. The EU ETS has been operating since 2005 and is by far the strongest measure for reducing emissions at both the domestic and EU level. The EU ETS is considered here as a domestic measure, even though entities with emission ceilings participating in the scheme acquire emission units (AAUs, CERUs and ERUs) through trading.

Table 4.6 shows that the total volume of EU ETS allowances for the period 2008–2012 in Finland amounts to 187.8 million tonnes CO_2 eq. corresponding to 37.6 million tonnes CO_2 eq. per year. Emission allowances of 7 million tonnes CO_2 eq. are reserved for the so-called new entrants joining the system during the trading period. The annual figure of 37.6 million tonnes CO_2 eq. represents a substantial reduction from the average actual emissions in previous years. Electricity production and district heating carry the heaviest burden in the emissions trading sector.

The electricity market in Finland operates as a part of the wider Nordic market. Market liberalisation in the mid-1990s resulted in a situation in which power plants are run primarily on the basis of cost-efficiency objectives. During a year of high precipitation in the Nordic countries the price of electricity is low because of extensive hydropower production. In a dry year the price is higher and the marginal production mode is condensing power. Greenhouse gas emissions therefore fluctuate according to hydrological conditions, but on the whole the deregulation of the market seems to have led to a reduction in emissions.

Renewable energy sources are supported by various national measures: investment grants, taxation, subsidies and support for research. Moreover, the EU ETS is especially important in promoting renewable energy sources.

Table 4.6
CO_2 emissions in the emissions trading sector and emissions allowances for 2008–2012 (million tonnes CO_2)

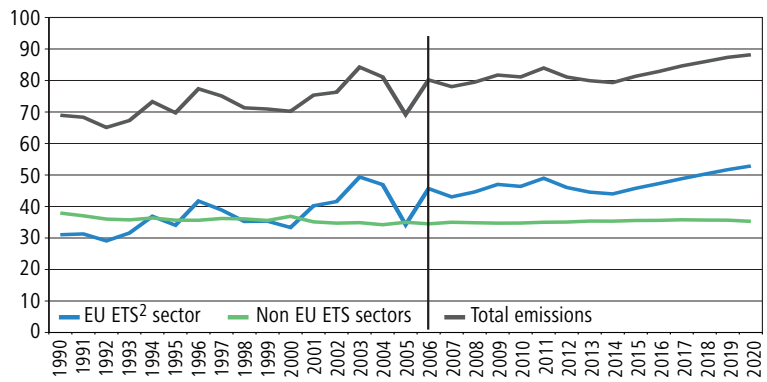
	Actual emissions (million tonnes CO_2)									Emission allowances for 2008–2012, million tonnes CO_2 per year	Emission allowances for 2008–2012, million tonnes CO_2 in total
	1998	1999	2000	2001	2002	2003	2005 *)	2006	2007		
Industrial processes	10.6	10.8	10.8	10.8	11.0	11.3	10.7	11.3	11.2	12.9	64.4
Industrial energy production	8.1	7.7	7.3	7.6	8.0	7.9	6.8	7.6	7.4	7.9	39.5
District heating and CHP	12.3	11.8	11.1	13.0	13.2	13.6	12.4	14.0	13.3	12.2	60.8
Condensing power production	4.6	5.1	4.7	8.0	9.5	16.3	3.1	11.6	10.6	3.1	15.6
Peak-load power production	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5
New entrants										1.4	7.0
Total	**35.7**	**35.5**	**34.0**	**39.4**	**41.7**	**49.2**	**33.1**	**44.6**	**42.5**	**37.6**	**187.8**

* For the year 2004 corresponding data is not available.

Energy conservation measures concern all sectors of the economy and are included in the WM scenario. Energy efficiency agreements, a voluntary scheme for industry and municipalities, have proven to be an efficient measure next to taxes and subsidies. The total effect of the voluntary agreements is estimated to exceed 4 million tonnes CO_2 eq. in 2010 (see more on the agreements p. 109).

Figure 4.2 illustrates the volume of greenhouse gases under the WM scenario in the ETS sector and the non-ETS sector. The emissions trend in the ETS sector has been increasing since 1990, and in the WM scenario this trend is expected to continue. In the non-ETS sector emissions have been

Figure 4.2
Greenhouse gas emissions in the WM Scenario (million tonnes CO_2 eq.)[1]
The year 2006 marks the start of the scenario



1 Greenhouse gas emissions without emission reduction units acquired by EU ETS entities.
2 EU ETS started in 2005

relatively stable or slightly decreasing, and the future trend in this sector is very flat under the WM scenario. However, this level of emissions exceeds the target set for non-ETS sectors in 2020, and so additional measures are needed in order to meet the 2020 targets. These measures and targets are discussed below. Meeting the Kyoto target has been described in Section 4.6.1.

'With additional measures' scenario

Table 4.7 shows the major policies and measures included in the 'with additional measures' (WAM) scenario in the energy sector. The measures are designed to achieve the EU targets for emissions reduction, increasing renewable energy sources and energy efficiency by 2020.

Table 4.7
Major policies and measures affecting greenhouse gas emissions in the energy sector in the 'with additional measures' scenario, 2007–2020

Policy	Objective	Type of instrument	Status	Estimated mitigation impact		
				2010	2015	2020
Common EU target for ETS sector	To reduce emissions, renewables	Economic	Target set	na	na	na
Subsidies, feed-in tariffs for renewables	To reduce emissions	Economic	Under implementation	na	na	na
Energy efficiency measures	Energy consumption	Economic, regulatory	Planning stage	na	na	na

na = Not available

Energy efficiency

The Finnish economy is relatively energy intensive, which has led to fairly high per capita greenhouse gas emissions. Energy use, however, is efficient by international comparison, which implies that the high energy intensity can be explained by structural factors. Finland has a cold climate and the need for space heating, measured by average heating degree days, is higher than in any other country in the world. In addition, Finland is relatively large and sparsely populated.

Energy efficiency agreements (see below) and economic subsidies for developing and implementing energy efficient technology and innovative modes of operation are important for reaching the targets.

In accordance with the Long-term Climate and Energy Strategy, a broad-based Energy Efficiency Committee was set up in spring 2008. The committee's task was to assess and propose measures for attaining the objective of saving 37 TWh in final energy consumption by 2020. The objective for 2050 is to reduce energy consumption by at least a further third.

In order to reach the objectives, energy efficiency must be enhanced, particularly in housing, construction and transport. The committee's report describes almost 125 new or significantly expanded energy saving and energy efficiency measures. The objectives can only be attained by a combination of these measures.

Table 4.8
Final consumption of energy in WM and WAM scenarios in 2020, TWh[16]

	2005	2006	2007	2020		
				WM	WAM	Change
Electricity	85	90	91	103	98	−5
Transport	51	51	52	58	48	−10
Space heating	58	58	57	182	160	−22
Agriculture	15	14	14			
Industry	89	97	97			
Own use in energy sector	3	3	3	4	4	0
Total	**302**	**313**	**311**	**347**	**310**	**37**

The Energy Efficiency Committee estimated that the following measures would yield the biggest annual energy savings by 2020:

- 8.5 TWh can be saved by introducing new vehicle technology and renewing the existing car stock more quickly, including the introduction of electric cars. In order to achieve this, several measures are needed, including staggered vehicle taxation, monitoring of the impact of this, and introducing an energy efficiency classification for cars.
- Energy consumption will be reduced by 4.9 TWh by tightening energy regulations for new buildings, to be implemented in two phases over the next few years, and by extending the same requirements to renovation construction.
- 2.8 TWh can be saved in the non-ETS sectors by substantially more challenging and broad-based energy efficiency agreements, combined with research and innovation.
- At least 2.1 TWh can be saved by energy efficiency requirements for equipment, with household appliances accounting for more than half of the total.

These measures, most of which are not covered by the EU ETS, will save approximately 18.3 TWh, which is half of the saving objective. Some of the overall savings can be attained within the emissions trading sector, where energy efficiency agreements and a range of other measures play a role too. In energy intensive industry, it has been estimated that emissions trading and other measures will cut energy consumption by some 8 TWh by 2020.

Voluntary energy efficiency agreements

Since the 1990s, Finland has employed a voluntary energy efficiency agreement scheme for companies and municipalities. Voluntary measures, such as energy conservation agreements, energy audits and sector or measure-specific programmes have already resulted in significant energy savings. Additional savings are sought by continuing and intensifying these measures, as well as by adopting new energy saving measures related to the

16 TWh is used for all sectors for the purpose of convenient comparison of the values. 1 TWh = 3600 PJ.

implementation of EU directives. The scheme covers around 85 per cent of all industrial energy use and over 50 per cent of the building stock of the service sector.

New energy efficiency agreements for industries, municipalities and the oil sector are mainly the responsibility of the Ministry of Employment and the Economy and have been signed for the period 2008–2016. They follow the energy conservation agreements that were in force in 1997–2007.

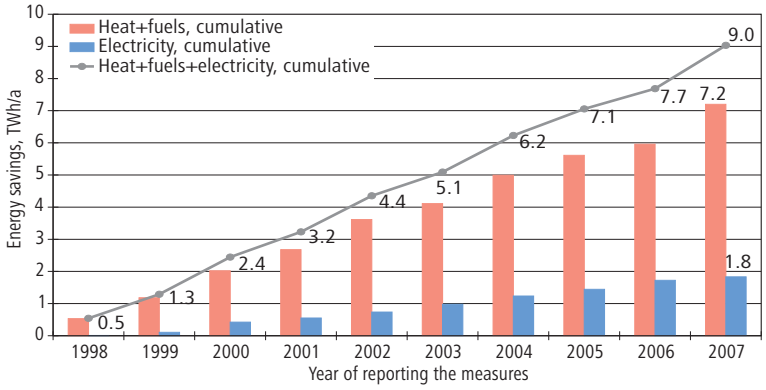
Additional energy efficiency agreements are currently in force for goods transport, logistics and public transport. These agreements fall under the responsibility of the Ministry of Transport and Communications. The housing sector has an energy conservation agreement scheme, which is overseen by the Ministry of the Environment. New agreements in this sector will enter into force in the beginning of 2010. In 2010, agreements will also be launched in the agriculture sector under the Ministry of Agriculture and Forestry.

Total savings from measures under energy efficiency agreements within the industry, energy, municipal, property and building sectors at the end of 2010 are estimated to be about 9 TWh per year.

The cumulative CO_2 reductions under the energy efficiency agreements are estimated to be about 3.4 million tonnes CO_2 per year by the end of 2007, based on a marginal emissions rate of 700 kg CO_2/MWh. By the end of 2010 the emissions reduction will exceed 4 million CO_2 tonnes per year.

New energy efficiency agreements for business, industry and municipalities for the period 2008–2016 were signed in December 2007. The new agreements are especially important for implementing the Energy Services Directive[17] that entered into force in May 2006. Further regulations will be prepared as necessary to ensure implementation of the obligations.

Figure 4.3
Total energy savings resulting from the energy conservation agreement scheme 1998–2007



17 (2006/327/EC)

Renewables

Finland aims to increase the proportion of renewable energy in final energy consumption to 38 per cent by 2020 (2005: 28.5 per cent). This target is to be achieved by reducing energy consumption and increasing the use of renewables. Wood-based fuels, liquid biofuels, wind power and heat pumps will contribute most to the target.

In September 2009 the working group set up by Ministry of Employment and the Economy to consider the structure and size of renewable energy feed-in tariffs submitted its final report for a feed-in tariff for wind power and electricity generated from biogas.

The working group suggests that a market-based guaranteed price be introduced for wind power in Finland. The guaranteed price for wind power would be introduced in early 2010 for a period of 12 years. At the initial stage, the guaranteed price for wind power determined by the authorities would be EUR 83.5/MWh. The difference between the market price of electricity and the guaranteed price would be paid to wind power producers as a feed-in tariff. For instance, at a EUR 50/MWh market price, the premium guaranteed by the feed-in tariff would be EUR 33.5/MWh. The tariff levels would be somewhat higher in the initial stage of the scheme order to facilitate the rapid launch of investments.

The feed-in tariff is expected to further the construction of wind power in line with the Long-term Climate and Energy Strategy, the objective of which is to increase the production of wind power to 6 TWh, i.e. by almost 30 times, by the year 2020 (current production level approximately 0.2 TWh).

Other measures to promote renewables, especially biomass, are currently being elaborated.

Table 4.9
Renewable energy in WM and WAM scenarios in 2020, TWh

	2005	2006	2007	2020	
				WM	WAM
Renewable fuels related to industrial production					
Black liquor	36.7	43.3	42.5	38	38
Industrial wood residues	23.1	26.7	26.0	22	22
Total	**59.8**	**70.0**		**60**	**60**
Renewables targeted by policies					
Hydro power	13.6	11.3	14.0	14	14
Recovered fuels and biogas	1.7	1.9	2.0	2	3.5
Forest chips	5.8	7.2	5.3	18	21
Small-scale combustion of wood	13.4	13.6	13.5	12	13
Wood pellets	0.1	0.1	0.2	0.7	3
Heat pumps	1.8	2.4	2.8	3	5
Liquid biofuels	0.0	0.0	0.0	6	6
Wind power and solar energy	0.2	0.1	0.2	1	6
Total	**94.9**	**102.7**	**106.5**	**115**	**128**

Energy use in residential and other buildings

'With measures' scenario

CO_2 emissions from the use of energy in buildings are mainly covered by the emissions trading sector. District heating is the source for about half of the space heating in Finland. The majority of district heating production – as with electricity produced in CHP plants – falls within the sphere of the emissions trading sector. Much of the rest of Finland's electricity production is also covered by the emission trading sector. Therefore, the category of direct CO_2 emissions from energy use in buildings in Finland only comprises emissions from domestic heating using light fuel oil and to a very small extent natural gas, which is typical of much of the country's detached housing stock. These CO_2 emissions amount to about 3 million tonnes annually. The non-CO_2 emissions from energy use in buildings are much smaller, approximately 0.2 million tonnes CO_2 eq. annually. Most of these emissions are CH_4 emissions from wood combustion.

The Directive on the energy performance of buildings[18] aims at reducing CO_2 emissions by improving the energy efficiency of buildings. The directive was implemented in Finland by a new regulation which came into force at the beginning of 2008. New Finnish legislation on the energy efficiency of buildings includes the following:

- Act on energy certification of buildings[19] and Ministry of the Environment Decree on Energy Certification of Buildings[20].
- Act on energy efficiency inspections of cooling equipment used in air conditioning systems in buildings[21].
- Amendments to the Land Use and Building Act[22], which was expanded to cover energy efficiency requirements and details on how energy efficiency should be calculated.[23]

Regulation on energy efficiency of buildings, included to the National Building Code, were modernised in 2007 and came into force at the beginning of 2008.

The Government has supported energy efficiency improvements in renovation and investment in low-carbon heating systems through various subsidies. There is also an interest subsidy system promoting loans for renovations which improve energy efficiency.

Information provision and campaigns supported by the Government seek to influence the behaviour of building users and owners and individual consumers.

'With additional measures' scenario

Policies and measures for residential and other buildings aim at improving energy efficiency, reducing emissions in the ETS and non-ETS sectors and increasing the use of renewable energy. Additional measures in the Finland's Long-term Climate and Energy Strategy include setting standards, economic

18 (2002/91/EC)
19 (487/2007)
20 (765/2007)
21 (489/2007)
22 (1129/2008)
23 (488/2007)

measures, and dissemination of information, education and research. Measures are targeted at both new buildings and the existing building stock.

4.7.2 Transport and communications

'With measures' scenario

Policies and measures in the transport sector under the 'with measures' (WM) scenario are outlined in Table 4.10. The WM scenario includes all climate policy measures in use in the transport sector at the beginning of 2008. It also includes the EU aim for increasing the share of biofuels in gasoline and diesel to 10 per cent by 2020, which was decided by the European Council in March 2008.

According to the present EU recommendation the share of biofuels in petrol and diesel should be 5.75 per cent by 2010. In Finland this recommendation has been implemented through the Act[24] on promoting biofuels in transport. Under the Act the annual minimum share of biofuels, measured from the total energy content of gasoline, diesel and biofuels delivered for consumption, must be 2 per cent in 2008, 4 per cent in 2009 and 5.75 per cent in 2010. This is one of the most important measures in the WM Scenario in transport sector.

Another important measure in this scenario is the voluntary agreements between the European Comission and car manufacturers. The aim of these agreements is that average CO_2 emissions of new registered cars should not exceed the level of 120 g/km for diesel cars and 140 g/km for gasoline cars. However, at the end of 2007 it seemed likely that this aim would not be fullfilled in all EU countries, and so the EU Comission decided to set new

Table 4.10
Estimated mitigation impact of the WM projection (million tonnes CO_2 eq.)

Policy or measure	Objective	GHG	Type of instrument	Status	Implementing entity	Estimated mitigation impact		
						2010	2015	2020
1. Biofuels	Renewables	CO_2	Regulatory	Under implementation	Ministry of Employment and the Economy	na	na	1.0
2. Voluntary agreements with car manufacturers	Energy saving, to reduce emissions	CO_2	Technical	Implemented	EU	na	na	na
3. Energy saving agreements	Energy saving, to reduce emissions	CO_2	Technical, informational, (economic)	Implemented	Ministry of Transport and Communications	na	na	na
4. Eco-driving	Energy saving, to reduce emissions	CO_2	Technical, informational, (economic)	Planned / implemented	Ministry of Transport and Communications	na	na	na
5. Promotion of public and non-motorised transport	Energy saving, to reduce emissions	CO_2	Regulatory, technical, informational, economic	Planned / proposed / implemented	Ministry of Transport and Communications	na	na	na
Effect of transport measures in total						**na**	**na**	**na**

na = Not available

24 (446/2007)

performance standards for the emissions of new passenger cars (see the WAM scenario).

There have been two energy efficiency agreements in the transport sector since the 1990s: one on goods transport and logistics and the other on public transport services. They were revised in 2007 and 2008 to comply with the requirements of Directive 2006/32/EC of the European Parliament and of the Council on energy end-use efficiency and energy services. The aim of the new agreements is a 9 per cent improvement by 2016 in the energy efficiency of those enterprises that adopt the agreements. The new agreements are part of the WAM scenario in the transport sector.

The aim of promoting public transport as well as pedestrian and cycling facilities is also an important measure in both the WM scenario and the WAM scenario. The difference between these scenarios and earlier goals is that previously there was no quantitative target set for this. The new targets for this are given below.

'With additional measures' scenario

Table 4.11 sets out the main policies and measures included in the 'with additional measures' (WAM) scenario in the transport sector. The measures are designed to achieve the EU targets for emissions reduction. The EU target set for Finland is to reduce greenhouse gas emissions in the transport sector and in other sectors outside the scope of emissions trading by 16 per cent from the 2005 level by 2020. In Finland's Long-term Climate and Energy

Table 4.11
Estimated mitigation impact of the WAM projection (million tonnes CO_2 eq.)

Policy or measure	Objective	GHG	Type of instrument	Status	Implementing entity	Estimated mitigation impact		
						2010	2015	2020
1. CO_2 performance standards for new passenger cars	Energy saving, to reduce emissions	CO_2	Regulatory	Under implementation	Ministry of Transport and Communications	na	na	2.1–2.4
2. Differentiation of car and vehicle taxation according to vehicle-specific emissions (CO_2/km)	Energy saving, to reduce emissions	CO_2	Fiscal	Implemented	Ministry of Finance	na	na	See above (number 1)
3. Implementation of vehicle energy labelling scheme	Energy saving, to reduce emissions	CO_2	Informational	Under implementation	Ministry of Transport and Communications	na	na	See above (number 1)
4. New energy saving agreements	Energy saving, to reduce emissions	CO_2	Technical, informational, (economic)	Implemented	Ministry of Transport and Communications	na	na	0.3
5. Mobility management / mobility centres (incl. eco-driving)	Energy saving, to reduce emissions	CO_2	Technical, informational	Planned	Ministry of Transport and Communications	na	na	See below (number 6)
6. Promotion of public and non-motorised transport	Energy saving, to reduce emissions	CO_2	Regulatory, technical, informational, economic	Planned / proposed / implemented	Ministry of Transport and Communications	na	na	0.3
7. Financial steering methods (fuel taxation and / or road user charges)	Energy saving, to reduce emissions	CO_2	Regulatory, fiscal and/ or economic	Planned	Ministry of Finance, Ministry of Transport and communications	na	na	Up to 1.4
Effect of transport measures in total								**2.7–3.0 (without number 7)**

na = Not available

Strategy the transport sector was set a target of reducing emissions by 15 per cent by 2020. This means that in 2020 greenhouse gas emissions from transport must not amount to more than 11.4 million tonnes CO_2 eq. In 2007 the total amount of greenhouse gas emissions from Finnish road, rail, air and sea transport was 13.7 million tonnes CO_2 eq.

In March 2008 the Ministry of Transport and Communications appointed a committee to draw up a proposal for a climate policy programme to be implemented within the Ministry's administrative sector between 2009 and 2020. The committee completed its work in March 2009. According to this programme the aim of Ministry's administrative sector is to substantially reduce emissions from business, industry, administration and people's everyday lives by means of transport and communications policies. In addition, by increasing the use of biofuels, emissions from transport will be cut by 2.8 million tonnes CO_2 eq. compared to the estimated emissions level for 2020 under the WM scenario.

The administrative sector of the Ministry of Transport and Communications will also take steps to adapt to climate change in the construction, maintenance and management of the transport and communications infrastructure, while maintaining the level of transport and communications services. It will also seek to utilise any advantage to be gained from possible benefits of climate change.

The following measures will be taken to achieve the climate policy aims of the administrative sector:

1. *The vehicle fleet will be renewed*. The aim is that by 2020 specific emissions of new cars sold in Finland would be close to the EU objective (95 g/km; the current level is at around 163.5 g/km) and the rate of vehicle fleet renewal would be around 7 per cent a year. The goal with regard to the entire vehicle fleet is that by 2020 the average carbon dioxide emissions would be 137.9 g/km at most (currently around 180.1 g/km). This means that the specific emissions of the Finnish vehicle fleet would be reduced by a third.

2. *Energy efficiency in transport will be improved*. The aim is that goods transport and public transport operators that are party to energy efficiency agreements will save 9 per cent in energy consumption and that the overall energy efficiency in the transport sector will improve.

3. *The growth of passenger traffic volumes in urban areas will be guided towards more environmentally friendly transport modes*. The aim is that by 2020 a total of 100 million more public transport journeys and 300 million more walking and cycling journeys will be made, which means about a 20 per cent increase on the current figures. The popularity of public transport, walking and cycling will be promoted particularly in growing urban areas that provide the best environment for public transport services and reasonable distances for walking and cycling.

4. *The attainment of Finland's climate policy objectives will be supported by information society and communications policy*. The administrative sector will systematically promote the use of information society services that

decrease emissions in business, industry, administration and people's everyday lives. The impact of communications technology and the spread of services in electronic form will be studied in 2009–2011.

5. *A decision will be made in 2012 on the financial steering methods used in the transport sector*. If it appears that the climate policy objectives for the transport sector cannot be achieved through the measures referred to above under 1–4, direct financial guidance mechanisms will be introduced to influence traffic volumes and the share of different transport modes. These mechanisms could include fuel taxation and road user charges. A decision on the possible introduction of financial steering methods will be made in 2012 at the latest. The new emissions reduction aims of the international climate agreement to be adopted will be taken into account in the decision-making process.

6. *Action will be taken to adapt to climate change*. The aim is that climate change will not lower the current service level in transport and communications. In order to ensure this, the Ministry's administrative sector will update its provisions concerning transport infrastructure construction, maintenance and management, outline an action plan for exceptional circumstances and invest in research. The administrative sector will also monitor and take advantage of possible new opportunities offered by climate change (e.g. the impact of a longer snow-free period on the popularity of walking and cycling, and the effect of a shorter ice-cover period on shipping).

4.7.3 International bunkers

There are currently no emission limits on international bunkers (aviation and shipping). Such limits have regularly been on the agendas of the International Civil Aviation Organisation (ICAO) and the International Maritime Organisation (IMO), but no decisions have been made.

Annual emissions from international bunkers fluctuated considerably in Finland until 1999, but have since been fairly stable or even decreased. Emissions from international bunkers amounted to 3.5 million tonnes CO_2 eq. in 2007. About two thirds of the emissions came from marine bunkers and one third from aviation. If no measures are taken, greenhouse gas emissions from international bunkers in Finland are expected to grow by approximately 0.1 million tonnes CO_2 eq. by 2020.

The EU has decided to include aviation in the EU ETS, starting in 2012. All aircraft taking off and/or landing in the EU will be included in the trading. The Parliament of Finland adopted an Aviation Emissions Trading Act in November 2009.

According to the conclusions of the EU Environment Council, adopted in October 2009, the EU strives for emission reduction targets for interna-

tional aviation and shipping in the international climate change agreement. The reduction target for emissions from shipping should be 20 per cent and for aviation 10 per cent by 2020 compared with the levels in 2005. Finland is ready to subscribe these new targets as a part of EU.

4.7.4 Industrial processes

The most significant CO_2 emissions from industrial processes are included in the EU ETS and are covered in Section 4.7.1. The remaining CO_2 sources in this sector are small and no specific policies in the WM scenario target either these emissions or the CH_4 and N_2O emissions from industrial processes.

In the WAM scenario the emissions trading sector is extended and additional emissions from industrial processes, for example N_2O emissions from nitric acid production, are included. Furthermore, the non-ETS emissions from industrial processes are subject to emission ceilings. An estimate of the impact on industrial process emissions is presented in Table 4.13.

Mitigation of F-gas emissions

'With measures' scenario

The most important regulations for reducing the amount of F-gases are the EC regulation on F-gases[25] and the directive on emissions from air-conditioning systems in motor vehicles[26]. Technical advances have affected emissions as well, because they have led to lower charges and decreased leakage.

F-gas emissions from electricity distribution equipment and foam blowing have declined as a result of voluntary measures in the industry and are expected to stabilise to the level of recent years. Restrictions prescribed by the EC regulation will cut emissions from aerosols and other sources, but emissions are expected to start rising again due to increased activity in the source fields not covered by the regulation. However, the total emissions are expected to decline as emissions from refrigeration and air conditioning equipment account for close to 90 per cent of Finnish F-gas emissions.

'With additional measures' scenario

Harmonised EU legislation does not allow national restrictions on the use of F-gases, but Member States are allowed to promote the use of alternatives. As an additional measure Finland is promoting F-gas substitutes through information dissemination and campaigns. Finland will also support partial prohibition of F-gases in the F-gas regulation that will be reviewed in 2011 (Table 4.12.).

The WAM projection for F-gases is based on the assumption that the review will lead to additional regulatory measures. Further restrictions are

25 (Regulation 842/2006/EC)
26 (Directive 2006/40/EC)

Table 4.12
Estimated mitigation impact of the WAM scenario (million tonnes CO_2 eq.)

Policy or measure	Objective	GHG	Type of instrument	Status	Implementing entity	Estimated mitigation impact		
						2010	2015	2020
Review of the EC F-gas regulation	Partial prohibition of the use of F-gases	HFCs, PFCs and SF6	Regulatory	planned*	Ministry of the Environment	0	0.16	0.38

*depends on decisions at the EU level

expected on the use in refrigeration and air conditioning equipment, foam blowing and aerosols in all technically feasible applications and in line with safety and health concerns. The emission reduction achieved with these additional measures is estimated to be 0.38 million tonnes CO_2 eq. more than in 2020 than with the WM projection.

4.7.5 Machinery

'With measures' scenario

The number of machines equipped with an internal combustion engine and used in, for example, agriculture or construction in Finland has increased in recent years to over 2.3 million. Although slightly over 10 per cent of these are tractors and other diesel-operated vehicles, they account for over 80 per cent of the CO_2 emissions of all machinery. Gasoline-driven machinery accounts for only a small proportion of emissions. About 2 per cent of all machinery is replaced annually with more energy-efficient models.

The greenhouse gas emissions generated by machinery are not directly covered by EC regulations or Finnish legislation.

In the WM scenario the CO_2 emissions generated by machinery are estimated to increase by 10 per cent from 1990 during the subsequent 25 years, to 2015. After 2015 the increase is estimated to slow down.

'With additional measures' scenario

CO_2 emissions from machinery will be tackled by promoting and increasing the use of renewable energy sources like biofuels (Table 4.13). The objective is to have the same share of bio-components in machinery fuel as in road transport fuels. The RES directive[27] on the promotion of the use of energy from renewable sources and the directive[28] and amendment[29] on the

Table 4.13
Estimated mitigation impact of the WAM scenario (million tonnes CO_2 eq.)

Policy or measure	Objective	GHG	Type of instrument	Status	Implementing entity	Estimated mitigation impact		
						2010	2015	2020
Biofuels in machinery	10 per cent share of bio-components in machinery fuel by 2020.	CO_2	Regulatory	Proposed	Ministry of Employment and the Economy	0.04	0.13	0.27

27 (Directive 2003/30/EC)
28 (Directive 1998/70/EC)
29 (Directive 2003/17/EC)

quality of gasoline and diesel fuels also create favourable conditions for increasing the use of biofuels in machinery.

4.7.6 Agriculture

WM scenario

Finnish agricultural policy is based on the view that the competitive disadvantage due to natural conditions (such as short growing period, low temperatures, frosts and problematic drainage conditions) must be compensated for in order to have profitable domestic production and to make agriculture sustainable and multifunctional. The objectives of sustainable and multifunctional agriculture include taking into account greenhouse gas emissions, the possible need for adaptation measures and other environmental and socio-economic aspects. These objectives can be reached through the Common Agricultural Policy of the EU as well as national measures. According to conclusions of the European Council, agricultural production should continue in all areas of the community.

The most effective climate policy measures can conflict with agricultural policy objectives and measures, such as securing the availability of food and animal welfare and reducing strain on water systems. If Finnish consumption patterns remained unchanged, a reduction in domestic agricultural production would be unlikely to reduce global greenhouse gas emissions as domestic production would be replaced by production elsewhere. On the contrary, transportation may even increase emissions.

Annual CH_4 and N_2O emissions from agriculture have fallen by 22 per cent since 1990 due to a decrease in the cultivation of organic soils, in the number of livestock and in nitrogen fertilisation. Changes in agricultural policy and farming subsidies have had a significant influence on agricultural activities and hence the emissions from this sector.

Agri-environmental payment is an essential tool for promoting sustainable development in agriculture, and about 90 per cent of Finnish farmers have participated in the payment programme. Its objectives are to decrease nutrient load on the environment, especially on surface and ground waters, and to preserve plant and animal biodiversity and the rural landscape. The measures also aim at maintaining or improving the productive capacity of agricultural land and reducing greenhouse gas emissions to meet the targets. Agri-environmental payment is part of the Rural Development Programme for Mainland Finland 2007–2013, which is based on a Council regulation[30].

WAM scenario

New national measures (Table 4.14) under the Long-term Climate and Energy Strategy include:

- Reduction of greenhouse gas emissions and the objectives of energy saving will be taken into account throughout agricultural policy.

30 (Regulation EC 1783/2003)

- Environmentally friendly manure treatment will be promoted.
- Production and use of energy crops will be intensified, as well as use of agricultural by-products and manure especially in biogas production.
- Finland intends to persuade the EU to change its EU state subsidy guidelines so that new national measures to reduce greenhouse gas emissions can be introduced.
- Measures to reduce greenhouse gas emissions from organic soils will be defined.
- Measures will be identified to decrease greenhouse gas emissions from animal husbandry while preserving the level of production.

Table 4.14
Estimated mitigation impact of the WAM projection (million tonnes CO_2 eq.)

Policy or measure	Objective	GHG	Type of instrument	Status	Implementing entity	Estimated mitigation impact		
						2010	2015	2020
Government Decree on the restriction of discharge of nitrates from agriculture into waters (931/2000)	To reduce discharge of nitrates	N_2O	Informational, regulatory	Implemented	Ministry of Agriculture and Forestry	na.	na.	na.
Promoting biogas treatment of manure	To reduce CH_4 emissions	CH_4	Economic, informational	Implemented	Ministry of Agriculture and Forestry	0.01	0.02	0.03
Measures affecting N_2O emissions from agricultural soils	To reduce N_2O emissions	N_2O	Economic, informational, research	Planned	Ministry of Agriculture and Forestry	0.14	0.32	0.50
Act on the implementation of the single payment scheme (557/2005) and Ministry of Agriculture and Forestry Decree (183/2006)			Economic, informational	Implemented	Ministry of Agriculture and Forestry	na.	na.	na.
Rural Development Programme for Mainland Finland 2007–20			Voluntary / negotiated agreement	Implemented	Ministry of Agriculture and Forestry	na	na	na

na = Not available

4.7.7 Land use, land-use change and forestry

'With measures' and 'With additional measures' scenario

Land use, land-use change and forestry (LULUCF) sector affects mitigation of climate change in three different ways:

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

The LULUCF sector as a whole acts as a net sink in Finland because emissions under this sector are smaller than removals. This net sink from the LULUCF sector can vary greatly from one year to the next: in 1990–2007 it was between 16.6 and 32.2 million tonnes CO_2 eq. This variation is mainly due to changes in forest harvesting levels.

According to the National Forest Inventory the annual increment of growing stock has been increasing since the 1970s, reaching its current level of 97 million cubic metres, of which 94 million cubic metres is in commercially managed forests.

Finland's forest policy aims at sustainable forest management, and the policy measures include legislation, the National Forest Programme 2015, financial support and extensive public forestry organisations. For more information on these, see Section 4.5.

The studies by the Finnish Forest Research Institute (METLA) indicate that Finnish forests will probably act as a net sink in the future, too. The objective for the forests' carbon sink (incl. trees and soil) set out in the National Forest Programme (NFP 2015) is to maintain the sink at a level of at least 10–20 million tonnes CO_2 eq. per year up to 2015. The harvesting is targeted to increase by 10–15 million cubic metres a year in the NFP 2015. The objectives and measures in the Long-term Climate and Energy Strategy are consistent with the policy defined in the NFP 2015 regarding the increase of industrial roundwood and energy wood, and will help to achieve the target set by the Directive on promotion of the use of energy from renewable sources[31]. The current global economic downturn will influence the achievements of the NFP 2015.

The national measures set out in the NFP 2015, consistent with the Long-term Climate and Energy Strategy, include the following measures to be implemented in order to secure the climatic advantages provided by forests and to ensure the availability of renewable raw materials:

- The amount of silvicultural and forest improvement work will be increased.
- A permanent bioenergy advisory service will be provided.
- Adequate training for forestry professionals, advisory services for forest owners and forest planning will be ensured.
- Forest management recommendations and instructions will be revised according to the latest research results, emphasising the vitality of forests, their impact as carbon sinks and measures promoting sustainable harvesting.
- Models for environmental payments will also be examined as well as other measures to stimulate increased sequestration of forest carbon.
- The use of wood for energy production will be promoted through provision of energy and investment subsidies while ensuring that subsidies do not distort competition.

The NFP 2015 provides the basis for both the WM and WAM scenarios, and so the WAM scenario is not described separately.

With regard to agricultural soils, CO_2 emissions from croplands and grasslands are not expected to be subject to large changes in the WM scenario by 2020. In the WAM scenario measures in the agriculture sector affecting CO_2 emissions are estimated to decrease CO_2 emissions from agricultural soils. There are still significant uncertainties in these estimates. New methods are being developed to increase the accuracy of the emissions. Emissions from peat production areas are estimated to be the same in WM and WAM scenarios.

31 (Directive 2001/77/EC)

Table 4.15
Estimated mitigation impact of the WAM projection (million tonnes CO_2 eq.)

Policy or measure	Objective	GHG	Type of instrument	Status	Implementing entity	Estimated mitigation impact		
						2010	2015	2020
Measures affecting CO_2 emissions from agricultural soils	To reduce CO_2 emissions	CO_2	Economic; informational; research	Planned	Ministry of Agriculture and Forestry	0.38	0.94	1.48
Finland's National Forest Programme			Informational	Adopted	Ministry of Agriculture and Forestry	na	na	na
Promoting the use of wood			Informational	Adopted	Ministry of Agriculture and Forestry	na	na	na
Promoting forest bioenergy			Informational	Adopted	Ministry of Agriculture and Forestry	na	na	na

na = Not available

Implementation of Articles 3.3 and 3.4 of the Kyoto Protocol

Articles 3.3 and 3.4 of the Kyoto Protocol concern emissions and removals from land use, land-use change and forestry (LULUCF) activities. Article 3.3 activities (afforestation, reforestation and deforestation) are based on land-use changes, and reporting of these activities is mandatory for the Annex I Parties. Election of activities under Article 3.4 (forest management, cropland management, grazing land management and revegetation) is voluntary for Parties during the first commitment period.

Based on a study by the Finnish Forest Research Institute (METLA), Article 3.3 activities are estimated to cause net emissions over the period 2008-2012. This is due to land-use changes from forest land to other land uses and low carbon sequestration rates in areas afforested or reforested since 1990. The estimations include high uncertainties and will get more accurate as the calculation methods are further developed.

In late 2006, the Finnish Government took the decision to elect forest management activity under Article 3.4 of the Kyoto Protocol, for the first commitment period. This would enable Finland to compensate for net emissions resulting from Article 3.3 activities and to provide removal units (RMUs) worth up to 0.59 million tonnes CO_2 eq. per year.

The potential of cropland management and grazing land management activities has been assessed by MTT Agrifood Research. It is estimated that CO_2 emissions from agricultural soils are declining. However, uncertainties associated with estimations of soil CO_2 emissions and removals and non-CO_2 emissions are still significant and therefore agricultural activities under Article 3.4 are not elected for the period 2008–2012.

4.7.8 Waste management

'With measures' scenario

Finnish waste legislation is largely based on the EU's Landfill Directive[32] and Waste Directive[33].

32 (Directive 1999/31/EC)
33 (Directive 2006/12/EC)

Implementation of the national Waste Act[34] has reduced emissions by increasing recycling and reuse of waste, landfill gas recovery and alternative treatment methods to landfills. In 2008 the Government approved the Revised National Waste Plan for 2008–2016, based on the Waste Act and EU waste legislation. It describes the current state of waste management and sets quantitative and qualitative targets to be achieved by 2016. The targets and measures are based on eight general objectives:

- Reduce the amount of waste by improving material efficiency
- Improve management of recycling
- Improve management of hazardous waste
- Reduce the greenhouse gas effect of waste management
- Reduce health and environmental disadvantages of waste management
- Improve the organisation of waste management
- Strengthen the know-how of waste management
- Perform international transfer of waste in a controlled way

Finland also has a national strategy for reducing the amount of biodegradable waste going to landfills. This national Bio Waste Strategy (2004) includes measures to implement the Landfill Directive. The directive, which sets targets for reducing the amount of biodegradable waste disposed of in landfills, was put into effect with the Government Decree on landfills[35]. Under this decree, disposal of biodegradable municipal waste at landfills had to be reduced to 75 per cent of the 1995 levels by 2006 and to 50 per cent by 2009. The target for 2016 is 35 per cent. The landfill tax was also adjusted in 2005 to encourage the reuse of biodegradable waste as material and for energy.

Greenhouse gas emissions from the waste sector will decrease in the 'with measures' (WM) projection by the year 2020. It is difficult to estimate the mitigation impacts of individual policies and measures, particularly because there is no 'without measures' scenario available for the waste management sector. The main reason for the decrease is the implementation of the Landfill Directive and national legislation and strategies to reduce the amount of waste and to minimise especially the amount of biodegradable waste delivered to the landfills.

Emission reductions have also been achieved by increasing landfill gas recovery. In the revision of the Government Decree on landfills in 2006 the collection of methane was extended to closed landfills. The total amount of landfill gas recovered in 2007 was more than a third of the total emissions from landfills, amounting to approximately 0.7 million tonnes CO_2 eq.

Finland's national waste legislation is currently under revision, and the revised statutes will implement the new Waste Framework Directive[36]. A new national waste plan is under preparation and is expected to be ready by the end of 2016. The 13 regional environment centres have each drafted their own regional waste plan.

34 (Act 1072/1993)
35 (202/2006)
36 (2008/98/EC)

'With additional measures' scenario

Greenhouse gas emissions generated by the waste sector in Finland are declining under the WM scenario, and the additional potential for emissions reductions under a WAM scenario are limited. Additional policies and measures focus on municipal waste and on biodegradable waste generated by forestry and tourism and the food and building industries. The aim is to reduce municipal waste and to achieve a situation in which 80 per cent of municipal waste is recycled or used as energy, and a maximum of 20 per cent ends up at landfills. Increased waste incineration will also reduce emissions from industrial waste generated by other industries.

Additional policies and measures in the waste sector aim at reducing the amount of waste, minimising biodegradable waste in landfills, promoting incineration and digestion of non-recyclable waste, increasing landfill gas recovery and improving waste water treatment in sparsely populated areas (Table 4.16).

The estimated total emission reduction in the WAM scenario in 2020 is 0.13 million tonnes CO_2 eq. more than in the WM scenario.

Table 4.16
Estimated mitigation impact of the WAM scenario (million tonnes CO_2 eq.)

Policy or measure	Objective	GHG	Type of instrument	Status	Implementing entity	Estimated mitigation impact		
						2010	2015	2020
Minimising CH_4 emissions from landfills	To reduce CH_4 emissions	CH_4	Regulatory	Implemented	Ministry of the Environment	0	0.15	0.09
Promoting digestion and increasing waste incineration	To reduce CH_4 emissions	CH_4, N_2O	Regulatory	Implemented	Ministry of Finance	0	0.01	0.02
Improvement of waste water management in sparsely-populated areas	To reduce N_2O emissions	N_2O		Planned	Ministry of the Environment	0.01	0.02	0.02

4.7.9 Land-use planning and spatial structure

The national Long-term Climate and Energy Strategy includes measures that aim to minimise the greenhouse gas emissions related to the urban structure. Development of the urban structure is crucial because it has a long-term effect on greenhouse gas emissions.

Measures focus on preventing urban sprawl, reducing the need for transportation and encouraging cycling and walking. The objectives include increasing the use of more efficient heating systems such as district heating in a dense urban structure. These require directing tax policies and other economic measures, municipal land use policies, guidance in land-use planning and building, and transport policy in such a way that preventing urban sprawl is a key target throughout the administration. Regional climate strategies are expected to provide information and assessments on the impacts of land-use planning on the greenhouse gas emissions.

The quantitative emission reduction potential of the policies and measures concerning land-use planning has not been estimated. Urban structure influences emissions mainly generated by transport and from heating

of buildings. Economic benefits gained from preventing urban sprawl usually outweigh the costs.

4.8 Taxation and subsidies

Energy taxation is a substantial source of revenue for the state, generating nearly EUR 3,000 million annually, or about 8 per cent of the total tax revenue. Energy taxation is an excise duty levied on transport and heating fuels and electricity. Besides its fiscal significance, energy taxation is a central instrument in energy and environmental policy. The aim is to curb the growth of energy consumption and direct the production and use of energy towards low carbon alternatives.

The current energy taxation scheme has been in force since 1997. Some modifications to the scheme have been made in order to alleviate the impact of the EU ETS, which started in 2005. Specifically, ETS was seen to cause problems for industrial competitiveness, mainly due to rising electricity prices. Therefore, from the beginning of 2007 the electricity tax for industry was halved from 0.44 c/kWh to 0. c/kWh.

Emission trading was also regarded as a threat to the use of peat in energy production, especially in the production of condensing power. This could lead to serious unemployment problems in the peat industry and weaken Finland's security of energy supply, as peat is a major domestic energy source. Therefore, in July 2005 the tax on peat was abolished, and at the same time tax subsidies for peat in electricity production were discontinued. A cost-effective feed-in tariff system for 2007–2010 has also allowed the continued use of peat instead of coal in some condensing power plants. According to the Long-term Climate and Energy Strategy, the feed-in tariff system will be continued after 2010.

Energy taxation is divided into a basic tax and a surtax. The basic tax is fiscal by nature and is collected on oil products only. It is graded according to the quality and environmental characteristics of gasoline and diesel oil. The surtax is collected on oil products, other fossil fuels and electricity. The surtax on fuels is determined according to their carbon content, and since 2008 it has been EUR 20.3 per tonne of CO_2, with the exception of natural gas, which is subject to a 50 per cent reduction in the surtax. Fuels used for power production are tax-free. Electricity is taxed at the consumption stage. This is divided into two classes, of which the lower tax is paid by industry and commercial greenhouses, and the higher tax by other consumers. In addition to the energy tax, a security of supply fee is charged for energy products.

The energy taxation scheme also encompasses other elements aimed at promoting the goals of energy and climate policy. In a broad sense, these can be called tax subsidies. Subsidies for power production were introduced in 1997. The taxation system has also been reformed, changing the focus from taxing the production of fuels to taxing their consumption. In addition, the weakening competitiveness of small power plants using renewable energy and peat has been addressed by introducing financial support for small power plants. More recently, the tax subsidy model has been applied more generally as a means of promoting electricity produced with renewable sources.

The latest extension of the financial support for power plants using renewable resources was in 2007. At present this support covers nearly all power production based on renewable energy sources, except large hydropower units. In 2007, this support, in the form of tax subsidies, was at three levels: EUR 0.69 c/kWh for wind power and electricity produced with forest chips; 0.25 c/kWh for electricity produced with recycled fuels; and 0.42 c/kWh for electricity produced with other renewable sources. In 2008, a little over EUR 9.5 million was paid as tax subsidies for power production. In addition, tax refunds for energy-intensive industries have been considered necessary to ensure that energy taxation is not an unreasonable burden. These refunds are around EUR 9 million annually.

Certain features of the taxation scheme also aim to favour selected sources of energy and forms of production. Such features are exceptions to the general calculation method of the CO_2 tax (natural gas) and to the calculation rules concerning the taxation of combined heat and power production. However, these are not regarded as direct subsidies.

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

4.9 Use of Kyoto mechanisms

Under the EU emissions trading scheme, companies may meet part of their emission reduction obligation by engaging in the Clean Development Mechanism (CDM) and the Joint Implementation (JI) mechanism. These are projects in developing countries and in other Annex I countries which will cost-efficiently reduce emissions and create tradable emission units in the form of certified emission reductions (CERs) and emission reduction units (ERUs). The Government may also use project mechanisms or acquire assigned amount units (AAU) through international emissions trading in accordance with the Kyoto Protocol in order to meet Finland's national emission commitments. In 2008–2012 Finland may allow its operators in the EU ETS to use CERs and ERUs up to a maximum relative threshold of 10 per cent.

The Government's budget for the acquisition of Kyoto mechanisms during the first commitment period is EUR 70 million. Approximately EUR 20 million has already been invested in the CDM/JI pilot programme, which operated from 1999 until early 2006. The rest has been or will be allocated in 2005–2010. Investments in projects and funds are described in Chapter 7, section 7.3. The Government will acquire the units using its own consultant and multilateral carbon funds.

The strategy of the purchase programme for the Kyoto period (2008–2012) was updated at the end of 2007. The Government's purchase programme for the Kyoto period was approved in November 2008. The target is to purchase emission units of 7 million tonnes CO_2 eq. to be used in 2008–2012. In addition, EUR 30 million will be allocated for purchasing credits for the post-2012 period. It has been estimated that the present contracts could generate more than 6 million tonnes CO_2 eq. Considerable uncertainties are involved, because both the funds and bilateral projects contain significant risks. The use of the Kyoto mechanisms is supplementary to domestic actions for cutting greenhouse gas emissions.

4.10 Effect of policies and measures on longer term trends

The effect of the policies and measures of the ETS and non-ETS sectors (excluding the LULUCF sector) under the WM and WAM scenarios in 2020 are presented in Table 4.17.

As agreed in the EU climate and energy package, Finland will cut its greenhouse gas emissions in the non-ETS sectors by at least 16 per cent by 2020 from 2005 levels. This means that emissions from the non-ETS sectors should not exceed 29.7 million tonnes in 2020.

Emissions from the EU ETS sector are expected to increase by 2020, under the WM scenario. In the WAM scenario, however, emissions will start to decline as a result of strict measures concerning energy efficiency, renewable energy sources and measures in the non-ETS sector.

Table 4.17
Emissions in WM and WAM scenarios in 2020 (million tonnes CO_2 eq.)

Sectors	2005	2006	2007	2020	
				WM	WAM
Transport	13.4	13.6	14.0	14.2	11.4
Space heating	3.1	3.0	3.1	2.6	1.2
Agriculture	5.6	5.6	5.5	5.7	5.1
F-gases	0.9	0.8	0.9	0.6	0.3
Waste management	2.4	2.5	2.4	1.8	1.7
Machinery	2.6	2.6	2.6	2.7	2.5
Other sources, of which:	7.7	7.2	7.5	8.4	7.5
• Non-ETS industry CO_2	1.6	1.6	1.6	1.5	1.1
• Combustion, N_2O	0.9	1.0	1.0	1.1	1.0
• Hydrogen production, CO_2	0.07	0.07	0.07	0.8	0.8
Non-ETS total	**35.7**	**35.3**	**36.0**	**36.0**	**29.7**
Emissions in the ETS sector	**33.1**	**44.6**	**42.5**	**52.6**	**38.8**
Total emissions	**68.8**	**79.9**	**78.5**	**88.6**	**68.5**

4.11 Mitigation benefits other than greenhouse gas reduction

The Finnish Environment Institute has performed environmental impact assessments (EIAs) on Finland's climate and energy strategies. The EIA of the latest strategy includes a comprehensive examination of the benefits and adverse impacts of the strategy. The measures for reducing greenhouse gas emissions included in the strategy are estimated to have an overall positive impact on the environment. In general, measures that reduce greenhouse gas emissions also reduce air pollution. Small-scale wood burning is an exception, however.

A life-cycle analysis of the WM and WAM scenarios shows that the combined environmental impact of fuel production and consumption is likely to decrease relative to the year 2000. The combined environmental impact includes

eight categories of effects on the environment: climate change, acidification, freshwater eutrophication, human health damage due to ozone formation, fresh water ecotoxicity, terrain ecotoxicity, human toxicity and fossil fuel depletion. This combined environmental impact will decrease mainly due to reduced fuel consumption in Finland.

Improved energy efficiency and energy savings are expected to have a positive effect on the environment as the need for energy resources and infrastructure will diminish. Natural resources will also be preserved.

According to the EIA flexible the mechanisms of the Kyoto Protocol can also be used in a way that supports the goals of national development policy.

4.12 Economic impacts

The Government Institute for Economic Research studied the effects of the Long-term Climate and Energy Strategy on the economy using a dynamic applied general equilibrium model (AGE model).

The simulations are based on the policies required for meeting the Kyoto and longer term emission targets. The EU's Emissions Trading Scheme (EU ETS) forms a natural starting point for the simulations. The ETS emission permit prices are assumed to rise gradually to EUR 25 per tonne CO_2 by 2012. By 2020, when the tougher target of 20 per cent below 1990 greenhouse gas levels applies, a CO_2 price of EUR 30 or 45 per tonne CO_2 is assumed. Increases in the use of renewable energy sources are assumed to be achievable using economic and mandatory measures. Finally, taking into account energy saving measures as well, the full impact of the measures is calculated.

It is not possible to achieve the targets for emissions, renewable energy and energy efficiency without economic costs. Gross domestic product (GDP) in 2020 under the WAM scenario would be 0.8 per cent lower than under the WM scenario. Private consumption would be 1.8 per cent below the WM scenario. The targets for renewable energy and energy efficiency would mean a slight increase in investments and employment, however.

Table 4.18
Economic impacts of the WAM scenario in comparison with the WM scenario, % (allowance price: EUR 30/tonne CO_2 eq.)

	EU ETS	Renewables target	Energy efficiency target	Total
Household Consumption	−1.6	0	−0.2	−1.8
Investments	−1.1	−0.15	+1.5	+0.25
Employment	−0.05	+0.02	+0.03	0
GDP	**−0.5**	**−0.25**	**−0.05**	**−0.8**

4.13 Minimising adverse effects of policies and measures in other countries

Finland strives to implement its commitments under the Kyoto Protocol in such a way that social, environmental and economic impacts on other Parties of the protocol, and developing countries in particular, are minimised.

It takes into account the available knowledge on and understanding of possible impacts of its anticipated measures, based on information received from other Parties. At the same time, it keeps in mind the need to achieve the ultimate objective of the Climate Convention and the need for developed countries to lead in combating climate change and its adverse effects.

An environmental impact assessment was performed on Finland's national Long-term Climate and Energy Strategy. The anticipated measures were assessed, publicised for stakeholder comments and made public before discussion and adoption of the strategy by the Parliament. The principle is to plan and implement emission reduction measures in an open and transparent way, in accordance with notification requirements under international trade conventions.

Development policy is one of the methods to minimise impacts of climate policies and measures in developing countries (see Chapter 7 for more details on development policy and climate change). Finland's Development Policy Programme identifies energy as a sector where sustainable development can be promoted. Finland aims to support programmes and projects that focus on saving energy, increasing energy efficiency and promoting renewable energy production, and it also aims to target these projects especially at poor countries and regions. The production of renewable energy, in particular bio, solar and wind energy, will provide employment and income for the local population. Bioenergy projects can be linked with the promotion of sustainable forestry, for example through the use of thinning and logging residues in power generation. Local production of renewable energy and linking this with forestry will generate sustainable economic growth.

Finland also supports developing countries by helping them to build their capacities and develop their economic infrastructure, thus helping diversify their economies and energy production. Economic diversification and private sector development are particularly important targets in various Finnish bilateral programmes and Finnish-supported multilateral programmes in Zambia, South Africa, Nicaragua and the Mekong region. Regional programmes that promote the role of private sector in providing energy services are being promoted in Latin America, Sub-Saharan Africa and parts of Asia (see Chapter 7).

Decision 15/CMP.1 under the Kyoto Protocol require Parties to report how they have given priority to specific actions taken to minimise the adverse impact of response measures in developing countries. A summary of these in relation to Finnish climate policy is presented in Annex 4. The annex includes information that is also referred to in Chapter 7.

Literature

Ministry of Employment and the Economy (2008) Long-term Climate and Energy Strategy. Government Report to Parliament, Ministry of Employment and the Economy Publications, Energy and Climate 36/2008, Helsinki, Finland (in Finnish).

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

Ministry of Trade and Industry (2005) Outline of the Energy and Climate Strategy Policy for the near future – National Strategy to implement the Kyoto Protocol. Government Report to Parliament, MTI Publications 27/2005, Helsinki, Finland

Prime Minister's Office (2009) Government Foresight Report on Long-term Climate and Energy Policy: Towards a Low-carbon Finland. Prime Minister's Office Publications 28/2009, Helsinki , Finland http://www.vnk.fi/julkaisut/listaus/julkaisu/en.jsp?oid=273275

Internet links

Association of Finnish Local and Regional Authorities, http://www.localfinland.fi

Cities for Climate Protection, http://www.icclei.org/ccp

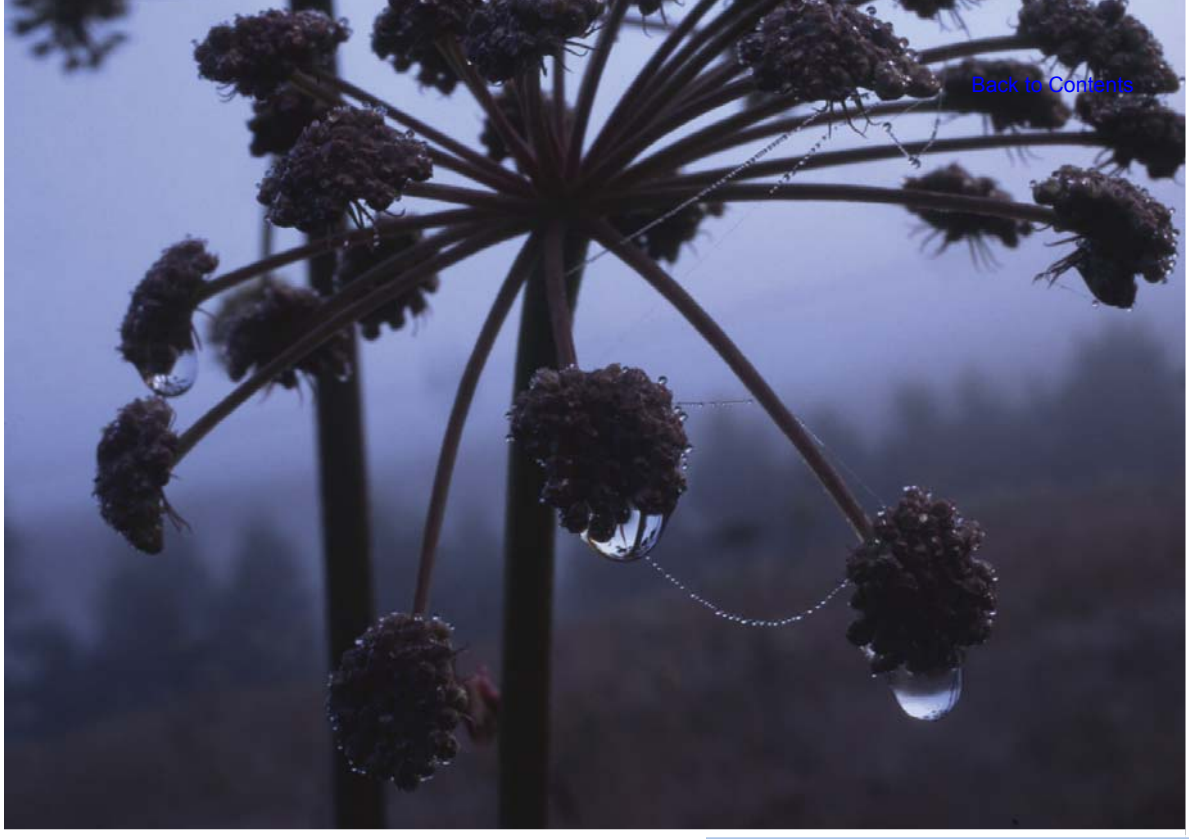
Climate Change and Helsinki Metropolitan area, http://www.ytv.fi/ENG/future/climate_change

The Finnish National Commission on Sustainable Development, http://www.environment.fi/sustainabledevelopment

METKA project, http://www.metkaprojekti.info

Information on energy efficiency agreements, http://www.motiva.fi/en/areas_of_operation/energy_efficiency_agreement

Ministry of Empoloyment and the Economy. The report of the Energy Efficiency Committee: Proposal for energy saving and energy efficiency measures. Extract from the report (in English) http://www.motiva.fi/en/finland_facts/energy_efficiency_committee/



Back to Contents

5 Projections and assessment of policies and measures

This chapter describes projections on Finnish greenhouse gas emissions and how the emissions are influenced by e.g. energy consumption and production. Two scenarios are presented: "with measures" and "with additional measures", to show how Finland will reach its emissions reduction targets up to 2020. The chapter ends with a description of a sensitivity analysis of the scenarios and the methodology used in developing them.

Back to Contents

Photos

Esko Kuusisto, page 137
futureimagebank.com, pages 141, 142, 143

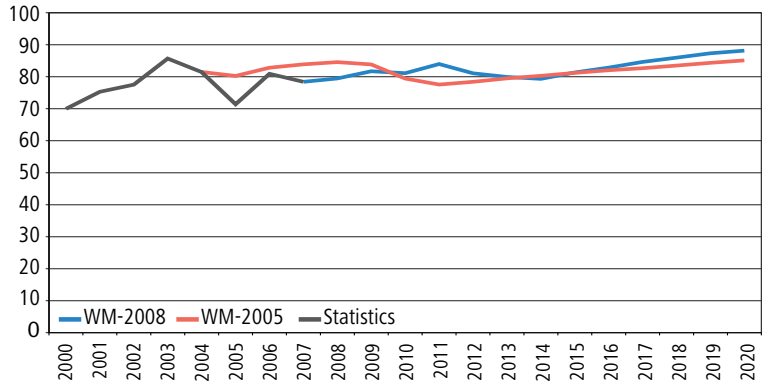
5 Projections and assessment of policies and measures

5.1 Assessment of WM scenarios for the present and previous climate and energy strategies

The national Long-term Climate and Energy Strategy was approved by the Government in November 2008. The previous strategy, which was described in detail in the Fourth National Communication, was published in 2005. Key-assumptions and starting points for the 'with measures' (WM) scenarios in both strategies are quite similar and hence the emissions projections are similar too. It should be noted that the present economic downturn and especially the structural adjustment of the forest industry have not been taken into consideration in these scenarios.

Figure 5.1 shows Finland's greenhouse gas emissions in the WM scenarios for the last two national climate and energy strategies. The main difference between the two scenarios is the assumed period for start-up of the fifth nuclear plant. In the 2005 WM scenario power production was assumed to start in 2009–2010, whereas the 2008 WM scenario takes into account the new estimated start-up year, 2012. The revised start-up is due to various delays in construction.

Figure 5.1
Greenhouse gas emissions in the WM scenarios for the climate and energy strategies published in 2005 and 2008, (million tonnes CO_2 eq.)[1]



1 Greenhouse gas emissions without emission reduction units acquired by EU ETS entities.

5.2 WM scenario for 2008–2020

5.2.1 Scenario formulation

When the 2008 WM scenario was compiled the present economic downturn was not fully evident. Moreover, the scenario did not take into account the rapid structural adjustment of the forest industry. For these reasons, the scenarios of the Long-term Climate and Energy Strategy are under revision, but updated scenarios will only be available late in autumn 2009. Therefore, the 2008 scenario results are reported below.

The WM scenario describes a development in which measures already implemented and adopted affecting different sectors are continued with. For the energy sector these include regulations that affect the energy performance of buildings, energy taxes and subsidies, financing research and testing related to energy technology and decisions that affect the structure of the energy market (electricity import capacity, nuclear energy capacity). Scenarios have been developed for other sectors as well, and these have been included in the calculations. The WM scenario does not state how probable or acceptable the final result will be. Neither does it assess the probability of the basic variables, such as economic growth or the trend in fuel prices on the world market. The scenario describes one vision that is internally consistent and is based on calculations with pre-defined starting points. From a greenhouse gas emissions point of view, the scenario represents a development path that shows the magnitude of new appropriate additional measures needed to reach the emissions targets. The scenario calculations were formulated by a working group consisting of experts from ministries that are central for Finland's climate policy.

5.2.2 Starting points of the WM scenario

Table 5.1 shows a summary of the main assumptions of the WM scenario for 2006–2010. The assumptions regarding international fuel prices on the world market are consistent with the latest estimates of the International Energy Agency (IEA) and studies made for the European Commission. Economic growth and the change in the structure of the economy play a key role in the calculation of energy consumption and emissions. In the long term, economic growth is mainly determined by the size of the labour force and its productivity. The ageing population is the single most signifi-

Table 5.1
Starting points and assumptions of the WM scenario

	2006–2010
GDP growth	More than 2 per cent per year
Structure of the economy	Increasing share of services
Structure of industry	Less capital and energy intensive
Growth of the population	Increasing slowly
Structure of the population	Ageing
Energy prices in world markets	Increasing prices
Price of emission allowances	About EUR 25/per tonne CO_2
Technological development	Gradual introduction of improved and more efficient technology

cant factor in terms of its effect on the development of the national economy. Another factor that affects the availability of labour is the level of structural unemployment. The calculations resulted in a slightly declining level of economic growth, which is nevertheless expected to remain a little over 2 per cent per year up to the 2020s.

It is estimated that services will grow slightly more quickly than the GDP, increasing the proportion of services in the national economy. Industrial production will become less energy and capital intensive. The electrical and electronics industry will still be the fastest growing industry. Average growth of production in energy intensive industries (i.e. the forest industry, the chemical industry and the manufacturing of basic metals) is estimated to remain clearly below the average level of industrial growth, which will reduce their share of total industrial production.

The scenario assumes that Finland's fifth nuclear power plant will be completed in 2012.

The use of coal in condensing power plants is assumed to increase until the completion of the new nuclear power unit and to decrease after that. Towards the end of the period the use of coal will slightly grow again as coal-based condensing power is needed to cover the growing electricity demand.

Competitiveness of wood fuels has greatly improved in the past few years due to the EU Emissions Trading Scheme (EU ETS), technological development and taxation. It is assumed that this will improve further mainly because of increasing emissions allowance prices.

Peat competes mainly with wood in CHP production. Based on the price assumptions of the WM scenario, industrial waste wood and some lower cost forest chips can compete with peat. When large amounts of fuel are needed for CHP production, peat is commonly the main fuel used, alongside a smaller proportion of wood. Consumption of peat will slightly decrease in the production of electricity and heat for municipalities. In industry, its use will remain stable. In condensing power production, the use of peat follows the same pattern as coal – declining initially after increased nuclear capacity, but starting to grow again towards 2020.

In relative terms, wind power shows the strongest growth in the WM scenario. Its production is estimated to grow from 261 GWh in 2008 to 1000 GWh in 2020, equating to a growth of 12 per cent per year.

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

Technological development is assumed to continue in the energy and other sectors, but no quick technological leaps or transfers are expected up to 2020. The best commercially available technology will be introduced gradually and increasingly efficient technology will be commercialised step by step. In practice, commercially available technology with the best energy efficiency has not always

been the technology chosen. Other properties such as price and market defects can be important and do not necessarily support the choice of energy-efficient products. In the WM scenario, this so-called efficiency gap is assumed to remain as broad as it is currently.

Energy taxes are assumed to remain at their current level in real terms. In other words, inflation would be the only factor affecting taxes. The structure of energy taxation and car taxation would also remain the same in the scenario.

Domestic migration is characterised by regional concentration in growth centres and by simultaneous decentralisation around these centres. The regional and urban structure is mainly controlled through land-use planning at the provincial and municipal levels. In the WM scenario, policies affecting the regional and urban structure are assumed not to change.

The WM scenario for transport is mainly in line with current transport policy, such as promoting sustainable development, limiting overall growth in transport, planning urban structure and land use, and developing logistics, public transportation and non-motorised modes of transport. The scenario seeks to reach the climate policy targets mainly by using the above-mentioned measures and by improved energy efficiency of vehicles.

Estimating future agricultural production under the WM projection is based on the assumption that agricultural policy will continue to follow the autumn 2008 decisions of the Agriculture and Fisheries Council regarding the so-called Common Agricultural Policy (CAP) Health Check, i.e. the policy review of the CAP.

The National Forest Programme (NFP 2015) forms the basis of Finland's national forest policy. The aim of the programme is to meet domestic and international requirements for sustainable forest management and protection in such a way that forests will provide Finns with as much work and sources of livelihood as possible. At the same time, the aim is that Finnish forests remain healthy, vital and diverse and provide spiritual and physical recreation for all.

The EU ETS and use of the Kyoto mechanisms have been included in the WM scenario.

5.2.3 Total energy consumption

In the WM scenario total consumption of primary energy will grow from approximately 1,510 PJ in 2006 to 1,725 PJ by 2020. The growth will clearly slow down compared to 1990–2006. The average annual growth in 2006–2020 will be only 1 per cent, whereas in 1990–2006 it was over 2 per cent (Table 5.2). Use of peat and hydropower as energy sources will remain close to their current levels, which means that their relative share will decrease. Use of oil will remain quite stable in the transportation sector, but it will increase in industry. The most significant growth, 58 per cent, in the WM scenario will occur in nuclear power. Use of coke, as well as blast furnace and coke oven gases will increase as a result of increasing steel production. Use of natural gas is estimated to increase by about 0.7 per cent annually during the period examined. Use of wood-based fuels will remain stable, but the use will

Table 5.2
Consumption of primary energy by source in the WM scenario 2005–2020, TWh

	2005	2006[2]	2007	2010	2015	2020
Transport fuels	46	47	48	46	48	48
Other oil	54	54	52	56	58	60
Coal-based fuels	38	62	53	57	56	70
Natural gas	41	47	41	48	47	52
Peat	19	26	28	25	22	24
Wood-based fuels	79	89	82	85	89	91
Nuclear power	68	67	68	67	106	106
Hydro power	14	11	14	13	14	14
Wind power	0	0	0	1	1	1
Others	5	6	9	10	11	13
Electricity import	17	11	13	11	5	0
Total consumption	**381**	**420**	**408**	**417**	**457**	**479**

vary considerably between different wood fuels. Use of the single biggest fuel, black liquor from the pulp industry, will decrease, while the use of forest chips will increase substantially. Electricity imports will decrease.

Heat consumption in buildings will grow approximately by 0.5 per cent per year in 2006–2020 as a result of the growth in the building stock. Decrease in specific consumption (kWh/m^3) due to renewal of the building stock will limit the growth in heating. The market share of district heating is estimated to grow further. The proportion of electric heating will decrease by approximately one percentage point and of oil heating by approximately ten percentage points. The proportion of ground heating will double, but it will remain modest in relation to the entire market.

More than 90 per cent of the energy consumption in transportation consists of gasoline and diesel oil in road transportation. The decrease in the consumption of gasoline that started in the early 1990s will continue thanks to clearly improving fuel economy of new passenger cars. The majority of diesel fuel is used for goods transportation and the consumption is thus largely dependent on the trends in transport-intensive industry and services. The share of new diesel-driven passenger cars is also expected to rise.

Agricultural production is not assumed to grow in the scenario and the total use of fuels in agriculture will decrease slightly. Use of wood and other biofuels will grow, whereas the use of light fuel oil will decrease. Use of fuels in construction is estimated to remain at approximately the same level.

2 The starting point in Long-term Climate and Energy Strategy was information for the year 2006. In the tables presented in this chapter, the values from energy statistics and the greenhouse gas inventory for the year 2007 have also been included.

5.2.4 Total consumption and production of electricity

In the WM scenario, total electricity consumption, including transfer and losses due to distribution, will grow from 90 TWh in 2006 to approximately 103 TWh by 2020 (Table 5.3). This is a clearly slower growth than in 1996–2006 when the growth was 20 TWh. The average annual growth is approximately 1 per cent, that is, the same as the growth in the consumption of primary energy.

Despite improved electricity efficiency, households will need more electricity mainly due to new appliances. The amount of electricity used for heating will remain practically unchanged. In service branches, production will grow relatively strongly, and this will also be visible in the considerable growth in electricity consumption. However, considering that the services sector accounts for more than 60 per cent of the GDP, its proportion of total electricity consumption is modest.

Table 5.4 shows the structure of electricity supply. The new nuclear power unit is assumed to start operation in 2012, which can be seen in the significant growth in nuclear power production at the beginning of the next decade. CHP production will increase in municipalities and industry. Production of conventional condensing power will decrease due to the new nuclear power unit, but it will start growing again later on. Net imports of electricity will decrease drastically from the present level. Production of hydropower will remain at approximately the current level (the production in 2006 was well below the average). Wind power production will increase and reach 1 TWh in 2020.

Table 5.3
Electricity consumption in each sector in the WM scenario in 2005–2020, TWh

	2005	2006	2007	2010	2015	2020
Industry and construction	44.2	48.1	48.0	49	53	55
Housing	12.7	12.8	13.0	14	14	15
Electrical heating	8.8	9.1	8.9	10	10	10
Services	14.7	15.2	15.2	16	17	18
Other consumption	1.5	1.6	2.4	2	2	2
Losses	3.1	3.2	3.0	3.2	3.5	3.6
Total consumption	**84.9**	**90.0**	**90.4**	**93**	**100**	**103**

Table 5.4
Structure of electricity supply in the WM scenario 2005–2020, TWh

	2005	2006	2007	2010	2015	2020
Hydropower	13.4	11.3	14.0	13.4	14.0	14.2
Wind power	0.2	0.1	0.2	0.5	0.8	1.0
CHP, industry	10.6	11.9	11.4	12.5	13.6	14.2
CHP, district heating	15.8	15.7	15.3	17.3	18.0	18.3
Nuclear power	22.4	22.0	22.5	22.0	34.9	34.9
Condensing power	5.3	17.6	14.3	16.4	13.8	21.3
Net imports	17.0	11.4	12.6	10.5	4.5	–1.0
Total	**84.8**	**90.0**	**90.4**	**92.5**	**99.6**	**103.1**

5.2.5 Greenhouse gas emissions

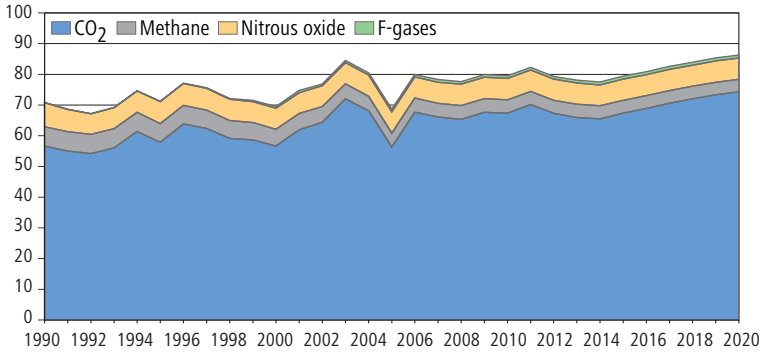
Summary of total emissions

Total emissions in the WM scenario in the years 1990–2020 are shown in Figure 5.2. Compared to the base year 1990, the total emissions are expected to be 15 per cent higher in 2010 and 25 per cent higher in 2020. With regard to CO_2 emissions, the corresponding figures will be 22 per cent and 35 per cent higher. On the other hand, increase in other greenhouse gas emissions will be small. In particular, the amount of methane from landfills will decrease. In 2007, emissions in the ETS -sector were 55 per cent and in the non-ETS sector 45 per cent of the total. The share of the EU ETS sector is estimated to start to decline at the beginning of the next decade (mainly due to the new nuclear power unit), but to increase again close to 60 per cent in 2020. In the ETS sector, the emissions in 2020 are estimated to be 52.6 million tonnes CO_2 eq. and in the non-ETS sector 36 million tonnes CO_2 eq.

In the EU's burden sharing agreement (see Chapter 4, Section 4.1.1) Finland agreed to cut its emissions in 2008–2012 to the level of 1990, that is an average of 71.0 million tonnes CO_2 eq. per year. The impacts from activities under article 3, paragraphs 3 and 4, are expected to result in credits (removal units (RMU)) equal to the cap set for Finland for forest management of 0.59 million tonnes CO_2 eq. per annum. Finland's emissions target would therefore be 71.6 million tonnes CO_2 eq. per year in the Kyoto period. Calculations show that with the assumptions of the WM scenario, emissions would be above the target level in 2008–2012.

However, in accordance with a decision of the European Commission in 2008, sectors under the ETS will be granted emissions allowances averaging 37.6 million tonnes CO_2 eq. per year during the Kyoto period. Emissions from non-ETS sectors are estimated to be an average of around 35.2 million tonnes CO_2 eq. per year in the same period. The total volume of emissions would therefore amount to 72.8 million tonnes CO_2 eq. The number of available assigned amount units, 71 million tonnes CO_2 eq., the removal units from forest management of 0.6 million tonnes CO_2 eq., and the emissions units that the Government will require using project mecha-

Figure 5.2
Total emissions in the WM scenario in the years 1990–2020 (without LULUCF)



nisms or through purchase of assigned amount units of 1.4 million tonnes CO_2 eq., in total 73 million tonnes CO_2 eq., would be sufficient to cover Finland's obligation even in the WM scenario during the Kyoto period. The Kyoto period is already in progress, and so the most important measures have already been implemented in order that targets can be met. Because of this the WM and WAM scenario outcomes are very similar over this time period. In the longer term they differ significantly from each other.

Carbon dioxide emissions

In the WM scenario CO_2 emissions from the combustion of fossil fuels and peat will increase along with the increasing consumption of primary energy and electricity. In 2007, the emissions were approximately 64 million tonnes, after which they will stay relatively stable until 2015 but start to grow again to 73 million tonnes by 2020.

CO_2 emissions will increase fastest in industry and in the district heating sector. Emissions from CHP production will increase, but emissions from residential heating will decrease. Although the consumption of heating energy will grow, the heat will more often be produced in district heating plants. Growth in electric heating will decrease residential heating emissions, but increase them in electricity production. Certain fossil fuels related to industrial processes that are difficult to replace are included in the calculations. These include the use of coke, because in steel manufacturing it is not only a fuel, but also a material that is tied to the end product. Another example is by-products of oil refining, such as refinery gases. In refineries, crude oil is used to produce oil products but it also generates refinery gases that can be utilised in energy production.

CO_2 emissions from industrial processes are mainly caused by burning of limestone ($CaCO_3$) and the manufacturing of hydrogen (Table 5.5). These emissions have amounted to approximately 3.5 million tonnes per year, and will reach 4.6 million tonnes after 2015 because of increasing chemical and metal production.

Table 5.5
CO_2 emissions in the WM scenario in 2006–2020

CO_2	million tonnes CO_2				
	2006	2007	2010	2015	2020
Total, without LULUCF	67.7	66.1	69.0	69.3	76.3
Energy	63.7	61.8	64.9	64.7	71.4
Industrial processes	3.8	4.2	4.1	4.6	4.9
Other	**0.1**	**0.1**	**0**	**0**	**0**

Methane

In 2006, methane emissions amounted to approximately 4.8 million tonnes CO_2 eq., while in 1990 they were 6.4 million tonnes CO_2 eq. Emissions from waste formed half of the total emissions in 2007, including emissions from landfills and wastewater treatment. A little more than a third of all emissions came from livestock husbandry, mainly cattle breeding. Approximately 10 per cent of all methane emissions come from incomplete combustion of fuel, which is mainly caused by fireplaces and small heating boilers. Methane emissions in power-and heating plants are very small. Ap-

proximately half of all methane emissions from combustion are caused by burning wood in fireplaces.

In the WM scenario, methane emissions are projected to continue falling as emissions from agriculture will fall and the amount of waste deposited in landfills will decrease as a result of waste management (Table 5.6). According to the Ministry of the Environment, the current development would lead to methane emissions in waste management of approximately 2.1 million tonnes CO_2 eq. in 2010. Methane emissions from agriculture are assumed to continue to fall by 2010 to a level which would be 16 per cent below the level in 1990. Methane emissions from energy production are estimated to remain stable.

Table 5.6
Methane emissions in the WM scenario in 2006–2020

CH_4	million tonnes CO_2 eq.				
	2006	2007	2010	2015	2020
Total, without LULUCF	4.6	4.6	4.4	4.0	3.9
Energy	0.4	0.3	0.5	0.5	0.5
Agriculture	1.9	1.8	1.8	1.7	1.7
Waste	2.4	2.3	2.1	1.8	1.7
LULUCF	0.1	0.1	0.2	0.2	0.2

Nitrous oxide

Emissions of N_2O amounted to 7.9 million tonnes CO_2 eq. in 1990 and 7.0 million tonnes CO_2 eq. in 2007. Close to 50 per cent came from agriculture, approximately 20 per cent from industrial processes and 10 per cent from transport, particularly from catalytic converters. The industrial emissions were from the manufacture of nitric acid. Solvents and waste also produced minor amounts of N_2O emissions.

In energy production, N_2O emissions come mainly from fluidized bed combustion and from the combustion of sewage sludge, i.e. from combustion at low temperatures. Fluidized bed combustion enables high efficiency and relatively low emissions when using low-quality fuel. The fact that these boilers are becoming more common will, on the one hand, promote the use of biofuels but, on the other, increase N_2O emissions.

The emission factors of bubbling fluidized bed combustion and wood combustion are relatively high. In the WM scenario, total emissions of N_2O are estimated to slightly increase during the period to 2020. A small change is expected in agricultural emissions since the emissions from manure management are forecast to decrease and the emissions from soils to grow slightly due to increases in the use of mineral fertilizers and organic soils. Direct N_2O emissions from transport are assumed to increase at a moderate level (Table 5.7). Increased use of biofuels and the consequent growing number of fluidized bed combustion boilers could lead to an increase in emissions in this subsector, though this will be countered by a renewal of the boiler base and possible additional measures aimed at reducing NO_x emissions will lower the N_2O emissions.

Table 5.7
Emissions of nitrous oxide in the WM scenario in 2006–2020

N_2O	million tonnes CO_2 eq.				
	2006	2007	2010	2015	2020
Total, without LULUCF	7.0	7.0	7.5	7.5	7.9
Energy (including transport)	1.5	1.5	1.5	1.5	1.5
Industrial processes	1.4	1.5	1.7	1.8	1.9
Solvent and other product use	0.0	0.0	0.2	0.2	0.2
Agriculture	3.7	3.7	3.8	3.8	3.9
Waste	0.2	0.2	0.2	0.2	0.2
LULUCF	0.1	0.1	2.8	3.1	3.1

F-gases

Emissions of F-gases have increased strongly in the past few years. In 2007, they amounted to 0.9 million tonnes CO_2 eq. The growing emission trend has been mainly driven by the substitution of ozone depleting substances in many applications. The WM scenario assumes that the growth is going to cease and turn downwards (Table 5.8). The majority of the emissions are caused by commercial refrigeration and mobile air conditioning systems. The refrigeration and air conditioning sector accounts for close to 90 per cent of the current F-gas emissions.

Table 5.8
Emissions of F-gases in the WM scenario in 2006–2020

F-gases	million tonnes CO_2 eq.				
	2006	2007	2010	2015	2020
F-gases	0.8	0.9	0.8	0.7	0.6

5.3 WAM scenario for 2008–2020

5.3.1 Starting points of the WAM scenario

The assumptions made regarding the development of the national economy and international energy prices were identical in both the 'with additional measures' (WAM) scenario and in the WM scenario. In addition, assumptions concerning nuclear power, hydropower, the natural gas network and the capacity of cross-border electricity transfer were similar. The differences between the scenarios were in the policy sector. The latest Long-term Climate and Energy Strategy incorporates the so-called 20–20–20-commitments of the EU, that is to reduce greenhouse gas emissions by at least by 20 per cent from 1990 by 2020, to have a 20 per cent share of renewable energy sources in final energy use and to increase energy efficiency by 20 per cent. Because all the EU countries are striving towards the same goals, the price of every EU ETS emission allowance is assumed to increase from EUR 25 per tonne CO_2 in the WM scenario to EUR 30 per tonne CO_2 in the WAM scenario. This assumption is based on studies made by the EU Commission. The Finnish national goals in line with the EU 20–20–20 package require that renewable energy should account for 38 per cent of final energy use by 2020, and that

greenhouse gas emissions in the non-ETS sectors should fall by 16 per cent between 2005 and 2020. Under a further EU-wide goal, renewable energy sources should account for 10 per cent of road transport fuels by 2020. The WAM scenario should allow Finland to achieve these main goals.

5.3.2 Energy

Greenhouse gas emissions from the non-ETS sectors accounted for more than 35 million tonnes of CO_2 eq. in 2005. Finland's obligation – a reduction of 16 per cent in the non-ETS sectors – means that by 2020, greenhouse gas emissions must not exceed 29.7 million tonnes. As a consequence, Finland must reduce emissions in these sectors by approximately 6 million tonnes CO_2 eq. Approximately 1 million tonnes can be achieved through the Kyoto mechanisms, for instance by procuring certified emissions reductions (CERs) from the developing countries.

Most of the emissions in the non-ETS sector are caused by transportation, agriculture, construction machinery and household heating boilers that use mainly light fuel oil as their energy source. Meeting the reduction target will require measures that focus particularly on these sources. Other sources also need to be considered, including small-scale district heating, methane and nitrogen emissions from agriculture and fluorinated gas emissions from industry.

In transport, emission reductions can be realised by promoting transport biofuels, improving the energy-efficiency of cars and, in the long term, by designing a more compact urban structure that would reduce transportation needs.

The greatest potential for increasing the share of renewable energy lies in greater use of wood chips, particularly in CHP generation. According to the National Forest Programme (NFP 2015), the use of wood chips could, by 2020, be tripled from the current 4 million cubic metres.

Increased use of wood would be insufficient to meet the entire obligation, however, and so greater use of all renewable energy forms is needed. Wind power must be increased markedly, in spite of the fact that it needs more financial support than biomass. The use of crop biomass and various waste-to-energy solutions should also be increased.

A sufficient increase in renewable energy will not be possible without extensive financial aid, paid for by society at large or by energy consumers. In the long term, however, renewable energy must become competitive without specific support. The current support systems are mainly based on investment and tax aid. To attain future targets, such support will need to be increased considerably, according to preliminary estimates. New steering tools are therefore required. A new feed-in tariff system for electricity produced from wind power and biogas is currently being set up.

The Energy Efficiency Committee, set by the Ministry of Employment and the Economy in 2008, finalised its work in June 2009 and proposed measures concerning all sectors of society, from trade and industry to private consumption. With the proposed measures, final energy consumption could be approximately 11 per cent lower in 2020 than without the measures. This target is in line with the Long-term Climate and Energy Strategy. The amount of energy saved would correspond to a decrease of approximately 9.3 million tonnes in CO_2 emissions.

Table 5.9
Consumption of primary energy by sources in the WAM scenario in 2005–2020, TWh

	2005	2006	2007	2010	2015	2020
Transport fuels	46	47	48	46	44	39
Other oil	54	54	52	54	49	43
Coal-based fuels	38	62	53	57	52	48
Natural gas	41	46	41	46	43	39
Peat	19	26	28	24	20	20
Wood-based fuels	79	89	82	84	90	97
Nuclear power	68	67	68	67	106	106
Hydro power	14	11	14	13	14	14
Wind power	0	0	0	1	2	6
Others	5	6	9	10	8	17
Electricity import	17	11	13	11	7	0
Total consumption	**381**	**420**	**408**	**412**	**434**	**429**

The consumption of primary energy in the WAM scenario is 11 per cent lower than in the WM scenario in 2020. This corresponds to the results of the Energy Efficiency Committee. Primary energy consumption will decrease in transportation fuels, other fossil fuels and peat. Use of wood based fuels and wind energy would increase in the WAM scenario.

Due to higher electricity prices (influenced by EU ETS allowance prices) and electricity saving measures, the consumption of electricity in the WAM scenario would be 5 TWh lower compared with the WM scenario in 2020 (Table 5.10).

Lower electricity consumption and energy policy measures would considerably cut the production of condensing power and would also slightly reduce CHP production. Wind power production would rapidly increase in the WAM scenario compared to the WM scenario (Table 5.11).

Table 5.10
Electricity consumption in the WM and WAM scenarios, TWh

	2006	2007	2010	2015	2020
WM	90	90	93	100	103
WAM	90	90	92	98	98

Table 5.11
Supply of electricity in the WAM scenario 2005–2020, TWh

	2005	2006	2007	2010	2015	2020
Hydro power	13.4	11.3	14.0	13.4	14.0	14.4
Wind power	0.2	0.1	0.2	0.7	1.5	6.0
CHP, industry	10.6	11.9	11.4	12.2	14.1	13.8
CHP, district heating	15.8	15.7	15.3	16.9	16.6	15.2
Nuclear power	22.4	22.0	22.5	22.0	34.9	34.9
Condensing power	5.3	17.6	14.3	16.7	12.4	14.6
Net imports	17.0	11.4	12.6	10.5	4.5	–1.0
Total	**84.7**	**90.0**	**90.4**	**92.4**	**98.0**	**98.1**

5.3.3 Assessment of aggregate effects of policies and measures

The aggregate effect of the policies and measures is presented in the tables below. Table 5.12 contains a summary of the WAM scenario emissions. Finland can achieve its Kyoto targets with either the WM or the WAM scenario, because both scenarios contain almost the same measures up to the end of the Kyoto period in 2012. However, Finland's post-Kyoto targets to 2020 as specified at EU level can only be reached with the WAM scenario.

Table 5.12
Emissions by gas and sector in the WAM scenario, million tonnes CO_2 eq.

CO_2	million tonnes CO_2				
	2006	2007	2010	2015	2020
Total, without LULUCF	67.8	66.1	68.8	64.1	57.1
Energy	63.9	61.8	64.7	59.6	52.3
Industrial processes	3.9	4.2	4.1	4.6	4.9
Other	0.1	0.1	0	0	0

CH_4	million tonnes CO_2 eq.				
	2006	2007	2010	2015	2020
Total, without LULUCF	4.6	4.6	4.3	4.0	3.8
Energy	0.4	0.3	0.5	0.5	0.5
Agriculture	1.9	1.8	1.7	1.7	1.7
Waste	2.4	2.3	2.1	1.8	1.5

N_2O	million tonnes CO_2 eq.				
	2006	2007	2010	2015	2020
Total, without LULUCF	6.8	7.0	7.3	7.2	7.3
Energy	1.5	1.5	1.5	1.5	1.5
Industrial processes	1.4	1.5	1.8	1.9	2.0
Agriculture	3.7	3.7	3.7	3.4	3.4
Waste	0.2	0.2	0.2	0.2	0.2
Other	0	0	0.2	0.2	0.2

F-gases	million tonnes CO_2 eq.				
	2006	2007	2010	2015	2020
Total, without LULUCF	0.8	0.9	0.8	0.5	0.2
Industrial processes	0.8	0.9	0.8	0.5	0.2

	Total				
	2006	2007	2010	2015	2020
Total, without LULUCF	80.1	78.3	81.3	75.8	68.5
Energy	65.8	63.6	66.8	61.6	54.3
Industrial processes	6.1	6.7	6.6	7.0	7.1
Agriculture	5.6	5.5	5.4	5.1	5.1
Waste	2.5	2.4	2.2	2.0	1.7
Other	0.1	0.1	0.2	0.2	0.2

Table 5.13
Total greenhouse gas emissions in the WM and WAM scenarios, (million tonnes CO_2 eq.)

Sectors	2005	2006	2007	2020	
				WM	WAM
Transport	13.4	13.6	14.0	14.2	11.4
Space heating	3.1	3.0	3.1	2.6	1.2
Agriculture	5.6	5.6	5.5	5.7	5.1
F-gases	0.9	0.8	0.9	0.6	0.3
Waste management	2.4	2.5	2.4	1.8	1.7
Machinery	2.6	2.6	2.6	2.7	2.5
Other sources, of which:	7.7	7.2	7.5	8.4	7.5
• Non-ETS industry CO_2	1.6	1.6	1.6	1.5	1.1
• Combustion, N_2O	0.9	1.0	1.0	1.1	1.0
• Hydrogen production, CO_2	0.07	0.07	0.07	0.8	0.8
Non-ETS total	**35.7**	**35.3**	**36.0**	**36.0**	**29.7**
Emissions in the ETS sector	**33.1**	**44.6**	**42.5**	**52.6**	**38.8**
Total emissions	**68.8**	**79.9**	**78.5**	**88.6**	**68.5**

5.3.4 LULUCF

The Land Use, Land-Use Change and Forestry sector (LULUCF) as a whole is expected to be a net sink in both the WM and WAM scenarios.

Studies indicate that Finnish forests will probably continue to act as a net sink in the future. The objective set out in the National Forest Programme (NFP 2015) for the forests' carbon sink (incl. trees and soil) is to maintain the sink at a level of at least 10–20 million tonnes CO_2 eq. per year up to 2015. The harvesting is targeted to increase by 10–15 million cubic metres a year. The current global economic downturn will, however, have some effect on the extent to which the goals of the NFP 2015 are achievable.

With regard to agricultural soils, no major changes in CO_2 emissions from cropland and grassland are expected in the WM scenario by 2020. In the WAM scenario, measures in the agriculture sector affecting CO_2 emissions are expected to decrease emissions from agricultural soils in the LULUCF sector. There is still considerable uncertainty in these estimates, however, but further refinement of the calculation methods is expected to reduce this uncertainty. Emissions from peat production areas are estimated to be the same in both the WM and WAM scenarios.

5.4 Sensitivity analysis of the scenarios

The calculations for the Long-term Climate and Energy Strategy were carried out before the current global economic downturn. This downturn will have a profound impact on many of the key assumptions.

Key parameters with an impact on CO_2 emissions are the assumptions concerning production in the energy-intensive sectors (pulp and paper industry, manufacture of metals and the chemical industry) and the assumptions concerning the electricity sector (forms of production and electricity import and export).

The ongoing structural change in the forest industry is having a significant impact on the energy sector, including renewable energy production, energy consumption and greenhouse gas emissions.

Under the Long-term Climate and Energy Strategy, Finland aims to ensure it has sufficient domestic electricity production capacity to cater for peak consumption and possible import disturbances. Net imports of electricity are assumed to decrease, being 10.5 TWh in 2010, 4.5 TWh in 2015 and 0 TWh in 2020. However, a zero net import of electricity in 2020 would mean about 9 million tonnes CO_2 eq. more in greenhouse gas emissions than a situation in which the net electricity import was 11 TWh.

The price of emissions allowances has a crucial effect on many issues. Variation in the price has an effect on carbon dioxide emissions through various mechanisms. When allowances become more expensive, the price ratios of fuels change, leading to the use of fuels that produce fewer emissions. Changes in these price ratios also lead to a specific types of electricity production structure. On the Nordic electricity market the price of emission allowances has an effect on the price of electricity when the use of fossil fuels becomes more expensive.

Changes in the price of electricity, on the other hand, have an effect on electricity consumption and, through the different production structure of different Nordic countries, also affect net electricity imports. The effects of emissions trading are clearly visible in the electricity sector. All the mechanisms mentioned above will lead to a decrease in CO_2 emissions as the price of emissions allowances rises. The price of emissions allowances will also have an impact on the economy. The sensitivity of these economic impacts has been studied with different emission allowance costs (see Chapter 4, Section 4.12).

5.5 Methodology

The calculations for the Long-term Climate and Energy Strategy were carried out before the current global economic downturn. This downturn will have a profound impact on many of the key assumptions. Therefore the scenarios have to be updated. This will be done before the end of 2009.

The Ministry of Employment and the Economy coordinated the preparation of the Long-term Climate and Energy Strategy under the Ministerial Working Group on Climate and Energy Policy. The calculations were made by various experts within the contact network set up by the main ministries involved in climate policy.

The background material for the Long-term Climate and Energy Strategy was compiled from sector-specific reports made by the ministries. Those most involved in preparing the projections were the Ministry of Employment and the Economy, the Ministry of Environment, the Ministry of Transport and Communications, the Ministry of Agriculture and Forestry and the Ministry of Finance.

The calculations for the projections were based on the scenario analysis. The Ministry of Employment and the Economy was responsible for the calculation of energy use within industry, construction, households and services, for the calculation of fuel and carbon dioxide emissions in the energy production sectors as a whole and for the coordination of these calculations. The Ministry

of the Environment was responsible for heating energy calculations for buildings, for the analysis of the regional and urban structure and for emission calculations for waste and machinery. The duty of the Ministry of Transport and Communications included the estimation of fuels and the use of electricity and emissions created in transport. The Ministry of Agriculture and Forestry oversaw the calculation of emissions and removals in agriculture and forestry (including land use, land-use change and forestry).

During the drafting process for the Long-term Climate and Energy Strategy, a host of studies concerning economic and technical assessments were carried out by the Government Institute of Economic Research, the VTT Technical Research Centre of Finland and other research organisations. An environment impact assessment was conducted by the Finnish Environment Institute.

The calculations concerning the energy sector made by VTT were carried out using a model known as the POLA model. This is a version of the TIMES model developed under the IEA ETSAP programme. It covers the whole of the Finnish energy production and consumption system, including the industrial, residential, service and transport sectors. The results of the POLA model were used as inputs to the VATTAGE model of economic effects. The latter is the AGE (applied general equilibrium model) model used by the Government Institute of Economic Research to calculate the economic effects of the strategy.

The VATTAGE model is a dynamic AGE model. The distinguishing features of the model concern its dynamics. Three inter-temporal links connect consecutive periods in the model: (1) accumulation of fixed capital, (2) accumulation of financial claims and (3) lagged adjustment mechanisms notably in the labour markets and in the balancing of the public sector budgets. Together, these mechanisms result in gradual adjustment to policy shocks to the economy.

In the model, capital is sector-specific, which means it takes time for an industry to adjust to the increased energy costs caused by emissions trading and increased energy taxes. In energy-intensive industries, the rise of energy costs lowers the return on capital, which slows down investments until a new equilibrium is reached. In other industries, similar effects are caused by a rise in domestic energy taxes. Some of the industries, however, gain from the subsidies granted to renewable energy, and even in energy-intensive industries, the subsidies can dampen the rise of costs if they can substitute renewable energy for fossil fuels.

The VATTAGE model assumes sluggish real wage responses to policy shocks. Real wages adjust sluggishly to deviations from expected equilibrium wage growth, with the result that in the short run, adjustment occurs partly through increased unemployment. In the long run, wages adjust fully to one-off shocks, and full employment is restored. In the case of gradually tightening emission targets, however, the shocks are not one-off, implying sustained above-equilibrium-unemployment rates.

The National Forest Programme (NFP 2015) sets the framework for national forest policy. Under the NFP 2015, the promotion of sustainable forest management will continue, ensuring significant removals of carbon from the atmosphere in the future, as projected by the Finnish Forest Research Institute (METLA).

Literature

Ministry of Employment and the Economy (2008) Long-term Climate and Energy Strategy. Government Report to Parliament, Ministry of Employment and the Economy Publications, Energy and Climate 36/2008, Helsinki, Finland (in Finnish)
http://www.tem.fi/index.phtml?1=en&s=2658

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

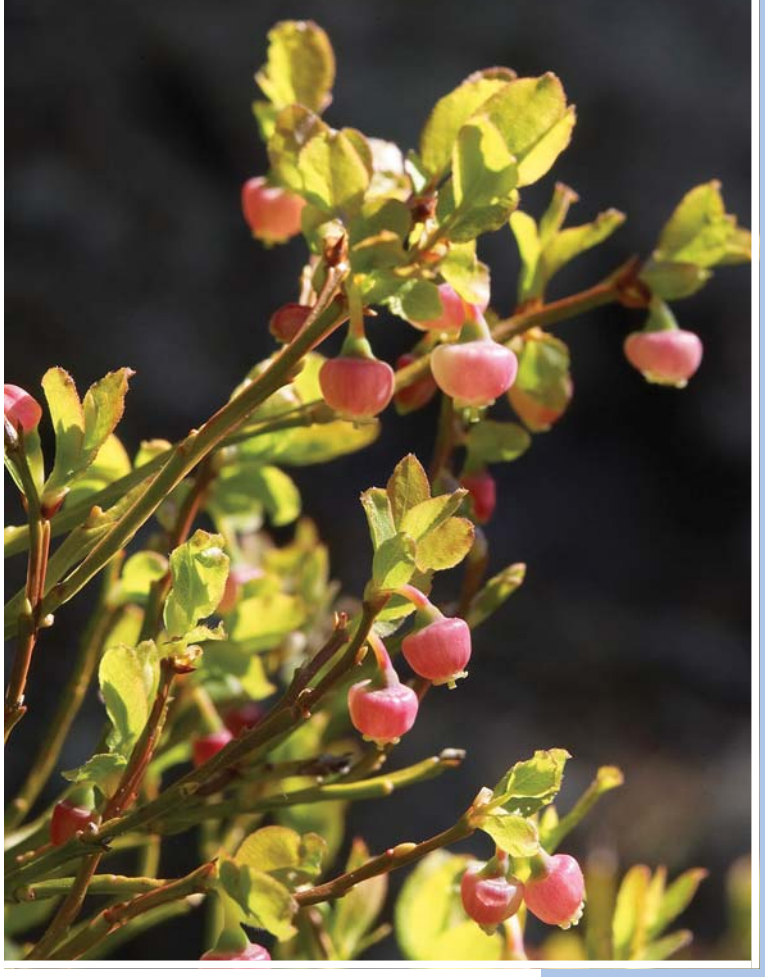
Ministry of Trade and Industry (2005) Outline of the Energy and Climate Strategy Policy for the near future – National Strategy to implement the Kyoto Protocol. Government Report to Parliament, MTI Publications 27/2005, Helsinki, Finland

Prime Minister's Office (2009) Government Foresight Report on Long-term Climate and Energy Policy: Towards a Low-carbon Finland. Prime Minister's Office Publications 28/2009, Helsinki , Finland
http://www.vnk.fi/julkaisut/listaus/julkaisu/en.jsp?oid=273275

Internet links

VATTAGE-model,
http://www.vatt.fi/en/publications/latestPublications/publication/Publication_1345_id/832

Back to Contents



6 Climate change impacts, adaptation measures and vulnerability assessment

This chapter describes how Finnish climate is expected to change in this century and how the change is expected to affect nature, the economy and society. The expected impacts are described together with identified adaptation measures in each sector. Lastly, there is an outline of efforts to assess vulnerability.

Back to Contents

Photos

Marita Björkström/YHA kuvapankki, page 171
futureimagebank.com, pages 164, 184
iStockphoto, page 161
Jyri Juujärvi, page 163
Riku Lumiaro/YHA kuvapankki, page 191
Raili Malinen/YHA kuvapankki, page 177
Esko Kuusisto, pages 167,185
Erkki Oksanen/Metla, pages 157, 172, 175
Unto Tapio/YHA kuvapankki, page 166
Aarno Torvinen/YHA kuvapankki, pages 173, 175, 189

6 Climate change impacts, adaptation measures and vulnerability assessment

6.1 How is Finland´s climate likely to change?

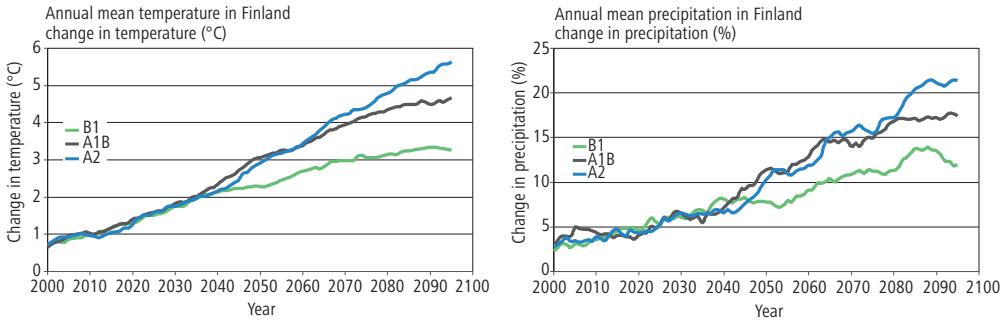
Climate scenario information for impacts and adaptation research as well as policy making has been produced as part of a climate scenario and information service project called ACCLIM, which is part of the Climate Change Adaptation Research Programme (ISTO, 2006–2010, see Chapter 8). Climate model simulations prepared for the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) together with regional climate model projections form the basis of the latest national climate scenarios. New, more comprehensive scenarios supersede earlier climate scenarios developed in the FINSKEN project 'Developing Consistent Global Change Scenarios for Finland'.

The future climate cannot be predicted accurately due to uncertainties in (i) future emissions of greenhouse gases and aerosols, (ii) natural climatic variability and (iii) imprecision of climate system models. Figure 6.1 shows the central estimates of the annual mean temperature and precipitation changes in Finland for three future emission paths, namely the high (A2), central (A1B) and low (B1) emission scenarios described in the Special Report on Emission Scenarios (SRES) of the IPCC. The range of the curves gives an uncertainty in projections due to emissions.

The temperature increase in Finland is expected to be about 1.5 times higher than the global average temperature rise (Table 6.1). The likely precipitation increase is also substantial. These increases will be larger during winter than summer. Different emission scenarios lead on average to quite similar changes in temperature and precipitation until about the 2040s. During the latter part of the 21st century climatic changes will depend strongly on the emission path. It is, however, very likely that there will be major climatic changes in northern Europe (Figure 6.2).

A new feature employed in the ACCLIM scenario development is a probability based approach to handle all sources of uncertainty. This approach demonstrates how rapidly relatively small changes in the mean val-

Figure 6.1
Projected changes in annual mean temperature and precipitation in Finland as deviations from the 1971–2000 average



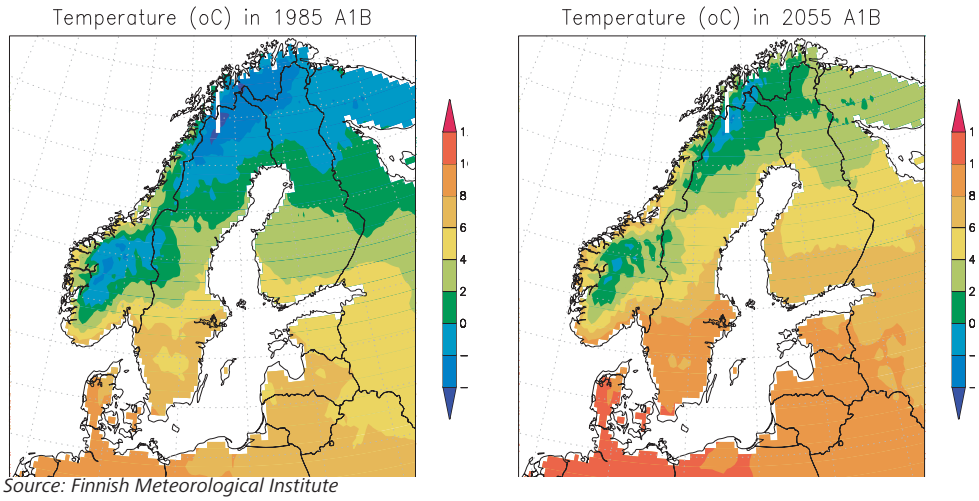
Source: Finnish Meteorological Institute

Table 6.1
Projected changes in the Finnish climate

Variable	Description
Temperature	Annual mean temperature increase of +3°C to +6°C between the periods 1971–2000 and 2070–2099. Greater increase in winter than in summer. Increase in mean minimum temperatures greater than increase in mean maximum temperatures. Decrease in number of frost days. Change in number and timing of days with temperatures around zero, depending on region and time interval considered
Precipitation	Increase of 10 to 25 per cent in annual precipitation between the periods 1971–2000 and 2070–2099. Greater increase in winter than in summer. Some models project no change in the summer. Increase in number of precipitation days in winter. Ratio of snow/rain decreases.
Ground frost	Less ground frost in snow-free areas (e.g. roads and yards). General decrease in number of ground frost days and depth of ground frost, modified regionally by snow cover changes.
Ice cover	Shorter ice period and decrease in ice strength.
Snow cover	Shorter and discontinuous snow season. Decrease in snow cover progressing from south to north.
Wind	Models give no clear indication of changes in mean windiness. Likely increase during wintertime over the Baltic Sea.
Cloud cover	Increase in cloud cover during winter.
Extreme events	Greater frequency and length of heat waves. Fewer and shorter periods of extreme cold. Greater intensity and frequency of heavy rainfall. No decrease in maximum snowfall. Longer periods of weak soil stability due to longer thaw. Risk of soil erosion.

ues can alter the probability of rare events. For example, according to statistics based solely on observations in Helsinki, the probability of exceeding the highest measured January mean temperature of +1.4°C during the coming five years due to natural variability is about 6 per cent. When the projected mean temperature changes are taken into account, the probability of setting a new record grows to 19 per cent. ACCLIM will continue

Figure 6.2
Present (1971–2000 average) and projected 2050s (central A1B emission scenario) annual mean temperature in northern Europe



Source: Finnish Meteorological Institute

developing better methods to estimate the probabilities of extreme weather and climatic events in the present and future climate.

To estimate the possible impacts in various climate scenarios, parameters are being developed with direct relevance to selected sectors. These include e.g. heating degree days in energy use, ground frost in road construction or snow cover in forestry. The new scenarios have already been used e.g. in hydrological modelling and considering agricultural potential.

6.2 Expected impacts of climate change and adaptation measures

The expected impacts described in this chapter are based on the results of various studies and research projects (see Chapter 8) or, in some cases, are based on expert opinions. They are followed by the adaptation measures which were identified in the evaluation of the national adaptation strategy (see 6.2.2).

6.2.1 General features of the impacts on Finland

Climate change has direct impact on nature, on industries dependent on natural resources, on the built environment and on human well-being. Knowledge of these impacts has increased in recent years.

The impacts of climate change create a range of different challenges for society and the economy. The FINADAPT research programme, has shown that there are still considerable uncertainties and information gaps in assessing the potential costs of the impacts and adaptation measures. Preliminary estimates of the economic impacts in this century suggest that they could be slightly positive. At the same time, climate-related risks are projected to increase. The extent to which benefits can actually be exploited and costs limited will in many cases depend on public and private policies other than climate policy, for instance agricultural, forest and urban and regional planning policies.

FINADAPT estimates that the forest and agriculture sectors could gain from climate change. Energy end-users may benefit from the reduction in demand for heating. The tourism sector might profit from warmer summers and from reliable winter snow cover in the north of the country, as this would increase the attractiveness of Finland as a tourist destination. However, these outcomes could change markedly if the negative consequences of extreme weather and climate events or volatility in world markets and trade reflected through foreign trade are included in the estimates. A sequence of negative climate change impacts within a short time span could test the resilience of several sectors of the economy or even the socio-economic system as a whole, locally or nationally. Furthermore, the global effects of climate change will be felt in Finland too (see Section 6.2.7).

In addition to direct impacts of climate change, mitigation and climate policy may have significant effect on the society and economy. Finland has challenging geographic con-

ditions and the economy relies on energy intensive industry. Both domestic and international mitigation policies will mean an increase in energy costs, and this will have major direct and indirect negative effects on the Finnish economy, including a need for structural change to a low-carbon economy. Information on the indirect impacts is still scarce, however.

For some sectors (e.g. energy production and manufacturing), climate mitigation policy is already firmly integrated with long-term public policy and business plans. Energy-intensive industry will face higher costs in the future because of emissions trading and rising energy prices. This will increase prices and reduce production and employment, and perhaps also lead to a relocation of some of the production to regions with a less ambitious climate policy.

Rising energy prices are distributed between companies in the emissions trading sector and sectors outside it (e.g. households, agriculture, transport and services). These rising prices may increase the living costs, which may, in turn, increase social inequity.

Mitigation measures and the need to save energy and improve energy efficiency require the development of new technologies. As indicated by the ClimBus research programme (see Chapter 8), this could bring many new business opportunities for Finland.

6.2.2 *Adaptation measures and estimated level of adaptation by sector*

The Ministry of Agriculture and Forestry published the National Strategy for Adaptation to Climate Change in 2005. The objective of the strategy is to reinforce and increase the adaptive capacity of society by minimising the negative impacts while taking advantage of any favourable impacts.

A Coordination Group for Adaptation to Climate Change has been set up to monitor and promote the implementation of the adaptation strategy. In winter 2008–2009 it steered an evaluation of the strategy implementation. The evaluation was based on a survey to establish whether and how the measures presented in the strategy have been launched in different sectors. The results were published by the Ministry of the Agriculture and Forestry in 2009 and are presented in this chapter under each specific sector.

In all sectors, decision-makers have at least some understanding of the impacts of climate change and recognise the need for adaptation measures. Practical adaptation measures have also been identified and plans have been made or even launched for their implementation. The most advanced sector is water resources management, where adaptation to climate change is already well integrated into decision-making. Good research on adaptation has been done in agriculture and forestry, but implementation of the measures is going to take some time. In fisheries, reindeer and game management, hardly any scenario-based research has been conducted, and adaptation measures are largely based on monitoring current climate conditions. Several research projects and strategy work have been started on biodiversity, but very few actual adaptation measures have been launched.

Ministry of the Environment launched in 2008 the environmental administration's action plan on climate change adaptation, defining adaptation measures concerning biodiversity, land use and construction, environmental protection and the use of water resources. The need to adapt to climate

change has been recognised and is being taken into account well in land-use and community planning, especially with regard to flood risks. In construction, planning the necessary adaptation measures calls for more research.

In the transport sector governmental agencies have conducted adaptation surveys concerning the different modes of transport. As for practical adaptation measures, the sector is already well prepared for weather-related disturbances in traffic safety and maintenance of the transport infrastructure. New adaptation measures concern long-term planning.

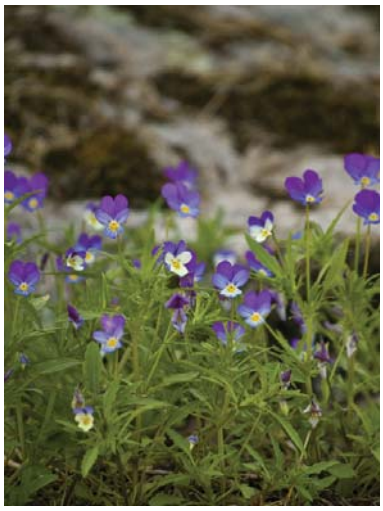
So far, the industrial and energy sectors have focused on climate change mitigation rather than adaptation to it. This is clearly reflected in the adaptation measures already launched, as well as in the number of measures proposed in the adaptation strategy. However, the views concerning the extent of adaptation measures in these sectors may be incorrect, because evaluation of the strategy implementation has not included measures in the private sector. The same applies to the tourism and insurance sectors. Private companies in these sectors are capable of adapting to the risks posed by the changing climate quite rapidly, even if less action were to be taken in the public sector.

In the health and social services sectors the need for adaptation has been recognised only in certain circles and there has been little research on the health impacts of climate change. By contrast, the health impacts of air quality and, through this, the health risks associated with the mitigation measures, such as small-particle emissions caused by biofuels, are better known. During the preparation of the adaptation strategy a thorough risk assessment and institutional management review was carried out in relation to the challenges that climate change could pose to the health sector. The Ministry of Social Affairs and Health is updating its action guide on environmental health, which will prepare for extreme weather events (extreme temperatures and flooding), in particular by ensuring the functioning of health care.

In the adaptation strategy of 2005, national security was not addressed as a sector of its own. In 2006 and 2008 two Government Resolutions were adopted to prepare the national defence administration for the consequences of climate change.

6.2.3 *Impacts on nature and natural resources, and the related adaptation measures*

Biodiversity



Climate change will probably increase the total number of Finnish flora and fauna. However, some species characteristic to Finland, like relict cold water fish and other reminders of the ice age, may become extinct.

A longer growing season and milder winters may lead to the rapid proliferation of a number of southern species that thrive in a warm climate. In southern Finland, invading species could threaten the habitats of native species, and the population of invaders may expand rapidly if they lack natural enemies. On the other hand, many native species in the south could find favourable living conditions further north if the climate is warming. Northern species requiring cold conditions will suffer from the change as habitats suitable for them become rarer.

The impacts of climate change on vegetation and forest composition will occur more gradually. In the forests, the amount of decayed wood and forest litter is likely to increase, thus creating suitable habitats for a number of endangered species. Climate change will threaten the habitats of the fells area (e.g. palsa mires), especially those in which snow or ground frost is an essential factor.

Climate change may also threaten the pollination of plants by decreasing suitable habitats for different pollinators which are essential in agricultural production. Additionally, some predatory insects that help to control agricultural pests are very vulnerable to changes in climate and their natural habitats.

Increasing temperatures and runoff into aquatic environments, and the resulting changes in nutrient loads, may have a profound impact on e.g. phytoplankton and zooplankton, benthic fauna, fish stocks and the number of species. The spring peak of phytoplankton in lakes will occur earlier and will be considerably more pronounced than today. The littoral zone is likely to be more sensitive to the effects of climate change than the pelagic ecosystem.

Snow and ice are essential for the Saimaa Ringed Seal

The warming climate is a serious threat to the endangered population of Saimaa Ringed Seals *(Phoca hispida saimensis)*. The only existing population of Saimaa Ringed Seal, about 260 individuals, is in Lake Saimaa, in eastern Finland.

The Saimaa Ringed Seal and its breeding are very dependent on cold winters, snow and ice cover. In February or March the female seal gives birth to its pup in a hollow lair built in snowdrift on ice. The risk of pup mortality increases if there are no snowdrifts by the shorelines or the temperature is not cold enough to prevent the collapse of the roof of the lair.

In winter 2006–2007 the pup mortality was exceptionally high, at around 30 per cent, compared with about 8 per cent in normal winters. The winter was warmer than usual. For a small population even a random variability in population size might be fatal.

Because of the threat which climate warming poses to the Saimaa Ringed Seal it is crucial to eliminate all other threats to the population. Voluntary fishing restrictions aim to prevent these seals drowning in fishing nets.

Summary of potential adaptation measures identified in the national adaptation strategy and measures already launched for protecting biodiversity in the context of climate change impacts and adaptation, and the preliminary timing of measures (*Immediate: 2005–2010, **short-term: 2010–2030, ***long-term: 2030–2080).

		Anticipatory measures (A)	Measures launched
PUBLIC	Administration and planning	• Reducing human-induced stress on nature by controlling land use* (A)	• Government Decision of 13 November 2008 on the revision of the National Land Use Guidelines: preservation of ecological corridors between protection areas and, where necessary, other valuable nature areas is being promoted.
		• Evaluation, development and monitoring of the extent of the network of protected areas* (A)	• In 2007 Metsähallitus published a report on the state of the parks in Finland. The Government has approved a National Strategy and Action Plan for the Conservation and Sustainable Use of Biodiversity in Finland 2006–2016. In 2007 Finland reported to the EU on the implementation of the protection of habitats and species under the Habitats Directive in 2001–2006, especially as regards favourable conservation status (Natura 2000 network).
		• Maintaining original habitats* (A)	• Maintenance of original diverse habitats is to be furthered by an assessment of the above-mentioned conservation areas and restoration and management of areas, for which the main responsibility rests with Metsähallitus, with funding from the Ministry of the Environment. The Forest Biodiversity Programme for southern Finland (METSO) is contributing to the preservation and maintenance of valuable forest habitats (in 2008 about 1500 ha) by means of funding from the Ministry of the Environment. • Preparation of a national strategy for invasive alien species and a national strategy for mires and peatlands has been launched.
		• Changes in policy regarding the management and use of protected areas, where necessary* (A)	• Where necessary, outlines for the management and use of conservation areas are revised in the performance guidance of the Ministry of the Environment and in updating the management and use plans.
		• Taking valuable habitats into consideration in the management and use of forests* (A)	• Mainly implemented through the METSO programme. • The METE inventory of particularly important habitats in the Forest Act has been completed.
		• Conservation of valuable traditional farmland biotopes with the help of the agrienvironmental support scheme* (A)	• Management of traditional biotopes has been intensified in nature conservation areas through the work of Metsähallitus on about 3000 ha. • In 2008 management contracts for traditional biotopes under the agrienvironment scheme covered more than 22,400 ha.
		• Inclusion of an evaluation of the impacts of climate change in the ongoing planning and development projects for the promotion of biodiversity* (A)	• Report on endangered habitats published by the Finnish Environment Institute (SYKE) in 2008. • VACCIA project launched by the Finnish Environment Institute (SYKE) in 2009
		• Introduction of an information system for protected areas* (A)	• Development project on a database and information system for conservation areas steered by the Ministry of the Environment (2009–2010).
	Research and information	• Increasing cooperation, information and consultation between the different administrative sectors* (A)	
		• Information for forest owners and training for forest professionals* (A)	
		• Improving the monitoring, planning and information systems for biodiversity* (A)	• The environmental administration has prepared a survey on developing the follow-up systems relating to biodiversity.
		• Evaluation of the possibilities for ex situ protection with regard to climate change *(A)	
		• Studies of threatening factors caused by climate change at the ecosystem and species level (A)	
		• Carrying out general habitat-level follow-ups and supplementary species-level follow-ups (A)	
	Economic and technical measures	• Control and prevention of the spread of invasive alien species* (A)	• Ministry of Agriculture and Forestry has launched the preparation of a national strategy for invasive alien species, which is intended for completion in December 2010.
		• Restoration and management of valuable habitats* (A)	• A research project on the subject was completed in 2008.– In the forest sector, the METE inventory of particularly important habitats listed in the Forest Act has been completed.
		• Prevention of the extinction of species with the help of zoos and planting* (A)	
		• Reconstructing and restoring wetlands and mires* (A)	• Reconstruction and restoration of mires will be taken into account in the preparation of the national strategy for mires and peatlands.

	Anticipatory measures (A)	Measures launched
PRIVATE	• Reducing the pollution load on the environment and the atmosphere (A)	
	• Conservation of valuable traditional farmland biotopes* (A)	• In 2008 management contracts for traditional biotopes under the agrienvironment scheme covered more than 22,400 ha.
	• Taking valuable habitats into consideration in the management and use of forests* (A)	

Water sector

The most important effect of climate change on hydrological regimes is the change in seasonal distribution of runoff. Winter runoff is expected to increase considerably due to an increase in snowmelt and rainfall, while spring floods are estimated to decrease in southern Finland. In northern Finland spring floods may increase during the next few decades due to increased snowfall, but then decline as the warming increases.

Due to higher winter temperatures, there will be an increase in the frequency and intensity of winter floods from heavy rainfall and periods of thaw. Summer rainfall might decrease, though even if it were to stay at the present level, higher temperatures could cause fairly intense and prolonged drought periods. However, summer floods are also projected to be more frequent and severe due to increased extreme rainfall.

Changes in yearly runoff are estimated to be between –5 per cent and +10 per cent, depending on the catchment. Decreases are predicted for catchments with large lake surface areas, which enhance evaporation. Increases are predicted for catchments in which there is high winter runoff. This applies especially to large central lakes Saimaa, Päijänne and Näsijärvi, the levels of which may be very high in the winter.

Floods and droughts are potentially harmful to water quality. Low flows boost concentrations of bacteria, algae and toxins. High flows and intense rainfall increase erosion and leach of nutrients from catchments into watercourses and coastal waters.

Groundwater is classified as high-quality household water. If dry periods become longer in the summer in southern Finland, groundwater discharges will be reduced. That may also lead to a shortage of dissolved oxygen, high concentrations of dissolved iron, manganese and metals in the groundwater. Shortage of dissolved oxygen may generate ammonium, organic matter, methane and hydrogen sulphide gases causing bad taste and smell. In wintertime, increasing precipitation and snowmelt will produce fresh and oxygen rich groundwater.

The changing climate is not likely to introduce new types of threats for the water supply and wastewater systems. However, the present problems related to climate will become more frequent. Small water utilities and wastewater systems with combined sewers are the most vulnerable to climate-related problems.

As to the safety of dams, very intense rainfall is estimated to increase by up to 40–60 per cent, which would cause problems for dams

particularly in small rivers. Increased monthly or seasonal precipitation together with winter snowmelt are reasons for considering the safety of dams in larger rivers. However, major problems look unlikely in this respect, because most dams have quite large spillways.

Frequent winter floods and a smaller amount of snow will mean a greater storage capacity requirement in the winter and less storage capacity in the spring in southern Finland. In northern Finland storage capacity will still be needed for snowmelt floods.

Milder winters will increase non-point source loading from catchments dominated by agriculture and forestry. According to recent modelling results of the EURO-LIMPACS project, the annual export of inorganic nitrogen will increase between 10 and 70 per cent, depending on the location and land-use patterns of the catchments. Warmer, wetter conditions are also likely to result in higher concentrations of dissolved organic carbon. Changes in stratification patterns and considerably shorter duration of the ice cover period in lakes were also predicted. These have implications for water quality management.

Summary of climate change adaptation measures (potential measures identified in the national adaptation strategy and measures already launched) concerning the use and management of water resources, and the preliminary timing of measures (*Immediate: 2005–2010, **short-term: 2010–2030, ***long-term: 2030–2080).

		Anticipatory (A) / Reactive (R) measures	Measures launched
PUBLIC	Administration and planning	• Planning of water services* (A)	• Municipal and regional planning of water services a regular activity.
		• Surveying of risk sites and preparation of general plans for risk sites* (A)	• Mapping of flood risk sites in 2009–2011. Flood hazard mapping has been carried out for about 60 significant flood risk sites, and flood risk mapping has been started on a small number of sites.
		• Acquisition of temporary flood control structures* (A)	• Responsibilities relating to temporary flood control structures have been clarified and a proposal made that the matter be included in flood risk management plans and building permits.
		• Emergency preparedness planning* (A)	• Regulations on the emergency preparedness planning of water services was examined by the working group on the revision of the Water Services Act.
		• Land use planning to reduce flood risks and especially to avoid construction in flood areas* (A)	• ISTO and environment cluster projects on land use planning and flood risks. • Flood risk management has been taken into account in the revision of the national land use objectives. • See 'Land use and community planning'.
		• Taking rain-induced floods into account in zoning and urban planning* (A)	• Research projects on heavy rainfall and urban floods and warning about these, e.g. RATU and RAVAKE • The Finnish Meteorological Institute will start warning about heavy rainfall in summer 2009.
		• Flood forecasts (A)	• The Finnish Environment Institute is responsible for operative flood forecasts and for developing these forecasts in conjunction with the Finnish Meteorological Institute.
		• Planning of trenching and storm water services (A)	• A guide on storm water/urban runoff is being prepared, and there are research projects on sufficient drainage for runoff water.
		• Operational flood prevention (R) • Cooperation between authorities (R)	• Working group set up to investigate the responsibilities and tasks of authorities involved in flood risk management and flood prevention.

		Anticipatory (A) / Reactive (R) measures	Measures launched
PUBLIC	Research and information	• Surveying the quality requirements for water at cattle farms and dairy farms* (A)	
		• Improvement in the predictability of floods (heavy rainfall): weather forecasts, weather radar, follow-up of soil dampness and snow/satellites and observation (A)	• Research projects relating to improving flood forecasts have been launched, e.g. OST-K, FloodFore, RATU and RAVAKE
		• Studying the impacts of rain-induced floods* (A)	• In e.g. ISTO project case studies on impacts of heavy rainfall.
		• Surveying the need for temporary flood protection structures, their acquisition and the responsibilities associated with their use* (A)	• Regional survey of temporary flood protection structures and their usability.
		• Information about flood hazards (A)	• Regional communication has been enhanced e.g. by informing about flood maps.
		• Information provision in flood and drought situations (R)	• Project of the Finnish Environment Institute (SYKE) and the, Finnish Meteorological Institute on the development of operative warning systems
		• Instructions from the authorities for reducing flood damage (R)	• Instructions on preparing for special water service situations and emergencies have been published.
		• Restrictions on water use (R)	
	Economic and technical measureS	• Raising of flood banks (A)	• Flood banks are being increased and reinforced in e.g. Pori and Lapland (Kittilä, Ivalo). To prepare for sea flooding, flood protection banks are being planned, e.g. in Helsinki.
		• Construction of reserve water intake plants* (A) • Interconnection of the networks of water supply plants* (A) • Investments in projects that improve preparation for exceptional situations and regional cooperation* (A) • Expansion of water supply and sewerage networks* (A) • Supporting the construction of irrigation systems for agriculture* (A)	• State-supported continuous investment in reserve water aquifers, joining of networks, preparing for special and emergency situations, regional cooperation and expanding of networks.
		• Compensation for damage caused by exceptional flooding of water systems (R)	• Proposal on revising the compensation system for flood damage has been prepared.
		• Use of temporary flood protection structures (R)	
		• Use of reserve systems at water supply plants, disinfection (R)	• Disinfection preparedness requirement prepared at the Ministry of Social Affairs and Health.
		• Transportation of water, water pickup points, bottling of water (R)	• Water services pool is planning the acquisition of a reserve water system.
		• Purchasing water from another water services company (R)	
		• Distribution of lower quality water (R)	• No further work on this since the long purification process following the water crisis in the town of Nokia,
	Normative framework	• Changes to regulation permits (A)	• Functioning of regulation in view of climate change adaptation studied in 2009 in respect of the Rivers Kokemäenjoki and Lapuanjoki.
		• Implementation of building regulations (R)	
		• Changes to regulation permits (R)	• Research projects on possible needs for change in regulation permits.

	Anticipatory (A) / Reactive (R) measures	Measures launched
PRIVATE	• Taking out insurance* (A)	• Proposal on revising the compensation system for flood damage has been prepared.
	• Construction of properties farther away from flood areas* (A)	• Land use objectives have been revised and the matter is taken into account in land use planning and building permit procedures.
	• Construction of irrigation systems* (A)	
	• Joining the network of a water services company / choosing the location for a well and maintaining its condition (A)	• A place for a well – guide published in 2008.
	• Protection of properties against flood (R)	• Use of temporary flood protection structures has been studied, and incentives continue to be provided for this, which is partly a regular activity of properties.
	• Saving and recycling water, use of lower quality water (R)	
	• Increasing the discharge capacity of dams (R)	• Research projects to assess the need to change the discharge capacity of dams.

The Baltic Sea and its coastal areas

Based on available regional models, a warming of the mean annual air temperature in the order of 3°C to 5°C is projected for the Baltic Sea area during this century. Most of the warming is likely to occur in the eastern and northern parts of the sea during winter months and in the southern parts of the sea during summer months. The annual precipitation would increase especially in the northern parts of the Baltic Sea basin, with more of the increase being in winter than in summer. The changes in precipitation will affect the runoff into the Baltic Sea, with potential increases in mean annual river flow from the northernmost catchments and decreases in the southernmost catchments.

There has also been a general tendency toward milder ice conditions in the Baltic Sea. The largest change has been in the length of the ice season, which has decreased by 14–44 days over the past century, mainly due to earlier ice break-up. The mean sea surface temperature of the Baltic Sea is projected to increase. As a result, the projected decrease in the ice cover by the end of the century is dramatic. The Bothnian Sea, large areas of the Gulf of Finland and the Gulf of Riga, and the outer parts of the southwestern archipelago of Finland will become, on average, ice free.

Although the mean sea level of the oceans is rising, this effect is partially balanced by the land uplift in the Baltic Sea. The calculated rate of sea level rise is estimated to be about 1.7 mm per year in the southeastern Baltic Sea, which reverses to –9.4 mm in the northwestern Gulf of Bothnia. By the year 2100, many parts of the Baltic Sea currently experiencing a relative fall in sea level would instead have a rising relative sea level.

Regional wind changes in the Baltic Sea may have an additional impact on sea level surge heights. In several regional scenario simulations, extreme sea levels are projected to increase significantly more than the mean sea level. The combination of high sea levels induced by storm surges, ice-free seas, and unfrozen sediments would enhance erosion and the transport of sediments.

Pristine peatlands

Changes in temperature, precipitation and evapotranspiration may have a considerable impact on the hydrology of wetlands and, consequently, the load of organic and inorganic matter from catchments. Furthermore, the continued increase in atmospheric CO_2 and N_2O might affect the quantity and quality of surface vegetation in peatlands.

Climatic warming will probably cause mire vegetation zones to move further north, i.e. raised mire vegetation will take over parts of the current low 'aapa' mires. It is estimated that peatlands may become drier than at present, especially in the summertime. Drier conditions will lead to barrenness of some peatlands and overgrowth of Sphagnum peat. It has been suggested that the drying of peatland surfaces may lead to carbon losses in the short term, but changing vegetation patterns may increase the long-term carbon sequestration, especially in northern Finland. Decreased water levels will also increase tree growth and, accordingly, lead to higher level of carbon storage in biomass.

In northernmost Lapland the Palsa mires (frozen mound bogs) are in danger of thawing with the warming climate, which would mean changed hydrological conditions and vegetation communities. Consequently, methane production would increase, but the higher carbon sequestration rates in the long term may compensate for the climatic impact.

Agriculture

Agricultural production in Finland is primarily limited by temperature. Other factors restricting production include solar radiation, precipitation and soil properties. The thermal growing season is estimated to lengthen by three to four weeks by 2050. However, the effective growing season will be prolonged by only about two weeks, mainly at the beginning of the season, because the low solar radiation and increasing rainfall prevent taking advantage of warming autumns.

Crop productivity will increase and the current main field crops could be cultivated further north. In the next few decades autumn-sown crops will become more common. However, the predicted increase in the variability of growing conditions is likely to increase production risks. In the early growing season, the risk of night frosts will remain and problems with drought will become more severe, increasing the need for irrigation.

Extreme weather events may become more frequent and bring heat waves and more heavy rainfall during the growing season, i.e. precipitation may be distributed more unevenly. As the temperature and precipitation in the autumn and winter increase, the decomposition of organic material will accelerate. The risk of erosion and leaching of nutrients will increase. The overwintering of plants may be hampered in southern Finland if the snow cover decreases. Also, the compaction of clay soil may increase and cultivation may become more difficult if the ground frost period shortens. The alternation between melting and freezing caused by mild winters may cause plants to suffer from anoxia beneath a forming ice cover.

Noxious insects will benefit from a warmer climate and longer growing season. The risk of plant disease epidemics may increase and disease outbreaks may occur earlier. Climate change will improve the living conditions of vectors, such as plant lice, that spread viral diseases.

Back to Contents

Farm animals will have a shorter indoor feeding and longer grazing season. Increased grazing may, however, enhance the leaching of nutrients to water. The risk of animal diseases may increase, although the risk is expected to be very low. The possible spreading of the vector-borne disease bluetongue is being followed closely and a contingency plan has been made. Diseases associated with the quality of water and feed may become more common. If the temperatures in sheds housing cattle and poultry rise very high, this would lead to a reduction in the milk yield of dairy cattle and in the growth of beef cattle and poultry.

Summary of climate change adaptation measures (potential measures identified in the national adaptation strategy and measures already launched) concerning agriculture, and the preliminary timing of measures (*Immediate: 2005–2010, **short-term: 2010–2030, ***long-term: 2030–2080).

		Anticipatory (A) / Reactive (R) measures	Measures launched
PUBLIC	Administration and planning	• Attention to production methods adaptable to climate change, production structure and locations in support policy*** (A)	• In the context of the mid-term review of the EU's common agricultural policy (CAP) a decision to increase measures under Rural Development Regulation, incl. measures concerning climate change adaptation.
		• Development of animal disease monitoring systems** (A)	• Finland has prepared a contingency plan for bluetongue disease, a catarrhal fever in ruminants spread by midges.
		• Development of plant disease and pest monitoring systems* (A)	
	Research and information	• Development of new technologies and cultivation methods and providing information on them** (A)	• Research project on impacts of climate warming on the health of reindeer.
		• Conceptualisation of climate change and its risks* (A)	• One of the ISTO research projects investigates the risks of a changing climate.
	Economic and technical measures	• Integration of changed climatic conditions and plant protection requirements into plant improvement programmes* (A)	• A joint Nordic plant breeding project has been launched.
		• Minimising the disadvantages of the potentially increasing use of pesticides** (R)	• National action programme required under the framework directive on sustainable use of pesticides is being prepared.
	Normative framework	• Assessment of the revisions to water protection guidelines** (A)	

	Anticipatory (A) / Reactive (R) measures	Measures launched
PRIVATE	• Introduction of new cultivation methods, cultivated crops and technology** (A)	• Raisio plc and Boreal Plant Breeding Ltd are contributors to the funding of the ILMASOPU research project. • Action on farmers' own initiative.
	• Extending the farm animal grazing period*** (R)	• For the animal welfare payments, 550 farms have selected grazing during the growing period as the additional measure.
	• Increasing the control of pests and diseases** (R)	• The ILMASOPU research project has noted an increase in prevention.

Fisheries and game

The warming climate may have a significant impact on the state of waters, fish stocks, fishing and fish farming. Changes in precipitation and temperature will probably affect the numbers, distribution and mutual relationships of fish populations both directly and through other changes in the ecosystem. Cold water species may decline particularly in small and shallow waters in southern Finland, while warm water species will benefit and spread further north. Changes in the salt concentration of the Baltic Sea could also have a great impact on its fish populations.

In most cases, young fish will benefit from the warming of waters, with longer growing periods in the spring and autumn. This may increase the abundance of plentiful age groups, also increasing the amount of prey available for predatory fish. It is estimated that climate change will increase leaching of nutrients into waters. This will increase eutrophication, which has already affected fish stocks in coastal waters. Generally, eutrophication increases the total fish biomass, but decreases species richness; cyprinid species thrive, but species requiring clear and well-oxygenated waters become scarce.

In the winter a shorter ice period and thinner ice will favour the most important mode of professional catching, trawling. On the other hand, it will hamper the wintertime seine catching of vendace as well as coastal net fishing. In summer, longer and more intense heat waves may increase fish diseases and parasites and make cultivation of fish more difficult. The most important cultivated fish is the rainbow trout, for which warming could be more a disadvantage than an advantage. If the climate warms significantly, there might be a need to farm a different fish species.

Moose, the most important game species in Finland, may first benefit from a warmer climate due to an increase in food resources. On the other hand, the heat physiology of the moose is not adapted to a temperate climate. Reduction in snow cover in southern and central Finland will contribute to the northward spread of roe deer and white-tailed deer.

The warming climate will increase the diversity of small game prey and predatory species and should stabilise the present strong population fluctuations. The abundance of medium-sized predators will increase. A decrease in snow cover and an increase in the frequency of freezing of snow may also be harmful for game birds which use snow for shelter.

Fisheries
Summary of climate change adaptation measures (potential measures identified in the national adaptation strategy and measures already launched) concerning fisheries, and the preliminary timing of measures (*Immediate: 2005–2010, **short-term: 2010–2030, ***long-term: 2030–2080).

		Anticipatory (A) / Reactive (R) measures	Measures launched
PUBLIC	Administration and planning	• Improvement of monitoring in order to assess the state of fish stocks, and development of cooperation between different parties* (A)	• Climate change taken into account in the overhaul of the Fishing Act. Test fishing register established for monitoring the management of waters facilitates follow-up of fish stocks.
		• Prevention of water pollution, fishing pressure and the deterioration of fish habitats* (A)	• Carried out as part of the regular planning of measures.
	Research and information	• Assessment of the ability of different species and age groups to adapt to the impacts of climate change* (A)	• ISTO research project launched in 2009.
		• Investigation of interdependencies between species and ecosystems* (A)	
		• Monitoring the development of the sector* (A)	
	Normative framework	• Consideration of the locations of new fish farming facilities with regard to climate change* (A)	

	Anticipatory (A) / Reactive (R) measures	Measures launched
Private	• Regulation of waters and diversion at power plants* (A)	• Support for the construction of passes for fish.
	• Increasing buffer zones around small waters* (A)	
	• Coordination of the temperature cycles important to the life cycle of fish at fish farming facilities to match natural cycles* (A)	
	• Investments in aeration and oxygenation equipment at fish farming facilities* (A)	
	• Change in fishing practices (for example, partial replacement of ice-fishing with open water fishing)*** (R)	• Changes in fishing practices taken into account in the overhaul of the Fishing Act and in the activities of the organisations involved.
	• Increased purification of discharge water from fish farming facilities in order to reduce feed and excrement* (R)	

Game management

Summary of climate change adaptation measures (potential measures identified in the national adaptation strategy and measures already launched) concerning game management, and the preliminary timing of measures (*Immediate: 2005–2010, **short-term: 2010–2030, ***long-term: 2030–2080).

		Anticipatory (A) / Reactive (R) measures	Measures launched
PUBLIC	Administration and planning	• Preparation of management plans for game stocks* (A)	• Management plans prepared for wolf, lynx, bear, wild forest reindeer, seal and partridge populations; preparation of management plans for wolverine and grouse populations under way. • National moose programme and wetland strategy are being prepared.
		• Guidelines for forest management and care should recommend that the living conditions of grouse be taken into account* (A)	
	Research and information	• Development of game management methods, i.e. measures directed at the habitats of game* (A)	• Several studies and projects of the Finnish Game and Fisheries Research Institute (FGFRI), the Finnish Forest Research Institute (Metla) and game management districts.
		• Continuing development of the game richness index, triangular game surveys and other methods of stock assessment* (A)	• The Finnish Game and Fisheries Research Institute (FGFRI) monitors and develops the game richness index and assesses the abundance of game.
		• Information about hunting and protection decisions* (A)	• Information on hunting and protection decisions is communicated in the relevant media. Organisations in the game sector also disseminate information on decisions.
		• Study on the response and adaptation of game species to climate change* (A)	
	Economic and technical measures	• Development of game management methods, as well as methods and equipment intended to prevent damage and support for their use.* (A)	• The Hunters' Central Organization acquires equipment to prevent damage with the aids of funding from the Ministry of Agriculture and Forestry and tries to find the best methods and equipment together with the manufacturers. Game management districts distribute equipment to potential damage sites.
		• Prevention of forest damage, agricultural damage and road accidents using suitable means (such as fences, mineral stones, repellents)* (A)	• Management plan for grouse populations is being prepared, communication to land and forest owners and hunters on taking grouse habitats and nests into account in the treatment of forests; 'Capercaillie Parliament of Central Finland'; Metsähallitus monitors game populations and manages game habitats constantly to ensure sustainable hunting. Note: connected to the previous measure.
	Normative framework	• Legislative regulation of game stocks (hunting and protection decisions)*** (A)	• Ministry of Agriculture and Forestry issues annual regulations on allowable game bags in order to steer the hunting of large carnivores. Game management districts may protect e.g. grouse in certain areas by their own decisions.

	Anticipatory (A) / Reactive (R) measures	Measures launched
PRIVATE	• Construction of game fences, use of repellents, restriction of stock by hunting or expansion of stock by restricting hunting* (A)	• See above. • Hunting is coordinated by the Ministry of Agriculture and Forestry, game management districts and Metsähallitus. Game management associations function as local experts and assess the damage. • Moose population has been reduced by hunting to prevent damage to forests, agriculture and traffic, and the population is now at the level of the mid-1990s.
	• The living conditions of game should be favoured in forest management* (A)	• Forest management guidelines, etc.
	• The growth of small predator populations should be controlled by hunting* (A)	• Continuous action by hunters. Intensified hunting in e.g. the archipelago with good results.
	• Regulation of hunting in accordance with game stocks (hunting clubs, hunters)* (R)	• Quotas of hunting clubs or associations, protection decisions and restrictions relating to the sex or age of game animals.

Forestry

Climate change will have an influence on the distribution and growth of boreal forests in Finland, where forests are one of the key sources of income. The natural regeneration of trees is mainly limited by low summer temperatures. Increases in temperature, carbon dioxide concentration and precipitation together with a longer growing season are likely to increase tree growth especially in northern Finland. According to some scenarios, the annual growth of forests (in cubic metres) is estimated to increase by one-third by the year 2100.

The timberline is expected to move slowly further north, with the two most important coniferous trees in economic terms, the Scots Pine (*Pinus sylvestris*) and Norway spruce (*Picea abies*), in the front line. Although deciduous trees would naturally gain ground in a warmer climate in southern Finland, the composition of tree species is mostly affected by forest management.

Climate change is a risk for forest health, productivity and biodiversity. Some typical boreal forest species and habitat types may decline or disappear. The forest health risks can be reduced, to some extent, by forest management. Risk of forest fires may increase in southern Finland if drought and heat waves become more common in summer. Periods of drought may also decrease tree growth. In autumn and winter, strong winds will increase wind damage to trees, especially if the period of ground frost shortens, as this will weaken the anchoring of trees to the ground. After such damage forests will be more vulnerable to pests. The shorter ground frost period and increased precipitation will also cause problems in forest management and harvesting.

The risk of snow damage to trees could decrease in southern and central Finland, because a smaller share of the wintertime precipitation is predicted to fall as snow. In northern Finland, however, an overall increase in precipitation and possibly wetter snow may increase snow damage.

Insect pests will benefit from increased temperatures and the longer growing season. This may increase the number of insect generations each year. One such species is the spruce bark beetle, the worst pest affecting spruce. An increase in minimum temperatures in the winter could facilitate the spread of pest species in Finland from south to north and from central Europe to southern Finland (e.g. the Gypsy and Nun moth).

The risk of fungal diseases may also increase in a warmer climate. For example, the economically most significant fungal disease, root rot caused by Heterobasidion spp., may spread further north, but will also cause more damage within its current range.

The changing climate will affect also forest berries. Cowberry (*Vaccinium vitis-idaea*), bilberry (*Vaccinium myrtillus*), and cloudberry (*Rubus chamaemorus*) are economically the most significant berry species. The flower buds of bilberries can be damaged by severe frost in the absence of insulating snow cover in the winter. As the growing season will start earlier, the berries will also ripen earlier. On the other hand, berries will be vulnerable to cold weather spells during flowering in the early summer.

Summary of climate change adaptation measures (potential measures identified in the national adaptation strategy and measures already launched) concerning forestry, and the preliminary timing of measures (*Immediate: 2005–2010, **short-term: 2010–2030, ***long-term: 2030–2080).

		Anticipatory (A) / Reactive (R) measures	Measures launched
PUBLIC	Administration and planning	• Inclusion of climate change aspects in the National Forest Programme* (A)	• Finland's National Forest Programme 2015, which was approved in 2008, contains measures related to adaptation.
		• Revision of forest management recommendations to incorporate climate change** (A)	• Forest management recommendations were revised in 2006.The specific recommendations for the management and use of peatland forests were published in 2007.
		• Protection of gene pools of forest trees* (A)	• Network of gene reserve forests set up in Finland: 42 forests, a total of about 7 000 ha. European gene reserve forest network is being created under the EUFOR-GEN programme.
	Research and information	• Development of forest management to adapt to climate change and to mitigate it* (A)	• Six ISTO research projects and the MIL research programme produce basic data on forest management methods that contribute to climate change adaptation and mitigation.
		• Development of a system for anticipating and monitoring damage* (A)	• Anticipation of damage investigated in two ISTO research projects. • National Storm Damage Contingency Plan (2007) extended in 2009 to cover other sudden forest damage. Forestry Centres drew up regional storm damage contingency plans in 2007 and they organise e.g. storm damage preparedness exercises with rescue authorities. • Further development of the follow-up system for damage as a joint project of the Finnish Forest Research Institute (Metla) and Forestry Development Centre Tapio.
	Economic and technical measures	• Development of harvesting* (A)	• Several ongoing surveys and development projects concerning harvesting equipment.
		• Tree improvement* (A)	• Forest tree breeding programme 2050 takes account of climate change. • Adaptation, especially of pine, to climate change investigated in an ISTO research project.
		• Control of pests and diseases*** (A)	• Preventing pests and diseases is taken into account in the budget, and the Finnish Forest Research Institute (Metla) is monitoring the pest and disease situation. Crisis contingency plan for pine wood nematode is being updated.
		• Maintenance of forest roads* (A)	• Exceptional weather conditions and periods of frost and other damage to roads taken into account in road maintenance. The objective set in National Forest Programme 2015 is to halve the length of roads with restrictions due to frost damage over the period 2006–2015.
		• Rapid harvesting of wind damaged trees in order to prevent consequential damage** (R)	• Harvesting of wind damaged trees takes place in accordance with the national and regional (Forestry Centres) forest damage contingency plans. A Contingency Manager appointed in all Forestry Centres.
		• Selection of the origin of artificial regeneration material** (R)	• Climate change taken into account in selecting the origin of forest reproductive material. Further information produced in e.g. the Forest Tree Breeding 2050 programme and ISTO research projects.
	Normative framework	• Assessment of the need for change in forest legislation in changing climatic conditions**/*** (A)	• Revision of Forest Act initiated in 2008. In this context it will be assessed whether adaptation and e.g. preparing for forest damage calls for changes in the legislation. • Crisis contingency plan for pine wood nematode is being updated.
		• Potential bans on wood imports from areas most badly contaminated by pests*** (A)	• Import restrictions have been imposed on coniferous plants and timber to prevent the spread of pine wood nematode.

	Anticipatory (A) / Reactive (R) measures	Measures launched
PRIVATE	• Preparation of forest plans on the basis of new management recommendations**/*** (A)	• No systematic approach to adaptation in forest planning and proposals for management measures of private forests.
	• Rapid harvesting of wind damaged trees in order to prevent consequential damage** (R)	• Harvesting of wind damaged trees coordinated in accordance with the national and regional (Forestry Centres) storm damage contingency plans (see public measures above). On private lands the forest owner decides who removes storm-damaged trees.

6.2.4 *Impacts on industries, infrastructure and human well-being, and the related adaptation measures*

Energy

Climate change affects the demand for electricity and heating. Demand for heating can be expected to decrease and demand for cooling to increase. The production of combined heat and power (CHP) may be reduced because of decreased demand for district heating. Warming will also affect the temperature of cooling water, reducing the efficiency of condensing power plants. The reliability of energy distribution and transmission will probably weaken, because the frequency of extreme weather conditions is likely to increase.

Hydropower resources and wind energy potential are likely to increase. Hydroelectric power generation is estimated to increase by 0–10 per cent up to the 2030s, mainly due to large winter discharges. Part of the increase will be caused by decreased spill-off in spring, with smaller floods. Some estimates suggest that solar energy may be reduced as a consequence of increased cloudiness. Biomass supply is expected to grow due to a longer growing season and improved potential productivity, hence increasing the amount of available bio energy. Climate change will have only minor direct impacts on the exploitation of fossil fuel and nuclear energy resources.

The potential for peat production is estimated to increase, mainly due to a longer harvesting period. However, higher summer rainfall would significantly reduce peat production, because this is very sensitive to weather conditions. Estimates concerning increased precipitation in the summer and the duration of dry periods are uncertain, however. Therefore, the overall impacts on peat production cannot be clearly deduced.

Climate change will have a great effect on the electricity network business. Increases in snow loads, floods and storms may affect the functioning of the energy supply network, due to falling trees, for example.

Summary of climate change adaptation measures (potential measures identified in the national adaptation strategy and measures already launched) concerning the energy sector.

		Anticipatory (A) measures	Measures launched
PUBLIC	Administration and planning	• Inclusion of adaptation to climate change in the long term planning and strategies of the energy sector. Progress will be gradual as necessary information is being accumulated. (A)	
	Research and information	• Research and development on adaptation will be expanded in order to continue and supplement the research on climate change mitigation (A)	• Studies on the functioning of low-energy building and on the impacts of improving the energy efficiency of structures on the functioning of the moisture technology of structures were published in 2008.
	Economic and technical measures	• More detailed examination of the need, quality, design and possible realisation times for concrete adaptation measures (A)	
		• Using suitable means of preparation for an increased need for repairs in some sectors (A)	
	Normative framework	• Surveying the potential need to change standards, etc. as necessary (A)	

	Anticipatory (A) measures	Measures launched
PRIVATE	• Adaptation surveys specific to each branch of energy (A)	
	• Systematically introducing adaptation to climate change as part of long-term planning and strategies in branch organisations and large enterprises of different energy branches (A)	

Land use planning and construction

The expected changes in precipitation and snow loads, wind velocity and temperature are a challenge for the construction sector. These stress factors are already having an impact on construction, because buildings have a long life cycle. It is expected that the number of freeze-thaw cycles on the exterior surfaces of buildings will increase considerably.

The most important impacts of climate change on land use are changes in flood risks, extreme weather events and groundwater conditions. The impacts will vary regionally. Changes in flood risks will mainly be caused by melting snow, heavy rainfall, the rise in sea level and changes in storm winds. This will create challenges for land-use planning, especially in the vicinity of rivers and lakes, in coastal areas and other areas vulnerable to floods.

Increased heavy rainfall will be a challenge for storm water management, especially in areas where most of the ground surface is covered with impermeable materials.

Dry summers and lower levels of groundwater may reduce the carrying capacity of soil and cause more settlement.

Ground frost conditions will also change, making it more difficult to build ice roads.

Land use and communities

Summary of climate change adaptation measures (potential measures identified in the national adaptation strategy and measures already launched) concerning land use and community planning.

		Anticipatory (A) / Reactive (R) measures	Measures launched
PUBLIC	Administration and planning	• Evaluation of the impact of climate change will be included in the long term planning of regional and urban structures (A) • Town planning processes will be associated with a requirement to carry out additional investigations on adaptation to climate change in particularly vulnerable areas (flood risk areas, attention to the microclimate, terrain and soil, conduction of rainwater and surface waters, construction in shore areas, potential increase in windiness, protective city block areas, avoidance of hollows) (A)	• Government Decision of 13 November 2008 on the revision of the National Land Use Guidelines. (Objectives laid down in the Land Use and Building Act must be taken into account and their implementation must be promoted in regional land use plans, local plans and activities of State authorities.) • Life+ project CCCRP ''Climate Change Community Response Portal'' (Finnish Meteorological Institute) has been launched.
	Research and information	• Flood-sensitive areas and structures will be surveyed (A) • Anticipatory systems and warning systems for extreme events will be developed (A) • Regional and local impacts and means of adaptation will be investigated (A)	• The Finnish Environment Institute (SYKE), Regional Environment Centres and Ministry of Agriculture and Forestry map/survey risk areas. • R&D projects (2009, 2010): flood risks in land use, geographic information analyses of flood risk areas. • Proposal on flood risk management (Ministry of Agriculture and Forestry) • Guide to preliminary assessment of flood risks, draft of 24 September 2008. • Steering of land-use planning, training and communication, incl. regional examples. • Life+ project SNOWCARBO "Monitoring and assessment of carbon balance related phenomena in Finland and northern Eurasia", Finnish Environment Institute(SYKE).
	Economic-technical measures	• The conduction of rain and surface waters will be improved (R)	• Proposal to include management of storm water/urban runoff in amendments to the Water Services Act (Ministry of Agriculture and Forestry). • Guide on storm water/urban runoff is being prepared (Association of Water and Sewage Plants (VVY), Association of Finnish Local and Regional Authorities, Ministry of Agriculture and Forestry, Ministry of the Environment).
	Normative framework	• The need to amend the Land Use and Building Act and Decree and municipal building codes will be investigated (A)	• Needs for change surveyed during 2009, draft Government proposal in December 2009.
		• Recommendations will be issued at different levels of planning as necessary (A)	• Commitment to adaptation in land use under Government Decision on the revision of the National Land Use Guidelines. Steering of land use planning, training and communication.

	Anticipatory (A) / Reactive (R) measures	Measures launched
PRIVATE	• The conduction of rain and surface waters will be improved (R)	

Buildings and construction
Summary of climate change adaptation measures (potential measures identified in the national adaptation strategy and measures already launched) concerning buildings and construction.

		Anticipatory (A) / Reactive (R) measures	Measures launched
PUBLIC	Administration and planning	• Climate change will be included in long-term planning and research activities in the construction sector (A)	• Government Decision of 13 November 2008 on the revision of the National Land Use
	Research and information	• Surveying the local impacts and spheres of influence of climate change (A) • Surveying flood-sensitive areas (A) • Anticipatory systems and warning systems for extreme events will be developed (A) • The need to rebuild rainwater drains in built-up areas and the scope for impregnating soil with water or directing it to basins will be studied (A) • The impacts of a potential increase in wind velocity will be taken into consideration with regard to the existing building stock and new construction (A) • Revision of existing structures (A)	• EXTREMES project (Natural hazards to infrastructure in a changing climate II). • Life+ 2007 project ''Climate Change Response through Managing Urban Europe-27 Platform'' (Union of Baltic Cities) launched on 1 January 2009. • The Ministry of Agriculture and Forestry, the Finnish Environment Institute (SYKE) and Regional Environment Centres map/survey flood risk areas. • RATU project (Heavy rains and urban flooding); publication Finnish Environment 31/2008 • Wind load study • Pre-study on the physical behaviour of buildings and the durability of building envelopes.
	Economic-technical measures	• Guidelines will be prepared for the treatment of storm water and the design of drainage systems (A)	• Proposal to include management of storm water/urban runoff in amendments to the Water Services Act (Ministry of Agriculture and Forestry). • Guide on storm water/urban runoff is being prepared (Association of Water and Sewage Plants (VVY), Association of Finnish Local and Regional Authorities, Ministry of Agriculture and Forestry, Ministry of the Environment).
		• Repair of storm damage to buildings will be further developed (R)	
		• Different repair measures (R)	
	Normative framework	• Potential revision of design standards, instructions and regulations based on research information (A)	
		• Potential issue of recommendations in accordance with local stress conditions (A)	

	Anticipatory (A) / Reactive (R) measures	Measures launched
PRIVATE	• Different repair measures (R)	

Manufacturing

The indirect impact of climate change through mitigation measures and greenhouse gas reduction targets will be much more important to industry than direct impacts.

Direct impacts have two main pathways. Firstly, in some sectors available raw materials may change. This can have implications for processing methods, for product assortments and perhaps even for the factory location. For example, changes in growing conditions may affect the chemical and structural properties of wood for the forest industry. In addition to the possible increase in annual growth, rising temperatures may increase the overall wood density, due to thicker fibre cell walls, and may also increase fibre length. Further, enhanced growth may improve branch growth, increasing knots in the wood and causing reduction in the quality and mechanical strength of sawn wood. The food processing industry may also face changes if regional shifts take place in crop production or if milk production moves further northwards. Secondly, the transport of industrial raw materials and products may become more vulnerable to adverse weather conditions. In the forest industry, this may also include seasonal shifts in the supply of roundwood if the duration of difficult road conditions in the spring increases. Severe storms may also induce peaks in the supply of roundwood.

Summary of climate change adaptation measures (potential measures identified in the national adaptation strategy and measures already launched) concerning manufacturing industry.

		Anticipatory (A) measures	Measures launched
PUBLIC	Administration and planning	• Inclusion of adaptation to climate change in the long term surveys of different industrial sectors. Progress will be gradual as the applicable information is accumulated. (A)	
	Research and information	• Sector-specific surveys of the information and research needs of adaptation and their focusing (A) • More detailed investigation of the economic impacts of adaptation specific to sector (A)	
	Economic and technical measures	• Sector-specific, detailed examination of the need, quality, design and possible realisation times for concrete adaptation measures (A)· • Systematic survey of industries located in flood-sensitive areas and consideration of the required adaptation methods as necessary (A)	• See table on Land-use and community planning.·
	Normative framework	• Surveying the potential need to change standards, etc. as necessary (A)	

	Anticipatory (A) measures	Measures launched
PRIVATE	• Sector-specific surveys of adaptation needs (A)	
	• Systematically introducing adaptation to climate change as a part of long-term planning and strategies in the branch organisations and large enterprises of different sectors (A)	

Transport and communications

Climate change is likely to affect the transport infrastructure and all modes of transport. Floods and heavy rainfall will increase erosion and risk of landslides along roads and railways. Temporary flooding of underpasses will become more frequent. The net change in maintenance costs of roads and highways over the entire cold season will probably be small.

Sea transport may benefit from climate change. The ice season is expected to shorten considerably in the Baltic. On the other hand, the heaviest storms often occur in winter months, and if the sea is open, waves may be very high. If there is ice, storms can create thick ice belts and high ridges on shipping routes and at harbour mouths.

Air traffic will suffer from heavy storms and lightning. Maintenance costs of airports and the use of de-icing chemicals may increase in mid-winter.

In telecommunications, the networks relying on cables may be vulnerable to storms and icy rain. The same applies to the automatic safety systems of different modes of transport. Ice and wind loads on telecommunications masts may also become heavier.

Summary of climate change adaptation measures (potential measures identified in the national adaptation strategy and measures already launched) concerning transport and communications, and the preliminary timing of measures (*Immediate: 2005–2010, **short-term: 2010–2030, ***long-term: 2030–2080).

		Anticipatory (A) / Reactive (R) measures	Measures launched
PUBLIC	Administration and planning	• Inclusion of climate change in the transport sector's long-term planning* (A)	• Survey on climate change adaptation conducted by the Finnish Road Administration in 2007, by the Rail Administration in 2008 and by the Finnish Maritime Administration in spring 2009. • Life+ project JULIA "Mitigation of and Adaptation to Climate Change in the Helsinki Metropolitan Area – From Strategy to Implementation" (Helsinki Metropolitan Area Council (YTV)) has been launched.
		• Securing the functionality of telecommunications networks (wired networks)** (A)	• The Finnish Rail Administration studies the improvement of redundancy in communication networks to remove accuracy problems, which has indirect impacts on ensuring the functioning of wire networks.
	Research and information	• Surveying of flood sensitive areas* (A)	• The Finnish Rail Administration has inventoried sensitive areas as regards flood risks in southern Finland in connection with preparedness exercises and preparedness plans. • The Ministry of Agriculture and Forestry, the Finnish Environment Institute (SYKE) and Regional Environment Centres map/survey flood risk areas.
		• Anticipatory systems and warning systems for extreme events** (A)	• The Finnish Meteorological Institute maintains and develops several observation and warning systems relating to weather and wind information.
		• Assessment of the ice situation in the Baltic Sea* (A)	• The Finnish Maritime Administration has participated in research on trends in the ice conditions of the Baltic Sea.

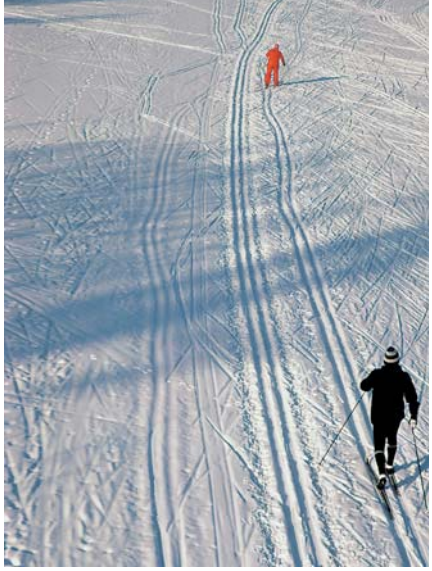
		Anticipatory (A) / Reactive (R) measures	Measures launched
PUBLIC	Economic and technical measures	• Maintenance of the structures (road, ditches, bridges and culverts) and condition of road network, particularly on smaller roads and gravel roads as floods and rainfall increase and ground frost diminishes** (A)	• Anticipatory action: as far as possible the matter is taken into account in new investments. • Reactive action: structures are maintained and managed within the budget appropriations for basic road maintenance.
		• Maintenance of the structures (track beds) and condition of railways while floods and rainfall increase and ground frost diminishes** (A)	• Anticipatory action: as far as possible the matter is taken into account in new investments. • Reactive action: structures are maintained and managed within the budget appropriations for basic railway maintenance.
		• Minimising the environmental hazards caused by antiskid treatments (alternatives to salt, planning of groundwater protection)** (A)	• The Finnish Road Administration has tested potassium formiate in deicing of roads in winter in Suomenniemi; implementation of the theme programme on groundwater protection is proceeding at a pace of about 3 km a year.
		• Taking more difficult traffic conditions into account in planning and schedules (R)	• Report of the Finnish Maritime Administration on Climate Change and Adaptation, publication 3/2009
		• Repair of storm damage to overhead cables (R)	• Removal of problem trees included in the present management contracts. The Finnish Rail Administration is responsible for the repair of damage.
		• Increase of winter traffic in the Baltic Sea (R)	• The Finnish Maritime Administration has prepared a forecast for maritime transport in 2030.
		• Antiskid treatment of roads and airports (R)	• The winter management guidelines of the Finnish Road Administration will be introduced on 1 October 2009 for main roads throughout the country, and for new work started on other roads.
		• Repair of storm damage to the road and rail networks (R)	• Within the budget framework.
	Normative framework	• New planning norms and guidelines for road and railway construction**/*** (A)	
		• Guidelines and definition of tolerances for the duration and disturbances (R)	• The Finnish Rail Administration has updated the disruption and response times in its new maintenance contracts.

	Anticipatory (A) / Reactive (R) measures	Measures launched
PRIVATE	• Maintenance of the structure and condition of the private road network as floods and rainfall increase and ground frost diminishes** (A)	
	• Taking more difficult traffic conditions into account in planning the schedules and timing (R)	
	• Salting and antiskid treatment of roads (R)	

Tourism and recreation

Finland is an attractive destination for tourists mainly because of the large variety of recreation opportunities available in the country's natural environment. The reliance on nature and seasonal variation make tourism and recreation vulnerable to climate change.

Snow-based activities such as cross-country skiing, alpine skiing, riding snowmobiles and ice-fishing are vulnerable to climate change. Increased uncertainty of snow conditions has already been a problem for winter tour-



ism and recreation, particularly in southern Finland. However, ski resorts in the north may benefit in the future from their relatively good snow conditions compared to other resorts in Europe or southern Finland.

The short summers are a major obstacle to the further development of summer tourism and recreation. A warmer and longer summer season would thus improve the conditions for summer sports and many water-based recreation activities (e.g. boating, swimming and fishing). On the other hand, algal blooms in warmer waters, increased summer precipitation or extreme weather events may lower the attraction in summer time. Changes to the flora and fauna could also have an impact if a particular species is an important attraction in the area (e.g. the Saimaa ringed seal is an important part of the positive image of the lakes region).

Summary of climate change adaptation measures (potential measures identified in the national adaptation strategy and measures already launched) concerning tourism and the recreational use of nature, and the preliminary timing of measures (*Immediate: 2005–2010, **short- term: 2010–2030, ***long-term: 2030–2080).

		Anticipatory (A) / Reactive (R) measures	Measures launched
PUBLIC	Administration and planning	• Integration of adaptation to climate change with tourism strategies* (A)	• Improving snowmobile routes in the national inventory of snowmobile routes in 2009.
		• Taking into account the increase in hiking outside the cold season in the planning and use of recreation areas*** (A)	• The revision of the Off-road Traffic Act in 2009 takes into account the development of off-road traffic during the period with no ground frost.
		• Development of other attractions besides those related to snow for winter tourism to reduce the dependence on snow* (A)	• Classification of hiking routes under way.
	Research and information	• Increased research both on the impacts of and adaptation to climate change* (A)	• Adaptation of tourism and outdoor and other recreation services has been studied e.g. under the FINADAPT research project.
		• Communicating research results to private actors* (A)	
	Economic and technical measures	• Development of artificial snow* (R)	

	Anticipatory (A) / Reactive (R) measures	Measures launched
PRIVATE	• Development of other attractions in winter tourism to reduce the dependence on snow* (A)	
	• Improving the economy of artificial snow on ski slopes and investigating the possibilities of its use in cross-country skiing* (R)	
	• Change of tourism patterns*** (R)	
	• Change in patterns of recreational use of nature*** (R)	• Lengthening the boating and camping season.

Opportunities for cross-country skiing will decrease

Skiing has been a popular physical activity and part of the Finnish way of life for generations. According to nationwide surveys, almost half of the population engages in either cross-country or alpine skiing at least once a year and over 90 per cent say that they have adequate cross-country skiing skills.

Fewer skiing days per season is the first consequence of a warmer climate. Fewer skiing opportunities close to home will have a negative impact on skiing frequency of those who are unable to travel to areas with guaranteed snow. The absence of cross-country skiing opportunities will reduce the chances for children to learn this traditional winter activity. This impact will be strongest for people living in southern Finland.

Skiers in southern Finland will thus become more interested in ski tourism to areas with guaranteed snow, where more opportunities will open to develop new services. At the moment, tourism enterprises do not see the shortened winter season as an immediate threat to their business, even though cross-country skiing and riding snowmobiles and dog-sleds are more sensitive to natural snow conditions than alpine skiing.

Insurance

Climate change is likely to increase the damage caused by extreme weather. Insurance companies face higher uncertainties in their risk estimates, which may be reflected in the insurance premiums and coverage. At present, the companies offer good insurance coverage for forests, for instance against fire, storms, floods, heavy snow, insects or pathogens. On average, some 70–80 per cent of annual compensation in forest insurance is paid for storm damage. This figure has remained unchanged over the last 5–6 years, i.e. over EUR 2 million, or 2,000 payments, annually. The figure includes also forest fires.

Home and property insurance policies do not cover damage caused by heavy rainfall or floods. However, if a flood from a river or lake is considered exceptional (i.e. it has a return period of over 20 years), it is possible to obtain compensation from the government. The average yearly compensation in this category has been less than EUR 1 million, but occasionally the amount has been higher, for example in 2004 it was EUR 7 million. The current system for compensating flood damage does not include floods caused by sea-level rise or storm water/urban run-off. This is one of the reasons why the system for compensating flood damage is under revision. An insurance -based system has been proposed.

The government also compensates agricultural operators for damage caused by adverse weather conditions if this exceeds 30 per cent of the value of a normal harvest. The annual budgeted sum for this compensation is EUR 3.4 million for harvest damage and EUR 0.8 million for flood damage. The average annual figure has risen because there have been a few years with exceptionally high compensation.

Summary of climate change adaptation measures (potential measures identified in the national adaptation strategy and measures already launched) concerning insurance, and the preliminary timing of measures (*Immediate: 2005–2010, **short-term: 2010–2030, ***long-term: 2030–2080).

		Anticipatory (A) measures	Measures launched
PUBLIC	Administration and planning	• Integration of climate change adaptation with tourism strategies* (A) • Development of an insurance pool jointly with insurance companies* (A)	
	Research and information	• Modelling and study of risks utilising existing climate change scenarios* (A) • Development of precautions to avoid damage* (A)	• Research project under way on weather-induced risks in the management of climate risks in agriculture.
	Economic and technical measures	• Development of technology to reduce risks* (A)	
	Normative framework	• Development of insurance legislation* (A)	

	Anticipatory (A) measures	Measures launched
PRIVATE	• Clarifying insurance policies and responsibilities* (A)	
	• Proactive planning and modelling* (A)	
	• Development of private insurance systems to take climate change into consideration* (A)	
	• Development of new products to control economic risks* (A)	
	• Diversification of risk with the help of bonds and derivatives* (A)	

Health

Increased intensity and frequency of extreme weather events may cause additional pressure in the health sector, particularly as the population ages. High temperatures will increase heat-related mortality and morbidity in the summer. There is a clear increase in mortality in Finland when the daily average temperature remains at about +20°C or more for 1–2 weeks. On the other hand, with milder winters the risks of additional mortality from cardiovascular and pulmonary diseases as a result of an extremely cold spell are likely to decrease. Darker winters, caused by a shorter snow cover period, increased precipitation and cloudiness, may increase cases of seasonal affective disorder. The number of days when the temperature hovers around 0°C will also increase. This may increase the risks of slipping injuries and traffic accidents. In addition, thinner and shorter duration of ice cover on waterways will be a safety risk.

Warming will contribute to the northward spread of ticks and the tick-borne diseases such as Lyme disease (borreliosis) and tick-borne encephalitis. A warmer climate will also stabilize the population fluctuations of small rodents, which will reduce the overall incidence of several rodent-borne diseases (e.g. Puumala hantavirus and tularaemia). The probable increase in density of medium-sized predators (red fox, raccoon dog) will increase the risk of rabies and alveolar echinococcosis spreading to Finland.

A warmer climate and longer growing season may favour the pollen production of certain plants and the occurrence of cyanobacteria in waters, which may cause allergic reactions. If forest fires become more common, airborne particulates may have an adverse health impact.

Storms, floods and intense small-scale wind phenomena may cause accidents and create health hazards. Floods may also induce large-scale health risks, particularly through contamination of the water supply.

Summary of climate change adaptation measures (potential measures identified in the national adaptation strategy and measures already launched) concerning social services and health care, and the preliminary timing of measures (*Immediate: 2005–2010, **short-term: 2010–2030, ***long-term: 2030–2080).

		Anticipatory (A) / Reactive (R) measures	Measures launched
PUBLIC	Administration and planning	• Securing the capacity of health care to correspond to changing climatic conditions* (A)	
		• Cooperation between climate researchers and health care and social services* (A)	• Networking has been launched and know-how enhanced especially on infectious diseases.
		• Supplementing of the guide for special circumstances by the Ministry of Social Affairs and Health with regard to hot periods (A)	• Guide on emergency situations in environmental health, which should be completed in 2009, offers a comprehensive account of emergency situations related to weather events.
		• Energy policy must aim to secure the distribution of electricity (A)	
	Research and information	• Information about the dangers of the changing climate, such as heat waves* (A)	• The Finnish Meteorological Institute has plans for warning systems for heat and cold. Criteria for the heavy rainfall warning system take account of the risk of water-borne epidemics.
		• Studies related to special circumstances, monitoring them and organising reporting on them (A)	• Generic action models have been prepared on research activities relating to emergency situations.
		• Information on the dangers of algal blooms* (A)	• The Ministry of Agriculture and Forestry, the Finnish Environment Institute (SYKE) and Regional Environment Centres issue weekly reports on algal blooms in summer.
		• Information about the increased risk of infectious diseases* (A)	
		• Studies related to special circumstances and organising reporting on them (R)	• Research and communication is carried out on all emergency situations where significant numbers of people are at risk of falling ill.
	Economic and technical measures	• Development of urban planning with regard to the control of the urban heat island phenomenon* (A)	
		• Preparedness planning must pay attention to backup systems for the distribution and production of electricity (A)	• The Ministry of Social Affairs and Health is updating the guide on emergency situations in environmental health, including risk management relating to power cuts.
		• Ensuring air conditioning and sufficient ventilation in retirement homes and hospitals, for example, by means of quality recommendations* (R)	• Classification of indoor air was revised in 2008.

	Anticipatory (A) / Reactive (R) measures	Measures launched
PRIVATE	• Increased air conditioning*** (R)	• Guide on the ventilation of residential buildings will be published during 2009.

Cultural environment

Climate change can affect the cultural environment and it may pose a threat to the preservation of the cultural and natural heritage. More research is urgently needed on the impacts of climate change in order to evaluate them comprehensively.

Cultural landscapes and traditional rural biotopes will be affected as changes are expected in biodiversity and in the distribution of species. As environmental conditions of the soil change, archaeological heritage will be endangered and stability of the soil as a foundation for buildings will weaken. Wood is also sensitive to changes in humidity. Wooden buildings are typical in Finland and, therefore, measures will be required to control decay and fungi growth even without flooding problems. The old town in Rauma and the Petäjävesi wooden church on the UNESCO World Heritage List represent Nordic wooden architecture. Extreme weather phenomena such as storms and flooding have an impact, for example, on the Suomenlinna Sea Fortress also listed on the World Heritage List.

Adaptation to climate change leads to an increased need for safety repairs at restoration and conservation sites. Climate and energy policies, like the increasing use of renewable energy sources, and energy-saving goals, like improving energy efficiency of buildings, may also have significant effect on the cultural environment.

6.2.5 *Impacts of climate change in Finnish Lapland, and the related adaptation measures*

In Finnish Lapland, the observed climatic changes have so far been relatively small. Exceptional snow conditions have occurred though, varying from record late arrival in some years to record high accumulations in late winter in others. In spring 2005, severe floods caused considerable damage in some communities.

The projected climate change in Lapland indicates a particularly large warming trend, and a considerable increase in precipitation. The changes are likely to have pronounced effects on the distribution and productivity of boreal forests and arctic vegetation. Forests will spread into the tundra, which may also produce a feedback effect on the regional climate by reducing the albedo and thus causing additional warming.

The shortening of the snow season has become very evident in recent years, threatening particularly the important Christmas tourism season. Tourism is the main industry in many communities in Lapland. During seven months of the year, tourism has been based on snow and winter conditions. For this reason, some municipalities in Lapland have begun to look ahead to the consequences of climate change.

Reindeer husbandry is important in Lapland, particularly in small communities. Reindeer are also of great cultural value because many of their

owners are indigenous Sami people. The impacts of climate change on reindeer populations are expected to be mainly unfavourable. If winters get milder and precipitation increases, snow may be thicker and icy layers may form inside the snow cover. This would make it difficult for reindeer to dig for lichen and their need for supplementary food will increase. The northward advance of the tree line and gradual replacement of lichens with vascular plants may also affect reindeer pastures.

Almost half of Finland's hydropower is generated in Lapland. Increased precipitation and more even discharges (smaller spring floods and bigger discharges in winter) will be beneficial for hydropower production. It is likely that additional capacity will be built alongside existing hydropower plants.

Summary of climate change adaptation measures (potential measures identified in the national adaptation strategy and measures already launched) concerning reindeer husbandry, and the preliminary timing of measures (*Immediate: 2005–2010, **short-term: 2010–2030, ***long-term: 2030–2080).

		Anticipatory (A) / Reactive (R) measures	Measures launched
PUBLIC	Administration and planning	• Coordinating the interests of reindeer husbandry and forestry* (A)	• The need to reconcile the interests of reindeer husbandry and forestry will become even more important as climate change alters the circumstances.
		• Development of aerial supervision in order to reduce the risk of large fires* (A)	
		• Comprehensive planning of different forms of land use through the development of planning systems* (A)	• Different forms of land use should be taken into account in natural resource planning by Metsähallitus.
	Research and information	• Studying the long-term changes experienced in the state of pastures and the impacts of climate factors** (A)	• The Finnish Game and Fisheries Research Institute (FGFRI) monitors and reports to the Ministry of Agriculture and Forestry. Maximum allowable reindeer numbers will be determined on the basis of the proposals of a working group to be set up (proposal to be based on the state of pastures).
		• Providing information on the most critical pasture areas* (A)	• Communicated on the basis of the above-mentioned reporting by the Finnish Game and Fisheries Research Institute (FGFRI).
		• Study of the adaptation of reindeer to climate change**(A)	• Ongoing study on reindeer forage and supplementary feeding.
		• Study on the ecophysiological impacts of environmental changes on plants and soil, particularly on horsehair lichen, mosses and lichen in northern regions** (A) • Development of planning systems for different forms of land use** (A)	• Studies by the Finnish Game and Fisheries Research Institute (FGFRI) on the amounts, state and productivity of pasture areas and changes in pastures and their causes. Research on the impacts of grazing reindeer and other land uses on pastures.
	Economic and technical measures	• Separation of winter and summer pastures by fences* (A)	

		Anticipatory (A) / Reactive (R) measures	Measures launched
PUBLIC	Normative framework	• Prescription on the maximum number of reindeer** (A)	• Number of reindeer established for 10 years (next time in 2010) based on the state of pastures, taking account of social and economic impacts.

	Anticipatory (A) / Reactive (R) measures	Measures launched
PRIVATE	• Development of pasture rotation systems (including rotation fences)* (A)	• Pasture rotation systems constantly developed by herding cooperatives. Research at the Finnish Game and Fisheries Research Institute (FGFRI) on e.g. the impacts of different reindeer herding methods on output and costs.
	• Arrangement of additional feeding** (R)	• Additional feeding of reindeer depending on the natural conditions and state of pastures.

6.2.6 *National security and the related adaptation measures*

The adaptation strategy of 2005 did not address national security as a sector of its own. A better understanding has since been developed of the impacts of climate change on societies and how the climate change related problems in some other parts of the world may be reflected in Finland through the global economy and via migration and environmental refugees. The Government Resolutions on the Internal Security Programme (Ministry of the Interior 2008) and Strategy for Securing the Functions Vital to Society (Ministry of Defence 2006) deal with the preparations within the national defence administration for the consequences of climate change.

Administrative sector of the Ministry of Defence
Summary of climate change adaptation measures already launched concerning the administrative sector of the Ministry of Defence.

		Measures launched
PUBLIC	Administration and planning	• According to the report on national security and defence policy (Finnish Security and Defence policy 2009: Government Report, 23 January 2009), the future development of national security must take into account the threats caused by climate change and adaptation to it, e.g. by means of land-use and other community planning, education and training and acquisition of rescue equipment.
		• In the Strategy for Securing the Functions Vital to Society (YETT Strategy, Government Resolution 2006) climate change is considered the most serious global environment threat.
		• According to the Ministry of Defence strategy 2025 'Securely into the Future', climate change is a factor that influences the security situation and it must be taken into account in the activities of the defence administration.
		• A study on the needs for adaptation and impacts of climate change on the activities of the defence forces has been launched based on the survey 'Defence Administration and Climate Change' (2008).
		• Planning of the military actions of the Defence Forces (Operative and development planning of garrisons, VARSU) also takes account of flood risk areas, norms for energy planning, energy efficiency of buildings and structures and environmental protection.

Administrative sector of the Ministry of the Interior
Summary of climate change adaptation measures already launched concerning the administrative sector of the Ministry of the Interior.

		Measures launched
PUBLIC	Administration and planning	• In the 'Safety First – Internal Security Programme' (2008), climate change is recognised to have on impact on security e.g. because of extreme weather events and increasing number of refugees.
		• In the administrative sector of the Ministry of the Interior, climate change mitigation and adaptation have been taken into account e.g. in the acquisition of equipment. It is considered particularly important to obtain research information on the security impacts of climate change in order to prepare for the future.
		• Preparing for the potential impacts of climate change on internal security, illegal immigration, smuggling and human trafficking.
		• Preparing for the growing frequency of storms and extreme weather events in rescue operations.

6.2.7 *Global impacts of climate change reflected in Finland*

Changes taking place in other parts of the world will create a need for adaptation in Finland, too. The IMPLIFIN project ('Implications of international climate change impacts for Finland') concludes that climate change impacts on the world economy and on the development of poorer countries could have important repercussions for the Finnish economy and for Finland's international relations in general. Furthermore, international climate policy and especially EU regulations will have implications for Finnish policy making.

In the early stages of warming, the impacts on the Finnish economy are not expected to be very large, with beneficial impacts compensating to a large extent for detrimental impacts. Moreover, the near-term adaptive capacity of Finland appears to be quite high, especially when compared to poorer countries. However, effects can be mixed and benefits could occur in some periods and disadvantages in others.

Finnish agriculture, forestry, energy, tourism and transport are sensitive to the international impacts of climate change. The impacts will also have consequences for Finland's international development cooperation.

Over the next few decades a slight change in the climate would have advantages for a northern developed country like Finland. However, the advantages may be reduced when the harmful impacts of climate change outside Finland are taken into consideration.

In the long run, external impacts could prove to be more significant for policy makers than domestic concerns (Table 6.2).

Table 6.2
Climate change impacts in other countries reflected in different sectors in Finland

Sector	Link between global events and adaptation need in Finland
Agriculture and food production	Agriculture, food prices and availability may be affected by: • Uncertainty concerning preservation of levels of production in present major production areas • Changes in demand for agricultural products • Implications of mitigation measures such as increased demand for bio-energy crops • A possible increase in the demand for Finnish food products.
Development cooperation	Finland's international development cooperation policies and practices need to be modified to take climate change into account.
Economy	Effects on the economy and foreign trade can be mixed and benefits could occur in some periods and negative effects in others. Extreme weather events could increase costs significantly.
Energy	EU energy policies create a need for restructuring Finland's energy production. Hydropower production is expected to increase in the Nordic countries, which have a common energy market. Energy infrastructure, and particularly transmission networks and pipelines, are likely to be vulnerable to climate change and extreme weather events. Climate change could affect the reliability of energy distribution and therefore energy supply in Finland.
Forestry	Diminishing non-boreal, but increasing boreal forest reserves may increase the importance of boreal forests as a carbon sink. Policy measures in other EU countries on renewable energy may reduce the effectiveness of national policies in Finland. Demand for bio-energy may lead to increased exports of forest-based biofuel and know-how from Finland.
Health	Forest fires in neighbouring countries may worsen air quality and cause negative health impacts.
Security	Resource scarcity could cause conflicts and forced migration. Opening of new sea routes in the Arctic also has a military and strategic dimension, which could alter the world's geopolitical balance.
Tourism	Regional climate effects in the Mediterranean and the Alps, for example, may affect tourists' preferences in ways which will affect Finnish tourism.
Transport and communications	Opening of the Northwest Passage and Northern Sea Route could mean substantial savings in transportation costs, as well as savings in time and energy costs. Opening of the Arctic Sea routes could mean increased transportation through northern Finland and Lapland and possibly also changes in marine transportation in the Gulf of Bothnia or in the Baltic Sea in general.

6.3 *Vulnerability assessment*

In comparisons of the vulnerability of different countries to climate change, the Nordic countries, including Finland, have been among the least vulnerable. The conclusion is the same when world-wide maps of various vulnerability indicators are examined.

So far, there have been few risk analyses concerning the impacts of climate change in Finland. In some sectors, the results of climate change research have included aspects of vulnerability assessment. In the European Environment Agency report 'Vulnerability and adaptation to climate change in Europe', agriculture and forestry are the only sectors for which Finland has specified some vulnerabilities.

Implementation of Finland's adaptation strategy requires that risk assessment methods applicable to the impacts of climate change must be developed and applied further. Moreover, assessments that integrate different risks, such as climate, environment, economy, health and insurance, will be needed. These will require precise information about the expected impacts and uncertainties of climate change.

In January 2009 a major project concerning vulnerability assessment was started. This MAVERIC project ('Map-based assessment of vulnerability to climate change employing regional indicators') has six objectives:

- To identify relevant climate variables for selected human activities and to use observations and model-based future projections of these variables to describe the exposure to climate change.
- To examine alternative impact models for evaluating sectoral or system sensitivity to climate change, and to analyse their suitability for application at a municipal level.
- To define appropriate indicators of adaptive capacity to climate change based on the modification of existing sustainability indicators and scenarios, a literature review and discussions with representatives from selected pilot study regions.
- To finalise a set of vulnerability indicators for Finland as a whole and develop web-based methods to map these interactively.
- To report results at stakeholder workshops to obtain feedback and facilitate refinement and nationwide application of the vulnerability indicators.
- To publish the results in peer reviewed literature.

The project is scheduled to end in December 2011. The research team is interdisciplinary and multi-institutional. The work will focus on three sectors: agriculture, tourism and recreation, and water resources. Other sectors are also under consideration.

Another major project VACCIA (Vulnerability of ecosystem services for climate change impacts and adaptation), started in January 2009, will make a detailed assessment of the vulnerability of main ecosystem services in Finland and collect information on possible adaptation measures.

Literature

Berghäll, J. & Pesu, M. (2008) Climate Change and the Cultural Environment. Recognized Impacts and Challenges in Finland. The Finnish Environment 44en/2008, Ministry of the Environment, Helsinki, Finland http://www.ymparisto.fi/default.asp?contentid=318369&lan=en

Carter, T.R. (ed.) (2007) Assessing the adaptive capacity of the Finnish environment and society under a changing climate: FINADAPT. Finnish Environment, 1/2007, Finnish Environment Institute, Helsinki, Finland http://www.ymparisto.fi/download.asp?contentid=64914&lan=en

Case Studies on Climate Change and World Heritage (2007) UNESCO World Heritage Centre, Paris, France http://unesdoc.unesco.org/images/0015/001506/150600e.pdf

Climate Change and World Heritage. Report on predicting and managing the impacts of climate change on World Heritage and Strategy to assist States Parties to implement appropriate management responses (2006) World Heritage Reports 22, UNESCO World Heritage Centre, Paris, France http://whc.unesco.org/uploads/activities/documents/activity-474-1.pdf

Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (2007), Cambidge University Press Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B., Averyt, M., Tignor M.M.B. & Miller H.L. (eds.) Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. http://www.ipcc.ch/ipccreports/ar4-wg1.htm

Futter, M., Forsius, M., Holmberg, M. and Starr, M. (2009) A long-term simulation of the effects of acidic deposition and climate change on surface water dissolved organic carbon concentrations in a boreal catchment. Hydrology Research Vol. 40 No 2–3 pp 291–305

Jylhä K., Ruosteenoja K., Räisänen J., Venäläinen A., Tuomenvirta H., Ruokolainen L., Saku S. & Seitola T. (2009) Changing climate in Finland: estimates for adaptation studies. ACCLIM project report 2009. Finnish Meteorological Institute, Report 2009:4, (in Finnish, extended abstract and figure captions in English)

Kankaanpää, S. & Carter, T.R. (forthcoming) IMPLIFIN -report (Implications of international climate change impacts for Finland).

Kankaanpää, S., Carter, T.R. & Liski, J. (2005) Stakeholder perceptions of climate change and the need to adapt. FINADAPT Working Paper 14, Finnish Environment Institute Mimeographs 344, Helsinki, Finland http://www.ymparisto.fi/download.asp?contentid=45376&lan=en

Kellomäki, S., Strandman, H., Nuutinen, T., Peltola, H., Korhonen, K.T. & Väisänen, H. (2005) Adaptation of forest ecosystems, forests and forestry to climate change. FINADAPT Working Paper 4, Finnish Environment Institute Mimeographs 334, Helsinki, Finland http://www.ymparisto.fi/download.asp?contentid=45301&lan=en

Kiander, J. (2008) Ilmastopolitiikka ja tulonjako. Selvitys Vanhasen II hallituksen tulevaisuusselontekoa varten. Ilmasto- ja energiapoliittisen tulevaisuusselonteon taustajulkaisu (Climate policy and income distribution. Background report for the government's foresight report on climate and energy policy) Yliopistopaino, Helsinki, Finland (in Finnish)

Kirkinen, J., Martikainen, A., Holttinen, H., Savolainen, I., Auvinen, O. & Syri, S. (2006) Impacts on the energy sector and adaptation of the electricity network business under a changing climate in Finland. FINADAPT Working Paper 10, Finnish Environment Institute Mimeographs 340, Helsinki, Finland http://www.environment.fi/download.asp?contentid=45340&lan=en

Lepistö, A., Kortelainen, P. & Mattsson, T. (2008) Increased organic C and N leaching in a northern boreal river basin in Finland. Global Biogeochemical Cycles Vol 22, GB3029, doi: 10.1029/2007GB003175 http://www.agu.org/pubs/crossref/2008/2007GB003175.shtml

Ministry of Agriculture and Forestry (2005) Finland's National Strategy for Adaptation to Climate Change. Publication 1a/2005, Helsinki, Finland www.mmm.fi/attachments/ymparisto/5kghLfz0d/MMMjulkaisu2005_1a.pdf

Ministry of Agriculture and Forestry (2008) Greenhouse impacts of the Use of Peat and Peatlands in Finland. Publication 11a/2007, Vammala, Finland http://www.mmm.fi/attachments/mmm/julkaisut/julkaisusarja/2008/5BKZGKG1a/MMM11a2007_nettiversio_turve.pdf

Ministry of Agriculture and Forestry (2009) The Evaluation of the Implementation of Finland's National Strategy for Adaptation. Publication 4a/2009, Helsinki, Finland www.mmm.fi/attachments/mmm/julkaisut/julkaisusarja/2009/5IEsngZYQ/Adaptation_Strategy_evaluation.pdf

Ministry of the Environment (2008) Adaptation to Climate Change in the Administrative Sector of the Ministry of the Environment, An Action Plan to Implement the National Strategy for Adaptation to Climate Change. Reports of the Ministry of the Environment 20en, Helsinki, Finland http://www.ymparisto.fi/print.asp?contentid=313737&lan=fi&clan=en

Ministry of the Environment (1995) Valtioneuvoston periaatepäätös maisema-alueista ja maisema-alueiden kehittämisestä. (Decision in Principle of the Council of State Concerning the Landscapes and Developing of the Landscapes.) (In Finnish) http://www.ymparisto.fi/download.asp?contentid=28080&lan=fi

Nakicenovic, N., et al. (2000) Special Report on Emissions Scenarios: A Special Report of Working Group III of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, U.K., www.grida.no/climate/ipcc/emission/index.htm

Peltonen-Sainio, P., Rajala, A., Känkänen, H. & Hakala, K. (2009) Improving farming systems in northern European conditions. Crop Physiology. Applications for Genetic Improvement and Agronomy. Elsevier B.V.

Pouta, E., Neuvonen, M. & Sievänen, T. (2009) Participation in cross-country skiing in Finland under climate change: Application of multiple hierarchy stratification perspective. Journal of Leisure Research 41(1), 91–108, National Recreation and Park Association, Ashburn, VA, USA.

Rankinen, K., Valpasvuo-Jaatinen, P., Karhunen, A., Kenttämies, K., Nenonen, S. & Bärlund, I. (2009) Simulated nitrogen leaching patterns and adaptation to climate change in two Finnish river basins with contrasting land use and climatic conditions. Hydrology Research Vol 40 No 2–3 pp 177–186

Räisänen, J. & Ruokolainen, L. (2008) Ongoing global warming and local warm extremes: a case study of winter 2006–2007 in Helsinki, Finland. Geophysica Vol. 44, Nos.1–2 pp 45–65, Geophysical Society of Finland, Helsinki, Finland http://www.geophysica.fi/pdf/geophysica_2008_44_1-2_045_raisanen.pdf

Saarinen, J. & Tervo, K. (2006) Perceptions and adaptation strategies of the tourism industry to climate change: The Case of Finnish nature-based tourism entrepreneurs. International Journal of Innovation and Sustainable Development 2:2, 214–228, Inderscience publishers, Geneve, Switzerland

Saloranta, T. M., Forsius, M., Järvinen, M. & Arvola, L. (2009) Impacts of projected climate change on thermodynamics of a shallow and deep lake in Finland: Model simulations and Bayesian uncertainty analysis. Hydrology Research Vol. 40 No 2–3 pp 234–248, http://www.iwaponline.com/nh/040/nh0400234.htm

Sievänen, T., Tervo, K., Neuvonen, M., Pouta, E., Saarinen, J. & Peltonen, A. (2006) Nature-based tourism, outdoor recreation and adaptation to climate change. FINADAPT Working Paper 11, Finnish Environment Institute Mimeographs 341, Helsinki, Finland http://www.ymparisto.fi/download.asp?contentid=45369&lan=en

Uudenmaan liitto (2007) Uudenmaan rannikkoalueiden yleispiirteinen tulvakartta (Flood map of the coastal areas of the province of Uusimaa). Uudenmaan liiton julkaisuja E 96 – 2007, Uudenmaan liitto, Helsinki, Finland (in Finnish) http://www.uudenmaanliitto.fi/modules/publishbank/julkaisupankki_files/364_E%2096%20Uudenmaan%20rannikkoalueiden%20yleispiirteinen%20tulvakartta.pdf

Vajda, A. (2007) Spatial variation of climate and the impact of disturbances on local climate and forest recovery in northern Finland. Doctoral dissertation, University of Helsinki, Department of Geography. Finnish Meteorological Institute, Contributions 64, Helsinki, Finland https://oa.doria.fi/bitstream/handle/10024/13149/spatialv.pdf?sequence=1

Internet links

ACCLIM Programme,
http://www.ilmatieteenlaitos.fi/research_climate/climate_2.html

Climate Change Adaptation Research Programme ISTO,
www.mmm.fi/ISTO/eng

ClimBus Programme,
http://akseli.tekes.fi/opencms/opencms/OhjelmaPortaali/ohjelmat/ClimBus/en/etusivu.html

EURO-LIMPACS project,
www.environment.fi/syke/euro-limpacs

FINADAPT Programme,
http://www.environment.fi/syke/finadapt

Ministry of the Agriculture and Forestry,
http://www.mmm.fi/en/index/frontpage.html

Ministry of the Environment,
http://www.environment.fi

National Board of Antiquities,
http://www.nba.fi/en/

Nationwide Outdoor Recreation Demand Study by the Finnish Forest Research Institute, Metla,
http://www.metla.fi/metinfo/monikaytto/lvvi/ (in Finnish)

VACCIA project,
www.environment.fi/syke/vaccia (in Finnish)

Back to Contents

7 Financial resources and transfer of technology

Finland as a developed country Party recalls its obligation to provide new and additional financial resources to meet the needs by developing country Parties and thus is complying under Article 4.3 of the Climate Convention. This chapter provides information on Finnish financial contribution to international climate change related funds, domestic and international projects and programmes. This includes information on activities and programmes under Articles 10 and 11 of the Kyoto Protocol. There is a special focus on resources related to energy and forestry sectors. These are followed by an account of Finnish activities in transfer of technology. The chapter ends with a description of three specific projects in Central America and Asia.

Back to Contents

Photos

Franck Koumolou, pages 202, 205
Markku Nurmi/YM, page 197
Kalaimani Supramaniam, page 199

7 Financial resources and transfer of technology

7.1 Provision of new and additional financial resources

Finland reaffirmed in the Bonn Declaration its strong political commitment to provide additional climate change funding for developing countries and has acted accordingly. Finland places particular emphasis on issues relating to climate change and the environment.

Finland provides funds for financial mechanisms of the Climate Convention and the funds under the Kyoto Protocol as well as through bilateral, regional and other multilateral channels.

Finland has also integrated the goals and objectives of the Climate Convention and the Kyoto Protocol to its development policy taking into account that economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties. It is steered by the Government Resolution on development policy adopted in October 2007. The main goal of the policy is to eradicate poverty and promote sustainable development in accordance with the UN Millennium Development Goals.

Finland pursues the development cooperation goals and approaches approved in the UN and the EU. Finnish development aid disbursements in 2008 were EUR 790 million, which was 0.43 per cent of its gross national income (GNI). Finland is committed to reaching the 0.51 per cent minimum set by the European Council by 2010, and to reaching 0.7 per cent, the target set by the UN, by 2015.

In a joint Political Declaration (Bonn 2001), Finland together with the European Community and its other member states and five other donor countries committed themselves to collectively providing USD 410 million annually as additional climate change funding for developing countries, starting in 2005. Finland's minimum share of this joint contribution is USD 6.4 million per year, but Finland has exceeded this figure: USD 7.4 million in 2005, USD 7.6 million in 2006, USD 9.4 million in 2007 and USD 28.5 million in 2008.

Finland has contributed additional resources to the Global Environment Facility (GEF) to prevent and mitigate global environmental problems in developing countries. During the 3rd replenishment period (2002–2006) the Finnish contribution was about EUR 30 million. The annual contribution has increased from EUR 3.4 million in 2002 to about EUR 8.0 million in 2004. During the 4th replenishment period (2006–2010) the contribution is EUR 7.8 million per year. The total Finnish contribution during the period will be about EUR 31.2 million, EUR 1.2 million more than during the 3rd replenishment period.

The Development Assistance Committee (DAC) of the OECD has determined that 77 per cent of the core contributions to the GEF fund are eligible to be counted as official development assistance (ODA) until the year 2007, and from 2008, 96 per cent. The GEF divides the funds by environmental focal areas, with 33 per cent of the funds focusing on climate change.

Table 7.1
Financial contributions to the Global Environment Facility (GEF) regarding implementation of the Climate Convention (UNFCCC), and to the climate funds under the GEF

	2004	2005	2006	2007	2008
	EUR million				
Global Environment Facility	1.8	1.5	2.2	2.2	2.2
Least Developed Countries Fund	0	1.0	0.7	1.5	1.6
Special Climate Change Fund	0	0.35	0.46	0.86	0.9
Kyoto Protocol Adaptation Fund	0	0	0	0	0.1

7.2 Assistance to developing country Parties that are particularly vulnerable to climate change

Finland attaches particular importance to assisting countries that are least developed, as they are among the countries most vulnerable to climate change. Finland's eight long-term partners in development cooperation are Ethiopia, Kenya, Mozambique, Nepal, Nicaragua, Tanzania, Vietnam and Zambia. Five of these are officially classified as least developed countries, and all are particularly vulnerable to climate change.

Finland has also provided assistance to Burkina Faso, Afghanistan, Timor-Leste and Laos, all least developed countries particularly vulnerable to climate change. The assistance has included forestry and capacity building of the governments, including environmental administration.

Finland's voluntary funding for the Least Developed Countries Fund and the Special Climate Change Fund under the GEF has increased from EUR 1.35 million in 2005 to EUR 2.5 million in 2008.

National meteorological services have a crucial role in producing data and information for adapting to climate change. Finland has over 20 years' experience in supporting development cooperation projects in meteorology, amounting to over USD 50 million in more than 80 countries. It is one of the major development cooperation donors in the field of meteorology, aiming to strengthen the capabilities of the national meteorological institutes (see more in Chapter 8).

7.3 Provision of financial resources

Financing decisions 5/CP.7 (implementation of Article 4, paragraphs 8 and 9, of the Convention) and 1/CP.10 (Buenos Aires programme of work on adaptation and response measures) have been taken into account by Finland (see also Chapter 4).

7.3.1 Multilateral assistance

Finland has also supported the World Bank's Trust Fund for Environmentally and Socially Sustainable Development (TFESSD) with EUR 1.5 million annually, of which 15 per cent can be counted under UNFCCC (EUR 0.225 million). As 2008 was a special theme year for climate change and

Table 7.2
Financial contributions to multilateral institutions and programmes
(only part of the contribution is related to climate change)

Institution or programme	Contributions (millions of EUR)				
	2004	2005	2006	2007	2008
Multilateral institutions					
1. World Bank/IDA	30.4	35.5	31.5	40.1	29.6
2. African Development Bank and AFDF	0.4	10.1	13.9	20.23	28.96
3. Asian Development Bank and ASDF	3.53	3.45	3.45	3.45	4.35
4. Inter-American Development Bank	0.14	0.4	0.38	0.33	1
5. United Nations Development Programme – specific programmes	13.99	14.8	15.5	16	17
6. United Nations Environment Programme – specific programmes	2.86	2.86	2.86	4.14	2.9
7. UNFCCC – Supplementary Fund	0.04	1.41	1.2	3.06	2.86
8. Other					
– European Development Fund	34.63	39.1	39.6	44.46	54
– European Community	67	73.5	82.7	84.1	92.5
– Nordic Development Fund	8.6	5.6	10.4	5.9	18.3
– Montreal Protocol	1.1	1.1	1.1	1.1	0.72
– CGIAR	1.35	1.35	1.35	1.4	2.6
– WIDER	0.33	0.22	0.63	0.5	0.4
– PROFOR					0.3
– NFP Facility					0.3
Total	**164.37**	**189.39**	**204.57**	**224.77**	**255.79**

adaptation 50 per cent was countable under UNFCCC (EUR 0.75 million). In 2008 Finland decided to contribute EUR 7 million to the Readiness Fund of the World Bank's Forest Carbon Partnership Facility (FCPF).

Finnish support to the UNFCCC, other than its multilateral aid through e.g. the GEF and the Forest Carbon Partnership Facility (FCPF), has been thematic in nature and listed under bilateral aid. This aid also includes EUR 1.1 million (2004–2008) as support for the costs of official participation by developing countries in UNFCCC meetings. The figure is made up of annual financial support of EUR 60,000 to 80,000 over the period, plus an additional sum of EUR 0.7 million in 2007.

7.3.2 Mechanisms

In the EU emissions trading scheme, companies may partly meet their emission reduction obligations by using emission units from projects reducing emissions in other countries (so-called project mechanisms). The government may also use project mechanisms (Clean Development Mechanism (CDM) and Joint Implementation (JI)) or acquire assigned amount units (AAU) through international emissions trading in accordance with the Kyoto Protocol in order to meet Finland's national emission commitments (see Chapter 4).

The government budget for the acquisition of emission credits is EUR 70 million for 2008–2012. Of this, approximately EUR 20 million was spent in the CDM/JI pilot programme, which operated from 1999 until early 2006. The rest is allocated for 2005–2010.

By the end of 2008, Finland had invested approximately EUR 14.3 million in 14 bilateral CDM/JI projects. Beside these projects Finland has invested in multilateral carbon funds (see Table 7.3).

Finland has also signed a EUR 4 million co-purchase agreement with the Fine Carbon Fund managed by Greenstream Network Ltd. In 2008 Finland invested USD 20 million in the Asian Development Bank's Future Carbon Fund and EUR 1 million in NEFCO's Future Carbon Fund for post-Kyoto credits. In addition, Finland has reserved EUR 30 million for purchase of emission units in the post-Kyoto period.

Table 7.3
Investments in multilateral carbon funds for acquisition of emission reduction units for the Kyoto-period 2008–2012

Multilateral carbon fund	Investment sum
World Bank's Prototype Carbon Fund (PCF)	USD 10 million
Nordic Environmental Financing Corporation's (NEFCO) Testing Ground Facility (TGF)	EUR 4.25 million
European Bank for Reconstruction and Development's Multilateral Carbon Credit Fund (MCCF)	EUR 10 million
Asian Development Bank's Asian Pacific Carbon Fund (APCF)	USD 25 million

7.3.3 Bilateral assistance to developing countries

The Finnish development policy emphasizes that development in all countries should be ecologically sustainable. Multilateral environmental agreements and implementation assistance for developing countries create a framework for promoting ecologically sustainable development. Assistance in implementation is a long-term investment in building sustainable national development policies and achieving international environmental targets. From a development cooperation point of view the UNFCCC is one of the most important conventions.

Finland supports projects and programmes that promote environmentally sustainable development in its partner countries and regions. In the energy sector, for example, which is important in terms of economic development, solutions are being pursued for promoting the use of renewable natural resources.

In 2004–2008 Finland funded 27 projects directly under climate change related assistance. In addition, a wide range of projects incorporated mitigation of the effects of climate change as a significant objective. The form of assistance varied between regions and programmes (Tables 7.4 and 7.5). Finland's funding for the UNFCCC has grown almost four fold over the period 2004–2008. Most of the long-term partner countries for development cooperation are in Africa, and this is reflected in the funding of climate change related projects and programmes. Due to new projects and partnerships in the energy and environmental sectors, there has been an increase in Finland's development cooperation in the area of climate change in Asia and Central America.

Table 7.4
Finland's bilateral and regional contributions towards implementation of the UNFCCC, 2004–2008 (EUR million)

Recipient country / Region	Mitigation				
	Energy	Transport	Forestry	Agriculture	Industry
Egypt					0.4
Ethiopia				0.002	
Kenya	0.02		0.13		
Malawi			0.03		
Mali				0.002	
Mozambique			0.2		
Namibia			0.18		
Senegal	0.05				
Tanzania			0.62		
Zambia			0.2		
China	5.59				
Indonesia			0.02	0.05	
Laos			0.8		
Sri Lanka	2.8				
Vietnam			0.35		
Nicaragua				0.15	
Central America regional	5.84				
Ecuador			0.058		
Total	**14.3**		**2.588**	**0.204**	**0.4**

Recipient country / Region	Adaptation	
	Capacity-building	Coastal zone management
Burkina-Faso	0.48	
Kenya	0.03	
Mozambique	2.12	
Nigeria	0.003	
South-Africa	0.93	
Sudan	0.014	
Tanzania	0.7	
Africa regional	0.05	
North-Africa and Middle East		0.5
Afghanistan	0.2	
China	0.14	
Georgia	0.7	
India	0.46	
Kyrgyzstan	0.09	
Nepal	0.37	
Thailand	0.0002	
Viet Nam	0.59	
Asia regional	0.12	0.25
Nicaragua	0.19	
Central America regional	0.33	
Peru	0.32	
South America regional	0.27	
Yugoslavia	0.16	
Total	**8.2672**	**0.75**

Table 7.5
Regional contributions of Finnish official development assistance (ODA) for the implementation of climate change related bilateral projects and programmes in 2004–2008 (EUR million)

	2004	2005	2006	2007	2008
Africa	2.09	1.37	1.28	0.52	1.6
Asia	1.67	1.95	1.96	3.75	5.16
Central America	1.09	1.02	1.45	1.32	1.65
South America	0,09	0.12	0.07	0.04	0.33
West Balkans	0.08	0.08			
Unlocated funding (i.e. not earmarked geographically)	0.26	2.27	4.61	3.12	6.02
Total (bilateral, UNFCCC focal area)	**5.28**	**6.81**	**9.37**	**8.75**	**14.76**

The energy sector accounts for the largest share of mitigation-related projects (Table 7.4). Support for forestry projects and adaptation is also substantial. With regard to adaptation, the most important element has been capacity building and vulnerability assessments in partner countries. Furthermore, Finland supports mitigation and adaptation measures through NGOs.

7.3.4 Energy sector cooperation

Energy-related pollution is increasing rapidly in many parts of the developing world, and preventing such pollution is becoming an important factor in Finland's development cooperation. It is important to increase sustainable energy use and to introduce renewable energy resources. Finland has enhanced sustainable wood fuel production and community forestry projects in e.g. Laos, Kenya, Tanzania, Zambia, Namibia and Mozambique.

A partnership initiative in energy and environmental cooperation with Central American countries was launched by Finland at the Johannesburg World Summit on Sustainable Development (WSSD) in 2002. The idea of the partnership model is to seek co-financing from the public and private sectors. Finland contributed EUR 7 million in total to the first and second phase of the partnership in 2003–2009 (Table 7.7). In 2009 the partnership was expanded to Africa and Asia. Finland's contribution for 2010–2012 is EUR 6 million.

Finland is also supporting energy efficiency improvements in Vietnam by training energy auditors and carrying out pilot audits in industry, buildings and transportation. In China, Finland has participated in district heating projects in urban areas by giving concessional credits for minimising emissions from heat production. A concessional credits scheme has also been utilised to finance solar PV systems in remote areas in Vietnam and in Sri Lanka.

7.3.5 Forestry cooperation

Forestry forms a significant sector in Finland's development cooperation. Finland has supported sustainable forest management in various countries by assisting partner countries in the preparation and implementation of national forest programmes as well as sector policies and strategies.

Community forestry is important in the promotion of sustainable forest management, and such forestry has been assisted in Mozambique, Namibia, Tanzania, Zambia, Vietnam and Laos. Community and private sector in-

volvement in forest management are particularly important, considering the risks that climate change poses to forests. Finland has supported pilot activities in the REDD programme (Reduced Emissions from Deforestation and Forest Degradation), which is based on rewarding individuals, communities, projects and countries that prevent deforestation and forest degradation.

Community-based forest fire management is also an important part of the Finnish ODA activities mitigating climate change. A programme for the control and management of forest and bush fires at the organisational and administrative levels has been supported in Namibia, Mozambique and Burkina Faso. It concentrated on involving the rural population in fire management and on capacity building in the national forestry organisations in order to promote local involvement.

In the global arena Finland has supported the Center for International Forestry Research (CIFOR) and the International Union of Forestry Research Organisations (IUFRO) in carrying out strategic research for advising policy makers. The research by IUFRO on climate change impacts on forests and people and on the options for adaptation received wide media publicity internationally.

7.3.6 Other climate change related cooperation

Finland has funded an international course on environmental law and diplomacy, organised annually by the University of Joensuu in eastern Finland and UNEP. In addition to teaching environmental law, the course aims to foster contacts between developing and industrialised countries and thus support international environmental negotiations.

Finland has supported a climate change and development project concerning Tanzania, Zambia and Mozambique. The project aims to ensure that climate change related policies and strategies lead to adaptation activities that emphasize the role of forests and water resources in supporting people's livelihoods and farming systems.

Finland has participated in a project which uses a regional networking approach to improve the development and exchange of knowledge among climate change focal points and climate change professionals in Southeast Asia. The project supports the sharing of best practices and accelerates the transfer of climate friendly technologies.

The Finnish government is also financing several Finnish experts working in climate or environment projects in international environmental organisations and developing countries. The total number of such experts over the period 2005–2009 was 21 persons, with a total financing of EUR 2.2 million.

Finland is also contributing to the Marrakech Process for Sustainable Consumption and Production by hosting a Task Force on Sustainable Building and Construction (SBC). The annual support given to the Marrakech Process in 2005–2009 was EUR 30,000 to 40,000.

7.3.7 Financial resources, including resources under Article 11 of the Kyoto Protocol

Finland has not provided funding for the adaptation fund established in accordance with decision 10/CP.7., except for EUR 0.1 million for supporting the participation of developing countries in meetings of the Adaptation Fund..

Table 7.6
Summary information on financial resources (EUR)

Official development assistance (ODA)	790 million in 2008 (0.43 per cent of gross national income (GNI).
Climate-related aid in bilateral ODA	14.76 million in 2008
Climate-related support programmes	Energy and Environment Partnership with Central America, VietAudit, Sustainable forestry for rural development project (SUFORD), Post-emergency reconstruction programme in the field of meteorology.
Contributions to GEF	2006 7.8 million, 2007 7.8 million, 2008 7.8 million
Pledge for fourth GEF replenishment	31.2 million
Activities implemented jointly (AIJ)	After the JI/CDM pilot programme (1999–2006) the Finnish Carbon Procurement Programme (Finnder) was launched. Finnder's portfolio of contracted projects contains 14 projects: 9 CDM and 5 JI projects. Emission reductions are 3.3 million tonnes CO_2 eq.
JI and CDM under the Kyoto Protocol	Investments in the Prototype Carbon Fund, Testing Ground Facility, Multilateral Carbon Credit Fund, Asia Pacific Carbon Fund, Fine Carbon Fund, ADB's Future Carbon Fund, Nefco's Future Carbon Fund.
Other (bilateral/multilateral)	Support to World Bank's Trust Fund for Environmentally and Socially Sustainable Development. 27 projects for developing countries directly relating to climate change (2004–2008).

7.4 Activities related to transfer of technology

Finland has specific programmes and financial arrangements for transferring environmentally sound technology to developing countries (examples in Table 7.7). These activities comprise transfer of both "soft" technology, including capacity building, creating information networks and enhancing training and research, and "hard" technology (technology to control greenhouse gas emissions and for adaptation measures). Differentiation between these is not always clear. In developing countries the private sector and entrepreneurs play a key role in economic development. The Finnish Fund for Industrial Cooperation Ltd. (Finnfund) is a mainly state-owned company that finances private projects in developing countries by providing long-term risk-capital for profitable projects. It cooperates with Finnish and foreign companies, investors and financiers. Finnfund has recently financed renewable energy production projects in Thailand, Honduras, Sri Lanka and Uganda, and tree-planting in Tanzania and southern Sudan. In addition it has made investments in the Central American Renewable Energy and Cleaner Production Facility (CAREC) and the Evolution One fund, which are investing in renewable and clean technologies in Central America and southern Africa.

Finland is also promoting business-to-business partnerships in environmentally sound technologies through Finnpartnership, as part of a wider set

of Aid for Trade interventions. For example, in Zambia Finland is the lead donor in the environmental sector as well as a donor facilitator in the Enhanced Integrated Framework. Finland also has multiple private sector development (PSD) related programmes and projects in Zambia, which enhance the mutual synergies between the environmental and PSD sectors.

Finland has established 'economic clusters' (e.g. environment and climate change, water and sanitation, energy, agriculture, forest) to promote broad-based partnership-building with institutions and the private sector in development cooperation.

Finland supports the Energy and Environment Partnership with Central America, which has established various renewable energy and clean energy projects. The partnership has recently expanded to southern Africa as well as some areas in Asia (Table 7.7).

Concessional credits are used primarily for environmental and infrastructure investments under national development programmes. They have been granted to various renewable energy projects, for example solar PV projects in Vietnam and Sri Lanka for providing basic energy and water services. In Vietnam and Honduras, projects to expand the electricity grid to improve access to energy have been supported, and in China, district heating projects have been implemented to improve energy efficiency, reduce emissions and improve air quality in cities.

In 2001 the UNFCCC established the Expert Group on Technology Transfer (EGTT) to enhance the implementation of the convention and to advance the technology transfer activities under it. Since establishment of the EGTT, Finland has participated actively in its work by providing expertise, leadership and financial resources. The latest Finnish chairmanship of the group was during 2008.

Since 2004 Finland has participated in the IEA CTI (Climate Technology Initiative), which is a multilateral initiative fostering international cooperation in the development and distribution of climate-friendly technologies and practices. The principal activities of the CTI include technology needs assessment, organising seminars and training courses, facilitating technology and information dissemination.

The publicly financed Finnish Funding Agency for Technology and Innovation (TEKES) also has programmes that include developing countries and focus on climate-friendly technology.

Table 7.7
Description of selected projects or programmes that promoted practicable steps to facilitate and/or finance the transfer of, or access to, environmentally-sound technologies

Project/programme title:
Energy and Environment Partnership with Central America

Purpose: To promote the use of renewable energy sources and sustainable development

Recipient country	Sector	Total funding	Years in operation
Central American countries	Energy/mitigation	EUR 7,000,000	2003–2009

Description:
The partnership was launched at the Johannesburg Summit for Sustainable Development in 2002 to promote the use of renewable energy sources and clean technologies in the Central American region, to combat climate change and to make energy services more accessible to the poor. The partnership aims at finding support for public or private investments, developing effective and consistent strategies in the national energy policies of each country as well as improving sustainable development of renewable energy on a small scale. Other goals are strengthening of effective programmes of rural electrification and developing capacity in the areas of financing and technical engineering on a regional level.

The goals are in conformity with the EU Energy Initiative, which is a new type of partnership model for multi-donor development cooperation to support sustainable development through utilisation of renewable energy resources. Public and private sectors are participating in the programme, which has increased the co-financing interest of international banks and funding institutions. The countries involved are Belize, Guatemala, Honduras, El Salvador, Costa Rica, Nicaragua, Panama and the Dominican Republic. Austria joined the Partnership as donor in 2007.

So far, partial funding has been granted to about 200 projects. These include feasibility studies, research projects and pilot and demonstration projects in all fields of renewable energy and energy efficiency. Thematic seminars have been organised twice a year to disseminate the experiences and best practices. To date 13 such seminars have been organised, with more than 2,500 participants.

A similar partnership programme has recently been launched in South Africa, the Mekong river area in Thailand, Vietnam, Cambodia and Laos, Indonesia and Columbia. Finland is providing EUR 6 million for the third phase of the partnership in 2010–2012.

Indicate factors which led to project's success:
Wide participation of the private sector, universities, donors and research institutes in the programme. A regional coordination office is located in San Salvador in the building of the General Secretariat of the Central American Integration System (SG-SICA). Capacity building and training (including CDM). Programme includes developing financing models, energy market development work and energy resource surveys and studies.

Technology transferred:
Demonstration projects e.g.:
- Installation of solar systems for a vaccination programme in Honduras
- Photovoltaic systems for two Kuna communities in Panama
- Solar electrification in Guatemala and solar pumping system in El Salvador
- Use of sawdust, coffee residues and sugar cane bagasse as biomass suitable for energy co-generation in Belize, Costa Rica, El Salvador and Nicaragua
- Support for ecological stove programmes in Honduras and Guatemala
- Feasibility studies and equipment for small hydroelectric power plants in Guatemala, El Salvador and Nicaragua. Support for Jatropha curcas plantations in several countries.

Central American Carbon Finance Guide was published in 2004 and updated in 2008.

Impact on greenhouse gas emissions/sinks:
A number of CDM projects have been supported.

More information: http://www.sica.int/energia

Project/programme title:
VIETAUDIT

Purpose: To develop energy auditing practices in Vietnam and to conduct pilot audits

Recipient country	Sector	Total funding	Years in operation
Vietnam	Energy/mitigation	EUR 1,000,000	2008–2009

Description:
Energy auditing procedures, where specialists analyse the energy use and energy efficiency of buildings and production processes and make proposals for cost-effective improvements, are key methods in finding the most effective measures to improve energy efficiency.

The overall objectives of the project, implemented by VTT (Technical Research Centre of Finland) and MOTIVA (governmental agency promoting energy efficiency) are to help Vietnam to:

- Strengthen the national policy framework and integrate energy efficiency and renewable energy use into national sustainable energy strategies
- Enhance national capacity for energy auditing and implementing cost-effective measures proposed by the audits.

This will require:

- Ensuring Vietnam has access to technical assistance for energy auditing and financial products.
- Wider dissemination of information, knowledge and best practices that support accelerated market development of energy efficiency and renewable energy.

Pilot energy audits have been carried out for industrial facilities, buildings and in the transport sector.

Indicate factors which led to project's success:
Vietnam has established an Energy Efficiency Office, but no budget funding will be available for 2–3 years. This provides Motiva and VTT with an excellent opportunity to provide capacity building and technical assistance and/or technology transfer during the transition period. The first results of the audits have shown substantial saving potential.

Technology transferred:
The objective is to offer a whole range of energy audit expertise, from general to simple and including more complex cases.

Target groups are (managerial) personnel of the ministries involved (Construction, Industry, Transport), especially selected persons from the Energy Efficiency Office, personnel of the regional offices of different ministries and plant management. Another important target group is the personnel of SMEs that want to increase their auditing expertise and/or want to develop into ESCOs (Energy Service Company). The pilot audits are conducted in close collaboration with local experts. With a particular view to sustainability, high level technology transfer will be targeted at the Hanoi University of Technology.

Impact on greenhouse gas emissions/sinks: A CDM component is included for the purpose of estimating the CDM potential and to develop PDDs.

Project/programme title:
SUFORD, Sustainable forestry for rural development project

Purpose: To promote sustainable forest management

Recipient country	Sector	Total funding	Years in operation
Lao PDR	Forest/mitigation	Phase I: EUR 6,000,000 Phase II: EUR 9,000,000	Phase I: 2004–2008 Phase II: 2009–2012

Description:

Specific objectives are to:
- Improve the policy, legal and incentive framework enabling the expansion of Participatory Sustainable Forest Management (PSFM) in the whole country
- Bring the country's priority natural production forests under the PSFM
- Improve well-being and livelihoods in villages through benefits from sustainable forestry, community development and development of viable livelihood systems
- Support the development of new and innovative methodologies for REDD monitoring.

Indicate factors which led to project's success:
The project is comprehensive in scope and covers the national policy, field implementation and capacity development.

Technology transferred:
Participatory forest management could provide a sound base for further development of the REDD concept. The SUFORD project has supported the Lao PDR government in piloting new and innovative tools for forest carbon assessment. High resolution satellite images and airborne laser scanning (LIDAR) have proved to be cost-effective tools for the assessment.

Impact on greenhouse gas emissions/sinks:

Project/programme title:
Post-Emergency Reconstruction Programme in the Field of Meteorology

Purpose: To reconstruct and rehabilitate the Meteorological Institute of Mozambique

Recipient country	Sector	Total funding	Years in operation
Mozambique	Meteorology/mitigation	EUR 4,200,000	2000–2006

Description:
After the most devastating floods in the history of Mozambique, the Finnish Government pledged EUR 4.2 million for the reconstruction programme of the Meteorological Institute of Mozambique (INAM). After the reconstruction a new project was established to rehabilitate the institute to serve the needs of society better.

The assistance was implemented in two phases: 1) an instant rebuilding of some lost observation facilities in 2001 and 2) a larger project (FINAM) with technical assistance and a significant amount of new equipment in 2002–2006. The project produced significant results leaving the national meteorological service much better prepared for future challenges.

The overall aim of FINAM was to decrease the vulnerability of Mozambican society to adverse weather, climate variability and global change by improving the working capacity of INAM. The enhanced capacities of INAM will improve the country's disaster management system and thus help avoid future casualties and support the sustainable development of Mozambican society. As a result of the project the national meteorological service is much better prepared for future challenges.

Internet links

Finnish Carbon Procurement Programme (Finnder),
http://www.environment.fi/finnder

Finnish Fund for Industrial Cooperation Ltd (Finnfund),
http://www.finnfund.fi/en_GB/

Finnish Meteorological Institute,
http://www.fmi.fi/en/

Finnish Business Partnership Programme (Finnpartnership),
http://www.finnpartnership.fi/default.asp?docId=12573

Ministry for Foreign Affairs,
http://www.formin.finland.fi/public/default.aspx?culture=en-US&contentlan=2

Finnish Funding Agency for Technology and Innovation (TEKES),
http://www.tekes.fi
http://www.tekes.fi/en/community/Home/351/Home/473

Energy and Environment Partnership with Central America,
http://www.sica.int/energia

Back to Contents

8 Research and systematic observation

This chapter describes Finnish research on climate change: international research cooperation, major research programmes, studies on climate process and system, climatic modelling and prediction, research that supports the greenhouse gas inventory as well as research on impacts, mitigation and adaptation. It is followed by a portrayal of atmospheric, ocean and terrestrial climate observing systems. In the end of the chapter there is an outline of the Finnish contribution to capacity building in relation to research and systematic observation.

Back to Contents

Photos

Jukka Alm/METLA, page 223
Esko Kuusisto, pages 213, 230
Riku Lumiaro/YHA kuvapankki, page 217
Mervi Nieminen/MTT, page 226
Erkki Oksanen/METLA, pages 220, 221, 233, 234

8 Research and systematic observation

8.1 General policy on research

8.1.1 Domestic activities

In 2007 Finland's research and development (R&D) expenditure was about EUR 6,200 million, or 3.5 per cent of the country's gross domestic product. This is one of the highest percentages among the OECD countries. 67 per cent of this was from the private sector, 26 per cent from the public sector and 7 per cent was foreign funding.

Over the past decade, the number of R&D personnel has grown from 40,000 to nearly 80,000. This equates to over 2 per cent of the labour force, which is the highest figure among all OECD countries. The number of doctoral degrees has also doubled in the past ten years.

Climate change has become a priority area in many research programmes and projects (see 8.2 and 8.3 for details). Large cross-sectoral climate change programmes have aimed at increasing understanding of the scientific basis of climate change as well as the impacts and options for mitigation and adaptation, including environmental and socio-economic questions. In addition, climate change has increasingly been integrated into other environmental, sectoral and technology research programmes and projects. Developing technology to improve energy efficiency is a key area in climate and energy research. Research in the area of adaptation has also been strengthened.

The Advisory Board for Sectoral Research, under the Ministry of Education coordinates the overall steering of state-funded sectoral research. Its Sustainable Development Subcommittee has decided on four preliminary research areas:

1. Climate change – assessment of mitigation and adaptation policies
2. Cost-benefit analysis and conservation scenarios for protecting the Baltic Sea
3. Energy efficiency in the public sector
4. Use of natural resources data in support of policy and decision-making

There is a clear need for information on these fields to help the ministries in outlining their strategies and determining priorities. The energy efficiency research field, in particular, has clear links with the ongoing energy efficiency and conservation drive and the enactment and amendment of relevant legislation.

The Centre of Expertise Programme (OSKE) is a fixed-term government programme aimed at focusing regional resources and activities on development areas of key national importance. The programme promotes the utilisation of knowledge and expertise of the highest international standard that exists in different parts of the country. For 2007–2013, the programme was redesigned around a cluster-based model, the overriding objective of which is to increase regional specialisation and to strengthen co-

operation between centres of expertise. The programme involves 13 national Clusters of Expertise and 21 regional Centres of Expertise. The clusters entitled Future of the Forest Industry, Energy Technology and Environmental Technology are the most relevant for advancing knowledge and expertise in areas pertaining to climate change mitigation and adaptation.

Strategic centres for science, technology and innovation are being set up in accordance with the recommendations of the Research and Innovation Council (former Science and Technology Policy Council) and the Government Programme. These centres promote research collaboration with research organisations, universities and industry by joint project planning and through new joint research programmes. The aim is to facilitate development of the whole innovation chain and development of globally competitive technology and service products. The strategic centre for science, technology and innovation of the Finnish energy and environment cluster, Cleen Ltd, is based on the common vision and strategic research agenda defined by the centre's owners, i.e. companies and research institutes. The research agenda includes the following main areas:

- Carbon neutral energy production
- Distributed energy systems
- Sustainable fuels
- Energy market and smart grids
- Efficient energy use
- Resource efficient production technologies and services
- Recycling of materials and waste management
- Measurement, monitoring and assessment of environmental efficiency.

New research information is communicated to decision-makers, other stakeholders and the general public (see Chapter 9). According to the Finnish Science Barometer 2007, Finns of all ages find matters relating to the environment and nature to be the most interesting topics in science. Finns are environmentally aware and concerned about the state of the environment. Climate change is considered a real and serious threat. 67per cent said it does require effective action from policy makers, while 6 per cent said no action is needed.

8.1.2 International activities

Finland emphasizes international collaboration in climate change research. The latest report of the Research and Innovation Council in 2008 noted that global climate change is a good example of a critical phenomenon that can be influenced only through international cooperation and pooling resources.

Finnish researchers participate actively in climate change related research under the framework programmes of the European Union. The 7th framework programme of the EU started in 2007. Funding for climate change related research is concentrated under the sub-programmes on environment and energy, in particular.

Finland has participated in the World Climate Research Programme (WCRP), the International Geosphere-Biosphere Programme (IGBP) and the International Human Dimensions Programme (IHDP). These have included many Finnish research projects funded by the Academy of Finland

and other funding organisations. Key partners in Finnish climate research include the other Nordic countries, the United Kingdom, Germany and the United States. The Top-level Research Initiative on Climate, Energy and the Environment (2009–2013), launched by the Nordic Council of Ministers in 2008, is a good example of Nordic climate cooperation. The programme's budget is DKK 400 million (approximately EUR 54 million).

Finland has built up an archive of systematic atmospheric, oceanic and terrestrial observations based on the regulations of corresponding international organisations. Finland is participating in World Weather Watch at an operational level, through the synoptic network of surface and upper-air stations. These stations also constitute the basis for climatological services, applications and research. The network of stations is complemented nationally by climatological and precipitation stations. Finland is also contributing to the Global Atmosphere Watch.

Finland has actively supported and participated in the work of the Intergovernmental Panel on Climate Change (IPCC). Finnish experts contributed to the Fourth Assessment Report as authors and through participation in the review process of the report, as well as contributing to most special reports, technical papers and methodological reports published by the IPCC in recent years. Finland has also provided support to the IPCC by hosting lead author and expert meetings.

Finland is a participant in the Arctic Monitoring and Assessment Programme (AMAP), which is an intergovernmental monitoring and research programme under the Arctic Council. AMAP monitors and assesses levels of pollutants and their effects in the arctic environment. AMAP studies have focused on links between environmental pollution, pathways of pollutants and climate change. Assessment of impacts of climate change on the Arctic environment is one of the priority areas. After publishing the Arctic Climate Impact Assessment (ACIA 2004/2005) reports, AMAP has focused its activities on short-lived climate forcers (black carbon, methane and tropospheric ozone) which may contribute to global and Arctic warming to a degree comparable to the impacts of CO_2. The SWIPA (Snow, Water, Ice and Permafrost in the Arctic) project will assess current scientific information on changes in the Arctic cryosphere, including impacts of climate change on ice, snow and permafrost characteristics of the Arctic, which have potentially far reaching implications for both the Arctic and the Earth as a whole.

The International Polar Year (IPY) 2007–2008 was an internationally coordinated research campaign with a multidisciplinary scope and participants from more than 30 countries. It included research on the polar regions and on the links between polar regions and other areas of the world. Finland participated in the IPY with various multidisciplinary research activities conducted by several research institutions and universities. These activities have included the KINNVIKA programme (2007–2009), which is a multinational initiative aimed at better understanding of the Arctic system. The programme focuses on monitoring global change and studying the effects of human activity on Arctic islands.

Finnish researchers have recently collaborated with scientists from developed and developing countries in a forest expert panel coordinated by the International Union of Forest Research Organizations (IUFRO). The work was led by the Finnish Forest Research Institute (METLA). The panel compiled a global assessment report entitled Adaptation of Forests and People to Climate Change, which was released at the UN Forum on Forests in April 2009. It stressed the risk that the changing climate could lead to serious damage in tropical, subtropical and southern temperate forests, which would accelerate global deforestation and worsen the living conditions of people in forested areas, especially in the developing countries.

8.2 Research

8.2.1 Major overarching research programmes on climate change

Climate change and its various effects have been intensively studied all over the world. In Finland such research has been supported through two major overarching research programmes on climate change: the Research Programme on Climate Change SILMU (1990–1995) and the Global Change Research Programme FIGARE (1999–2002). Coordinated by the Academy of Finland, these programmes covered research projects on the science and impacts of climate change as well as on adaptation, mitigation and socio-economic aspects of climate change. The programmes funded almost a hundred projects at many different research institutions and universities, and involved hundreds of researchers. The programmes enhanced knowledge of climate change, established a pool of experienced researchers, enhanced participation in international collaboration networks and laid a firm foundation for climate change research in Finland. The SILMU and FIGARE programmes have been presented in Finland's earlier national communications.

A new multidisciplinary research programme on climate change is under preparation at the Academy of Finland. The programme, to be called the Finnish Climate Change Programme (FICCA), is to be launched as a joint activity with the Finnish Funding Agency for Technology and Innovation (TEKES). The Academy's likely funding for the programme, EUR 12 million, is planned mainly for the years 2011–2014. The FICCA programme will be carried out in cooperation with other Finnish stakeholders, including ministries, and international partners. International joint funding is planned via international thematic joint calls with, for example, China and India. Within the FICCA programme the Academy of Finland will also be participating in European climate change research via CIRCLE-2 ERA-NET (Climate Impact Research & Response Coordination for a Larger Europe). In addition, the programme will support the Nordic Top-level Research Initiative on Climate, Energy and the Environment.

8.2.2 Climate process and climate system studies

The Finnish Meteorological Institute (FMI) has its own research programme entitled Climate Change, with a staff of around 65 scientists. With regard to climate process and climate system studies, the emphasis of the programme is on:

- Climate research and services (supply of climate data, atmospheric radiation, analysis of extreme events, climate modelling and scenarios, impact and adaptation studies, including socio-economic aspects and communicating climate change)
- Greenhouse gases (measuring greenhouse gas concentrations and fluxes and interpretation of measurements with modelling tools)
- Aerosols and climate (measuring aerosol properties, modelling aerosol dynamics)

The aerosol-climate research at the FMI concentrates on two main areas: the role of natural boreal forest aerosols in the aerosol system and climatic influences of anthropogenic aerosols in both polluted and pristine regions. It relies on field measurements, modelling, and laboratory work and satellite retrieval. The focus is in investigating:

1. Atmospheric aerosol formation
2. Aerosol-cloud interactions
3. Aerosol optical properties
4. Radiative forcing by atmospheric aerosols

The FMI operates five stations in Finland which measure climatically important aerosol properties continuously. The most advanced of these is the Pallas-Sodankylä GAW station in northern Finland, where aerosol measurements were started in 1996. Other stations include Utö (Baltic Sea, since 2003), Virolahti (eastern Finland, since 2005), Kuopio (central Finland, since 2006) and Helsinki (since 2004). The FMI has also assisted in establishing and enhancing aerosol measurements at stations in India, China, South-Africa, Antarctica and Russia, and on polar research cruises.

The research aims at improving the treatment of aerosol processes in climate models and investigating future aerosol emission scenarios. The FMI is using and developing a number of aerosol process models for atmospheric applications. It also has facilities to conduct aerosol laboratory experiments, develop instruments and conduct chemical analysis. In addition, algorithms for retrieving aerosol data from satellites have been developed.

The Universities of Helsinki and Kuopio and the FMI host the Finnish Centre of Excellence in Physics, Chemistry, Biology and Meteorology of Atmospheric Composition and Climate Change. Its main objective is to reduce the scientific uncertainties concerning global climate change issues, particularly those related to aerosols and clouds. Its research aims at creating a deep understanding of the dynamics of aerosol particles and ion and neutral clusters in the lower atmosphere, with the emphasis on biogenic formation mechanisms and their linkage to biosphere-atmosphere interaction processes, biogeochemical cycles and trace gases. The latest measure-

The climatic information of annual rings are preserved in tree trunks in the bottoms of cold lakes in Lapland for more than 7000 years. This section of a Scots pine stump was found in a forest stand in western Lapland, 800 years after the death of the tree.

ment techniques as well as modelling approaches are developed and utilised. The core activities are:

- Continuous measurements and database of atmospheric and ecological mass fluxes and aerosol precursors and CO_2/aerosol/trace gas interactions at the SMEAR (Station for Measuring Forest Ecosystem-Atmosphere Relations) and GAW stations
- Focused experiments and modelling to understand the observed patterns

Finnish research institutes have extensive activities in paleoclimatology. These are partly based on good natural archives. The lakes are rich in layered sediments, where age-old tree trunks near the northern tree line have been preserved.

- At the Environmental Change Research Unit of the University of Helsinki, the central research theme is the development and application of hydrobiological, paleoecological and computational techniques to provide historical perspectives on ecological and environmental change. The focus is on Arctic lakes.
- The Institute of Geology at the University of Helsinki has specialised in dendrochronological research. The Dating Laboratory analyses isotopic and elemental compositions of samples from different environmental archives that contain detailed information about climate variability. As a joint effort, the Finnish Forest Research Institute and the Institute of Geology have constructed the longest annual pine chronology in the world (7640 years) based on megafossil trees from lake bottoms. It can reveal past changes and variability of northern climate after the last glaciation. The Institute of Geography focuses on biological indicators in varved lake sediments. These are also researched at the universities of Joensuu and Jyväskylä.
- The Finnish Geological Survey also studies varved sediments, with an emphasis on their physical properties.
- The Arctic Centre at the University of Lapland conducts paleoclimate studies on Antarctic blue ice fields with ground-penetrating radar (2005–2008) to determine, among other things, how blue ice areas in the Antarctic respond to changes in climate.

8.2.3 Climatic modelling and prediction

The Finnish Meteorological Institute (FMI) studies climate change using climate models describing physical and chemical processes of the Earth's climate system. The modelling is based on close cooperation with the Max Planck Institute for Meteorology in Hamburg. Components of the European Community Earth System Models (COSMOS) and the ECHAM global climate model family form the basis of the climate modelling. The focus of model development at the FMI is on aerosol and cloud parameterisation and related radiative transfer effects as well as atmospheric chemistry. As a part of the climate modelling cooperation within COSMOS, the FMI runs a simulation of the last millennium using a coupled Earth system model (atmosphere-ocean-carbon cycle).

The FMI develops and uses also the regional climate model REMO. Regional climate modelling is used for producing data for evaluating the societal impacts of climate change in northern Europe. It also provides a platform for process development, such as the effect of aerosols on cloud formation.

The FMI has in-house high performance computing (HPC) facilities for modelling. It also has access to the HPC resources at the Finnish Centre for Scientific Computing.

8.2.4 Research in support of the national greenhouse gas inventory

Research in support of the national greenhouse gas inventory has aimed at developing methodologies and emission factors or other parameters to improve the accuracy and reduce uncertainties of the greenhouse gas inventory. This research has been funded to a large extent by the Ministry of the Environment and the Ministry of Agriculture and Forestry. Funding has also been provided by consortiums including other ministries, national funding organisations such as the Academy of Finland and the Finnish Funding Agency for Technology and Innovation, and the private sector.

In the energy sector, country-specific emission factors have been developed based on measurements made by industrial users and by the VTT Technical Research Centre of Finland.

In the agriculture sector and the land use, land-use change and forestry (LULUCF) sector the focus in recent years has been on developing methods and national parameters for estimating the carbon stock changes in forests and agricultural soils. Research by the Finnish Forest Research Institute and MTT Agrifood Research Finland has provided input to the greenhouse gas inventory development. The YASSO model for estimating carbon stock changes in forest soils has been acknowledged internationally and is used in inventory preparation in other countries too. The model is being modified to cover agricultural soils as well. Two research projects, including measurements, are running to support the modification.

The research programme entitled Greenhouse Impacts of the Use of Peat and Peatlands in Finland provided more accurate emission factors for organic soils and peat extraction (see also 8.2.5).

Efforts to disseminate the results of the research have been made to support other countries in their inventory preparation. In addition to publishing the results in internationals journals, the national emission factors and parameters have been provided to the IPCC Emission Factor Data Base (EFDB), which is a key source of information for developing countries in particular.

8.2.5 Research on impacts of climate change, adaptation and mitigation

A precondition for launching adaptation measures is the recognition of the need for adaptation to climate change in different sectors. That, in turn, must be based on applied research on adaptation and communication of the results in a way that allows the utilisation of the results in decision-making. Adaptation research cannot be done unless the impacts of climate change on the sector are known. In practice the impacts are not always known, and therefore the adaptation research still contains a great deal of study on the impacts. The trend in adaptation research is, however, from natural science towards comprehensive socio-economic studies.

In 2004–2005, the FINADAPT project (Assessing the adaptive capacity of the Finnish environment and society under a changing climate) assessed the adaptive capacity of the Finnish environment and society to a changing climate. FINADAPT was a consortium of 14 sub-projects that participated in the Finnish Environmental Cluster Research Programme coordinated by the Ministry of the Environment. The consortium involved 11 partner institutions and was coordinated by the Finnish Environment Institute. The reports of the 14 sub-projects analyse the adaptation questions in different sectors and for a number of cross-cutting themes. FINADAPT researchers also participated actively in the preparation of the National Strategy for Adaptation to Climate Change, published in 2005.

The need for adaptation research was stressed in the national adaptation strategy. The Climate Change Adaptation Research Programme (ISTO 2006–2010) implements the adaptation strategy by providing funding for research aimed at producing information to support planning of the adaptation measures (see list of projects in Annex 5). In 2006–2008 the Ministries of Agriculture and Forestry, the Environment and Transport and Communications provided funding for the programme amounting to about EUR 0.5 million annually.

The mid-term ISTO evaluation was conducted in 2008. It was concluded that, despite its limited resources, the programme has succeeded quite well in raising awareness on climate change and the required action. However, the funding for the programme has been only about a third of the planned level, which has inevitably affected the research projects and resulted in only a small number of fields being covered. Only eight fields out of the planned twenty had been covered at the time of the evaluation. Fields that have not been addressed include the health and social sector and many fields of business. The need for long-term planning was emphasised, and communicating the results to decision-makers and the general public was stated as being increasingly important.

The recommendations of the mid-term evaluation were taken into account in the decisions on the funding of new projects in 2009. The range of sectors covered by the programme has increased to some extent. It is likely that for the rest of the programme period the ISTO will be incorporated into the climate programme to be launched under the Advisory Board for Sectoral Research. The new climate programme aims to continue the applied research essential for the implementation of the adaptation strategy.

The Arctic Centre at the University of Lapland has various research activities related to climate change which provide support for decision-making and sustainable development in the Arctic:

- The GICSAC project (2006–2008) studied the capability of international governance systems in the Arctic (e.g. Arctic Council and Inuit Circumpolar Conference) to contribute to the mitigation of climate change and to adaptation within the Arctic area
- The FIN-CAVIAR project (2007–2009) has the focus on community adaptation and vulnerability in Arctic regions. The overall goal of CAVIAR is to enhance the theory, empirical understanding and practical application of processes that shape vulnerability and adaptation in communities across the polar region

A four-year research programme entitled Greenhouse Impacts of the Use of Peat and Peatlands in Finland was launched in 2002. It consisted of several research projects which were to establish the greenhouse gas balances of peatlands in various types of land use. The programme was carried out by research teams at the Universities of Helsinki, Joensuu and Kuopio, the Finnish Forest Research Institute, the Finnish Meteorological Institute, the Geological Survey of Finland and the VTT Technical Research Centre of Finland. The programme was jointly funded and steered by the Ministries of Trade and Industry (now Employment and the Economy), Agriculture and Forestry and the Environment.

The results of the programme have contributed to the specification of emission factors for the greenhouse impacts of peatlands for the purposes of the greenhouse gas inventory. Life-cycle analyses were also employed to establish peat utilisation models that would minimise the greenhouse impact of peat use.

The Finnish Funding Agency for Technology and Innovation (TEKES) has coordinated major research programmes on the mitigation of climate change. The ClimTech programme (1999–2003, see the Fourth National Communication) was followed by the ClimBus programme (Business Opportunities in the Mitigation of Climate Change, 2004–2008). The programme helped to develop technologies, business concepts, products and services for reducing greenhouse gas emissions on a highly cost-effective basis. The total budget of the programme exceeded EUR 90 million, of which TEKES funded EUR 43.6 million. The programme comprised 165 industrial research and development projects and 22 research projects on clean energy production and fuels, business services and technologies for energy efficiency and non-CO_2 greenhouse gases.

The mitigation of climate change and adaptation to it are central themes in the fourth phase (2006–2009) of the Finnish Environmental Cluster Research Programme. This is being coordinated by the Ministry of the Environment and financed mainly by the Ministries of the Environment, Employment and the Economy, Agriculture and Forestry and Transport and Communications, as well as the Academy of Finland and TEKES. Projects related to adaptation are also included in the ISTO programme. Projects related to mitigation include modelling global burden sharing of greenhouse gas emission requirements to support reduction negotiations, greenhouse gas emission mitigation opportunities for industry in the in the region of the city of Tampere, and a study on the impact of public procurement on energy consumption and greenhouse gas emissions.

Many research activities of the Finnish Environment Institute (SYKE), such as research on biodiversity, hydrology, water resources, environmental policies and production and consumption, provide information essential to understanding scientific and societal phenomena related to the mitigation of and adaptation to climate change and finding solutions to these. Studies related to climate change have been conducted in almost every research area where SYKE works. The following research programmes at SYKE have special focus on climate change:

- The Research Programme for Biodiversity, which includes various research projects studying impacts of climate change on biodiversity
- The Research Programme for Global Change, which assesses the long-term effects and risks of air pollution and climate change on terrestrial and aquatic ecosystems. Fluxes of greenhouse gases and carbon storage are estimated and pollution control measures assessed. The programme provides policy-oriented assessments.

The VTT Technical Research Centre of Finland has several research programmes and projects on saving energy and improving energy efficiency for climate change mitigation:

- The Eco-effective Built Environment programme (EUR 3.5 million), which aims at radically improving energy efficiency in the built environment through intelligent solutions in planning and control systems and platforms
- The Energy Savings in Transportation and Alternative Fuels programme (EUR 3.4 million), which aims to produce tools for adapting road transportation in Finland the EU's climate and energy targets in a cost-effective way
- The Fuel Cells programme (EUR 4.6 million), which aims at producing new business opportunities for the industry, with a near-term target of two significant demonstration projects in fuel cell applications.

Other focus areas are CO_2-free energy production, an optimal production and use chain for bioenergy and biorefineries, CO_2 capture and storage and its application to Finnish boiler technology, and various studies to support decision-making by the government and industry in climate change mitigation.

In 2001–2006, the Finnish Forest Research Institute (METLA) ran an extensive research programme entitled Pools and Fluxes of Carbon in Finnish Forests and Their Socio-Economic Implications. The projects within the programme were part of the EU-funded research consortium CarboInvent (Multi-Source Inventory Methods for Quantifying Carbon Stocks and Stock Changes in European Forests). The results have been utilised in the national greenhouse gas inventory. The European collaboration resulted in a database of biomass and volume equations for common European forest tree species. New information was also published on how different management scenarios affect the effectiveness of carbon sequestration in forest stands, which can be used in planning of mitigation measures. This work is continuing in new projects at METLA.

METLA has recently initiated a new research programme entitled Functioning of Forest Ecosystems and Use of Forest Resources in a Changing Climate (2007–2011). The projects can be broadly classified under the following topics:

- Carbon and nutrient cycling of forests
- Regeneration success, growth and phenology of forest trees under a changing climate
- Reconstruction of the past climate based on a link between temperature and tree growth
- Risks for forest insect pests, pathogens and damage caused by mammals
- Resistance of trees to flooding and freezing of soil
- Roots and mycorrhizas
- Distribution of various forest plant species
- Integration of forest and climate policies

Several projects at METLA are investigating the opportunities for active climate change mitigation within the forest sector. The feasibility, impact and business opportunities of various policy measures promoting carbon sequestration are being examined at national level (see Box 8.1). A simulation model combining the energy, climate and forest sectors is being developed as a tool to test the impacts of policy measures. METLA is also a participant in the EU-funded project CC-TAME (Climate Change- Terrestrial

Box 8.1

Research will help in finding sound climate and energy policy measures

Demand for research on the impacts and cost efficiency of different policy instruments in climate change mitigation and adaptation is increasing rapidly. In Finland, there is a growing need to view two important sectors – the energy sector and the forest sector – together when responding to international and domestic calls for climate and energy policy design. The Finnish Forest Research Institute (METLA) is addressing these needs in the Future of Finnish Forest Sector project (a joint project with Metsämiesten Säätiö Foundation), as well as in a project on the role of forests in climate change and terrestrial adaptation and mitigation in Europe (part of the EU-sponsored pan-European CC-TAME research consortium). Special emphasis is put on numerical modelling combining economic behaviour, policy options and a description of forest resources.

Cofiring (using two or more fuels to produce power or heat) of fossil and renewable biofuels is considered potentially one of the most efficient ways of increasing the use of renewable energy sources and thus decreasing CO_2 emissions from fossil fuels. One of METLA's policy studies looked at the impacts of policy instruments on the choice of fuels in cofiring processes. The outcome was that while a feed-in-tariff and feed-in-premium generally increase the use of renewable fuels, this effect decreases with high prices of tradable CO_2 emission permits. In fact, feed-in-tariff and feed-in-premium might have a negative impact on the use of renewable fuels in certain types of high-efficiency energy plants. The implication is that policy instruments designed to mitigate climate change may in certain conditions work against their purpose.

Adaptation and Mitigation in Europe, 2008–2011), which evaluates the impacts of agricultural, forest, climate, energy and other associated land-use policies with regard to their effects on the Earth's atmosphere.

In addition, the research programme Bioenergy from Forests (2007–2011) is designed to support the use of renewable energy as a mitigation measure. Its 20 projects assess the bioenergy resources of forests as well as the ecological, social and economic impacts of the increased use of forest-based energy. Methodologies for sound production and harvesting of bioenergy are under development and new forms of forest-based fuels are being investigated.

Climate Change and Agriculture is one of the eight research programmes at MTT Agrifood Research Finland. The overall goal of the programme is to utilize the opportunities provided by climate change for the Finnish agricultural and horticultural sector in a sustainable way as well

as to reduce the climate change related production risks and other vulnerabilities of the sector. It aims to assess and enhance the adaptive capacity of agrifood systems at various levels and to study alternative pathways of reducing greenhouse gas emissions from agriculture.

Themes of the programme and its 14 key projects are:

- Prediction of change and adaptation to change; sustainable utilisation of the changing conditions; reduction of risks; and enhancement of the resilience of the agrifood and horticultural sector
- Risks and benefits related to invasive species, and biological control of plant pests and diseases
- Exploitation of the genetic resource data for new cultivars and new business models
- Greenhouse gas mitigation options in agriculture
- Management of changes to the use of agricultural land.

The Government Institute for Economic Research (VATT), the Research Institute of the Finnish Economy (ETLA), the Pellervo Economic Research Institute (PTT) and the VTT Technical Research Centre of Finland have all been engaged in recent years, either individually or jointly, in extensive research on the economic impacts of climate change mitigation and to a lesser degree also the economic impacts of adaptation (see example in Box 8.2).

Box 8.2
Climate Bonus: Combining carbon footprinting, monitoring, feedback and rewards, and demonstrating the potential of green ICT

The implementation of ambitious climate policies needs new instruments and approaches that go beyond the current portfolio of policies and measures. In the Climate Bonus project (2008–2009), a feedback and reward system for households and retailers was developed by a consortium of five Finnish research institutions and six companies. The piloted ICT service enables consumers to monitor and follow the accumulated greenhouse gas emissions of their household purchases. Users of the service also have the possibility to compare their results with target levels and other users of the system. They can acquire bonus points (credits), e.g. on the basis of a reduction of the greenhouse gas intensity.

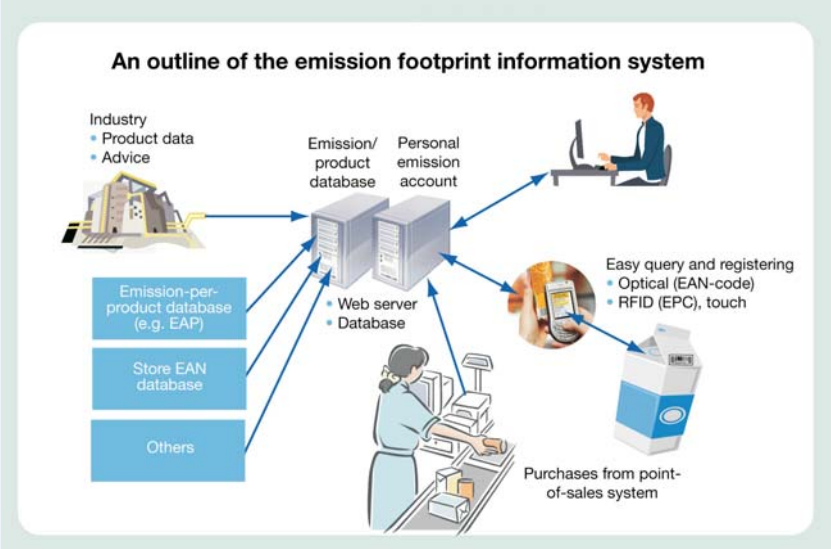
The demonstration version of the service covers emissions from foodstuffs, transport fuels and services, energy consumption at home, and a category "other consumption". It combines several approaches and data sources (life-cycle analysis, input/output analyses and emissions trading).

Foodstuff purchases are registered with the service automatically through a special system (www.nutritioncode.com) that uses a dedicated key card and the information systems of the Kesko retail chain. The rest of the purchases are recorded manually via a computer interface or using the optical barcode recognition capabilities of Nokia mobile phones. The project also introduced the basic structure of a system to produce data for generating product-oriented "certified carbon footprints".

Feedback from the pilot has been encouraging: consumers believed that the use of a monitoring and feedback system for consumption-induced greenhouse gas emissions could change the consumption patterns of households and reduce greenhouse gas emissions from consumption. The authors of the study believe that feedback systems like Climate Bonus could activate significant voluntary emission reduction potential if disseminated for extensive use.

The accuracy and tractability of carbon footprint data should be adequate in order to maintain credibility among consumers, retailers and producers. Consequently, the approval of carbon footprints should be based on transparent and comparable methods and impartial third party verification if used for crediting purposes. Up to date, reliable and comparable carbon footprint data of products and services is seldom available, restricting rapid commercial introduction of these kinds of ICT services. Due to the challenges relating to emission monitoring of international real world supply chains, expansion of such systems is expected to be gradual, starting with selected products, product categories and sectors.

An illustration of the emission footprint information system (demonstration version) of the Climate Bonus project is given in the figure below. The key purpose of the project was to assess the possibilities and effectiveness of a feedback and bonus system for households, which encourages them to consume in such a way that greenhouse gas emissions are reduced and retailers are prompted to offer a product portfolio that enhances the availability of low carbon products for households.



A number of socio-economic studies have also been carried out as background for the preparation of the Government's foresight report on climate and energy policy and for the preparation of the Long-term Climate and Energy Strategy (see also Chapter 4).

The descriptions of research given in Section 8.2 are not exhaustive. Related research is also being carried out by universities, other research organisations and the private sector.

8.3 Systematic observations

The routine surface and upper air weather observations made by the Finnish Meteorological Institute (FMI) are the prime source of atmospheric observations relevant to climate change. The observations are archived in databases. The FMI plays also an important role in air chemistry observations.

Climate-related observing activities have also been carried out by the Finnish Environment Institute (SYKE) and the Finnish Institute of Marine Research (FIMR). At the beginning of 2009 the FIMR's activities were

taken over by SYKE and the FMI, with both organisations continuing the FIMR's observation activities. The FMI is responsible for the physical marine research and monitoring, while the new Marine Centre at SYKE is responsible for research on the status of the Baltic Sea and its changes, eutrophication, marine biodiversity and invasive species. Some climate-related observations are also made by the Finnish Forest Research Institute, MTT Agrifood Research and several universities.

8.3.1 Atmospheric climate observing system

Meteorological observations have been made in Finland for more than a hundred years. In October 2009, the observation network comprised 3 meteorological observatory stations (including upper-air observations), 190 synoptic stations (of which 185 were automatic) and 110 precipitation stations. Automation of this network is continuing.

Synoptic weather messages are transmitted from automated and semi-automated weather stations every three hours, though automated measurements are also supplied more frequently. Many of the weather stations are semi-automated, which means human observers make some but not all of the observations. Traditionally, three manual observations have been made daily. Compared to synoptic messages, the observations on clouds and weather phenomena are limited. Observations of rainfall and snow are made once a day at precipitation stations.

The Finnish Meteorological Institute (FMI) has a network of 8 C-band Doppler radars installed during 1993–2005. In 2009, two of the oldest radars have been replaced with new C-band dual-polarization radars. The radar data are used to serve society in a wide range of applications from aviation weather service to flood protection.

Under the Global Climate Observing System (GCOS) programmes, the Jokioinen, Jyväskylä and Sodankylä stations are included in the GCOS Surface Network (GSN) and Sodankylä in the GCOS Upper-Air Network (GUAN). The Finnish national report on systematic observations for climate was submitted to GCOS in 2008.

Long climatological time series form a necessary basis not only for climatological research itself, but also for estimating the impacts of climate change. Finnish climate observations have been included in, for example, the NkDS (NordklimDataSet) and ECA&D (European Climate Assessment & Dataset) datasets, which are Nordic and European collections of reliable long-term climatic observations for climate change research.

The FMI maintains a climatological database of the following components:

- Station metadata register
- Daily values
- Synop data
- Hourly values for solar radiation and sunshine hours
- Rawinsonde data
- Normal values
- Automatic weather station data since 1996
- Automatic synop data since 1998
- Mast data since 1986

The archives are full of observations in analogue form that need to be digitized. The FMI is digitizing these data, though currently focusing on temperature and precipitation. The same remains to be done for other variables such as air pressure, wind, snow cover, and also for additional precipitation stations. Compiling daily meteorological series covering a long period is important for impact studies of extreme events. Moreover, in parallel with the global efforts, such data are needed to produce global historical reanalysis datasets.

The Network of European Meteorological Services (EUMETNET) was established to promote European cooperation in developing the meteorological observing network and the basic weather services. The FMI has hosted the programme, which was established to improve the observation technology for severe weather conditions, and been actively involved in the work of the European Climate Support Network (ECSN). The FMI is responsible of the EUMETNET training programme, EUMETCAL. A key objective of the EUMETCAL is to provide quality virtual training material and a training environment for the meteorological staff of the EUMETNET members.

Finland is a participant in the Global Atmosphere Watch (GAW) programme of the World Meteorological Organization (WMO), the purpose of which is to observe greenhouse gas concentrations and long-range transport of pollutants in the atmosphere.

The FMI maintains a GAW station at Pallas-Sodankylä in Lapland, where greenhouse gas concentrations are measured on a mountain top in a national park. Carbon dioxide, methane, nitrous oxide, sulphur dioxide and ozone are measured continuously at the station. Continuous measurements of carbon dioxide started in 1996 and of methane in 2004.

- Flask samples are collected weekly at Pallas. The Earth System Research Laboratory in Boulder, Colorado analyses them for CO_2, CH_4, CO, H_2, N_2O, and SF_6 concentrations, and the Stable Isotope Laboratory of the University of Colorado in Boulder analyses them for concentrations of the stable isotopes of CO_2 and CH_4. At Sodankylä, ozone soundings in the troposphere and stratosphere are conducted weekly. Regular ozone soundings have also been performed at Marambio (Antarctica) since 1988; the data has been used in scientific publications, and forms a significant contribution to the WMO ozone bulletins.
- Global data integration and earth system modelling are essential for assessing global trends and regional sources and sinks. The data from the station in Lapland is sent to relevant data banks including the World Data Centre for Greenhouse Gases in Japan and European data banks of the CARBOEUROPE and GEOmon projects.
- The FMI is responsible for the national background air quality monitoring. The monitoring network consists of about twenty measurement stations in different parts of the country. Most of the measurements are part of international monitoring and research programmes.

- The background air quality monitoring started at the beginning of the 1970s. Nowadays the measurements include major ions, polycyclic aromatic hydrocarbons (PAHs), heavy metals and mercury in the air and in precipitation, ozone, sulphur oxides, nitrogen oxides, volatile organic compounds and fine particles.
- The GAW programme of the WMO provides highly accurate measurement data on atmospheric composition and other information related to physical characteristics of the background atmosphere from all parts of the globe. In addition to the GAW functions the Pallas-Sodankylä station is also part of the Arctic Monitoring and Assessment Programme coordinated by the Arctic Council. Five stations (Pallas, Ähtäri, Virolahti, Oulanka and Utö) belong to the European Monitoring and Evaluation Programme (EMEP).
- The Integrated Monitoring programme, coordinated by the United Nations Economic Commission for Europe (UNECE), refers to the simultaneous measurements of physical, chemical and biological properties of an ecosystem over time and across compartments at the same location (stations Kotinen and Hietajärvi). The objective of HELCOM (Baltic Marine Environment Protection Commission, or the 'Helsinki Commission') is to protect the marine environment of the Baltic Sea (station at Hailuoto).
- The FMI also maintains the monitoring and warning system of the tropospheric ozone concentrations in accordance with the European Union's Ozone Directive. Air quality issues in the EU are coordinated by the European Environment Agency and in the European Topic Centre on Air Quality.

Aerosols have direct and indirect effects on the atmosphere. The magnitude of these effects, as regards warming or cooling, remains one of the most significant sources of uncertainty in climate models. As a part of WMO's GAW programme, the scattering, backscattering, absorption and size distribution are measured at Pallas. Aerosol optical depth is measured at the Pallas-Sodankylä GAW station and Jokioinen Observatory as well as at the Argentinian Marambio Antarctic station. The results are regularly submitted to the World Data Centre for Aerosols. Furthermore, there are three AERONET stations in Finland, located at Hyytiälä (run by the University of Helsinki), Kuopio and Helsinki (both run by the FMI) for measuring aerosol optical depth as well as microphysical and radiative properties of aerosols in the atmospheric column. The fourth station is at Gual Pahari in India, which operates as part of the EU-funded international cooperation (EUCAARI). Mass concentration monitoring (PM10, PM2.5) is performed at five stations by the FMI. The chemical composition of aerosols (major ions and heavy metals) is also analysed.

Finland is a member of the European Space Agency (ESA) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). ESA is focused on research and development projects, while EUMETSAT is more orientated towards pre-operational and operational projects. Both have activities in the field of climate monitoring. The FMI hosts EUMETSAT's ozone research programme O3SAF and participates in the satellite climate data programmes of ESA and NASA.

8.3.2 Ocean climate observing systems

The Finnish Meteorological Institute (FMI) maintains networks of water level and water temperature observations in Finnish marine areas. The Finnish Institute of Marine Research has developed the Baltic Sea Database (as part of the Algaline project) now in use at the Finnish Environment Institute, which provides real-time information on the state of the Baltic Sea for the general public, the media and public authorities.

The Algaline-project utilises the so-called ship-of-opportunity (SOOP) monitoring system, which uses merchant ships as operating platforms. The data collection and water sampling for analytical measurements are carried out with autonomous flow-through measuring systems. The SOOP system has been increasingly adopted all over the world for routine use as the most cost-effective environmental monitoring system. The Algaline project is a forerunner in the field of unattended SOOP monitoring. It currently forms a state-of-the-art environmental monitoring system from data collection and assimilation to Internet applications and products.

The Finnish Ice Service (part of the FMI) is responsible for collecting, analysing and distributing sea ice data covering the Baltic Sea. The input data consists of ground truth, visual air-borne data and space-borne data from various satellites. Satellite data from RADARSAT 1, ENVISAT, AMSR, NOAA/AUHRR and MODIS are or have been used.

8.3.3 Terrestrial climate observing systems

The Finnish Environment Institute (SYKE) is the national centre for monitoring the physical, chemical and biological state of inland waters. Terrestrial essential climate variables and relevant metadata are included in the following registers:

- Hydrology and Water Resources Management Data System
- Groundwater Database
- State of Finland's Surface Waters
- Lake Register
- Information System for Monitoring Land Use Planning.

The first register is of particular interest in climate change studies, because it contains a number of time series dating back to the 1800s. The series on the freezing and breakup dates of Finnish lakes and rivers are particularly long. The longest of them, breakup dates of the River Tornio in northern Finland, goes back as far as 1693.

Finland reports to the Global Runoff Data Centre, located in Koblenz, Germany. The number of stations reported is 50, out of the total of 280. The Nordic runoff data centre at the Swedish Meteorological and Hydrological Institute also contains a considerable amount of Finnish runoff data.

Finland has one of the densest snow survey networks in the world. Snow depth is measured at 50–80 points and snow density at ten points on each survey line, which covers a length of 2.5–4 km.

Cryospheric data from Finland have been reported to the National Snow and Ice Data Center (NSIDC) at the University of Colorado. These data include the longest freezing and breakup data series in the world.

Finland has a network of 54 groundwater stations, which are operated and maintained by SYKE. In addition to groundwater levels, soil moisture and the depth of soil frost are measured. Most stations were established in the 1970s.

Flood forecasting at SYKE is based on the Watershed Simulation and Forecasting System. Its main component is a hydrological model representing the circulation of water in a catchment. The forecasts are made daily for 300 water level and discharge observation points.

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 the EUROWATERNET, which provides reliable and comparable data on the state of inland waters all over Europe. In Finland, this new monitoring system was introduced at the beginning of 2000. There are 195 observation points for rivers, 253 for lakes and 74 hydrological sampling stations.

8.3.4 Other observing systems

The Finnish Forest Research Institute (METLA) performs national forest inventories (NFIs), which produce reliable information on the land use, forest resources, growth, condition and biodiversity of forests. NFIs are based on statistical sampling. The most recent NFI was done in 2004–2008 and consisted of approximately 60,000 sample points. Ten NFIs have been completed since the 1920s, providing internationally unique time series on the development of land use and forest resources. The eleventh NFI was started in 2009 and will be completed in 2013.

In addition, METLA systematically collects information on the phenology of tree and forest berry species and prepares annual reports on forest condition and observed damage, as a part of a European network of monitoring the condition of forests. The extent of climatic warming can thus be assessed on the basis of the time series of bud burst of different tree species. Moreover, trends indicating a likely increase in the occurrence of forest damage can be detected to enable preventive measures.



As a member country of the Arctic Council, Finland is participating in the SAON initiative (Sustaining Arctic Observation Networks) under the Arctic Monitoring and Assessment Programme (AMAP). SAON is a process to enhance multinational engagement in developing sustained and coordinated pan-Arctic observing and data sharing systems that serve societal needs, particularly related to environment, social, economic and cultural issues. The challenge that climate change poses to Arctic regions is an important motive for developing SAON. All eight Arctic Council states participate in SAON in close collaboration with 13 international research and scientific bodies, including the International Arctic Science Committee (IASC) and the World Meteorological Organization (WMO).

8.3.5 Capacity building in developing countries

For many years Finland has been operating extensive capacity building programmes around the world. Climate data management systems have been implemented in several developing countries through Finnish development agencies and with considerable financial and personnel support. The institutional support for the capacity building programmes has been channelled mainly through technical aid to strengthen the meteorological observing networks and weather services as well as climatological databases, expert services and training programmes.

Since the early 1970s, the Ministry for Foreign Affairs has financially supported the strengthening of the WMO's Global Observing System.

The Finnish Meteorological Institute (FMI) is engaged in several separate projects for the Finnish Ministry for Foreign Affairs and the European Community to develop the institutional capacities of national meteorological services in developing countries through various activities. In most countries, the national weather service is the de facto official dealing with weather and climate risks and disseminating warnings and forecasts to the general public. Increasing the capacity of these services to carry out their increasingly demanding tasks will benefit society through the delivery of more timely and accurate weather and climate services to the public.

Ongoing FMI capacity building activities include:

- Peru 2009–2012: increasing the capacity of the national meteorological service to design, operate and maintain a real-time hydro-meteorological observation network, to improve forecast services and develop in-house climate change research activities relevant to Peruvian society
- Oceania 2009–2011: increasing the capacity of Pacific Small Island Developing States to deliver quality-managed aviation weather forecasts, improve the visibility and impact of weather and climate services and develop a regional action plan for the improvement of weather and climate observations in the Pacific

- Southern Africa 2009–2010: authoring of a regional weather and climate observation network development plan and increasing the capacity of southern African meteorological services to deliver quality-managed aviation weather forecasts and improve the visibility and impact of weather and climate services
- Croatia 2008–2010: EU-twinning project for the establishment of an air quality monitoring and management system in the meteorological and hydrological service of Croatia
- Lithuania 2005–2007: increasing the institutional capacity of the Lithuanian national meteorological service to carry out and manage automatic weather and air quality observations, observation networks and data management

In addition to the above-mentioned list of ongoing activities, the FMI will begin capacity building projects in Nepal, Vietnam, Sudan, Trinidad & Tobago, Barbados and elsewhere in the Caribbean region in the coming years, focusing on institutional capacity building of the national meteorological (and hydrological) services, including observations, services, data management and strategic planning.

Literature

Finnish Science Barometer (2007) A study of the Finns' attitudes towards science and their opinions on scientific and technological progress. Finnish Society for Scientific Information, Helsinki, Finland

Hongisto et al. (2008) How households could monitor and manage the climate impact of their own consumption, pp. 42–51 Ympäristö ja Terveys, vol 39, 10:2008, Pori, Finland (In Finnish)

Hyvönen, K., Saastamoinen, M., Timonen, P., Kallio, A., Hongisto, M, Melin, M. & Södergård, C. (2009, in press) Consumers' views of the monitoring and feedback system regarding climate impacts of households. Climate Bonus project report (WP5). VATT Research Reports 143:4/2009, Helsinki, Finland (In Finnish)

Kangas, H.-L., Lintunen, J. & Uusivuori, J. (2009) The cofiring problem of a power plant under policy regulations. Energy Policy 37(5):1898–1904.

Ministry of Education, Advisory Board for Sectoral Research (2009) Annual report of the Advisory Board for Sectoral Research, Helsinki, Finland (In Finnish)

Perrels, A. et al. (2008) CLIMATE BONUS – more enjoyment from fewer emissions. Yearbook, TEKES ClimBus programme, Helsinki, Finland

Perrels, A., Hongisto, M. Hyvönen, K. Nissinen, A., Usva, K., Kallio, A., Koskela, S. & Katajajuuri, J-M. (2009) CLIMATE BONUS – Combining carbon footprinting, monitoring, feedback, and rewards. Final report. TEKES Climbus programme CD, Helsinki, Finland

Perrels, A., Nissinen, A. & Sahari, A. (2009, in press) The overall economic and environmental effectiveness of a combined carbon footprinting and feedback system. Climate Bonus project report (WP6). VATT Research Reports 143:5/2009, Helsinki, Finland

Science and Technology Policy Council (2008) Review 2008, Helsinki, Finland

Science and Technology Policy Council (2006) Science, Technology, Innovation, Helsinki, Finland

Seppälä, R., Buck, A. & Katila, P. (eds) (2009) Adaptation of Forests and People to Climate Change – A Global Assessment Report. IUFRO World Series Volume 22, Helsinki, Finland
http:www.iufro.org/science/gfep/embargoed-release/

Södergård, C. (2006) Vision on the impact of IT on compliance processes and functions and consequences for future actions by the various stakeholders. VTT presentation at an informal WG3 meeting: use of IT for EU-ETS compliance and similar reporting, Helsinki, Finland

Usva, K., Hongisto, M., Saarinen, M. Nissinen, A., Katajajuuri, J-M., Perrels, A. Nurmi, P. Kurppa, S. & Koskela, S. (2009, in press) Towards certified carbon footprints of products – a road map for data production. Climate Bonus project report (WP3). Government Institute for Economic Research, VATT Research Reports 143:2/2009, Helsinki, Finland

Internet links

Arctic Centre at the University of Lapland,
http://www.arcticcentre.org/?deptid=9015

British Standards Institution: Publicly Available Specification (PAS-2050) on requirements for assessing the life cycle greenhouse gas emissions of goods and services,
http://www.bsigroup.com/en/Standards-and-Publications/Industry-Sectors/Energy/PAS-2050

The Centre of Expertise Programme (under the Ministy of Employment and the Economy),
http://www.oske.net/en/

Climate Change Adaptation Research Prgoramme ISTO,
http://www.mmm.fi/en/index/frontpage/ymparisto/ilmastopolitiikka/researchprogrammeonadaptationtoclimatechange.html

Climate Bonus,
http://extranet.vatt.fi/climatebonus/

Environmental Research Cluster Programme homepage,
http://www.ymparisto.fi/default.asp?contentid=105793&lan=en

Final report of the research programme Greenhouse Impacts of the Use of Peat and Peatlands in Finland,
http://www.mmm.fi/attachments/mmm/julkaisut/julkaisusarja/2008/5BKZGKG1a/MMM11a2007_nettiversio_turve.pdf

Finnish national report on systematic observations for climate,
http://unfccc.int/files/methods_and_science/research_and_systematic_observation/application/pdf/finnland.pdf

Government foresight report on climate change and energy, summaries of supporting research,
http://www.vnk.fi/hankkeet/tulevaisuusselonteko/aineistot/en.jsp

IPCC Emission Factor Data Base,
http://www.ipcc-nggip.iges.or.jp/EFDB/main.php

Top-level Research Initiative on Climate, Energy and the Environment,
http://www.norden.org/en/top-level-research-initiative/about-the-top-level-research-initiative?set_language=en

Back to Contents

9 Education, training and public awareness

This chapter describes how climate change is included in the education system, both in teaching and managing schools or other educational institutions. That is followed by a portrayal of international training activities. Finally, raising public awareness is discussed in length. The role of ministries, local authorities, other public bodies and private agents is explained and many climate change or energy saving campaigns are presented.

Back to Contents

Photos

Pradipta Halder, page 244
Pentti Hokkanen/YHA kuvapankki, page 246
Vesa Kaarakka/VITRI, University of Helsinki, page 243
Käpylän koulu, Helsinki, page 237
Ilmo Pylkkänen, Viherjuuri, page 239
Kalaimani Supramaniam, page 242
Ping Zhou/VITRI, University of Helsinki, page 243

9 Education, training and public awareness

9.1 General policy

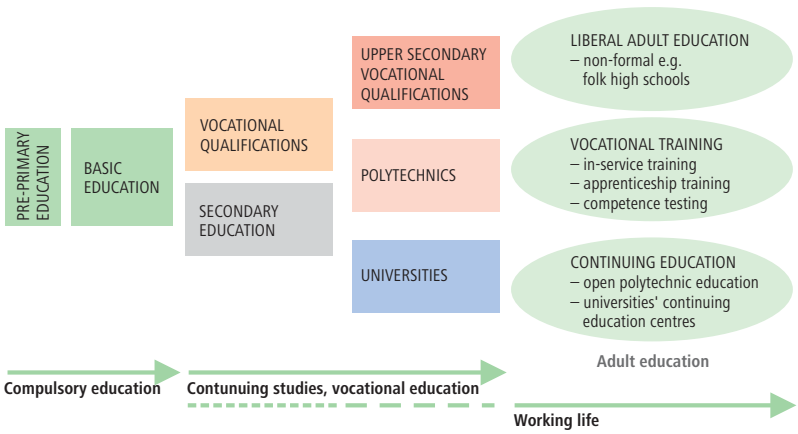
9.1.1 Education policy

All children in Finland receive compulsory basic education between the ages of 7 and 16. Ninety-six per cent of six-year-olds participate in pre-school education. Education beyond the age of 16 is voluntary. Pupils can choose either an upper secondary school lasting 3–4 years or a vocational education institution lasting 2–5 years. In 2008 about 97 per cent of those completing their compulsory basic education went on to upper secondary school or a vocational institution (Figure 9.1).

The higher education system comprises universities and polytechnics. A network of 20 state-run universities covers the whole country. With the forthcoming university reform, all universities will become legal entities in their own right, separate from the state, either forming corporations under public law or foundations under the Foundations Act. Due to mergers, the number of universities will be reduced to 17. The annual enrolment in universities is about 20,000 students, almost one third of the age group. The network of 26 polytechnics, which was created in the 1990s, admits some 34,000 new students annually.

The Finnish school system received high scores in the international PISA (Programme for International Student Assessment) science performance comparison in 2006. The comparison of 70 countries put Finnish schoolchildren at the top in mathematics, reading and science. PISA is a

Figure 9.1
Finnish education system



Source: Ministry of Employment and the Economy, Report of the Energy Efficiency Committee http://lato.poutapilvi.fi/p4_tem/files/23449/TEM_ETT_Proposal_Englanti_100609.pdf

three-yearly appraisal of 15-year-olds in industrialised countries, organised by the OECD.

All schools in Finland are connected to the Internet. More than 3.2 million Finns, or some 83 per cent of 16–74-year-olds, had used the Internet regularly during 2008. All municipalities have at least one free public library, and about 80 per cent of Finns are regular library users. The circulation of daily newspapers is among the highest in the EU, around 460 per 1,000 adult population.

9.1.2 Climate change communications policy

Climate change is already firmly anchored in the education and public awareness policies and practices of the government, and these policies and practices remain under continuous development. The Government Programme (2007) of the current cabinet states that environmental education will be strengthened at all levels and public awareness of energy efficiency enhanced by e.g. promoting the remote metering of energy consumption. The national Long-term Climate and Energy Strategy (2008) states that citizens are provided with up-to-date information on all aspects of the climate and energy policy. It also states that sufficient resources will be made available to develop a nationwide advice and information service on energy and climate.

9.1.3 New Delhi Work Programme

Under the New Delhi Work Programme, launched at the 8th Conference of Parties (COP 8) in 2002, the Parties are encouraged to engage all stakeholders (e.g. local governments, non-governmental organisations (NGOs), intergovernmental organisations (IGOs), business and industry) in education, training, public awareness, public participation, public access to information and international cooperation reflecting the elements of Article 6 of the Convention. The New Delhi Work Programme serves as a framework for country-driven actions giving the Parties flexibility in implementation and taking into account national circumstances and priorities. The programme was reviewed in COP 13 in 2007, resulting in a request to Parties to report on their further efforts in implementing the programme.

Activities described in this chapter include Finland's efforts in implementing the New Delhi Work Programme.

9.2 Climate change issues in Finland's educational system

9.2.1 Education on sustainable development and climate change in the national curricula

Climate change issues are included in the education given on sustainable development in Finland's compulsory basic education system. Sustainable development and climate change are dealt within many subjects and as a cross-curricular theme. Teachers decide the context and how the issues are

taught. The teaching should form a systematic learning path progressing through the classes.

The National Core Curriculum for Basic Education (2004) outlines the general objectives of sustainable development education. Pupils should understand the necessity of environmental protection, learn to observe the changes taking place in the environment and evaluate the impacts of their own consumption, and adapt their behaviour to support sustainable development.

The National Core Curriculum for Upper Secondary Schools (2003) also highlights a number of sustainability and climate-related issues. Students (aged 16–19) should be familiar with the main aspects of the ecological, economic, social and cultural dimensions of sustainable development and be able and willing to act in support of sustainable development in their own lives.

The National Core Curriculum for Upper Secondary Vocational education define sustainable development as one of the key skills. It is included in the qualification modules with a field-specific emphasis and is assessed as part of vocational skills demonstrations and/or other competence. Education providers are required to carry out measures to promote sustainable development. Sustainable development must also be visible in quality management issues.

All Finnish schools and educational establishments are required to have a sustainable development action programme by 2010. In addition, 15 per cent of them will have acquired external certification for their work on sustainable development by 2014. These targets have been set in the national strategies for sustainable development education.

The national system of Environmental Certification of Educational Establishments (see links at end of chapter) encompasses the following elements

- criteria for incorporating sustainable development in the management, teaching and maintenance activities of educational establishments
- large amount of support material
- a nationwide auditor network for evaluating and developing the operation of schools and educational establishments
- teacher training courses supporting the creation of sustainable development programmes
- arrangements for external evaluation and certification.

The Environmental Certification scheme was started in March 2004 and the criteria were updated in 2009. The new criteria and the related self-evaluation tool assist educational establishments in planning their teaching and designing sustainable development programmes. The system covers all schools and educational establishments except polytechnics and universities. Their possible inclusion is being studied further.

Many nationwide projects, networks, campaigns or competitions in and between schools support the teaching on sustainable development and climate change and give pupils a chance to make use of their knowledge. Environment Online is an example of such a project (see Box 9.1). Other examples can be found in the Internet links at the end of this chapter.

Many different public service organisations have funded NGOs to visit schools as climate ambassadors and to discuss climate change and ways to curb it. This programme has been actively pursued for in the present decade and with good results.

Box 9.1
Environment Online – ENO

Environment Online, ENO, is a global virtual school for sustainable development created in Finland in 2000. Since its founding, a growing number of schools around the world have participated, studying the same environmental topics and sharing their knowledge among local communities and worldwide on the Internet. The themes covered include climate change, forests, water, ecological footprints and cultural issues. The study material and structured courses for each theme are available in English on the ENO website.

Planting trees has been one of the most popular activities since 2004. The ENO tree planting day in September 2009 brought together about 2,500 schools in 122 countries, and about 300,000 trees were planted to celebrate the day.

Climate change has been a regular theme in the ENO programme since 2002. Students have written articles about the impact of climate change in their countries. They have made radio interviews for the ENO web radio, made climate change videos for the website and marched during the ENO campaign weeks. About 1,000 schools in 102 countries took part in the ENO Climate Change Campaign in January 2009.

ENO is administered by the education department of the city of Joensuu. It has numerous partner organisations and networks including the United Nations Environment Programme and the University of Joensuu. It has won 14 national and international awards.

ENO website: www.enoprogramme.org

9.2.2 *Climate change in higher education and climate change training*

Universities provide climate change education as a part of different degree programmes, including environmental studies, environmental technology, chemistry, chemical technology and energy technology. Some universities also offer postgraduate studies in climate change. Teaching related to climate change is closely tied to the research in this field.

Climate issues are today also included in the sustainable development teaching given as part of teacher education, which in Finland is a university-level programme for all teachers throughout the education system. Nevertheless, only a fraction of all the country's teachers outside the natural sciences have adequate pedagogical expertise in sustainable development and climate change.

Universities, polytechnics and several training institutes provide continuing education programmes and vocational training in climate change and related issues, e.g. energy efficiency and environmental technology, for individuals and companies.

9.3 *International training activities*

Training of experts for developing countries in managing forests and other natural resources is an integral part of the agricultural and forest sciences programmes at the University of Helsinki. For example, the Viikki Tropical Resources Institute (VITRI) at the Faculty of Agriculture and Forestry trains 3 to 6 Masters of Forestry and 2 to 3 doctors annually. So far about 70 stu-

dents have completed the master's degree and 30 students the doctoral degree. VITRI has maintained a strong focus on rehabilitation of degraded natural and man-made production systems, including agroforestry systems and on the various products and services provided by these systems, across the different ecological zones in Asia, Africa and Latin America. More than half of the doctoral students come from developing countries, such as Sudan, Thailand and China. In addition, various departments and projects at the University of Helsinki have actively taken part in exchanging students, teachers and researchers with developing countries, thus contributing to the transfer of knowledge on environmental and natural resource management.

Photosyntesis measurements in irrigated forest plantations. Adaptation of trees and carbon sequestration under environmental stress have been among the topics of the Finland-Kenya research cooperation led by VITRI at the University of Helsinki since 1984.

The Faculty of Forest Sciences at the University of Joensuu has participated in several international exchange programmes in forestry education. Currently it is coordinating a two-year Erasmus Mundus programme called Master of Science in European Forestry (MSc EF), funded by the EU. The programme links the increasing number of forest-related issues with a European dimension. Three quarters of the students come from developing countries, supported by special grants. The programme's network of six European universities offers students from the developing countries excellent opportunities to learn, make contacts and specialize. In addition, the programme arranges visits to these universities for teachers and researchers from the developing countries. The University of Joensuu also coordinates the Finnish Graduate School in Forest Sciences, which trains international doctoral students, including students from developing countries, in various fields of forest and biological sciences.

Training experts in the management and sustainable use of forests and other natural resources contributes to the development of human capital necessary for the mitigation and adaptation efforts in the developing countries. This is especially the case with experts who have doctoral degrees and are, ac-

Soil sampling by Finnish-Chinese research team in the Yangtze River watershed in Sichuan, China. At the University of Helsinki, VITRI is involved in institutional capacity building in the fields of forest ecology and natural resource management in several tropical and developing countries.

European Forestry students are participating in their first MSc EF course called "Trends in European Forestry" in Sweden. The course includes a visit to the arboretum, where different European tree species are introduced to the students.

cordingly, trained in scientific methods. Many academic units in Finland also cooperate with universities, research institutes and governmental organisations in developing countries to support institutional development in various sectors. For example, VITRI is an active participant in the development of the forestry sector in Sudan, Kenya, Ethiopia, Thailand, Indonesia and Laos.

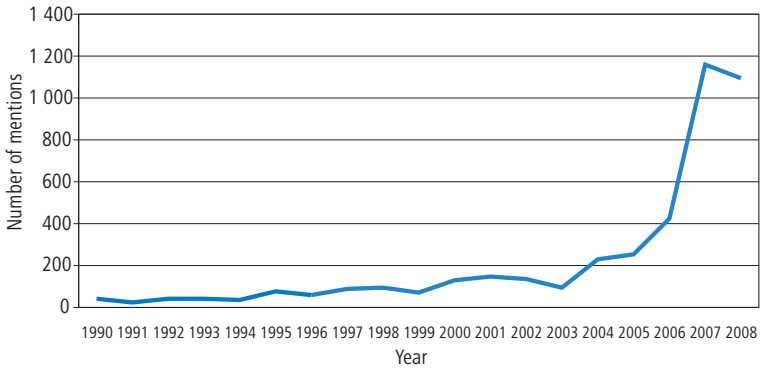
9.4 *Increasing public awareness*

As a result of good media coverage and various climate change awareness campaigns, Finns know what climate change is and understand the need to curb it. Climate change has undergone a shift from the margins to the centre of media attention. Before the ratification of the Kyoto Protocol in 2002, articles on climate change were published mainly in the science and nature sections. Since then, the media have integrated climate change into other areas too, covering not only the scientific but also the political, economic and social aspects. This change has been particularly evident since the Intergovernmental Panel on Climate Change (IPCC) released its Fourth Assessment Report in 2007 (Figure 9.2). Finnish media coverage no longer concentrates only on defining the phenomenon, but focuses on the ways of responding to it.

In Finland journalists have direct access to civil servants who deal with climate change issues and to climate change experts in various organisations. This makes it possible to provide the public with first hand information and a broad background on e.g. domestic measures and international negotiations.

Various NGOs are also actively communicating on climate change. Nine NGOs share a website on climate change, and several of these have run public campaigns motivating citizens to take action to protect the climate (see 9.4.4 and Internet links at the end of this chapter)

Figure 9.2
"Climate change" in the biggest national daily newspaper 'Helsingin Sanomat' 1990–2007



Source: Lasse Peltonen, Head of Research, Centre for Urban and Regional Studies, Helsinki University of Technology

9.4.1 Actions by the government

Communication on climate change is performed by several different ministries and government research organisations, each within the sphere of their own tasks and responsibilities: the ministries of Agriculture and Forestry, Employment and the Economy, the Environment, Transport and Communications, the Ministry for Foreign Affairs, the Prime Minister's Office, the Finnish Environment Institute and the Finnish Meteorological Institute (FMI).

With climate change communication being performed in this manner, there is a need for cooperation to ensure that actions are coordinated. Consequently, in autumn 2008 the Ministries of Agriculture and Forestry, the Environment, Employment and the Economy, Transport and Communications, the Finnish Environment Institute and the FMI began unofficial cooperation on climate change communication. Other ministries with climate change related responsibilities have also been invited to participate in this collaboration. The Prime Minister's Office and the Ministry for Foreign Affairs have already decided to join it.

In 2009 this collaborating group of ministries and government organisations introduced a common newsletter called 'Klimaatti'. It is published on the Internet four times a year in Finnish and in Swedish. Each issue features articles on climate change mitigation and adaptation, current research, eco-efficiency, energy consumption, international negotiations and legislation. Each organisation edits its own articles and pictures. The newsletter is being coordinated by the Ministry of the Environment, which is also in charge of the final content and visual image of the publication. The newsletter has proven to be an efficient vehicle in raising awareness on climate change.

The group has also increased collaboration in organising training for journalists.

Another example of cooperation is the shared Climate Change Community Response Portal aimed at municipalities, which is being built by the FMI, the Finnish Environment Institute and the Helsinki University of Technology's Centre for Urban and Regional Studies. The aim is to bring greater uniformity to the diverse and fragmented array of climate change information

and to bring it under a single portal. The aim is also to provide a means for examining the local impact of climate change and to offer practical tools for local and municipal planning and decision-making. The portal is an EU Life+ project coordinated by the FMI and will be launched in May 2011.

Most communication activities are still carried out independently by the various government bodies. The Ministry of Employment and the Economy is responsible for communication on the Long-Term Climate and Energy Strategy, for example, while the communication and climate change experts of the Ministry of the Environment have prepared a communication strategy for the United Nations climate change negotiations in 2009. To cope with the interest displayed by the Finnish media, by civil society, by industry and by the general public, the ministry will organise press events on the negotiations. During the key climate meetings the ministry will communicate actively through press releases and provide publications on the negotiations. The ministry will prepare and coordinate Finland's views on the international climate negotiations at the European Union level and in regard to the United Nations. The ministry is the national focal point for the UNFCCC and is also responsible for implementing the Kyoto Protocol and for the related strategic planning in its own branch of administration. In addition, the ministry is responsible for land use, waste and building policies, all of which have specific climate change implications. The ministry also provides information on energy regulations for new buildings, which are designed to improve their energy efficiency.

The national IPCC working group coordinates and presents Finnish standpoints to the IPCC reports. It aims at raising awareness of the IPCC's work in Finland and the Finnish contribution towards it. The communications department of the FMI is responsible for IPCC communications, in close cooperation with the communications department of the Ministry of the Environment. The most important channels are press releases and conferences, seminars for decision-makers and training programmes for journalists.

The Finnish Environment Institute is also active in climate change communication. It provides information on the latest domestic climate change research through press releases and newsletters. It also publishes a widely read magazine called 'Environment'. In addition, the institute's communication unit is involved in three climate change related Life+ projects of the EU: VACCIA, CCCRP, and Julia2030. Like the Ministry of the Environment, the institute provides education and training in media outreach and public relations for its experts and researchers. It also distributes information on the Partnership for European Environmental Research (PEER) and reports both nationally and at EU level.

Many of the government organisations were already providing training independently for various stakeholders before the unofficial cooperation was established. For example, as part of the national climate change communications programme (see Box 9.2), the FMI organised a two-day climate change course for journalists in March 2006. The course, entitled 'The climate is changing – who´s to blame?', was attended by 40 journalists. Their

feedback was very positive and convinced the FMI to continue providing such training on an annual basis. To date, the course has been attended by some 180 journalists specialising in the economy, science and the environment. In November 2008 the Ministry of Agriculture and Forestry, in charge

Box 9.2

Climate Change Communications Programme 2002–2007

The Climate Change Communications Programme, launched following a parliamentary initiative in autumn 2002, formed an important part of Finland's national climate strategy. The programme was aimed at increasing awareness on climate change, its impacts and mitigation. The culmination of the programme coincided with an EU-wide public information campaign in 2006.

The programme was coordinated by Motiva, an affiliated government agency promoting the sustainable use of energy and other resources, and implemented jointly by the ministries of Employment and the Economy (formerly Trade and Industry), Transport and Communications, Agriculture and Forestry, the Environment, and the Finnish National Board of Education. The project's steering group had a strong representation of climate change and communication experts from the participating ministries.

The programme included campaign and project funding for many different groups. This focused on businesses, including companies in the energy, waste management, construction, forestry and farming sectors, as well as local authorities, regional associations and journalists.

Special efforts were made throughout the programme to reach young people, the decision-makers of the future. Schools and teachers were key target groups.

In five years the programme funded 62 projects with a total budget of about EUR 2.5 million.

Short presentations of the projects are available at *http://www.ilmastonmuutos.info/eng/cfmldocs/.*

During the programme's final year, starting in June 2006, a special EU-initiated campaign "Make a change" was run across Finland. The campaign was run in national formats simultaneously in all EU countries. The Finnish campaign aimed especially at bringing climate issues closer to ordinary people – to arouse their interest, increase awareness and change attitudes. The campaign involved open meetings, outdoor events, exhibitions and training sessions, as well as prominent advertising in newspapers and magazines, on the radio, billboards and on buses and taxis.

The Finnish campaign was uniquely intense and effective, thanks to the networks, materials and working methods already established during the earlier phases of the communications programme. The involvement of the EU helped to raise the profile of the campaign, which engaged more than 70 domestic partner organisations and a group of high-profile climate ambassadors.

Active grassroots projects and well-attended local events proved to be the best ways to reach people. Local organisations were uniquely able to highlight the vital issues for local audiences and attract the local media. The "Make a change" campaign was most successful in places where active networks had already been built up earlier in the programme.

A survey conducted in 2007 showed that most Finns had grasped the main message of the campaign and realised its importance. The celebrity climate ambassadors, chosen to help reach priority target groups, gained considerable attention in the media.

Compared with the earlier surveys in 2002 and 2004, the survey showed that Finns had clearly understood better how they can help to mitigate climate change. More people were aware of the benefits of activities like using public transport, separating and recycling waste and saving energy. Readiness to change lifestyle had also increased, even though many possible actions still seemed difficult or irrelevant to some people.

Networks of the key actors that have been built up during the programme have continued to spread information and ideas. Existing material will have to be updated and there is also a need for a further coordinated communications programme, as specified in the programme of the current cabinet.

of coordinating the national climate change adaptation strategy, organised a one-day 'adaptation workshop' for journalists. 35 journalists, most of whom had already attended the FMI's course on climate issues, took part in the workshop. Another workshop is under preparation for 2010.

9.4.2 Raising awareness in energy efficiency

Energy and materials efficiency and use of renewable energy sources are the easiest and most effective ways to combat climate change. Motiva is a state-owned company and operates as an affiliated government agency promoting efficient and sustainable use of energy and materials. It provides information, training and expert services. It furthers energy education through specific projects and campaigns at primary schools, boosting awareness and climate friendly consumption. Motiva also facilitates energy efficiency agreements with the public and private sectors, and provides training for energy auditors and energy efficiency training seminars for industrial and service sectors. It also coordinates communications and awareness raising, e.g. through the National Energy Awareness Week.

Motiva produces and distributes information and action advice for clearly segmented target groups among communities, companies, households and schools through its website and informative materials.

Energy Awareness Week

Motiva has successfully run the National Energy Awareness Week and the specific energy awareness week for primary schools since 1996. The week has become an established annual event in October, during which companies, schools and other organisations concentrate on promoting energy efficiency. The week is a means of getting people to think and act in favour of sensible use of energy and an environmentally conscious way of life – voluntarily.

Every year some 300 companies and organisations participate in the week. Half of Finland's school children aged around eight (close to 25,000 pupils) take part in the week by studying energy from its production and consumption to energy saving and by taking energy saving action at home and in school. Many companies have incorporated the week into their own environmental programmes and implemented voluntary energy saving measures.

Motiva provides Awareness Week participants with tools, tips, informative material and support for distributing information, and acts as the national media contact point. It also organises seminars and workshops to activate different organisations to exchange ideas, collaborate and arrange events together.

The Energy Awareness Week is supported by the Ministry of Employment and the Economy.

9.4.3 Local and regional activities

Dozens of municipalities participate in a long-running campaign to reduce their own greenhouse gas emissions. Five municipalities have even committed to cutting their emissions faster than the EU targets would require (see Chapter 4 for the campaign and the five municipalities). Another campaign, ILMANKOS, is trying to activate the residents in Finland's second largest city region (see Box 9.3)

Box 9.3
ILMANKOS campaign

ILMANKOS is a campaign to combat climate change and promote grass-roots participation in preparing mitigation measures in the Tampere region. Its aim is to increase the participation of residents and groups in the region in reducing greenhouse gas emissions.

The ILMANKOS campaign declares that it is time to switch from worrying to action and to start making climate-friendly every-day choices: "Make your pledge for the climate, fulfil it and invite others to join."

The campaign and a regional newspaper challenged three families to reduce their carbon footprint. In spring 2009 their carbon footprints were assessed and they were given advice how to reduce their greenhouse gas emissions. The newspaper published articles on their progress every Sunday.

The campaign started in autumn 2008. It supports the preparation of a climate strategy for the Tampere region and gives residents a chance to take part in and influence the strategy preparation process.

9.4.4 Other campaigns

Many NGOs, the media and one-off partners have run climate change related campaigns. For example, Maanystävät (the Finnish Friends of the Earth) is running a campaign to push for a climate change bill with an emissions reduction obligation. A television programme 'Operaatio Maa' ('Operation Earth'), on a commercial channel, together with WWF Finland, challenged viewers to donate money for climate change projects in Nepal and Madagascar and for the protection of the Baltic Sea.

A campaign called Green Fingerprint (see Box 9.4) challenged Finns to save energy and introduced a website to advise them how to do it.

Box 9.4
Green Fingerprint campaign and website for energy saving

In their Green Fingerprint campaign, the Helsinki power company Helsingin Energia, the state-owned company Motiva and WWF Finland challenged Finns to save energy and thus curb climate change. The campaign was designed to promote a website set up by Helsingin Energia to provide advice in saving energy. The idea was to make people think about their own energy consumption habits and discover that small deeds can make a difference. The campaign also involved celebrities.

The campaign ran in autumn 2008, but the website will be a permanent part of the energy advisory services of the three campaign organisers.

During the Green Fingerprint roadshow, a group of campaign cyclists travelled through Finland from Kilpisjärvi in the north to Helsinki in the south. The total length of the journey was about 1,500 kilometres. Every energy-saving pledge made by people along the route moved the cyclists forward by 100 metres i.e. they needed 15,000 pledges to make the journey. In three weeks, a total of 15,772 energy-saving pledges were given.

Box 9.4 Continued

Box 9.4 *Continued*

The cyclists attracted positive attention throughout their journey and gathered people to events in selected towns. They also received good media exposure and acted in an exemplary way as spokesmen for energy saving and eco-efficiency.

The three-week campaign culminated in a concert as a way of expressing gratitude. It was possible to obtain a ticket for the concert only by making an energy-saving pledge. Almost 6,000 tickets were handed out.

During the three-week campaign there were more than 165,000 visits to the website by more than 28,000 people and the average time spent browsing the website was 4.5 minutes. More than 30 per cent of the visitors re-entered the site at a later date.

The nature of the campaign was interactive and participative. The strength of the campaign lay in its activities. Consumers were not lectured at, but were included in activities to curb climate change. Both actual and virtual contacts were utilised in the campaign in a new way. The campaign received only positive attention.

Literature

Ekholm P., Jutila K. & Kiljunen P. (2007) How much are People Willing To Do: Finns and Climate Change. Thinktank e2, Helsinki, Finland http://www.e2.fi/files/Julkaisut%20ja%20aineistot/Ilmastoraportti_eng.pdf

Kuittinen O., Neuvonen A., Mokka R., Riala M. & Sivonen R. (2008) Ilmastoasenteiden muutos ja muuttajat (Change in climate attitudes and the reasons for it). Valtioneuvoston kanslian julkaisu-sarja 9/2008, Valtioneuvoston kanslia, Helsinki, Finland (In Finnish)

Lamminmäki R. (2006) Muuttuva ilmasto ja media: ilmastonmuutosilmiön ja -riskin rakentuminen sanomalehtikeskustelussa 2004–2005 (Changing climate and the media: emergence of the phenomenon of climate change and its risks in Finnish newspapers in 2004–2005). Master's thesis, University of Helsinki, Faculty of Social Sciences, Helsinki, Finland (In Finnish)

Finnish National Commission on Sustainable Development, Sub-committee for Education (2006) Strategy for Education and Training for Sustainable Development and Implementation Plan 2006–2014, Helsinki, Finland http://www.edu.fi/teemat/keke/sustain_strategy.pdf

Internet links

Environmental Certification of Educational Establishments, http://www.koulujaymparisto.fi/index-en.htm

Motiva, a state-owned company promoting suistainable use of energy and materials, http://www.motiva.fi/en

National IPCC working group, http://www.fmi.fi/IPCC (In Finnish)

Internet links for campaigns and short descriptions

Active Learning

A number of schools are involved in the sustainable energy education projects funded by the EU Intelligent Energy Programme. In 2006–2008, 11 Finnish schools participated in the Active Learning project (Integration of Active Learning and Energy Monitoring with School Curricula), which involved 162 European schools. The project developed a special on-line toolbox for teachers in 14 European languages providing suggestions for lessons with a wide range of energy awareness activities closely linked to the curriculum. One of the core

activities was based on energy monitoring at school, with many opportunities for pupils to participate in real mathematics and science activities. There were also numerous supplementary activities with particularly strong links to geography, design/technology and citizenship. The on-line toolbox is available on the Internet. It is already being used by several schools and projects.
http://www.teachers4energy.eu

Kids4Future

Kids4Future (Creating Actions among Energy Conscious Children) is a IEE project with 240 pilot schools in 10 European countries studying energy through the story "Rainmakers". 21 Finnish schools are participating in the project, which includes TV programmes, events and websites. The Rainmaker story inspires lively discussion in the classroom, ensuring that pupils understand the message. The Finnish Rainmakers also participate in the 'Energy orientation challenge' during the National Energy Awareness Week in October. Some schools have included the Rainmaker book in their mandatory education material.
http://www.kids4future.eu,
http://www.rainmakers-eu.eu
http://www.sateenkaarentekijat.fi

CO2nnect

Climate issues have also been dealt with in the Environment and School Initiative (ENSI) and in its SUPPORT project. The goal of the ENSI is to support educational developments that promote environmental understanding through research and the exchange of experiences internationally. Teaching climate change has been one of the major topics in the 'Knowledge Forum' of ENSI on the Internet. In 2009 the project organised a global school campaign on transport and climate change (CO2nnect). Many Finnish schools have participated in the project and its campaign.
http://www.co2nnect.org
http://ensihanke.wordpress.com (in Finnish)

Kelaa! Sustainable consumption and material efficiency

A service centre for sustainable development and energy in southwest Finland and a centre for sustainable development in the Lahti region in southern Finland are together running the KELAA! project, which focuses on sustainable consumption and material efficiency. The project partners provide companies, municipalities and citizens with concrete options to reduce their ecological footprint.

The overall target of the project is to promote sustainable operations, technologies and procurement in the participating municipalities and companies. Local companies and organisations participate in the project by providing their expertise and competence.
http://www.kelaahanke.fi (in Finnish)

Energy Awareness Week

http://www.motiva.fi/energyawarenessweek

ILMANKOS project

http://www.ilmankos.fi/index.php?mid=1&pid=44

Green Fingerprint campaign and energy saving website

http://www.energianeuvoja.fi/?id=248 (in Finnish)
http://www.energianeuvoja.fi (in Finnish)

List of abbreviations

AAU	Assigned Amount Unit
ACCLIM	Climate scenario and information service project (FMI)
ACIA	Arctic Climate Impact Assessment
AERONET	Aerosol Robotic Network
ALFRA	Association of Finnish Local and Regional Authorities
AMAP	Arctic Monitoring and Assessment Programme
AR4	Fourth Assessment Report (IPCC)
BAT	Best Available Techniques
CAP	Common Agricultural Policy (EU)
CARBOEUROPE	Assessment of the European Terrestrial Carbon Balance
CarboInvent	Multi-Source Inventory Methods for Quantifying Carbon Stocks and Stock Changes in European Forests
CCP	Cities for Climate Protection
CCPM	Common and Coordinated Policies and Measures (EU)
CC-TAME	Climate Change - Terrestrial Adaptation & Mitigation in Europe
CDM	Clean Development Mechanism
CGIAR	Consultative Group on International Agricultural Research
CHP	Combined Heat and Power Production
CIRCLE 2 ERA-NET	Climate Impact Research & Response Coordination for a Larger Europe
CITL	Community Independent Transaction Log (EU)
ClimBus	Creating Business, Mitigating Climate Change
ClimTech	Technology and Climate Change Programme (Tekes)
CO	Carbon monoxide
COP	Conference of Parties
COSMOS	European Community Earth System Models
CO_2	Carbon dioxide
CO_2 eq.	Carbon dioxide equivalent
CH_4	Methane
CRF	Common Reporting Format
ECA&D	European Climate Assessment & Dataset
ECCP	European Climate Change Programme
ECHAM	A global climate system model (Max Planck Institute for Meteorology)
ECSN	European Climate Support Network
EFDB	Emission Factor Data Base (IPCC)
EFI	European Forest Institute
EIA	Environmental Impact Assessment
EMAS	Eco-management and Audit Scheme
EMEP	European Monitoring and Evaluation Programme
EMU	European Monetary Union
ENVISAT	An Earth observation satellite (ESA)
EMU	European Monetary Union
ESA	European Space Agency
ESCO	Energy Service Company
ETSAP	Energy Technology Systems Analysis Programme

ETS	Emissions Trading Scheme
EUCAARI	European Integrated Project on Aerosol Cloud Climate Air Quality Interactions
EU ETS	European Union Emissions Trading Scheme
EUFORGEN	European Forest Genetic Resources Programme
EUMETCAL	Training programme of EUMETNET
EUMETNET	Network of European Meteorological Services
EUMETSAT	European Meteorological Satellite Organisation
EURO-LIMPACS	Evaluating the Impacts of Global Change on European Freshwater Ecosystems
EUROWATERNET	The European Environment Agency´s Monitoring and Information Network for Inland Water Resources
FICCA	Finnish Climate Change Programme
FIGARE	Finnish Global Change Research Programme
FIMR	Finnish Institute of Marine Research
FINADAPT	Assessing the Adaptive Capacity of the Finnish Environment and Society Under a Changing Climate
Finavia	Finnish civil aviation authority
FIN-CAVIAR	A project studying community adaptation and vulnerability in Arctic regions
FINSKEN	Developing Consistent Climate Scenarios for Finland
FMI	Finnish Meteorological Institute
GAW	Global Atmospheric Watch
GCOS	Global Climate Observing System
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEOmon	Global Earth Observation and Monitoring of the Atmosphere
Gg	Gigagram
GHG	Greenhouse gas
GICSAC	A project studying the capability of international governance systems in the Arctic
GSN	GCOS Surface Network
GUAN	GCOS Upper-Air Network
HELCOM	Helsinki Commission
HFCs	Hydrofluorocarbons
HPC	High performance computing
H_2	Hydrogen
IASC	International Arctic Science Committee
ICAO	International Civil Aviation Organisation
ICLEI	International Council for Local Environmental Initiatives
IEA	International Energy Agency
IGBP	International Geosphere-Biosphere Programme
IHDP	International Human Dimensions Programme on Global Environmental Change
ILMASOPU	Adaptation of Agri-Sector to Climate Change (Finnish consortium)
IMO	International Maritime Organisation
IMPLIFIN	Implications of international climate change impacts for Finland
IPCC	Intergovernmental Panel on Climate Change

IPY	International Polar Year
ISTO	Climate Change Adaptation Research Programme (in Finland)
ITL	Independent Transaction Log (UNFCCC)
IUCN	World Conservation Union
IUFRO	International Union of Forest Research Organisations
JI	Joint Implementation
KINNVIKA	A multinational initiative aimed at better understanding of the Arctic system
LDC	Least Developed Countries
LULUCF	Land Use, Land-Use Change and Forestry
MAVERIC	Map-based Assessment of Vulnerability to Climate Change Employing Regional Indicators
METLA	Finnish Forest Research Institute
METSO	Forest Biodiversity Programme for Southern Finland
MODIS	Moderate Resolution Imaging Spectroradiometer
Motiva	An expert company promoting sustainable and efficient use of energy and materials in Finland
Mt	Million tonnes
MTT	Agrifood Research Finland
NASA	National Aeronautics and Space Administration
NCS	National Climate Strategy
NFI	National Forest Inventory
NFP 2015	Finnish National Forest Programme 2015
NGO	Non-governmental organisation
NkDS	NordklimDataSet
NMVOC	Non-methane volatile organic compounds
NOAA/AUHRR	Advanced Very High Resolution Radiometer
NSIDC	National Snow and Ice Data Center (University of Colorado)
N_2O	Nitrous oxide
ODA	Official Development Assistance
O3SAF	Ozone research programme (EUMETSAT)
OECD	Organisation for Economic Co-operation and Development
OSKE	Centre of Expertise Programme of the Finnish Government
OTC	Over the counter
PAH	Polycyclic aromatic hydrocarbon
PAM	Policies and Measures
PCF	Prototype Carbon Fund
PDD	Project Design Document
PFCs	Perfluorocarbons
PISA	Programme for International Student Assessment (OECD)
PJ	Petajoule
PM	Particulate (e.g. 2.5 or 10)
QA	Quality Assurance
QC	Quality Control
RADARSAT1	An Earth observation satellite (Canadian Space Agency)
RC	Regional Council

REC	Regional Environment Centre
REDD	Reducing Emissions from Deforestation and Forest Degradation
REMO	Regional Climate Model
R&D	Research and Development
SAON	Sustaining Arctic Observing Networks
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SF_6	Sulphur hexafluoride
SILMU	Finnish Research Programme on Climate Change
SME	Small and medium-sized enterprises
SMEAR	Station for Measuring Forest Ecosystem-Atmosphere Relations
SOOP	Ship-of-opportunity monitoring system
SRES	Special Report on Emissions Scenarios (IPCC)
SYKE	Finnish Environment Institute
SWIPA	Snow, Water, Ice and Permafrost in the Arctic
Tekes	Finnish Funding Agency for Technology and Innovation
TFESSD	Trust Fund for Environmentally and Socially Sustainable Development
Tg	Teragram
TGF	Testing Ground Facility (Baltic Sea Region Energy Co-operation)
TJ	Terajoule
TPES	Total Primary Energy Supply
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
VACCIA	Vulnerability of Ecosystem Services for Climate Change Impacts and Adaptation
VPN	Virtual Private Network
VTT	Technical Research Centre of Finland
WAM	With Additional Measures
WM	With Measures
WCRP	World Climate Research Programme
WMO	World Meteorological Organisation
WSSD	World Summit on Sustainable Development
WWF	World Wildlife Fund
YASSO	A model for estimating carbon stock changes in soils

Annex 1

Summary information on greenhouse gas emissions and their trends

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 1 of 3)

Inventory 2007
Submission 2009 v1.6
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs[1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
	(Gg)			CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals	**40 614,34**	**217,76**	**22,44**	**1 395,84**	**903,92**	**11,93**	**8,40**	**0,01**	**0,00**	**183,13**	**487,45**	**128,24**	**82,03**
1. Energy	**61 792,90**	**15,58**	**4,81**							**182,03**	**486,41**	**89,55**	**66,76**
A. Fuel Combustion — Reference Approach[2]	61 929,30												
Sectoral Approach[2]	61 657,87	13,14	4,81							182,03	486,41	76,90	66,76
1. Energy Industries	30 439,30	1,08	1,05							50,48	18,17	0,97	42,41
2. Manufacturing Industries and Construction	11 231,70	0,66	0,50							41,98	41,59	1,97	16,42
3. Transport	14 044,39	2,12	2,12							68,81	305,73	44,52	1,44
4. Other Sectors	4 918,21	9,21	0,23							18,86	110,79	29,19	5,60
5. Other	1 024,26	0,07	0,90							1,90	10,12	0,25	0,88
B. Fugitive Emissions from Fuels	135,03	2,44	0,00							NO	NO	12,65	NO
1. Solid Fuels	NO	NO	NO							NO	NO	NO	NO
2. Oil and Natural Gas	135,03	2,44	0,00							NO	NO	12,65	NO
2. Industrial Processes	**4 249,89**	**0,43**	**4,78**	**1 395,84**	**903,92**	**11,93**	**8,40**	**0,01**	**0,00**	**1,07**	**IE,NA,NO**	**10,61**	**15,27**
A. Mineral Products	1 266,32	NO	NO							0,11	NO	0,91	0,43
B. Chemical Industry	523,83	NO	4,78	NO	NO	NO	NO	NO	NO	0,68	NO	2,35	8,37
C. Metal Production	2 459,74	0,43	NO				NO		C,NO	0,20	IE,NO	1,05	4,13
D. Other Production[3]	NO									0,08	NO	6,29	2,34
E. Production of Halocarbons and SF_6					NA,NO		NA,NO		NO				
F. Consumption of Halocarbons and SF_6				1 395,84	903,92	11,93	8,40	0,01	0,00				
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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

Note: All footnotes for this table are given at the end of the table on sheet 3.

Back to Contents

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 2 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs [1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
	(Gg)			CO_2 equivalent (Gg)						(Gg)			
3. Solvent and Other Product Use	**60,65**		**0,12**							**NO**	**NO**	**27,57**	**NO**
4. Agriculture		**87,82**	**11,89**							**0,02**	**0,63**	**NA,NE,NO**	**NO**
A. Enteric Fermentation		74,28											
B. Manure Management		13,51	1,60									NA,NE,NO	
C. Rice Cultivation		NO										NO	
D. Agricultural Soils[4]		NE	10,28									NE,NO	
E. Prescribed Burning of Savannas		NO	NO							NO	NO	NO	
F. Field Burning of Agricultural Residues		0,03	0,00							0,02	0,63	NE,NO	
G. Other		NO	NO							NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	[5] **-25 489,10**	**6,18**	**0,30**							**0,01**	**0,41**	**NE**	**NE**
A. Forest Land	[5] -32 829,63	0,05	0,05							0,01	0,41	NE	
B. Cropland	[5] 3 329,25	NA,NE	NA,NE							NE	NE	NE	
C. Grassland	[5] 4 057,14	NE,NO	NE,NO							NE	NE	NE	
D. Wetlands	[5] 1 173,82	6,13	0,25							IE	IE	NE	
E. Settlements	[5] IE,NA,NE	NA,NE	NA,NE							NA	NA	NE	
F. Other Land	[5] IE,NA,NE	IE,NA	IE,NA							NA	NA	NE	
G. Other	[5] -1 219,67	NE	NE							NE	NE	NE	NE
6. Waste	**IE,NO**	**107,74**	**0,55**							**IE,NO**	**IE,NO**	**0,52**	**IE,NO**
A. Solid Waste Disposal on Land	[6] NO	98,13								NO	NO	0,13	
B. Waste-water Handling		6,31	0,33							NO	NO	0,33	
C. Waste Incineration	[6] IE	IE	IE							IE	IE	IE	IE
D. Other	NO	3,30	0,22							NO	NO	0,05	NO
7. Other ***(please specify)*** [7]	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Note: All footnotes for this table are given at the end of the table on sheet 3.

Back to Contents

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 3 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
	(Gg)			CO_2 equivalent (Gg)						(Gg)			
Memo Items: [8]													
International Bunkers	**3 152,58**	**0,15**	**0,11**							**36,83**	**5,03**	**1,11**	**15,42**
Aviation	1 662,37	0,04	0,07							4,70	3,07	0,32	0,42
Marine	1 490,21	0,11	0,04							32,13	1,96	0,79	15,00
Multilateral Operations	**NO**	**NO**	**NO**							**NO**	**NO**	**NO**	**NO**
CO_2 Emissions from Biomass	**32 257,48**												

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

[2] For verification purposes, countries are asked to report the results of their calculations using the Reference approach and to explain any differences with the Sectoral approach in the documentation box to Table 1.A.(c). For estimating national total emissions, the results from the Sectoral approach should be used, where possible.

[3] Other Production includes Pulp and Paper and Food and Drink Production.

[4] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

[5] For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

[6] CO_2 from source categories Solid Waste Disposal on Land and Waste Incineration should only be included if it stems from non-biogenic or inorganic waste streams. Only emissions from Waste Incineration Without Energy Recovery are to be reported in the Waste sector, whereas emissions from Incineration With Energy Recovery are to be reported in the Energy sector.

[7] If reporting any country-specific source category under sector "7. Other", detailed explanations should be provided in Chapter 9: Other (CRF sector 7) of the NIR.

[8] Countries are asked to report emissions from international aviation and marine bunkers and multilateral operations, as well as CO_2 emissions from biomass, under Memo Items. These emissions should not be included in the national total emissions from the energy sector. Amounts of biomass used as fuel are included in the national energy consumption but the corresponding CO_2 emissions are not included in the national total as it is assumed that the biomass is produced in a sustainable manner. If the biomass is harvested at an unsustainable rate, net CO_2 emissions are accounted for as a loss of biomass stocks in the Land Use, Land-use Change and Forestry sector.

Back to Contents

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

Inventory 2007
Submission 2009 v1.6
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs [2]	PFCs [2]	SF_6 [2]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**40 614,34**	**4 572,91**	**6 957,55**	**903,92**	**8,40**	**22,59**	**53 079,71**
1. Energy	**61 792,90**	**327,20**	**1 490,90**				**63 610,99**
A. Fuel Combustion (Sectoral Approach)	61 657,87	275,97	1 490,03				63 423,86
1. Energy Industries	30 439,30	22,64	326,85				30 788,80
2. Manufacturing Industries and Construction	11 231,70	13,78	155,62				11 401,09
3. Transport	14 044,39	44,60	657,19				14 746,18
4. Other Sectors	4 918,21	193,38	71,10				5 182,70
5. Other	1 024,26	1,56	279,27				1 305,10
B. Fugitive Emissions from Fuels	135,03	51,23	0,87				187,13
1. Solid Fuels	NO	NO	NO				NO
2. Oil and Natural Gas	135,03	51,23	0,87				187,13
2. Industrial Processes	**4 249,89**	**9,08**	**1 482,05**	**903,92**	**8,40**	**22,59**	**6 675,93**
A. Mineral Products	1 266,32	NO	NO				1 266,32
B. Chemical Industry	523,83	NO	1 482,05	NO	NO	NO	2 005,88
C. Metal Production	2 459,74	9,08	NO	NO	NO	C,NO	2 468,82
D. Other Production	NO						NO
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NO	NA,NO
F. Consumption of Halocarbons and SF_6 [2]				903,92	8,40	22,59	934,91
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**60,65**		**36,42**				**97,07**
4. Agriculture		**1 844,29**	**3 685,46**				**5 529,75**
A. Enteric Fermentation		1 559,95					1 559,95
B. Manure Management		283,71	497,01				780,72
C. Rice Cultivation		NO					NO
D. Agricultural Soils [3]		NE	3 188,26				3 188,26
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		0,63	0,19				0,82
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry [1]	**-25 489,10**	**129,79**	**93,67**				**-25 265,63**
A. Forest Land	-32 829,63	0,98	16,79				-32 811,86
B. Cropland	3 329,25	NA,NE	NA,NE				3 329,25
C. Grassland	4 057,14	NE,NO	NE,NO				4 057,14
D. Wetlands	1 173,82	128,81	76,88				1 379,51
E. Settlements	IE,NA,NE	NA,NE	NA,NE				IE,NA,NE
F. Other Land	IE,NA,NE	IE,NA	IE,NA				IE,NA,NE
G. Other	-1 219,67	NE	NE				-1 219,67
6. Waste	**IE,NO**	**2 262,54**	**169,06**				**2 431,60**
A. Solid Waste Disposal on Land	NO	2 060,68					2 060,68
B. Waste-water Handling		132,54	101,05				233,59
C. Waste Incineration	IE	IE	IE				IE
D. Other	NO	69,32	68,01				137,33
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: [4]							
International Bunkers	3 152,58	3,06	33,03				3 188,67
Aviation	1 662,37	0,74	21,05				1 684,16
Marine	1 490,21	2,32	11,98				1 504,51
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**32 257,48**						**32 257,48**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	78 345,34
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	53 079,71

[1] For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

[2] Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

[3] Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

[4] See footnote 8 to table Summary 1.A.

TABLE 10 EMISSION TRENDS
CO_2
(Part 1 of 2)

Inventory 2007
Submission 2009 v1.6
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**53 254,91**	**51 831,44**	**51 124,04**	**53 025,90**	**58 237,43**	**54 792,38**	**60 453,38**	**58 764,64**	**55 613,03**	**55 022,37**
A. Fuel Combustion (Sectoral Approach)	53 035,20	51 622,43	50 904,96	52 758,74	58 071,78	54 621,25	60 298,99	58 565,34	55 469,51	54 893,68
1. Energy Industries	19 057,37	18 820,00	18 582,69	21 293,46	26 199,26	23 922,18	29 591,22	27 202,32	23 945,96	23 434,75
2. Manufacturing Industries and Construction	13 232,94	12 731,24	12 221,18	12 308,98	12 608,18	12 038,35	11 926,90	12 072,95	11 741,11	11 718,85
3. Transport	12 517,11	12 162,68	12 083,63	11 617,19	11 969,74	11 766,18	11 741,91	12 332,65	12 482,66	12 681,55
4. Other Sectors	7 040,32	6 886,73	6 988,18	6 510,34	6 157,78	5 698,05	5 814,26	5 826,18	5 918,65	5 830,48
5. Other	1 187,46	1 021,77	1 029,29	1 028,78	1 136,81	1 196,49	1 224,71	1 131,25	1 381,12	1 228,05
B. Fugitive Emissions from Fuels	219,71	209,01	219,08	267,15	165,66	171,13	154,39	199,29	143,52	128,69
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	219,71	209,01	219,08	267,15	165,66	171,13	154,39	199,29	143,52	128,69
2. Industrial Processes	**3 241,33**	**3 092,68**	**2 963,63**	**2 936,42**	**3 075,49**	**2 996,94**	**3 322,27**	**3 539,62**	**3 464,95**	**3 560,30**
A. Mineral Products	1 254,33	1 079,53	974,04	883,78	938,77	910,66	939,63	954,33	957,96	1 036,48
B. Chemical Industry	125,35	139,12	102,91	93,74	129,11	110,79	126,68	125,51	115,38	113,16
C. Metal Production	1 861,65	1 874,03	1 886,67	1 958,90	2 007,62	1 975,49	2 255,96	2 459,78	2 391,60	2 410,66
D. Other Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	116,37	108,51	95,56	88,42	84,56	80,77	75,96	73,72	74,28	73,04
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use, Land-Use Change and Forestry[2]	**-17 959,83**	**-31 682,11**	**-26 399,17**	**-24 321,36**	**-17 457,78**	**-16 742,71**	**-25 904,05**	**-19 898,60**	**-16 799,58**	**-18 738,07**
A. Forest Land	-23 220,23	-37 703,88	-31 512,79	-30 046,18	-22 833,05	-23 125,07	-32 169,40	-25 009,72	-22 380,17	-24 606,54
B. Cropland	7 414,86	5 613,18	5 436,60	5 426,59	5 237,52	6 899,09	7 127,08	6 704,95	6 127,63	5 797,59
C. Grassland	-2 131,21	-834,97	-1 074,32	-601,26	-130,38	-683,97	-880,53	-570,18	90,58	963,57
D. Wetlands	922,39	936,28	976,00	992,67	1 024,47	1 037,04	1 066,52	1 097,91	1 128,88	1 145,74
E. Settlements	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE
F. Other Land	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE
G. Other	-945,64	307,28	-224,67	-93,19	-756,35	-869,80	-1 047,72	-2 121,56	-1 766,49	-2 038,44
6. Waste	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**
A. Solid Waste Disposal on Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Waste-water Handling										
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CO_2 emissions including net CO_2 from LULUCF	**38 652,78**	**23 350,53**	**27 784,05**	**31 729,38**	**43 939,71**	**41 127,37**	**37 947,57**	**42 479,38**	**42 352,68**	**39 917,64**
Total CO_2 emissions excluding net CO_2 from LULUCF	**56 612,61**	**55 032,63**	**54 183,22**	**56 050,74**	**61 397,49**	**57 870,08**	**63 851,62**	**62 377,98**	**59 152,26**	**58 655,72**
Memo Items:										
International Bunkers	**2 856,38**	**2 710,66**	**3 059,30**	**2 526,43**	**2 181,91**	**1 968,77**	**2 173,56**	**2 315,88**	**2 711,08**	**2 902,32**
Aviation	1 011,84	952,11	841,73	791,00	832,72	900,65	964,19	1 001,74	1 026,34	1 098,51
Marine	1 844,54	1 758,55	2 217,58	1 735,43	1 349,18	1 068,12	1 209,37	1 314,14	1 684,75	1 803,81
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass	19 294,58	18 993,74	18 709,93	22 231,16	23 078,23	23 428,77	23 435,03	26 680,54	27 618,19	29 581,10

Note: All footnotes for this table are given at the end of the table on sheet 5.

Back to Contents

TABLE 10 EMISSION TRENDS
CO_2
(Part 2 of 2)

Inventory 2007
Submission 2009 v1.6
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**53 070,60**	**58 271,01**	**60 820,24**	**68 184,67**	**64 117,40**	**52 615,89**	**63 803,84**	**61 792,90**	**16,03**
A. Fuel Combustion (Sectoral Approach)	52 942,14	58 152,20	60 695,87	68 065,42	64 004,09	52 489,89	63 689,90	61 657,87	16,26
1. Energy Industries	21 898,91	27 234,06	29 944,28	36 833,12	32 616,45	21 642,18	32 489,67	30 439,30	59,72
2. Manufacturing Industries and Construction	11 726,60	11 280,39	10 985,68	11 347,56	11 435,27	11 147,16	11 414,75	11 231,70	-15,12
3. Transport	12 590,96	12 714,01	12 905,25	13 097,58	13 446,02	13 482,37	13 673,33	14 044,39	12,20
4. Other Sectors	5 456,18	5 662,50	5 600,62	5 434,23	5 349,65	5 132,20	4 982,54	4 918,21	-30,14
5. Other	1 269,49	1 261,24	1 260,05	1 352,93	1 156,71	1 085,98	1 129,62	1 024,26	-13,74
B. Fugitive Emissions from Fuels	128,46	118,81	124,37	119,25	113,31	125,99	113,93	135,03	-38,54
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	0,00
2. Oil and Natural Gas	128,46	118,81	124,37	119,25	113,31	125,99	113,93	135,03	-38,54
2. Industrial Processes	**3 545,55**	**3 607,43**	**3 508,92**	**3 754,83**	**3 941,99**	**3 671,36**	**3 840,44**	**4 249,89**	**31,12**
A. Mineral Products	1 089,20	1 101,84	1 104,05	1 155,93	1 237,21	1 179,75	1 263,53	1 266,32	0,96
B. Chemical Industry	124,27	120,07	133,12	150,54	164,04	119,42	139,14	523,83	317,91
C. Metal Production	2 332,08	2 385,52	2 271,75	2 448,37	2 540,74	2 372,19	2 437,77	2 459,74	32,13
D. Other Production	NO	NO	NO	NO	NO	NO	NO	NO	0,00
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0,00
3. Solvent and Other Product Use	72,01	72,40	67,68	64,16	64,80	59,89	60,81	60,65	-47,88
4. Agriculture									
A. Enteric Fermentation									
B. Manure Management									
C. Rice Cultivation									
D. Agricultural Soils									
E. Prescribed Burning of Savannas									
F. Field Burning of Agricultural Residues									
G. Other									
5. Land Use, Land-Use Change and Forestry[(2)]	**-18 629,42**	**-21 716,17**	**-22 711,11**	**-22 718,82**	**-23 527,95**	**-28 528,97**	**-32 437,62**	**-25 489,10**	**41,92**
A. Forest Land	-25 725,55	-30 077,50	-30 193,14	-29 815,67	-30 780,35	-36 374,46	-40 712,38	-32 829,63	41,38
B. Cropland	5 280,91	5 088,18	4 621,03	4 168,64	3 857,31	3 546,34	3 235,57	3 329,25	-55,10
C. Grassland	1 915,36	2 417,40	2 145,33	2 663,04	3 013,83	3 440,38	4 239,01	4 057,14	-290,37
D. Wetlands	1 166,37	1 170,56	1 152,47	1 154,29	1 212,93	1 198,80	1 194,23	1 173,82	27,26
E. Settlements	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	0,00
F. Other Land	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	0,00
G. Other	-1 266,51	-314,82	-436,80	-889,13	-831,68	-340,03	-394,06	-1 219,67	28,98
6. Waste	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**0,00**
A. Solid Waste Disposal on Land	NO	NO	NO	NO	NO	NO	NO	NO	0,00
B. Waste-water Handling									
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	0,00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	0,00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0,00**
Total CO_2 emissions including net CO_2 from LULUCF	**38 058,74**	**40 234,67**	**41 685,73**	**49 284,84**	**44 596,24**	**27 818,17**	**35 267,46**	**40 614,34**	**5,07**
Total CO_2 emissions excluding net CO_2 from LULUCF	**56 688,16**	**61 950,85**	**64 396,84**	**72 003,66**	**68 124,19**	**56 347,14**	**67 705,09**	**66 103,44**	**16,76**
Memo Items:									
International Bunkers	**3 147,58**	**2 955,97**	**3 180,06**	**3 203,71**	**2 966,48**	**2 946,37**	**3 256,59**	**3 152,58**	**10,37**
Aviation	1 067,62	1 094,41	1 081,97	1 118,13	1 287,44	1 295,42	1 440,43	1 662,37	64,29
Marine	2 079,95	1 861,56	2 098,09	2 085,58	1 679,04	1 650,95	1 816,16	1 490,21	-19,21
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	0,00
CO_2 Emissions from Biomass	29 376,36	28 142,61	30 324,97	30 962,05	32 274,47	30 090,02	33 853,20	32 257,48	67,18

Note: All footnotes for this table are given at the end of the table on sheet 5.

Back to Contents

TABLE 10 EMISSION TRENDS
CH_4
(Part 1 of 2)

Inventory 2007
Submission 2009 v1.6
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	15,14	16,31	16,92	17,60	18,04	17,96	18,40	17,82	17,87	16,89
A. Fuel Combustion (Sectoral Approach)	14,61	14,33	14,25	14,15	14,22	14,16	14,47	14,41	14,40	14,07
1. Energy Industries	0,39	0,41	0,42	0,48	0,58	0,62	0,73	0,76	0,78	0,78
2. Manufacturing Industries and Construction	0,61	0,59	0,57	0,65	0,67	0,69	0,66	0,71	0,69	0,70
3. Transport	4,75	4,50	4,37	4,19	4,03	3,90	3,74	3,60	3,47	3,36
4. Other Sectors	8,73	8,71	8,78	8,73	8,83	8,83	9,22	9,23	9,33	9,12
5. Other	0,14	0,11	0,10	0,10	0,11	0,11	0,11	0,10	0,13	0,12
B. Fugitive Emissions from Fuels	0,53	1,98	2,67	3,45	3,82	3,80	3,93	3,41	3,47	2,81
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	0,53	1,98	2,67	3,45	3,82	3,80	3,93	3,41	3,47	2,81
2. Industrial Processes	**0,24**	**0,24**	**0,25**	**0,44**	**0,46**	**0,46**	**0,46**	**0,44**	**0,46**	**0,45**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Metal Production	0,24	0,24	0,25	0,44	0,46	0,46	0,46	0,44	0,46	0,45
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use										
4. Agriculture	**102,88**	**98,69**	**95,78**	**95,85**	**96,34**	**92,43**	**93,00**	**94,64**	**92,70**	**91,30**
A. Enteric Fermentation	91,85	88,21	85,36	85,17	85,29	80,70	81,14	82,16	80,35	79,12
B. Manure Management	10,94	10,47	10,41	10,66	11,04	11,72	11,83	12,47	12,33	12,18
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	0,09	0,01	0,01	0,02	0,01	0,02	0,03	0,02	0,01	0,01
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	**4,84**	**4,82**	**5,09**	**5,11**	**5,33**	**5,40**	**5,55**	**5,76**	**5,85**	**5,99**
A. Forest Land	0,19	0,08	0,14	0,05	0,11	0,09	0,07	0,10	0,04	0,09
B. Cropland	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
D. Wetlands	4,65	4,74	4,95	5,06	5,22	5,31	5,49	5,67	5,82	5,90
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
F. Other Land	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**181,89**	**183,91**	**184,73**	**184,74**	**182,24**	**179,58**	**175,47**	**171,08**	**163,77**	**160,25**
A. Solid Waste Disposal on Land	173,55	175,87	176,57	176,34	173,87	170,88	166,74	162,43	155,16	151,71
B. Waste-water Handling	7,31	6,89	6,87	7,02	6,88	7,00	6,82	6,73	6,57	6,37
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other	1,03	1,15	1,29	1,39	1,49	1,70	1,91	1,92	2,04	2,16
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CH_4 emissions including CH_4 from LULUCF	**305,00**	**303,97**	**302,77**	**303,74**	**302,41**	**295,83**	**292,87**	**289,74**	**280,65**	**274,87**
Total CH_4 emissions excluding CH_4 from LULUCF	**300,16**	**299,15**	**297,68**	**298,63**	**297,08**	**290,43**	**287,32**	**283,98**	**274,79**	**268,89**
Memo Items:										
International Bunkers	0,16	0,15	0,18	0,15	0,12	0,10	0,12	0,13	0,16	0,18
Aviation	0,03	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,04
Marine	0,14	0,13	0,16	0,13	0,10	0,07	0,09	0,09	0,12	0,14
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

Note: All footnotes for this table are given at the end of the table on sheet

Back to Contents

TABLE 10 EMISSION TRENDS
CH_4
(Part 2 of 2)

Inventory 2007
Submission 2009 v1.6
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	16,20	17,20	16,95	17,20	16,46	16,37	16,21	15,58	2,88
A. Fuel Combustion (Sectoral Approach)	13,58	13,98	14,23	14,26	13,84	13,32	13,57	13,14	-10,07
1. Energy Industries	0,73	0,92	1,15	1,34	1,18	0,96	1,20	1,08	173,51
2. Manufacturing Industries and Construction	0,72	0,68	0,66	0,67	0,69	0,66	0,72	0,66	7,57
3. Transport	3,15	3,02	2,92	2,79	2,59	2,41	2,24	2,12	-55,25
4. Other Sectors	8,86	9,25	9,38	9,35	9,27	9,19	9,32	9,21	5,52
5. Other	0,12	0,11	0,11	0,11	0,10	0,09	0,09	0,07	-45,02
B. Fugitive Emissions from Fuels	2,62	3,23	2,72	2,93	2,62	3,05	2,64	2,44	358,63
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	0,00
2. Oil and Natural Gas	2,62	3,23	2,72	2,93	2,62	3,05	2,64	2,44	358,63
2. Industrial Processes	**0,46**	**0,45**	**0,46**	**0,45**	**0,45**	**0,45**	**0,43**	**0,43**	**77,62**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	0,00
B. Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	0,00
C. Metal Production	0,46	0,45	0,46	0,45	0,45	0,45	0,43	0,43	77,62
D. Other Production									
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0,00
3. Solvent and Other Product Use									
4. Agriculture	**91,34**	**89,87**	**90,89**	**89,86**	**88,86**	**88,55**	**88,94**	**87,82**	**-14,64**
A. Enteric Fermentation	78,96	77,86	78,24	76,91	75,92	75,36	75,45	74,28	-19,13
B. Manure Management	12,34	11,98	12,62	12,93	12,92	13,18	13,47	13,51	23,45
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	0,00
D. Agricultural Soils	NE	NE	NE	NE	NE	NE	NE	NE	0,00
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	0,00
F. Field Burning of Agricultural Residues	0,04	0,02	0,02	0,02	0,02	0,01	0,02	0,03	-66,37
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	0,00
5. Land Use, Land-Use Change and Forestry	**6,03**	**6,12**	**6,03**	**5,99**	**6,38**	**6,34**	**6,35**	**6,18**	**27,63**
A. Forest Land	0,04	0,12	0,13	0,09	0,02	0,07	0,11	0,05	-75,52
B. Cropland	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0,00
D. Wetlands	5,99	6,00	5,91	5,90	6,35	6,27	6,24	6,13	31,86
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
F. Other Land	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	0,00
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	0,00
6. Waste	**150,62**	**144,38**	**134,26**	**125,76**	**119,23**	**109,24**	**112,14**	**107,74**	**-40,76**
A. Solid Waste Disposal on Land	142,07	135,81	125,38	116,84	110,16	100,01	102,83	98,13	-43,46
B. Waste-water Handling	6,27	6,19	6,39	6,33	6,38	6,21	6,31	6,31	-13,67
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	0,00
D. Other	2,28	2,38	2,49	2,59	2,69	3,02	2,99	3,30	221,64
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0,00**
Total CH_4 emissions including CH_4 from LULUCF	**264,64**	**258,03**	**248,58**	**239,26**	**231,38**	**220,95**	**224,08**	**217,76**	**-28,60**
Total CH_4 emissions excluding CH_4 from LULUCF	**258,61**	**251,91**	**242,55**	**233,27**	**225,00**	**214,61**	**217,72**	**211,58**	**-29,51**
Memo Items:									
International Bunkers	0,20	0,18	0,18	0,18	0,16	0,16	0,17	0,15	-10,72
Aviation	0,04	0,04	0,03	0,03	0,04	0,03	0,03	0,04	33,33
Marine	0,16	0,14	0,16	0,16	0,12	0,12	0,13	0,11	-19,23
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	0,00
CO_2 Emissions from Biomass									

Note: All footnotes for this table are given at the end of the table on sheet 5.

Back to Contents

TABLE 10 EMISSION TRENDS
N_2O
(Part 1 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**3,24**	**3,21**	**3,21**	**3,39**	**3,54**	**3,49**	**3,72**	**3,83**	**3,86**	**3,96**
A. Fuel Combustion (Sectoral Approach)	3,24	3,21	3,21	3,39	3,53	3,49	3,72	3,83	3,86	3,96
1. Energy Industries	0,39	0,43	0,46	0,52	0,60	0,61	0,72	0,71	0,71	0,71
2. Manufacturing Industries and Construction	0,56	0,52	0,48	0,53	0,55	0,54	0,55	0,60	0,59	0,61
3. Transport	0,56	0,63	0,70	0,75	0,82	0,89	0,97	1,09	1,19	1,30
4. Other Sectors	0,28	0,27	0,28	0,27	0,26	0,24	0,25	0,25	0,26	0,25
5. Other	1,45	1,36	1,30	1,31	1,31	1,21	1,22	1,18	1,11	1,09
B. Fugitive Emissions from Fuels	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00
2. Industrial Processes	**5,34**	**4,64**	**4,20**	**4,39**	**4,63**	**4,72**	**4,72**	**4,66**	**4,44**	**4,34**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical Industry	5,34	4,64	4,20	4,39	4,63	4,72	4,72	4,66	4,44	4,34
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20	0,20
4. Agriculture	**16,02**	**14,88**	**13,53**	**13,59**	**13,54**	**14,14**	**13,77**	**13,61**	**13,28**	**12,93**
A. Enteric Fermentation										
B. Manure Management	2,14	1,97	1,86	1,83	1,83	1,83	1,86	1,94	1,90	1,82
C. Rice Cultivation										
D. Agricultural Soils	13,87	12,91	11,67	11,76	11,71	12,31	11,91	11,68	11,38	11,11
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	**0,27**	**0,26**	**0,23**	**0,22**	**0,25**	**0,24**	**0,25**	**0,27**	**0,28**	**0,27**
A. Forest Land	0,09	0,07	0,03	0,01	0,04	0,02	0,03	0,04	0,04	0,03
B. Cropland	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
D. Wetlands	0,19	0,19	0,20	0,20	0,21	0,21	0,22	0,23	0,24	0,24
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
F. Other Land	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**0,53**	**0,52**	**0,51**	**0,50**	**0,51**	**0,52**	**0,53**	**0,52**	**0,51**	**0,50**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	0,46	0,44	0,43	0,41	0,41	0,41	0,40	0,40	0,38	0,36
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other	0,07	0,07	0,08	0,09	0,10	0,11	0,12	0,13	0,13	0,14
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total N_2O emissions including N_2O from LULUCF	**25,60**	**23,70**	**21,89**	**22,29**	**22,67**	**23,31**	**23,19**	**23,10**	**22,57**	**22,21**
Total N_2O emissions excluding N_2O from LULUCF	**25,33**	**23,45**	**21,66**	**22,07**	**22,42**	**23,08**	**22,94**	**22,83**	**22,29**	**21,94**
Memo Items:										
International Bunkers	**0,09**	**0,09**	**0,09**	**0,08**	**0,07**	**0,07**	**0,07**	**0,08**	**0,09**	**0,09**
Aviation	0,04	0,04	0,03	0,03	0,03	0,04	0,04	0,04	0,04	0,04
Marine	0,05	0,05	0,06	0,05	0,04	0,03	0,03	0,03	0,04	0,05
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

Note: All footnotes for this table are given at the end of the table on sheet 5.

Back to Contents

TABLE 10 EMISSION TRENDS
N_2O
(Part 2 of 2)

Inventory 2007
Submission 2009 v1.6
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**3,95**	**4,19**	**4,38**	**4,66**	**4,68**	**4,42**	**4,81**	**4,81**	**48,38**
A. Fuel Combustion (Sectoral Approach)	3,95	4,19	4,38	4,65	4,67	4,42	4,81	4,81	48,47
1. Energy Industries	0,66	0,82	0,94	1,07	1,00	0,81	1,07	1,05	168,43
2. Manufacturing Industries and Construction	0,61	0,59	0,56	0,56	0,59	0,55	0,53	0,50	-9,82
3. Transport	1,39	1,48	1,60	1,71	1,85	1,95	2,04	2,12	278,63
4. Other Sectors	0,24	0,25	0,25	0,24	0,24	0,23	0,23	0,23	-18,14
5. Other	1,04	1,05	1,03	1,08	1,00	0,87	0,95	0,90	-37,78
B. Fugitive Emissions from Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-25,71
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	0,00
2. Oil and Natural Gas	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-25,71
2. Industrial Processes	**4,40**	**4,17**	**4,30**	**4,54**	**4,83**	**5,24**	**4,64**	**4,78**	**-10,49**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	0,00
B. Chemical Industry	4,40	4,17	4,30	4,54	4,83	5,24	4,64	4,78	-10,49
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	0,00
D. Other Production									
E. Production of Halocarbons and SF_6									
F. Consumption of Halocarbons and SF_6									
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	0,00
3. Solvent and Other Product Use	0,17	0,16	0,14	0,13	0,13	0,15	0,13	0,12	-41,26
4. Agriculture	**13,07**	**12,80**	**12,64**	**12,45**	**12,12**	**12,07**	**12,00**	**11,89**	**-25,77**
A. Enteric Fermentation									
B. Manure Management	1,80	1,72	1,70	1,67	1,64	1,65	1,65	1,60	-25,23
C. Rice Cultivation									
D. Agricultural Soils	11,27	11,08	10,94	10,77	10,49	10,43	10,35	10,28	-25,85
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	0,00
F. Field Burning of Agricultural Residues	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-66,37
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	0,00
5. Land Use, Land-Use Change and Forestry	**0,27**	**0,28**	**0,28**	**0,27**	**0,30**	**0,29**	**0,31**	**0,30**	**9,95**
A. Forest Land	0,03	0,04	0,04	0,04	0,04	0,04	0,06	0,05	-38,31
B. Cropland	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0,00
D. Wetlands	0,24	0,24	0,24	0,24	0,26	0,25	0,25	0,25	32,62
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	0,00
F. Other Land	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	0,00
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	0,00
6. Waste	**0,51**	**0,52**	**0,51**	**0,52**	**0,52**	**0,53**	**0,53**	**0,55**	**2,95**
A. Solid Waste Disposal on Land									
B. Waste-water Handling	0,36	0,36	0,34	0,35	0,34	0,33	0,33	0,33	-29,72
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	0,00
D. Other	0,15	0,16	0,16	0,17	0,18	0,20	0,20	0,22	232,88
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**0,00**
Total N_2O emissions including N_2O from LULUCF	**22,37**	**22,11**	**22,25**	**22,57**	**22,57**	**22,71**	**22,42**	**22,44**	**-12,34**
Total N_2O emissions excluding N_2O from LULUCF	**22,09**	**21,83**	**21,97**	**22,29**	**22,28**	**22,42**	**22,11**	**22,14**	**-12,58**
Memo Items:									
International Bunkers	**0,10**	**0,09**	**0,10**	**0,10**	**0,09**	**0,10**	**0,11**	**0,11**	**18,84**
Aviation	0,04	0,04	0,04	0,05	0,05	0,05	0,06	0,07	64,41
Marine	0,05	0,05	0,05	0,05	0,04	0,04	0,05	0,04	-20,07
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	0,00
CO_2 Emissions from Biomass									

Note: All footnotes for this table are given at the end of the table on sheet 5.

Back to Contents

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990) (Gg)	1991 (Gg)	1992 (Gg)	1993 (Gg)	1994 (Gg)	1995 (Gg)	1996 (Gg)	1997 (Gg)	1998 (Gg)	1999 (Gg)
Emissions of HFCs[3] - (Gg CO_2 equivalent)	**0,02**	**0,05**	**0,10**	**0,10**	**6,52**	**29,33**	**77,30**	**167,77**	**245,22**	**318,59**
HFC-23	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	0,00	C,NA,NO	0,00
HFC-32	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,00	0,01
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-125	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,01	0,02	0,03
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-134a	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,01	0,04	0,09	0,09	0,13
HFC-152a	0,00	0,00	0,00	0,00	0,00	0,02	0,04	0,04	0,03	0,03
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143a	NA,NO	NA,NO	NA,NO	NA,NO	0,00	0,00	0,00	0,01	0,02	0,01
HFC-227ea	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed HFCs[4] - (Gg CO_2 equivalent)	0,01	0,01	NA,NO	0,01	NA,NO	0,01	NA,NO	0,12	0,02	2,41
Emissions of PFCs[3] - (Gg CO_2 equivalent)	**0,07**	**0,08**	**0,09**	**0,10**	**0,12**	**0,14**	**0,16**	**0,18**	**0,21**	**27,97**
CF_4	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO
C_2F_6	C,NA,NO	C,NA,NO	NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO
C_3F_8	C,NA,NO	C,NA,NO	NA,NO	C,NA,NO	C,IE,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	0,00
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
c-C_4F_8	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	C,NA,NO
Unspecified mix of listed PFCs[4] - (Gg CO_2 equivalent)	0,07	0,08	0,09	0,10	0,12	0,14	0,16	0,18	0,21	2,62
Emissions of SF_6[3] - (Gg CO_2 equivalent)	**94,38**	**67,32**	**36,64**	**33,61**	**34,90**	**68,53**	**72,20**	**75,98**	**53,18**	**51,98**
SF_6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Note: All footnotes for this table are given at the end of the table on sheet 5.

Back to Contents

TABLE 10 EMISSION TRENDS
HFCs, PFCs and SF_6
(Part 2 of 2)

Inventory 2007
Submission 2009 v1.6
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
Emissions of HFCs[3] - (Gg CO_2 equivalent)	**501,73**	**656,87**	**463,44**	**652,07**	**695,07**	**863,80**	**747,66**	**903,92**	**5 106 815,76**
HFC-23	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NE,NO	C,NA,NE,NO	C,NA,NE,NO	0,00
HFC-32	0,00	0,01	NA,NO	0,01	0,02	0,02	0,01	0,01	100,00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-125	0,03	0,05	0,03	0,06	0,07	0,08	0,08	0,08	100,00
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-134a	0,24	0,20	0,13	0,16	0,16	0,21	0,14	0,24	100,00
HFC-152a	0,02	0,00	0,00	0,00	0,00	0,00	0,00	0,00	3 201,11
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-143a	0,02	0,04	0,04	0,06	0,06	0,07	0,07	0,07	100,00
HFC-227ea	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Unspecified mix of listed HFCs[4] - (Gg CO_2 equivalent)	0,13	74,90	67,47	67,25	63,48	77,16	78,87	77,11	1 511 803,92
Emissions of PFCs[3] - (Gg CO_2 equivalent)	**22,46**	**20,06**	**13,37**	**14,85**	**12,23**	**9,88**	**15,43**	**8,40**	**11 894,29**
CF_4	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	0,00
C_2F_6	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	NA,NO	0,00
C_3F_8	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	100,00
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
c-C_4F_8	NA,NO	NA,NO	NA,NO	C,NA,NO	NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	0,00
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
Unspecified mix of listed PFCs[4] - (Gg CO_2 equivalent)	0,28	0,32	0,77	1,06	0,97	0,94	1,10	0,54	664,29
Emissions of SF6[3] - (Gg CO_2 equivalent)	**51,49**	**55,03**	**51,31**	**41,71**	**23,18**	**19,56**	**40,44**	**22,59**	**-76,07**
SF_6	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-76,07

Note: All footnotes for this table are given at the end of the table on sheet 5.

Back to Contents

TABLE 10 EMISSION TRENDS
SUMMARY
(Part 1 of 2)

GREENHOUSE GAS EMISSIONS	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
CO_2 emissions including net CO_2 from LULUCF	38 652,78	23 350,53	27 784,05	31 729,38	43 939,71	41 127,37	37 947,57	42 479,38	42 352,68	39 917,64
CO_2 emissions excluding net CO_2 from LULUCF	56 612,61	55 032,63	54 183,22	56 050,74	61 397,49	57 870,08	63 851,62	62 377,98	59 152,26	58 655,72
CH_4 emissions including CH_4 from LULUCF	6 405,01	6 383,37	6 358,24	6 378,53	6 350,56	6 212,45	6 150,33	6 084,63	5 893,61	5 772,35
CH_4 emissions excluding CH_4 from LULUCF	6 303,31	6 282,09	6 251,38	6 271,27	6 238,63	6 099,06	6 033,73	5 963,67	5 770,67	5 646,62
N_2O emissions including N_2O from LULUCF	7 937,05	7 347,76	6 786,12	6 909,75	7 026,52	7 227,34	7 188,07	7 159,87	6 996,19	6 885,93
N_2O emissions excluding N_2O from LULUCF	7 851,85	7 268,13	6 715,56	6 842,96	6 949,63	7 154,32	7 111,74	7 076,12	6 909,83	6 802,44
HFCs	0,02	0,05	0,10	0,10	6,52	29,33	77,30	167,77	245,22	318,59
PFCs	0,07	0,08	0,09	0,10	0,12	0,14	0,16	0,18	0,21	27,97
SF_6	94,38	67,32	36,64	33,61	34,90	68,53	72,20	75,98	53,18	51,98
Total (including LULUCF)	**53 089,30**	**37 149,11**	**40 965,24**	**45 051,46**	**57 358,33**	**54 665,17**	**51 435,63**	**55 967,81**	**55 541,09**	**52 974,46**
Total (excluding LULUCF)	**70 862,24**	**68 650,31**	**67 186,99**	**69 198,78**	**74 627,29**	**71 221,46**	**77 146,74**	**75 661,69**	**72 131,37**	**71 503,31**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)
1. Energy	54 577,71	53 169,66	52 475,62	54 447,15	59 712,58	56 252,88	61 994,00	60 327,62	57 185,21	56 605,10
2. Industrial Processes	4 996,62	4 603,17	4 308,46	4 339,64	4 561,64	4 567,45	4 944,92	5 236,24	5 149,00	5 315,01
3. Solvent and Other Product Use	178,37	170,51	157,56	150,42	146,56	142,77	137,96	135,72	136,28	135,04
4. Agriculture	7 125,73	6 684,60	6 206,61	6 225,88	6 222,01	6 324,76	6 222,14	6 207,42	6 063,55	5 926,76
5. Land Use, Land-Use Change and Forestry[5]	-17 772,94	-31 501,20	-26 221,75	-24 147,32	-17 268,96	-16 556,29	-25 711,11	-19 693,88	-16 590,28	-18 528,85
6. Waste	3 983,81	4 022,38	4 038,74	4 035,69	3 984,49	3 933,59	3 847,73	3 754,69	3 597,33	3 521,40
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)[5]	**53 089,30**	**37 149,11**	**40 965,24**	**45 051,46**	**57 358,33**	**54 665,17**	**51 435,63**	**55 967,81**	**55 541,09**	**52 974,46**

[1] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the COP. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

[2] Fill in net emissions/removals as reported in table Summary 1.A. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

[3] Enter actual emissions estimates. If only potential emissions estimates are available, these should be reported in this table and an indication for this be provided in the documentation box. Only in these rows are the emissions expressed as CO_2 equivalent emissions.

[4] In accordance with the UNFCCC reporting guidelines, HFC and PFC emissions should be reported for each relevant chemical. However, if it is not possible to report values for each chemical (i.e. mixtures, confidential data, lack of disaggregation), this row could be used for reporting aggregate figures for HFCs and PFCs, respectively. Note that the unit used for this row is Gg of CO_2 equivalent and that appropriate notation keys should be entered in the cells for the individual chemicals.

[5] Includes net CO_2, CH_4 and N_2O from LULUCF.

Back to Contents

TABLE 10 EMISSION TRENDS
SUMMARY
(Part 2 of 2)

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	(%)
CO_2 emissions including net CO_2 from LULUCF	38 058,74	40 234,67	41 685,73	49 284,84	44 596,24	27 818,17	35 267,46	40 614,34	5,07
CO_2 emissions excluding net CO_2 from LULUCF	56 688,16	61 950,85	64 396,84	72 003,66	68 124,19	56 347,14	67 705,09	66 103,44	16,76
CH_4 emissions including CH_4 from LULUCF	5 557,52	5 418,66	5 220,16	5 024,49	4 859,03	4 639,98	4 705,58	4 572,91	-28,60
CH_4 emissions excluding CH_4 from LULUCF	5 430,85	5 290,06	5 093,52	4 898,62	4 725,10	4 506,77	4 572,22	4 443,12	-29,51
N_2O emissions including N_2O from LULUCF	6 934,18	6 854,04	6 896,53	6 995,72	6 998,13	7 038,88	6 950,72	6 957,55	-12,34
N_2O emissions excluding N_2O from LULUCF	6 849,41	6 767,81	6 810,92	6 910,48	6 906,49	6 949,03	6 853,83	6 863,88	-12,58
HFCs	501,73	656,87	463,44	652,07	695,07	863,80	747,66	903,92	5 106 815,76
PFCs	22,46	20,06	13,37	14,85	12,23	9,88	15,43	8,40	11 894,29
SF_6	51,49	55,03	51,31	41,71	23,18	19,56	40,44	22,59	-76,07
Total (including LULUCF)	**51 126,12**	**53 239,34**	**54 330,54**	**62 013,67**	**57 183,88**	**40 390,26**	**47 727,29**	**53 079,71**	**-0,02**
Total (excluding LULUCF)	**69 544,10**	**74 740,67**	**76 829,40**	**84 521,39**	**80 486,26**	**68 696,17**	**79 934,67**	**78 345,34**	**10,56**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	Change from base to latest reported year
	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	CO_2 equivalent (Gg)	(%)
1. Energy	54 634,86	59 932,04	62 533,01	69 989,21	65 912,64	54 329,13	65 636,94	63 610,99	16,55
2. Industrial Processes	5 494,33	5 640,11	5 381,08	5 880,23	6 178,44	6 199,17	6 091,29	6 675,93	33,61
3. Solvent and Other Product Use	124,71	122,00	111,08	104,46	105,10	106,39	100,18	97,07	-45,58
4. Agriculture	5 968,93	5 854,08	5 827,34	5 745,31	5 624,49	5 602,78	5 587,93	5 529,75	-22,40
5. Land Use, Land-Use Change and Forestry[5]	-18 417,98	-21 501,34	-22 498,86	-22 507,71	-23 302,38	-28 305,91	-32 207,39	-25 265,63	42,16
6. Waste	3 321,27	3 192,45	2 976,89	2 802,18	2 665,59	2 458,70	2 518,33	2 431,60	-38,96
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	0,00
Total (including LULUCF)[5]	**51 126,12**	**53 239,34**	**54 330,54**	**62 013,67**	**57 183,88**	**40 390,26**	**47 727,29**	**53 079,71**	**-0,02**

[1] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the COP. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

[2] Fill in net emissions/removals as reported in table Summary 1.A. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

[3] Enter actual emissions estimates. If only potential emissions estimates are available, these should be reported in this table and an indication for this be provided in the documentation box. Only in these rows are the emissions expressed as CO_2 equivalent emissions.

[4] In accordance with the UNFCCC reporting guidelines, HFC and PFC emissions should be reported for each relevant chemical. However, if it is not possible to report values for each chemical (i.e. mixtures, confidential data, lack of disaggregation), this row could be used for reporting aggregate figures for HFCs and PFCs, respectively. Note that the unit used for this row is Gg of CO_2 equivalent and that appropriate notation keys should be entered in the cells for the individual chemicals.
[5] Includes net CO_2, CH_4 and N_2O from LULUCF.

Documentation box:
• Parties should provide detailed explanations on emissions trends in Chapter 2: Trends in Greenhouse Gas Emissions and, as appropriate, in the corresponding Chapters 3 - 9 of the NIR. Use this documentation box to provide references to relevant sections of the NIR if any additional information and further details are needed to understand the content of this table.
• Use the documentation box to provide explanations if potential emissions are reported.

Back to Contents

Annex 2

Common and Coordinated Policies and Measures (CCPMs) of the European Community implemented in Finland

CCPM	Implementation in Finland	Status	Policies and measures (PAM): quantitative reduction or qualitative category	Note
Emissions trading (Directive 2003/87/EC)	Act on emissions trading (683/2004), amended in 2007 (108/2007 and 1468/2007).	Implemented	Total volume of allowances for 2008–2012 amounts to approximately 187.8 million tonnes, corresponding to 37.6 million tonnes per year.	The EU ETS will be implemented in Finland for the period 2013–2020 according to the revised EU ETS directive and the harmonised allocation rules.
Kyoto Protocol project mechanisms (Directive 2004/101/EC)	Act on the use of the Kyoto mechanisms (109/2007); Decree on joint implementation (913/2007); Decree on the clean development mechanism (915/2007).	Implemented	The intended purchase of the Kyoto Protocol mechanisms by the Government and the amount allowed for the EU ETS operators mean an annual use of around 5.16 million tonnes in the period 2008–2012.	
Integrated pollution prevention and control (IPPC) (Directive 96/61/EC)	Environmental Protection Act (86/2000) introduced a uniform system of environmental permits and a single permit procedure.	Implemented		Directive (COM(2007)844) under preparation.
Promotion of electricity produced from renewable energy sources in the internal electricity market (Directive 2001/77/EC)	New action plan for renewable energy sources; Act on certification and notification of the origin of electricity (1129/2003); Government Decree on certification of the origin of electricity (1357/2003).	Implemented in 2003		The action plan is partly under Directive 2001/77/EC.
Promotion of cogeneration (Directive 2004/8/EC)		Implementation under preparation		
Taxation of energy products (Directive 2003/96/EC)	Energy taxation; Act on excise duty on electricity and certain fuels (1260/1996); Act on excise duty on liquid fuels (1472/1994).	Implemented in 1997, latest change in 2003 (raised tax rates, extension of tax subsidies).		National PAM already in force but enforced by a CCPM.
The Act is mainly under the IEM directive (Directive 2003/54/EC) and partly under Directive 2001/77/EC	Electricity Market Act (386/1995) and Government Decrees issued under it, and several other acts.	Implemented in 1995, last modified in 2009.		National PAM already in force but enforced by a CCPM.
Internal market in natural gas (Directive 2003/55/EC)	Act on natural gas markets (508/2000 and its amendments 445/2003, 1293/2004).	Implemented		
Ecodesign requirements for energy-using products (Directive 2005/32/EC)	Act on ecodesign and energy labelling (1005/2008).	Implemented		
Energy performance of buildings (Directive 2002/91/EC)	Acts and amendments to the Land Use and Building Act came into force in 2008; Decrees on energy efficiency of buildings came into force on 1 January 2008.	Implemented		National PAM already in force but enforced by a CCPM.

Annex 2

Continued

CCPM	Implementation in Finland	Status	Policies and measures (PAM): quantitative reduction or qualitative category	Note
End-use efficiency and energy services (Directive 2006/32/EC)	Energy audits and analyses; voluntary energy efficiency agreements.			National PAM already in force but enforced by a CCPM.
Efficiency requirements for new hot-water boilers (Directive 92/42/EEC)	Act on ecodesign and energy labelling (1005/2008).	Implemented		
Eco-management and audit scheme (EMAS) (Regulation 761/2001) and 1996/2006)	Implementation of EMAS.	Implemented voluntarily		New Decree on EMAS under preparation by the COM
Energy labelling of household appliances (Directives 2003/66/EC (refrigerators – freezers), 2002/40/EC (electric ovens), 2002/31/EC (air-conditioners), 99/9/EC (dishwashers), 98/11/EC (lamps). 96/89/EC (washing machines), 96/60/EC (washer-driers) and 92/75/EC)	Decrees on energy labelling of household appliances (8 categories).	Implemented		
Energy-efficiency labelling for office equipment (Regulation 2422/2001)	Energy labelling of office equipment.			
Efficiency fluorescent lighting (Directive 2000/55/EC)	Act on efficiency requirements of ballasts for fluorescent lighting (318/2002).	Implemented		
Voluntary agreement with car manufacturers to reduce specific CO_2 emissions (ACEA, KAMA, JAMA)	No specific measures in Finland.			
Marketing of new passenger cars (Directive 1999/94/EC)	Decree on declaring the fuel consumption and carbon dioxide emissions of new passenger cars (938/2000).	Implemented		
Monitoring the average specific emissions of CO_2 from new passenger cars (Decision 1753/2000/EC)	Charter by the Ministry of Transport and Communications.	Implemented		
Use of biofuels or other renewable fuels for transport (Directive 2003/30/EC)	Act on the promotion of the use of biofuels for transport (446/2007).	Implemented		Programme for modification of Directive by the Commission in progress.
Quality of petrol and diesel fuels (Directive 1998/70/EC, modified by Directive 2003/17/EC)	Act on the quality of petrol and diesel fuels (767/2003).	Implemented		Programme for modification of Directive by the Commission in progress.

Annex 2

Continued

CCPM	Implementation in Finland	Status	Policies and measures (PAM): quantitative reduction or qualitative category	Note
Shifting the balance between modes of transport, in particular towards rail transport (Directives 2001/12/EC, 2001/13/EC, 2001/14/EC)	Railway Act (198/2003).	Implemented in 2003		
Environmental performance of freight transport (Marco Polo Programme)				
(Directive 2008/101/EC amending Directive 2003/87/EC to include aviation activities in EU ETS		Implementation under preparation		
F-gas regulation (Regulation 842/2006)	The Regulation entered into force on 4 July 2006 and applied with effect from 4 July 2007. Some amendments were made to the Environmental Protection Act and Penal Code to implement certain provisions of the Regulation. National legislation ready: an Amendment to the Penal Code (748/2007) entered into force on 12 July 2007 and an Amendment to the Environmental Protection Act (681/2008) entered into force on 24 November 2008.	Implemented		
HFC emissions from air conditioning in motor vehicles (Directive 2006/40/EC)	Decree of the Ministry of Transport and Communications (1268/2007) entered into force in 4 January 2008.	Implemented		
Nitrates Directive (Directive 91/676/EEC)	Government Decree on the restriction of discharge of nitrates from agriculture into waters (931/2000).	Implemented	The Nitrates Directive reduced nitrogen use by 12% in 1998–2007 and the resulting reduction in greenhouse gas emissions have been 0.13 million tonnes CO_2. In the future, however, nitrogen use is not predicted to decrease.	
Common rules for direct support schemes under the common agricultural policy (Regulation 1782/2003)	Act on the implementation of the single payment scheme (557/2005); Ministry of Agriculture and Forestry Decree (183/2006).	Implemented		Programme modification approved by the Commission in April 2005.
Support for rural development (Regulation 1783/2003 amending a number of other Regulations)	Rural Development Programme for Mainland Finland 2007–2013.	Implemented, started 2007		
Transition to rural development support (Regulation 2603/1999)	Horizontal Rural Development Programme in mainland Finland (2000–2006).	Implemented		

Annex 2

Continued

CCPM	Implementation in Finland	Status	Policies and measures (PAM): quantitative reduction or qualitative category	Note
Agricultural production methods compatible with the environment (Regulation 2078/92)	Agri-environmental programme 1995–1999.	Expired		
Aid scheme for forestry measures in agriculture (Regulation 2080/92)	Programme for forestry measure in agriculture (1995–1999).	Expired		
Packaging and packaging waste (Directives 94/62/EC, 2004/12/EC, 2005/20/EC)	Government Decisions on packaging and packaging waste (962/1997, 1025/2000, 987/2004, 817/2005).	Implemented		
Landfill of waste (Directive 1999/31/EC)	Government Decision on landfills (861/1997); biowaste strategy (2004)	Implemented		National PAM already in force but enforced by a CCPM
Waste (Directive 2006/12/EC) replaced by Directive 2008/98/EC)	Waste Act (1072/1993); national waste plan to 2016.	Earlier directive implemented, implementation of new directive in progress		

Annex 3
Government Foresight Report on Long-term Climate and Energy Policy: Towards a Low-carbon Finland

The foresight report of Prime Minister Matti Vanhanen's second Cabinet reviews the long-term challenges of climate and energy policy from global and national perspectives. In the report, the Government outlines targets and measures marking out the road to a thriving and low-carbon Finland.

The time horizon of the report extends until mid-century and beyond as necessary, covering measures both to mitigate climate change and to adapt to its impacts. Besides energy production, the report discusses energy consumption, transport, the forests and other themes central to climate protection.

In the report, the Government sets its target to actively contribute towards limiting the rise in the global average temperature to two degrees Celsius at most. For this target to be achieved, all key countries will need to be committed to strict emission limits. As part of international cooperation, Finland is committed to reducing its emissions to a sustainable level - by at least 80 per cent from the 1990 level by 2050.

Building a low-carbon society calls for strong and urgent measures at all levels and sectors. Municipalities, enterprises, organisations and private individuals alike are needed in the joint effort to combat climate change. The climate perspective needs to be mainstreamed throughout all decision-making, and current policies and measures need to be strengthened while also adopting new ones.

Determined effort is made to achieve comprehensive and effective agreements in climate negotiations. Finland also works actively to strengthen the climate perspective in international cooperation in all forums. One goal is to stop global deforestation and to achieve an upturn in the total area of forests, for instance by promoting sustainable forestry, by 2020. Provision is made to increase public funding to climate work in developing countries, in line with Finland's own fair share, as part of the international agreement in the making.

The background scenarios included in the foresight report are meant to provide material for debate by giving examples of potential low-carbon paths. The scenarios show that Finland can reduce emissions by at least 80 per cent by 2050 in many different ways. For example, urban structure, the share of nuclear power, and industry's energy needs can be very different in a low-carbon Finland. In practice, however, all paths require the adoption of energy and transport systems with nearly zero emissions. Each scenario has its own strengths and challenges; none of the scenarios is selected for implementation as such.

Key policies of the report
A. Vision: a low-carbon Finland in 2050
- measures will be taken in order to limit global warming to two degrees Celsius at most
- Finland's emissions will be cut by at least 80 per cent from the 1990 level by 2050, as part of a wider international effort
- the shift to a low-carbon society will be carried out in a way which promotes well-being

- the targets will be revised as necessary as scientific information becomes more accurate and international cooperation progresses

B. Targets towards a low-carbon society
The target is set

- in the long term, to shift to a virtually zero-emission energy system and passenger road traffic
- to cut the energy intensity of the economy by at least 50 per cent by the year 2050 through radical improvement of energy efficiency
- to improve the efficiency of energy use in buildings so that consumption is at least 30 per cent lower in 2030, 45 percent lower in 2040 and 60 per cent lower in 2050
- to gradually phase out the use of fossil fuels and peat in energy production as power plants are decommissioned, unless carbon-capture technology is installed
- to continue raising the share of renewable energy so that it will reach at least 60 per cent of energy end use in 2050
- to cut the average emissions from passenger cars to at most 80-90 grams of carbon dioxide per kilometre in 2030, 50–60 g in 2040 and 20–30 g in 2050
- to gradually abandon the present-form landfilling of waste

The preparation of the report included commissioning a number studies on climate and energy policy issues as background material. Stakeholder panels and online discussions provided feedback for the preparation. The background scenarios included in the report are also based on a participatory approach.

Annex 4

Summary of specific actions to minimise the adverse impact of response measures in developing countries.

Action	Implementation in Finnish policy
The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse-gas-emitting sectors, taking into account the need for energy price reforms to reflect market prices and externalities.	These factors are taken into account for all greenhouse gas emitting sectors, together with consideration of national preferences and circumstances and the need for economic efficiency and feasibility. Various methodologies, including economic modelling, are used in the planning of economic instruments.
Removing subsidies associated with the use of environmentally unsound and unsafe technologies.	No subsidies for environmentally unsound and unsafe technologies have been identified.
Cooperating in the technological development of non-energy uses of fossil fuels, and supporting developing country Parties to this end.	Finland does not have any support activities in this field.
Cooperating in the development, diffusion, and transfer of less-greenhouse-gas-emitting advanced fossil-fuel technologies, and/or technologies, relating to fossil fuels, that capture and store greenhouse gases, and encouraging their wider use; and facilitating the participation of the least developed countries and other non-Annex I Parties in this effort.	Several actions have been undertaken in the area of enhancing technologies that emit less greenhouse gases, with main focus on increased energy efficiency and promotion of renewable energy. Some examples are listed below (see also Chapter 7). The two-phase energy auditing project in Vietnam aims to highlight the importance of energy auditing as a tool to increase energy efficiency and achieve savings. The objective of the first phase of the project was to identify the potential for improving energy efficiency in certain sectors in Vietnam. The second phase aims to build capacities of the authorities and professionals for carrying out energy audits, and to perform pilot audits in industry, building and transport sectors. The overall objectives of the project are to help Vietnam to strengthen the Vietnamese national policy framework and integrate energy efficiency and renewable energy use into national sustainable energy strategies, and to enhance national capacity for energy auditing and for implementing cost-effective measures. Finland supports district heating projects in China by providing interest subsidies to Concessional Credit Projects. The objective of these projects is to increase energy efficiency and to reduce emissions from heat production by introducing centralised combined heat and power (CHP) generation and modern heat distribution systems. With Concessional Credit Projects in Vietnam the distribution of electricity is improved by optimising distribution voltages and by introducing distribution automation.
Strengthening the capacity of developing country Parties identified in Article 4, paragraphs 8 and 9, of the Convention for improving efficiency in upstream and downstream activities relating to fossil fuels, taking into consideration the need to improve the environmental efficiency of these activities.	Finnish development policy supports low carbon development paths in developing countries. Finland has started to prepare guidelines for this purpose.

Annex 4
Continued

Action	Implementation in Finnish policy
Assisting developing country Parties which are highly dependent on the export and consumption of fossil fuels in diversifying their economies.	Action has been undertaken both through support by international organisations such as UNCTAD (United Nations Conference on Trade and Development) and through bilateral partnerships. The Energy and Environment Partnership with Central America (EEP), launched during the United Nations World Summit on Sustainable Development in 2002 by the Government of Finland and the Central American partner countries, is based on efficient, project-centred operating principles. Following the evaluation of the first phase of the project (2003–2005), the Finnish Ministry for Foreign Affairs has continued the funding of the project for the 2006–2009 period, and has allocated a total of EUR 7 million for the purpose. Austria joined the EEP in 2007, contributing a significant addition to the public financing of the partnership. The Dominican Republic joined in 2007, bringing the number of Central American partner countries up to eight. The recent second evaluation proposes that funding be continued for the next three-year period. Within the collaborative framework, partial funding has thus far been granted to 189 projects. These include research projects, such as feasibility studies, and pilot and demonstration schemes in all the main fields of renewable energy production, and in all the Central American partner countries. The projects have been developed by private and governmental organisations including, for example, companies and research institutes. Biannual thematic seminars, taking place in Central America, represent another aspect of the partnership. In the field of renewable energies, these have become perhaps the most important events in Central America. The seminars have brought together a significant number of private sector, governmental and non-governmental actors and organisations and served to increase awareness of the potential of renewable energy sources. So far, 13 such events have been organised, with more than 2500 participants. • The partnership is open to other European donors • The operating principles and the strategic foci of the partnership will be developed further, based on the practical experience gained and recommendations made by the evaluation • The thematic forums on renewable energies will be continued on a biannual basis • Cooperation with other EU renewable energy programmes and initiatives will be continued to the extent that provides benefits to the parties, and that promotes further cooperation • The Finnish Ministry for Foreign Affairs is currently in negotiations with the Central American Bank for Economic Integration (CABEI), with the aim of establishing a partial risk guarantee-facility for small and medium-sized enterprises • Finland is investigating the possibility of replicating the partnership model in other regions in Asia, Africa and Latin America.

Annex 5.

Projects in the Climate Change Adaptation Research Programme (ISTO)

Project	Conducted by
Climate	
ACCLIM II – Climate change survey and expert service for adaptation assessment	Finnish Meteorological Institute
Forestry	
What can provenance trials tell us about acclimation of trees to a changing climate?	University of Helsinki
Pine reforestation material for the year 2050	Finnish Forest Research Institute
Regional scenarios of forest resources in a changing climate – planning for adaptive forest management and risks	Finnish Forest Research Institute
The effect of climate change on biotic damage in boreal forests	University of Joensuu
Growing forest stands in a changing climate – development of a general model system and its application to pine stands	University of Helsinki
Evaluation of the need to adapt forest management in order to consider the risks of wind- and snow-induced damage to forests under a changing climate	University of Joensuu
Agriculture and food production	
ILMASOPU – Adaptation of Finnish agrifood sector to climate change	MTT Agrifood Research Finland
Risk assessment of alien species in plant production	MTT Agrifood Research Finland
ELICLIMATE – Food safety and climate change	VTT Technical Research Centre of Finland
ADACAPA – Enhancing the adaptive capacity of Finnish agrifood systems	MTT Agrifood Research Finland
Fisheries	
Changes in Finnish fish fauna, fish stocks and alien species in a changing climate	Finnish Game and Fisheries Research Institute
Sensitivity of key life history events of salmon to climate change	Finnish Game and Fisheries Research Institute
Extreme weather events, floods, droughts	
WaterAdapt – Finland's water resources and climate change – Effects and adaptation	Finnish Environment Institute
Land use and technical planning in managing flood risks in densely populated areas	Gaia Consulting Oy
TOLERATE – Towards levels of required adaptation to cope with extreme weather events	Government Institute for Economics Research
EXTREFLOOD II – Minimising flood damage: Flood scenarios, damage assessments and risks maps	University of Turku
Urban planning and built environment	
Climate change considerations in urban planning	VTT Technical Research Centre of Finland
Adaptation of built environment to flood impacts	VTT Technical Research Centre of Finland
EXTREMES II – Impacts of natural hazards to infrastructure in a changing climate	VTT Technical Research Centre of Finland

Annex 5
Continued

Project	Conducted by
Biodiversity	
Biodiversity and climate change: efficiency of the network of nature reserves and grazed meadows in maintaining species populations (scoping study)	Finnish Environment Institute
Saimaa ringed seal and adaptation to climate change	University of Joensuu
Importance of climate change for spread of introduced species in Finland – synthesis of current research and macro-scale climate analogy analysis	Finnish Environment Institute
International dimension	
IMPLIFIN – Finland and global climate impacts (scoping study)	Finnish Environment Institute
Climate risk management – an integral part of climate change adaptation in Finnish development cooperation	Gaia Consulting Oy
Regional adaptation strategies	
Readnet – Regional adaptation networks	Centre for Urban and Regional Studies, Helsinki University of Technology
Social impacts	
Climate change adaption and social impacts	University of Joensuu
Presenting research results	
Extension of FINESSI web tool to reflect needs of ISTO projects	Finnish Environment Institute

Annex 6

Summary of reporting of the Supplementary information under Article 7, paragraph 2, of the Kyoto Protocol in the NC 5

Information reported under Article 7, paragraph 2		NC5 section
National system in accordance with Article 5, paragraph 1		3.3
National registry		3.4
Supplementarity relating to the mechanisms pursuant to Articles 6, 12 and 17		4.6.1
Policies and measures in accordance with Article 2		4, 7 and 8
Domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures		3.3, 3.4, 4.2, 4.3, 4.4, 4.5
Information under Article 10	Art 10a	3.3, 8.2.4
	Art 10b	4.6, 4.7, 6.2
	Art 10c	7.4
	Art 10d	8.3.5
	Art 10e	8, 9
Financial resources		7

Contributors

Ahola Paavo-Petri	Academy of Finland
Alestalo Mikko	Finnish Meteorological Institute
Appel Barbara	Ministry of the Environment
Backman Leif	Finnish Meteorological Institute
Cederlöf Magnus	Ministry of the Environment
Eriksson Lolan	Ministry of Transport and Communications
Eerola Hannu	Ministry for Foreingn Affairs of Finland
Estlander Alec	Finnish Environment Institute
Forsell Pia	Statistics Finland
Forsius Martin	Finnish Environment Institute
Granholm Heikki	Ministry of Agriculture and Forestry
Grönfors Kari	Statistics Finland
Hakala Kaija	MTT Agrifood Research Finland
Hantula Jarkko	Finnish Forest Research Institute
Heikinheimo Pirkko	Prime Minister's Office
Heikura Eeva-Kaisa	Finnish Meteorological Institute
Henttonen Heikki	Finnish Forest Research Institute
Hepola Jouko	Energy Market Authority
Hongisto Mikko	VTT Technical Research Centre of Finland
Hutila Asko	Finnish Meteorological Institute
Ilme Jarno	Energy Market Authority
Iivonen Pasi	Ministry of the Environment
Irjala Antti	Ministry of the Environment
Isokallio Kristiina	Ministry of the Environment
Jalkanen Anneli	Finnish Forest Research Institute
Jylhä Kirsti	Finnish Meteorological Institute
Jylhä-Pyykönen Annu	Ministry of Education
Kaarakka Vesa	Ministry for Foreign Affairs of Finland
Kaipainen Jaana	Ministry of Agriculture and Forestry
Karhu Juha A.	Finnish Meteorological Institute
Karppanen Jaakko	Finnish Meteorological Institute
Kerminen Veli-Matti	Finnish Meteorological Institute
Keskisarja Ville	Ministry of Agriculture and Forestry
Kinnunen Mohr Karoliina	Ministry of the Environment
Korhonen Kari T.	Finnish Forest Research Institute
Koskela Juha	Finnish Game and Fisheries Research Institute
Kuokkanen Tuomas	Ministry of the Environment
Laine Jukka	Finnish Forest Research Institute
Lappalainen Antti	Finnish Game and Fisheries Research Institute
Laukka Jari	Ministry for Foreign Affairs of Finland
Laurikka Harri	Ministry of the Environment
Loukola Marja-Leena	Finnish National Board of Education
Luukkanen Olavi	University of Helsinki
Maijala Juha-Pekka	Ministry of the Environment
Mattila Hanna	Ministry of Agriculture and Forestry
Mielikäinen Kari	Finnish Forest Research Institute
Mähönen Outi	Lapland Regional Environment Centre
Möttönen Marjoriitta	University of Joensuu
Niemivuo-Lahti Johanna	Ministry of Agriculture and Forestry
Nummela Piia	Ministry for Foreign Affairs of Finland
Nummelin Matti	Ministry for Foreign Affairs of Finland
Oinonen Kari	Finnish Environment Institute
Ojala Jaakko	Ministry of the Environment
Paunio Mikko	Ministry of Social Affairs and Health
Pekurinen Seppo	Federation of Finnish Financial Services
Peltonen-Sainio Pirjo	MTT Agrifood Research Finland

Perähuhta Minna	Ministry of the Environment
Pesu Minna	National Board of Antiquities
Peuranen Else	Ministry of the Environment
Pietikäinen Johanna	Ministry for Foreign Affairs of Finland
Piri Tuula	Finnish Forest Research Institute
Pursiainen Anna	Ministry for Foreign Affairs of Finland
Regina Kristiina	MTT Agrifood Research Finland
Rekola Aino	
Reskola Veli-Pekka	Ministry of Agriculture and Forestry
Ritonummi Timo	Ministry of Employment and the Economy
Rouhinen Sauli	Ministry of the Environment
Ruuhela Reija	Ministry of Agriculture and Forestry / Finnish Meteorological Institute
Salminen Pekka	Ministry of the Environment
Salo Kauko	Finnish Forest Research Institute
Saltikoff Elena	Finnish Meteorological Institute
Sarkkinen Seppo	Ministry of the Environment
Seppälä Jyri	Finnish Environment Institute
Seppälä Risto	Finnish Forest Research Institute
Seppänen Ari	Ministry of the Environment
Sievänen Tuija	Finnish Forest Research Institute
Siikavirta Hanne	Ministry of Employment and the Economy
Siitonen Juha	Finnish Forest Research Institute
Talsi Tuija	Ministry of the Environment
Toikka Tuulia	Ministry of the Environment
Tuomainen Tarja	Finnish Forest Research Institute
Tynkkynen Aulis	Ministry of the Environment
Vahvelainen Simo	Statistics Finland
Vanhanen Henri	University of Joensuu/ Scion – New Zealand Forest Research Institute Limited
Vapaavuori Elina	Finnish Forest Research Institute
Vehnämäki Mika	Ministry for Foreign Affairs of Finland
Vehviläinen Anne	Ministry of Agriculture and Forestry
Viiri Heli	Finnish Forest Research Institute/ University of Joensuu
Viitanen Jussi	Ministry for Foreign Affairs of Finland
Virtanen Kimmo	Geological Survey of Finland
Vuorio Anssi	Statistics Finland
Ylioja Tiina	Finnish Forest Research Institute
Ylitalo Esa	Finnish Forest Research Institute
Yrjölä Tiia	Ministry of Agriculture and Forestry
Äikäs Mikko	Energy Market Authority

Back to Contents

YMPÄRISTÖMINISTERIÖ
MILJÖMINISTERIET
MINISTRY OF THE ENVIRONMENT

Ministry of the Environment
PO Box 35,
FI-00023 GOVERNMENT, FINLAND

Statistics Finland

Statistics Finland
PO Box 4C,
FI-00022 Statistics Finland, FINLAND

ISBN 978–952–244–184–3 (pdf)
ISBN 978–952–244–185–0 (print)
Printed by: Multiprint Oy