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

Climate Change

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Foreword

Climate change policy must be guided by science. The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) will present the latest assessment of climate change, its impacts and mitigation options at the global level. Its message must be taken into account at all levels equally by those involved in the international negotiations, as well as by those acting locally. It is extremely important that the UN climate change negotiations progress towards an ambitious and comprehensive agreement. Finland will, as a party to the UNFCCC and Kyoto Protocol and as a Member of the European Union, work actively for the international climate change agreement in Paris in 2015.

To ensure multidisciplinary scientific research input in all our national initiatives, the Ministry of the Environment established a Climate Panel in 2011. The panel brings together a representative group of top Finnish scientists from different disciplines to process relevant data, advise decision-makers and participate in public debate on climate change and energy issues.

Since the publication of the Fifth National Communication under the UNFCCC in 2010, Finland's climate change policy has advanced. We are well on track to achieving the emission reduction targets of the first commitment period of the Kyoto Protocol. We are also achieving our targets in the EU's climate and energy package.

At the national level, progress is seen in many sectors of the society. Earlier this year, we updated our national energy and climate change strategy, which contains the necessary measures for ensuring we achieve our national targets for 2020 and which lays out a pathway towards meeting the long-term energy and climate objectives set by the European Union. Our government has outlined a carbon-neutral society as our long-term goal. To achieve this goal the right actions must be taken already today. The government is now working together with parliament and different stakeholders to prepare a roadmap to 2050. We are also updating the national adaptation strategy and preparing a national climate change act to be presented to parliament for adoption in the beginning of next year.

At the same time that we are preparing roadmaps, strategies, new laws and international agreements, it is equally important to consult and listen to civil society and all interest groups. The Sixth National Communication is a result of broad and close cooperation, and also a good example of a joint national effort. The report describes a wide variety of activities concerning mitigation, adaptation, technology transfer, finance, climate change research, and education. It shows the participation of the government and its different ministries, and the contribution of other stakeholders such as communities, business and civil society. Clearly, the efforts of all these stakeholders are needed to move forward towards the long-term goal of a carbon-neutral Finland.

Our Sixth National Communication was prepared through close cooperation of the Ministry of the Environment, the Ministry for Foreign Affairs, the Ministry of Finance, the Ministry of Education and Culture, the Ministry of Agriculture and Forestry, the Ministry of Transport and Communications and the Ministry of Employment and the Economy. Several research institutes and other organisations have given their input and shared their expertise for the preparation of the report, including the Academy of Finland, the Finnish Environment Institute, the Finnish Forest Research Institute, the Finnish Meteorological Institute, MTT Agrifood Research Finland, VTT Technical Research Centre of Finland, the Finnish National Board of Education, the Energy Market Authority, the Finnish Transport Agency and Motiva Oy. Statistics Finland had the overall responsibility for coordination. The contribution of all participants is highly appreciated.

Helsinki, December 2013

Mr Ville Niinistö
Minister of the Environment, Finland

1 Executive summary

Photo:
Jouko Lehmuskallio / Image bank of the Environmental Administration

1 Executive summary

1.1 National circumstances relevant to greenhouse gas emissions and removals

The population of Finland was 5.4 million at the end of 2011, and according to projections, it will increase to 6.0 million by 2040. The average population density is 18 inhabitants per km^2. As a result of the low population density and the geographical extent of the country, the average distances travelled for different purposes can be quite long.

Finland is situated at a latitude between 60 and 70 degrees north, with a quarter of the country extending north of the Arctic Circle. With a total area of 338,432 km^2, it is Europe's seventh largest country.

Nearly all of Finland is situated in the boreal coniferous forest zone, and 72 per cent of the total land area is classified as forest land, while only some 8 per cent is farmed. Finland has more than 34,300 km^2 of inland water systems, which represents approximately 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 its northern location, the mean temperature in Finland is several degrees higher than in most other areas at these latitudes. The temperature is higher due to the Baltic Sea, because of the inland waters and, above all, as a result of air flows from the Atlantic Ocean, which are warmed by the Gulf Stream. The mean annual temperature is approximately 5.5°C in south-western Finland and decreases 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 prominent service and manufacturing sectors. The main manufacturing industries include electrical and electronics, forest and metal and engineering industries. Foreign trade is important, with exports accounting for about 40 per cent of the gross domestic product (GDP).

In 2011, the total energy consumption was 1,392 PJ. Finnish industry used 47 per cent of the country's final energy consumption and 48 per cent of its electricity in 2011. For decades, the use of primary energy as well as electricity has been increasing, and they reached their top values in the years 2006–2007. Demand rose more rapidly than GDP until 1994. Since then, parallel with the structural changes in the economy, both the energy intensity and the electricity intensity of the economy have decreased.

The use of fossil fuels and peat in energy production causes considerable carbon dioxide (CO_2) emissions. Nevertheless, CO_2 emissions per total primary energy unit are lower than in many other European countries. This is due to the quite high share of non-fossil energy sources in power and heat production, i.e. hydro, nuclear and biomass sources.

The emissions trading scheme (ETS) of the European Union (EU) has become a significant factor in the energy market. In Finland, the number of installations needing an emissions permit under the EU ETS scheme is around 600.

Domestic passenger transport, measured in terms of passenger-kilometres, has increased by approximately 22 per cent since 1990. Cars account for around 83 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 also within the public and service sectors. However, during the past three decades the consumption of energy per unit of heated space has been reduced significantly, in particular due to tightening building regulations.

Forests (trees and soil) absorb a significant proportion of the carbon dioxide (CO_2) emissions. The forest sink varied between 22.4 and 48.2 million tonnes CO_2 equivalent (CO_2 eq.) during the years 1990–2011, which represents 20–60 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 2011 totalled 67.0 million tonnes CO_2 eq., excluding land use, land-use change and forestry (LULUCF). The total emissions in 2011 were approximately 5 per cent (3.4 million tonnes) below the level for the 1990 emissions. Compared to 2010, the emissions decreased by 10 per cent (Table 1.1).

The most significant greenhouse gas in Finland's inventory is CO_2. Its share of the total emissions ranged between 80 and 86 per cent for the years 1990–2011. CO_2 emissions have decreased by 0.2 million tonnes since 1990. Methane (CH_4) emissions have gone down by 33 per cent from the 1990 level, whereas nitrous oxide (N_2O) emissions have decreased by 29 per cent. In 2011, the F-gas emissions (HFCs, PFCs and SF_6) were nearly eleven times higher than the emissions for 1995 (the base year for F-gas emissions).

Table 1.1
Greenhouse gas emissions (+) and removals (–) by sector, 1990, 1995 and 2000–2011 (million tonnes CO_2 eq.)

Sector	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Energy	54.5	56.1	54.5	59.8	62.3	69.9	65.8	54.0	65.4	63.3	54.8	52.7	60.6	53.4
Industrial processes[1]	5.1	4.6	5.0	5.0	5.0	5.3	5.5	5.4	5.5	5.9	6.1	4.4	4.6	4.5
F-gases[2]	0.1	0.1	0.6	0.7	0.5	0.7	0.8	0.9	0.8	1.0	1.1	0.9	1.2	1.1
Solvent and other product use	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	0.1
Agriculture	6.7	6.1	5.9	5.8	5.9	5.9	5.8	5.8	5.8	5.8	5.9	5.8	6.0	5.9
Waste	4.0	3.9	3.3	3.1	2.9	2.7	2.6	2.4	2.5	2.4	2.3	2.2	2.2	2.1
Total	**70.5**	**70.9**	**69.4**	**74.6**	**76.7**	**84.6**	**80.6**	**68.8**	**80.1**	**78.4**	**70.2**	**66.1**	**74.6**	**67.0**
Land use, land-use change and forestry[3]	−15.2	−14.1	−20.5	−23.7	−24.2	−24.7	−25.6	−29.9	−33.9	−25.7	−29.6	−39.3	−24.6	−24.6

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.

Similar to other industrialised countries, Finland's largest source of greenhouse gas emissions is the energy sector. The cold climate, long distances and energy-intensive industries all contribute to the high emissions volumes of the energy sector. In 2011, the energy sector's share (including transport) of the total greenhouse gas emissions was 80 per cent (53.4 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. The emissions from 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 normal, hydro power becomes scarce and Finland's net imports of electricity decrease.

Greenhouse gas emissions generated by transport amounted to 13.2 million tonnes CO_2 eq. in 2011 (20 per cent of total greenhouse gas emissions). Road transport accounted for 88 per cent of the total domestic transport emissions. During the period 1990–2011, transport emissions increased by 4 per cent due to the growth in traffic volume.

The greenhouse gas emissions generated by industrial processes amounted to roughly 5.6 million tonnes CO_2 eq. in 2011 (8 per cent). Emissions from the agricultural sector were some 5.9 million tonnes CO_2 eq. (9 per cent). Waste sector emissions amounted to 2.1 million tonnes CO_2 eq. in 2011 (3 per cent). The LULUCF sector acted as a greenhouse gas sink of 24.6 million tonnes CO_2 eq. in 2011.

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 for communicating with the UNFCCC, for coordinating participation in the inventory review and for publishing and archiving 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 by government authorities. The legal framework of the national system is further defined by an agreement between the Ministry of the Environment and Statistics Finland on operating the national system for estimating greenhouse gas emissions under the Kyoto Protocol and on the reporting requirements under the UNFCCC; it is also defined by the regulations concerning Statistics Finland (the Statistics 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 all require Finland to annually submit 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 consistently the QA/QC plan and procedures.

National registry

The EU Emissions Trading Scheme (EU ETS) began in January 2005 and is mandatory for specific industries in the EU with emissions above a certain threshold. The EU ETS and wider international emissions trading under the Kyoto Protocol have operated parallel to one another since October 2008. Both emissions 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 must meet the technical and functional specifications issued by the European Commission and the UNFCCC Secretariat. Finland used the Greta registry until the summer of 2009, when it replaced it with the CR registry software, which was developed by the Commission. The CR in turn, as well as all EU ETS national registries, was replaced by the Union Registry (UR) in June 2012. In Finland, the Energy Market Authority is the competent authority and the registry administrator for the national emissions trading registry.

1.3 Policies and measures

Policy framework and policy making process

Finland's climate policy is defined in government programmes, and strategic work has since 2003 been steered by a ministerial working group on energy and climate policies. Effective climate change policies require global collaboration and actions. Therefore, the Finnish climate policy is based on international agreements: the UNFCCC, the Kyoto Protocol and the common policies of the EU, such as the EU Climate and Energy Package and Effort Sharing Decision. National energy and climate strategies have been prepared since 2001 to fulfil the international commitments and to define sectoral policies and measures.

The Finnish 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. The Ministry of Employment and the Economy coordinates the energy and climate strategy work. Municipal authorities also have a significant role in climate policy and emission reductions, for example due to their responsibilities in land-use and traffic planning and waste management. The Finnish Climate Panel, which was nominated in 2011, strengthens the interaction between research and policy-making, and other stakeholders, including industrial and environmental non-governmental organisations (NGOs), research institutes and labour unions, can present their views on climate policy at the Ministry of the Environment's Climate Arena.

As a result of the burden sharing agreement within the EU, Finland is committed to bringing its national average annual emissions down to their

1990 level during the first commitment period of the Kyoto Protocol (2008–2012). Finland will fulfil its commitments: based on the greenhouse gas inventory for 2008–2011 and the preliminary inventory data for 2012, the greenhouse gas emissions in 2008–2012 were approximately 5 per cent below the assigned amount (see Table 1.2).

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 global and comprehensive agreement is reached. The majority of the reduction will be reached via the 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 its final energy consumption and its share of biofuels in gasoline and diesel to 10 per cent by 2020.

Finland has prepared several strategies on energy and climate policy, which were completed in 2001, 2005, 2008 and 2013. The key objectives of the latest strategy update were to ensure that the national targets for 2020 are achieved and to prepare a pathway towards meeting the long-term energy and climate objectives set by the EU. Finland also includes energy and climate aspects to its innovation policies. As an example of this, the Finnish government launched a strategic programme for the cleantech business in 2012.

Legislation

Finland is implementing at the 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. A specific act provides an administrative framework for participation in Joint Implementation (JI) and Clean Development Mechanism (CDM) project activities and in emissions trading under the Kyoto Protocol.

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

Sectoral policies and measures

The main policies and measures used for the with measures (WM) projection in the energy sector include the EU ETS, increasing renewable energy sources and energy conservation measures. The EU ETS is an EU-wide domestic measure, while renewable energy sources are supported by various national measures: investment grants, taxation, support for research and feed-in tariffs. Within the energy sector (excluding transport), the promotion of the use of forest chips is estimated to have the largest mitigation impact by 2020 (9.9 million tonnes CO_2 eq.), followed by energy efficiency agreements (5.2 million tonnes) and promoting wind power (3.6 million tonnes). For both new and existing buildings, building codes and regulation play an important role.

Within the transport sector, the most important measures in the WM projection include renewing the vehicle through performance standards for new cars, car and vehicle taxation, and information measures (estimated mitigation impact: 2.1 million tonnes CO_2 eq. by 2020). Promotion of the use of biofuels in transport is estimated to contribute to emission reduction by 2.0 million tonnes CO_2 eq. by 2020.

The most significant CO_2 emissions from industrial processes are included in the EU ETS. EU regulations on F-gases constitute the most significant emission reduction measure in the sector beyond the EU ETS (estimated mitigation impact: 1.0 million tonnes CO_2 eq. by 2020). Within the agricultural sector, most of the measures fall under the sphere of the EU's Common Agricultural Policy, including the agri-environmental payment, which covers approximately 90 per cent of Finnish farms and aims, among other things, to decrease the nutrient load on the environment and reduce greenhouse gas emissions. Within the LULUCF sector, the most important measure is the National Forest Programme 2015, which promotes sustainable forest management, including maintaining the forest carbon sink.

Within the waste sector, the most important policies and measures in the WM projection aim at increasing the recovery of waste fractions, reducing the amount of waste disposed to landfills (including restrictions on biodegradable waste) and increasing landfill gas recovery. The total mitigation impact of these waste sector measures is estimated at 2.3 million tonnes CO_2 eq. for 2020.

Policies and measures to mitigate emissions from international bunkers include implementing the measures of the International Maritime Organization (IMO) regarding the Energy Efficiency Design Index and Ship Energy Efficiency Management Plans and also implementing aviation emissions trading as part of the EU ETS.

Finland strives to implement its climate policies in such a way that the social, environmental and economic impacts on other countries, and on developing countries in particular, are minimised. The Sixth National Communication provides updated information on how to minimise adverse impacts compared to the Fifth National Communication and the National Inventory Report submitted in 2013.

Effect of policies and measures on longer term trends

A large proportion of current Finnish climate and energy policies also contribute to the reduction of greenhouse gas emissions in the longer term. For example, buildings have long lifetimes, and therefore, the regulations for the energy efficiency of new and existing buildings have long-lasting impacts. Land-use planning also results in permanent emission reductions in buildings and transport, for example, by allowing the use of low-emission heating modes or by improving possibilities for walking, cycling and using public transportation. Measures that promote investments in renewable energy and that improve the competitiveness of renewable energy sources also reduce greenhouse gas emissions in the longer term, since investments in the energy infrastructure have long lifetimes. Prohibiting certain F-gases or halting the disposal of biodegradable waste in landfills can be expected to lead to permanent changes in current practices, and therefore to yield long-term emission reductions.

1.4 Projections and total effects of policies and measures

With Measures and With Additional Measures projections

The with measures (WM) and with additional measures (WAM) projections correspond to the projections by the National Energy and Climate Strategy of 2013. The WM projection includes measures that were implemented or adopted in 2012 or earlier.

According to the population forecast by Statistics Finland used in the projections, Finland's population will increase from the current 5.4 million to 5.9 million in 2035. During the 2010s, the economy will not reach the growth rate experienced before the global recession of 2009. In the projections, the annual growth of the national economy will be 1.6 per cent during the present decade and 1.9 per cent in the 2020s.

It is assumed that Finland's fifth nuclear power unit will be completed in 2015 and that two additional nuclear power units, for which decisions-in-principle have been approved, will be operational by the 2020s. In the projections, it is assumed that from 2020 onwards Finland will be self-sufficient in electricity on a yearly basis. Within the EU ETS sector, the CO_2 emissions for district heating will decline steadily based on the WM projection, whereas the CO_2 emissions will be rather stable (Figure 1.1).

Within the non-ETS sector, the decrease in emissions is expected to continue until 2025 (Figure 1.2). In 2020, the WM projection for emissions from the non-ETS sector will be 17 per cent below the 2005 level, which is

Figure 1.1
CO_2 emissions in the EU ETS sector according to the greenhouse gas inventory (1990–2011) and the WM projection (up to 2025)

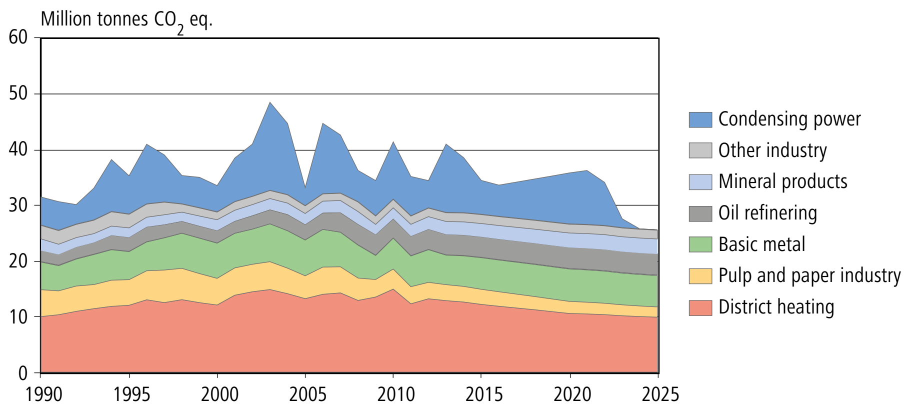
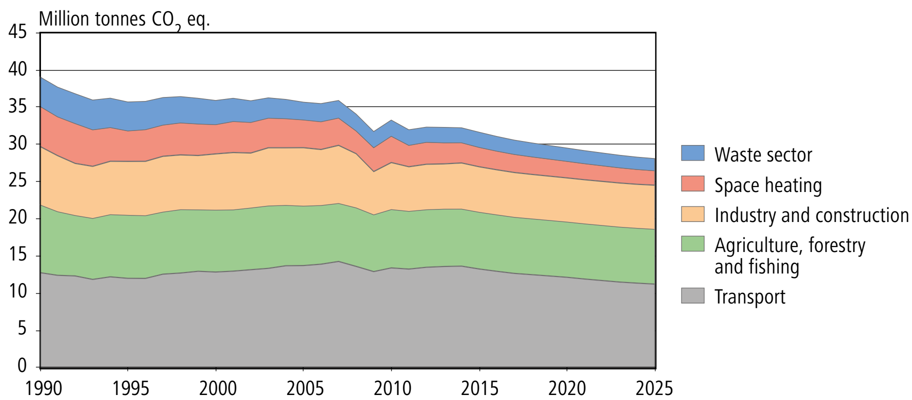


Figure 1.2
Emissions in the non-ETS sector by category (1990–2011) based on the latest greenhouse gas inventory and the WM projection (up to 2025)



sufficient for reaching the target set by the EU Climate and Energy Package (16 per cent reduction in 2020 compared to 2005).

The WM projection estimates that the total greenhouse gas emissions in 2020 will be 65 million tonnes CO_2 eq., whereas the WAM projection assesses that they will be 63 million tonnes CO_2 eq. The additional emission reduction measures in the WAM projection include the additional promotion of renewable energy, a decree on the improvement of energy efficiency in buildings as a result of renovations and alterations, further energy efficiency agreements in the transport sector and the promotion of public transport, as well as walking and cycling.

Total effect of policies and measures

The total effect of the policies and measures is estimated by aggregating the impact estimates of individual policies and measures and by comparing the baseline scenario of the climate strategy for the year 2001 to the emissions in 2010 and the WM projection's projected emissions for 2020. The total effect of the policies and measures contains noticeable uncertainties. However, the estimated range was 6-15 million tonnes CO_2 eq. in 2010, and it is estimated that it will be approximately 30 million tonnes CO_2 eq. in 2020 with the existing measures.

Supplementarity relating to the Kyoto Protocol mechanisms

According to the greenhouse gas inventory data for 2008–2011 and the preliminary data for 2012, the emissions in Finland during the first commitment period of the Kyoto Protocol were nearly 5 per cent (approximately

Table 1.2
Preliminary assessment of accounting for Finland during the first commitment period of the Kyoto protocol

	2008	2009	2010	2011	2012 (Preliminary data)	Sum[1]
Total national emissions	**70.2**	**66.1**	**74.6**	**67.0**	**61.4**	**339.2**
Finland's assigned amount	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**355.0**
Emissions trading sector						
Emissions[2]	36.2	34.4	41.3	35.1	29.5	176.4
Allocated units	36.5	37.1	37.9	38.0	38.1	187.6
Surplus/deficit of units[3]	+0.4	+2.7	-3.4	+2.9	+8.6	+11.2
Non-trading sector						
Emissions	34.1	31.7	33.3	32.0	31.9	162.8
Allocated units[4]	34.5	33.9	33.1	33.0	32.9	167.4
Surplus/deficit of units	+0.4	+2.2	−0.2	+1.1	+1.0	+4.6
Units from LULUCF activities and other mechanisms under the Kyoto Protocol						
Article 3, paragraphs 3 and 4 [5]	+0.6	+0.6	+0.6	+0.6	+0.6	+2.9
Acquisitions of units from JI and CDM[6]	+0.1	+0.4	+0.3	+0.5	+2.3	+3.6
Transfer of units from Finnish JI projects[7]					−1.0	−1.0
Surplus in Finland's account[8]	**+1.1**	**+3.2**	**+0.7**	**+2.1**	**+3.9**	**+10.1**

Due to rounding, the figures in the table may not always sum up.
1 Preliminary data/estimate.
2 Energy Market Authority press release 2.4.2013.
3 A surplus (positive number) means that entities have received units in excess, of the annual emissions, whereas a deficit (negative number) means the opposite.
4 Computational allocation, i.e. the difference between the average annual assigned amount minus the unit allocated to the trading sector.
5 Finland's forest management cap.
6 Units acquired by 14 May 2013 *(source: Ministry of the Environment)*.
7 Estimate for the whole commitment period *(source: Ministry of the Environment)*.
8 The units lost as a result of bankruptcies are not included.

15.8 million tonnes CO_2 eq.) below Finland's assigned amount (approximately 355.0 million tonnes CO_2 eq.).

As of May 2013, the amount of Kyoto units obtained by Finland through the Kyoto Protocol mechanisms was 3.6 million tonnes CO_2 eq., whereas the amount of Kyoto units from JI projects implemented in Finland (which will be transferred outside Finland) was estimated at 1.0 million tonnes CO_2 eq. (Table 1.2). This shows that the Kyoto target could have been met entirely by way of domestic action, and therefore, the use of the Kyoto mechanisms is supplemental to domestic action.

1.5 Climate change impacts, adaptation measures and vulnerability assessment

Climate projections for Finland

Climate change projections are based on simulations performed with 28 global climate models participating in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). The temperature change in Finland is expected to be 2.4°C by 2040 and 3.6°C by 2080 in the RCP4.5 scenario representing fairly moderate emissions, and 2.9°C and 5.8°C in the RCP8.5 scenario representing high emissions. The temperature increase in Finland is expected to be more than 1.5 times as large as the global mean average. Both the increases in temperature and precipitation will be greater in winter than in summer. As a consequence of climate change, it is expected that heat waves will become longer and more frequent; heavy rainfall events will intensify in summer; the number of days with precipitation will increase in winter; the snow season will shorten and the duration and depth of soil frost will decrease, particularly in snow-free areas like roads and airports.

Vulnerability and climate change impacts

A summary of Finnish research results on impacts and adaptation has recently been published. Vulnerabilities were identified in all sectors. A gradual shift in average conditions that favour currently unknown, rare or new pests may be particularly problematic for agriculture and forestry, while extreme climate events may have major consequences on terrestrial and urban environments. Transportation is particularly vulnerable to conditions near or below freezing.

Climate change has a direct impact on nature, industries dependent on natural resources, the built environment and human well-being, bringing advantages and opportunities as well as disadvantages and threats to Finland.

It is estimated that gradual changes, such as the increase in average temperature, will bring potential benefits to some natural resources sectors, such as agriculture, forestry, the outdoor recreation business and tourism. The combined potential benefits for these sectors could be approximately 0.2 per cent of the gross domestic product (GDP). However, the estimate does not include the growing risks, such as the increased risks of damages caused by invasive alien species, pests and diseases. On the other hand, the benefits can be gained only if the sectors adapt themselves to the new conditions. The changes in biodiversity, for instance, in the distribution patterns of species and habitats, may have a considerable impact on the ecosystem services, while changing the operational preconditions of other sectors as well.

According to assessments, the water sector will be most affected by the impacts of climate change, including heavy rainfall and severe flooding. Storms causing large amounts of damage will challenge the general functioning of society and also rescue services as storms may cut the power supply and communication links.

Adaptation

Finland's National Strategy for Adaptation to Climate Change was published in 2005. The objective of the strategy is to reinforce and increase the adaptive capacity of society by minimising the negative impacts of climate change while taking advantage of any favourable impacts.

Currently, the most advanced sector in adaptation is water management, where adaptation has already been integrated into decision-making processes. Essential adaptation measures include intake wells in groundwater bodies with favourable water yields and placing wastewater facilities, especially pumps, outside groundwater areas and flood risk areas. Precautionary measures are also important: drawing up preparedness plans, improving cooperation between waterworks, compiling thorough guidelines on land use, and further developing and utilising databases and models.

In most other sectors the impacts of climate change are quite well known and the need for adaptation is recognised. The measures in most sectors have been identified and their implementation has either been planned or started. However, concrete adaptation measures need to be further enhanced in different sectors.

In the energy sector, adaptation measures have already been launched. For example, regulations aimed at improving the security of power supply have recently been included in the revised electricity market legislation. Nuclear power plants are modified or the design checked to fulfil the requirements of the changing environment.

The current legislation on building and other statutes include requirements for taking climate change into consideration. According to the revised land use guidelines, new construction should not be located in areas that are prone to flooding. Local master and detailed planning should take account of the increasing possibility of storms, heavy rainfall and flooding in built areas. A recent act and government decree (2010) regulate flood risk management and the management of river basins. The possibility of rising sea levels along the shores of the Baltic Sea (coastal flooding) is currently being studied.

Agricultural research has been designed to support the development of practical adaptation means. Farmers in general are well aware of the likely changes in the growing conditions and are ready to react by adopting cultivars as well as cultivation methods and systems. Climate-related risk assessment has been strengthened for the Finnish Food Safety Authority Evira and new projects on the risks caused by plant pests and diseases have been launched.

Within the forestry sector, identified adaptation measures include the site-specific selection of species and methods in forest regeneration; avoiding the cultivation of Norway spruce on dry sites in southern Finland; timely and proper management of young stands to maintain the resistance of trees to wind and snow-induced damage; and sophisticated systems to monitor forest resources and damage at various scales.

In most industrial operations, it has been assumed that climate change will not result in significant changes and the focus of the industry has been more on mitigation rather than adaptation. However, potential risks have been identified that should be taken into consideration in the future. Climate change affects mining, especially open pit mining. The Finnish mining industry is being subject to 'stress tests' to reduce the risk of adverse environmental consequences, which climate change can aggravate.

Within the transport sector, envisaged actions that will enhance the adaptive capacity of the sector during the coming decades include developing warnings and providing information, rescue planning, developing maintenance measures and improving structures. The development of pavement and property maintenance as well as pedestrian weather services are considered effective measures for limiting the number of slipping and falling accidents, most of which take place during wintertime.

In the health sector, a handbook on 'Exceptional situations related to environmental health' published in 2010 for environmental health care staff and cooperation partners also includes information about weather and climate-related events. The Finnish Meteorological Institute (FMI) has been issuing heat wave and cold spell warnings since 2011.

Awareness of climate change and a capacity for adaptation is improving among tourism enterprises. However, most insurance companies are still operating at a low adaptation level.

Global impacts of climate change and international cooperation

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. Climate change can also contribute to conflicts and migration in developing countries – climate change is considered a threat multiplier. In order to support especially the most vulnerable developing countries, Finland has integrated climate change concerns with development cooperation. Finland also supports long-term measures that reduce the vulnerability of people and communities to natural disasters. Finland has supported the United Nations Office for Disaster Risk Reduction (UNISDR) since 2004. The present support level is EUR one million per year (2012–2013). Finland has also participated as an observer in the World Bank Consultative Group of the Global Facility for Disaster Reduction.

1.6 Financial resources and transfer of technology

Finland has integrated the goals and objectives of the UNFCCC and the Kyoto Protocol into its development policy, while taking into account the fact that economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties. Besides providing funds to the operating entities of the financial mechanism of the UNFCCC and the funds under the Kyoto Protocol, Finland provides support through bilateral, regional and other multilateral channels.

Finland's share of the EU's overall 'fast-start finance' contribution was EUR 110 million during the years 2010–2012. This contribution was counted as Official Development Assistance (ODA), but it was also part of the new, growing Finnish ODA during 2010–2012 (see Table 1.3). After the Copenhagen fast-start finance pledge, Finland decided to use the year 2009 as a baseline for defining new and additional funding. The Finnish commitment is being implemented through a net increase of Finnish funding directly allocated to developing countries' climate activities. The baseline figure for overall Finnish climate funding in 2009 was EUR 26.8 million. In 2010, the overall final figure disbursed was approximately EUR 41.7 million. Thus, the final fast start finance figure (i.e. the net increase) in 2010 was about EUR 14.9 million. For 2011, the figures were around EUR 61.5 million in total and approximately EUR 34.7 million as fast-start finance. For 2012, the figures were about EUR 108.2 million and approximately EUR 81.5 million, respectively. During the years of the fast-start finance period (2010–2012), the support shares of the least developed countries (LDCs) and Africa have been almost the same: on average, approximately 20 per cent of the total Finnish climate finance reported for both. However, this share is a rough estimate, as it does not include all support to LCDs and African countries.

Finland has contributed additional resources to the Global Environment Facility (GEF) to prevent and mitigate global environmental problems in developing countries. During the current fifth replenishment period, the Finnish contribution is EUR 57.3 million in total: EUR 15.0 million per year during the years 2010–2011 and EUR 13.7 million per year during the years 2012–2013. Summary information on financial resources and technology transfer is presented in Table 1.3.

Table 1.3
Summary information on financial resources and technology transfer

Official development assistance (ODA)	EUR 927 million in 2009 (0.53 per cent of gross national income (GNI)), EUR 1,006 million in 2010 (0.55 per cent), EUR 1,011 million in 2011 (0.53 per cent), EUR 1,027 million in 2012 (0.53 per cent).
Climate-related aid in bilateral ODA	EUR 12.95 million in 2009, EUR 21.97 million in 2010, EUR 35.35 million in 2011, EUR 33.66 million in 2012 (amounts of the project funding directly directed to climate activities).
Climate-related support programmes	Energy and Environment Partnership (EEP) with Central America, the Making agriculture part of the solution to climate change – Building capacities for Agriculture Mitigation project, the Sustainable Forest Management in Changing Climate project, the Climate Change and Development Project (CCDP), the Southeast Asia Climate Change Network.
Contributions to GEF	EUR 7.8 million in 2009, EUR 15 million in 2010, EUR 15 million in 2011, EUR 13.65 million in 2012.
Pledge for fifth GEF replenishment	EUR 57.30 million in total.
JI and CDM under the Kyoto Protocol	The Finnish Carbon Procurement Programme (Finnder) has contracted 12 bilateral projects: 8 CDM and 4 JI projects (EUR 20.8 million). Alongside purchases from bilateral projects, Finland has invested in the Prototype Carbon Fund (USD 10 million), the Testing Ground Facility (EUR 4.25 million), the Multilateral Carbon Credit Fund (EUR 10 million), the Asia Pacific Carbon Fund (USD 25 million), the Future Carbon Fund (USD 20 million) and the NEFCO Carbon Fund (EUR 3 million). In total, Finland has got credits from about 110 projects at both the bilateral level and through funds.
Other (bilateral/multilateral)	The Global Gender and Climate Alliance (GGCA) project to strengthen the role of women and mainstream the gender perspective in global climate policy. The total contribution is EUR 6.8 million during the implementation period of 2008–2014.

Finland attaches particular importance to assisting the least developed countries, as they are among the most vulnerable to climate change. During the reporting period (2009-2012), Finland's eight long-term partners in development cooperation were Ethiopia, Kenya, Mozambique, Nepal, Nicaragua, Tanzania, Vietnam and Zambia. Five of these countries are officially classified as the least developed countries, and all are particularly vulnerable to climate change.

The energy and forestry sectors are the most important sectors in climate-related development co-operation efforts. Most of Finland's bilateral development co-operation funds in the energy sector are channelled through five regional Energy and Environment Partnership (EEP) Programmes, which currently cover 32 countries in Central America, the Andean region, southern and eastern Africa, the Mekong region and Indonesia. The share of forestry projects is presently approximately 4 per cent of the total ODA, or EUR 40 million annually. Finland has supported sustainable forest management in partner countries, e.g. in preparing and implementing national forest programmes as well as sector policies and strategies. The development cooperation projects implemented by Finland typically include a strong capacity building component.

Finland has specific programmes and financial arrangements for transferring environmentally sound technology to developing countries. These activities consist of transferring both 'soft' technology, such as 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.

Private sector projects in developing countries are supported, for example, through the Finnish Fund for Industrial Cooperation Ltd and Finnpartnership. Finnfund is a state-owned company that finances private projects in developing countries by providing long-term risk capital for profitable projects. Finnpartnership aims to increase business-to-business cooperation between companies in Finland and in developing countries. In 2011, Finnfund provided approximately EUR 10 million and Finnpartnership about EUR 0.1 million in public climate funding. According to rough estimates, the public funding provided through Finnfund's climate-related projects leverages private funding at a level at least four times that of public funding for the investment. The average and median ratio values during the past few years have been much higher: 17 and 15, respectively. Finnpartnership has not made climate-specific estimates, but during the years 2006-2009, the ratio was generally at least six times as great.

1.7 Research and systematic observation

In 2011, Finland's research and development expenditure was approximately EUR 7,000 million, or 3.8 per cent of the country's GDP.

Climate change is recognised in the Finnish national research and innovation policy (e.g. in the Research Innovation Council's Research and Innovation Policy Guidelines 2011-2015) as one of the significant challenges currently facing society. Climate change continues to be a priority area in many research programmes and projects. The largest providers of public funding for research and development projects are the Academy of Finland (EUR

350 million in 2011) and Tekes – Finnish Funding Agency for Technology and Innovation (EUR 590 million). The Academy of Finland's ongoing climate change research programme (FICCA, 2011–2014) was launched to respond to the scientific challenges posed by climate change on a broad front. One of the principles underlying FICCA is to support multidisciplinary research that addresses both social and environmental areas. While the ongoing programmes supported by Tekes, such as Green Growth (2011–2015) and Groove – Growth from Renewables (2010–2014) have a broad scope, their topics are also relevant for climate change. Tekes funds both research and enterprise projects. The overall funding provided by Tekes for climate-change-related projects was approximately EUR 50 million in 2011.

The FMI has its own research programme, entitled Climate Change, with a staff of around 80 scientists. The emphasis of the programme is on climate research and services, greenhouse gases and aerosols and climate.

The Universities of Helsinki and Eastern Finland and the FMI host the Finnish Centre of Excellence (CoE) in Physics, Chemistry, Biology and the Meteorology of Atmospheric Composition and Climate Change (CoE status in the years 2002–2007 and 2008–2013). Its main objective is to reduce the scientific uncertainties concerning global climate change issues, particularly those related to aerosols and clouds.

Finnish research institutes also have extensive activities in paleoclimatology.

A large number of research institutes and universities carry out research on climate change impacts, adaptation and mitigation in Finland, and the number has increased since the Fifth National Communication. For example, during the years 2009–2012 almost 20 organisations received funding from the Academy of Finland for climate change research.

Finland emphasises international collaboration in climate change research. It has participated in the World Climate Research Programme (WCRP), the International Geosphere-Biosphere Programme (IGBP) and the International Human Dimensions Programme (IHDP). Finland has also actively participated in the work of the Intergovernmental Panel on Climate Change (IPCC).

Systematic meteorological observations have been made in Finland for more than a hundred and fifty years. The primary sources of atmospheric observations relevant to climate change include routine surface and upper air weather observations made by the FMI. In April 2013, the observation network consisted of three meteorological observatory stations, which included upper-air observations, 180 synoptic stations and 101 manual precipitation stations. Under the Global Climate Observing System (GCOS) programmes, three stations are included in the GCOS Surface Network (GSN) and one in the GCOS Upper-Air Network (GUAN). As part of the WMO's Global Atmosphere Programme, the FMI maintains a Global Atmosphere Watch (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. The Finnish Forest Research Institute, Metla performs national forest inventories (NFIs), which produce information on the land use, forest resources, growth, condition and biodiversity of forests.

For many years, Finland has been operating extensive capacity building programmes relevant to mitigating and adapting to climate change; these programmes concern climate observations, research, the sustainable use of forests and higher education cooperation. Climate data management systems have been implemented in several developing countries supported by Finnish development cooperation and with considerable financial and personnel support.

1.8 Education, training and public awareness

Climate change is already firmly anchored in the education and public awareness policies and practices of the Finnish Government, and these policies and practices are continuously being developed.

Climate change issues are included in basic education and in upper secondary level education as part of education on sustainable development. The national strategy for education pertaining to sustainable development (2006–2014) sets targets for compiling sustainable development plans (SD plan) and certifying sustainable development work in schools and educational establishments. Currently, around one half of all Finnish schools have prepared or are preparing a SD plan and the share of external certifications is approximately ten per cent.

Universities and polytechnics provide climate change education as a part of different degree programmes. Some universities also offer postgraduate studies in climate change. Teaching related to climate change is closely tied to 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.

The training of experts to manage forests and other natural resources in developing countries is an integral part of the agricultural and forest sciences programmes at the University of Helsinki. In the Faculty of Science and Forestry at the University of Eastern Finland, six out of 12 master's degree programmes are directly targeted towards the sustainable use of natural resources and climate change mitigation. During the past decade, these programmes, which are partnered with programmes in other European, North American, Russian, Chinese, Brazilian and Ghanaian universities, have trained more than 100 experts from more than 50 different countries. In addition, many other higher education institutions and research institutions in Finland provide international training and cooperate with research and higher education institutions as well as governmental institutions in developing countries to support institutional development.

Communication about climate change is performed by several ministries and government research organisations, each within the sphere of their own tasks and responsibilities. Since 2010, the Ministry of the Environment has been coordinating cooperation on climate communications. At the moment, the Steering Group for Climate Communications consists of all relevant ministries, research organisations, the Association of Finnish Local and Regional Authorities, Motiva Oy and the think tank Demos Helsinki. Many of the government organisations provide training for various stakeholders.

The FMI has, for example, organised a climate change course for journalists since March 2006, and more than 200 journalists have attended the course.

Raising awareness about energy efficiency includes campaigns, consumer advice and mobility management. A national Energy Awareness Week is organised annually. More than 300 companies and organisations participate in the activities and one half of Finland's school children aged around eight (close to 25,000 pupils) take part in the week's activities by studying how energy is produced and consumed as well as how it can be saved and the energy saving actions they can take at home and in school. Finnish consumers are also provided with advice to support their choices on energy use at home, on building and renovation work, and on mobility by networks of experts throughout the country.

More than one third of Finland's municipalities have a climate strategy or are in the process of preparing one. Several municipalities are actively promoting climate change awareness among their citizens through providing consumer advice and organising events, discussion forums and campaigns. In addition, the NGOs run climate change or energy related campaigns, some of which have received a great deal of publicity.

2 National circumstances

This chapter describes the national circumstances relevant to Finnish greenhouse gas emissions and removals. The emphasis is on the present national circumstances, 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.

Photo:
Kalervo Ojutkangas / Image bank of the Environmental Administration

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, for example, on whether to join or withdraw from international organisations and on the signing, ratification and entry into force of international conventions. The Government, in its narrower sense, refers to 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 Section 4.2.

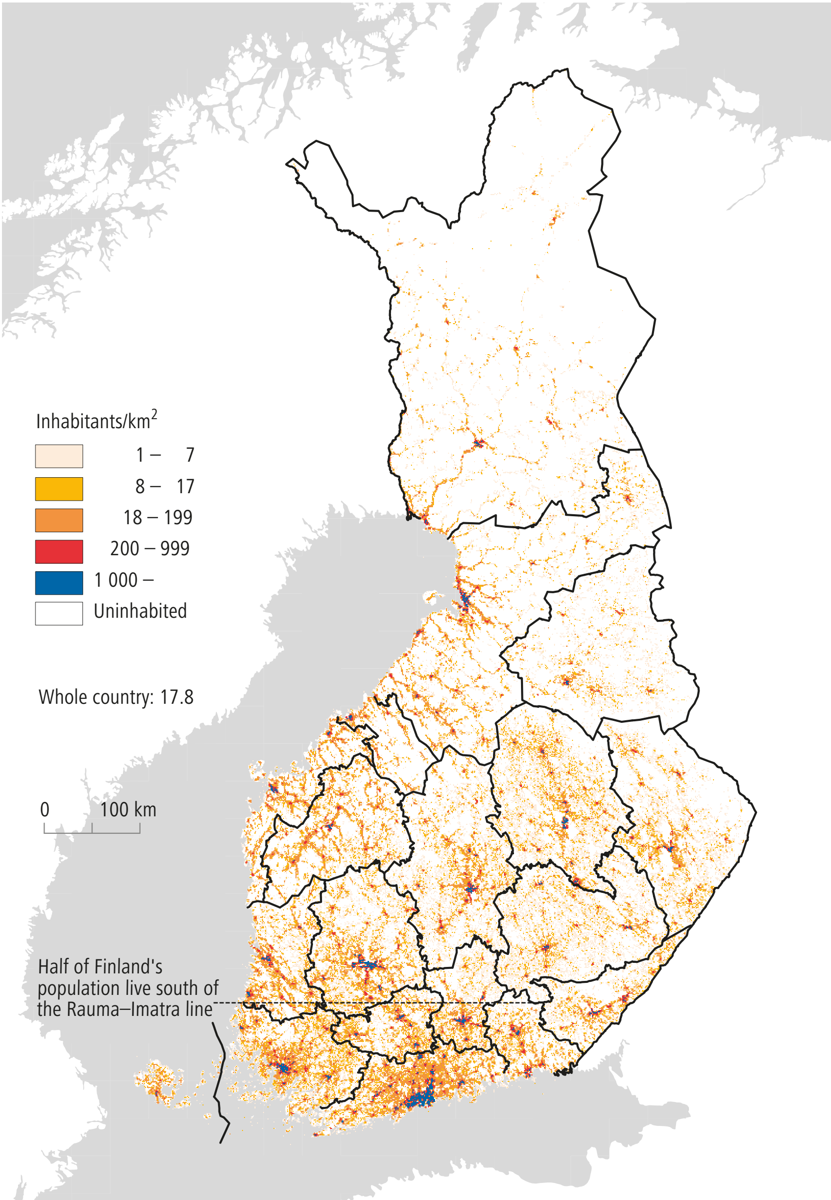
2.2 Population profile

The population of Finland was 5.4 million at the end of 2011. It increased by an annual average of 0.38 per cent between 1990 and 1999, by 0.34 per cent between 2000 and 2009 and by 0.46 per cent in the early 2010s. According to population projections made by Statistics Finland in autumn 2012, it is estimated that the Finnish population will increase to 6.0 million by 2040 (6.2 million by 2060). The population density averages 18 inhabitants per km², but ranges from 2 inhabitants per km² in northern Finland to 170 inhabitants per km² in the south of the country (in the Helsinki-Uusimaa region). As a result of the low population density and the geographical extent of the country (Figure 2.1), the average distances travelled for different purposes can be quite long.

There is a strong internal migration from rural to urban areas. In the period 1990–2011, net migration from rural to urban areas amounted to a total of 127,000 people: 71,000 people during the years 1990–1999 and 56,000 people during the years 2000–2011. Many rural communities have a declining population, particularly in northern and eastern Finland.

In 2011, the net migration to urban areas was 5,000 people, which was considerably lower than in the latter half of the 1990s, when it exceeded 10,000 people per year. The urban population (3.7 million) made up 68.4

Figure 2.1
Population density in Finland, 1 January 2012



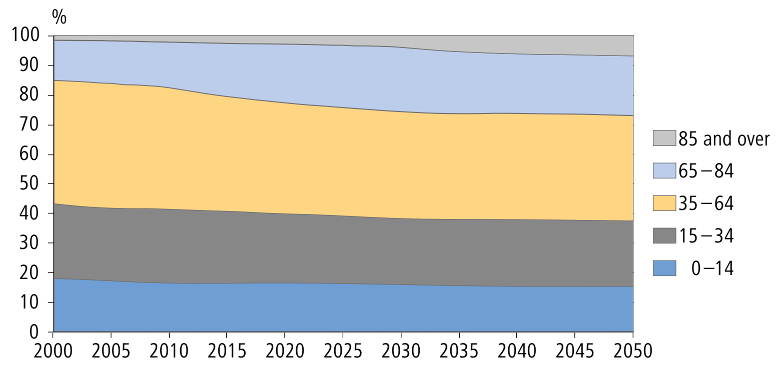
Regional division as on 1. January 2012

per cent of the total population (5.4 million) in 2011. The corresponding figure in 1990 was 63.4 per cent (3.2 million) of the total population (5.0 million). The urban population has grown not only due to the net migration, but also because of municipal mergers, as some of rural municipalities have been joined to urban municipalities.

The number of one-person households has increased and the average household size has decreased. The total number of households at the end of 2011 was 2.6 million. 41 per cent of households, or 1.1 million of them, consisted of only 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 2011, the proportion of people more than 65 years of age was 18.1 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 by 2040, more than one quarter of Finland's population will be above the age of 65 (Figure 2.2). Life expectancy has risen rapidly during the past 30 years. At present, women may expect to reach the age of 83.5 and men the age of 77.2. Despite this trend, population growth has slowed down, and it is expected that the natural increase in population will decrease in the coming decades. The proportion of elderly people out of the total population is increasing due to declining mortality rates and therefore longer life expectancies. In the long run, the population will likely increase only if there is a surplus of immigrants.

Figure 2.2
Population profile for 2000–2050



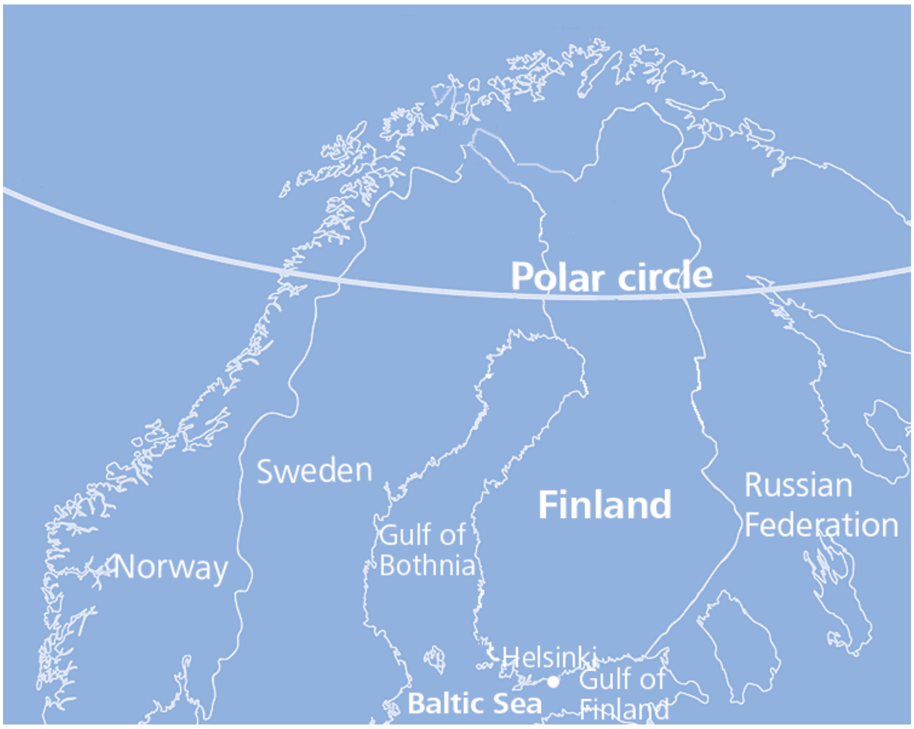
Years 2000–2011 actual, years 2012–2050 projected

2.3 *Geographical profile*

Finland is situated at a latitude 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 coast. With a total area of 338,000 km^2, it is Europe's seventh largest country. The land boundary with Sweden is 614 km long, with Norway 736 km long and with Russia 1,340 km long.

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 72 per cent of the total land area is classified as forest land, while only some 8 per cent of it is farmed. Finland has more than 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, with almost half of the latter existing along the Baltic Sea coast.

Figure 2.3
Finland's location



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 in by numerous rivers. The salinity of the surface water in the southern Baltic Sea is as high as 20 per mille, but in the northern 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 Sea region.

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. The areas of settlements have increased, while the areas of forest land, cropland and wetlands have decreased.

Table 2.1
Land use in 1990 and 2011
Source: Finnish Forest Research Institute / National Forest Inventory

Land use classification[1]	1990 (km^2)	2011 (km^2)	Change
Forest land	221,880	220,170	–0.8 %
Cropland	24,529	24,406	–0.5 %
Grassland	2,824	2,637	–6.6 %
Wetlands	30,006	29,930	–0.3 %
Settlements	12,296	14,387	17.0 %
Other land	12,386	12,369	–0.1 %
Total	**303,921**	**303,899**	

1 The classification is based on the IPCC Good Practice Guidance for land use, land-use change and forestry (2003)

2.4 Climate profile

The climate of Finland displays features of both maritime and continental climates, depending on the direction of air flow. Considering its 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 higher because of the Baltic Sea, due to the inland waters and, above all, as a result of the air flows from the Atlantic Ocean, which are warmed by the Gulf Stream.

The mean annual temperature is approximately 5.5°C in south-western Finland and decreases towards the northeast. The 0°C mean limit is approximately as far north as the Arctic Circle. Temperature differences between regions are the greatest in January, when the difference between southern and northern Finland is, on average, approximately 10°C. In June and July it is closer to 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 descend below the horizon at all. In the far north, there is a period around midsummer of more than two months during which time the sun never sets. Conversely, in wintertime the northernmost region has two months of uninterrupted night.

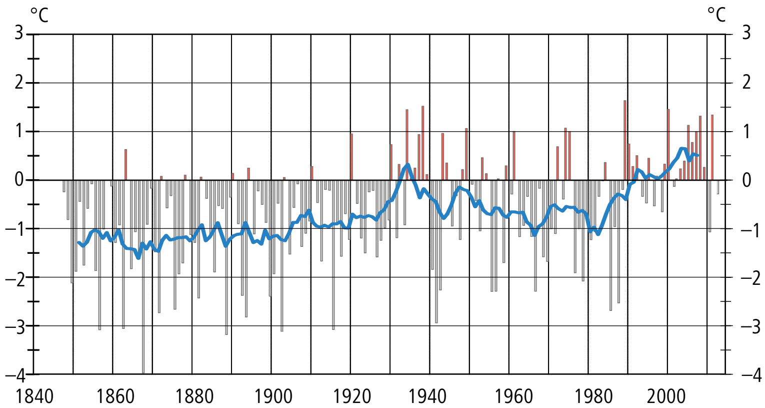
The Finnish climate is characterised by irregular precipitation and there are typically rapid changes in the weather. Only summer showers and thunderstorms show some sort of regularity, with rain occurring mostly in the afternoon. The mean annual precipitation in southern and central Finland is mainly between 600 mm and 750 mm, except near the coast, where it is slightly lower. In northern Finland, the annual precipitation is 450–650 mm.

The seasonal variation in precipitation is similar throughout the country, with the driest months being February, March and April. From then on, precipitation gradually increases until July and August, or until September and October on the coast, after which time it decreases towards the winter and springtime. The lowest annual precipitation ever recorded was less than 300 mm in northern Finland, while the country's maximum recorded precipitation exceeded 1,100 mm. The highest daily precipitation ever recorded was almost 200 mm, but values above 50 mm are not very common. During an average year, more than half of the days have some precipitation, except near 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 in the form of snow and it remains on the ground for 6–7 months. The lakes freeze over in October in Lapland and in early December in southern Finland. During severe winters, the Baltic Sea may freeze over almost completely, but during mild winters it for the most part remains open, except for the Gulf of Bothnia and the eastern part of the Gulf of Finland.

The most common wind directions (17–18 per cent) are from the south and southwest (land areas and sea areas, respectively). The least common wind directions (8–10 per cent) are from the east and northeast (sea areas and land areas, respectively). Wind comes from all other directions with more or less equal frequency. The average wind speed is 3 to 4 m/s inland; it is slightly higher on the coast and 5 to 7 m/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 seasons, increasing from the northwest towards the southeast. The long-term average for the monthly cloud cover ranges from approximately 50 per cent in May-June to about 80 per cent in September–November.

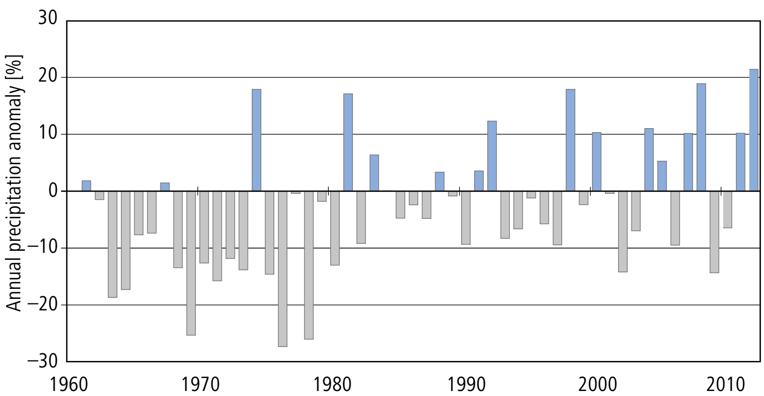
The average annual temperature has increased during the last 150 years by slightly more than one degree (Figure 2.4). The increase has been the greatest in springtime. Winters have become about one degree warmer and summers and autumns about half a degree warmer. Considerable temperature fluctuations have also occurred during this period. The winters of 1985 and 1987, for example, were very cold, whereas in the 1990s and during the present century there have been a number of mild winters. The culmination occurred in the winter 2008, which was the warmest measured since the beginning of the 20th century. Twentieth-century observations indicate that such a mild winter will occur only once every 200 years. However, climate

Figure 2.4
Annual mean temperature in Finland, 1847–2012, presented as anomalies [°C] for the reference period 1981–2010 in terms of mean temperature (the curve represents temperature variability per decade)



Source: Finnish Meteorological Institute

Figure 2.5
Annual mean precipitation in Finland, 1961–2012, presented as anomalies [%] for the reference period 1981–2010 in terms of mean precipitation



Source: Finnish Meteorological Institute change projections suggest that by 2050, one in five winters will be as warm as, or warmer, as the record mild winter of 2008.

The average annual precipitation shows significant variations from year to year (Figure 2.5) and long-term changes in precipitation are obscured by the natural variability in the precipitation levels. The national average precipitation in 2012 was the highest in Finland since the start of the gridded precipitation data set in 1961.

2.5 Economy

Finland has an open economy with prominent service and manufacturing sectors (Figure 2.6). As a member of the European Union and euro area, Finland's economy is integrated with the economies of other EU countries. The main manufacturing industries include electrical and electronics, forest and metal and engineering industries. Foreign trade is important, with exports accounting for approximately 40 per cent of the gross domestic product (GDP). The cold climate, energy intensive industry structure and long distances have led to a relatively high energy intensity and per capita greenhouse gas emissions.

For several decades, the Finnish economy was characterised by rapid growth combined with vulnerability to international cyclical fluctuations. Finland went through severe economic recessions in the early 1990s and again in 2008–2009 (Figure 2.7). The economy recovered rapidly after the first recession, and between 1994 and 2007 output grew by nearly 5 per cent and exports by more than 10 per cent per year. The growth rate was lower but still more than 3 per cent in the years 2001–2007.

During the 2008–2009 recession, the Finnish economy contracted by 10 per cent in the peak-to-trough period. The Finnish economy has still not recovered from the deep recession that began in 2008. The economy showed healthy growth in 2010–2011, but since then it has once again stagnated. World trade has already recovered to the same levels seen before the finan-

Figure 2.6
Structural changes in the economy

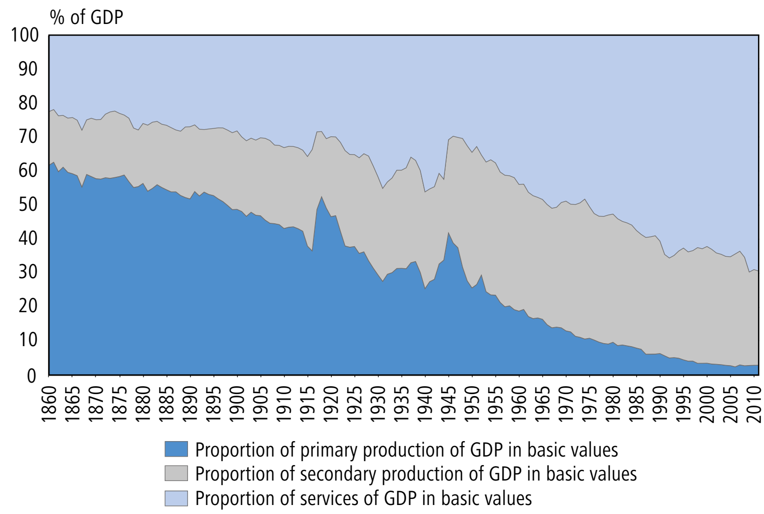
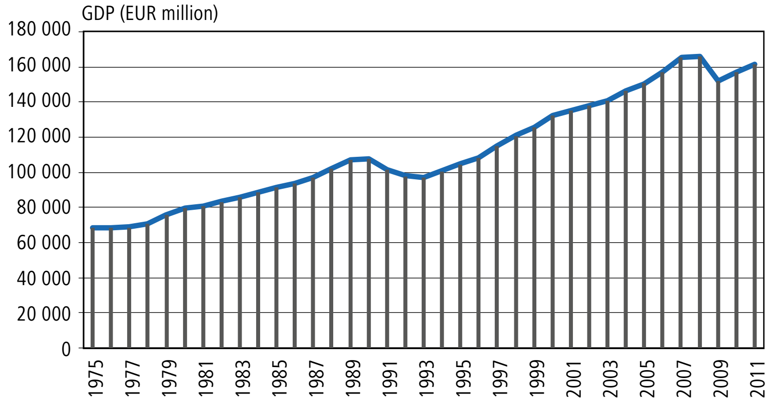


Figure 2.7
Gross domestic product, 1975–2011 (at 2000 prices)

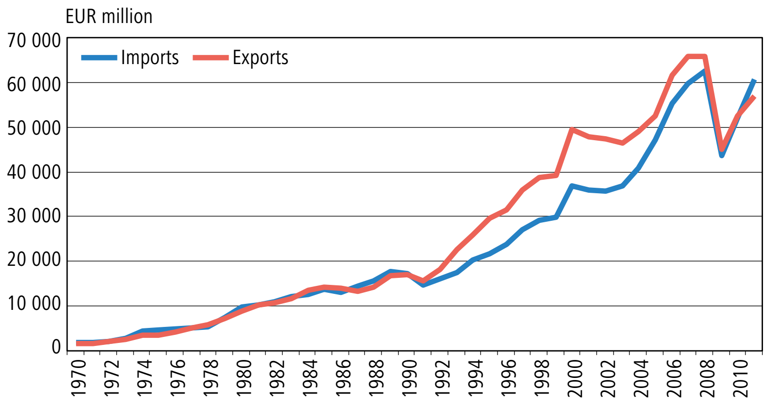


cial crisis, but Finnish exports remain well below their pre-recession levels. The output of the national economy stood at EUR 194,000 million in 2012. It is predicted that GDP growth will remain sluggish. Net national income describing the income of the national economy declined by two per cent in real terms, and growth in a household's real income was almost stagnant for the second year in a row. Investments decreased, but demand was maintained by consumption.

After a long period of strong growth, Finland's productivity performance has weakened recently, reflecting not only a weak performance in information and communication technologies but also in the public sector. Over the ten-year period before the recession in 1998–2008, total productivity trend growth averaged 1.8 per cent per year. Potential output growth is expected to accelerate in the next few years together with the rebounding of total productivity. However, the growth rate will remain very modest.

Whereas domestic demand has proved relatively resilient so far, exports are once again weakening. Exports remain more than 20 per cent below their 2008 peak, and the ongoing deceleration in global growth will lead to a further weakening in demand (Figure 2.8). Finland's weak export performance, which has been especially clear in the information and communication technology (ICT), forestry and metal industries, reflects falling demand

Figure 2.8
Finland's imports and exports, 1970–2011 (at current prices)



for many products that Finnish firms produce for the global market. To some extent, this development reflects a normalisation of the ICT sector's performance, following a lengthy boom period. Finnish exports are highly cyclical and the final extent of the structural adjustment in the traditional export sectors remains unclear.

Finland imported nearly 62 million tonnes of goods in 2011. A fifth of the weight of the imported goods was biotic, in particular agricultural and forestry products, refined wood products and food. The import volume of food (2.3 million tonnes) doubled in the past decade, and that of wood products grew even more. However, a majority of imported goods were abiotic, mainly energy minerals, oil products, chemicals, ores and metals. The single largest product groups were crude oil (11.2 million tonnes), coal, gas and iron ore.

The volume of exports was 45 million tonnes in 2011. The export volume of biotic products was nearly the same as that of abiotic products. In addition to wood and paper products, the highest volumes were seen in oil products, chemicals, base metals and stone products. The export volumes in the forest industry were clearly lower than during the early years of the millennium. The export volumes for abiotic products were larger than those for biotic products for the first time in 2009. The degree of refining in exported goods is clearly higher than in imported goods.

The value of Finland's exports was EUR 57,000 million in 2011 and 2012. The imports, which decreased by two per cent, amounted to EUR 59,000 million in 2012. Oil products were the most important growth area in exports. The export volumes for many electrical appliances and foodstuffs also increased. The long-term decrease in the communication equipment exports continued. Exports to non-EU countries grew by four per cent in 2012, whereas exports to other EU countries diminished by four per cent. Imports from other EU countries declined by one per cent, while imports from non-EU countries decreased by four per cent. Exports to the eurozone declined by three per cent and imports by two per cent. Exports to the eurozone decreased slightly less than to all EU countries.

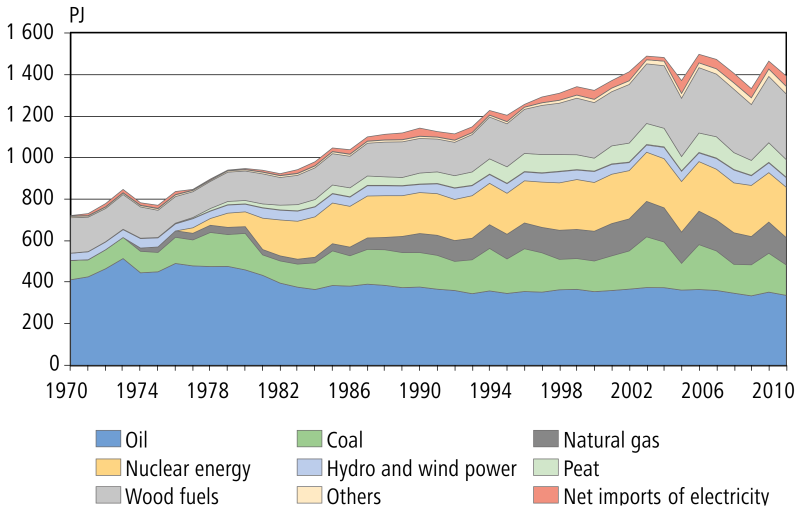
The increase in the price of crude oil, foodstuffs and certain chemical industry products kept the value of the total imports in 2012 nearly at the same level as the year before, although electro-technical imports as well as the import volumes for metals, machinery and means of transport decreased.

2.6 Energy

2.6.1 Energy supply and consumption

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 hydropower stations and the 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 Russia to eastern Finland was completed in 1973 and later extended to the capital area and to some

Figure 2.9
Total energy consumption, 1970–2011

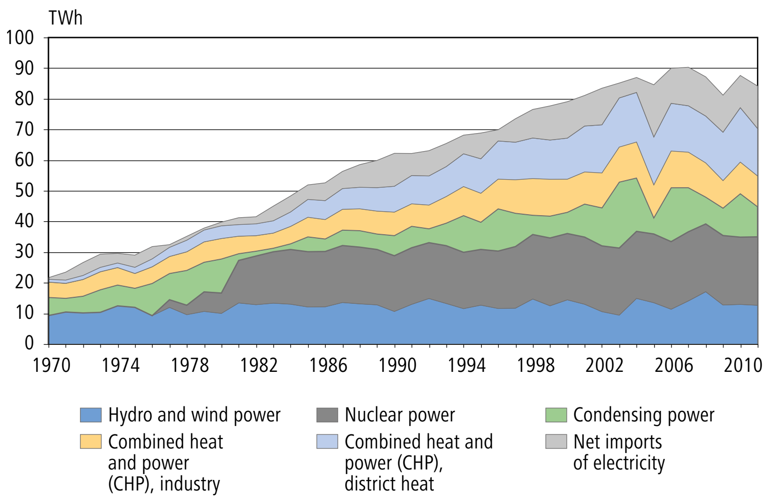


other cities. The first nuclear power unit was taken into use in 1977, followed by three other units in the years 1979–1982. A fifth unit is currently under construction and is expected to be completed in 2016. The 1970s also brought peat into the Finnish energy mix (Figure 2.9).

In 2011, the total energy consumption was 1,392 PJ. Finland's domestic energy sources are wood-based fuels, hydropower, wind power and peat. Its energy dependence, calculated as the proportion of imported net energy in the total primary energy supply (TPES), was 54 per cent in 2011. In reality, Finland relies more on imports than this energy dependency figure indicates, as the indicator considers nuclear energy to be domestic.

Electricity generation was 73.5 TWh in 2011. This consisted of combined heat and power production (36 per cent), both in connection with district heat production and by industry for its own use, nuclear power (32 per cent), hydropower (17 per cent), conventional condensing power (14 per cent) and wind power (1 per cent) (Figure 2.10). Electricity consumption was 84.4 TWh.

Figure 2.10
Electricity supply by production mode, 1970–2011



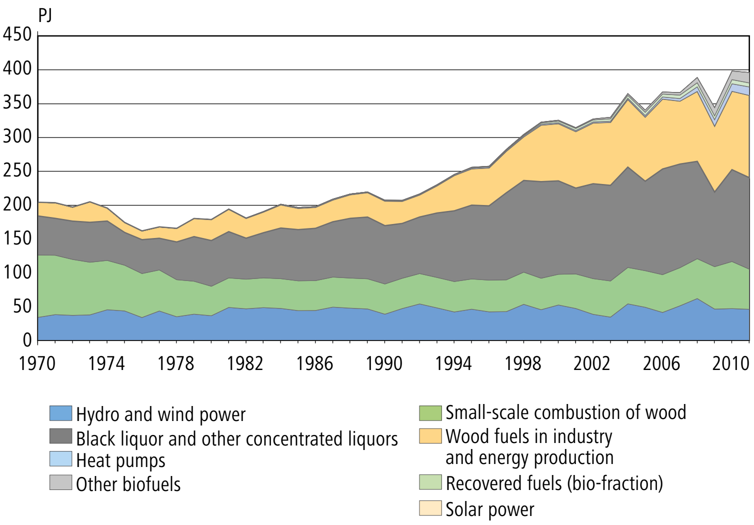
The power system is interconnected with systems in Russia, Sweden, Norway and Estonia. A second sea cable to Estonia, EstLink 2, is under construction and is expected to be commissioned by the beginning of 2014. Net imports from the Nordic market and Russia vary considerably from year to year, mainly due to variations in hydropower production in the Nordic countries. Between 1990 and 2011, maximum net imports were 17.0 TWh (in 2005) while minimum net imports were 3.7 TWh (1996).

Renewables accounted for 12.5 per cent of final energy consumption within the EU in 2010. In Finland, the corresponding figure was consistently around 29 per cent for the period 2000–2007, but it has increased over the last years, reaching 33 per cent in 2011 (Figure 2.11). In 2010, an extensive package of obligations concerning renewable energy was launched in order to reach the EU 2020 renewable energy target set for Finland, i.e. 38 per cent of its overall energy consumption. The package promotes the use of forest chips and other wood-based energy in particular, alongside wind power, the use of transport bio-fuels, and the increasing utilisation of heat pumps (see Section 4.7.1).

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 approximately corresponds to 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 12 per cent. Installed wind power capacity has increased steadily in Finland since 1990 as a result of the Government's support measures. The capacity was only about 1 MW in 1992, whereas it climbed to 82 MW in 2005 and reached 288 MW at the end of 2012.

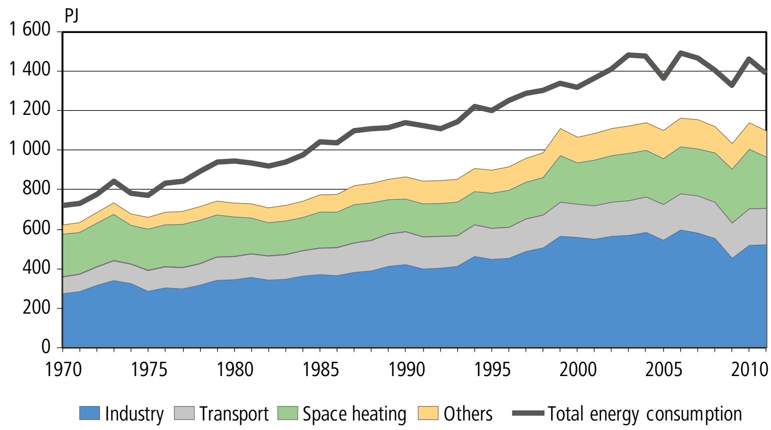
The use of fossil fuels and peat in energy production causes considerable CO_2 emissions (see also Section 3.2.1). Nevertheless, the CO_2 emissions per total primary energy unit are lower than in many other European countries. This is due to the quite high share of non-fossil energy sources in power and heat production, i.e. hydro, nuclear and biomass sources.

Figure 2.11
Renewable energy sources, 1970–2011



For several decades the use of primary energy as well as electricity were increasing and they reached their peak values in 2006–2007. Demand rose more rapidly than GDP until 1994. Thereafter, both the energy intensity and the electricity intensity of the economy have decreased. The decrease reflects the structural change within the economy from basic industry towards services and less energy-intensive industry. Industry is still the largest energy consuming sector, with a 47 per cent share of final energy consumption in 2011 (Figure 2.12). Space heating accounted for 24 per cent and transport for 17 per cent of energy consumption, while the share of energy used for other purposes was 12 per cent. Industry consumed 48 per cent of electricity, households 26 per cent and services and the public sector consumed 20 per cent of electricity.

Figure 2.12
Total energy consumption and final energy consumption by sector, 1970–2011



2.6.2 *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 generation sector is characterised by a large number of actors. The total number of companies producing electricity is around 120 and the number of production plants is around 550. To serve Finland's 3.1 million electricity customers, there are currently 73 retail suppliers.

The Finnish electricity wholesale market is part of the Nordic power market. For more than a decade, Finland has formed an integrated wholesale electricity market together with Denmark, Norway and Sweden, and since 2010, Estonia. The Nordic power market is also connected to the Central Western European electricity market. Physical day-ahead and intra-day trading takes place in the Nordic power exchange Nord Pool Spot. The formulation of area prices and the allocation of cross-border capacity between Finland and the other Nordic countries and Estonia are managed by implicit auctions in the power exchange's day-ahead market. The share of electricity consumed in Finland and sourced through Nord Pool Spot was 57 per cent in 2011. Electricity is also traded on the OTC market and directly between the buyer and the seller.

The system operator Fingrid Oyj is responsible for managing the national power balance and ensuring that the transmission system is maintained and used in a technically appropriate manner. Together with the other Nordic system operators, Fingrid is responsible for safeguarding the necessary reserves for the operation of the power system.

The natural gas market in Finland is relatively isolated and small. There is only one importer and wholesale supplier: Gasum Oy. The largest natural gas user groups are the energy companies, the pulp and paper industry and the chemical industry; together, they use approximately 95 per cent of the gas. There are 23 natural gas retail suppliers and approximately 36,000 retail customers. The retail supply of natural gas covers only about 5 per cent of the total gas consumption. 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 of natural gas 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 the functioning of all energy markets, such as the oil and heating markets. The ministry monitors both the market situation and the level of security for energy supply. Where necessary, it presents initiatives for improving the functioning of the markets.

Emissions trading within the EU has become a significant factor on the energy market. Finland's Emissions Trading Act (683/2004) applies to the CO_2 emissions from combustion installations with a thermal input of more than 20 MW, to smaller combustion installations connected to the same district heating network, to mineral oil refineries, to coke ovens and to 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. The new Emissions Trading Act (311/2011) will be in force from 2013 onwards (see Section 4.3).

2.7 Transport

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

The Finnish transport network consists of roads, rail transport, waterways and the air traffic infrastructure, the main elements of which form part of the EU's Trans-European Networks. The Finnish road network has approximately 78,000 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 780 km of motorways and 120 km of semi-motorways. The rail network amounts to a total of 5,900 km, of which 3,200 km is electrified.

Three quarters of Finland's foreign trade go 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 22 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.

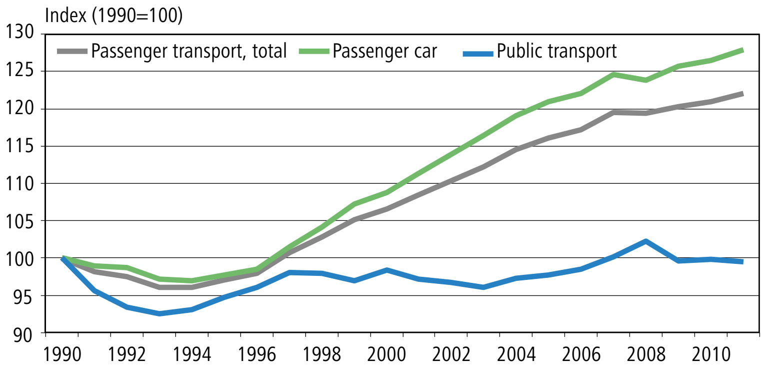
Finland has a network of 28 airports, of which 25 are maintained by Finavia (formerly the Civil Aviation Administration). Approximately 95 per cent of the country's international air traffic operates via Helsinki-Vantaa Airport.

2.7.1 Passenger transport

Domestic passenger transport, measured in terms of passenger-kilometres, has increased by approximately 22 per cent since 1990. Cars account for approximately 83 per cent of the total passenger-kilometres. Since 1990, the number of passenger-kilometres travelled by car has grown by 28 per cent, while in 2011 the number of passenger-kilometres by public transport was at the 1990 level (Figure 2.13). Rail and air travel have increased, whereas the use of buses has decreased in terms of passenger-kilometres. Greenhouse gas emission trends in the transport sector are presented in Section 3.2.2.

For international rail traffic, the number of passenger-kilometres has increased by 49 per cent, while the figure has more than doubled for international air traffic.

Figure 2.13
Development of passanger-kilometres in domestic transport, 1990–2011

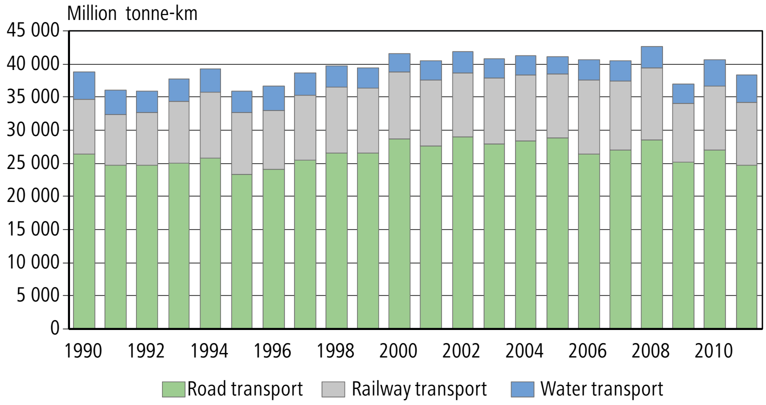


2.7.2 Freight transport

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 industries all need transport for their raw materials and products. The structural change in manufacturing has resulted in 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 (Figure 2.14). More than 66 per cent of all freight is transported by road, while rail transport accounts for 24 per cent of all transport and inland waterways for just under one per cent of all transport. Air transport's share is almost negligible.

Figure 2.14
Tonne-kilometres in domestic goods transport, 1990–2011

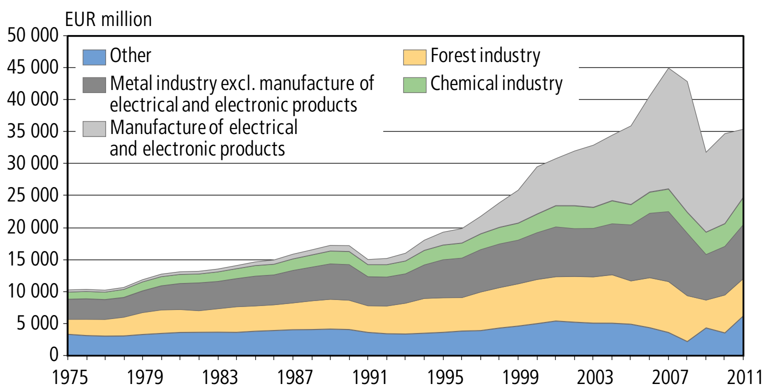


Since 2000, Finland's international freight transport has increased by approximately 46 per cent when measured in terms of the tonne-kilometres in goods transport. Almost 99 per cent of this overseas freight travels by sea, while approximately one per cent travels by road. Air freight is almost negligible in terms of tonne-kilometres, whereas in terms of value it accounts for more than 6 per cent of all transport. Products with a high added value, such as electronics, are transported by air.

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 undergone a profound change, and this has occurred at a very fast rate starting in the mid-1990s. 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.

Figure 2.15
Output of manufacturing industries by sector, 1975–2011 (at 2000 prices)



The proportion of the GDP accounted for by the forest industry, one of Finland's traditional industrial sectors, was still 6 per cent in 2000, but by 2011 this had fallen to 2.5 per cent. This occurred despite the increasing proportion of higher value added products in this sector. Currently, the forest industry is undergoing a structural change as manufacturers downsize their capacity in Finland and shift new investments to regions with a high end-product consumption potential and low operating costs.

The impact of the high-tech industry, mainly communications, is significant. Its relative share of the Finnish economy is the highest in any of 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 the GDP.

Until the 1980s, Finnish industry was almost entirely domestically owned and the existing 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 2011, Finnish industry used 47 per cent of the country's total primary energy and 48 per cent of its total electricity (Figure 2.12).

Final energy consumption by the industrial sector consists of biomass (31 per cent), electricity (21 per cent), oil (14 per cent), purchased heat (13 per cent), natural gas (9 per cent), coal (8 per cent) and other energy sources (4 per cent) (Figure 2.16). The forest industry (55 per cent) uses more energy than any other industrial sub-sector; this is followed by the chemical industry (20 per cent) and the manufacturing of basic metals (14 per cent) (Figure 2.17).

A considerable number of the energy-intensive industries are export oriented. More than 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, between 1990 and 2010 industrial output almost doubled (measured in terms of value added in 2000 prices), while the final consumption of energy rose by only about one quarter.

Figure 2.16
Energy use in manufacturing by energy source, 2011

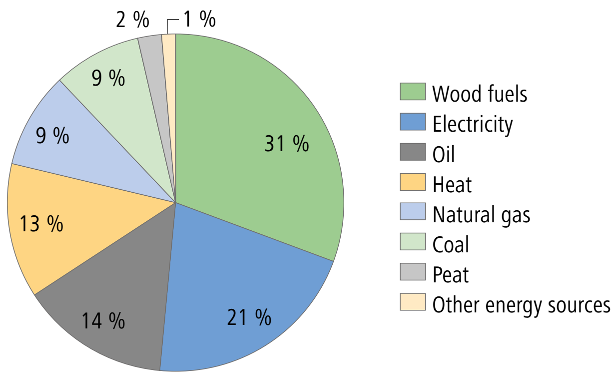
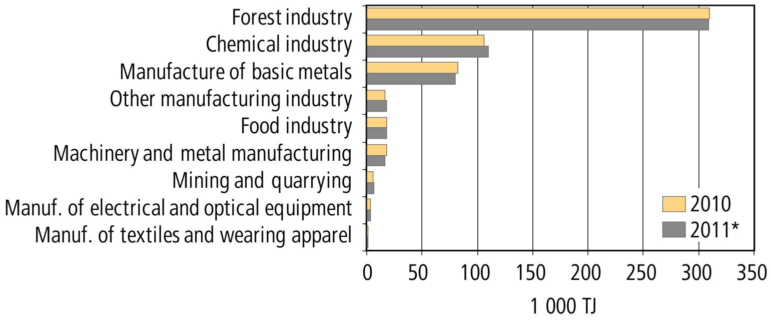


Figure 2.17
Energy use in manufacturing by industry in 2010 and 2011



* preliminary

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 produce energy in excess of 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 their search for higher profit margins, industrial installations have increasingly outsourced their electricity generation to the open electricity market.

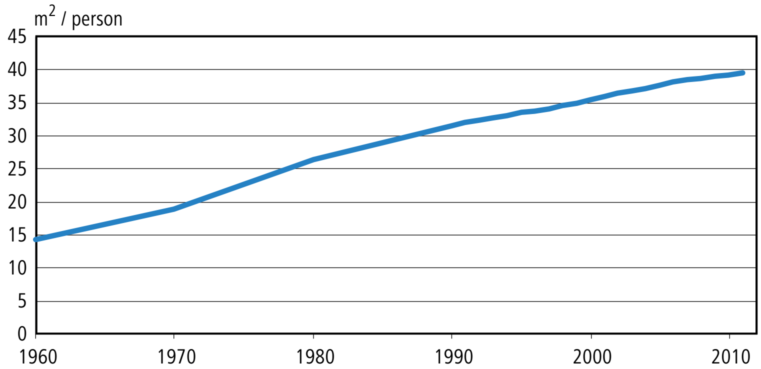
2.9 Building stock

Finland's largest cities are located in the south and western parts of the country, and the size of settlements tends to decrease towards the north and eastern parts of the country. Outside the 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 along the coast or inland at the intersections of the various lake systems.

In 2011, the total heated building area amounted to 442 million m². Residential buildings accounted for 63 per cent of the area, while office, commercial, public and industrial buildings made up 37 per cent of the area. The remainder consisted of free-time residences, agricultural buildings and other small outbuildings. There were 1,150,000 detached houses, 390,000 dwellings in attached houses (mainly semi-detached and terraced houses) and 1,250,000 dwellings in apartment blocks. The number of dwellings increased by 28 per cent between 1990 and 2011. In addition to 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. By 2011, it had increased by 6 m² to 80 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. It was 39 m^2 in 2011 compared with 19 m^2 in 1970 and 31 m^2 in 1990 (Figure 2.18). On average, Finns spent one fifth of their disposable income on housing in the year 2006; since then, there have been no radical changes in the share of income spent on housing. The building stock is fairly new, with only 11 per cent of all buildings having been constructed before 1940. More than 95 per cent of dwellings have flush toilets and more than 98 per cent of them have a sewer and running water.

Figure 2.18
Development of floor space m²/person, 1960–2011

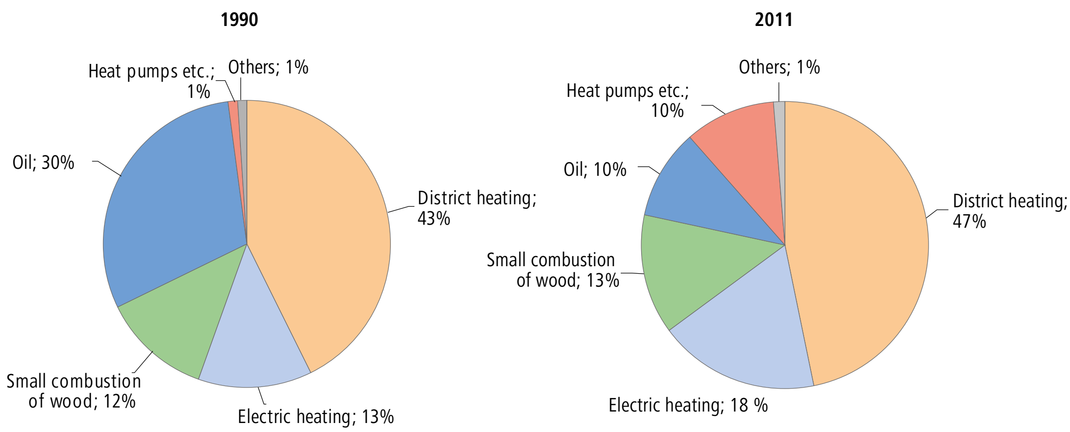


2.9.1 *Energy use for indoor heating*

Because of the country's northern location, a great deal of energy is used for indoor heating in Finland. It is the biggest source of CO_2 emissions by household and also within the public and service sectors (see also Section 3.2.1). However, during the past three decades the consumption of energy per unit of heated space has been reduced significantly. This is largely due to the tightening of the building regulations,which are being set since 1976. The figure for heating degree days (HDD) is a quantitative index designed to reflect the demand for the amount of energy needed to heat a building; it is calculated using a 17°C indoor temperature as the base. The HDD varied in Helsinki from 3,200 to 4,700 per year during the years 1981–2010. In Sodankylä, in northern Finland, the corresponding range was 5,500–7,300. Energy conservation has been aided considerably by technical advances in insulation and window designs, and also by developments in combined heat and power (CHP) production, district heating, heat recovery and air-conditioning and ventilation systems.

Between 1990 and 2011, the composition of energy sources used for heating changed significantly (Figure 2.19). The use of heavy fuel oil has decreased by 70 per cent and the use of light fuel oil by 53 per cent. At the

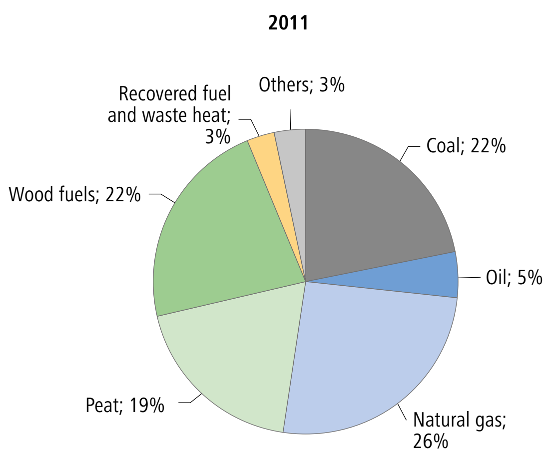
Figure 2.19
Heating energy used in residential, commercial and public buildings, 1990 and 2011 (the category 'others' mainly consisted of natural gas in 2011)



same time, energy obtained from natural gas has more than doubled. Light fuel oil has lost some of its market share to electric heating and later also to ground heat pumps in detached houses. The share of heat pumps was only one per cent in 1990, but in 2011, their share was equal to that of oil: 10 per cent. In the last four years, the energy obtained from heat pumps has increased by 150 per cent. The increase in the use of heat pumps is due to economic and environmental reasons as well as to advances in technology. The small-scale combustion of wood has increased by 41 per cent since 1990. It is often used as a secondary heating system, but in rural areas it is also used as the principal heating source. Electric heating has increased by 83 per cent and district heating by 41 per cent since 1990. The share of district heating was 47 per cent of the total heating energy in 2011. District heating is the primary heating system in apartment blocks, and one half of the country's total building stock relies on it.

A wide range of fuels is used to produce district heat (Figure 2.20). 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 in the form of by-products from the forest industry. The district heating network now covers most areas with a cost-efficient potential. CHP accounts for 76 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 2.20
Fuels used in district heating production in 2011

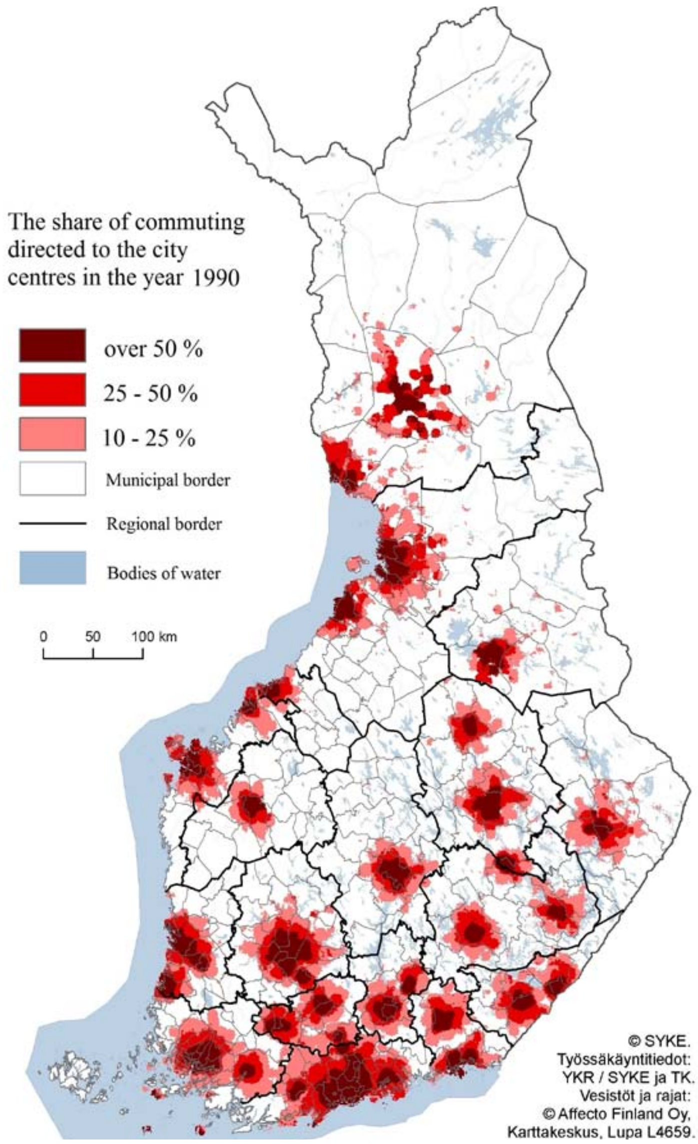


2.9.2 Urban structure

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, 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 in 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. Growth has occurred as well in many other urban areas due to migration. In rural areas, however, the population has been declining for many years. The population of remote villages has also been declining, whereas villages closer to the growing urban regions have grown.

In 2010, the combined population of the 34 largest urban areas in Finland was 3.6 million, an increase of 704,000 since 1990. These urban areas contained 69 per cent of the total population in 2010 (60 per cent in 1990), and in 2009 they had 77 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 only approximately one per cent of the surface area of the country. Population growth is concentrated very clearly around the largest urban centres, especially in the south of the country.

Figure 2.21
Share of commuting directed towards city centres, 1990

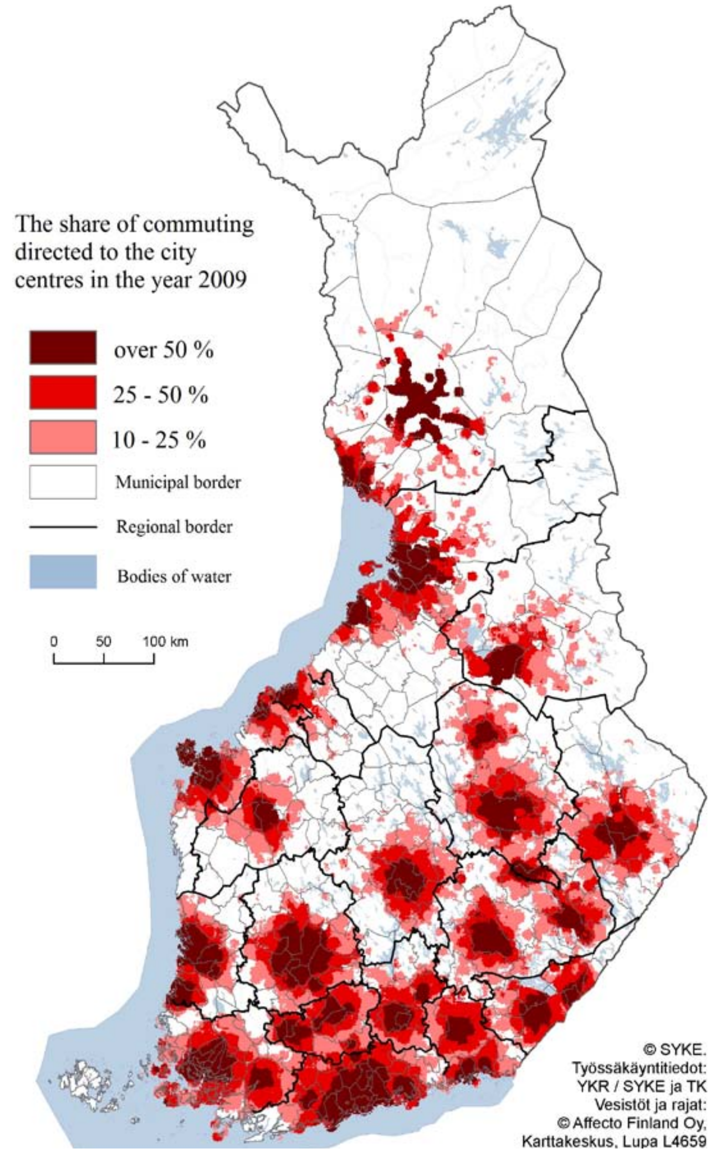


Source: Finnish Environment Instutute, Statistics Finland

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 83.1 per cent of the population in 2010. There are 735 built-up areas covering approximately two per cent of the land area. In 1990, the corresponding proportion was 1.2 per cent. The population density in these built-up areas was 695 inhabitants per km² in 2010. However, the density has declined by 103 inhabitants per km² since 1990 as the lower density fringes of these built-up areas have grown. Compared with the other Nordic and European countries, the population density of these built-up areas is quite low. It is less than half the population density of 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 ar-

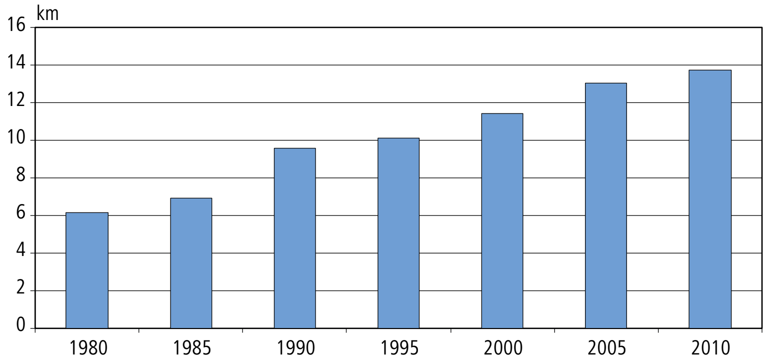
Figure 2.22
Share of commuting directed towards city centres, 2009



Source: Finnish Environment Instutute, Statistics Finland eas. 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 outside the urban plan cover some 28 per cent of the land surface of the country's urban areas — even in the main growth centres. This development can be seen in Figures 2.21 and 2.22, which show the development in commuting to city centres from 1990 to 2009. Arranging services for the low-density urban areas is quite difficult. Many of the households in these areas 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 the country's economic, regional and urban structure, the average daily one-way commuting distance has more than doubled in just 30 years, to 13.7 km, as shown in Figure 2.23.

Figure 2.23
Average daily commuting distance, 1980–2010



Source: Finnish Environment Institute, Statistics Finland

2.10 Agriculture

Farming in Finland is possible as a result of the warming effect of the Gulf Stream, which makes temperatures 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 more than +5°C) varies from nearly six months in the south to between two and three months in the north. The growing season in Finland is too short for many 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 affecting the feasibility of crop production. Cultivation of wheat and oilseed plants is restricted to southern Finland, whereas barley, oats, grass and potatoes can be cultivated in most parts of the country. In many parts of Finland, livestock farming, especially dairy farming, is the only profitable form of agricultural production.

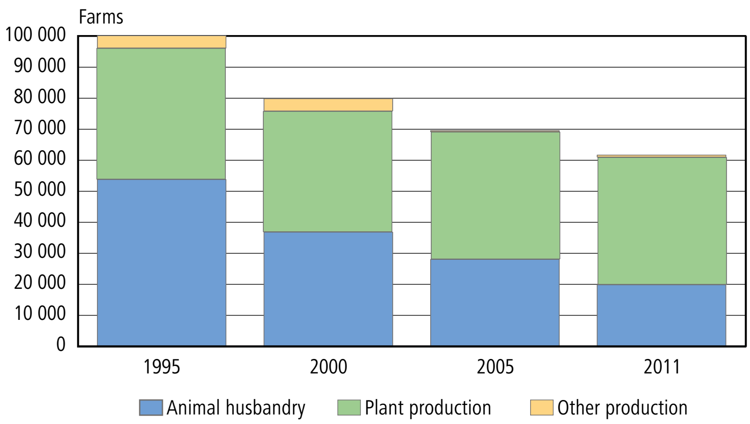
Finnish agriculture is based on family farms. In 2011, private persons owned more than 88 per cent of the farms, while heirs and family companies owned more than 10 per cent of farms and the state, municipalities and other communities about 1 per cent of farms.

Between 1990 and 2011, the number of active farms fell from 130,000 to 62,000 (Figure 2.24). At the same time, the average farm size increased from 17 to 37 arable hectares. Total agricultural production has remained at almost the same level since 1990. The area cultivated as arable land has decreased about 5 per cent since 1990. In 2011, the cultivated arable land area was 22,490 km^2, or approximately 7.4 per cent of the total land area. Structural changes in agriculture have also led to a reduction in greenhouse gas emissions from the agriculture sector (see Section 3.2.5)

More than 65 per cent of the active farms practice crop production as their main line of farming. The share of grassland crops was 29 per cent, while the share of barley was 20 per cent, oats 14 per cent and wheat 11 per cent in 2011. These shares have remained fairly stable since 1990. By comparison, the number of dairy cows decreased in this period from 490,000 to 280,000. Dairy production is the main production line of farming, with just over 17 per cent of the farms engaging in it. Approximately 6 per cent of farms specialise in beef production and 4 per cent in pig husbandry, while 4 per cent of farms are poultry farms. The share of other production lines (sheep and goat husbandry and reindeer herding) is approximately 6 per cent. About 7 per cent of all farms are organic.

In 2011, agriculture, forestry, hunting and fishing together accounted for 2.9 per cent of Finland's gross domestic product (GDP). The economic significance of the total food chain 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 approximately 300,000 people (excluding the retail trade). By 2011, the agricultural labour force accounted for 3.6 per cent of the national labour force. This is still considerably higher than the percentage of the GDP accounted for by agriculture (1 per cent). Agriculture is the most important employer in the countryside and, alongside forests, the dominating element in the rural landscape.

Figure 2.24
Number of farms by production sector, 1995–2011



Source: Finnish Environment Institute, Statistics Finland

As a member of the EU, Finland follows the Common Agricultural Policy (CAP, see also Section 4.7.5). The CAP is nationally implemented and aims to develop the agricultural production of the European Union in a balanced way, while taking the environment, climate and animal welfare into consideration. One important aim of the CAP is also to promote the vitality of rural areas.

2.11 Forestry

In Finland, forestry land covers 26 million hectares, or 77 per cent of the total area (incl. inland waters). Land classified as forestry land consists of the subcategories of forest land, poorly productive land and unproductive land. Of the total land area, 20 million hectares is classified as forest land according to the national definition, which is 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 significance of forests for the national economy and society at large has been at its greatest in Finland.

There are approximately 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 one half of the forest land area consists of mixed stands.

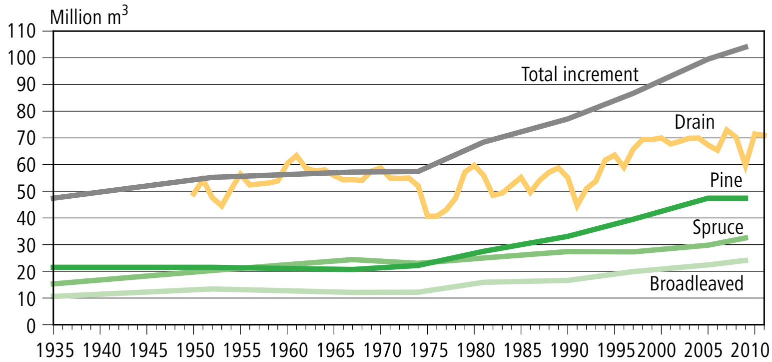
Finland's forest policy aims at sustainable forest management. The aim is to ensure the welfare founded on the use of forests and the diversity of the forest nature. Policy measures include the Forest Act and other legislation, Finland's National Forest Programme 2015, financing and public forestry extension organisations (see Section 4.6: National forest legislation and programmes).

Finnish forests are managed in a sustainable manner. About one third of the forests are regenerated naturally, while two thirds are generated artificially by using indigeneous tree species with local provenance. 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 seed 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, which accounts for approximately 118,000 hectares annually. Every year, 160 million seedlings are planted in the forests.

The total volume of Finland's forest stock amounts to 2,306 million m^3. The growing stock volume has been increasing for a long time, mainly because the growth in forest volume has exceeded the harvesting volumes and natural drain (Figure 2.25). In 2011, the total drain was 71 million m^3, while the total increment of the growing stock was 104 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, while other cutting, e.g. clear felling and seed and shelter wood felling, accounts for the other half.

The growing stock has increased by 80 per cent since the 1960s. Pine has contributed most to the increase due to the large number of young stands at

Figure 2.25
Total annual increment and drain of stemwood in Finland since the 1920s



Source: Finnish Forest Research Institute / National Forest Inventory

a rapid growth stage. The draining of mires in the 1960s and 1970s has also improved the growing conditions for trees in peatlands. This has also added to the increase in the growing stock.

More than 50 per cent of Finland's forests are owned by private individuals, 35 per cent by the state, about 8 per cent by private forest companies and the rest by other owners. The average size of a forest holding owned by private individuals is small, approximately 30 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.

Approximately EUR 200 million is invested every year in forest regeneration, young stand management and other silvicultural practices. More than two thirds of this amount is financed by private, non-industrial owners and the rest is covered by state subsidies. The raw material value of wood harvested annually was between EUR 1,200 and 2,500 million in the period 2007–2012, of which approximately 81 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.

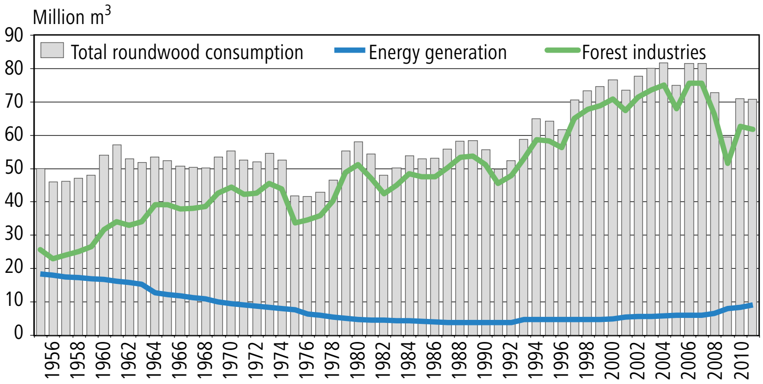
In 2011, the total use of round wood (raw, unmanufactured timber) in Finland was 70.6 million m^3. Approximately 90 per cent (61.6 million m^3) of this was used in the forest industry and 9.0 million m^3 was used for energy production (Figure 2.26).

Forests (trees and soil) absorb a significant proportion of Finland's carbon dioxide (CO_2) emissions. The forest sink varied between 22.4 and 48.2 million tonnes CO_2 eq. during the years 1990–2011, which represents 20–60 per cent of Finland's total emissions. The proportion has varied considerably due to fluctuating trends in emissions and forestry activity (see Section 3.2.6).

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 threefold increase in the area of protected forests over the last 30 years.

Thirteen per cent of the forest area (forest land and poorly productive forest 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 protect-

Figure 2.26
Total roundwood consumption, 1955–2011
(Between 1955 and 1992, roundwood consumption for energy generation also included marginal quantities of industrial roundwood used in other consumption categories, e.g. small-sized dwellings, traffic and civil engineering)



Source: Finnish Forest Industries Federation, Finnish Forest Research Institute

ed areas altogether account for 22 per cent of the forest area. In the south, the protected area is approximately 0.5 million hectares, which is 4 per cent of the forest area. Almost 70 per cent (more than 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 approximately 9 per cent.

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 was EUR 144 million for 2008–2012 (see also Section 4.6).

2.12 Waste

The amount of waste deposited in landfill sites has been significantly reduced by effective waste regulation. Finland's waste policy aims at preventing waste, increasing re-use and recycling, reducing landfilling and reducing the environmental impact of various forms of waste management (see Section 4.7.7).

In Finland, 96.6 million tonnes of waste were generated in 2011, an increase of 2 per cent from the previous year. The largest quantities of waste came from mining and quarrying and construction and manufacturing and they were primarily of mineral origin. The amount of mineral waste was 77.3 million tonnes, or 80 per cent of all waste. The amount of wood waste was 11.7 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. The amount of solid municipal waste generated in Finland in 2011 was 2.7 million tonnes. Though accounting for only 3 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 (see also Section 3.2.8). The amount of solid municipal waste has continued to grow in recent years, aside from the years 2009 and 2010. In 2011, the amount increased by 8 per cent over the previous year's figure. Municipal waste generation in total was 503 kg per capita in 2011, which was also the EU average.

The manufacturing industry generated 13.8 million tonnes of waste in 2011. The largest quantities of manufacturing waste were waste wood and bark, slag from the basic metal industry and various other types of waste, especially gypsum, from the chemical industry.

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

In 2011, the waste recovery rate was 46 per cent, i.e. 44.3 million tonnes of waste was recovered; altogether, 33.9 million tonnes of waste was recovered as material and 10.4 million tonnes as energy. The latter figure comprises mostly wood waste (almost 8.2 million tonnes). The wood waste was almost fully recovered, as 2.8 million tonnes of wood waste was recovered as material in addition to the high energy recovery rate. A total of 27.5 million tonnes of mineral waste was recovered as material in 2011.

In 2011, more than one half, or 59.8 per cent, of all municipal waste was recovered as material (34.8 per cent) or energy (25.0 per cent) (Figure 2.27). Sorting and the separate collection of municipal waste have been improved. The separate collection of biodegradable waste fractions from municipal waste has increased significantly in recent years and was 92 per cent in 2011. According to the Finnish Forest Industries Federation, 70 per cent of paper waste (e.g. newspapers, printed paper and cardboard) was recycled in the year 2011, which is the same as the average rate in Europe.

At the end of the 1990s, almost 65 per cent of all municipal waste was disposed in landfills. The proportion of municipal waste sent to landfills has decreased every year since 2002 as a result of the increased waste recovery rate. In 2002, the proportion was 62 per cent, and in 2011 it amounted to 40 per cent, or 1.1 million tonnes.

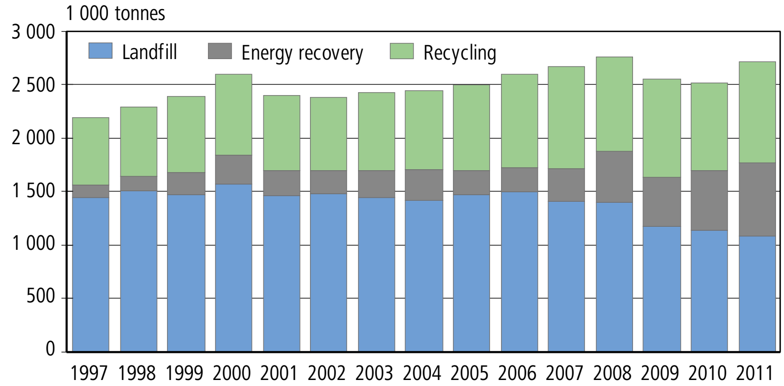
The share of waste incineration has increased considerably in the last two decades. Initially in the early 1990s, the focus of waste policy was on waste prevention and recycling. Only recently has waste incineration started to become more important in municipal waste management. There have been many investments in waste incineration plants beginning from the year 2006. In 2011, the incinerated amount accounted for 25.0 per cent of the total municipal waste. There was an increase of more than 20 per cent in the incinerated amount from 2010 to 2011. All waste incineration plants produce heat and electricity for municipalities and industry.

Table 2.2
Generation of waste in 2011

2011	Chemical waste	Wood waste	Mineral waste	Other waste 1)	Total
	1,000 tonnes per year				
Agriculture, forestry and fishing 2)		2,760			2,760
Mining and quarrying			56,910		56,910
Manufacturing	1,085	8,340	1,360	3,039	13,825
Energy supply	9	225	1,158	120	1,514
Construction		253	17,815	357	18,425
Service activities and private households	19	88	83	2,971	3,161
Total	**1,113**	**11,666**	**77,326**	**6,487**	**96,595**
of which hazardous waste	343	33	248	320	944

1) Metallic waste, Glass waste, Paper and cardboard waste, Plastic and rubber waste, Animal and vegetal waste, Household and mixed waste, Sludges (dry weight)
2) Excluding organic waste utilised in agriculture and logging waste left on site

Figure 2.27
Municipal solid waste in Finland, 1997–2011



Sources: Finnish Environment Institute, Statistics Finland

2.13 Peatlands

Pristine peatlands are carbon accumulating ecosystems in the long term. Depending on weather conditions, a particular peatland can vary on a year-to-year basis from a net sink to a net source of emissions. It is estimated that since the last ice age, peatlands have accumulated some 5,400 million tonnes of carbon, forming the largest soil carbon stock in Finland.

Peatlands cover one third of the total land area in Finland, approximately 9.3 million hectares. Regional differences in coverage and drainage are considerable. The majority of the peatlands are located in the north (Lapland and Pohjanmaa-Kainuu), while only 7 per cent are in southern Finland. Conversely, most of the drainage has occurred in southern Finland. Approximately 6.3 million hectares of peatlands have been drained for forestry and about 0.3 million hectares for agriculture. The total area of undrained peatlands is approximately 4 million hectares.

Peat is a domestically important fuel source, one that currently represents approximately 6 per cent of the total primary energy supply. In view of its employment impact, it is also significant from a regional policy standpoint. The area used for the harvesting of energy and environmental peat is approximately 75,000 hectares. In 2011, the emissions from peat extraction areas were a source of 2.1 Tg CO_2 eq. The emissions mostly consist of CO_2.

Almost 13 per cent of Finnish peatlands — amounting to 1.2 million hectares — are protected. They consist mainly of areas under the national mire protection programme, areas in national parks and nature reserves, and old-growth forest conservation programme and wilderness areas.

In 2012, the Finnish Government approved a decision-in-principle on the sustainable and responsible use and protection of mires and peatlands. The decision directs human activities to peatlands that have been drained or whose natural state has otherwise been significantly changed, it is used to implement sectoral policies and measures for sustainable use, and it is used to improve the status of the existing network of protected peatlands. As a part of the decision-in-principle, a long-term peatland protection and restoration programme will be carried out by 2025.

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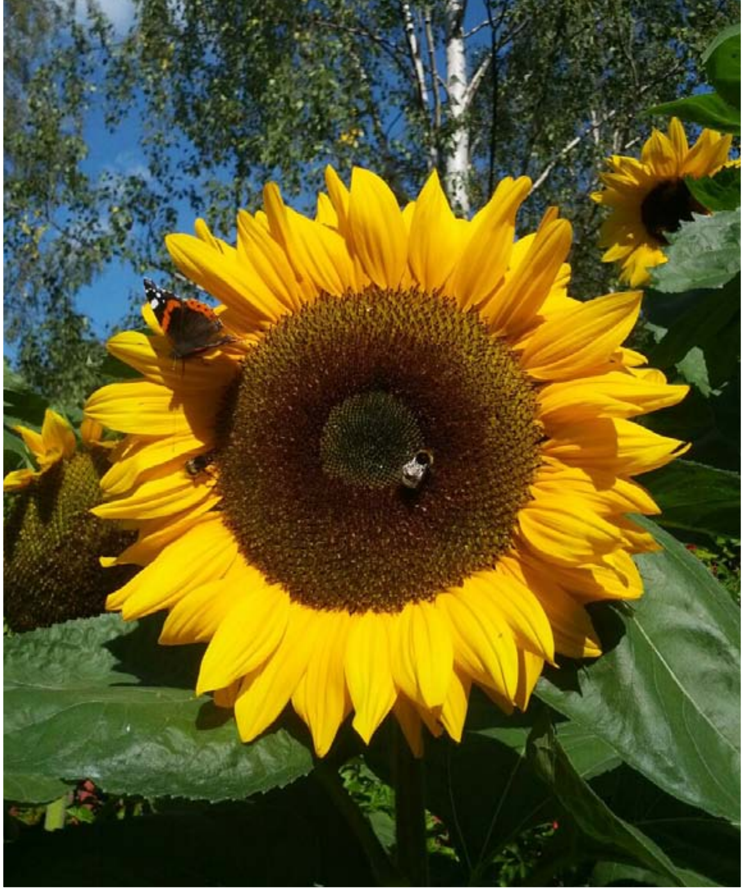


3 Greenhouse gas inventory information, including the national system and the national registry

This chapter describes Finnish greenhouse gas emissions and their development in 1990–2011 by sector. Thereafter, it outlines how the national greenhouse gas inventory is compiled and how the high quality of the inventory is guaranteed. Finally, the national registry and its functioning are explained.

Photo: Heikki Lehikoinen

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

3.1 Total greenhouse gas emissions and trends

In 2011, Finland's greenhouse gas (GHG) emissions totalled 67.0 million tonnes CO_2 equivalent (CO_2 eq.) (excluding land use, land-use change and forestry (LULUCF)). The total emissions in 2011 were approximately 5 per cent (3.4 million tonnes) below the 1990 emissions level. Compared to 2010, the emissions decreased by 10 per cent. According to the greenhouse gas inventory data for 2008–2011 and the preliminary data for 2012, the emissions in Finland during the first commitment period of the Kyoto Protocol were nearly 5 per cent (approximately 15.8 million tonnes CO_2 eq.) below Finland's assigned amount (approximately 355.0 million tonnes CO_2 eq.).The emission trends by sector are presented 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 fuels used to generate energy, including fuel used in transport and the fugitive emissions related to the production, distribution and consumption of fuels. In 2011, the energy sector accounted for 80 per cent of Finland's total greenhouse gas emissions (Figure 3.2). The second largest source of emissions was agriculture, with an emission share of some 9 per cent. Emissions from the industrial processes sector amounted to approximately 8 per cent. Emissions from industrial processes refer to emissions that result from the use of raw materials in industrial processes. Emissions from the waste management sector amounted to 3 per cent of the total emissions. The contribution of emissions from the

Figure 3.1
Finland's greenhouse gas emissions by sector, 1990–2011, excluding the LULUCF sector

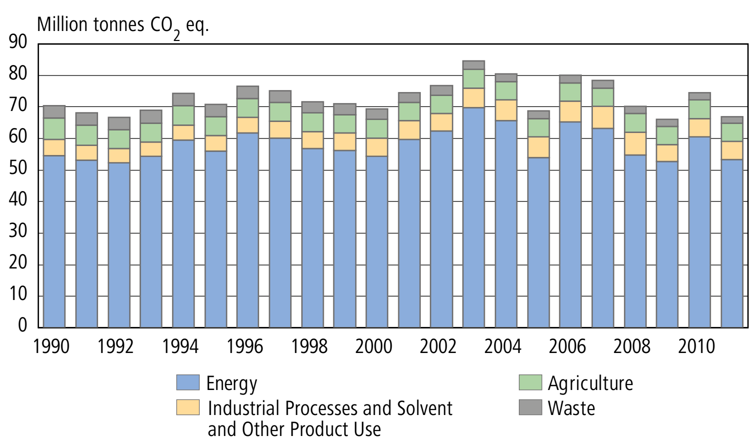
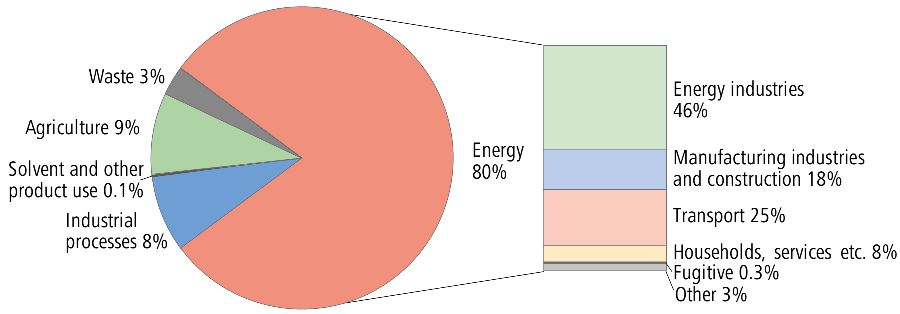


Figure 3.2
Greenhouse gas emissions by source, 2011, excluding the LULUCF sector
(67.0 million tonnes CO_2 eq.)



use of solvents and other products to the Finnish greenhouse gas emissions is small, about 0.1 per cent of the total.

The most important greenhouse gas in Finland is carbon dioxide (CO_2). The share of CO_2 emissions out of the total greenhouse gas emissions (excluding LULUCF) has varied from 80 to 86 per cent between 1990 and 2011. In absolute terms, CO_2 emissions were 0.2 million tonnes lower in 2011 than in 1990. Around 92 per cent of all CO_2 emissions originated from the energy sector in 2011. The amount of energy-related CO_2 emissions has fluctuated greatly according to the economic trend, the energy supply structure and climate conditions. Methane (CH_4) emissions have decreased by 33 per cent from their 1990 level. This is mainly due to improvements in waste treatment and a contraction in animal husbandry within the agricultural sector. Correspondingly, emissions of nitrous oxide (N_2O) have also decreased by 29 per cent; the biggest decline occurred in 2009 when the implementation of N_2O abatement technology in nitric acid production plants reduced emissions significantly. Another reason for the decrease in emissions has to do with reduced nitrogen fertilisation of agricultural fields. In 2011, the F-gas emissions (HFCs, PFCs and SF_6) were nearly eleven times greater than the emissions in 1995 (base year for F-gas emissions). A key driver behind the growing emission trend has been the substitution of ozone depleting substances (ODS) by F-gases in many applications.

In Finland, the LULUCF sector is a net sink, that is, the volume of greenhouse gas emissions it removes from the atmosphere is higher than what it emits. This sector is not included in the total national emissions; but it is reported separately (Table 3.1, Figure 3.3). In 2011, the net sinks amounted to 24.6 million tonnes CO_2 eq. The net sink in the LULUCF sector has varied from approximately 20 to 60 per cent of the annual emissions for the other sectors during the years 1990–2011. Most of the removals in the LULUCF sector come from tree biomass growth.

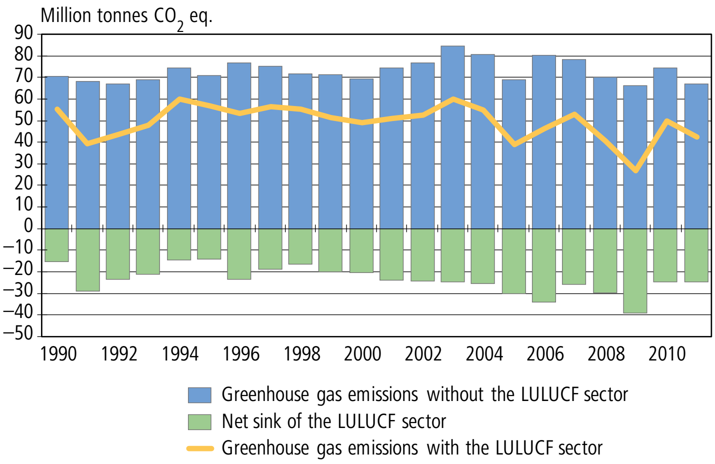
The majority of the CO_2 emissions originate from energy production based on the combustion of fossil fuels and peat. Peat is not a fossil fuel as such, but lifecycle studies indicate that the climate effects of peat combustion are comparable with those of fossil fuels. The CO_2 emissions from wood combustion are not included in the total national emissions but are reported separately. CO_2 emissions from combustion in energy production totalled 52 million tonnes in 2011. The production and use of energy also generate methane and nitrous oxide emissions. The majority of the methane

Table 3.1
Greenhouse gas emissions (+) and removals (–) by sector, 1990, 1995 and 2000–2011 (million tonnes CO_2 eq.)

Sector	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Energy	54.5	56.1	54.5	59.8	62.3	69.9	65.8	54.0	65.4	63.3	54.8	52.7	60.6	53.4
Industrial processes[1]	5.1	4.6	5.0	5.0	5.0	5.3	5.5	5.4	5.5	5.9	6.1	4.4	4.6	4.5
F-gases[2]	0.1	0.1	0.6	0.7	0.5	0.7	0.8	0.9	0.8	1.0	1.1	0.9	1.2	1.1
Solvent and other product use	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	0.1
Agriculture	6.7	6.1	5.9	5.8	5.9	5.9	5.8	5.8	5.8	5.8	5.9	5.8	6.0	5.9
Waste	4.0	3.9	3.3	3.1	2.9	2.7	2.6	2.4	2.5	2.4	2.3	2.2	2.2	2.1
Total	**70.5**	**70.9**	**69.4**	**74.6**	**76.7**	**84.6**	**80.6**	**68.8**	**80.1**	**78.4**	**70.2**	**66.1**	**74.6**	**67.0**
Land use, land-use change and forestry[3]	−15.2	−14.1	−20.5	−23.7	−24.2	−24.7	−25.6	−29.9	−33.9	−25.7	−29.6	−39.3	−24.6	−24.6

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.

Figure 3.3
Finland's greenhouse gas emissions, 1990–2011, excluding the LULUCF sector (blue bars) and including the LULUCF sector (orange line). The green bar shows the net removals in the LULUCF sector.



emissions originated from waste management and agriculture in 2011. The majority of the nitrous oxide emissions originated from agriculture. F-gas emissions originate from the consumption of halocarbons and SF_6 and are reported in the industrial processes sector.

Finland's annual greenhouse gas emissions have varied considerably due to changes in electricity imports and the 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 using renewable energy sources (see trends by sector in Figure 3.4).

The trend in greenhouse gas 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 GHG/GDP ratio rose almost 15 per cent above the 1990 level. This was largely due to the economic recession, which led to a steeper fall in the GDP than in emissions. In 2011, the GHG /GDP ratio was more than 35 per cent below the

Figure 3.4
Greenhouse gas emission trends by sector, 1990–2011, excluding the LULUCF sector

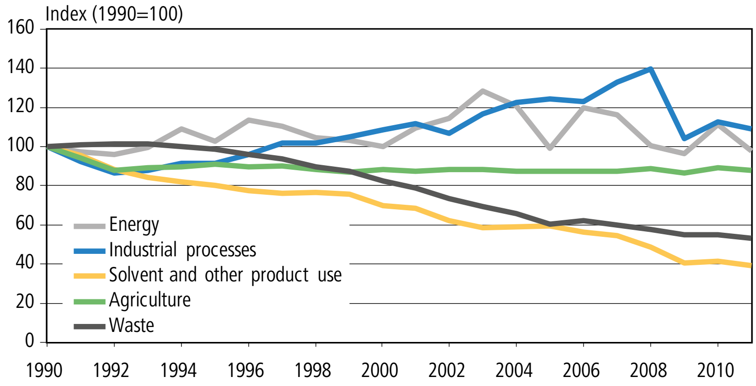
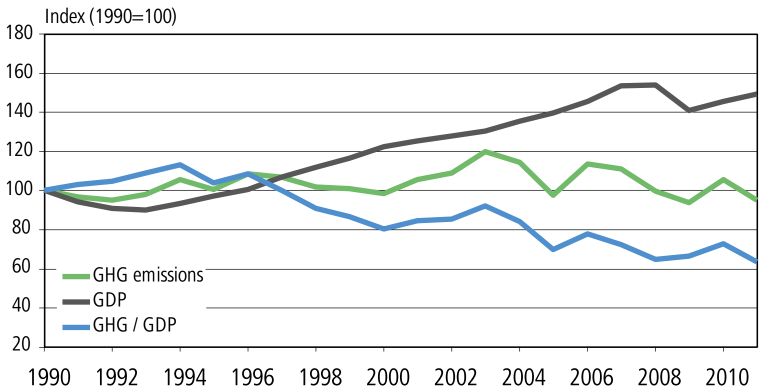


Figure 3.5
Greenhouse gas emissions relative to GDP, 1990–2011, excluding the LULUCF sector



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 2011, its share of the total greenhouse gas emissions, including transport, was 80 per cent (53.4 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 since 1990. The emissions from the energy sector are strongly affected by the availability of hydropower in the Nordic electricity market. If the annual precipitation in the Nordic countries is lower than usual, hydropower will become scarce and Finland's net imports of electricity will decrease. During such years, Finland has generated additional electricity using coal and peat in condensing power production for its own needs and also for sale on the Nordic electricity market. This can be seen directly in the emissions of the energy sector (Figure 3.6).

In 2011, the energy sector emissions were almost 12 per cent lower than in 2010, and they were 2 per cent lower than the 1990 level. CO_2 emissions in the energy sector decreased more than the total use of energy. Total energy consumption in Finland amounted to 1,392 petajoules (PJ) in 2011, which was 5 per cent less than in 2010. The reduction in emissions was due to a drop in Finland's condensing power generation as a result of the increased electricity imports due to a good water situation in the Nordic countries as well as warmer weather, which reduced the need for heating (Figure 3.7).

Of all fuels, the largest decrease (22 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. The consumption of peat decreased by 10 per cent.

Net imports of electricity increased by 32 per cent compared with 2010. A proportion of Finland's condensing power production was replaced with electricity imports and domestic wind power, thus reducing the consumption of coal and other fuels in power production (Figure 3.8).

Renewable energy accounted for about 26 per cent of the total energy use in 2011. Among renewable energy sources, the consumption of wood fuels decreased by some 2 per cent compared to the previous year, but the consumption of wind power increased significantly.

In 2011, the emissions from the combustion of fossil fuels and peat in electricity and district heat production amounted to 24.6 million tonnes

Figure 3.6
Greenhouse gas emissions in the energy sector, 1990–2011

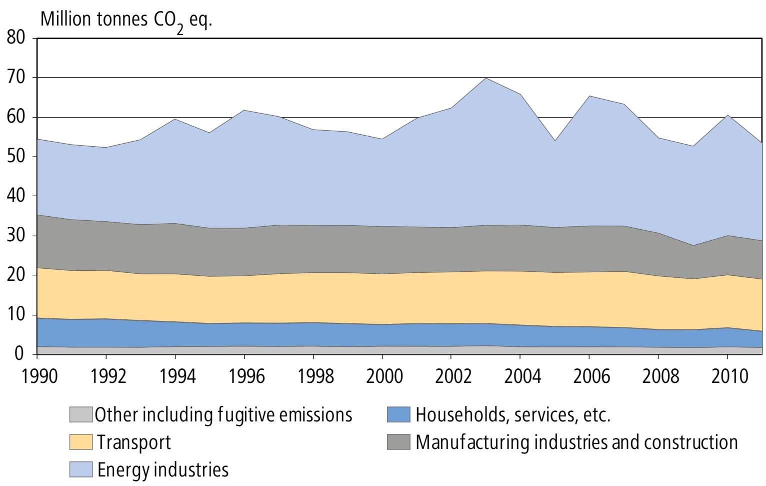


Figure 3.7
Total energy use relative to energy sector greenhouse gas emissions, 1990–2011

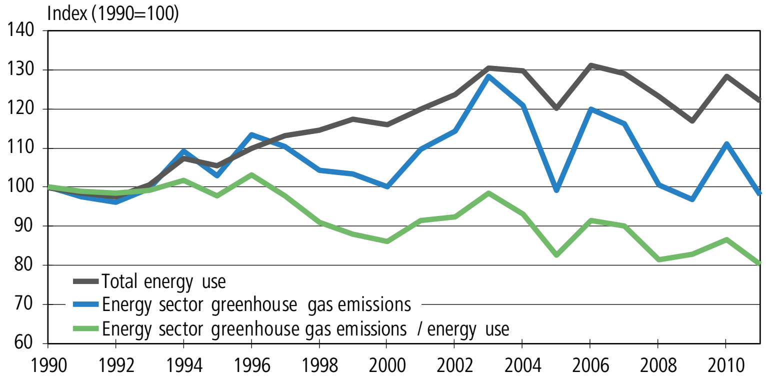
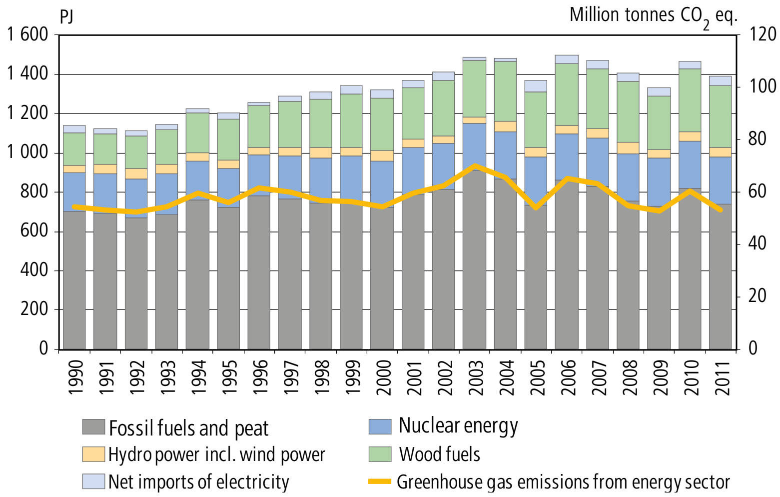


Figure 3.8
Total energy use by energy source (PJ) and energy sector greenhouse gas emissions (million tonnes CO_2 eq.), 1990–2011



CO_2 eq., which was 46 per cent of the energy sector´s total emissions. Other significant emission sources in the energy sector are transport fuels and the energy produced by industry primarily for its own needs.

The forest industry is an example of an industry that produces a significant share of the energy it requires. Greenhouse gas emissions from manufacturing industries accounted for roughly 18 per cent (9.7 million tonnes CO_2 eq.) of energy sector emissions and some 14 per cent of all greenhouse gas emissions in 2011. Emissions from the fuels used by different industries have fallen by 28 per cent compared with the emission levels in 1990. This is a result of the increased use of biomass by the forest industry in particular.

Emissions attributable to energy use by individual households and the service sector accounted for approximately 6 per cent of Finland's total emissions. These emissions are down significantly from the 1990 levels. The service sector's emissions have decreased by as much as 52 per cent, while those by households by 50 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

In 2011, the greenhouse gas emissions from transportation amounted to 13.2 million tonnes CO_2 eq. The transport sector's share of the total greenhouse gas emissions has remained fairly constant since 1990: it was approximately 18 per cent in 1990 and 20 per cent in 2011. Road transportation is the most important emission source in transport, accounting for more than 88 per cent of the sector's emissions in 2011. Cars make up the biggest share of road transport emissions (Figure 3.9).

During the period 1990–2011, transport emissions increased by 4 per cent due to the growth in traffic volume (Figure 3.10). 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. The emissions in 2011 were close to those in 2010 due to the growing share of biofuels in fuels used in road transport and to improving the fuel efficiency of vehicles, which restrain the otherwise growing emission rates due to increasing kilometrage.

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

Figure 3.9
Road transport greenhouse gas emissions by vehicle type, 1990–2011

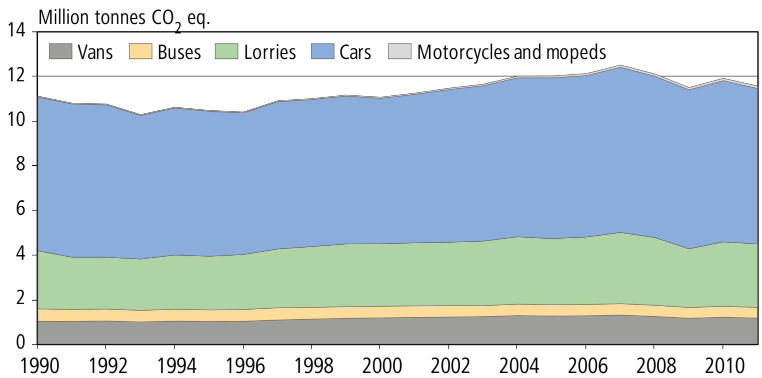
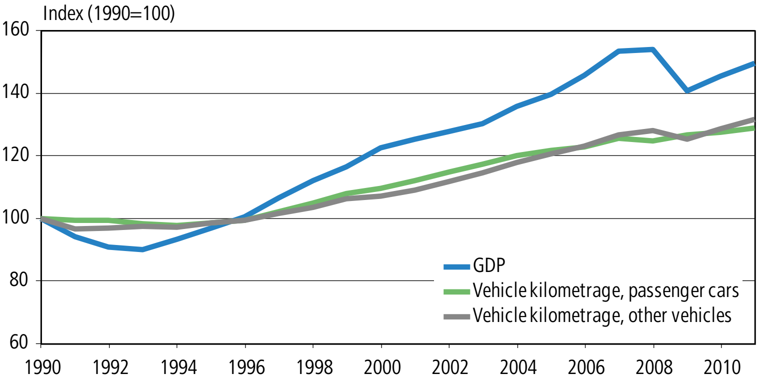


Figure 3.10
Development of traffic volume (vehicle-kilometres, passenger cars and other vehicles) and GDP, 1990–2011



Car use has been growing steadily as a proportion of all passenger traffic. The market share of public transport in proportion to the total volume of passenger transport has decreased steadily since 1990: it was 17 per cent in 2011. The CO_2 emissions per kilometre driven have decreased both for passenger cars and for other vehicles (Figure 3.11).

The energy efficiency of new registered cars began to improve in the 1990s, and during the period 1990–2011 the vehicle-specific CO_2 emissions of new registered passenger cars fell by almost 30 per cent (gasoline by 28 per cent and diesel by 30 per cent) (Figure 3.12).

Figure 3.11
Relative development of CO_2 emissions from cars and other vehicles (CO_2 /km=carbon dioxide emissions per vehicle-kilometre), 1990–2011

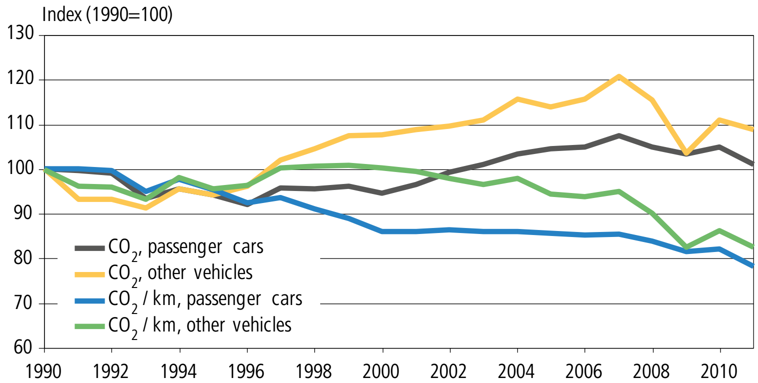
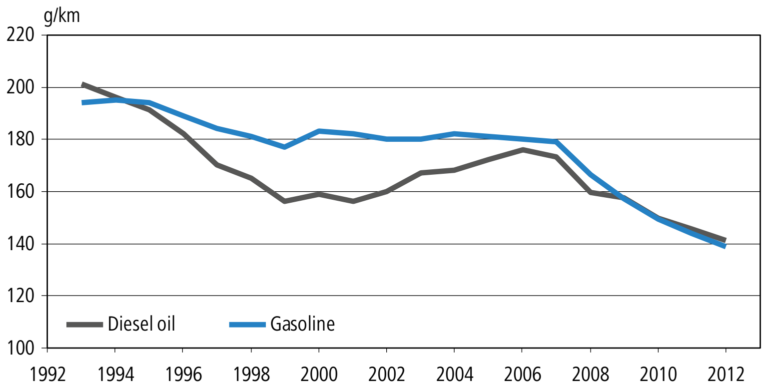


Figure 3.12
CO_2 emissions (g/km) of new registered cars (gasoline and diesel), 1993–2012



3.2.3 Industrial processes

Greenhouse gas emissions from industrial processes contributed 8 per cent to the total greenhouse gas emissions in Finland in 2011, totalling 5.6 million tonnes CO_2 eq. The most significant emission sources included iron and steel production (3.5 per cent of Finland's total emissions in 2011), hydrogen production (1.0 per cent) and cement production (0.8 per cent). CO_2 emissions were also generated to produce lime, glass and phosphoric acid as well as in the use of limestone, dolomite and soda ash. Small amounts of methane (CH_4) were generated for coke production in the iron and steel industry and nitrous oxide (N_2O) emissions were generated to produce nitric acid. Indirect CO_2 emissions from CH_4 and NMVOC (non-methane volatile organic compounds) emissions are also reported in the industrial processes sector.

In 2011, CO_2 emissions accounted for 78 per cent of the emissions from industrial processes and nitrous oxide emissions from nitric acid production accounted for 2.4 per cent of emissions, while the methane emissions generated during the manufacturing process of coke accounted for less than 0.2 per cent of industrial processes emissions.

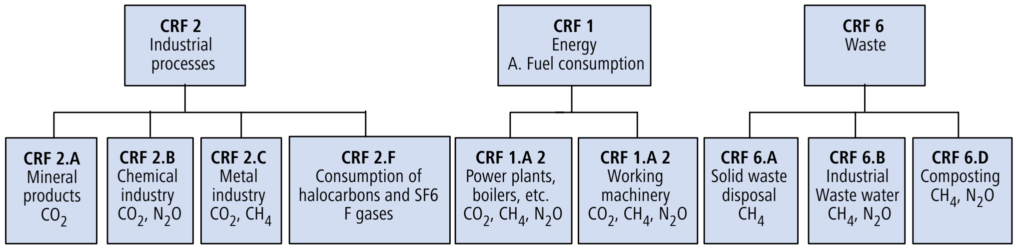
Fluorinated greenhouse gases, or F-gases, form a category of their own under industrial processes. They are used to replace ozone-depleting substances in refrigeration and cooling devices as well in air conditioning devices and as aerosols, and they accounted for 1.6 per cent of total national greenhouse gas emissions and 19 per cent of the greenhouse gas emissions of industrial processes in 2011.

Emissions from the production of electricity consumed by Finnish industry and from the electricity and heat produced by the 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 3.13).

The emissions resulting from industrial processes are mostly affected by changes in production output, as they depend on the use of raw materials and production volumes. Emissions caused by industrial processes did not vary much during the 1990s (Figure 3.14). The implementation of N_2O abatement technology in nitric acid production plants in 2009 reduced the emissions from the chemical industry significantly. In the period from 1990 to 2011, the largest relative change occurred in F-gas emissions, which increased eleven-fold (Figure 3.15).

Total CO_2 emissions from industrial processes decreased 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 2011, they were 30 per cent above the 1990 level. N_2O emissions have been decreasing; in 2011, they were more than 90 per cent lower than in 1990. Methane emissions have grown continuously. In 2011, they were 75 per cent above the 1990 level, but their share of the sector's total emissions is still less than one per cent.

Figure 3.13
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).

Figure 3.14
Greenhouse gas emissions from industrial processes, 1990–2011

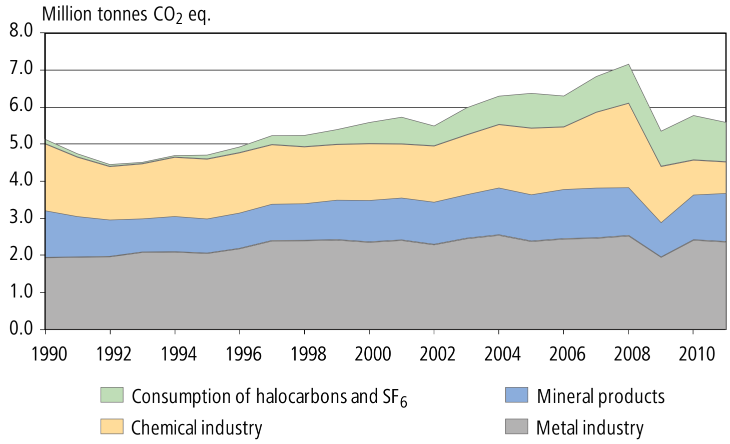
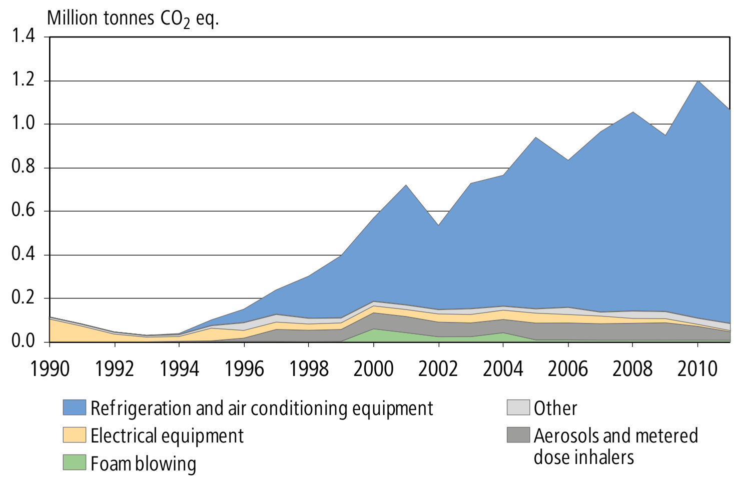


Figure 3.15
F-gas emissions, 1990–2011



3.2.4 Solvent and other product use

This sector accounts for only a small proportion of the total emissions; it amounted to only 0.1 per cent of all emissions in 2011. These emissions result from the use of N_2O in industrial and medical applications and from indirect CO_2 emissions, which in turn result from NMVOC emissions. NMVOC emissions are generated in the production and use of paints, in pharmaceutical, plastic, leather and textile manufacturing, and in printing, timber preservation; they are also generated by the use of pesticides, the manufacturing of fibreglass, household solvent use and the extraction of fats and oils.

Total N_2O emissions in this sector have decreased by 60 per cent between 1990 and 2011. Indirect CO_2 emissions have also decreased along with the decreasing NMVOC emissions.

3.2.5 *Agriculture*

Emissions from the agriculture sector were approximately 5.9 million tonnes CO_2 eq. in 2011. Agricultural emissions include methane (CH_4) emissions from the enteric fermentation of domestic livestock, manure management and crop residue burning, as well as nitrous oxide (N_2O) emissions from manure management and direct and indirect emissions from agricultural soils and crop residue burning. The agricultural sector accounted for approximately 9 per cent of Finland's total greenhouse gas emissions in 2011. The CH_4 emissions from enteric fermentation were 27 per cent, the CH_4 emissions from manure management were 5 per cent, the N_2O emissions from manure management were 7 per cent and the N_2O emissions from agricultural soils were 60 per cent of the total agricultural emissions. The share of emissions from the field burning of agricultural crop residues is less than 0.01 per cent altogether.

In accordance with the UNFCCC reporting guidelines, some of the greenhouse gas emissions from agriculture are reported under sectors other than agriculture (Figure 3.16). 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 under the energy sector. Emissions from the energy use related to agriculture were 1.3 million tonnes CO_2 eq. in 2011, whereas agricultural emissions reported in the land use, land-use change and forestry sector were 7.1 million tonnes CO_2 eq. in 2011. When all of the agricultural emission sources from the different reporting sectors (agriculture, LULUCF and energy) are taken into account, agricultural emissions totalled 14.3 million tonnes CO_2 eq. in 2011.

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 agriculture sector are direct and indirect N_2O emissions from agricultural soils.

Emissions in the agriculture sector decreased by 12 per cent during 1990–2011. This was 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 33 per cent less in 2011 than in 1990. The decrease in the number of livestock is visible in the lower CH_4 emissions from enteric fermentation and N_2O emissions from manure management (Figure 3.17). The emissions have not decreased in proportion to the drop in the number of livestock, however, because milk

Figure 3.16
Reporting of emissions generated by agriculture, in accordance with the CRF categories

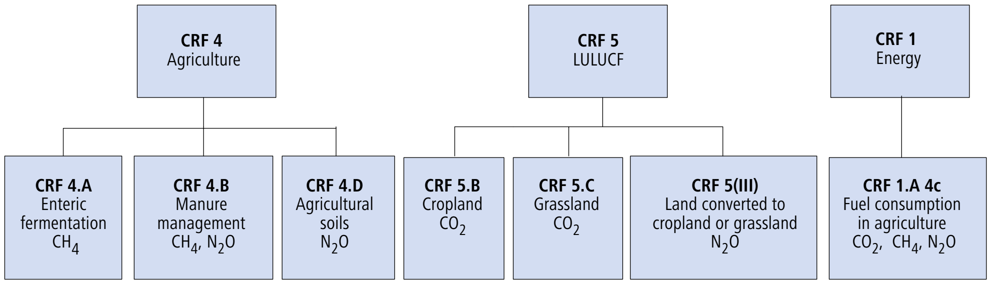
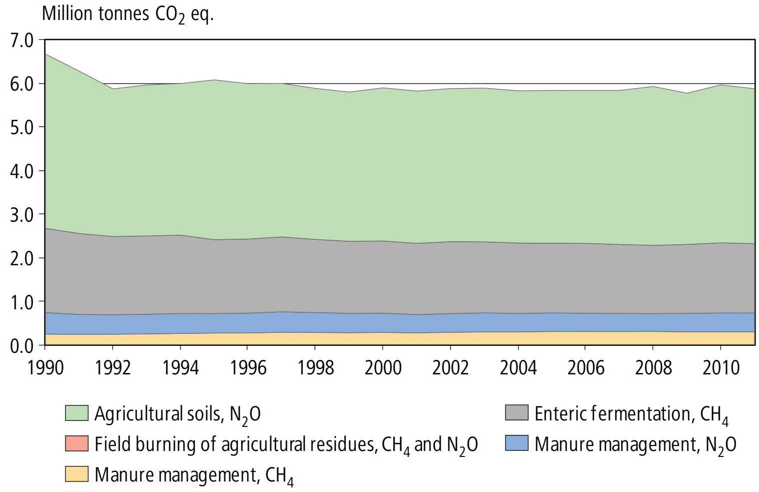


Figure 3.17
Greenhouse gas emissions from agriculture, 1990–2011



and meat output and the emissions per animal have increased. The implementation of agri-environmental programmes aiming to minimise nutrient loading into waterways has reduced use of nitrogen fertilisers and improved manure management, and thus it has also contributed to a reduction in N_2O emissions. The decrease in N_2O emissions from agricultural soils was 11 per cent in 2011 compared with the 1990 level.

3.2.6 Land use, land-use change and forestry

Finland reports both greenhouse gas emissions and removals in the LULUCF sector. Removals refer to the absorption of CO_2 from the atmosphere by carbon sinks, such as plant biomass or soil.

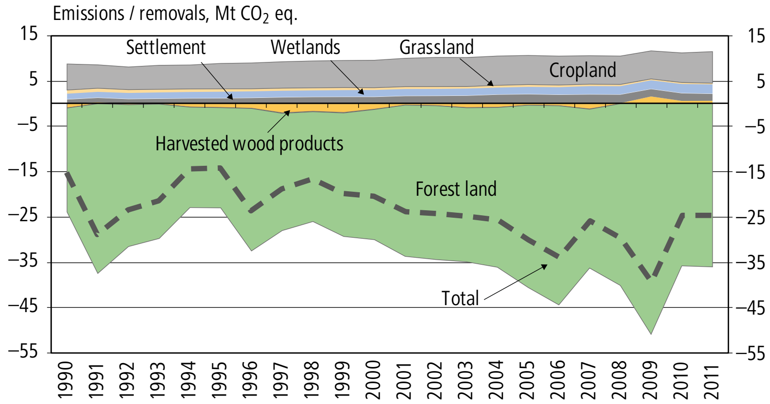
Changes in carbon stocks in six land-use categories covering the whole of Finland are reported in this sector. In accordance with the IPCC guidelines, the changes in different carbon pools, which include the above- and below-ground biomass, dead wood, litter and soil, are reported for each category. 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 controlled burning) and the nitrogen fertilization of forest land. Emissions and removals are not reported for unmanaged wetlands and other land.

Finland's largest carbon sinks are the forests. The LULUCF sector in 2011 as a whole acted as a CO_2 sink for –24.6 million tonnes CO_2 eq. because the total emissions resulting from the sector were smaller than the total removals. The sink in 2011 was 37 per cent of the total national emissions excluding the LULUCF sector. In forest land, the largest sink in 2011 was tree biomass: –37.3 million tonnes CO_2 eq. Mineral forest soils were a sink of –6.2 million tonnes CO_2 eq., whereas organic forest soils were a source of 7.6 million tonnes CO_2 eq. Other emission sources in the forest land category are nitrogen fertilisation (0.02 million tonnes CO_2 eq.) and biomass burning (0.007 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 and silvicultural measures. Felling volumes have varied according to the market situation and demand. In 2011, loggings were at a long-term average level of 52 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 also produces significant emissions. The largest emissions come from the soils of drained peatlands in forests and croplands. Other emission sources in the LULUCF sector include grasslands, peat production areas, forest fires, the nitrogen fertilization of forests and the liming of agricultural lands.

The trend in emissions and removals from the different land-use categories reported in the LULUCF sector is presented in Figure 3.18.

Figure 3.18
Greenhouse gas emissions (positive values) and removals (negative values) in the LULUCF sector, 1990–2011



Harvested wood products

The harvested wood products (HWP) category basically includes the carbon balance of all wood products in use in Finland. The carbon balance has been calculated using the Stock Change Approach (SCA). HWP are divided into solid wood products (sawnwood, wood-based panels and round timber in long-term use, e.g. poles) and paper products (paper and paperboard). The changes in roundwood stocks and their carbon balance are not taken into account in the reporting. Furniture and wooden packages are also excluded from the estimate, but fittings are included. The carbon balance of HWP at solid waste disposal sites is also excluded from the estimate. Harvested wood products as a whole have served as a carbon sink, apart from the years 1991 and 2008–2011, when they were a minor carbon source.

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 related activities (afforestation (A), reforestation (R) and deforestation (D)) are addressed in Article 3.3 of the Kyoto Protocol. Reporting under this article was mandatory during the first Kyoto Protocol commitment period, 2008–2012. Article 3.4 includes the following activities: forest management, cropland management, grazing land management and revegetation. Parties have elected which activities, if any, they will report. Finland has elected forest management (FM).

Net emissions from Article 3.3 activities were 3.5 million tonnes of CO_2 eq. in 2011. Afforestation and reforestation resulted in a net emission of 0.2 million tonnes CO_2 eq., while the rest of the emissions were from deforestation. The area subject to AR was about 168,000 ha at the end of the fourth year of the first commitment period. At the end of 2011, the area deforested since 1 January 1990 was approximately 334,000 ha. Net removals as a result of forest management under Article 3.4 were 34.8 million tonnes CO_2 eq. in 2011. An accounting table concerning the period 2008–2011 is presented below (Table 3.2).

The emissions and removals from ARD lands vary between the years depending on the timing and quantity of the land-use changes, which vary depending on the economy.

Since the area under forest management has not changed significantly, the inter-annual variation in the total CO_2 removals from FM is mainly due to variations in the amount of logging, which have a direct impact on the quantity of the biomass sink. In addition, the changes in soil carbon vary according to the variation in the carbon amounts for vegetation, but the changes occur at a slower rate than they do for biomass.

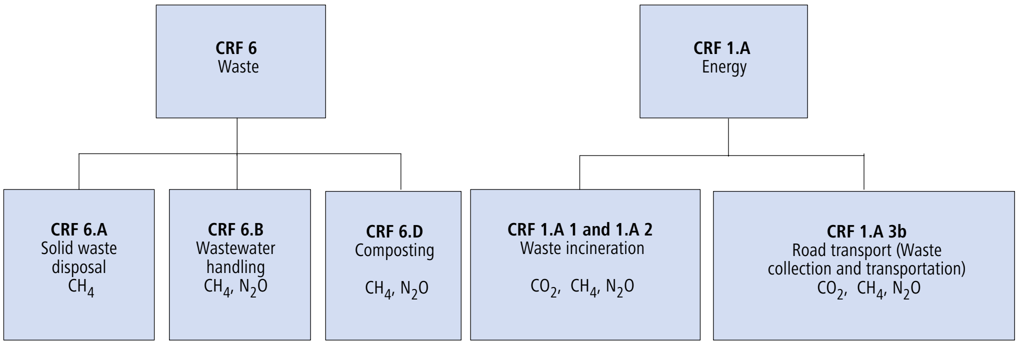
Table 3.2
Information table on accounting for activities under Articles 3.3 and 3.4 of the Kyoto Protocol

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	Net emissions/removals					Accounting parameters	Accounting quantity
	2008	2009	2010	2011	Total		
	Million tonnes CO_2 eq.						
A. Article 3.3 activities							
A.1. Afforestation and Reforestation							**765**
A.1.1. Units of land not harvested since the beginning of the commitment period	217	206	184	158	765		765
A.1.2. Units of land harvested since the beginning of the commitment period	NA	NA	NA	NA	NA		NA
A.2. Deforestation	**3,448**	**3,128**	**3,321**	**3,133**	**13,030**		**13,030**
B. Article 3.4 activities							
B.1. Forest Management	**−39,040**	**−49,749**	**−34,623**	**−34,793**	**−158,204**		**−16,729**
3.3 offset						13,795	−13,795
FM cap						2,933	−2,933

3.2.8 Waste

Methane (CH_4) emissions from landfills and CH_4 and N_2O emissions from composting and wastewater treatment are reported under the waste sector (Figure 3.19). Greenhouse gas emissions from the combustion of waste are reported fully in the energy sector, as waste incineration without energy recovery is almost non-existent. Waste sector emissions amounted to 2.1 million tonnes CO_2 eq. in 2011, which accounts for approximately 3 per cent of Finland's total emissions. Landfill emissions accounted for 84 per cent of all waste sector emissions. Landfill emissions cover the emissions from municipal, industrial and construction and demolition waste, as well as the emissions from municipal and industrial sludge. The emissions from waste water treatment accounted for 10 per cent and those from composting 6 per cent of waste sector emissions in 2011.

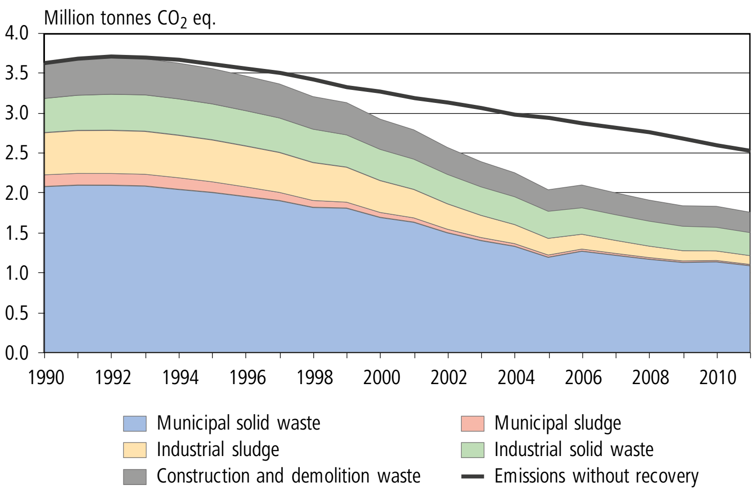
Figure 3.19
Reporting of waste sector emissions in the greenhouse gas inventory



Waste sector emissions have decreased by 47 per cent compared with the 1990 levels. A new Waste Act entered into force in 1994, which has led to a reduction in methane emissions from landfill sites (Figure 3.20). The Waste Act has cut back on the volume of waste deposited at landfills by promoting recycling and reuse as well as the energy use of waste materials. The recovery of landfill gas 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. CH_4 emissions from landfills are expected to decrease further due to the implementation of EU and national policies and measures (see Section 4.7.7).

Emissions from wastewater treatment have also been successfully reduced by 28 per cent compared with the situation in 1990. The reduction in emissions has been affected by, for example, 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 in 2011 were three times greater than the emissions in 1990. The reason for this has to do with the increased amount of composting, especially in semi-urban areas, due to the separate collection of organic waste.

Figure 3.20
Methane emissions from solid waste disposal on land, 1990–2011



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.

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Email: riitta.pipatti@stat.fi

As a national entity, Statistics Finland also bears the responsibility for the general administration and quality management of the inventory and for communicating with the UNFCCC, for coordinating participation in the inventory review and for publishing and archiving the inventory results. In addition, Statistics Finland calculates the estimates for the energy and industrial processes (except for F-gases: HFCs, PFCs and SF_6) 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; it is also defined 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 compiling the European Community's greenhouse gas inventory and also has obligations to report to the European Commission (see Box 3.1).

Various specialist organisations acting as parties to the inventory system are responsible for the inventory data of the different sectors (Figure 3.21).

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) and VTT Technical Research Centre of Finland. 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 contribution by VTT Technical Research Centre of Finland is based on annual contracts with Statistics Finland. The continuance of this contribution is ensured via a long-term framework agreement. In addition, all ministries participating in the preparation

Box 3.1

European Community monitoring mechanism for greenhouse gas emissions and for implementing the Kyoto Protocol

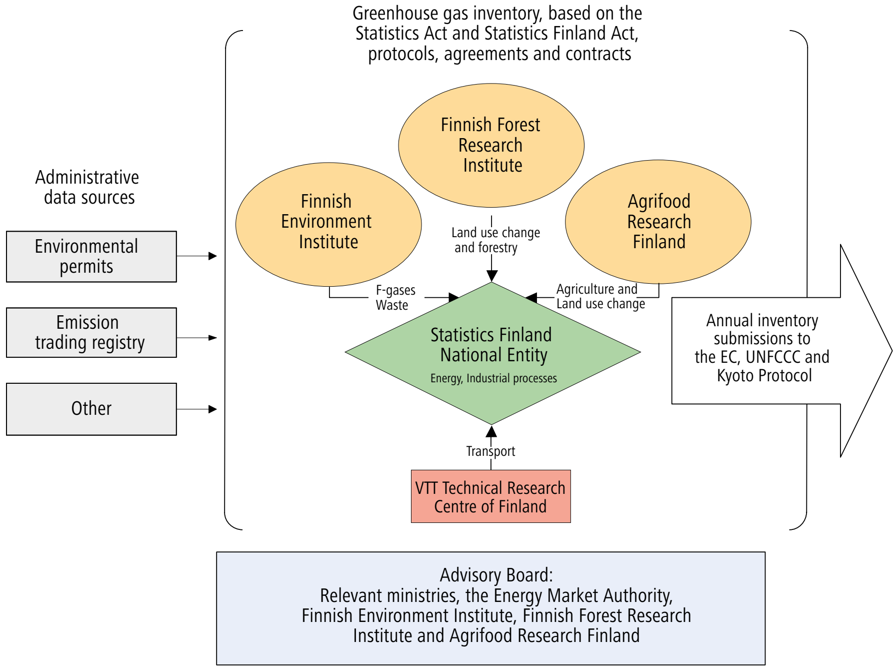
EC monitoring mechanism for greenhouse gas emissions and for implementing the Kyoto Protocol Decision 280/2004/EC of the European Parliament and of the Council of 11 February 2004; it contains provisions for monitoring greenhouse gas emissions and for implementing the Kyoto Protocol. The reporting requirements for the Member States are elaborated in European 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 European Community's commitments under the UNFCCC and Kyoto Protocol. It includes provisions concerning monitoring and reporting on the anthropogenic greenhouse gas emissions, as well as the policies and measures being implemented, adopted and planned, and on the projections based on such policies and measures. According to Decision 280/2004/EC, Member States are required to submit their national inventories annually to the European Commission – DG Climate Action (DG Clima). DG Clima bears the main responsibility for preparing the EC inventory, which is compiled on the basis of the national inventories of the Member States. As the EC inventory is an aggregated total of the national emissions, its quality depends on the quality as well as the quality assurance and quality control procedures of the Member States' inventories.

In order to implement the reporting provisions set by the Climate and Energy Package of the European Union (see Chapter 4) and take into account recent developments in the UNFCCC negotiations, the Commission proposed in 2011 a new Monitoring Mechanism Regulation (MMR) to replace Decision 280/2004/EC and its implementing provisions, 2005/166/EC. In April 2013, an agreement was reached between the Council and the European Parliament on the content of the regulation. The MMR Regulation (EU) 525/2013 further strengthens the reporting of the Member States' information on greenhouse gases, their projections and their policies and measures. Detailed reporting provisions are to be agreed upon through implementing and delegated acts in 2014.

Figure 3.21

National system for the greenhouse gas inventory in Finland



of the climate policy ensure that their data is available for use in the emission inventories.

SYKE prepares the estimates for the F-gas and NMVOC emissions (excluding combustion sources) and for the waste sector. MTT estimates the agricultural emissions, including the CO_2 emissions reported by the LULUCF sector, while Metla has the overall responsibility for estimates in the LULUCF sector. VTT Technical Research Centre of Finland provides 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, which is available on the Internet.

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

Statistics Finland has also set up an advisory board consisting of representatives from the participating organisations, the responsible ministries and the Energy Market Authority. The advisory board functions as a higher level forum for collaborating and communicating with the parties involved in the national greenhouse gas inventory system and it decides on changes in the division of responsibilities. In addition, the advisory board coordinates longer term research programmes related to developing the inventory and reporting as well as to international cooperation, which includes participating 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 policy. 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, which includes the division of reporting responsibilities.

3.3.2 Inventory process

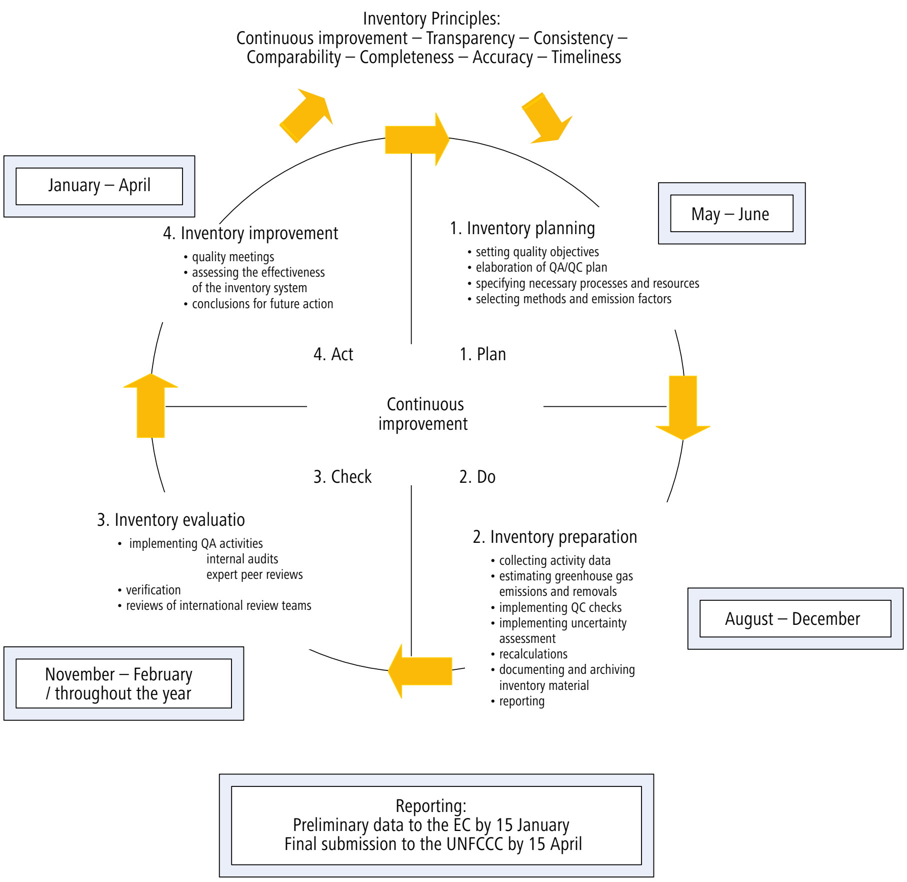
The UNFCCC, the Kyoto Protocol and the European Community monitoring mechanism for greenhouse gas emissions require Finland to submit annually a National Inventory Report (NIR) and Common Reporting Format (CRF) tables. The annual submission contains emission estimates for the year prior to the previous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

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

The preparation of the annual inventory follows a predefined reporting schedule. Under the EC monitoring mechanism, the annual inventory must be submitted to the Commission by 15 January. The Member States may then complement and update their submissions until 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 3.22 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.

Figure 3.22
Annual inventory process



The methodologies, collection of activity data 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 (Tier 1) methods. Detailed activity data is used for most categories, and the emission factors and other parameters are based on national research and other data. For large point sources within 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 Centres for Economic Development, Transport and the Environment for processing and monitoring environmental permits, is the central data source for plant and process-specific data. Detailed descriptions of the methodologies used can be found in the sector-specific chapters of the National Inventory Report.

Statistics Finland annually conducts a Tier 2 key category analysis prior to submitting inventory information to the EC. The Tier 2 methodology makes use of category-specific uncertainty analyses. The analysis covers all of the sources and sinks of the inventory.

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. The detailed analysis also provides the sector experts with recommendations 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 within the inventory or for correcting identified errors, omissions, overlaps or inconsistencies within the time series.

Greenhouse gas inventory recalculations are based on an annual evaluation of the preparation and improvement needs for the inventory, including input from the QA/QC activities. The driving forces when applying the recalculations are the need to implement the guidance given in the IPCC Good Practice Guidance reports and the recommendations in the UNFCCC inventory reviews.

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

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 that are made are documented in the CRF tables and in the National Inventory Report in accordance with the IPCC Good Practice Guidance reports and the UNFCCC reporting 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 the methods used in the greenhouse gas inventory (see Section 8.2.4). The results have been disseminated through, for example, 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, the IPCC Emission Factor Database and the '2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands'.

3.3.3 Quality management

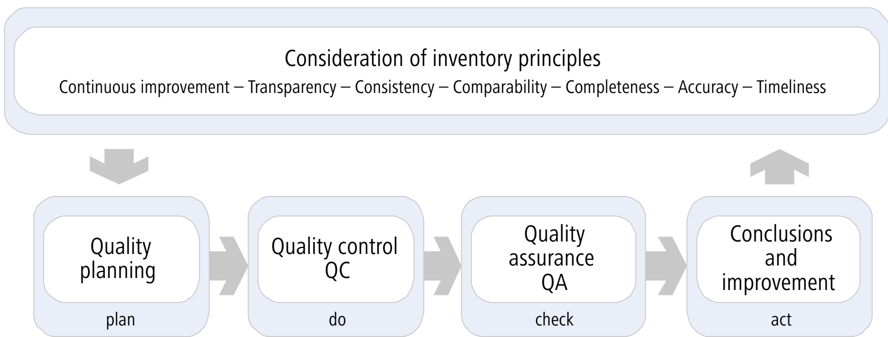
Statistics Finland has the responsibility for co-ordinating the quality management measures and for steering and facilitating the quality assurance and quality control (QA/QC) process of the greenhouse gas inventory at the national level. The expert organisations contributing to the production of emission or removal estimates are responsible for the quality of their own inventory calculations and for implementing and documenting the QA/QC procedures.

The objective of Finland's GHG inventory system is to produce high-quality GHG inventories. Within 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, timeliness and continuous improvement — are fulfilled by implementing the QA/QC process consistently (Figure 3.23).

The setting of quality objectives is based on the inventory principles. Quality objectives are specified statements about the intended quality level when preparing the inventory with regard to the inventory principles. The objectives aim to be appropriate and realistic while taking into account

Figure 3.23
QA/QC process concerning preparation of the national greenhouse gas inventory



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 3.3.

The quality objectives and the planned general quality control and quality assurance procedures regarding all sectors are set in the QA/QC plan. It is a checklist that specifies the actions, schedules and responsibilities necessary for attaining the quality objectives and instilling 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 and IPCC Good Practice Guidance for LULUCF. General inventory QC checks (IPCC GPG 2000, Table 8.1; and IPCC GPG LULUCF 2003, Table 5.5.1) include performing routine checks on the integrity, correctness and completeness of the data, identifying errors and deficiencies and documenting and archiving 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 by 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, which is conducted under the European Community monitoring mechanism for greenhouse gas emissions (e.g. completeness checks, consistency checks and comparisons across Member States), produces valuable information about

Table 3.3
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 (EU / UNFCCC) within the set time

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 that assess the quality of the inventory and the inventory preparation and reporting process, determine the conformity of the procedures taken and 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 and EU 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 based on the realised 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 so that they can make decisions 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 parallel to one another since 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 EU Member States that are also Parties to the Kyoto Protocol (25), plus Iceland, Liechtenstein and Norway, decided to operate their registries in a consolidated manner. The Consolidated System of EU registries was certified on 1 June 2012 and went into production on 20 June 2012. The CDM Executive Board has established a CDM registry, the EU Commission has established the European Union Transaction Log (EUTL) and the UNFCCC Secretariat has established an Independent Transaction Log (ITL). The CDM registry is being used for issuing certified emission reduction units (CERs) from registered CDM project activities and for distributing them to national registries. The ITL and the EUTL are not emissions trading registries but transaction logs that keep track of all issuances, transfers and cancellations of allowances and units in the national registries.

The 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 software until the summer of 2009, when it replaced it with the CR registry's software, which was developed by the Commission. The CR in turn was replaced, as were all EU ETS national registries, by the Union Registry (UR) in June 2012.

The registry is a web-based application. The website's homepage must have a public area and a secure area. After UR deployment the public information is available on the Energy Market Authority's web site and on the European Commission Transaction Log's web site.

The secure area of the registry permits account holders to access their accounts using a username and password, and, as an additional security measure, the European Commission Authentication Service (ECAS).

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 are fees for opening a person holding account and a trading account in the registry and there are annual fees for the use of different account types.

In Finland, the Energy Market Authority is the competent authority and the registry administrator of the national emissions trading registry. In the Union Registry, Member States continue to provide local support (local helpdesks) to their account holders, but the Commission has set up an ETS Service Desk acting as second level of support for incidents relating to the software and the infrastructure. The ETS Service Desk acts as the communication focal point between National Administrations and their national helpdesk, the UNFCCC Service Desk, the Central Administrator (DG CLIMA), the Development Contractor (responsible for the maintenance of the systems) and the Hosting Organisation (DIGIT).

3.4.2 Registry users

Registry users are classified under the following categories, with each user 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 the 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 a legal obligation to surrender annually allowances or Kyoto units for each of their installations; the allowances or units must correspond to verified emissions for the previous year. These companies must use the registry to demonstrate compliance, and therefore, they need accounts for each installation.

Organisations:
These are many 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 that their annual emissions are in compliance under the EU ETS. In the Union Registry, verifiers are required to open a verifier account in order to verify the annual emissions of each installation whose emissions report they have verified. To do this, the verifiers need to log into the registry.

3.4.3 Types of account

There are several types of accounts in the registry. Operators use operator holding accounts (for each installation that has the legal obligation to annually surrender allowances or Kyoto units under the EU ETS), while other individuals and organisations use person holding accounts or trading accounts. When account holders acquire or sell any units, the transfers will be made to and from their holding accounts. Verifiers are also required to open an account in the Union Registry. The other main types of accounts in the registry are retirement and cancellation accounts, i.e. additional Party accounts that are used for demonstrating compliance with national emissions targets. In addition, implementing the Effort Sharing Decision of the European Parliament and of the Council (406/2009/EC) will require new account types in the registry in the future.

All units are differentiated by unique serial numbers. The owners can obtain the necessary information for their accounts, i.e. the unit type, commitment period, originating registry, etc., through a user interface.

Each account must have at least two authorised representatives, with the exception of verifier accounts, which only need one authorised representative. Account holders are allowed to add an additional authorised representative to their accounts and also an authorised representative for viewing purposes only, if they so desire. 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 involving Kyoto Protocol units and EU ETS allowances. 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 to surrender emission allowances to cover their verified emissions and national competent authorities to demonstrate compliance with national emissions reduction targets (through retirement).

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

Cancellation and replacement, and carryover of units and allowances in accordance with the emissions trading rules: allows the registry to comply with both the EU and Kyoto Protocol regulations.

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

A range of administrative functions.

Functions for generating reports and compliance status tables are being developed.

3.4.5 Roles of ITL and EUTL

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

At least once every 24 hours, the ITL and the EUTL will be reconciled with the 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 Service Desk of the EUTL 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 being affected by the inconsistency.

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 as part of the relevant decisions and the extent to which it conforms to the requirements on technical standards for data exchange (Data Exchange Standard (DES)). These descriptions are provided in Table 3.3.

Table 3.4
Description of the functions of the national registry and its conformity with the Data Exchange Standards (DES) under the Kyoto Protocol

Reporting Item	Description
Registry Administrator	Jouko Hepola Energy Market Authority Address and phone number are available at: homepages http://www.energiamarkkinavirasto.fi/alasivu.asp?gid=116&languageid=826
Parties with which Finland cooperates by maintaining the registry in a consolidated system	The EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway have decided to operate their registries in a consolidated manner. The Consolidated System of EU registries was certified on 1 June 2012 and went to production on 20 June 2012. A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. This description includes: • Readiness Questionnaire • Application Logging Plan • Change Management Procedure • Disaster Recovery • Manual Intervention • Operational Plan • Roles and Responsibilities • Security Plan • Time Validation Plan • Version Change Management These documents above have been provided to the UNFCCC by European Comission and in April 2013 as part of Finland’s inventory submission. A new central service desk was also set up to support the registry administrators of the consolidated system. The new service desk acts as 2nd level of support to the local support provided by the Parties. It also plays a key communication role with the ITL Service Desk with regard to connectivity or reconciliation issues.
Database structure and capacity of national registry	In 2012, the EU registry has undergone a major redevelopment with a view to comply with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011 in addition to implementing the Consolidated System of EU registries (CSEUR), also known as the Union Registry. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries.The relevant documentation was provided to the UNFCCC as part of Finland’s greenhouse gas inventory submission on 15 April 2013. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). All tests were executed successfully and lead to successful certification on 1 June 2012.
Conformity to DES	The overall change to a Consolidated System of EU Registries triggered changes to the registry software and required new conformance testing. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries.The relevant documentation was provided to the UNFCCC as part of Finland’s greenhouse gas inventory submission on 15 April 2013. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the DES. All tests were executed successfully and lead to successful certification on 1 June 2012.
Procedures to minimise discrepancies in issuance, transfer, cancellation and retirement of registry units	The overall change to a Consolidated System of EU Registries also triggered changes to discrepancies procedures, as reflected in the updated manual intervention document and the operational plan. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The relevant documentation was provided to the UNFCCC as part of Finland’s greenhouse gas inventory submission on 15 April 2013.

Table 3.4 Cont.

Reporting Item	Description
Overview of security measures (includig maintence of the measures) for unauthorised manipulations and to prevent operator error	The overall change to a Consolidated System of EU Registries also triggered changes to security, as reflected in the updated security plan. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The relevant documentation was provided to the UNFCCC as part of Finland's greenhouse gas inventory submission on 15 April 2013.
List of publicly available information	Public reports available on the Energy Market Authority's website: http://www.emvi.fi/alasivu.asp?gid=314&pgid=314&languageid=826.
Internet address of the interface	The new internet address of the Finnish part of the Unionin registry is: https://ets-registry.webgate.ec.europa.eu/euregistry/FI/index.xhtml.
Data integrity measures	The overall change to a Consolidated System of EU Registries also triggered changes to data integrity measures, as reflected in the updated disaster recovery plan. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The relevant documentation was provided to the UNFCCC as part of Finland's greenhouse gas inventory submission on 15 April 2013.
Test results	On 2 October 2012 a new software release (called V4) including functionalities enabling the auctioning of phase 3 and aviation allowances, a new EU ETS account type (trading account) and a trusted account list went into production. The trusted account list adds to the set of security measures available in the UR. This measure prevents any transfer from a holding account to an account that is not trusted.

Literature

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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 Greenhouse Gas Inventory Unit's website at Statistics Finland, http://www.stat.fi/greenhousegases

European Union Transaction Log, http://ec.europa.eu/environment/ets/account.do?languageCode=en

Finland's annual national inventory submissions are also published on the UNFCCC's website, http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/7383.php

Finnish part of the Union Registry, https://ets-registry.webgate.ec.europa.eu/euregistry/FI/index.xhtml

National climate and energy strategies for 2001, 2005, 2008 and 2013 approved by the Government are available on the Ministry of Employment and the Economy's website, http://www.tem.fi/index.phtml?l=en&s=2542

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.

Photo: Janne Ulvinen / Image bank of the Environmental Administration

4 Policies and measures

4.1 Climate policy framework in Finland

Finland's climate policy is defined in government programmes, and since 2003, strategic work has been steered by a ministerial working group on energy and climate policies. Effective climate change policies require global collaboration and actions. Therefore, the Finnish climate policy is based on international agreements: the UNFCCC, the Kyoto Protocol (Section 4.1.1) and the common policies of the EU, such as the EU Climate and Energy Package and Effort Sharing Decision (Sections 4.1.2, 4.3 and 4.5). National energy and climate strategies have been prepared since 2001 (Section 4.5) to fulfil the international commitments and to define sectoral policies and measures (Section 4.7).

4.1.1 The Kyoto Protocol

In accordance with the Kyoto Protocol, the EU was committed to reducing its emissions by 8 per cent in 2008–2012 compared to the base year emissions. This commitment was shared among the EU Member States through the Council Decision of 25 April 2002[1] concerning the joint fulfilment of commitments pursuant to Article 4 of the Kyoto Protocol. Under this burden sharing agreement, Finland's commitment was defined as limiting its national average annual emissions to their 1990 level during the first commitment period of the Protocol, 2008–2012. The emission levels in terms of tonnes of carbon dioxide equivalent (tonnes CO_2 eq.) allocated to the Community and to the Member States were determined in 2006 via a Commission Decision[2]. 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 approximately 71 million tonnes CO_2 eq. per year).

Finland will fulfil its commitments under the first commitment period of the Kyoto Protocol. Based on the greenhouse gas inventory for 2008–2011 and the preliminary inventory data for 2012, the greenhouse gas emissions in 2008–2012 were about 5 per cent below the assigned amount (see Table 5.13). The assessment for compliance will be concluded in 2015, after the review of the final inventory submission and at the end of the true period for the first commitment period.

The Kyoto Protocol has been amended with new quantified emission limitation and reduction commitments for the second commitment period, 2013–2020, which continue the commitments established for the first period. The EU is committed to reducing its emissions jointly by 20 per cent compared to the base year and is preparing to ratify the amendments.

1 (2002/358/EC)
2 (2006/944/EC)

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 subsequent to 2012. Under this 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 global and comprehensive agreement is reached. The majority of the reduction will be reached as part of the EU emissions trading scheme (EU ETS): in 2020, emissions from sectors covered by the EU ETS will be 21 per cent lower than in 2005. Emissions from sectors not included in the EU ETS — such as transport, housing, agriculture and waste — will be cut by approximately 10 per cent from the 2005 level by 2020 within the EU as a whole.

The Effort Sharing Decision[3] established binding annual greenhouse gas emission targets for Member States for the period 2013–2020. These targets concern emissions from sectors not included in the EU ETS, such as transport, buildings, agriculture and waste. Finland's reduction obligation for the sectors not covered by the EU ETS is 16 per cent. It is up to each Member State to decide how these targets will be achieved, but domestic measures are needed to fulfil the targets. Certified emission reduction units from the clean development mechanism and emission reduction units from joint implementation projects, as well as units transferred from other Member States, can be used to fulfil the targets, but only to a limit of 3–4 per cent of the total emissions for 2005. A Member State that fails to meet its annual target will be penalised with an additional 8 per cent emission reduction obligation for the following year.

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.

The discussion about the framework for the EU's climate policy after 2020 began in spring 2013 with the publication of the Commission's Green Paper on the subject. The Green Paper works as a starter for a public consultation; it allows the Member States, other EU institutions and stakeholders to participate in the discussion about the type, nature and level of the climate and energy targets after 2020.

Finnish climate policy beyond 2020 is analysed in the Government Foresight Report on Long-term Climate and Energy Policy (2009) and also in the Government's updated National Energy and Climate Strategy (2013). A roadmap on climate and energy policy until 2050 is currently under preparation and will be finalised in 2014. The starting point for this work is the objective for an 80–95 per cent emissions reduction by 2050 compared to 1990 levels.

A working group has been appointed to prepare a proposal for the national climate change act. The purpose of the climate change act would be to steer the reduction of emissions not covered by the EU ETS. A long-term emissions reduction target would be included in the act. The act would make emission reduction measures more systematic and predictable.

3 (406/2009/EC)

4.2 Climate policy-making process in Finland

4.2.1 Government and the 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 upon in the Cabinet Committee on EU Affairs, though Finland generally follows the common positions of the EU in these negotiations.

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

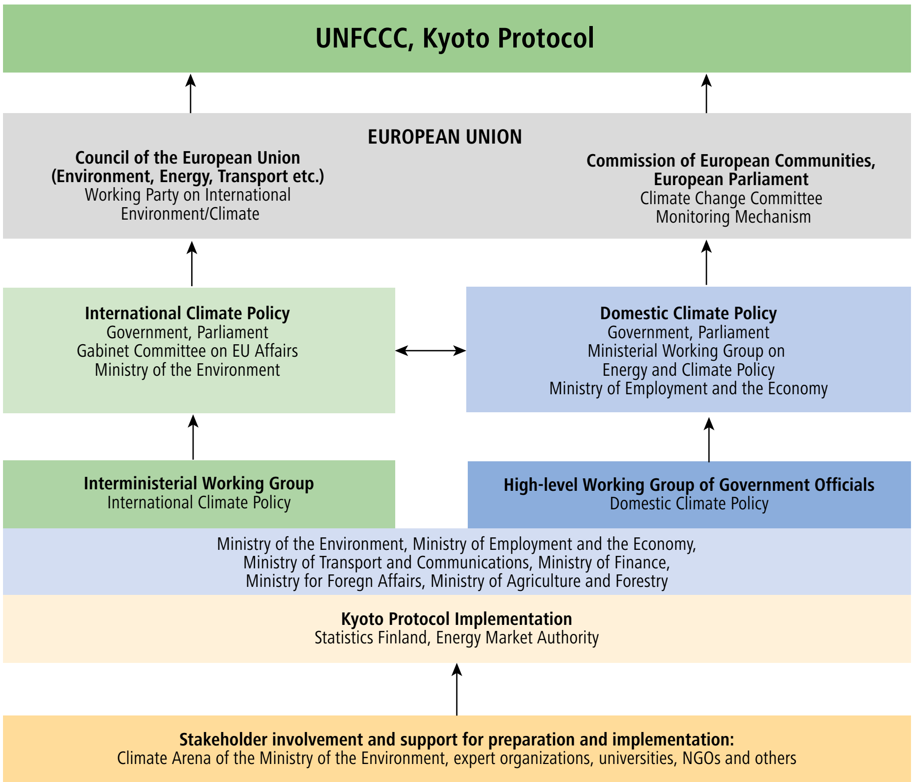
Since the year 2003, every Finnish government has appointed a ministerial working group on energy and climate policy with representatives from all government parties. These ministerial working groups have been responsible for preparing and updating the national strategies on energy and climate policy. The ministerial working group has a network of officials acting as its preparatory body, comprising representatives from the Ministry of Employment and the Economy, the Ministry of Transport and Communications, the Ministry of Agriculture and Forestry, the Ministry of Education and Culture, the Ministry for Foreign Affairs, the Prime Minister's Office, the Ministry of Finance, and the Ministry of the Environment. The network of officials is led by the Ministry of Employment and the Economy, which is in charge of the overall coordination of the strategy work. The current strategy on energy and climate policy, which has been updated in 2013, is described in Section 4.5.

In Finland, climate policy is increasingly being integrated with the decision-making processes in energy production, transport, agriculture, forestry and land-use and other planning. For example, the transport sector has its own climate policy programme. Finland was also one of the first countries to prepare a national climate adaptation strategy. In addition, climate and energy issues are being taken into consideration in the process of preparing Society's Commitment to Sustainability, which is due to be approved by the National Commission on Sustainable Development and the government by the end of 2013.

Statistics Finland is the national entity responsible for compiling the Finnish greenhouse gas inventory. The Finnish Environment Institute (SYKE), the Finnish Forest Research Institute (Metla), MTT Agrifood Research Finland and VTT Technical Research Centre of Finland participate in the inventory preparation as a part of the national system. 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 for the national emissions trading registry under the Kyoto Protocol (see Chapter 3) and the EU ETS. The institutional arrangements related to climate policy and its implementation in Finland are described in Figure 4.1.

Figure 4.1
Institutional arrangements related to climate policy and its implementation in Finland



4.2.2 The Finnish Climate Panel

The Foresight Report on Long-term Climate and Energy Policy in 2009 highlighted the need to establish a scientific advisory body to strengthen climate policy. The present government decided in its programme to set up a multidisciplinary, independent climate panel.

The Ministry of the Environment nominated the Finnish Climate Panel in December 2011 for a two-year period. Thirteen experienced scientists were nominated to the panel from among 50 nominees put up by Finnish universities and research institutions.

The main task of the Climate Panel is to strengthen the interaction between research and policy making. According to the letter of nomination, the panel:

- Gives advice to the ministerial working group on energy and climate policy in order to support decision making
- Monitors the implementation of the energy and climate strategy
- Makes assessments concerning the consistency and adequacy of the policies
- Promotes public discussion based on science and expertise
- Follows the development of climate science, technology and policy
- Makes proposals on developing and supporting research on climate policy
- Participates in the preparations of the Climate Act.

The Climate Panel is an independent, multi-disciplinary scientific body that operates in active interaction with policy making. The Panel can independently choose topics for its consideration and reporting. Also, relevant bodies in the formal climate policy process can suggest themes to the Climate Panel. During the first two-year term, both approaches have been used (see Box 8.1 for publications by the Panel). Annual funding of EUR 250,000 is granted in the Ministry's budget for preparing reports and other operational expenses.

In the science-policy dialogue, interaction with relevant ministries has taken place in different ways: the Climate Panel has discussed current policy issues with ministry representatives, government experts have given feedback on the Panel's plans and the Panel members have made presentations in government's climate policy working groups.

Panel members are also increasingly invited to speak at seminars, stakeholder events, parliamentary hearings, etc. The panellists have focused on communication issues since the beginning of their work, and during the first year, the panellists participated in media training. So far, the media has been quite interested in the activities and views of the Panel.

The secretariat of the Climate Panel consists of two ministry representatives (from the Ministry of the Environment and the Ministry of Employment and the Economy) and two scientific experts who work close to the Chair of the Panel. The tasks of the ministry experts are to facilitate information exchange between the Panel and the policy process and to take care of administrative issues, mainly related to funding for the Panel's reports. The scientific secretaries primarily take care of the meetings of the Panel as well as of some of the outreach projects.

The Ministry of the Environment has commissioned an evaluation of the Panel's work. It will be published in mid-autumn 2013. Although the panel is still in its early stages, the evaluation is expected to be relevant for the planning of a possible second term for the Climate Panel.

4.2.3 Other stakeholders

The Climate Arena 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 Arena also allows background studies on climate policy to be presented and proposals to be made for new studies. It also aims to increase awareness about climate change and 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.

4.2.4 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[4] ensures everyone the right to information on the activities of public officials. Access to documents is the main principle and secrecy an exception.

4.2.5 Regions and municipalities

The Centres for Economic Development, Transport and the Environment (ELY Centres) are responsible for the regional implementation and development tasks of the government. They come under the administrative branch of the Ministry of Employment and the Economy, but deal also with tasks coming under the administrative branches of the Ministries of the Environment, Transport and Communications, Agriculture and Forestry, Education and Culture and the Interior. The 15 ELY Centres prepare environmental strategies that guide regional environmental and land-use planning. 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, the use of renewable energy, energy and resource efficiency as well as a coherent urban structure should be promoted in the plan. The national Forestry Centre under the Ministry of Agriculture and Forestry works in 13 regions and bears the responsibility for sustainable forest management.

Following the requirement of the Long-term Climate and Energy Strategy from 2008, the RCs, with the assistance of the ELY Centres, have prepared regional strategies concerning climate and energy issues. Most of the regions had prepared a strategy by the end of the year 2012.

Municipal authorities also play a significant role in climate policy and the implementation of mitigation and adaptation measures due to their responsibilities in land-use and transport planning and in providing public transport and waste management services. In Finland, some of the municipalities are still major local energy suppliers or owners of energy supply companies, even though this role has changed in many municipalities during the last 15 years due to the privatisation and liberalisation processes of the electricity market. The municipalities are also responsible for granting building permits, and can therefore promote energy efficiency and renewable energy. The municipalities can also influence the behaviour of people, for example, via information measures.

More than 130 municipalities (out of a total 320) have joined the voluntary energy efficiency agreements or programmes (see Section 4.7.1) and are thus committed to reducing municipal energy consumption rates.

According to a survey carried out by the Association of Finnish Local and Regional Authorities (AFLRA) in 2012, almost 150 municipalities were active in climate change mitigation (i.e. had calculated their GHG emissions, set emission reduction targets and/or were preparing or had prepared a climate strategy). The most common climate change mitigation measures carried out in the municipalities were related to extending the district heating network, using renewable energy, improving energy efficiency and developing a biking infrastructure.

4 (621/1999)

AFLRA coordinates the Cities for Climate Protection (CCP) campaign, the purpose of which is to encourage cities and municipalities to plan and initiate their own actions for reducing local greenhouse gas emissions. By 2013, more than 50 municipalities had joined the campaign. CCP Finland is part of a campaign organised by the International Council for Local Environmental Initiatives (ICLEI). The campaign consists of five main stages:

- Inventorying emissions (KASVENER model) and estimating the needed adaptation
- Setting the greenhouse gas emission reduction targets (part of local climate change strategy)
- Making a plan for emission reduction to be approved by local political decision makers
- Implementing the plan
- Conducting a follow-up assessment

In 2010–2011, ALFRA also coordinated a campaign called 'Climate Change and Municipalities' Decision-Making' with the aim to improve municipalities' ability to make climate-wise decisions in an economical way.

The Carbon Neutral Municipalities project (HINKU project), which is coordinated by SYKE, brings municipalities, businesses, citizens and experts together to create and implement solutions to reduce greenhouse gas emissions. The project aims to create solutions that have economic and social benefits as well as environmental advantages. The HINKU project was launched in 2008 when five municipalities committed themselves to an 80 per cent reduction in greenhouse gas emissions from the 2007 levels by 2030. By 2011, these five municipalities had already reduced their GHG emissions by 12–18 per cent compared to the 2007 levels. Since it was first launched, seven new municipalities have joined the project, all of which made the same commitment, and three other municipalities have joined the project as partner municipalities. A large group of companies and experts are involved as partners.

The mayors of the six largest cities in Finland (total population 1.7 million, representing approximately 30 per cent of the total Finnish population) established the Mayors' Climate Network in 2011. The network's purpose is to promote the achievement of the EU energy and climate policy targets and eco-efficient urban development. The network helps to highlight new initiatives, increase cooperation and disseminate best practices throughout the major cities (see Box 4.1).

Seven Finnish cities (including the six largest ones), representing one third of the Finnish population, have joined the European Covenant of Mayors (CoM). The participants in CoM commit themselves to meeting and exceeding the European Union's 20 per cent CO_2 reduction objective by 2020 by increasing energy efficiency and the use of renewable energy sources within their cities. Already six of these Finnish cities have compiled Sustainable Energy Action Plans (SEAP), which include the measures by which the CoM target will be reached. The cities are also committed to monitoring their progress towards the target and reporting on it regularly.

Local activities related to increasing public awareness are presented in Chapter 9.

Box 4.1
Mayors' Climate Network

In 2011, the mayors of the six largest cities in Finland established the 'Mayors' Climate Network'. The initiative for the network came from Sitra, and it was part of the 'ERA17 for an Energy-Smart Built Environment 2017' programme (see Section 8.2.1).

During the first year, the Mayors' Climate Network carried out the following activities:

- Promoting the use of renewable energy in their cities
- Prescribing proactive quality control for construction to improve energy efficiency
- Providing energy and climate advice to residents
- Taking the climate impacts into account in budgeting
- Appointing eco-counsellors for workplaces
- Reducing travel by using video conferences.

In 2012, the Mayors decided to:
- Evaluate the possibilities to reduce GHG emissions in the cities by 30 per cent by 2020
- Support the cooperation between municipalities and the government in implementing and financing emission reduction measures
- Promote the use of low-emission cars in the cities
- Increase climate cooperation between the cities and businesses.

As an example of the last point, the City of Helsinki launched the 'Climate Partners Network', which meets regularly and fosters cooperation between the city and businesses in order to both reduce GHG emissions and make companies more competitive. The companies that join Climate Partners specify their own goals and sign the Climate Commitment together with the Mayor of Helsinki.

4.3 Legislative arrangements and programmes under the European Community

The European Climate Change Programme (ECCP), launched by the European Commission in 2000, aims to identify the most effective and cost-efficient policies and measures to reduce greenhouse gas emissions in the European Union, to enhance the EU's implementation of the Kyoto Protocol and to develop further the Union'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. The ECCP brings together the Commission and multiple stakeholders, for example, in working groups in various policy areas.

In 2007, the EU heads of state agreed on ambitious targets to combat climate change via a unilateral commitment to reduce greenhouse gas emissions by 20 per cent by 2020 from the emission levels in 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 target, a binding target (the Climate and Energy Package) was set, which prescribes 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 for the year 2020.

Finland is currently implementing at the national level many EU-wide legislative arrangements and programmes known as Common and Coordinated Policies and Measures (CCPMs), which affect greenhouse gas emissions. These include a burden sharing agreement pursuant to Article 4 of the Kyoto Protocol,[5] the EU Emissions Trading Scheme,[6] the EU Climate and Energy Package for the post-2012 period and the Decision on the Monitoring Mechanism,[7] which was replaced by the Monitoring Mechanism Regulation[8] in 2013.

According to the treaty establishing the EC, the European Commission may start an infringement proceeding against a Member State that 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.

Directive 2009/29/EC of the European Parliament and of the Council, which amends Directive 2003/87/EC so as to improve and extend the Community's greenhouse gas emission allowance trading scheme, has been implemented in Finland via the legislative arrangements described in Table 4.1.

Directive 2008/101/EC of the European Parliament and of the Council, by which aviation is included in the EU ETS, entered into force on 2 February 2009. According to this Directive, all aircraft taking off and/or landing in the EU will be included in the trading. The Directive has been implemented in Finland as part of the Act on Aviation Emissions Trading Scheme.[9] The decision by the European Parliament and the Council to derogate temporarily from the aviation ETS[10] entered into force on 25 April 2013. The decision enables airlines to derogate from their obligations under the ETS relating to the 2012 emissions with respect to their activities to and from aerodromes in countries outside the EU.

Table 4.1
Finnish legislation for implementing the EU emissions trading scheme (ETS)

Domestic legislative arrangements for implementing the EU ETS (Directive 2003/87/EC, as amended by Directives 2009/29/EC and 2008/101/EC)	Description
Act on Emission Trading (311/2011)	The new ETS Directive 2009/29/EC was included into Finnish legislation via the new Emissions Trading Act, which entered into force on 1 May 2011. The new Act will be applied during the third trading period (2013–2020) and it replaces the old Emissions Trading Act (683/2004), which is still being applied to obligations related to trading periods for 2005–2012. The new Act includes all necessary provisions on emission permits, union registry, auctioning, free allocation, monitoring and reporting, verification, etc. The Act also allows several technical details to be regulated in detail by governmental or ministerial decrees. To date, seven such decrees have been passed.
Environmental Protection Act (86/2000), section 43 of which was amended in 2004 (684/2004)	If the activity falls under the scope of the Emissions Trading Act (683/2004), the environmental permit may not set emission limits for the greenhouse gas emissions referred to in section 2 of the Emissions Trading Act, unless they are necessary for ensuring the prevention of significant pollution at the local level.
Act on the Energy Market Authority (591/2013)	Pursuant to section 1 of the Act, the Energy Market Authority shall carry out the tasks assigned to it in the Emissions Trading Act.
Act on Aviation Emissions Trading Scheme (34/2010)	The directive 2008/101/EC, which includes aviation as part of the EU ETS, was implemented in Finnish legislation by Act 34/2010.

5 Decision 2002/358/EC
6 Directive 2003/87/EC
7 (280/2004/EC)
8 Regulation No 525/2013 of the European Parliament and the Council
9 (34/2010)
10 (377/2013/EU)

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[11] and a Decree[12] transposing provisions of the Kyoto Protocol into Finnish legislation entered into force at the same time as the Kyoto Protocol entered into force, on 16 February 2005. After the adoption of the Marrakech Accords in Montreal in 2005, the above-mentioned Decree was amended[13] in order to transpose into the Finnish legislation the decisions of the Conference of the Parties, which served as the First Meeting of the Parties to the Kyoto Protocol.

4.4.2 Legislation on the Kyoto Mechanisms

An administrative framework for participating in the Joint Implementation (JI) and Clean Development Mechanism (CDM) project activities and emissions trading under the Kyoto Protocol (Articles 6, 12 and 17) is provided by the Act on the Use of the Kyoto Mechanisms.[14] Decrees on JI[15] and the CDM[16] include guidance on the contents of the applications for project approvals and on authorisation for entities to participate in the projects.

The Ministry of the Environment decides whether or not to authorise legal entities to prepare for and participate in a JI project and it 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.

11 (383/2002)
12 (13/2005)
13 (37/2006)
14 (109/2007)
15 (91372007)
16 (915/2007)

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).

4.5 National energy and climate strategies

The Finnish national goals in the EU Climate and Energy Package require increasing the share of renewable energy sources in the final energy consumption to 38 per cent by 2020 and reducing greenhouse gas emissions outside the emission trading scheme by 16 per cent from the 2005 level by 2020. The goal of attaining a 10 per cent share of renewable energy sources in road transport fuels by 2020 is an EU-wide goal, but Finland has set itself a higher national target of 20 per cent. In October 2009, the Government adopted the Foresight Report on Long-term Climate and Energy Policy and 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 a global effort (see also Box 4.2).

Finland has prepared several strategies on energy and climate policy, which were completed in 2001, 2005, 2008 and 2013. The latest strategy update, the National Energy and Climate Strategy, was approved by the Government on 20 March 2013. Key objectives of the latest strategy update were to ensure that the national targets for 2020 are achieved and to prepare a pathway towards meeting the long-term energy and climate objectives set by the EU.

Parliament's opinion on the previous (2008) strategy, according to which cost-efficiency, greater energy self-sufficiency and ensuring a sufficient and moderately priced electric power supply, must be emphasised in the fulfilment of energy and climate commitments, has been taken into account in the strategy update. The updated strategy is intended as a basis for the Government's positions, both in European Union negotiations and other international contexts and in domestic policy preparation and decision-making activities.

Box 4.2
The national energy and climate roadmap towards the year 2050

As outlined in the Government Programme, the national long-term goal of Finland is a carbon-neutral society, which can be achieved by following a roadmap towards 2050 and which involves an increase in energy-efficiency and the use of renewable energy. The Government's objective is to reduce greenhouse gas emissions by 80–95 per cent by 2050, which means that energy-related emissions in particular have to be dramatically cut in the upcoming decades. The roadmap will outline the key options for reaching the 2050 emission reduction targets. Furthermore, it will assess the challenges, opportunities and economic impacts of these options. Work on the national roadmap started in spring 2013 and involves extensive consultation with interest groups and citizens.

The impact of alternative energy sources on GHG emissions from the transport sector were considered during 2012–2013 in a working group set up by the Ministry of Transport and Communications (see also Sections 4.7.2 and 4.7. 3). The group's vision is that passenger car traffic, rail transport and boating will be almost entirely independent of oil in 2050. Liquid and gaseous biofuels should cover at least 70 per cent of the fuels used in heavy-goods transport by 2050, and electricity should have an equally large share in bus and delivery transport in urban areas. In aviation, biokerosine would replace 40 per cent of the current fuels, whereas in shipping the use of sustainable alternative fuels would contribute to the reduction of greenhouse gas emissions by 40–50 per cent. Transport in airport and port terminals would be nearly emission-free as early as 2030.

The strategy update includes a baseline scenario for estimating the impact of previously decided measures on future developments (corresponding to the with measures (WM) projection in this report). In addition, the strategy introduces a set of cost-efficient additional measures, which are likely to be implemented in accordance with various ministries' plans. This package, which is formed by the baseline scenario and the accompanying additional measures, is termed the revised baseline scenario (with additional measures (WAM) projections).

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. With respect to sectors not covered by the ETS, Finland may be able to meet its emission reduction commitment (–16 per cent) for 2020 based on existing measures and without the use of flexible mechanisms. The renewable energy objective for 2020, 38 per cent of final consumption, can be achieved with existing measures. The fulfilment of the renewable energy target in the transport sector (20 per cent) will be ensured through the biofuel blending obligation placed on fuel suppliers (see Section 4.7.2). The target for final energy consumption in 2020 is 310 TWh. Additional measures may be needed to fulfil this target. The indicative objective set under the Energy Services Directive[17] for improving the efficiency of energy use by 9 per cent by 2016 will be met.

Policies outlined in the 2013 strategy update concern the following topics: the EU's energy and climate policy after 2020, energy efficiency measures, flexible mechanisms and carbon sinks, additional measures by 2020, possible tightening of the EU's emission reduction objective, renewable energy and peat, measures required by developments in the European and national energy markets, district heating and co-generation of heat and power, consumers and the steering of consumer measures, agriculture and food, the development of clean technology businesses, public sector activities and activities at a regional and local government level, and adaptation to climate change. In accordance with the Government Programme, a programme for reducing mineral oil consumption has been prepared as an appendix to the strategy.

The relevant ministries are responsible for monitoring and evaluating their respective policies and measures. In some cases this responsibility has been delegated to specialised government agencies, such as Motiva Oy, which is a state-owned expert company promoting the efficient and sustainable use of energy and materials.

Examples of sectoral climate policy progress reports include the yearly progress report on the climate policy programme of the Ministry of Transport and Communications and the reports on the impact of energy efficiency agreements published by Motiva Oy.

As a member of the European Union, Finland has reporting obligations concerning policies and measures and projections. The requirements are set by the EU Monitoring Mechanism Decision,[18] which will be replaced by the Monitoring Mechanism Regulation[19] in 2013. The biennial report on policies and measures and projections has been compiled in cooperation with

17 (2006/327/EC)
18 (280/2004/EC)
19 Regulation No 525/2013 of the European Parliament and the Council

the Ministry of Employment and the Economy (responsible for the overall coordination), the Ministry of the Environment, the Ministry of Transport and Communications, the Ministry of Agriculture and Forestry, the Ministry of Finance, Statistics Finland, the Finnish Environment Institute (SYKE), Motiva Oy, the Finnish Forest Research Institute (Metla) and MTT Agrifood Research Finland.

In the Government's yearly report to the Parliament, mitigation measures and the emission development are evaluated on a general level.

4.6 National forest legislation and programmes

The sustainable management of forests in Finland is based on legislation and good practices. Maintaining the forest carbon sink is part of sustainable forest management, and it is also required as a means of conforming to the forest management reference level (–19.30 Mt CO_2) set for Finland for the second commitment period of the Kyoto Protocol (2013–2020).

The means for steering the use of forests include legislation, Finland's National Forest Programme 2015 (NFP), 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[20] and the Act on the Financing of Sustainable Forestry.[21] There is also legislation dealing with the prevention of forest damage and the trade in forest reproductive material, timber measurement, jointly owned forests and organisations in the forestry sector. The drafting of laws on timber measurement and jointly owned forests, as well as on some forest organisations, is currently underway in Finland.

The Forest Act sets requirements for felling, as well as for the 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, which have been compiled and promoted by public forestry extension organisations. The drafting of a new Forest Act is underway. The new law is expected to allow for more diversified management methods, such as uneven aged forest management, and to encourage the natural regeneration of forests. The guidelines for the sustainable management of forests will be renewed, parallel to the Forest Act process.

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. NFP consists of prioritised goals and actions. NFP actions are connected to renewable energy as well as to mitigation and adaptation to climate change, including maintaining the forest carbon sink, and have close links to the national strategy on energy and climate change (see also Section 4.7.6).

Finland's National Forest Programme 2015 is based on three objectives:
- Strengthening forest-based business and increasing the value of production;
- Improving the profitability of forestry; and

20 (1093/1996)
21 (1093/1996)

- Strengthening forest biodiversity, environmental benefits, and welfare implications.

The attainment of these objectives is supported by means of several cross-cutting themes:
- Diversifying and strengthening forest sector know-how; and
- Increasing contributions to international and EU-level forest policy development.

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, has the overall responsibility for the programme. The Forest Council includes representatives from different administrative sectors, industries, NGOs and specialist organisations. For more information on the national measures of the NFP, see Section 4.7.6.

In addition, regional forest programmes include development plans for the whole forest sector of the regions concerned. They define the needs and objectives for the management of forests, forest-based businesses and the multiple uses of and protection of forests, and they also suggest the measures and necessary funding for reaching the objectives.

With regard to contributing to the conservation of biodiversity and the sustainable use of natural resources, the most important instruments are Section 10 of the Forest Act (on preserving 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), both of 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 to establish stable and favourable conditions for forest biodiversity in southern Finland by 2016. The programme is being implemented through ecologically efficient, voluntary and cost-effective means. A new Government decision-in-principle is at the drafting stage and will set goals for METSO up to 2020.

Forestry is a significant income source for forest owners and provides benefits to society at large. Private and public organisations provide guidance and consultation services for forest owners. The provision of these services will be liberalised by a new law, which is currently at the drafting stage. A private forest owner also may receive assistance from the State for forest management and improvement work. State support encourages measures with long-term impacts. Managing 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 the 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 the restoration of ditched areas.

The current NFP will be revised in 2014 based on a report on forest policy and long-term strategic guidelines given by the Parliament. The report will contain future images and scenarios along with a long-term vision and strategic objectives towards 2050.

4.7 Sectoral policies and measures

4.7.1 Energy

Policies and measures in the WM projection

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, one third of which (including energy for transport) are domestic. The major trend is a steady increase both absolutely and in relative terms in the use of renewable energy.

The 'with measures' (WM) projection includes all energy policy measures in use at the end of 2012. 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 to promote the development of domestic energy sources, such as biomass, hydro, wind and peat.

Within the energy sector, the greenhouse gas emissions are in practice reduced in two ways: 1) the primary energy consumption is reduced by cutting the end use or by increasing the conversion efficiency in power plants; 2) fuels and energy use are shifted to alternatives with less emission.

The main policies and measures in the energy sector include the EU ETS, an increase in renewable energy and energy conservation measures.

The EU ETS is an EU-wide domestic measure, while renewable energy sources are supported by various national measures: investment grants, taxation, support for research, and the most recently introduced measure, feed-in tariffs.

Energy conservation measures concern all sectors of the economy. Energy efficiency agreements, a voluntary scheme for industry and municipalities, have proven to be an efficient measure along with taxes and subsidies. For both new and existing buildings, building codes and regulations play an important role.

The policies and measures included in the WM projection for the energy sector are described in more detail in the following section. A list summarising the policies and measures can be found in Table 4.4 at the end of this section. Energy taxation and tax-related subsidies are described in Section 4.8.

EU Emissions Trading Scheme

The EU ETS has been operating since 2005 and is the most important economic steering method for reducing emissions at both the domestic and EU level. The EU ETS is included in the WM projection. It is considered here as a domestic measure, even though entities with emission ceilings participating in the scheme acquire emission units (AAUs, CERs and ERUs) through trading. The EU ETS covered only CO_2 emissions until the year 2013, when N_2O and PFC emissions from certain industries were also included. In addition to emissions from energy production and use, the EU ETS also includes emissions from industrial processes. Industrial processes currently count for one tenth of EU ETS emissions in Finland (Table 4.2).

The share of EU ETS emissions with respect to the total greenhouse gas emissions in Finland was 52–55 per cent between the years 2008 and 2011 (Table 4.2). The share is clearly higher than the EU-27 average, which is around 40 per cent.

The emissions in the EU ETS sector have decreased since 2010. The main reason for this has to do with a reduced use of fossil fuels and increased imports of electricity. The EU ETS sector emissions are also expected to decrease in the future. This is partly the result of the EU ETS making emission-free production of electricity and heat more competitive and partly the result of its promotion of renewables and energy efficiency.

A steady decrease is foreseen in the emissions from district heating and combined heat and power (CHP) production. The use of domestic condensing power will decrease when Olkiluoto 3, the nuclear power plant unit that is currently under construction, begins operation. Positive decisions-in-principle have been made concerning two additional nuclear power units. The start up of these nuclear power units will reduce the emissions in the ETS sector from the 2020s onwards. The emissions from industry are not expected to change dramatically.

Table 4.2
Greenhouse gas emissions in the emission trading (ETS) sector (including the plants participating in the emissions trading each year) and non-emission trading sector in 1990, 2005 and 2008–2012 in Finland, million tonnes CO_2 eq. (the figure for 1990 is an estimate)

	1990	2005	2008	2009	2010	2011	2012*
ETS	31.4	33.1	36.2	34.4	41.3	35.1	29.5
of which energy		29.5	31.8	30.8	37.3	31	26
industrial processes		3.6	4.3	3.4	4.0	4.0	3.5
Non-ETS	39	35.6	34	31.7	33.2	31.9	31.9
Total	**70.4**	**68.7**	**70.2**	**66.1**	**74.5**	**67.0**	**61.4**

* preliminary data

Energy efficiency

The Finnish economy is relatively energy intensive, which has led to fairly high per capita greenhouse gas emissions. However, because energy use is efficient by international comparison, the high energy and emission intensities can be explained by structural factors. While the industrial structure has changed significantly towards less energy intensive industries, Finland still has a considerable number of energy intensive industries. Other factors explaining the quite high energy use per capita are the cold climate and long transport distances.

In the spring of 2008, the Ministry of Employment and the Economy set up a broad-based committee to prepare new energy conservation and energy efficiency measures in accordance with the climate and energy strategy. The committee report, completed in June 2009, includes 125 measures for the period between 2009 and 2020. On the basis of the committee's proposals, the Government Decision on Energy Efficiency Measures (4 February 2010) established the policy lines and measures for pursuing energy efficiency. An *ex post* evaluation framework has been established to monitor the progress achieved as a result of the Government Decision.

Energy efficiency agreements and energy audits (see below) and subsidies for developing and implementing energy efficient technology and innovative modes of operation are important for reaching the energy efficiency targets. The Government Decision also includes measures that aim to cause a behavioural change and, in the longer term, to effect a fundamental change in society through education, research and development.

Voluntary energy efficiency agreements

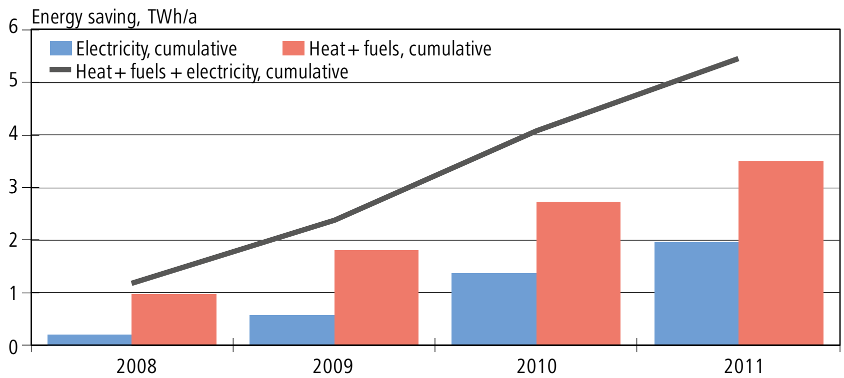
Since the 1990s, Finland has employed a voluntary energy efficiency agreement scheme for companies and municipalities. Voluntary measures, such as energy efficiency agreements, energy audits and sector or measure-specific programmes, have already resulted in significant energy savings. The agreement scheme covers almost 85 per cent of all industrial energy end-use and more than 50 per cent of the building stock of the service sector.

The second generation of 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 the period 1997–2007.

Additional energy efficiency agreements are currently in force for goods transport, logistics and public transport (see Section 4.7.2). The housing sector has an energy conservation agreement scheme (since 2010), which is overseen by the Ministry of the Environment, and there is another one for commercial properties (since 2011) under the responsibility of the Ministry of Employment and the Economy. In 2010, an energy efficiency agreement was also launched in the agriculture sector under the Ministry of Agriculture and Forestry.

Total new savings from measures under the energy efficiency agreements (2008–2016) within the industry, energy, municipal, property and building sectors were approximately 5.5 TWh per year at the end of 2011 (Figure 4.2). More than one third of the energy saved was electricity. The savings were equal to 1.4 per cent of Finland's total energy consumption (386 TWh

Figure 4.2
Total energy savings resulting from energy efficiency agreement scheme, 2008–2011



in 2011). For example, in 2010 in the food and drink industry approximately one third of the savings arose from measures related to heat recovery, while roughly one third of the savings were related to the heating of buildings. Within the plastic industry, one third of savings stemmed from more efficient process cooling. Within the energy intensive industry, savings in the actual process equipment and processes accounted for more than half of the savings, while measures addressing, e.g. steam and condensate, were also significant.

CO_2 reductions under the energy efficiency agreements were approximately 4.1 million tonnes CO_2 per year at the end of 2010 (based on a marginal emissions rate of 600 kg CO_2/MWh for electricity). It is estimated that by the end of 2015, the emissions reduction will be 5.9 million CO_2 tonnes per year, and 5.2 million tonnes per year by 2020 when taking into account the termination of current agreements at the end of 2016 (see Table 4.4). Additional emissions reductions have been achieved as a result of the energy efficiency agreement (2008–2016) for the oil sector. These amounted to 0.34 million tonnes in 2010 and are estimated to reach 0.39 million tonnes in 2015 and 0.43 million tonnes in 2020.

The energy efficiency agreements are especially important for implementing the Energy Services Directive,[22] which entered into force in May 2006, and its successor, the Energy Efficiency Directive,[23] which entered into force in December 2012.

Energy audits

The Energy Audit Programme is one of the oldest national energy efficiency grant schemes in place in Finland. The full-scale programme was launched in January 1994.

The purpose of energy auditing is to analyse the energy use of the facility being audited, to work out the potential for energy savings and to present a profitability calculation of saving proposals. In addition to working out possible ways to use different forms of renewable energy and the energy saving potentials, the energy audit reports on the impact of the proposed measures on CO_2 emissions.

The Energy Audit Programme is a voluntary programme promoted by a 40 to 50 per cent subsidy by the Ministry of Employment and the Economy. The ministry provides subsidies for conducting energy audits on commercial and public buildings and in the industrial and energy sectors. It also supports municipalities to carry out audits concerning the promotion of renewable energy use within the municipality's territory (Renewable Energy Municipal Audit). Apart from energy audits subsidised by the Ministry of Employment and the Economy, there are energy audits intended for blocks of flats and terraced housing. Subsidies for private sector buildings are granted by municipalities, whereas subsidies for municipal housing stock are granted by the Housing Finance and Development Centre of Finland (ARA). The Ministry of the Environment determines the total annual amount of these subsidies.

By the end of 2010, the estimated savings in energy achieved by conducting audits in the service, municipal and industry sectors were approximately 1.0 TWh per year. About 90 per cent of the savings originated in the industry sector. The corresponding CO_2 reduction was 0.98 million tonnes

22 (2006/327/EC)
23 (2012/27/EC)

CO_2 per year (based on a marginal emissions rate of 600 kg CO_2/MWh for electricity). The emissions reduction is estimated to be 0.65 million CO_2 tonnes per year by the end of 2015 and 0.56 million tonnes per year by the end of 2020 (an example of an implemented energy saving measure is presented in Box 4.3). While 90 per cent of the energy audits are implemented in connection with the energy efficiency agreements, overlap in energy savings and emission reductions has been removed in the estimates and the results are additive.

Box 4.3
Reduction of energy consumption for pressurised air in industry

The production of pressurised air can account for a third of energy costs for a company and leaks can cause considerable losses.

Motiva Oy has developed an analysis method for improving energy efficiency in compressed air systems together with equipment manufacturers and industrial companies. The analysis (called PATE) covers all of the most significant factors for the energy efficiency of the system. Improvement measures are proposed with annual savings, investment needs and pay-back times. Most measures concern making improvements in the control of compressors, making changes in blow, fixing leaks and reducing pressure levels.

J.M. Huber Oy and Forchem Oy are two companies producing chemical products. Compressed air analysis was carried out in their processes in 2011. Both companies were familiar with the individual metering of compressors, repairing leaks and reducing pressure levels already before the assessment. Yet, the analysis revealed a total electricity savings potential of 640 MWh, which corresponds to about 30 per cent of the combined electricity consumption by pressurised air systems in the two companies. An additional savings potential of 277 MWh per year was revelead in heat recovery.

Renewables

Finland aims to increase the proportion of renewable energy in final energy consumption to 38 per cent by 2020 (32.2 per cent in 2010). 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.

The Act on Production Subsidy for Electricity Produced from Renewable Energy Sources[24] and the Government Decree on Production Subsidy for Electricity Produced from Renewable Energy Sources[25] entered into force on 1 January 2011, with the exception of subsidy levels. The provisions on subsidy levels entered into force on 25 March 2011 under a Government Decree.[26]

The production subsidy scheme initially consisted of two different subsidy categories: a feed-in tariff and a fixed production subsidy. A fixed subsidy was paid only for the year 2011, after which this subsidy category was discontinued.

A feed-in tariff is available for new and existing forest chip power plants, new wind power plants, new biogas power plants (gas produced by digestion) and new wood-fuelled power plants, which also produce heat.

For forest chip power plants, the feed-in tariff varies between 0 and 18 EUR/MWh according to the price of emission allowances. For other renewables, the basic subsidy is the difference between 83.5 EUR/MWh and the market price.

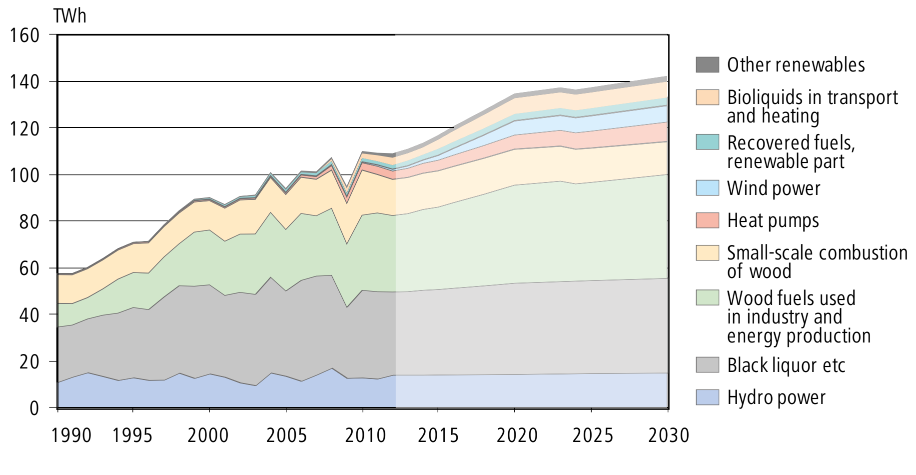
24 (1396/2010)
25 (1397/2010)
26 (258/2011)

The feed-in tariff is expected to further the construction of wind power in line with the National Energy and Climate Strategy (2013). The objective is to increase the production of wind power to 6 TWh by the year 2020, whereas the current production level is approximately 0.5 TWh. The effect on emissions has been estimated based on the assumption that wind power reduces the need to produce electricity mainly in condensing power plants using fossil fuels and peat (for more information on the IMPAKTI calculation tool used to estimate the emission reduction impacts of renewables, see Section 5.8). Using a marginal emission coefficient of 600 t CO_2/GWh, the promotion of wind power will reduce the emissions in the year 2020 by 3.6 million tonnes CO_2 (Table 4.4). The reduction will occur totally in the ETS sector. The estimate includes the impact of all policies and measures promoting wind power (including the impact of the feed-in tariff).

Increasing the use of forest chips in multi-fuel boilers is the most central and cost-efficient way of increasing the use of renewable energy in the generation of power and heat. Adopted in the summer of 2010, the Finnish National Renewable Energy Action Plan sets the 2020 target for the use of forest chips in the generation of heat and power at 25 TWh. The use of forest chips will replace the use of other fuels (mainly peat) in heat and power production and heating oil on farms. The estimated emission reduction achieved due to the use of forest chips was 5.2 million tons CO_2 for the year 2010, whereas it should be 9.9 million tonnes in 2020. Slightly more than 10 per cent of the emission reduction is in the non-ETS sector. The estimates do not include the impact of the increased use of wood energy on the carbon sink of forests. Current scenarios for the increase of wood energy suggest a reduction that is equal to about one third of the total sink of Finnish forests (from 6 to 10 Mt CO_2 eq./year).

The impact of the feed-in tariff for biogas has not been numerically estimated for 2020. The promotion of biogas will replace power and heat production using other fuels. CH_4 and N_2O emissions from material used for biogas production will also be avoided, such as CH_4 emissions from landfilling of biogenic waste or CH_4 and N_2O emissions from manure management.

Figure 4.3
Historic development and WM projection for renewable energy



The National Energy and Climate Strategy (2013) also contains more than just economic measures to promote renewables, especially biomass. These include improving the logistics for harvesting and transporting forest chips and furthering the emergence of local heat entrepreneurs. Wind power will be advanced by reducing barriers for wind power investment and by enabling demonstration projects for off-shore wind power. The historic use of and WM projection for renewable energy in Finland is shown in Figure 4.3 and Table 4.3.

Renewable energy policies and measures for the transport sector are described in Section 4.7.2.

Table 4.3
Renewable energy in the WM projection, TWh

	2008	2009	2010	2011	2020	2025	2030
Renewable fuels related to industrial production							
Black liquor	39.9	30.6	37.7	37.5	39	40	41
Industrial wood residues	20.0	15.0	18.5	18.8	18	18	18
Total	**60**	**46**	**56**	**56**	**57**	**58**	**59**
Renewables targeted by policies							
Hydro power	16.9	12.6	12.7	12.3	14	15	15
Wind power	0.3	0.3	0.3	0.5	6.0	6.5	7.0
Forest chips	8.8	12.1	13.8	15.0	25	24	27
Small-scale combustion of wood	16.4	17.4	19.3	16.5	15	15	14
Heat pumps	1.9	2.6	3.0	3.5	6.0	7.2	8.3
Bioliquids in transport and heating	1.0	2.0	2.2	2.7	7.0	7.1	7.1
Biogas	0.5	0.5	0.5	0.6	0.7	0.6	0.6
Recovered fuels	1.7	1.6	1.7	1.6	3.0	3.2	3.4
Other	0.4	0.6	0.6	0.5	1.3	1.5	1.9
Total	**48**	**50**	**54**	**53**	**78**	**80**	**84**

Energy use in residential and other buildings

CO_2 emissions from the use of energy in buildings are mainly covered by the EU ETS. District heating is the source of about half of all space heating in Finland. The majority of district heating production falls within the sphere of the EU ETS. The total space heating energy used in residential, commercial and public buildings was 70 TWh in 2011 (23 per cent of the total end use of energy). Slightly less than 30 TWh of the space heating belongs to the non-ETS sector. Non-ETS CO_2 emissions from the energy used to heat buildings are less than 5 million tonnes annually. These emissions mainly cover the use of light fuel oil (and to a very small extent, natural gas) in buildings, as well as the fuels used in small district heating plants. 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.

Policies and measures for buildings and housing aim at improving energy efficiency, reducing ETS and non-ETS-emissions and increasing the use of renewable energy sources. Policy measures include standard setting, economic instruments, the dissemination of information and education and research. The measures target both new and existing buildings, including the use and maintenance of the building stock. In addition to policy measures in the building sector, energy use is affected by policy instruments for renewable energy via changes in the prices of heat and electricity.

The Directive on the Energy Performance of Buildings (EPBD)[27] aims to reduce CO_2 emissions by improving the energy efficiency of buildings.

27 (2002/91/EC)

The directive was implemented in Finland by a new regulation that 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[28] and the Ministry of the Environment Decree on Energy Certification of Buildings[29]
- Act on Inspection of Air-conditioning Systems[30]
- Amendments to the Land Use and Building Act,[31] which was expanded to cover energy efficiency requirements and details on how energy efficiency should be calculated[32]

The minimum requirements for thermal insulation and ventilation in new buildings have been set by the National Building Code since 1976. The energy efficiency requirements were tightened by 30 per cent compared to earlier requirements in December 2008 due to the implementation of the EPBD. The requirements were further tightened (by 20 per cent) in March 2011 due to the implementation of the Directive on the Energy Performance of Buildings (Recast).[33] The new building regulation came into force in July 2012, and it is based on the overall energy consumption, which takes into account, among other things, air conditioning, cooling, lighting and heating, the washing water and heating energy. The new regulation favours the utilisation of district heating and renewable energy when defining the energy performance of a building as a whole.

The Government has supported energy efficiency improvements in renovation and investment in low-carbon heating systems through various subsidies. Low-carbon heating systems utilise renewable energy sources, especially ground heat and wood bioenergy (pellets, small-scale firewood). Due to the overall reductions in the Government's budget, these subsidies have now been ceased. There is also an interest subsidy system promoting loans for renovations that improve energy efficiency.

Based on the modification in the decree of the national building code for sewage and fresh water systems, water measurement instruments became compulsory in new apartment buildings at the beginning of 2011. The aim was to reduce the consumption of water and the need for heating it. The water measurement instruments provide information on the use of water in each apartment and make it so that the billing is done according to the actual water use, which provides a direct price signal for inhabitants. The requirement will be expanded into the existing building stock in 2013 in the case of pipe and plumbing system repairs subject to a building permit.

Information provision and the campaigns supported by the Government seek to influence the behaviour of building users and owners. At the moment, activities exist for giving internet-based informational guidance, e.g. in repair, energy efficiency and long-term planned real estate maintenance issues.

Systematic and well-timed real estate maintenance activities for buildings include repairs and replacement as well as the proper adjustment and settings for heating, ventilation and air conditioning equipment. The aim is to reach

28 (487/2007)
29 (765/2007)
30 (489/2007)
31 (1129/2008)
32 (488/2007)
33 (2010/31/EU)

the full extent of the technical and economic lifecycle. The maintenance and repair plan is based on condition assessment surveys in which the conditions as well as any need for repairing a building or equipment are determined, mainly by sensory and empirical evaluations and non-destructive methods. Systematic and well-timed renovations can reduce costs while meeting the needs of users and sustainable development, e.g. energy and material efficiency.

Renovation and the retrofitting of buildings will increase rapidly in Finland in the next two decades. The reason is that, among other things, a large amount of the building stock will need improvements in their physical condition or in their energy efficiency. Such an increase in repair and renovation work will require considerable development and changes in the property and building sectors. In order to address the expected challenges, the Ministry of the Environment launched a programme in co-operation with the Finnish real estate and construction branch, various research institutions and the public administration. As a result of the programme, the Strategy for Repair and Renovation 2007–2017, an implementation plan (2009) and the Government Resolution on Renovation (2008) were compiled.

The implementation plan consists of thirteen measures for action that define the aims and concrete measures to be taken. The actions include, e.g. developing a maintenance culture, making improvements in energy efficiency, improving know-how and disseminating knowledge, developing the materials and resource efficiency, and developing renovation services. Research and communication play an important role in the implementation of the strategy. The responsibility for implementing the strategy is broadly spread among the actors in the property and building sectors.

Improving the built environment, including the transport systems, thus plays a key role in reducing greenhouse gas emissions and mitigating climate change. The Energy-Smart Built Environment 2017 (ERA17) action plan originally proposed 31 necessary actions for reducing emissions in the built environment, for improving energy efficiency and for promoting the use of renewable energy. The overall target of the programme is to create an 'energy-smart built environment' that is energy-efficient and low in emissions and that provides a high-quality living and working environment. The action plan combined simultaneous and former programmes and was drawn up as a joint effort by the Ministry of the Environment, the Finnish Innovation Fund (Sitra) and the Finnish Funding Agency for Technology (Tekes) and in collaboration with the business sector, research institutions and the public administration. The programme has focused on five actions for the years 2013–2014.

The emission impacts of building-related policy measures have been evaluated using EKOREM and POLIREM calculation models (see Section 5.8) and information on the emission coefficients for district heating and electricity. These models calculate the heat and energy consumption and the resulting greenhouse gas emissions of the building stock. The impacts of policy measures are evaluated by modifying the energy efficiency of the building elements (EKOREM) or specific consumptions of energy (POLIREM), or the distribution of heating systems. The energy savings are converted into emission reductions with an average emission coefficient in the case of district heating (236 t CO_2/GWh) and with a mean marginal emission coefficient in the case of electricity (600 t CO_2/GWh

The emission reduction impacts of the policy measures are presented in Table 4.4. The regulation for the energy performance of new buildings entails the largest emission reductions, namely 2.1 million tonnes CO_2 by 2020 and 3.7 million tonnes CO_2 by 2030. Most of the emission reduction will take place in the EU ETS sector through the reduced use of district heat and electricity.

The reduction of indoor temperature by 0.5°C has been used to illustrate the possible impact of long-term planned real estate maintenance. The estimated impact would be 0.7 million tonnes CO_2 annually by 2020 and 2030.

Subsidies for energy efficiency improvements will supposedly reduce the annual emissions by 0.3 million tonnes CO_2 in 2010, 2020 and 2030. The impact will be larger in the non-ETS sector because of the fact that subsidies were provided to replace the oil boilers with ground heat or wood bioenergy (pellets, small-scale firewood) in 2011–2012.

Real estate maintenance activities, like adjusting the heat and ventilation systems, are able to provide immediate energy savings and emission reductions. In addition, no investments in equipment or materials are needed. Therefore, the net emission and cost reductions will take place immediately. The possibilities to reduce emissions are, however, limited. The short-term impacts of minimum standards for energy performance in new and existing buildings are small. The impact will gradually increase over time when the building stock is renewed and renovated.

New regulations for both new and existing buildings state that the energy performance target can be obtained by improving the energy efficiency and/or changing the heating system. This substantially complicates the evaluation of energy saving and emission impacts.

Policies and measures in the WAM projection

A package of measures – the clean energy programme – was outlined in connection with preparing the energy and climate strategy. The aim of the programme is to balance Finland's current account by investing in the domestic production of clean energy in order to replace imports, thereby creating tens of thousands of new jobs in the energy cluster and reducing Finland's greenhouse gas emissions to a level that is on track to meet the EU's 2050 target for 2025.

In terms of its energy objectives, the clean energy package can be summarised as follows:

- An approximately 20 per cent reduction in the use of mineral oil will be pursued. Most of this cut will originate in road transport, while the rest will come from replacing oil heating. Increased investments will be made in development projects for domestic biofuels. The adoption of new motor technology will be supported, while an infrastructure and incentives will be created to purchase low-emission cars.
- Use of coal in power plants will be for the most part replaced by new, emission-free forms of energy production, such as nuclear power and wind power. The wind power target for the year 2025 is 9 TWh. In addition, the net import of electricity will largely be replaced. Most coal used for heat generation in cities will be replaced with biomass. Further use will be made of the opportunities provided by heat pumps, solar heat and the energy efficiency of buildings. Building-specific, small-scale generation of energy will be promoted.
- Approximately 10 per cent of natural gas will be replaced with biomass-based solutions, which will make it possible to replace imported gas while utilising the current gas pipelines and power plants.

The public administration has employed and will continue to employ various measures to promote the objectives of the clean energy package. These include emissions trading, taxes levied on heating fuels, taxes levied on transport fuels and taxes levied on the acquisition and use of vehicles, as well as various financial incentives granted by Finland or the EU and positive decisions-in-principle for two nuclear power units.

However, the package of measures would require additional public funding as well as the addition of further measures. It would require a continuation of the feed-in tariff for wind power when the current maximum of 2500 MW, which has been accepted as part of the support scheme, is full; securing the use of renewable sources of energy in heat and power cogeneration plants; possible incentives for the acquisition of low-emission vehicles; and incentives to make the transition from mineral oils used as heating fuels to other sources of energy, either through fiscal or other means, in case the desired progress is not otherwise achieved.

In the building sector, additional measures include a regulation to ensure the improvements of energy and resource efficiency in the renovation and alteration of buildings. Due to the implementation of the Directive on the Energy Performance of Buildings (Recast), the regulation for the energy efficiency of the existing building stock was put into effect on 27 February 2013. The impacts of the regulation on energy savings are evaluated using the REMA calculation model (see Section 5.8). The corresponding emission reductions, presented in Table 4.4, have been calculated by using the additional information on the shares of different energy types and the emission coefficients for district heating and electricity.

It is estimated that the emission reductions due to improvements in energy performance in renovations and alterations in the WAM projection will be 0.5 million tonnes CO_2 in 2020 and 1.0 million tonnes CO_2 in 2030. Energy efficiency improvements are related to the normal lifecycle of buildings and are thus realised during long periods of time in connection with other renovations and alterations. Some efficiency improvements will already take place as part of the WM projection. Most of the emission impact is due to the reduced use of district heating and electricity produced in the ETS sector. It is estimated that the emission reductions in the non-ETS sector will be quite modest, namely 0.04 million tonnes CO_2 in 2020 and 0.05 million tonnes CO_2 in 2030. Part of the emission reductions will be obtained when oil fuelled boilers are replaced with ground heat and other heating systems that need electricity. This will increase emissions somewhat in energy production within the ETS sector.

One goal of the National Energy and Climate Strategy is to level off growth in final energy consumption by improving energy efficiency so that, in 2020, consumption will be a maximum of 310 TWh. With the policies and measures included in the WAM projection, the estimated final energy consumption in Finland should be 317 TWh in 2020. Further measures are consequently needed to reach the target, and it can be assumed that some of them will also reduce greenhouse gas emissions.

Summary of policies and measures

A summary of the policies and measures in the energy sector is presented in Table 4.4.

Table 4.4
Summary of the policies and measures in the energy sector (the mitigation impact is expressed as kilotonnes CO_2 eq.)
The first figure represents the total estimated mitigation impact, and the figure in brackets is the mitigation impact outside the EU emissions trading scheme

Name of Mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of implementation	Brief Description	Start year of implementation	Implementing entity or entities	Estimated mitigation impact (kilotonnes CO_2 eq.)						
								1995	2000	2005	2010	2015	2020	2030
*Energy conservation agreements 1997–2007	Energy efficiency improvement in multiple sectors	CO_2	Voluntary agreement	Ended in 2007	Energy saving in industry, energy industry, municipalities, the private services sector, the property and building sector	1997	Ministry of Employment and the Economy, industry associations	0	841	2,494	IE	IE	IE	na
*Energy efficiency agreements 2008–2016	Energy efficiency improvement in multiple sectors	CO_2	Voluntary agreement	Implemented	Energy saving in industry, energy industry, municipalities, the private services sector, the property and building sector	2008	Ministry of Employment and the Economy, industry associations	0	0	0	4,083 (78)	5,940 (56)	5,150 (39)	na
*Energy efficiency agreements 1997–2007 and 2008–2016	Energy efficiency improvement in oil sector	CO_2	Voluntary agreement	Implemented	Energy savings in oil heated buildings	1997, revision 2008	Ministry of Employment and the Economy, Finnish Petroleum Federation	0	123 (123)	265 265)	341 (341)	389 (389)	433 (433)	na
*Energy Audit Programme	Energy efficiency improvement in multiple sectors	CO_2	Financial	Implemented	Energy saving in industry, municipalities and the private services sector	1992	Ministry of Employment and the Economy	61 (2)	437 (14)	734 (24)	979 (31)	651 (24)	564 (22)	na
*Act on Ecodesign and Energy Labelling (1005/2008, amendment 1009/2010)[1]	Reduction of electricity use by equipment, lighting and applicances	CO_2	Regulatory, Information	Implemented	Minimum energy performance standards (MEPS), energy labelling of appliances	MEPS 2008, labelling earlier	Ministry of Employment and the Economy, Finnish Safety and Chemicals Agency (TUKES)	0	0	0	0	830 (0)	2,052 (0)	na
*Promoting windpower	To increase the construction of wind power plants.	CO_2	Economic, fiscal, information, planning	Implemented	Measures implemented since 1996 include investment subsidies for wind power plants, electricity tax subsidies, feed-in tariff, information measures and support for land-use planning .	1996	Ministry of Employment and the Economy, Ministry of the Environment	na	na	na	177 (0)	na	3,600 (0)	na
*Promoting woodchips	To increase the use of of wood chips in electricity and heat production.	CO_2	Economic, fiscal, information, research	Implemented	Measures implemented since 1992 include investment subsidies for heat and power production plants using forest chips, subsidies for harvesting of forest chips, electricity tax subsidies, feed-in tariff and information measures.	1992	Ministry of Employment and the Economy, Ministry of Argiculture and Forestry	na	na	na	5199 (962)	na	9,861 (1,102)	na
*Promoting biogas in electricity and heat production	To increase the utilization of biogas for energy.	CO_2, CH_4, N_2O	Economic, fiscal, regulatory, information, research	Implemented	Measures implemented since 1997 include investment subsidies, electricity tax subsidies and feed-in tariff.	1997	Ministry of Employment and the Economy, Ministry of Argiculture and Forestry	na	na	na	169 (75)	na	na	na

Table 4.4 Cont.

Name of Mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of implementation	Brief Description	Start year of implementation	Implementing entity or entities	Estimated mitigation impact (kilotonnes CO_2 eq.)						
								1995	2000	2005	2010	2015	2020	2030
*Lower excise duty for biofueloil	To increase the use of biofueloil	CO_2	Economic, fiscal	Implemented	The excise duty for biofueloil is lower than that of fossil heating oil.	2010	Ministry of Employment and the Economy	na	na	na	51 (51)	na	na	na
*Building regulations	Aims at more energy efficient construction	CO_2	Regulatory	Implemented	Provides minimum standards for new buildings	2003/2008/ 2010	Ministry of the Environment	0	0	221 (17)	648 (26)	812 (42)	812 (42)	812 (42)
*Renewed building regulations	Aims at more energy efficient construction and use of low emission heating system in buildings	CO_2	Regulatory	Implemented	Provides minimum standards for new buildings, switch to full energy based calculation	2012	Ministry of the Environment	0	0	0	0	473 (25)	1,268 (65)	2,854 (147)
*Subsidies for energy efficiency in buildings (block of flats, single houses)	To improve energy efficiency and promote the use of renewable energy in buildings	CO_2	Economic	Implemented	Dedicate subsidies for energy efficiency and for use of renewable energy	2003	Ministry of the Environment	0	0	24 (3)	74 (10)	335 (238)	335 (236)	335 (231)
*Long term planned real estate maintenance	To reduce the use of energy and increase energy efficiency	CO_2	Information	Implemented	Provide information for appropriate use of the buildings and the proper adjustment and settings of heating, ventilation and air conditioning equipment, as well as maintenance and repair plans.	Long term implementation, strengthening since 2000	Ministry of the Environment	0	0	na	na	412 (63)	685 (92)	683 (69)
*Decree on water measurement instruments	To reduce the use of energy	CO_2	Information, economic	Implemented	Provides information on the use of water in each apartment and allows the billing based on the water consumption	2011	Ministry of the Environment	0	0	0	0	16 (2)	34 (3)	69 (7)
*Act on energy certificates for buildings (487/2007)	To provide information on energy performance of buildings and guide consumers	CO_2	Information	Implemented	Houseowners are obliged to provide information on energy efficiency	2008	Ministry of the Environment	0	0	0	na	na	na	na
*Act on energy efficiency inspections of cooling equipment used in air conditioning systems in buildings (489/2007)	To maintain energy efficiency	CO_2	Regulatory	Implemented	Houseowners are obliged to take care of inspection of the energy effeciency of cooling equipment	2008	Ministry of the Environment	0	0	0	na	na	na	na
*Towards nearly zero-energy buildings	Aims at nearly zero-energy building	CO_2	Information	Implemented	Information campaign "Energy efficient home"	2006	Ministry of the Environment	0	0	0	na	na	na	na
Decree on the improvement of energy efficiency in buildings in renovation and alteration	Regulation to ensure energy and resource efficiency in renovating buildings	CO_2	Regulatory	Adopted	Provides minimum standards for improving energy performance of buildings in renovations and alterations	2013	Ministry of the Environment	0	0	0	0	220 (19)	524 (42)	1,043 (49)

na = estimate not available
IE = estimate included in the other measures
* denotes a measure included in the WM projection. Some of these measures are further strengthened in the WAM projection.
1 Estimated mitigation impact includes ecodesing only.

4.7.2 Transport

Policies and measures in the WM projection

Policies and measures within the transport sector under the WM projection are outlined in Table 4.5. The WM projection includes all measures that were in use in the transport sector to cut down the emissions at the beginning of the year 2013. The measures are designed to achieve the target of the Climate Policy Programme for the Transport Sector and Finland's Long-term Climate and Energy Strategy (–15 per cent in 2020) and the EU's Effort Sharing Decision (–16 per cent in 2020).

The WM projection contains the following measures: 1) promoting the use of biofuels within the transport sector, 2) renewing the vehicle fleet, 3) improving energy efficiency within the transport sector, and 4) directing the growth of passenger traffic volumes in urban areas to include more environmentally friendly transport modes. It is assumed that the growth in transport performances needs to stay at a moderate level (0.5–1.5 per cent per year) so that it will be possible to achieve the climate policy aims within the transport sector.

The greenhouse reduction impact of the policies and measures (both ex post and ex ante) has been estimated by the VTT Technical Research Centre of Finland and Motiva Oy based on, for example, the results of the LIPASTO calculation model, which is the model used to estimate emissions from the transport sector for the GHG inventory. The methods used for impact assessment are documented in Finland's second National Energy Efficiency Action Plan (NEEAP 2).

Promoting the use of biofuels

The amendment to the national act on promoting the use of biofuels within the transport sector[34] came into force on 1 January 2011. The biofuel distribution obligation will be six per cent for 2011–2014, followed by a phased increase to 20 per cent by 2020. At the beginning of 2011, 95 E10 petrol with a 10 per cent share of biofuel was introduced to the market; it replaced 95 E5 petrol. The energy content of second-generation biofuels (biofuels produced, for example, from waste material) is taken into account as double its actual energy content when calculating the share of biofuels for the purposes of the distribution obligation. Therefore, the actual share, by which biofuels would replace fossil fuels, is likely to be smaller than the target.

By 2020, it is assumed that biofuels will have replaced 12.5 per cent of fossil fuels in transport (5 per cent of first-generation biofuels and 7.5 per cent of second-generation biofuels). This means that emission reductions in the transport sector will be 2 million tonnes in 2020. In 2011, the estimated emission reduction was 0.7 million tonnes.

Biofuels can be used in machinery and in various sectors in addition to transportation (construction, agriculture, forestry, mining, industry, service and households). In the WM projection, it is assumed that the share of biofuels used in machinery will be 10 per cent in 2020. Due to the use of biofuels, the emissions from machinery in 2020 are projected to remain approximately at the 2010 level despite the increased use of machinery.

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34 (446/2007)

Renewing the vehicle fleet

In the Climate Policy Programme for the Transport Sector, the aim is that in 2020 the specific emissions of new cars sold in Finland will be close to the EU objective (95 g/km; the level in 2011 was at around 144.5 g/km and 2012 at 139,7 g/km) and that the rate of vehicle fleet renewal will be approximately 7 per cent a year.

Regulation No 443/2009 of the European Parliament and of the Council setting emission performance standards for new passenger cars (a binding CO_2 standard for passenger cars), entered into force in June 2009. It set the average CO_2 emissions for new passenger cars at 130 g CO_2/km by 2015 and 95 g/km by 2020. A corresponding regulation for light commercial vehicles (Regulation No 510/2011 of the European Parliament and of the Council) entered into force in 2011. This regulation sets a target of 175 g CO_2/km by 2017 and 147 g/km by 2020 for the average emissions of new light commercial vehicles registered in the European Union.

Car taxation was reformed in Finland in 2007 and in 2011. The tax on passenger vehicles was differentiated according to vehicle-specific emissions (g CO_2/km). The lowest tax rate (5 per cent) applies to cars with zero carbon dioxide emissions, while the highest tax rate (50 per cent) applies to cars with carbon dioxide emissions exceeding 360 g/km. The Vehicle Tax Act was also reformed in 2007 and 2011. In these reforms, the basic part of the tax was differentiated according to the carbon dioxide emissions of each vehicle, similarly as in the car taxation reform. The basic part of the emission-based vehicle tax now varies between EUR 43 and 606 per year, depending on the car's specific carbon dioxide emissions. This taxation model is beneficial to all low-emission cars, irrespective of the technology used.

Finland has also been active in providing information to consumers about the CO_2 emissions of passenger cars. Examples of this include the energy label for cars, the Choosing a Car website and the online car comparison engine produced by the transport administration, which enables potential car buyers to compare different car models based on fuel consumption and CO_2 emissions.

If the renewal rate of the vehicle fleet speeds up to reach the level set for the sector, it is estimated that the emission reduction effects of new vehicle technologies will be as much as 2.1 million tonnes in 2020.

During the period 2007–2011, the average CO_2 emissions of new cars decreased by some 20 per cent. The average CO_2 emissions in December 2011 were 142.6 g/km for new petrol-driven passenger cars and 146.1 g/km for diesel-driven passenger cars (see Figure 3.12). A total of some 111,000 new cars were sold in 2012 (the goal was 150,000). The emission reduction effects of new low-emission cars were estimated at approximately 0.16 million tonnes CO_2 in 2011.

Energy efficiency in the transport sector

According to the Climate Policy Programme for the Transport Sector, energy efficiency in transport will be improved. This can be achieved through such means as energy efficiency agreements and eco-driving.

There are two ongoing energy efficiency agreements in the transport sector: one on goods transport and logistics and one on public transport services. Both aim to reduce the energy consumption of enterprises that have joined the agreement by 9 per cent by the year 2016 (a target set out in the directive on energy end-use efficiency and energy services). The target in public transport services is to have at least 80 per cent (around 560) of enterprises join the effort. In goods transport, the target is 60 per cent, or 5,400 enterprises.

Training in eco-driving has been provided to bus and coach drivers since 1997. The Act on Professional Qualifications for Truck, Bus and Coach Drivers entered into force in August 2007. The Act emphasises predictive and economical ways of driving. Eco-driving education is included in basic driver training, too. The basics of eco-driving have been included in basic driver training since 1994 and in the revised two-stage training since 1997.

For bus and coach drivers, the annual CO_2 emission reduction is estimated at 0.01 million tonnes annually. It is estimated that the annual CO_2 emission reductions for trucks will be 0.07 and for private drivers 0.06 million tonnes by 2020.

Influencing modal splits and curbing the growth in vehicle kilometres

According to the Climate Policy Programme for the Transport Sector, the growth in passenger traffic volumes in urban areas will be directed to 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 constitutes an approximate 20 per cent increase over the current figures.

The reconciliation of land use, housing and transport is promoted through MAL letters of intent in the Finnish urban regions (see also Section 4.7.9). These aim at creating more efficient urban structures and reducing people's need to use private cars. Transport and land-use planning is also being carried out in conjunction with regional transport system work and other land-use planning. Efforts are being made to implement transport infrastructure investments in such a way as to contribute to better cohesion of the urban structure.

Finland's Public Transport Act was reformed in 2009 to comply with the requirements of the EU's Public Service Obligations (PSO) regulation. The current bus transport system is to be reorganised after the service contracts for the transition period, concluded pursuant to the Public Transport Act, expire between 2014 and 2019. After a transition period, competent authorities must organise public transport in their area. When implementing the Public Transport Act, particular attention must be paid to introducing a national ticketing system and implementing a schedule and journey planner service. The goal is to create a uniform, user-friendly service package and to increase the number of people using public transport. In 2011, some EUR 10 million of State aid was granted to support public transport in large urban areas (Helsinki, Tampere, Turku and Oulu).

A national strategy and implementation plan for the promotion of walking and cycling, covering the period 2011–2020, was released in 2011. This strategy aims to increase the share of trips made by walking or cycling. The target is that by 2020, the share of walking and cycling trips will increase from the current 32 per cent to 35–38 per cent in the modal slit and that the proportion of short trips made by passenger cars will correspondingly decrease.

The popularity of public transport, walking and cycling is also being promoted through Mobility Management, which was made a national-level project in 2010. With Mobility Management, the aim is to reduce travelling by car by, for example, providing information and developing services that ease the usage and combine different travel modes. Mobility Management work at the regional level has been supported through R&D calls for projects and through a EUR 0.7 million appropriation included in the 2012 budget.

Policies and measures in the WAM projection

Table 4.5 sets out the main policies and measures included in the WAM projection for the transport sector. The WAM projection contains the following measures: 1) energy efficiency in transport will be improved by offering new energy subsidies for the transport sector, 2) the growth in passenger traffic volumes in urban areas will be directed to more environmentally friendly transport modes by offering new financial support for public transport in urban areas, and 3) traffic volumes and the modal split will be influenced by additional/supplementary economic steering measures, such as fuel taxes, car taxes and/or road user charges if the climate policy objective for the transport sector cannot be achieved through other measures. Decisions regarding potential new financial steering models can be expected in 2013–2014 at the earliest.

It has been estimated that the potential emission reduction effects of the energy efficiency agreements will be as much as 0.3 Mt CO_2 by 2020. This figure partially overlaps with the impact assessment of eco-driving training for professional drivers.

It has been estimated that the emission reduction effects of public transport, walking and cycling will total some 0.3 Mt CO_2 by 2020. For public transport, the target is to reach a 0.15 Mt emission reduction, and the same target applies to walking and cycling.

In the Climate Policy Programme for the Transport Sector, it has been estimated that the emission reduction effects of additional economic steering measures will be as much as 1.4 Mt CO_2 by the year 2020.

Summary of policies and measures

A summary of the policies and measures in the transport sector is presented in Table 4.5.

4.7.3 International bunkers

Policies and measures in the WM projection

Finland has participated actively in IMO's and ICAO's work to limit emissions from international traffic. In October 2013, ICAO's Assembly adopted a resolution on climate change and environmental protection according to which the ICAO Council will prepare an international emission limiting mechanism. The aim is to adopt the mechanism at the 2016 Assembly and for it to enter into force in 2020. In July 2011, the IMO approved binding energy efficiency targets for new ships. An Energy Efficiency Design Index (EEDI) will be calculated for each ship during the planning phase. The new regulations have been in force since the beginning of 2013. In addition, all ships, the gross tonnage of which is 400 tonnes or more, are required to compile a Ship Energy Efficiency Management Plan (SEEMP) following a guidance format prepared by IMO. National implementation of these measures is currently being prepared by the Ministry of Transport and Communications. The impacts of these measures on the emissions of ships in Finland have not yet been evaluated.

Table 4.5
Summary of the policies and measures in the transport sector (the mitigation impact is expressed as kilotonnes CO_2 eq.)

Name of Mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of implementation	Brief Description	Start year of implementation	Implementing entity or entities	Estimated mitigation impact (kilotonnes CO_2 eq.)						
								1995	2000	2005	2010	2015	2020	2030
*Promotion of biofuels in the transport sector; energy taxation (fuel tax)	Replacing use of fossil fuels by renewables	CO_2	Regulatory	Implemented	The biofuel distribution obligation will be six per cent for 2011–2014, followed by a phased increase to 20 per cent by 2020. The excise duty of biofuels is lower than that of fossil fuels.	2008/2010	Ministry of Employment and the Economy	0	0	0	700	na	2,000	na
*Renewing of the vehicle fleet: CO2 performance standards for new passenger cars; car and vehicle taxation; informational steering	Energy saving, emission reduction	CO_2	Regulatory, fiscal, information	Implemented	The EU regulation implemented in Finland sets energy performance standards for new passenger cars; reformed car and vehicle taxation depends on the CO2 emissions/km.	2009/2011	Ministry of Transport and Communications, Ministry of Finance	0	0	0	160	na	2,100	na
*Energy saving agreements and eco-driving	Energy saving, emission reduction	CO_2	Voltary agreement, information	Implemented	Energy saving agreements are on-going for goods transports and logistics, and for public transport. Eco-driving training is provided to bus and coach drivers and it is also included in basic driver training.	1994/1997/2008	Ministry of Transport and Communications	na	na	na	71	122	135	na
*Promotion of public and non-motorised transport	Energy saving, emission reduction	CO_2	Regulatory, informational, economic	Implemented	Several measures aim at promoting public and non-motorised transport, including land-use planning and mobility management.	2009	Ministry of Transport and Communications	0	0	0	na	na	na	na
"Energy saving agreements, new energy subsidies	Energy saving, emission reduction	CO_2	Economic	Planned		–	Ministry of Transport and Communications	0	0	0	0	na	300	na
Promotion of public and non-motorised transport, more financial support	Energy saving, emission reduction	CO_2	Economic	Planned		–	Ministry of Transport and Communications	0	0	0	0	na	300	na
Additional financial steering methods (fuel and car taxation and / or road user charges)	Energy saving, emission reduction	CO_2	Fiscal and/or economic	Planned	If the climate policy objective in the transport sector will not be achieved through the other measures, traffic volumes and the modal split will be influenced by additional/supplementary economic steering measures, such as fuel taxes, car taxes and/or road user charges.	–	Ministry of Finance, Ministry of Transport and Communications	0	0	0	0	na	upto 1,400	na

na = estimate not available
* denotes a measure included in the WM projection.

The legislation to include aviation in the EU ETS was adopted in November 2008, and it entered into force as Directive 2008/101/EC of the European Parliament and of the Council on 2 February 2009. According to this directive, all aircraft taking off and/or landing in the EU will be included in the trading system. Airlines have been able to derogate temporarily from their oblications under the EU ETS relating to their 2012 emissions based on a decision by the European Parliament and the Council (see Section 4.3 above).

The environmental outcome of an emissions trading system is pre-determined through the setting of an emissions cap. In the case of the EU ETS, a cap is established for aviation emissions in addition to the overall emissions cap. However, aircraft operators are also able to use allowances allocated to other sectors to cover their emissions. It is therefore possible (indeed highly likely given traffic growth forecasts) that the absolute level of CO_2 emissions from aviation will exceed the number of allowances allocated to aviation. However, any aviation emissions will necessarily be offset by CO_2 emission reductions elsewhere, either in other sectors within the EU that are subject to the EU ETS or through emission reduction projects in third countries. The 'net' aviation emissions will, however, be the same as the number of allowances allocated to aviation under the EU ETS.

In terms of contributing to the ICAO global goals, the states implementing the EU ETS together delivered, in 'net' terms, a 3 per cent reduction below the 2005 level of aviation CO_2 emissions in 2012, and will deliver a 5 per cent reduction below the 2005 level of aviation CO_2 emissions for the period 2013–2020.

Policies and measures in the WAM projection

In 2012, the Ministry of Transport and Communications set up a working group to consider the possible future energy sources for transportation. The task of the working group was to consider the extent to which and the time frame within which alternative energy sources could be used in different transport modes and to propose objectives and measures. One of the proposed objectives was to increase the use of LNG (liquefied natural gas) and other alternative energy sources in marine transport, which would result in considerable reductions of both air pollutants and CO_2 emissions. In aviation the objective was to increase the use of biofuels so that the share would be 40 per cent in 2050, which is in line with the common EU target.

Summary of policies and measures

A summary of the policies and measures for international bunkers is presented in Table 4.6.

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 projection target either these emissions or the CH_4 emissions from industrial processes. Therefore, the policies and measures described in this section are those mitigating nitrous oxide (N_2O) emissions and F-gases.

Table 4.6
Summary of the policies and measures for international bunkers (the mitigation impact is expressed as kilotonnes CO_2 eq.)

Name of Mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of implementation	Brief Description	Start year of implementation	Implementing entity or entities	Estimated mitigation impact (kilotonnes CO_2 eq.)						
								1995	2000	2005	2010	2015	2020	2030
*Energy Efficiency Design Index (EEDI) for new ships; Ship Energy Efficiency Management Plans (SEEMP)	To save energy and reduce emissions	CO_2	Regulatory	Adopted	The new IMO regulations set binding energy efficiency targets based on EEDI for new ships and require compilation of SEEMP by ships, the gross tonnage of which over 400 tonnes.	2013	Ministry of transport and communications	0	0	0	0	na	na	na
*Aviation Emissions Trading	To reduce emissions	CO_2	Regulatory	Implemented	Aviation is included in EU emissions trading	2013	Ministry of transport and communications	0	0	0	0	na	na	na
Liquefied natural gas and other alternative fuels in the sea traffic	To increase the use of alternative fuels, including renewables	CO_2	Regulatory	Planned	The use of alternative fuels in marine transport is promoted.		Ministry of Employment and Economy	0	0	0	0	na	na	na
Biofuels in air traffic	To increase the use of renewables	CO_2	Regulatory and/or economic	Planned	The use of biofuels in aviation are promoted.		Ministry of Employment and Economy	0	0	0	0	na	na	na

na = estimate not available
* denotes a measure included in the WM projection.

Policies and measures in the WM projection

During the years 2009–2012, there were three JI projects under track I within the Finnish territory. The projects cut N_2O emissions at the nitric acid plants of Yara Suomi Oy, two of which are located in Uusikaupunki and one in Siilinjärvi. The Ministry of the Environment has issued 971 926 emission reduction units (ERUs) for these projects. In addition, the projects contributed altogether approximately 1.85 million tonnes of CO_2 eq. towards achieving Finland's Kyoto targets because the actual emissions cut exceeded the verified amount and the requirements of the environmental permits. The estimated mitigation impact in 2010 presented in Table 4.7 is based on the information in the JI project's verification reports. Since 2013, nitric acid production is included in EU ETS, and therefore, the mitigation impact has not been estimated for future years.

The amount of emissions from F-gases (HFC, PFC, SF_6) is small in Finland (about 1 per cent of total emissions). Emissions from the use of HFC have increased since the 1990s, while PFC emissions have declined since their peak level in the late 1990s and SF_6 emissions have decreased compared to 1990. The most important regulations affecting the amount of these gases are the F-gas regulation[35] and the directive relating to HFC emissions from air-conditioning systems in motor vehicles.[36] Also, technical developments have affected the development of emissions. There is no domestic production of F-gases in Finland.

The WM projection for F-gases includes the impacts of the EC regulation concerning F-gases (842/2006) and the EC directive relating to emissions from air-conditioning systems in motor vehicles (2006/40/EC). Emissions from refrigeration and air-conditioning equipment are expected to decline due to these measures and technical changes that will lead to smaller charges and decreased leakage. Emissions from electricity distribution equipment and foam blowing have declined as a result of voluntary actions by the industries and are assumed to be similar to recent years' emission levels. Restrictions forced by the EC regulation will decrease emissions from aerosols and other sources, but it is expected that the emission levels will begin increasing again due to increased activity in the remaining source fields. Emissions from refrigeration and air-conditioning equipment account for close to 90 per cent of Finnish F-gas emissions, and therefore the projected overall emission trend is declining.

The mitigation effect of the policy measures has been estimated by assuming that the emissions prior to the introduction of the measures would have continued to grow in line with the volume of F-gases being used. This assumption is subject to several uncertainties, but it provides an indication of the mitigation impact. The mitigation measures were able to cut the almost exponential increase in emissions from refrigeration and air-conditioning equipment that started in the mid-1990s.

Policies and measures in the WAM projection

While harmonised EC legislation limits the possibilities to apply different national restrictions on the use of F-gases, it does not fully refute it. Some EU Member States, like Denmark, Sweden and Finland, have some stricter rules in their legislation. Member States are also allowed to promote the

35 (842/2006)
36 (2006/40/EC)

use of alternative substitutes for F-gases. As an additional measure, Finland will promote F-gas substitutes by using information dissemination and campaigns. Finland will also give its support to including a partial prohibition on F-gases in the EU F-gas regulation during its review process in 2013.

The WAM projection for F-gases is based on the assumption that the Commission's reassessment (2011) of the EC regulation on F-gases (842/2006) will lead to additional regulatory measures. Further restrictions on its use in refrigeration and air-conditioning equipment, foam blowing and aerosols are expected in all applications that are technically feasible and in line with safety and health concerns. The additional reductions relative to those of the WM projection are expected to be small. The EU Commission's draft proposal[37] for revising the existing F-gas regulation was published in November 2012. The objective of the proposal is to cut F-gas emissions by two thirds by 2030 compared to their current levels. The proposal will be dealt with in the EU legislative process in 2013. The new F-gas regulation will take effect in 2014 at the earliest. The elements of the draft proposal have not been taken into account in the WAM projection.

It is estimated that the emission reduction achieved by these additional measures will be 0.07 Mt CO_2 eq. in 2020 compared to the WM projection.

Summary of policies and measures

A summary of the policies and measures in the industrial processes sector is presented in Table 4.7.

4.7.5 Agriculture

Policies and measures in the WM and WAM projections

Finnish agricultural policy is based on the view that the competitive disadvantage due to natural conditions (such as the 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 (CAP) of the EU as well as through national measures. According to conclusions made by 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 remain unchanged, a reduction in domestic agricultural production would probably not reduce global greenhouse gas emissions because domestic production would be replaced by production elsewhere.

Annual CH_4 and N_2O emissions from agriculture have fallen by 12 per cent over the period 1990–2011 due mainly to a decrease 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, on the emissions from this sector.

37 (COM(2012) 643)

There are measures in the CAP to reduce greenhouse gas emissions. Agri-environmental payment is an essential tool for promoting sustainable development in agriculture. Approximately 90 per cent of Finnish farmers have participated in the payment programme. Agri-environmental payment is part of the Rural Development Programme for Mainland Finland 2007–2013, which is based on a Council regulation.[38] The objectives of the programme 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 to maintain or improve the productive capacity of agricultural land and reduce greenhouse gas emissions to meet these targets. The Rural Development Programme for Mainland Finland will be renewed for the time period 2014–2020. Similar actions as were taken in the period 2007–2013 will be planned for the new programme period.

Table 4.8 presents a quantitative emission reduction estimate for one of the measures promoted by agri-environment payment: the long-term cultivation of grass on organic soils. The effect of other measures cannot be estimated before the programme for 2014–2020 has been accepted.

The WAM projection does not include any additional measures compared to the WM projection, and therefore, the two projections are identical for the agriculture sector.

4.7.6 Land use, land-use change and forestry

Policies and measures in the WM and WAM projections

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

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

The LULUCF sector as a whole acts as a net sink in Finland because the emissions under this sector are smaller than the removals. This net sink from the LULUCF sector can vary greatly from one year to the next: in the period 1990–2010 it was between 14.5 and 36.1 million tonnes CO_2 eq. In 2010, the net sink was 22.1 million tonnes CO_2 eq. The 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 104 million cubic metres, of which 97 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 4.6.

The studies by 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

38 (1783/2003)

Table 4.7
Summary of the policies and measures in the industrial processes sector (the mitigation impact is expressed as kilotonnes CO_2 eq.)

Name of Mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of implementation	Brief Description	Start year of implementation	Implementing entity or entities	Estimated mitigation impact (kilotonnes CO_2 eq.)						
								1995	2000	2005	2010	2015	2020	2030
*Joint implementation project	Reduction of emissions from nitric acid production	N_2O	JI	Implemented	The emissions from 3 nitric acid plants were reduced in JI projects.	2009	Industries	0	0	0	300	na	na	na
*Regulation 842/2006/EC, Directive 2006/40/EC[1]	Control of F-gases	HFCs, PFCs and SF_6	Regulatory	Implemented	Implementation of EU regulation to manage F-gases and reduce emissions	2006	Ministry of the Environment	0	0	0	30	700	1,000	1,300
Review of the EC F-gas regulation	Control of F-gases	HFCs, PFCs and SF_6	Regulatory	Planned	Implementation of EU regulation to manage F-gases and reduce emissions	– (depends on EC process)	Ministry of the Environment	0	0	0	0	20	70	na

na = estimate not available
* denotes a measure included in the WM projection.
1 No actual without measures (WOM) scenario has been prepared in Finland. The WOM scenario figures used to estimate the mitigation impact are only approximate and considered very rough estimates. They are based on the Model AnaFgas (Analysis of Fluorinated greenhouse gases in the EU-27). Between the years 2007 and 2010, the same difference (in percentages) between the WOM and WM scenario estimates has been assumed as in the AnaFgas in the EU-27. The estimates after 2010 have been calculated by assuming the same growth rate in the WOM scenario estimates compared to 2010 as in the AnaFgas in the EU-27.

Table 4.8
Summary of the policies and measures in the agriculture sector (the mitigation impact is expressed as kilotonnes CO_2 eq.)

Name of Mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of implementation	Brief Description	Start year of implementation	Implementing entity or entities	Estimated mitigation impact (kilotonnes CO2 eq.)						
								1995	2000	2005	2010	2015	2020	2030
*Agri-environmental payment programme (part of Rural Development Programmes for Mainland Finland for 2007–2013 and 2014–2020)	Several objectives, including reducing nutrient load and GHG emissions	CH_4, N_2O	economic, fiscal	implemented	Agri-environmental payment programme covers over 90% of farms in Finland and it promotes decreasing nutrient load, preserving plant and animal biodiversity and the rural landscape; improving the productive capacity of agricultural land; and reducing GHG emissions.	2007	Ministry of Agriculture and forestry	0	0	0	na	na, IE	na, IE	na, IE
*Increasing the area of multiannual crops on organic soils	To increase the proportion of grass crops on organic soils	CH_4, N_2O	economic, fiscal	implemented	As part of agri-environmental payment programme, subsidies are provided for farmers who commit to long-term cultivation of grass crops in organic soils.	2007	Ministry of Agriculture and forestry	0	0	0	na	267.0	557.4	557.5

na = estimate not available
* denotes a measure included in the WM projection.
IE=included elsewhere. The measure on increasing the area of multiannual crops on organic soils (part of the agri-environmental payment programme) is presented separately.

maintain the sink at a level of at least 10–20 million tonnes CO_2 eq. per year up to 2015. The harvesting of wood is targeted to increase by 10–15 million cubic metres a year in the NFP 2015. The objectives and measures in the Long-term Energy and Climate Strategy are consistent with the policy defined in the NFP 2015 regarding the increase in industrial roundwood and energy wood, and they will help achieve the target set by the directives on promoting the use of energy from renewable sources.[39] The current global economic downturn will influence the achievements of the NFP 2015.

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

- Producing forecasts of the forest damage risks associated with climate change, developing the forest damage monitoring system, improving preparedness plans for forest and other damages, and coordinating efforts among the authorities;
- Factoring in the effects of the carbon sink and measures for improving harvesting conditions, and including the vitality of forests in revised forest management recommendations and guidelines as well as in the provision of advice and guidance;
- Implementing the Functioning of Forest Ecosystems and Use of Forest Resources in Changing Climate Research Programme (concluded 2012) and the Finnish Research Programme on Climate Change (FICCA) 2011–2014;
- Exploring models of operation for trading or leasing carbon sinks as well as for other means of increasing carbon sequestration in forests; and
- Promoting the carbon sink effects of forests and the carbon stored in wood products in negotiations on the UNFCCC.

With regard to agricultural soils, CO_2 emissions from croplands and grasslands are not expected to be subject to large changes in the WM projection by 2020. The CO_2 emission reductions due to increasing the area of multiannual crops on organic soils (see Section 4.7.5) is presented in Table 4.9. There are still significant uncertainties in these estimates, and new methods are being developed to increase their accuracy.

The WAM projection does not include any additional measures compared to the WM projection, and therefore, the two projections are identical for the LULUCF sector (Table 4.9).

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 these activities is mandatory for the Annex I Parties. Under Article 3.4, the election of activities (forest management, cropland management, grazing land management and revegetation) is voluntary for Parties during the first commitment period. The Finnish Government has decided to apply Kyoto Protocol Article 3.4 regarding forest management

39 Directives 2001/77/EC and 2009/28/EC

Table 4.9
Summary of the policies and measures in the LULUCF sector (the mitigation impact is expressed as kilotonnes CO_2 eq.)

Name of Mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of implementation	Brief Description	Start year of implementation	Implementing entity or entities	Estimated mitigation impact (kilotonnes CO_2 eq.)						
								1995	2000	2005	2010	2015	2020	2030
*National Forest Programme (NFP)	Strengthening forest-based business and increasing value of production; improving the profitability of forestry; strengthening forest biodiversity, environmental benefits, and welfare implications.	CO_2	regulatory, fiscal, economic, research, education, information	implemented	The mission is to generate increased welfare through diverse and sustainable forest management. The key principles of the programme include the comprehensive development of existing and new forest-based products and services and the entire value chain, the integration of different uses of forests, and the preservation of the environmental benefits of forests.	2010	Ministry of Agriculture and Forestry	na	na	na	na	na	na	na
*Increasing the area of multiannual crops on organic soils	To increase the proportion of grass crops on organic soils	CO_2	economic, fiscal	implemented	As part of agri-environmental payment programme, subsidies are provided for farmers who commit to long-term cultivation of grass crops in organic soils.	2007	Ministry of Agriculture and forestry	0	0	0	na	331.5	776.1	776.1

na = estimate not available
* denotes a measure included in the WM projection.

(FM) for the first commitment period. This enables 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 accounting for the emissions and removals under Article 3, paragraphs 3 and 4 will be done at the end of the commitment period.

Based on a study by Metla, Article 3.3 activities are estimated to cause net emissions for the period 2008–2012. This is due to land-use changes as a result of converting forest land to other land uses as well as low carbon sequestration rates in areas afforested or reforested since 1990. During the period 2008–2011, the emissions were on average 3.6 million tonnes CO_2 eq. per year. Land-use change from forest land to other land uses is difficult to avoid in a country where forests cover 72 per cent of the land area. Most of the change is driven by settlements and infrastructure (e.g. roads and transmission lines). The estimations still include high degrees of uncertainty and will become more accurate as the calculation methods are further developed.

In line with Article 3.4, the FM net sink between 2008 and 2011 has been approximately 39.6 million tonnes CO_2 eq. per year. Net removals from forest management vary significantly based on the overall economic situation. In 2009, the sink was 47 million tonnes, whereas in 2008 it was 36 million tonnes. The NFP 2015 estimates that the annual carbon sink of forests (incl. trees and soil) will remain at a level of at least 10–20 million tonnes CO_2 eq. by 2015 if logging increases by 10–15 million cubic metres a year, as is currently projected. The policy defined in the NFP regarding the increase in industrial roundwood and energy wood is consistent with the climate and energy strategy and it will help to achieve the target set by the directive on promoting the use of energy from renewable sources.

It is estimated that forest management will be a sink for the entire duration of the first commitment period, and therefore Finland expects to receive a total of 2.95 million tonnes worth of RMU units (0.59 million tonnes/year, i.e. the maximum cap).

The potential of cropland management and grazing land management activities has been assessed by MTT Agrifood Research. It estimates that CO_2 emissions from agricultural soils are increasing. 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 were not elected for the period 2008–2012.

The information provided in Section 4.6 regarding how the Forest Act and METSO programme contribute to the conservation of biodiversity and the sustainable use of natural resources is also applicable to lands under Articles 3.3 and 3.4 of the Kyoto Protocol. Detailed information on Kyoto Protocol activities under Articles 3.3 and 3.4 is presented in Finland's latest National Inventory Report under the UNFCCC and the Kyoto Protocol.

Forest Management Reference Level

For the second commitment period of the Kyoto Protocol, forest management will become a compulsory activity and the accounting will be based on a reference level (RL) approach. Finland´s RL is an average value of the projected removals and emissions for the period 2013–2020 and it is based on the long-term climate and energy strategy as well as the National Forest Programme (NFP 2015). The FMRL for 2013–2020 is –19.30 million tonnes CO_2 eq. and –20.4 million tonnes CO_2 eq., including harvested wood products (HWP).

4.7.7 Waste management

Policies and measures in the WM projection

Greenhouse gas emission projections from the waste sector include CH_4 from landfills, CH_4 and N_2O emissions from composting and CH_4 and N_2O emissions from wastewater treatment. Finnish waste legislation is largely based on the EU's Landfill Directive,[40] the Waste Directive[41] and, most recently, the Waste Framework Directive.[42] The first Waste Tax Act[43] entered into force in 1996 for municipal landfills. The tax level per tonne of waste has increased from EUR 15.15/t in 1996 to EUR 23/t in 2003, EUR 30/t in 2005 and EUR 40/t in 2011. A new Waste Tax Act[44] entered into force at the beginning of 2011 and replaced the former Waste Tax Act. The purpose of the new Waste Tax Act is to collect tax from those waste fractions that could be technically and environmentally recovered but are currently being disposed in landfill sites. The tax list for waste is based on a Commission decision[45] regarding what to include on the waste list. The industrial landfills are under taxation as well. The waste tax was EUR 40 per tonne in 2011 and EUR 50 per tonne in 2013.

Enforcement of the new Waste Act[46] will increase recycling and recovery, thus replacing landfilling, and it will contribute to reducing greenhouse gas emissions as well.

Restrictions on the landfilling of biodegradable municipal waste have been introduced based on the biowaste strategy (2004) and through the Government decree on landfills (revised 2006, 2012).

The monitoring of the effectiveness of the policies and measures affecting waste are based on statistics and modelling that follow the IPCC methodology for estimating emissions. It is not possible to identify in detail the effects of individual policy measures in terms of emission reductions. The overall reduction that has been achieved has been estimated by using 1995 as a base year, when none of the climate-oriented waste policies were yet in place. When estimating the mitigation impact, the assumption has been made that 1995 would represent the average emission level without measures. This assumption is somewhat uncertain as the amount of waste would probably have changed and the accumulation of waste would have increased CH_4 emissions. The average emissions from the waste sector in 1990–1995 were close to the 1995 level of approximately 3.9 million tonnes CO_2 eq.

The same IPCC-based modelling methodology is also used for projections based on assumed developments in the amount of waste. The projections for the waste sector do not, however, include emissions from waste incineration, which belong to the energy sector emissions.

Greenhouse gas emissions from the waste sector will decrease in the WM projection (Table 5.9). The main reason for this is the implementation of the Landfill Directive and national legislation and strategies that aim at reducing the amount of waste and minimising the amount of waste delivered to the landfills. The reform of the waste legislation, previously reported in the

40 (Directive 1999/31/EC)
41 (Directive 2006/12/EC)
42 (Directive 2008/98/EC)
43 (495/1996)
44 (1126/2010)
45 (2000/532/EC)
46 (646/2011)

WAM projection, has now been included in the WM projection, leading to an additional reduction in emissions relative to those reported earlier.

Policies and measures in the WAM projection

The additional potential for emission reductions under the WAM projection is limited. A new national waste plan is under preparation and is expected to be ready by the end of 2016. Plans are progressing to ban legally the landfilling of biodegradable and other organic waste after 2016.

The limiting value for organics in waste would be 10 per cent total organic carbon (TOC) or loss on ignition (LOI). This is likely to increase the incineration of waste significantly.

The additional emission reductions in the waste sector are thus mainly based on a drastic reduction of biowaste in landfills. However, as existing measures have already reduced emissions significantly, the additional reduction relative to the WM projection is modest in terms of million tonnes CO_2 eq. and should only be 0.2 million tonnes CO_2 eq. in 2020.

Summary of policies and measures

A summary of the policies and measures in the waste sector is presented in Table 4.10.

4.7.8 Land-use planning and spatial structure

The development of the urban structure has long-term effects on greenhouse gas emissions from transport and buildings. The most recent national Energy and Climate Strategy (2013) includes policy objectives and indicates measures that aim to minimise greenhouse gas emissions related to land use and the urban structure.

The National Energy and Climate Strategy of 2013 specifies the following policy objectives in relation to the spatial structure and related land-use planning:

- In urban regions and built-up areas, enhanced cohesion of the urban structure will be promoted as part of planning a high-quality living environment. Dependence on private cars will be reduced through land-use planning, by steering construction into zones that offer the opportunity to walk, cycle and use public transport. Resources allocated for transport will be targeted at small, cost-efficient development measures that promote public transport, walking and cycling.
- Municipalities will be encouraged to plan energy-efficient, high-quality communities and planning and assessment tools employed to this end will be developed.
- Enhancing the cohesion of the urban structure in major urban regions and reconciling regional land use and the transport system will be done more efficiently by means of the 'MAL' letters of intent (MAL=land-use, housing and transport) and, if necessary, legislative amendments. The binding nature of the MAL letter of intent procedure will be increased by taking better account of service structures and the operating conditions of businesses. Promotion of a low-carbon economy is also one of the priorities in the forthcoming Structural Fund period, 2014–2020.

Table 4.10
Summary of the policies and measures in the waste sector (the mitigation impact is expressed as kilotonnes CO_2 eq.)

Name of Mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of implementation	Brief Description	Start year of implementation	Implementing entity or entities	Estimated mitigation impact (kilotonnes CO_2 eq.)						
								1995	2000	2005	2010	2015	2020	2030
*Government decision on packaging and packaging waste (962/1997, 1025/2000, 987/2004, 817/2005)	To meet EU and domestic requirements on recycling and use of packages and packaging waste	CH_4, N_2O	Regulatory, economic	Implemented	Ensuring that packaging recovery obligations are fulfilled economically and easily.	1997	Ministry of the Environment and the Environmental Register of Packaging (PYR Ltd.). PYR Ltd. is a non-profit firm, operating in conjunction with producer organisations in the packaging sector	0	640	1,500	1,700	2,100	2,300	2,600
*Government decree on landfills (861/1997, revised 2006), Biowaste strategy (2004)	To reduce amount of waste disposed to landfills and to increase landfill gas recovery	CH_4, N_2O	Regulatory	Implemented	Regulating the handling and treatment of biodegradable waste and setting obligations for landfill gas recovery	1997	Ministry of the Environment; regulatory authorities; municipalities; waste treatment firms	0						
*Support for production and use of biogas, Act (1396/2010)	To reduce methane emissions and produce renewable energy	CH_4, N_2O	Economic	Implemented	Feed-in tariff for biogas plants	2011	Ministry of Employment and the Economy; Energy Market Authority	0	0	0	0			
"*General reform of waste legislation; Act on Waste (646/2011); Decree on Waste (179/2012); Waste Tax Act (1126/2010) "	To reduce production of waste, amount of organic waste disposed to landfills, to promote recycling and reuse	CH_4, N_2O	Regulatory, economic	Implemented	General regulation of waste treatment and waste management for resource efficiency and sustainable solutions	2012	Ministry of the Environment; regulatory authorities; Finnish Customs	0	0	0	0			
New regulation on landfills	New regulation to reduce amount of organic waste disposed to landfills to 10 % by focusing on household and production waste	CH_4	Regulatory	Planned	Setting quantitative limits on amount and proportion of organic waste in landfill waste. Implementing and going beyond landfill directive.	2016	Ministry of the Environment; regulatory authorities	0	0	0	0	0	200	380

na = estimate not available
* denotes a measure included in the WM projection.

- Municipalities and the state will jointly carry out pilot projects to promote sustainable means of travel (for example, high-quality cycle paths to highlight the cycling opportunities in city centres and to improve the image of cycling).

Nearly all regions in Finland and many individual municipalities have prepared their own climate strategies. It is, however, difficult to provide quantitative emission reduction potentials for the policies and measures concerning land-use planning and the urban structure. The urban form influences emissions mainly through its effects on transport and the heating of buildings. Estimates suggest that differences in greenhouse gas emissions between planning options will be approximately 10 per cent at a regional level, 60 per cent at the level of a single municipality and as much as 200 per cent at the level of a specific community. In particular, emissions from daily mobility may be many times higher in car-oriented zones compared to urban centre areas. Emissions from the heating of buildings depend greatly on energy solutions for the dwelling and possible district heating. The location of a dwelling is also connected to emissions via the consumption of goods and services as well as long leisure trips, mainly due to spatial differences in income levels. The overall reductions in emissions in different regions are thus dependent not only on the urban structure, but also on complex processes that include lifestyle changes as well as economic conditions and developments.

4.8 Energy taxation and related measures

4.8.1 Energy taxation

Energy taxes are a substantial revenue source for the Government. They generate around EUR 4 000 million annually, or nearly 10 per cent of the Government tax revenue. Over the past ten years, energy taxes have been increasing steadily in terms of the amount generated and as a share of the total tax revenue. Energy taxation is a key instrument of the Government's energy and climate policy.

Energy taxes are levied on electricity, coal, natural gas, peat, tall oil and liquid fuels. Major changes to the structure of energy taxation were introduced in January 2011. Energy taxation now takes account of the energy content, carbon dioxide emissions and sulphur content of fuels (see Table 4.11 for details). The overall tax rates are driven primarily by the energy content component and the CO_2 component. An additional surcharge, called the strategic stockpile fee, is also added to the total (to cover expenses incurred by the state when securing the supply of energy).

The energy content tax has been adjusted to reflect the volumetric energy content of the fuel. The energy tax component is levied on both fossil fuels and biofuels, based on the same taxation criteria. For liquid fuels, the energy content is based on the heating values (MJ/litre) used in the European Union Directive 2009/28/EC on the promotion of the use of energy from renewable sources.

The CO_2 component is based on the CO_2 emissions of the fuel in question. The weight of levies on CO_2 has been raised from their 2011 levels. For

Table 4.11
Energy taxes in Finland

Date	Energy taxes, strategic stockpile fees and oil pollution fees											
	Fuels [1]							Electricity				
								Consumption		Production		
	Motor-gasoline, unleaded [2]	Diesel fuel [3]	Light fuel oil [12]	Heavy fuel oil	Hard coal [11]	Natural gas	Peat	Elec-tricity, I [4]	Elec-tricity, II [5]	Nuclear power	Hydro power	Imports
	c/l			c/kg	€/t	c/nm³	€/MWh	c/kWh				
Excise taxes [10]												
1.1.1990	21.53	16.82	0.34	0.34	2.69	0.17	0.34	–	–	–	–	–
1.1.1995	45.12	27.5	3.02	3.12	19.53	0.94	0.59	–	–	0.4	0.07	0.37
1.7.2005	58.08	31.59	6.71	5.68	43.52	1.82	–	0.73	0.44	–	–	–
1.1.2007	58.08	31.59	6.71	5.68	43.52	1.82	–	0.73	0.22	–	–	–
1.1.2008	62.02	36.05	8.35	6.42	49.32	2.016	–	0.87	0.25	–	–	–
1.1.2011	62.02	36.05	15.7	18.51	126.91	8.94	1.9	1.69	0.69	–	–	–
1.1.2012	64.36	46.6	15.7	18.51	126.91	8.94	1.9	1.69	0.69	–	–	–
1.1.2013	64.36	46.6	15.99	18.93	131.53	11.38	4.9	1.69	0.69	–	–	–
Energy content tax [8]												
1.1.2011	50.36	–	7.7	8.79	54.54	3	–	–	–	–	–	–
1.1.2012	50.36	30.7	7.7	8.79	54.54	3	–	–	–	–	–	–
1.1.2013	50.36	30.7	6.65	7.59	47.1	4.45	–	–	–	–	–	–
Carbon dioxide tax [9]												
1.1.2011	11.66	–	8	9.72	72.37	5.94	–	–	–	–	–	–
1.1.2012	14	15.9	8	9.72	72.37	5.94	–	–	–	–	–	–
1.1.2013	14	15.9	9.34	11.34	84.43	6.93	–	–	–	–	–	–
Energy tax [7]												
1.1.2011	–	–	–	–	–	–	1.9	1.69	0.69	–	–	–
1.1.2013	–	–	–	–	–	–	4.9	1.69	0.69			
Strategic stockpile fees												
1.7.1984	0.72	0.39	0.39	0.32	1.48	–	–	–	–	–	–	–
1.1.1997	0.68	0.35	0.35	0.28	1.18	0.084	–	0.013	0.013	–	–	–
Oil pollution fees [6]												
1.1.1990	0.28	0.031	0.031	0.037	–	–	–	–	–	–	–	–
1.1.2005	0.038	0.042	0.042	0.05	–	–	–	–	–	–	–	–
1.1.2010	0.113	0.126	0.126	0.15	–	–	–	–	–	–	–	–

1) Fuels in electricity production tax-exempt since 1 January 1997
2) Reformulated, since 1 January 1993, also sulphur-free since 1 September 2004. Fossil fuel
3) Sulphur-free, sulphur content < 50 ppm since 1 July 1993, sulphur content < 10 ppm since 1 September 2004. Fossil fuel.
4) Tax class I: others
5) Tax class II: industry and professional greenhouses
6) Fee for imported oil and oil products: EUR 1.50/t
7) Energy tax included in excise taxes
8) Energy content tax included in excise taxes
9) Carbon dioxide tax included in excise taxes
10) Excise taxes contain energy content tax,, carbon dioxide tax, and energy tax
11) Excise taxes for hard coal is in the heat production. In CHP use excise tax is lower.
12) Fossil fuel.Sulfur free

fossil fuels, the CO_2 emission values (g/MJ) are based on the values used in the national fuel classification of Statistics Finland.

The energy content component is levied on both fossil fuels and biofuels based on their volumetric energy content. Higher rates apply to fuels used in the transport sector. Lower rates apply in the case of light and heavy fuel oils and electricity used for agricultural purposes. The CO_2 component is based on the CO_2 emissions of the fuel in question, and for this reason biofuels are subject to a CO_2 tax rate that is reduced from 50 to 100 per cent if they meet the European Union's sustainability criteria. Carbon dioxide taxes for the fossil fuels used in combined electricity and heat production are also lowered by 50 per cent. The strategic stockpile fees range from EUR 0.28 per kilo for heavy fuel oil to the EUR 0.68 per litre for most liquid fuels.

Furthermore, a reduced energy content tax is applied to fuel grades that are better in terms of local emissions than traditional fossil fuels. Local emissions are emissions causing healt effects in nearby areas like NO_x and particle emissions. The reduction corresponds to the imputed value of the emission benefit in accordance with the principles set out in EU Directive 2009/33/EC on the promotion of clean and energy-efficient road transport vehicles.

Energy taxation rules include exemptions and reduced tax rates resulting in tax expenditure. LPG and fuel for commercial aviation and shipping are not taxed. Peat is taxed at a lower rate, but it is subject to progressive increases in 2013 and 2015. Natural gas is subject to a tax expenditure that is due to expire in 2015.

In transport, diesel fuel accounts for more than 50 per cent of CO_2 emissions and energy content. Diesel and biofuels are taxed at lower rates than gasoline, leading to a tax expenditure compared to the taxes levied on gasoline. In heating and process use, waste and biomass are not taxed and account for more than 40 per cent of the energy content and emissions from the heating and process use of fuels. All heating fuels are taxed at a lower rate than transport fuels.

Electricity used by industry is taxed at a much lower rate than electricity used for commercial and residential purposes. Energy taxes are not levied on energy used for the transformation of other fuels and for rail.

A further tax applied to diesel-driven vehicles is the annual propelling-force tax, which is on average EUR 420 per diesel vehicle. The annual propelling-force tax is levied to achieve the tax burden required by the environmental tax model.

4.8.2 Government expenditure on energy and climate policy

Government appropriations for the energy and climate policy are discussed and decided upon during the annual budget process. Table 4.12 highlights the main energy and climate appropriations included in the state budget for 2011–2013. The list of policy measures included in the table is not exhaustive. Funding for most energy and climate policy measures will continue beyond 2013.

Table 4.12
Energy and climate policies in the state budget in 2011–2013

		EUR million 2011 final accounts	2012 estimated	2013 budgeted
	APPROPRIATIONS			
R&D	Energy technology research and development	210	184	176
	Climate research (ministries and the Academy of Finland)	16	21	7.9
SUBSIDIES	Electricity production subsidy (feed-in tariff/wind power plants, wood chip power plants, wood-fuel powered plants, biogas power plants)	0.1	33	125
	Fixed electricity production subsidy (wind power plants, wood chip power plants, biogas power plants, hydro power plants)	–	8.5	–
	Subsidy for land-use planning for wind power	1.5	1.5	1.5
	Repair and energy grants (residential buildings)	44	19	13
	Forest management and basic improvement subsidies (KEMERA)			
	Energy wood harvesting subsidy	14	11	12
	Energy wood chipping subsidy (discontinued at the end of 2012)	5.2	11.3	–
	Subsidies for the production of bioenergy (included in the 2012 budget for the last time, funds available until the end of 2014)	5.0	5.5	
	Certain climate measures under agri-environmental subsidies			
	Long-term grass cultivation on peat fields	0.3	0.3	0.3
	Use of liquid manure in fields	5.3	3.0	3.0
	Measures for winter-time plant coverage	33	30	30
	Renewable energy investment subsidies for micro enterprises under the Rural Development Programme	7.3	11	9.0
	Agricultural investment subsidies for heat plants using renewable energy	6.2	5.6	5.6
	Public transport subsidies	30	30	30
INFORMATION	Mobility management and other public transport development projects	1.0	2.9	2.8
	Communications, guidance, studies	4.6	3.9	3.9
OTHER	Kyoto mechanisms	7.0	0.4	2.0
	Promotion of cycling and walking	20	20	20
	Climate funding for developing countries (ODA, incl. FSF)	62	68	64
	Appropriations TOTAL	**472**	**469**	**506**
	BUDGET AUTHORITY			
SUBSIDIES	Energy subsidy for investments (enterprises and corporations; incl. biofuels and offshore wind power)	114	38	145
	Budget authorities TOTAL	**114**	**38**	**145**
ADDITIONAL ITEMS	Tax subsidy for production of electricity (until 2011)			
	Estimated share of energy repairs in the increased tax credit scheme for domestic costs			
	Certain tax reliefs and exemptions from taxes related to R&D activities and increasing the use of renewable energy			
	Interest subsidy loans for energy repairs in housing companies (Housing Fund of Finland)			
	Interest subsidy loans for low-energy houses (Housing Fund of Finland)			
	Loans, guarantees and investments by Finnvera plc and Finnish Industry Investment Ltd			

Source: National Energy and Climate Strategy, Government Report to Parliament on 20 March 2013

4.9 Use of Kyoto mechanisms

Under the EU emissions trading scheme, companies may meet part of their emission reduction obligations 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 that 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 allowed its operators in the EU ETS to use CERs and ERUs up to a maximum relative threshold of 10 per cent. The operators used 12.3 Mt CERs and 4.1 Mt ERUs.

The budget for the acquisition of Kyoto mechanisms is approximately EUR 80 million. About EUR 21 million of this amount has been allocated for purchasing post-2012 credits. Approximately EUR 20 million were invested already during the CDM/JI pilot programme, which operated from 1999 until early 2006. The rest have been allocated in the years 2006–2012.

To date, Finland has invested approximately EUR 20.8 million in 12 bilateral projects for Kyoto Protocol first commitment period credits. In addition, Finland has committed more than EUR 3 million for Kyoto Protocol second commitment period credits from some of these bilateral projects. Beside these projects Finland has invested in multilateral carbon funds. Ten million US dollars have been invested in the World Bank's Prototype Carbon Fund (PCF), EUR 4.25 million in the Nordic Environmental Financing Corporation's (NEFCO) Testing Ground Facility (TGF), EUR 10 million in the European Bank for Reconstruction and Development's Multilateral Carbon Credit Fund (MCCF), USD 25 million in the Asian Development Bank's Asian Pacific Carbon Fund (APCF), EUR 3 million in the NEFCO Carbon Fund and USD 20 million in the Asian Development Bank's Future Carbon.

Several reports that examine the use of the mechanisms were compiled in January–February 2006; based on these reports, the inter-ministerial Mechanisms Use Steering Group prepared strategic policies for the use of the Kyoto mechanisms for the years 2006–2012. In addition, the Ministry for Foreign Affairs has drafted its own action plan for CDM acquisitions. The Ministry of the Environment has compiled an executive strategy for joint implementation projects and international emissions trading for the years 2006–2012. The use of the Kyoto mechanisms was reviewed at the end of 2007. The Ministerial Working Group on Climate and Energy Policy approved the new strategy in February 2008.

It has been estimated that the present investments and contracts could generate more than 5 million tonnes CO_2 eq. for the first Kyoto commitment period and more than 4 million tonnes CO_2 eq. for the second Kyoto commitment period. Considerable uncertainties are involved, because both the funds and bilateral projects contain some risks. The use of the Kyoto mechanisms is supplementary to domestic actions for cutting greenhouse gas emissions (see also Section 5.7).

4.10 *Effect of policies and measures on longer term trends*

The Government's Foresight Report on Long-term Climate and Energy Policy (published in 2009) highlighted possible paths towards a low-carbon Finland. The national energy and climate roadmap will outline the key options for reaching an 80–95 per cent emission reduction by 2050 (see Box 4.2).

A large proportion of current Finnish climate and energy policies also contribute to reducing greenhouse gas emissions in the longer term, in particular when they are based on creating structural changes in the respective systems. For example, buildings have long lifetimes, and therefore the regulations for improving the energy efficiency of new and existing buildings will have long-lasting impacts.

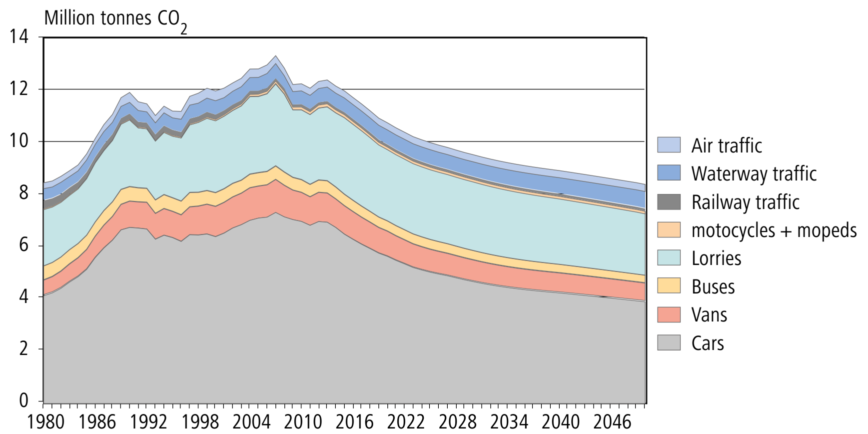
Land-use planning yields also permanent emission reductions in buildings and transport, for example by allowing the use of low-emission heating modes or by improving the possibilities for walking, biking and using public transportation. However, the actual emission reductions will depend on a large array of factors, including general economic development.

Investments in the energy infrastructure have long lifetimes. Therefore, measures that promote investments in renewable energy and improve the competitiveness of renewable energy sources will reduce greenhouse gas emissions in the longer term. This applies also to measures that would in principal contribute to emission reductions only as long as the measure is ongoing, such as feed-in tariffs for renewable energy or biofuel blending obligations for transport fuels.

Prohibiting certain F-gases or halting the disposal of biodegradable waste on landfills can be expected to lead to permanent changes in current practices, and therefore to yield permanent emission reductions.

In the research project ILARI (2010–2012), the longer-term impacts of alternative policies and measures in GHG emissions within the transport sector were studied. The first phase of the project produced a baseline scenario for CO_2 emissions related to transport in Finland up to the year 2050. The baseline scenario was based on statistics and forecasts on transport volumes and vehicle fleets provided by the Finnish Transport Agency and the Finnish Transport Safety Agency, energy efficiency forecasts for private vehi-

Figure 4.4
The baseline scenario for greenhouse gas emissions from the transport sector by 2050



cles provided by VTT Technical Research Centre of Finland and the national calculation system for measuring traffic exhaust emissions and energy consumption in Finland, LIPASTO. The baseline scenario, presented in Figure 4.4, shows that the GHG emissions from transport are expected to decrease considerably by 2050 without further measures. During the second phase of the project, the impacts of different policy packages on emissions in the transport sector were considered for 2030 and 2050. The project produced alternative future visions and scenarios, including policy packages, for meeting the projections. The results of the research show what policy packages will have the most important impacts in terms of GHG emission reductions, and which, in contrast, will have only marginal impacts in the longer term.

4.11 Mitigation benefits other than greenhouse gas reduction

Environmental impact assessments (EIAs) have been made for all of Finland's national energy and climate strategies. The EIAs for the strategies include a general examination of the benefits and adverse impacts of the strategy, specifically using lifecycle assessments and evaluating the relationship between measures for climate mitigation and air pollution. The latest assessment concludes that measures for reducing the greenhouse gas emissions included in the strategy should have an overall positive impact on the environment. From an environmental point of view, the most important measures are those for improving energy efficiency and those that will result in an absolute reduction in energy demand. A reduction in energy demand will make it easier to fulfil the objectives regarding the share of renewable energy and reduce pressures on using natural resources and on biodiversity.

In general, measures that reduce greenhouse gas emissions will also reduce air pollution. Small-scale wood burning is an exception, however. A significant expansion of small-scale wood burning using simple technologies would have negative health impacts and also contribute to global warming through black carbon emissions.

The lifecycle analysis of the WM and WAM projections 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 and technological improvements.

4.12 Minimising the adverse effects of policies and measures in other countries

Finland strives to implement its climate policies in such a way that the social, environmental and economic impacts on other countries, and on developing countries in particular, will be minimized. Applicable notification requirements under international trade conventions are also followed. Finland takes into account knowledge on and an understanding of the possible impacts of its measures based on available information received from other Parties. The main principles of minimising adverse impacts have not changed since reporting on this matter in the Fifth National Communication and latest National Inventory Report (NIR). However, this chapter provides updated information compared with that provided in the NIR in 2013.

Environmental impact assessments have been performed on Finland's national energy and climate strategies. The assessments have identified on a qualitative level the kind of impacts that the measures may have. A lifecycle analysis of fuel import takes into account impacts arising beyond the Finnish borders. Finland has also participated in the work on developing sustainability criteria for biofuels through scientific studies. In line with the most recent energy and climate strategy, the identified potential adverse environmental impacts due to the increased use of bioenergy are addressed as early as possible.

Finland strives to minimise the adverse effects of climate change on developing countries by including in its development policy both climate change mitigation and adaptation in developing countries (see Chapter 7 for more details). Finland promotes low carbon development and the capacity of its partner countries to adapt to climate change, and it furthers the integration of these goals into partner countries' own development planning. Particular attention is paid to the roles of women, children and indigenous peoples in adapting to and combating climate change. Finland has adopted a climate sustainability tool for assessing the climate change impacts of its development policy and preventing the adverse impacts of climate change, including disaster risk reduction. Thus, climate change has been mainstreamed in Finland´s development programming. Finland aims to support programmes and projects that focus on saving energy, increasing energy efficiency and promoting renewable energy production, focusing on poor countries and regions in particular. According to its development policy, Finland supports access to sustainable renewable energy and also promotes energy and overall resource efficiency and research on those issues. In its own development cooperation, Finland aims to achieve carbon neutrality as soon as possible.

Finland's Development Policy Programme has the eradication of extreme poverty as an overarching goal. Regarding the minimisation of adverse social impacts, the Ministry for Foreign Affairs commissioned a study on integrating poverty reduction and climate change response measures in Finland's development cooperation and CDM activities. The results showed that the level of coherence between climate funding and development co-operation objectives has progressed, although there is still room for learning how to focus in particular on CDM activities in such a way that they also contribute to poverty reduction.

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

Among the actions listed in the Annex to Decision 15/CMP.1, Part I.H, 'Minimization of adverse impacts in accordance with Article 3, paragraph 14', Finland gives particular priority to the following actions:

- Action (a): Finland has addressed the progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions and subsidies in all greenhouse-gas-emitting sectors
  - domestically, with a major revision in energy taxation (2011), according to which all fuels are taxed based on their energy and fossil carbon content,
  - in its development policy by including in the support provided to developing countries through multinational development banks criteria that are targeted at removing subsidies for fossil fuels and phasing out support for investments based on fossil fuels by the year 2050.
- Action (d): Finland has cooperated in the development, diffusion, transfer and wider use of less-greenhouse-gas-emitting, advanced fossil-fuel technologies and technologies that capture and store greenhouse gases from fossil fuel use by supporting, at a policy level, methane capture for electricity generation instead of gas flaring, clean coal technologies and carbon capture and storage.
- Action (f): Finland has assisted developing country Parties that are highly dependent on the export and consumption of fossil fuels in diversifying their economies in several projects:
  - In Lao PDR, Finland has implemented a policy level programme that aims to diversify the economy and energy mix towards renewable sources that will provide local employment and increase energy and income security.
  - Through the Energy and Environment Partnership Programme (EEP), Finland supports the participating developing countries in developing, adopting and scaling-up appropriate and affordable renewable energy and energy efficiency technologies for improved energy access and local employment. Finnish-supported EEP programmes are executed in Central America, the Mekong Region, southern and eastern Africa, the Andean Region and Indonesia.

More details on the actions being taken by Finland to minimise the adverse impact of response measures in developing countries is provided in Annex 3. The annex includes information that is also referred to in Chapter 7.

Finland is committed to policy coherence for development and promotes its implementation at the national level and in relation to its own partner countries and other donors. Finland also promotes policy coherence actively in the EU. Regarding policy coherence for development, Finland implements the recommendations of the OECD. The OECD's tool for policy coherence will be piloted on the themes of food security and the right to food. Policy coherence on other themes, such as trade and development, tax and development, migration and development, and security and development, will be strengthened both nationally and internationally. The Government will submit a communication to the Parliament on aid effectiveness and policy coherence for development in the first half of 2014.

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Finnish National Commission on Sustainable Development, http://www.ym.fi/en-US/The_environment/Sustainable_development

Information on energy efficiency agreements, http://www.energiatehokkuussopimukset.fi/en/

List of municipalities which have joined Cities for Climate Protection campaign, http://www.kunnat.net/fi/asiantuntijapalvelut/ymparisto/ilmastonmuutos/ilmastokampanja/kampanjakunnat/Sivut/default.aspx

Sitra's press release regarding Mayors Climate Network, http://www.sitra.fi/node/77710

5 Projections and total effects of policies and measures

This chapter describes projections on Finnish greenhouse gas emissions and how the emissions are influenced by various factors such as energy consumption, production and policies and measures. Two projections are presented: 'with measures' and 'with additional measures', to show the projected greenhouse gas emissions from Finland up to 2030. The chapter also describes the total effect of policies and measures and supplementarity relating to Kyoto Protocol mechanisms. The chapter ends with a description of a sensitivity analysis of the projections and the methodology used in developing them.

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Sannamari Pehkonen / Image bank of the Environmental Administration

5 Projections and total effects of policies and measures

5.1 Overview of WM and WAM projections

The projections presented in this chapter correspond to the projections of the National Energy and Climate Strategy that were presented by the Government in March 2013. The projections were formulated in 2012 by a working group consisting of experts from ministries that are central to Finland's climate policy.

The 'With Measures' projection (WM) describes a development in which the measures already implemented and adopted that affect the different sectors are continued. Therefore, the projection represents a development path that is likely to take place in the light of the current situation and assumptions.

The 'With Additional Measures' projection (WAM) consists of a set of cost-efficient additional measures that will likely be implemented in accordance with various ministries' plans at the time of Energy and Climate Strategy update. In the meantime, an implementation decision has been approved for some of the WAM measures. The WAM measures typically reduce national greenhouse gas emissions and the domestic use of energy. However, the measure concerning additional biorefineries in the WAM projection increases domestic energy use and emissions in stationary combustion within the energy sector. The net effect of the biorefineries is nevertheless positive, which will result in less emissions in Finland because the fuel produced from domestic, renewable energy sources will replace imported fuel, which is mainly of fossil origin.

Most of the measures included in the WAM projection of the Fifth National Communication have already been implemented and are now part of the WM projection. In addition, the WM projection includes measures that were decided upon in 2010 by the Government regarding renewable energy and energy efficiency in order to meet the obligations for Finland in 2020 set by the EU Climate and Energy Package (see Chapter 4). The most significant measures affecting future energy consumption, and hence, decreasing greenhouse gas emissions compared to the Fifth National Communication have to do with tightening the National Building Code in 2008 and 2011 and measures aiming at renewing the existing car fleet with vehicles that emit considerably less CO_2.

The WAM projection includes the need to continue promoting renewable energy as well as measures to further reduce greenhouse gas emissions and energy consumption. These are described in Chapter 4.

In 2010, the gross final energy consumption was 322 TWh. The National Energy and Climate Strategy states that a target will be set to level off growth in the final energy consumption by improving energy efficiency so that the consumption level in 2020 will be, at a maximum, 310 TWh. The final energy consumption in the WAM projection is 317 TWh, which means that further measures are required in order to reach the new target of 310 TWh. These new measures are not included in the current projections because they had not yet been specified at the time when the projections and calculations were made.

Economic growth and the change in the structure of the economy play a key role in the estimation of energy consumption and emissions. In the long term, economic growth will mainly be determined by the size of the labour force and its productivity. The ageing population is the single most significant factor in terms of its effect on the development of the national economy. Another factor that will affect the availability of labour is the level of structural unemployment. The population forecast of Statistics Finland is used in the projections. It estimates that the population will increase from the current 5.4 million to 5.9 million by 2035. The average size of households will decrease slightly, while the number of households is expected to grow from 2.5 million to 2.9 million during the period.

The economic outlook provided by the Ministry of Finance forms the basis for the estimate regarding the development of the Finnish economy in the near future, whereas longer term development assumptions are based on a study published by the Government Institute for Economic Research.

During the 2010s, the economy will not reach the growth rate experienced before the global recession of 2009. In the projections, the annual growth of the national economy will be 1.6 per cent during the current decade and slightly higher, 1.9 per cent, in the 2020s. The Finnish economy is experiencing a structural change, where the outlook of energy intensive industries in particular differs from the past. In addition to the generally lower starting level, the branch-specific growth expectations have partly changed due to the recession compared to the projections made in the Fifth National Communication. The main differences include a more positive development expectation for the mining industry in particular and, on the other hand, lower production level expectations for the forest industry and basic metals than originally predicted in 2008.

The economic growth expectation after 2020 is overall about the same as in the Fifth National Communication, even though the starting level is clearly lower. It may not be possible to make up for the gap caused by the recession.

It is assumed that Finland›s fifth nuclear power plant unit will be completed in 2015. In 2010, decisions-in-principle were approved for constructing two additional nuclear power plant units. The projections assume that the units will be operational during the 2020s. Finland is currently heavily dependent on electricity imports. One of the aims of the Government is to achieve a level of self-sufficiency in terms of the nation's electricity supply. In the projections, it is assumed that the electricity net imports will decrease from its current level so that from 2020 onwards, Finland will be self-sufficient on a yearly basis. In addition to the EstLink2 cable that is currently under construction, the projections include a new electricity interconnection with Sweden and a bi-directional interconnection with Russia. The development of the primary energy supply in the WM projection is shown in Figure 5.1.

Table 5.1 shows a summary of the main assumptions of the WM projection for 2015–2020. Numerical values for key variables and assumptions are presented in Section 5.8. The assumptions regarding international fuel prices on the world market are consistent with the latest estimates of the International Energy Agency (IEA).

Figure 5.1
Historical development (1990–2011) and WM projection (up to 2030) of the primary energy supply

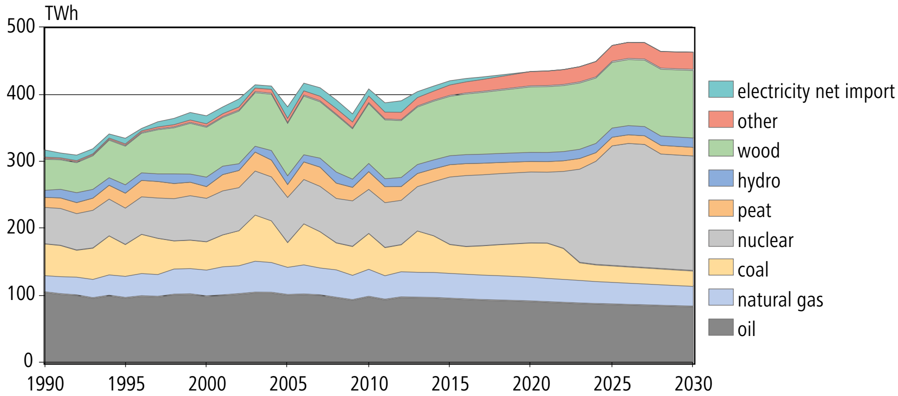


Table 5.1
Assumptions of the WM projection

Parameter	Trend 2015–2020
GDP growth	Almost 2 per cent annually
Structure of the economy	Increasing share of services
Structure of industry	Less capital and energy intensive
Population growth	Increasing slowly
Population structure	Ageing
Technology development	Gradual introduction of improved and more efficient technology

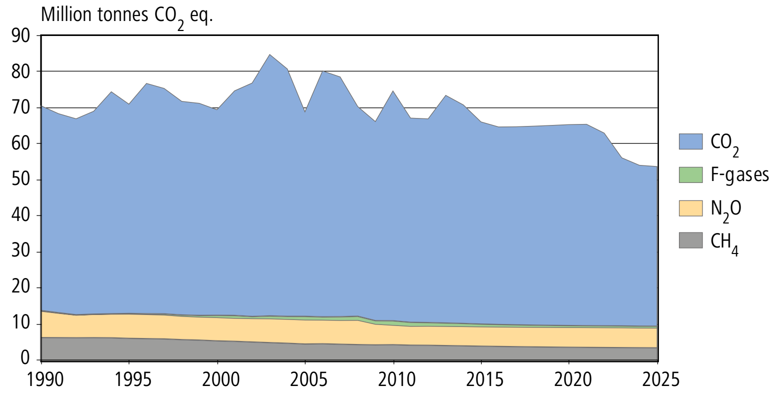
5.2 'With Measures' projection

5.2.1 Total effects

Total emissions in the WM projection for the years 1990–2025 are shown in Figure 5.2. Compared with the base year of 1990, the total greenhouse gas emissions are expected to be 7 per cent lower in 2020 and 24 per cent lower in 2025. Correspondingly, the CO_2 emissions are projected to be 2 per cent lower in 2020 and 22 per cent lower in 2025. CH_4 emissions are expected to continue to decline steadily, whereas N_2O emissions are projected to remain at current levels, which is one fourth lower than in 1990. The amount of emissions from F-gases is small and expected to decrease in the coming years.

The split of greenhouse gas emissions between the EU ETS sector and the non-ETS sector is illustrated in Figure 5.3. It seems that emissions in the EU ETS sector have reached their peak in the mid-2000s and they are expected to decline. In 2011, emissions in the EU ETS sector were 52 per cent of the total GHG emissions, whereas they were 48 per cent in the non-ETS sector. The split is expected to remain roughly the same during the current decade. In the WM projection, new nuclear power units units will reduce the EU ETS emissions by the mid 2020s.

Figure 5.2
Greenhouse gas emissions by gas according to the latest greenhouse gas emission inventory (1990–2011) and the WM projection (up to 2025)



The development of total emissions with regard to the number of inhabitants, primary energy use and economic development is presented in Table 5.2.

The emissions from the non-ETS sector have steadily decreased since 1990, and the decrease is expected to continue until 2025 (Figure 5.4). According to the WM projection, the emissions from the non-ETS sector in the year 2020 will be 17 per cent below the 2005 level, which is sufficient for reaching the target set by the EU Climate and Energy Package (16 per cent reduction in 2020 compared to 2005, see Section 4.1.2).

Figure 5.3
Greenhouse gas emissions according to the latest greenhouse gas emission inventory (1990–2011) and the WM projection (up to 2025) in the EU ETS and non-ETS sectors

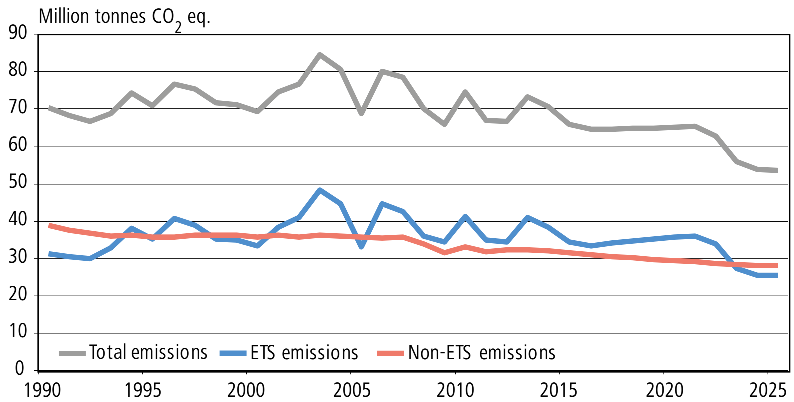


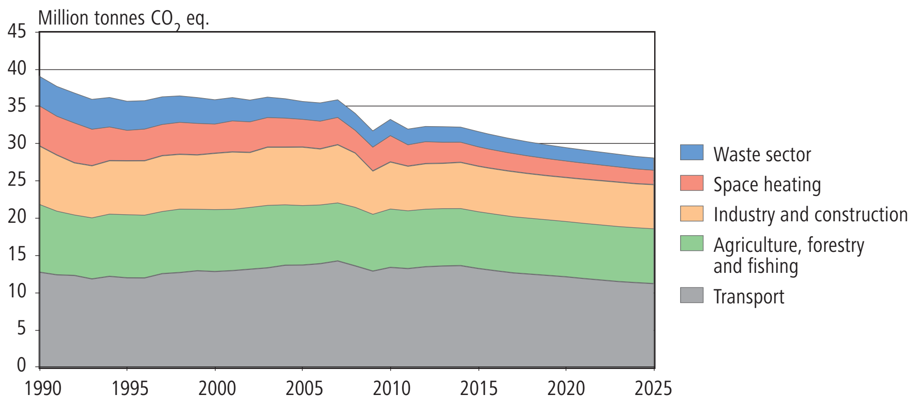
Table 5.2
Greenhouse gas emission intensity based on the latest greenhouse gas inventory for 2010–2011 and the WM projection for 2015–2030

	2010	2011	2015	2020	2025	2030
Emissions per capita, tonnes CO_2 eq. /capita	13.9	12.4	11.8	11.4	9.2	8.6
Emissions per GDP, kg CO_2 eq./EUR	0.55	0.49	0.45	0.41	0.30	0.27
Emissions per primary energy, tonnes CO_2 eq./MWh	0.18	0.17	0.15	0.15	0.11	0.11

Table 5.3
Greenhouse gas emissions according to the most recent inventory data (1990–2011) and the WM projection (2015–2030)

	GHG emissions and removals (kilotonnes CO_2 eq.)						GHG emission projections (kilotonnes CO_2 eq.)			
	1990	1995	2000	2005	2010	2011	2015	2020	2025	2030
Sector										
Energy including transport	54,495	56,063	54,465	54,036	60,550	53,385	51,700	51,100	39,600	37,700
Industrial Processes	5,130	4,699	5,583	6,374	5,773	5,586	5,500	5,700	5,700	5,800
Solvent and Other Product Use	178	143	125	106	74	70	100	100	100	100
Agriculture	6,674	6,084	5,902	5,842	5,969	5,881	5,900	5,900	5,900	5,700
Land Use, Land-Use Change and Forestry	−15,162	−14,138	−20,452	−29,940	−24,624	−24,577	−11,900	−11,900	−11,900	−11,900
Waste	3,975	3,911	3,271	2,405	2,186	2,112	1,800	1,600	1,400	1,300
Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gas										
CO_2 emissions including net CO_2 from LULUCF	41,334	43,637	36,261	26,476	38,770	31,718	42,800	42,500	31,000	29,100
CO_2 emissions excluding net CO_2 from LULUCF	56,643	57,909	56,860	56,570	63,584	56,493	54,900	54,500	43,000	41,200
CH_4 emissions including CH_4 from LULUCF	6,373	6,166	5,470	4,594	4,410	4,279	3,800	3,700	3,500	3,400
CH_4 emissions excluding CH_4 from LULUCF	6,330	6,121	5,423	4,545	4,453	4,220	3,800	3,600	3,400	3,300
N_2O emissions including N_2O from LULUCF	7,468	6,859	6,594	6,814	5,548	5,395	5,600	5,600	5,700	5,600
N_2O emissions excluding N_2O from LULUCF	7,364	6,770	6,495	6,709	5,415	5,258	5,500	5,500	5,600	5,500
HFCs	0	29	492	863	1,164	1,026	750	640	580	570
PFCs	0.1	0.1	22.5	9.9	0.7	1.4	2	2	2	2
SF_6	115	71	54	66	35	36	50	50	60	60
Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)	**55,290**	**56,763**	**48,894**	**38,824**	**49,928**	**42,456**	**53,100**	**52,500**	**40,800**	**38,700**
Total (excluding LULUCF)	**70,452**	**70,901**	**69,345**	**68,763**	**74,551**	**67,033**	**65,000**	**64,400**	**52,700**	**50,600**

Figure 5.4
Emissions in the non-ETS sector by category (1990–2011) based on the latest greenhouse gas inventory and the WM projection (up to 2025)



5.2.2 *Sectoral emissions*

Energy

The energy sector is strongly affected by the measures to reduce the emissions, to enhance energy efficiency and to increase the share of renewable energy sources. Both the supply and demand sides will face important changes in the coming years. As many of the changes concern investments like power plants and the building stock, the impact will be robust and long lasting.

In the WM projection, the most significant changes in electricity production will be introduced by the start up of the nuclear power plant unit currently under construction in 2015, two more units in the 2020s and the increase in the use of renewable energy sources, mainly wind power and biomass in CHP plants. All of these changes will reduce emissions. In the WM projection, Finland will not remain a net importer of electricity after the year 2020, which will still serve to increase the emissions from condensing power plants using fossil fuels for the next few years.

Factors affecting the future energy demand are first of all energy efficiency measures, but also structural changes within the industry. According to the WM projection, heating energy consumption in 2020 will be on par with 2012, but slightly lower in 2030 (by 0.5 per cent), even though the volume of buildings is expected to increase continuously. The emissions from space heating are decreasing even faster than the energy demand due to the increased use of renewable energy. The historical and projected emissions from the energy sector in the WM projection are presented in table 5.4.

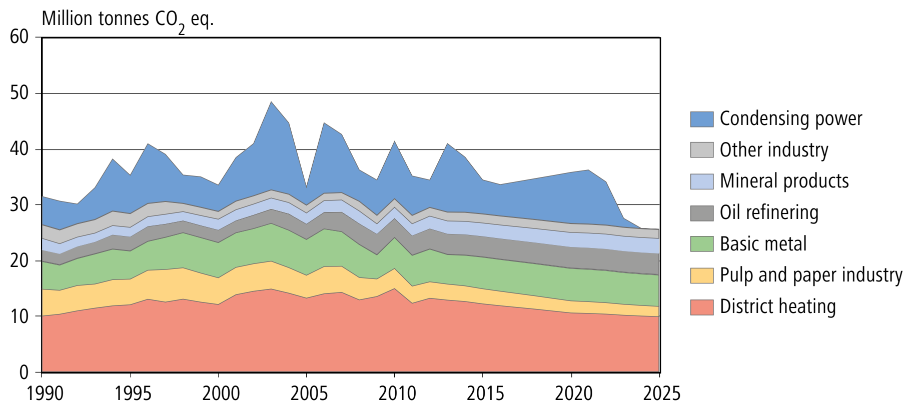
The emissions in the energy sector are mainly CO_2 emissions from the combustion of fossil fuels and peat. The development of CO_2 emissions in the EU ETS sector is illustrated in Figure 5.5 for the years 1990–2025.

Historically, district heating emissions have varied according to the heating demand (cold or warm winters). The emissions from condensing power have varied strongly depending on the hydro situation in the Nordic electricity market. In the WM projection for future years, the electricity import and export assumptions and the possible deficit in domestic power generation will influence the generation level of condensing power, and hence, the total emissions. The CO_2 emissions in district heating are declining steadily in the WM projection, whereas the industry's CO_2 emissions will remain rather stable.

Table 5.4
Historical (1990–2011) and projected (upto 2030) greenhouse gas emissions from the energy sector (excluding transport) based on the latest inventory and the WM projection, respectively

	Historical						WM Projection			
	1990	1995	2000	2005	2010	2011	2015	2020	2025	2030
Total emissions, million tonnes CO_2 eq.	41.7	44.1	41.6	40.3	47.1	40.2	38.4	39.0	28.3	27.0
CO_2	40.7	43.0	40.6	39.2	45.9	39.1	37.3	37.8	27.2	25.8
CH_4	0.2	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3
N_2O	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8

Figure 5.5
CO_2 emissions in the EU ETS sector according to the greenhouse gas inventory (1990–2011) and the WM projection (up to 2025)



The importance of CH_4 and N_2O emissions within the energy sector is quite small. Slightly less than 10 per cent of all CH_4 emissions come from the incomplete combustion of fuel, which is mainly caused by fireplaces and small heating boilers. CH_4 emissions from power and heating plants are quite small.

The development of emissions outside the EU ETS is presented in Figure 5.4 above. Non-ETS emissions within the energy sector (excluding transport) are mainly the result of using space heating for buildings, industry outside the EU ETS and machinery. For example, in agriculture and forestry the energy-related greenhouse gas emissions in 2010 were 2 million tonnes CO_2, of which machinery's share was 0.8 million tonnes CO_2. In the WM projection, the energy-related emissions, excluding machinery, will decline from 1.2 million tonnes CO_2 in 2010 to 0.8 million tonnes CO_2 in 2020. It is estimated that the emissions from forest and agriculture machinery will remain approximately at their current level, i.e. 0.7–0.8 million tonnes CO_2, even though the use of machinery is expected to increase over time. The reasons for this favourable development are more efficient equipment, more efficient use of the equipment and an increasing share of biofuels.

Transport

The WM projection for the transport sector includes all of the measures that were already being used within the transport sector to cut down on emissions at the beginning of the year 2013 (see also Section 4.7.2).

According to the WM projection, even though the total vehicle mileage will increase, the energy use as well as the emissions will start to decline in 2015 (Table 5.5). The emission reductions will be achieved by domestic and EU-wide policy measures, including promoting of the use of biofuels, improving vehicle technology and renewing the vehicle fleet, as well as by improving energy efficiency and directing the growth in passenger traffic volumes to more environmentally friendly transport modes. It is assumed that the use of biofuels will increase to a total of at least 12.5 per cent of the transport fuel sold in 2020 and that the growth in transport performances will remain at a moderate level, i.e. 0.5–1.5 per cent annually.

Table 5.5
Historical (1990–2011) and projected (2015–2030) greenhouse gas emissions from transport based on the latest greenhouse gas inventory and the WM projection, respectively

	Historical						WM Projection			
	1990	1995	2000	2005	2010	2011	2015	2020	2025	2030
Total emissions, million tonnes CO_2 eq.	12.8	12.0	12.8	13.7	13.4	13.2	13.3	12.1	11.2	10.6
CO_2	12.5	11.7	12.6	13.5	13.2	13.0	13.0	11.9	11.0	10.4
CH_4	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
N_2O	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Industrial processes, solvent and other product use

The main factors affecting the development of emissions from industrial processes include changes in industrial production and measures applied for reducing emissions. The global recession temporarily reduced the emissions from industrial processes in 2009, after which they have increased again, but not to their previous level. From 2015 onwards, emissions are expected to increase (Table 5.6). CO_2 emissions from industrial processes are mainly caused by the manufacturing of iron and steel, cement, lime and hydrogen. In the WM projection, these emissions will slightly increase as industrial production increases. N_2O emissions will be small, only 0.2 million tonnes CO_2 eq. in 2020, and they will also slightly increase towards the year 2030.

The WM projection for F-gases includes the impacts of the EC regulation on F-gases (842/2006) and the EC directive relating to emissions from air-conditioning systems in motor vehicles (2006/40/EC). Emissions from refrigeration and air-conditioning equipment are expected to decline as a result of these measures and technical changes leading to smaller charges and decreased leakage. Emissions from electricity distribution equipment and foam blowing have declined as a result of voluntary actions on the part of the industries and it is assumed that they will remain close to the emission levels for recent years. Restrictions put into effect by the EC regulation have reduced emissions from aerosols and other sources, but the emissions are expected to start increasing again due to increased activity in the remaining source fields. Emissions from refrigeration and air-conditioning equipment account for close to 90 per cent of Finnish F-gas emissions, and therefore, the projected overall emission trend is declining.

Emissions from solvent and other product use are expected to remain at their present level according to the WM projection.

Table 5.6
Historical (1990–2011) and projected (2015–2030) greenhouse gas emissions from industrial processes and solvent and other product use based on the latest greenhouse gas inventory and the WM projection, respectively

	Historical						WM Projection			
	1990	1995	2000	2005	2010	2011	2015	2020	2025	2030
Industrial processes										
Total emissions, million tonnes CO_2 eq.	5.1	4.7	5.6	6.4	5.8	5.6	5.5	5.7	5.7	5.8
CO_2	3.35	3.1	3.6	3.8	4.4	4.4	4.5	4.7	4.8	4.8
CH_4	0.01	0.01	0.01	0.01	0.01	0.01	0.0	0.0	0.0	0.0
N_2O	1.7	1.5	1.4	1.6	0.2	0.1	0.2	0.2	0.3	0.3
F-gases	0.1	0.1	0.6	0.9	1.2	1.1	0.8	0.7	0.6	0.6
Solvent and other product use										
Total emissions, million tonnes CO_2 eq.	0.18	0.14	0.12	0.11	0.07	0.07	0.1	0.1	0.1	0.1
CO_2	0.12	0.08	0.07	0.06	0.05	0.04	NE	NE	NE	NE
N_2O	0.06	0.06	0.05	0.05	0.03	0.03	NE	NE	NE	NE

Agriculture

In recent years, the changes in the emissions from the agriculture sector have been small. Under the WM projection, the emissions are expected to remain at their current level until the year 2020, but there will be small changes in the distribution of the different emission sources. The decline in livestock numbers will slightly lower the emissions from enteric fermentation and manure management. However, at the same time a slight increase in soil nitrous oxide emissions will cancel out that effect.

According to the WM projection, the total greenhouse gas emissions from agriculture will be 12 per cent lower in 2020 than in 1990 (Table 5.7). However, the largest decrease has occurred between 1990 and 2000.

Table 5.7
Historical (1990–2011) and projected (2015–2030) greenhouse gas emissions from agriculture based on the latest greenhouse gas inventory and the WM projection, respectively

	Historical						WM Projection			
	1990	1995	2000	2005	2010	2011	2015	2020	2025	2030
Total emissions, million tonnes CO_2 eq.	6.7	6.1	5.9	5.8	6.0	5.9	5.9	5.9	5.9	5.7
CH_4	2.2	2.0	1.9	1.9	1.9	1.9	1.7	1.8	1.8	1.8
N_2O	4.5	4.1	3.9	3.9	4.0	4.0	4.1	4.1	4.1	4.0

Between 2010 and 2020, the CH_4 emissions are projected to decrease by 5 per cent and N_2O emissions to increase by 1 per cent.

Energy-related emissions are reported in the energy sector and not included in the table.

LULUCF

The land use, land-use change and forestry sector (LULUCF) as a whole is expected to be a net sink in the WM projection (Table 5.8).

The WM projection for forestry is based on the National Forest Programme (NFP) 2015, which estimates that the carbon sink of forests (including trees and soil) will remain at a level of at least 10-20 million tonnes CO_2 eq. per annum by 2015. The estimate is based on the assumption that loggings will increase by 10–15 million cubic metres per year and that the use of wood for bioenergy will continue as defined in the national long-term climate and energy strategy and the NFP. The forest management reference level for the second commitment period of the Kyoto Protocol (2013-2020) is 19.3 million tonnes CO_2 (see Section 4.7.6).

The government and stakeholders will continue to carry out joint initiatives to promote the use of wood as a renewable material that also contributes to climate change mitigation. The impact of harvested wood products on emissions varies annually. In the most recent inventory, harvested wood products were estimated to be a source of 0.65 million tonnes CO_2 eq. In the reference level calculations for the second commitment period of the Kyoto Protocol, the harvested wood products are a sink of 1.1 million tonnes CO_2.

With regard to agricultural soils, CO_2 emissions from croplands and grasslands are not expected to be subject to large changes by the year 2020 according to the WM projection. The uncertainties in these estimates are significant, and new methods are being developed to increase their accuracy.

Table 5.8
Historical (1990–2011) and projected (2015–2030) greenhouse gas emissions and removals from the LULUCF sector based on the latest greenhouse gas inventory and the WM projection, respectively

	Historical						WM Projection			
	1990	1995	2000	2005	2010	2011	2015	2020	2025	2030
Total emissions and removals, million tonnes CO_2 eq.	−15.2	−14.1	−20.5	−29.9	−24.6	−24.6	−11.9	−11.9	−11.9	−11.9
CO_2	−15.3	−14.3	−20.6	−30.1	−24.8	−24.8	−12.1	−12.1	−12.1	−12.1
CH_4	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
N_2O	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Waste

Greenhouse gas emission projections for the waste sector include CH_4 from landfills, CH_4 and N_2O emissions from composting and CH_4 and N_2O emissions from wastewater treatment. Projections for the waste sector do not include emissions from waste incineration, which are reported in the energy sector. According to the WM projection, greenhouse gas emissions from the waste sector will decrease (Table 5.9). The main reason for this is the implementation of the Landfill Directive and national legislation and strategies aimed at reducing the amount of waste and minimising the amount of waste disposed at landfills.

CH_4 emissions decline significantly in the WM projection: by the year 2020, they will be approximately one third the amount they were in the year 1990. This trend will also continue after 2020, and emissions in 2030 are projected to be 18 per cent below the 2020 level.

The N_2O emissions in the waste sector were 0.16 million tonnes CO_2 eq. in 2011 and are not expected to change much over time.

Table 5.9
Historical (1990–2011) and projected (2015–2030) greenhouse gas emissions from the waste sector based on the latest greenhouse gas inventory and the WM projection, respectively

	Historical						WM Projection			
	1990	1995	2000	2005	2010	2011	2015	2020	2025	2030
Total emissions, million tonnes CO_2 eq.	4.0	3.9	3.3	2.4	2.2	2.1	1.8	1.6	1.4	1.3
CH_4	3.8	3.7	3.1	2.2	2.0	2.0	1.7	1.4	1.3	1.2
N_2O	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2

International bunkers

According to the most recent greenhouse gas emission inventory, the fuel consumption for international aviation was about 26,700 TJ and for international marine transportation 7,900 TJ in 2011. The annual growth rate by 2020 is estimated at 2 per cent for international marine transportation and 3 per cent for international aviation. Based on these assumptions, the total greenhouse gas emissions from bunker fuels are projected to be 3.3 million tonnes CO_2 eq. in 2020 (0.7 million tonnes from marine and 2.6 from aviation bunkers).

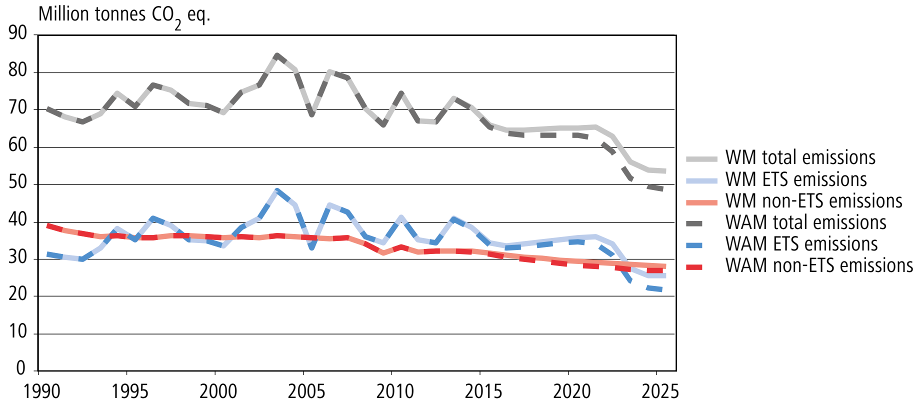
The projected emissions of marine and aviation bunkers do not take into account the impact of the measures presented in Table 4.6 which aim at improving energy efficiency and increasing the use of alternative fuels.

5.3 With 'Additional Measures' projection

The effect of the policies and measures included in the WAM projection on the total greenhouse gas emissions is illustrated in Figure 5.6. Continuous lines portray the WM projection and dashed lines the WAM projection.

The total greenhouse gas emissions in 2020 are estimated to be 65 million tonnes CO_2 eq. in the WM projection and 63 million tonnes CO_2 eq. in the WAM projection. The additional emission reduction measures in the WAM projection will mainly affect the emissions trading sector. Many of the measures in WAM projection are primarily designed to meet the national

Figure 5.6
Greenhouse gas emissions in EU ETS and non-ETS sectors in the WAM projection (dashed lines) compared to the WM projection (solid lines) in the years 2012–2025 and historical emissions for 1990–2011 based on the most recent inventory



renewable energy and energy efficiency targets and they will have positive effects on the security of the energy supply. While having a positive effect on the transport sector, the new biorefineries will increase the emissions of the emissions trading sector.

Table 5.10 presents a summary of the WAM projection emissions and the difference between them and the emission levels in the WM projection.

In the WAM projection, the heating energy consumption of residential and service buildings will decrease between 2012 and 2020 by approximately 9 per cent (6.5 TWh). By 2030, the consumption of heating energy will have decreased by 20 per cent (15 TWh) from 2012. The emission reductions due improvements in energy performance in renovations and alterations should be 0.5 million tonnes CO_2 in 2020 and 1.0 million tonnes CO_2 in 2030. Most of the emission impact falls on the EU ETS sector, while the improvements in energy efficiency will decrease the need for district heating and electricity (see also Table 4.4).

In the transport sector, the estimated total emission reductions in the WAM projection is 0.6 million tonnes CO_2 in 2020 compared to the WM projection. The potential emission reduction impact of energy efficiency agreements included in the WAM projection is 0.3 million tonnes CO_2 eq. in 2020 compared to the WM projection. The emission reduction effects of promoting public transport, walking and cycling should total some 0.3 million tonnes CO_2 eq. in 2020. For public transport, the target is to reach an

Table 5.10
Greenhouse gas emissions on a gas-by-gas basis for the WAM projection and difference between them and the WM projection in 2015–2030, million tonnes CO_2 eq.
(the greenhouse gas emissions in 2010 and 2011 are based on the most recent inventory)

	2010	2011	2015	2020	2025	2030
CO_2	63.6	56.5	54.3	52.9	38.6	36.8
CH_4	4.3	4.2	3.8	3.4	3.1	2.9
N_2O	5.4	5.3	5.3	5.3	5.2	5.1
F-gases	1.2	1.1	0.8	0.6	0.5	0.4
Total	**74.5**	**67.0**	**64.2**	**62.2**	**47.4**	**45.1**
difference to WM	0.0	0.0	–0.8	–2.2	–5.3	–5.5

emission reduction rate of 0.15 million tonnes CO_2, and the same target applies to walking and cycling. The possible additional financial steering methods referred to in Section 4.7.2 are not included in the WAM projection.

For F-gases, the WAM projection is based on the assumption that the European Commission's reassessment of the EC regulation on F-gases (842/2006) in 2011 will lead to additional regulatory measures. Further restrictions on the use of F-gases in refrigeration and air-conditioning equipment, foam blowing and aerosols are expected in all applications where it is technically feasible, and the changes should be in line with safety and health concerns. It is estimated that the emission reductions achieved by these additional measures will be 0.07 million tonnes CO_2 eq. in 2020 compared to the WM projection.

In the waste sector, the additional emission reductions are based on a drastic reduction of biowaste in landfills. However, as existing measures have reduced emissions significantly, the additional emission reductions are relatively modest (about 0.2 million tonnes CO_2 eq. in 2020 compared to the WM projection).

In agriculture and the LULUCF sectors, the WAM projection does not include any additional measures compared to the WM projection, and therefore, the two projections are identical for these sectors.

5.4 *Total effect of policies and measures*

In the estimate for the total effect of policies and measures (PaMs), the Business as Usual (BAU) scenario of the Finnish climate strategy from the year 2001 was used (denoted here as BAU*). The BAU scenario presents a development path without measures implemented after the year 2000. The scenario used 1999 as a starting point. The estimates for CH_4 and N_2O were modified for this assessment to take into account the changes in inventory methodologies by applying the percentage difference of the 1999 emissions in the most recent inventory and in the 2001 climate strategy to the 2010 and 2020 emissions estimates in the BAU scenario. In the case of CO_2, the original BAU scenario was modified to exclude emissions that are currently reported in the LULUCF sector (peat production and CO_2 from agricultural soils). In addition, the BAU estimate was modified to take into account the actual electricity imports in 2010 and the projected imports for 2020 in the WM projection (0 TWh); this was done using the sensitivity study for the 2001 climate strategy, in which the scenario was presented with different electricity import levels.

Based on the results presented in Table 5.11, the total effect of PaMs in 2010 was 6.1 million tonnes CO_2 eq., which means that the emissions in 2010 would have been 8 per cent higher without the PaMs implemented since the year 2000. According to the comparison of the BAU* scenario with the WM projection for 2020, the total effect of PaMs in 2020 will be 31.5 million tonnes CO_2 eq. (–33 per cent compared to the BAU* figure).

The aggregated estimates for the greenhouse gas reduction impacts of individual policies and measures presented in Chapter 4 are 15 and 33 million tonnes CO_2 eq. for 2010 and 2020 (without LULUCF), respectively. However, the impact estimates of individual policies and measures are not fully additive, which may result in an overestimation of the mitigation im-

Table 5.11
Greenhouse gas emissions by gas in the BAU* scenario for 2010 and 2020, with the 2010 emissions based on the most recent inventory and the emissions for 2020 on the WM projection. The total effect of the policies and measures (PaMs) is calculated based on the difference between the inventory emissions and the BAU* (for 2010) and the difference between the WM projection and the BAU* (for 2020)

Emissions, million tonnes CO_2 eq.	BAU* 2010	2010 (inventory)	Total effect of PaMs in 2010	BAU* 2020	WM 2020	Total effect of PaMs in 2020
CO_2	67.0	63.6	−3.4	81.6	54.5	−27.1
CH_4	5.6	4.4	−1.3	5.0	3.6	−1.4
N_2O	6.7	5.4	−1.3	6.8	5.5	−1.3
F-gases	1.4	1.2	−0.2	2.4	0.7	−1.7
Total	**80.6**	**74.6**	**−6.1 (−8%)**	**95.9**	**64.4**	**−31.5 (−33%)**

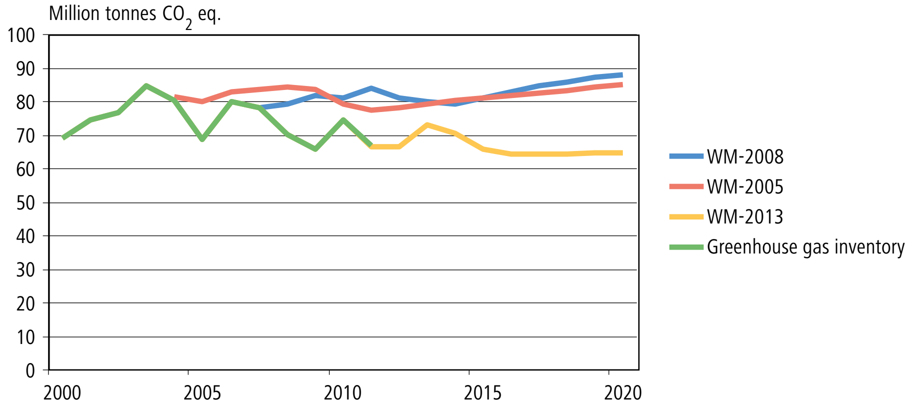
pact. On the other hand, the mitigation impact has not been estimated for all policies and measures.

The total effect of policies and measures contains noticeable uncertainties. The estimated range for the total effect of policies and measures implemented in Finland is 6-15 million tonnes CO_2 eq. for 2010. In 2020, the total effect of policies and measures will be approximately 30 million tonnes CO_2 eq. with existing measures, based on the two approaches described above.

Figure 5.7 shows Finland's greenhouse gas emissions in the WM projections in the last three national climate and energy strategies, i.e. strategies from the years 2005, 2008 and 2013. The WM projections in the 2005 and 2008 national climate and energy strategies projected 7–25 per cent higher emissions for 2010 and 2011 than those reported in the latest greenhouse gas inventory. This suggests that the recent additional measures have had a significant impact on the total emissions.

The main difference between the projections is that in the newest projection, many measures from previous WAM projections have been implemented and now included in the WM projection. The projections differ most compared to the Fifth National Communication in terms of road transport, space heating of buildings and renewable energy. In addition, the global recession and the structural adjustment of the Finnish forest industry have been taken into consideration in the 2013 strategy but not in the previous

Figure 5.7
Greenhouse gas emissions according to the most recent inventory for 1990–2011 and in the WM projections of the climate and energy strategies published in 2005, 2008 and 2013 for 2012–2020



ones. The total effect of implementing additional measures can be seen in the emission development trend after 2015, which has levelled off in the most recent projection, whereas it continued to increase in the projections from 2005 and 2008. Yet another difference between the projections, one which clearly impacts the emissions, is the assumed start-up year for the nuclear plant unit Olkiluoto 3. The start-up year has been postponed several times, and the 2013 projection assumes that the unit will start up in 2015, whereas the strategies from 2005 and 2008 assumed production would already start in 2009–2010 and 2012, respectively. In the current WM projection, the emissions in 2020 are projected to be 24-26 per cent below the projected levels in the earlier projections.

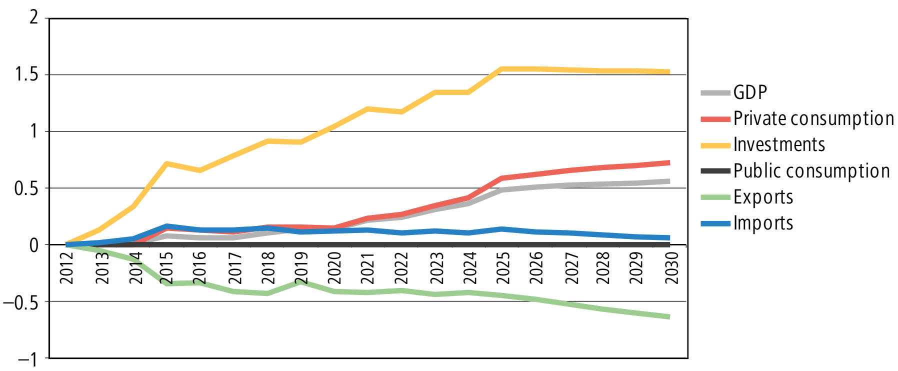
5.5 Economic impacts

The Government Institute for Economic Research (VATT) has studied the effects of the WAM projection on the Finnish economy using a dynamic, applied general equilibrium model (VATTAGE model). In the long run, it estimates that the measures used in the WAM projection will improve Finland's employment and energy self-sufficiency and increase the national product. The precondition for achieving the improved employment and increased national product is that the main part of the needed investments are market based, with the exception of the first biorefineries and the replacement of coal with renewables, which will require economic support. Wood biomass will also need to be available in sufficient quantities and at competitive prices.

Figure 5.8 illustrates the estimated effects of the WAM projection on the demand components of the national product compared to the WM projection.

The measures in the clean energy programme (included in the WAM projection, see Section 4.7.1) will require significant investment in the stock of equipment producing and consuming energy. According to initial estimates, the investment needs total approximately EUR 20,000 million. The

Figure 5.8
Estimated changes in the demand components of the national product (WAM projection compared to the WM projection, per cent difference) in the years 2012–2020



Source: VATT Government Institute for Economic Research largest investments concern nuclear power units that have been granted favourable decisions-in-principle, biorefineries and a plant for producing synthetic natural gas, as well as constructing additional wind power facilities. In addition, during the clean energy programme period, approximately EUR 6,000 million will be allocated to strengthening the electricity and gas networks, and investments will be made in cars that reduce traffic emissions.

5.6 Sensitivity analysis of the projections

In 2010, Finnish industry used 46 per cent of the country's total primary energy and 47 per cent of its electricity. 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. Iron and steel production is another energy-intensive branch, the development of which will impact the projections noticeably. Therefore, a sensitivity analysis has been made on how the changes in growth rates within energy-intensive industries will affect the overall energy balance and emissions in Finland. The studied industries consist of pulp and paper production and iron and steel production.

The sensitivity analysis compares the WM projection with two other projections, where the annual growth rates of pulp and paper and iron and steel production will be one percentage point higher and lower than expected in the WM projection (projections WM+ and WM–, respectively) from the year 2014 onwards. The main results for the sensitivity analysis are presented in Table 5.12.

The amount of electricity that is imported will significantly affect greenhouse gas emissions within the EU ETS sector. The yearly net import varies primarily according to the hydro situation in Norway and Sweden. Under the National Energy and Climate Strategy (2013), Finland aims to ensure it will have sufficient domestic electricity production capacity to be able to cater to peak consumption levels and possible import disturbances. Net imports of electricity should decrease in the future, being 17 TWh in 2012, 6 TWh in 2015 and 0 TWh in 2020. In practice, the electricity market determines the imports and exports, and therefore, the energy policies of the neighbouring countries will impact whether Finland will be a net importer or exporter. Zero net imports of electricity in 2020 would mean about 8.3

Table 5.12
Main results for the sensitivity analysis on how the growth rate changes in energy-intensive industries affect the overall energy balance and CO_2 emissions

	2010	2015			2020		
	statistics	WM	WM +	WM –	WM	WM +	WM –
Pulp and paper production (base year 2005 = 1,00)	0.95	0.91	0.93	0.89	0.95	1.02	0.89
Iron and steel production (base year 2005 = 1,00)	0.82	0.95	0.97	0.93	1.02	1.10	0.96
Primary energy consumption, TWh	407	420	422	417	433	443	424
Final energy consumption, TWh	322	320	322	319	325	332	319
Electricity consumption, TWh	87.7	90.4	90.9	89.9	93.8	95.9	92.0
Share of renewables in final energy consumption, %	32.2	34.0	34.1	33.9	38.8	39.1	38.4
CO_2 emissions, million tonnes CO_2 eq.	74.5	65.8	66.3	65.3	65.0	66.8	63.2

WM +: annual growth rates of pulp&paper and iron&steel production are 1 percentage point higher than in WM
WM –: annual growth rates of pulp&paper and iron&steel production are 1 percentage point lower than in WM

million tonnes CO_2 eq. more in greenhouse gas emissions than a situation in which the net electricity import is 10 TWh, provided that the corresponding electricity is produced domestically with conventional condensing power.

5.7 Supplementarity relating to the Kyoto Protocol mechanisms

According to the greenhouse gas inventory data for 2008–2011 and the preliminary data for 2012, the emissions in Finland during the first commitment period of the Kyoto Protocol were nearly 5 per cent (approximately 15.8 million tonnes CO_2 eq.) below Finland's assigned amount (approximately 355.0 million tonnes CO_2 eq.).

As of May 2013, the amount of Kyoto units obtained by Finland through the Kyoto Protocol mechanisms was 3.6 million tonnes CO_2 eq., whereas the amount of Kyoto units from JI projects implemented in Finland (which will be transferred outside Finland) was estimated at 1 million tonnes CO_2 eq.

This shows that the Kyoto target could have been met entirely by domestic actions, and therefore, that the use of Kyoto Mechanisms is supplemental to domestic actions.

Table 5.13 shows a preliminary estimate of Finland's national emissions during the first commitment period of the Kyoto Protocol and how Finland's assigned amount has been allocated to the emissions trading sector and the non-trading sector; it also shows the emissions in these sectors during the first commitment period. The entities in the trading sector have been return-

Table 5.13
Preliminary assessment of accounting for Finland during the first commitment period of the Kyoto protocol

	2008	2009	2010	2011	2012 (Preliminary data)	Sum[1]
Total national emissions	**70.2**	**66.1**	**74.6**	**67.0**	**61.4**	**339.2**
Finland's assigned amount	**71.0**	**71.0**	**71.0**	**71.0**	**71.0**	**355.0**
Emissions trading sector						
Emissions[2]	36.2	34.4	41.3	35.1	29.5	176.4
Allocated units	36.5	37.1	37.9	38.0	38.1	187.6
Surplus/deficit of units[3]	+0.4	+2.7	-3.4	+2.9	+8.6	+11.2
Non-trading sector						
Emissions	34.1	31.7	33.3	32.0	31.9	162.8
Allocated units[4]	34.5	33.9	33.1	33.0	32.9	167.4
Surplus/deficit of units	+0.4	+2.2	−0.2	+1.1	+1.0	+4.6
Units from LULUCF activities and other mechanisms under the Kyoto Protocol						
Article 3, paragraphs 3 and 4[5]	+0.6	+0.6	+0.6	+0.6	+0.6	+2.9
Acquisitions of units from JI and CDM[6]	+0.1	+0.4	+0.3	+0.5	+2.3	+3.6
Transfer of units from Finnish JI projects[7]					−1.0	−1.0
Surplus in Finland's account[8]	**+1.1**	**+3.2**	**+0.7**	**+2.1**	**+3.9**	**+10.1**

Due to rounding, the figures in the table may not always sum up.
1 Preliminary data/estimate.
2 Energy Market Authority press release 2.4.2013.
3 A surplus (positive number) means that entities have received units in excess, of the annual emissions, whereas a deficit (negative number) means the opposite.
4 Computational allocation, i.e. the difference between the average annual assigned amount minus the unit allocated to the trading sector.
5 Finland's forest management cap.
6 Units acquired by 14 May 2013 *(source: Ministry of the Environment)*.
7 Estimate for the whole commitment period *(source: Ministry of the Environment)*.
8 The units lost as a result of bankruptcies are not included.

ing units amounting to their emissions annually, and the surplus/deficit of units will remain with the entities. The allocation of units to the non-trading sector is computational. The final accounting of the emissions and assessment of Finland's compliance with the emission limitation commitment under the Kyoto Protocol will only be done after the 2014 greenhouse gas inventory has been submitted and reviewed at the end of the so-called true-up period in 2015. However, significant changes in the emission estimates and the assessment of additionality are not expected.

5.8 Methodology

5.8.1 Approach and responsibilities

The WM and WAM projections presented in this chapter correspond to the projections of the National Energy and Climate Strategy, which was presented by the Government in March 2013. The preparation of the strategy was coordinated by the Ministry of Employment and the Economy under the Ministerial Working Group on Energy and Climate Policy.

The basis for the projections is a projection framework describing the future development of central factors and circumstances affecting the projections. The framework as well as sector-specific key assumptions and policy measures are described in the background report to the National Energy and Climate Strategy. The ministries most involved in preparing the framework and projections were the Ministry of Employment and the Economy, the Ministry of the Environment, the Ministry of Transport and Communications, the Ministry of Agriculture and Forestry, and the Ministry of Finance.

The sectoral projections and calculations were made by various experts within the contact network set up by the main ministries involved in drafting the climate policy. The main models and methods used in the work are briefly described in Section 5.8.3. The Ministry of Employment and the Economy was responsible for the projections regarding the amount of energy used by industry, households and services and for the calculations regarding fuel and carbon dioxide emissions in the energy production sectors as a whole; it was also responsible for coordinating the calculations. The Ministry of the Environment was responsible for the projection regarding space heating, for the analysis of the regional and urban structure, and for emission projections and calculations for waste and machinery. The duty of the Ministry of Transport and Communications included making projections for fuel and electricity usage as well as emissions from the transport sector. The Ministry of Agriculture and Forestry oversaw the calculation of emissions and removals in the land use, land-use change and forestry sector.

5.8.2 Assumptions underlying calculations

A summary of key variables and assumptions is presented in Table 5.14.

Finland's population will increase from the current 5.4 million to about 5.9 million by the year 2035. The age structure of the population will change significantly over the next couple of decades as the share of older age groups increases. The number of households is expected to increase from the current 2.5 million to approximately 2.9 million by 2035. At the same time,

Table 5.14
Key variables and assumptions used in the projections analysis for 1990–2030

	Unit	Historical 1990	1995	2000	2005	2010	2011
Population	Million inhabitants	4.99	5.11	5.18	5.25	5.38	5.40
Value added, gross at basic prices	Million EUR, 2000 prices	92,000	91,000	115,000	129,000	135,000	138,000

	Unit	Projected 2015	2020	2025	2030
Population	Million inhabitants	5.51	5.64	5.75	5.85
Value added, gross at basic prices	Million EUR, 2000 prices	146,000	159,000	173,000	189,000

however, the average size of households will decrease. The number, structure and location of households will have an impact on energy demand.

GDP growth in the coming years will be well below the rate of growth experienced in the past, mainly due to the global economic recession. Economic growth is estimated to be 1.6 per cent per annum in the present decade and approximately 1.9 per cent per annum in the next decade. The Finnish economy is going through a major structural change, which is affecting the energy-intensive sectors of production in particular. The activities that will sustain growth in production are expected to be mining, machinery and equipment manufacturing, the retail trade and the public social services sector. The expected development of the economy by branch is illustrated in Table 5.15.

The international fuel price estimates are taken from the IEA's World Energy Outlook publication (2012). The price of crude oil should constitute a rising trend with periodic fluctuations. Emission allowance prices are expected to rise in 2020 to EUR 18–25/ t CO_2. The primary energy by source, the energy sources for district heat and combined heat and power production, the electricity supply and the energy sources in the transport sector are presented in Tables 5.16–5.19.

In the transport sector, greenhouse gas emissions are influenced by a decline in specific energy consumption and, in particular, by an increased share of biofuels. In the WM projection, the average emissions of the passenger car fleet will be reduced by about 22 per cent by 2020 and by approximately 53 per cent by 2050 as a result of increased energy efficiency. In addition, it

Table 5.15
Development of the economy by branch, average annual percentage change in the years 2000–2010 and in the WM projection for 2010–2020 and 2020–2035

Branch	2000–2010	2010–2020	2020–2035
Agriculture and forestry	**2.1**	**1.6**	**0.8**
Extractive industry	**7.5**	**4.7**	**2**
Manufacturing industry	**2.2**	**2.1**	**2.1**
Forest industry	–0.8	0.6	0.8
Chemical industry	1.9	1.8	2
Metal production	–1.7	2.5	1.5
Electrotechnical products	8.4	1	2.3
Other industries	0.6	2.3	2.4
Electricity, gas and water supply	**0.9**	**2**	**2.8**
Construction	**5.9**	**1.8**	**2**
Services	**1.5**	**1.6**	**1.8**
Total appreciation	**1.7**	**1.6**	**1.9**

Table 5.16
Primary energy by energy source and gross final energy in 2010 and in the WM projection for 2020–2030, TWh

	2010	2020	2025	2030
Fuels in the transport sector	50	48	45	42
Oil other	48	43	42	41
Coal [1]	52	50	24	22
Natural gas	41	37	33	31
Peat	26	16	13	13
Wood fuels from which	89	98	98	101
• black liquor etc	38	39	40	41
• bark and waste wood	18	18	18	18
• forest chips	14	25	24	27
• small scale combustion	18	15	15	14
• pellets	0.8	1	1.2	1.3
Nuclear	66	106	178	171
Hydro	13	14	15	15
Wind	0.3	6	6.5	7
Other	10	16	18	19
Import of electricity	11	0	−9	−3
Total primary energy	**407**	**433**	**463**	**459**
Gross final energy consumption	322	325	325	327

1 hard coal, coke, blast furnace gas, coke oven gas

Table 5.17
Energy sources for district heat and combined heat and power production in 2010 and in the WM projection for 2020–2030, TWh

	2010	2020	2025	2030
Oil	3.2	2.2	2.2	1.9
Coal	14	10.4	9	7.6
Natural gas	23	19.5	17.5	15.6
Peat	12.2	7.8	8.5	8.9
Wood fuels	11	19.4	20.3	21.9
Other	2.7	5	5.4	5.6
Total	**66**	**64**	**63**	**62**

Table 5.18
Electricity supply in 2010 and in the WM projection for 2020–2030, TWh

	2010	2020	2025	2030
Hydro	12.7	14.2	14.6	14.8
Wind	0.3	6	6.5	7
CHP, district heating	17.8	17.2	16.8	16.4
CHP, industry	10.3	9.2	9.3	9.4
Nuclear	21.9	35	58.8	56.4
Condensing power	14.2	12.2	−8.5	−2.4
Net imports	10.5			
Total electricity supply	**88**	**94**	**98**	**102**

Table 5.19
Energy sources in transport in 2010 and in the WM projection for 2020–2030, TWh

	2010	2020	2025	2030
Petrol	18.7	14.2	12.6	11.8
Diesel	27.8	31.5	29.5	28.3
Other fuels	3.9	4	4.1	4.1
Electricity	0.7	1.1	1.8	2.9
Total	**51**	**51**	**48**	**47**

is estimated that the share of bio-based fuels will increase to 12.5 per cent in 2020 and to 15 per cent in 2030.

The landfilling of waste will be increasingly replaced with recycling and energy recovery. In 2010, the amount of municipal waste incinerated at waste incineration plants was approximately 244,000 tonnes. The WM projection estimates that from 2020 onwards, the amount of municipal waste incinerated at waste incineration plants will be approximately 800,000 tonnes per annum. In addition, co-incineration plants are expected to use 300,000 tonnes of waste-based fuels annually. Waste co-incineration is included in the emissions trading sector.

5.8.3 Description of models and methods

Buildings

The EKOREM model is a bottom-up building stock calculation model developed by the unit of Construction Management and Economics at Tampere University of Technology and VTT Technical Research Centre of Finland. The calculation model is based on part D5 (2007) of the National Building Code of Finland: 'Calculation of energy needs for heating of buildings'. The model can be used to calculate energy consumption and greenhouse gas emissions and also to analyse the energy savings and greenhouse gas emission reduction potentials achieved by different policy scenarios. These scenarios can include building-related structural measures as well as changes in the energy production structure.

In the EKOREM model, the building stock is divided into building type categories, which are similar to those used by Statistics Finland, so that official building statistics can be used as a basis for the calculations. Building stock data can further be divided into different age classes to better describe the methods of construction in different eras. The model includes a great deal of descriptive data, such as U-values for structures, technical specifications for ventilation and information about electricity consumption. The model also includes heating system distributions for the different building types. These distributions and emission coefficients are used to determine greenhouse gas emissions (CO_2 eq.) for the studied building stock.

One of the main purposes of the model has been to produce assessments for the climate and energy policy reporting that show how developments in Finnish climate policies have affected the energy consumption and the greenhouse gas emissions of the Finnish building stock.

POLIREM is also a bottom-up building stock model. It covers less technical details than the EKOREM model. Instead, it takes into account the different primary energy sources in a more detailed manner than EKOREM. The POLIREM model is well suited to analysing the impacts of policy measures on emissions, the use of renewable energy resources and the division of impacts between the ETS and non-ETS sectors.

EKOREM calculation model,
http://webhotel2.tut.fi/ee/en/Tutkimus/ekorem.html

The REMA model developed by VTT Technical Research Centre of Finland is used for forecasting the developments in energy consumption for the building stock in Finland. It is a bottom-up model that uses representative building types (archetypes) for estimating energy usage in different segments of the building stock. Future developments are estimated using annual rates of new construction, renovations and removals from the building stock.

The REMA model includes a simplified model of the energy sector that allows for primary energy and CO_2 emission calculations. REMA is a light model with a degree of flexibility that makes it possible to test different contingencies and the sensitivities of scenarios with relative ease.

The REMA model does not include any dynamic modelling, and therefore, the results are based on predetermined parameters. Moreover, it does not take into account the costs or economic impacts of the policies.

The REMA model was also used to estimate the emission reduction impacts of policies and measures (presented in Chapter 4) in the WAM projection, whereas the impacts of policies and measures in the WM projection were estimated using EKOREM and POLIREM models.

Energy production

The Ministry of Employment and the Economy prepares the projections for energy production using demand projections for each consumption sector as a basis. With the exception the energy used by industry, households and services, as well as the energy used for other, smaller consumption purposes, the demand projections are produced by other organisations using the models described in this section. The energy demand projections for industry and services are determined by industrial production per product group (pulp and paper, basic metals), branch-specific economic growth (other industry, public and commercial services), specific energy use trends and expected energy-efficiency improvements. The household projection is based on population and household forecasts and the extensive surveys made by Adato Energy on electricity use in different households. The demand projection assumptions are based on statistics, expert judgements and surveys by consultants, research organisations and branch organisations.

The energy needed from power and heat generation plants (main activity producer plants) is based on the total electricity and heat demand, the calculated electricity and heat generated by the industry itself (autoproducer plants), as well as on assumptions about electricity net imports. Using the information on existing and planned power plants and their possible dismantling schedule, the need for new production capacity can be calculated. In the projections, the demand for new capacity is expected to be met with energy from the plants promoted by the various policies and measures (such as the feed-in-tariff for wind power). If there is still a deficit in electricity or the heating energy supply, it will be produced by a default technology and fuel mix.

CO_2 emission projections are obtained by multiplying fuel consumption by the emission factors. Historical emissions and amounts of fuel are used for calculating CH_4 and N_2O emissions.

The IMPAKTI calculation tool is used for calculating the emission mitigation impact of measures promoting the use of renewable energy (presented in Chapter 4). The IMPAKTI calculation tool is based on the assumption that forest chips, wind power and biogas from digesters will not be used without existing policies and measures. Therefore, the aggregated impact of policies and measures promoting the use of these energy sources is estimated based on the energy production (wind power and biogas plants) or fuel use (forest chips) and the assumptions about the energy source that is being replaced by the renewable energy source. It is assumed that forest chips will mainly replace peat in power and heat production and, to a small extent, other fuels. For agricultural farms, it is assumed that the use of forest chips will replace light fuel oil. It is assumed that the electricity produced by renewable energy sources (wind, biogas) will mainly replace marginal electricity, i.e. electricity produced by condensing power plants using fossil fuels for peat. However, as these marginal production modes may not be in operation at each point of time, it is assumed that the production of electricity using renewables can also replace other electricity generation modes or electricity imports. Therefore, the emission factor used for replaced electricity (600 t CO_2/GWh) is smaller than the emission factor used for electricity production in condensing power plants that use fossil fuels or peat (on average 850 t CO_2/GWh). The emission factor for electricity defined in the IMPAKTI calculation tool (600 t CO_2/GWh) is also used to estimate the mitigation impact of energy efficiency measures presented in Chapter 4.

Transport

The transport sector projections are compiled using the LIPASTO calculation system, which is also used to estimate emissions for the greenhouse gas inventory (see Finland's National Inventory Report for a description of the methodology). The LIPASTO calculation system includes four submodels: LIISA for road transportation, RAILI for railways, MEERI for waterborne transport and ILMI for air traffic. LIPASTO is compiled and updated by VTT Technical Research Centre of Finland. The ILMI submodel is compiled and updated by the Finnish Aviation Administration. The LIPASTO model covers emissions of carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO_x), particles (PM), methane (CH_4), nitrous oxide (N_2O), sulphur dioxide (SO_2) and carbon dioxide (CO_2). The mileage projections for road transport are based on the Finnish Transport Agency's base forecast. Fuel consumption is assumed to decrease by 1.5 per cent in vehicles using petrol and by one per cent in diesel vehicles yearly. The changes in the vehicle fleet are taken into account based on the estimated annual sales of new vehicles and the scrappage rate. In rail transportation, the mileage development forecasts are based on the estimates given by the Finnish State Railways, VR Ltd. The developments in emission coefficients are based on research carried out at VTT and in other countries. The projection regarding future emissions from aviation is based on assumptions about the growth in the number of commercial flights and improvement rates for the energy efficiency of aircraft engines. The projection for waterborne transport emissions is based on estimates by the Finnish Transport Agency. The future development of the emissions coefficients for navigation is based on estimates and research results from other countries.

LIPASTO calculation system,
http://lipasto.vtt.fi/indexe.htm

F-gases

The F-gas emission projections (including HFCs, PFCs and SF_6) are prepared by the Finnish Environment Institute.

The total F-gas emission projections are sums of the subsector emission scenarios. The F-gas emission sectors are as follows: refrigeration and air conditioning equipment, foam blowing and use of foam products, aerosols, electrical equipment and grouped emission sources (e.g. fixed firefighting systems and semiconductor manufacturing). In the emission projections, the refrigeration and air conditioning sector is further divided into eleven subsectors. Each source category has a specific calculation method because of the differences in available data and background information.

Full descriptions of the use of F-gases in Finland as well as the documentation with abatement costs were first provided by Alaja in 2009. Since then, the emission projections have been updated in 2010 and 2012 based on information from the 2008-2011 emission inventories of F-gases, Gschrey and Schwarz (2009), TEAP (2009 and 2010) and Schwarz et al. (2011).

The sources of information that have been used in order to form scenarios for each subsector have been summarised by Mattinen et al. (2012) (pp. 43-44).

Agriculture

An economic model and several greenhouse gas calculation models were used to compile the projections for the agriculture sector (CH_4, N_2O) and croplands and grasslands in the LULUCF sector (CO_2).

Future agricultural production intensity was estimated using the agricultural sector model (Dremfia), which takes into account the prices of agricultural inputs and outputs and agricultural policy. The results from Dremfia were fed into the calculation models, which are used for the greenhouse gas emission inventory (see National Inventory Report for details). Dremfia produced most of the input data for the greenhouse gas modelling: the area of cultivated soils, the use of mineral fertilizers and the numbers for the most important animal species. In addition, the development of some parameters in the future were estimated using expert judgments: the area of organic soils, the spread of manure management systems, the number of horses (slightly increasing population), sheep, fur animals, reindeer and turkeys (stable population), and developments in the weight of cattle and N excretion of animals.

The method and assumptions were done in the same way in previous National Communications. The method makes it possible to take into account all measures that are related to agricultural policies and it produces time series that are consistent with the reported emissions.

Waste

The Finnish Environment Institute calculates the projections for the waste sector.

The waste scenarios are based on statistics and modelling following IPCC guidelines. The scenario tool is thus primarily an accounting model, which is complemented with expert judgments on how rapidly the measures will affect the waste sector (Mattinen et al. 2012). The same basic modelling tool has been used for previous National Communications.

The scenario calculations are based on assumptions concerning developments in the amount of waste related to standard population projections and the rate at which new waste treatment facilities are introduced, in particular their incineration capacity, which will reduce the stream of waste to landfills. The modelling deals separately with solid municipal waste, municipal sludge, industrial sludge, industrial solid waste and building waste. Different treatments are considered separately (landfills, composting, incineration, recycling). Emissions from wastewater treatment and composting are dealt with separately, and methane collection from landfills is also taken into account. CH_4 and N_2O emissions are treated separately.

The modelling builds on aggregating information for the waste sector, and thus, there are only limited opportunities to project the detailed effects of individual policy measures in terms of emission reductions. So far, there has been only limited information on the costs and benefits of the measures included in the analyses. There are no direct overlaps with projections from other sectors, as the projections of the waste sector do not include emissions from waste incineration, which are reported in the energy sector.

LULUCF

The development of the tree stock and drain (m^3) for the LULUCF sector projection is estimated using the MELA model. MELA is a forestry model consisting of two parts: 1) a forest simulator based on individual tree growth and development models, and 2) a linear optimisation package. The information on forest resources, which is based on the national forest inventory, is used as a basis for MELA. The model utilises the roundwood demand and information on stump prices produced by the SF-GTM model. The SF-GTM model is a partial equilibrium model depicting Finland's forestry sector: forestry, the forest industry and the forest product market. The MELA model also provides the input data for the Yasso model, which is used to project the changes in carbon stocks in mineral forest soils.

The projections for croplands and grasslands were compiled using the Dremfia model (see the section on agriculture above).

The MELA model is described in the document on forest management reference level calculations for Finland,
http://unfccc.int/files/meetings/ad_hoc_working_groups/kp/application/pdf/awgkp_finland_2011.pdf

Economic effects

The VATTAGE model is a dynamic AGE (applied general equilibrium) model developed and used by the Government Institute of Economic Research (VATT) for analysing economic effects. The distinguishing features of the model concern its dynamics. Three inter-temporal links connect consecutive periods in the model: (1) the accumulation of fixed capital, (2) the accumulation of financial claims and (3) lagged adjustment mechanisms, notably for the labour markets and for balancing the public sector budgets. Together, these mechanisms result in gradual adjustments to policy shocks to the economy.

In the model, capital is sector specific, which means that 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, a rise in 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 in costs if they can substitute renewable energy for fossil fuels.

The VATTAGE model assumes sluggish real-wage responses to policy shocks. Real wages will adjust sluggishly to deviations from expected equilibrium wage growth, with the result that in the short run, adjustments will occur partly through increased levels of unemployment. In the long run, wages will adjust fully to one-off shocks, and full employment will be restored. In the case of gradually tightening emission targets, however, the shocks are not one-off, implying sustained, above-equilibrium unemployment rates.

VATTAGE model,
http://www.vatt.fi/en/publications/latestPublications/publication/Publication_1345_id/832

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6 Climate change impacts, adaptation measures and vulnerability assessment

This chapter describes how the Finnish climate is expected to change in this century and how the change is expected to affect nature, the economy and society. The chapter includes an outline of efforts to assess vulnerability. The expected impacts are described together with adaptation measures in each sector. Finally, international cooperation is briefly discussed.

Photo: Milla Popova / Image bank of the Environmental Administration

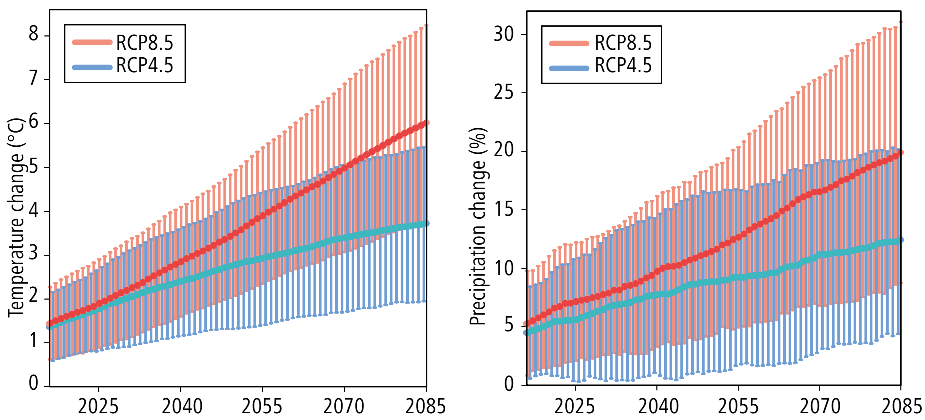
6 Climate change impacts, adaptation measures and vulnerability assessment

6.1 Climate projections for Finland

Climate change projections are based on simulations performed using 28 global climate models for the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). The future climate cannot be predicted accurately due to uncertainties in (i) the future emissions of greenhouse gases and aerosols, (ii) natural climatic variability, and (iii) the incomplete representation of the climate system in the models. Figure 6.1 shows multimodel mean estimates and the associated uncertainty intervals for the future evolution of annual mean temperatures and precipitation rates in Finland for two greenhouse gas scenarios, with the RCP4.5 scenario representing fairly moderate emissions and the RCP8.5 scenario representing high emissions. The solid curves give estimates for the change related to future emissions, hatching the uncertainty caused by modelling uncertainties and natural variability.

The temperature change in Finland is expected to be 2.4°C by 2040 and 3.6°C by 2080 in the RCP4.5 scenario representing fairly moderate emissions, and 2.9°C and 5.8°C in the RCP8.5 scenario representing high emissions. The temperature increase in Finland is expected to be more than 1.5 times as large as the global mean warming on average. The projected increase in precipitation will be substantial as well. Both greenhouse gas scenarios lead to a quite similar evolution of temperatures and precipitation rates until about the 2040s. During the latter half of the 21st century, by contrast, climatic changes will depend strongly on the emission path. The uncertainty associated with the model differences and natural variability is likewise fairly large.

Figure 6.1
Projected temporal evolution of annual mean temperature (left) and precipitation (right) in Finland by 2085, relative to the means for the period 1971–2000. The thick solid lines represent the multimodel means, hatching the 90 per cent confidence interval of the projection. Both are given separately for the moderate-emission scenario, RCP4.5 (blue), and the high-emission scenario, RCP8.5 (red)



Both the increases in temperatures and precipitation rates will be larger in wintertime than in summertime (Figure 6.2). If the RCP8.5 scenario proves true, the January mean temperature is projected to increase by 4 to 12°C and precipitation by 10 to 60 per cent by the end of the 21st century. If emissions are reduced (e.g. in accordance with the RCP4.5 scenario), the seasonal distribution of the response will be qualitatively similar, but the magnitude will be smaller. The same characteristic can be seen when studying less distant future periods.

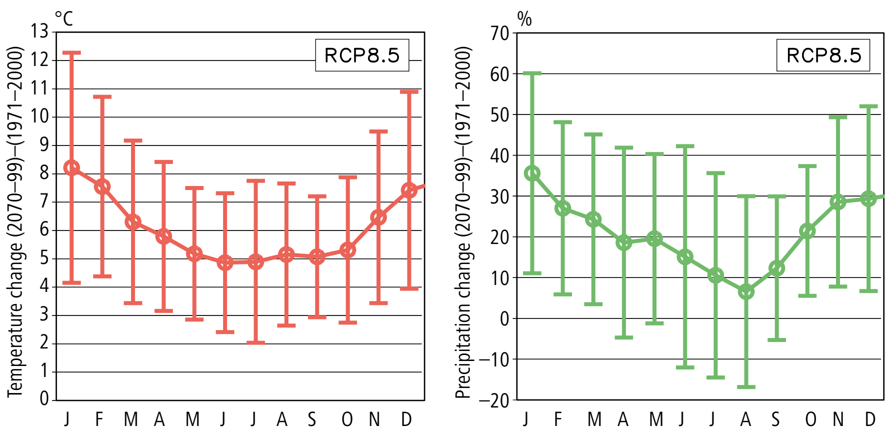
Compared to the climate scenarios generated by the previous model (which was used to prepare the IPCC's 4th Assessment Report), the present summer temperature projections are as much as 1°C higher. This can be deduced by comparing the RCP4.5 and SRES B1scenarios; the evolution of greenhouse gas concentrations is nearly equal in both scenarios. Conversely, winter temperature projections and precipitation scenarios for all seasons are fairly similar in the two models.

The new temperature and precipitation projections were not published until February of 2013, and hence the adaptation research described in this chapter still makes use of the older scenarios.

Other examples of projected climatic changes in Finland (mainly based on the older model) include the following:

- Heat waves will become longer and more frequent, whereas severe cold spells will gradually diminish.
- Heavy rainfall events will intensify in summertime.
- The number of days with precipitation will increase in the wintertime.
- The snow season will become shorter and the snow water equivalent will decrease on average, particularly in southern Finland.
- The duration and depth of soil frost will decrease, particularly in snow-free areas like roads and airports. This will also hold true for sea and lake ice cover.
- Winters will become cloudier and solar radiation will decrease.
- There will be minor increases in wind speeds in autumn and wintertime.

Figure 6.2
Projected temperature (left, °C) and precipitation (right, per cent) changes in Finland during the various calendar months (J = January, F = February, etc.). The circles and the curve denote the multimodel mean projection. The 90 per cent confidence interval for the change is denoted by vertical bars. The changes are presented for the period 2070–2099, relative to 1971–2000, under the RCP8.5 scenario.



6.2 Vulnerability assessment

Research has provided new information on Finland's vulnerability to climate change. A general assessment of vulnerability across sectors was the basis for the original national adaptation strategy of 2005. Subsequently, more detailed studies of vulnerability in specific sectors or specific environments have been made. These include the following (see also Chapter 8):

- Water: designating flood-prone areas and flood maps (work carried out and made publicly available, further research on water management is being done, for example, as part of the research project ClimWater, which is part of the Finnish Research Programme on Climate Change (FICCA)); the impacts of climate change scenarios (ProDOC) are also being studied.
- Exploration of indirect economic effects at the regional and national level owing to river floods and urban floods caused by extreme downpours (TOLERATE and IRTORISKI projects).
- Forest: exploring the impacts of high winds, heat spells, drought, snow and frozen ground, and winter temperatures.
- Biodiversity: in particular, the sensitivity of bird populations and certain biotopes to climate change (FICCA research project A-LA-CARTE).
- Agriculture: studies on crop changes have been carried out at the national level. An international network of crop science experts working within the context of climate impact research has studied the sensitivity of crop production to climate change. There is also an ongoing project closely related to vulnerability assessment: Improving resilience to climate change and variation induced risks in agriculture (ILMAPUSKURI).
- Transport: Changes in exceedance frequency of critical thresholds of weather phenomena for transport systems (EWENT project of the 7th Framework Programme of the EU).
- Health: ongoing work on vulnerability of the elderly to climate change.
- Regional perspective on the Arctic region (FICCA research project CLICHE).

Finland has also experienced practical reminders of what vulnerability means. Severe thunderstorms in the summer of 2010 and wind storms in December 2011 demonstrated the vulnerability of Finnish society to wind damage and power outages. In the spring of 2013, several catchments on the west coast experienced severe flooding.

A summary of Finnish research results on impacts and adaptation has been published covering a wide variety of sectors and also dealing with cross-cutting topics. Vulnerabilities were identified in all sectors, but the nature of the expected impacts and vulnerabilities vary. A gradual shift in average condition that favours currently unknown, rare or new pests may be particularly problematic for agriculture and forestry, while extreme climatic events may have major consequences in terms of the vulnerability of both terrestrial and urban environments. Traffic and transportation have turned out to be particularly vulnerable to conditions near or below freezing.

The national Climate Change Adaptation Research Programme (ISTO, 2006–2010) has funded 30 studies concerning the vulnerability of various sectors and also a number of synthesis studies. The Academy of Finland currently runs a climate change research programme (FICCA), of which five projects also deal to some extent with vulnerability. Finnish research institutes have also participated in numerous EU-funded vulnerability and adaptation studies, which have also produced useful information for adaptation policies in Finland. Furthermore, several projects by the Nordic Research Council deal with vulnerability and adaptation. For example, a substantial part of the new insights and lessons regarding energy and transport systems come from these international projects.

The research projects highlight the nature of vulnerability and the relevant processes in different sectors of society. These studies contribute to a better understanding of vulnerabilities and risks related to climate change. In the revised version of the national climate adaptation strategy, special emphasis will be put on a systematic consideration of vulnerabilities, including considerations of how the vulnerabilities are projected to develop. The objective is to base adaptation measures on improved risk assessments that recognize key vulnerabilities.

Tools to help actors consider possible impacts and vulnerabilities have been developed and have also been made available through the Internet service 'Climate Guide'. It allows stakeholders to get access to spatially disaggregated information on climate projections and projected impacts.

6.3 Expected climate change impacts and adaptation measures

This section is an update of Finland's Fifth National Communication under the UNFCCC, and it utilises the recent results from various studies and research projects on adaptation. Adaptation research done in recent years (see Section 8.2) has increased our understanding of climate change impacts and vulnerabilities as well as the adaptation measures required for different sectors, while also highlighting sectoral differences.

6.3.1 Overview of impacts and economic consequences

Climate change has a direct impact on nature, the industries dependent on natural resources, the built environment and human well-being; as such, it will result in advantages and opportunities as well as disadvantages and threats for Finland. There are still considerable uncertainties and information gaps when assessing the potential costs of the impacts and adaptation measures. In general, the vulnerability of the Finnish society to extreme weather events and natural disasters has increased in the past few decades due to the society's increasing sensitivity to disturbances, for instance to wind damage and power outages.

It is estimated that gradual changes, such as the increase in average temperatures, will bring potential benefits to some natural resource sectors, such as agriculture, forestry and outdoor recreation business and tourism. The combined potential benefits for these sectors could be approximately 0.2 per cent of the gross domestic product (GDP). However, the estimate does not include the growing risks, such as the increased risks of damages caused by invasive alien species, pests and diseases. On the other hand, the benefits can only be realised if the sectors adapt themselves to the new conditions. The changes in biodiversity, for instance in the distribution patterns of species and habitats, may have a considerable impact on ecosystem services and also impact the operational preconditions of different sectors.

The water sector will supposedly be most affected by the climate change impacts. The direct costs from heavy rain (10 per cent annual probability) may increase to several million euros, and more infrequent events, such as severe flooding (1 per cent probability or less), may increase costs to EUR 100 million. Furthermore, the indirect economic costs of extreme weather events may be higher than the direct costs. Due to the multiplier effect, the economic impacts within a ten-year period may be double or even more compared to the direct costs.

Storms causing large amounts of damage will present challenges for the general functioning of society as well as for rescue services, as storms may cut down the power supply and communication links. Some of the general changes in society, such as population ageing, will further reinforce the impacts of climate change and require changes in the adaptation measures. In the future, emphasis should be put on risk assessment and management for extreme weather conditions and weather fluctuations.

Table 6.1 summarises the existing information on estimated economic impacts in different sectors. It also shows that fairly little is still known about the economic effects of climate change. When conducting economical assessments, the direct and indirect impacts of global climate change should also be taken into consideration, as they can be more significant than climate change impacts within Finland. The repercussions can be caused for instance

Table 6.1
Sectoral estimates of the economic impacts of climate change in Finland, and a summary of current research from the Finnish perspective (positive economic impact figures denote a net benefit)

Sector	Economic impacts	State of research
Tourism	By 2020, EUR 107 million; by 2050, EUR 107 million; by 2080, EUR 107 million (changes in net value added).	International research, with Finland involved from 2006. Research conducted within Finland in 2005.
Insurance	Weather and climate risks increasing, no overall estimates on economic impacts.	No Finnish research.
Agriculture	• By 2020, EUR 60 million; by 2050, • EUR 100 million; by 2080, EUR 120 million (changes in net value added). • About 0.1 per cent of GDP.	Latest study conducted within Finland in 2005. European PESETA project in 2009.
Forestry	By 2020, EUR 75 million; by 2050, EUR 150 million; by 2080, EUR 250 million (changes in net value added).	Latest figures from 2005, estimates also from the recent VACCIA project.
Biodiversity	No economic estimates. An estimate of EUR 10,000 million regarding negative impacts within Europe.	
Health and welfare	No economic estimates.	No overall estimates, research also scarce on a global level.
Built environment	Costs due to rivers flooding: • in Pori, EUR 40–50, or up to EUR 100 million (for flooding events occurring once every 50 years) • 0.2–0.4 per cent of GDP.	TOLERATE, PESETA, and ClimateCost estimated the impacts of river floods; no overall estimates for the built environment.
Transport and communications	Overall estimates based only on current costs. For example, weather-induced traffic accidents: about EUR 230 million; pedestrian slipping injuries: about EUR 2.4 billion.	The EWENT project and the VTT Technical Research Centre of Finland estimated current costs; there are no Finnish estimates on the overall costs induced by climate change.
Energy sector	By 2020, EUR –37 million; by 2050, EUR –73 million; by 2080 EUR –141 million (changes in net value added).	Latest estimates from 2005.

by trade, migration or global economical crises. Therefore, domestic research should be more closely linked with international research in the future.

6.3.2 National adaptation strategy and the current level of adaptation

Finland's National Strategy for Adaptation to Climate Change was published 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. The main principle of the strategy was that adaptation measures should be integrated into the normal planning and operational work in different sectors. The implementation of indicative measures listed in the adaptation strategy (reported in Finland's Fifth National Communication) has already started in different administrative sectors. Some of the administrative sectors, for instance the Ministry of the Environment and the Ministry of Agriculture and Forestry, have published implementation programmes.

A significant share of the adaptation measures are implemented at the regional and local level. Various measures promoting the provision for climate change, such as flood protection, have already been taken on at the regional or municipal level for quite a long time, though they have not been seen as adaptation measures as such. By the end of 2012, 16 out of 18 regions had published a climate strategy, which included a certain degree of adaptation as well. In 2012, approximately 40 per cent of municipalities were undertaking systematic climate actions and, although their focus has been on climate change mitigation, climate change adaptation has also been promoted. In order to be able to advance effective adaptation measures, local and regional operations should be further promoted.

One essential implementation tool for the national strategy has been the ISTO research programme, which produced comprehensive knowledge on the impacts of climate change and vulnerability in different sectors, thereby laying the foundation for sectoral adaptation measures. The final evaluation of the ISTO programme was published in 2011. The results from the ISTO programme and other adaptation research projects have been compiled into a synthesis report, 'How to adapt to inevitable climate change–Synthesis of Finnish adaptation research in different sectors', which was published in 2012.

The Coordination Group for Adaptation to Climate Change was reappointed in 2012 to monitor and promote the implementation of the adaptation strategy. The tasks of the coordination group also include a broader assessment of the implementation of the adaptation strategy and a revision of the strategy in 2012–2013.

A five-step indicator representing the adaptation level was developed during the mid-term assessment of the adaptation strategy, which was completed in 2009. When defining the adaptation level, the level of knowledge behind the measures and the level of cross-sectoral cooperation are taken into account (Table 6.2).

In Finland, climate change is relatively well recognised in different sectors. It is estimated that the different sectors (see Sections 6.3.3 and 6.3.4) will reach either level 2 or level 3 in the adaptation process (see Table 6.2). The most advanced sector is water management, where adaptation has already been integrated with decision making (level 4). Many of the indicative

Table 6.2
Levels of adaptation to climate change

	Awareness	Knowledge	Adaptation Measures	Cross-sectoral Cooperation
step 1	• Need for adaptation measures recognised among a group of pioneers within the sector	• Little research done on the impacts of or adaptation to climate change	• Some adaptation measures identified but not yet implemented	
step 2	• Need for adaptation measures recognised to some extent within the sector (some decision makers)	• Impacts of climate change known indicatively (qualitative information), taking account of the uncertainty involved in climate change scenarios	• Adaptation measures identified and plans made for their implementation, some of them launched	
step 3	• Need for adaptation measures quite well recognised (majority of decision makers) within the sector	• Impacts of climate change quite well known (quantitative information), taking account of the uncertainty involved in climate change scenarios	• Adaptation measures identified and their implementation launched	• Cross-sectoral cooperation on adaptation measures started
step 4	• Need for adaptation measures widely recognised and accepted within the sector	• Impacts of climate change well known, within the limits of the uncertainty involved in climate change scenarios	• Adaptation incorporated into regular decision-making processes • Implementation of adaptation measures widely launched and their benefits assessed at least to some extent	• Cross-sectoral cooperation on adaptation measures an established practice
step 5	• Adaptation measures (for example those under the Adaptation Strategy) implemented within the sector			

sectoral measures listed in the strategy (see Finland's Fifth National Communication) have already been started, but concrete adaptation measures need to be further enhanced in different sectors.

When evaluating the successes and bottlenecks of the implementation process for the various adaptation measures, the differences between sectors were clearly highlighted: in some sectors, the impacts of climate change can easily be recognised and uncertainties are either small or relatively easy to deal with, meaning that the necessary adaptation measures are easier to define. In general, an understanding of climate change risks has increased due to the more frequent occurrence of extreme weather events and increasing adaptation research promoting the launching of adaptation measures. There is also an identified need for a more thorough analysis in relation to possible synergies and conflicting aspects of climate change adaptation and mitigation objectives in different sectors.

In many cases, the provision measures aimed at increasing climate resiliency in terms of everyday actions also improve the level of preparedness for dealing with extreme weather conditions and weather fluctuation, thus promoting further adaptation measures in the longer run. By developing adaptation measures as an integral part of the existing operations, it is also possible to strengthen the other functions of the sector or organisation. For instance, adaptation measures in water management can improve water quality and/or water protection, while the adaptation measures adopted by rescue services for dealing with storm damage can improve the management system in general.

Although the sectoral approach of the Finnish Adaptation Strategy has facilitated implementation and follow-up in different administrative sectors, it has not yet sufficiently encouraged the launch of cross-sectoral cooperation. In the future, cross-sectoral measures should be better integrated with and promoted as part of adaptation measures.

6.3.3 Climate change impacts on and adaptation measures for nature and natural resources

Biodiversity

Climate change will probably increase the total number of species in the Finnish flora and fauna. Furthermore, considerable changes are likely to occur in the distribution patterns of species and habitats. Some northern habitats and species, such as relict cold-water fish and other reminders of the ice age, may become extinct. Northern boreal species of forests, mires and Arctic mountain habitats are threatened and predicted to decline due to the warming climate.

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. Currently, rare species living at the northernmost extreme of their distribution could become more common. In southern Finland, some invasive 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 in the warming climate. Northern species requiring cold conditions will suffer from the change as habitats suitable for them become rarer. In particular, climate change will threaten the habitats of the fell area (e.g. palsa mires), especially those habitats for which snow or ground frost is an essential factor.

The impacts of climate change on vegetation and forest composition will occur gradually. Under current forest management practices, the amount of decaying wood and forest litter is likely to increase, thus creating suitable habitats for a number of endangered species. However, the growing use of biomass to substitute for fossil fuels may reduce the amount of wood left in forests after harvesting.

Climate change may 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 vulnerable to changes in the climate and their natural habitats.

Rising temperatures and runoff into aquatic environments, and the consequent changes in nutrient loading, may have a profound impact on, for example, phytoplankton and zooplankton, benthic fauna, fish stocks and the number of species in both lakes and marine waters. The spring peak of phytoplankton in lakes will occur earlier and will be considerably more pronounced than it is today. The littoral zone is likely to be more sensitive to the effects of climate change than the pelagic ecosystem.

Water sector

Climate change studies indicate that winter discharges are going to increase significantly, particularly in southern and central Finland. Floods caused by spring snowmelt will decrease, but may remain at their present level in northern Finland. Autumn and winter floods caused by precipitation will increase especially in large lakes and their outflow rivers. Since estimations of climate change impacts include uncertainties at every step of the modelling process, the accumulated total uncertainties are considerable. The large differences between the results from different climate scenarios and assem-

Box 6.1
Pristine peatlands

In southern Finland, raised bogs, mire complexes with an extremely nutrient-poor and acidic ombrotrophic (deposition-fed) centre and minerotrophic (additionally fed by water inputs from the catchment) laggs are an integral part of the boreal landscape. In the north, the raised bog complexes are replaced by aapa mires with characteristic extensive wet minerotrophic centres. The distribution of these two main types of mire complexes depends on climate and roughly follows the 1,100 °C dd (degree days) isocline (sum of growing season daily average temperatures above +5 °C). The range of peatland habitats found within raised bogs and/or aapa mires extends from highly productive spruce swamps in the south to open Sphagnum fuscum dominated bogs and treeless palsa mires with local permafrost in the north. Rates of carbon accumulation vary greatly between peatland types depending on the year. Accumulation is generally faster in ombrotrophic bogs than in minerotrophic fens. In an optimally rainy year, a peatland can sequester carbon dioxide at a rate of up to 3,500 kg per hectare annually, but release the same amount in a dry year.

The estimated summertime warming would increase evapotranspiration and lead to lowered water table (WT) levels in peatlands. Furthermore, the number of exceptionally dry summers is expected to increase. Generally, it has been estimated that the WTs in northern peatlands will decline by 15–20 cm due to the predicted climate warming. Lowered WTs will likely have a greater impact on peatland ecosystems than the warming itself. On the other hand, it is also assumed that precipitation will increase, especially during wintertime. Any consistent changes in climate may be expected to affect the biodiversity, carbon accumulation potential and other ecosystem services provided by peatlands. Some of these changes may be considered positive and some negative from the human perspective.

Warming accompanied with drying would greatly affect the structure and functioning of northern pristine peatlands. Shifts from sedge-dominated fens to Sphagnum-dominated bogs could take place faster than at present in the south. Furthermore, the zone where this transition may take place (raised bog zone) could migrate northwards, while the northern aapa mires would retreat further north. Simultaneously, diversity would decline as fen species adapted to wet conditions would give way to species adapted to drier conditions. Excluding the most nutrient-poor bog sites, this could also mean the spread of shrubs and trees, leading to the replacement of open mires with peatland forests and consequent losses of species requiring open habitats, such as certain butterfly species. In northernmost Lapland, the palsa mires (peat mounds with permafrost) are in danger of thawing with the warming climate.

Switches from minerotrophy to ombrotrophy would, in principle, accelerate carbon sequestration in the peat soil. However, drying will also lead to carbon losses from peat, which will be caused by accelerated decomposition both at the nutrient-rich end and at the most nutrient-poor, inherently treeless end of the habitat gradient. At the moderately nutrient-poor sites, carbon accumulation in the soil may continue after a transient period when the acclimation and/or adaptation to drier conditions takes place; this will be reflected in species changes and an increase in shrubs and/or trees. This will be facilitated by changes in the quantity and quality of litter inputs. Consistent droughts during late summer in particular will enable the development of tree stands, in which case increasing tree biomass will accumulate carbon, to an extent temporarily compensating for the losses from soil at the nutrient-rich sites and increasing total carbon sequestration at poorer sites. The carbon loss from the soils of the most nutrient-poor treeless sites will not be compensated for by any potential changes in vegetation and litter inputs.

The worst scenario from a carbon accumulation standpoint may result from considerable variation in the WTs between years. This would lead to a state of 'consistent disturbance', where productivity and carbon sequestration are low, while carbon would be continually lost from the old deposits. Changes in methane emissions will depend on changes in the WTs and vegetation. Mere warming will likely increase these emissions, while drying and the replacement of sedges by other vegetation types will lead to lowered methane emissions. Overall, 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.

In 2012, the Finnish Government approved a resolution on the sustainable and responsible use of and protection of mires and peatlands (see Section 2.13).

bly modelling highlight the need to use several climate scenarios in climate change impact studies.

Possibilities to adapt to climate change impacts through changes in lake regulations have been studied in Finland. Changing the management strategies and permits for many of the regulated lakes will likely become necessary in the 21st century in response to shifts in the hydrological regime induced by climate change.

Summer rainfall might decrease and, even if it were to stay at the present level, higher temperatures could cause fairly intense and prolonged periods of drought. However, summer floods are also projected to be more frequent and severe due to increased extreme rainfall. Floods and droughts have the potential to be harmful to water quality. Low flows boost concentrations of bacteria, algae and toxins. High flows and intense rainfall increase erosion and the leaching of nutrients from catchments into watercourses and coastal waters.

Approximately sixty flood-prone areas have been identified in Finland. Some forty of them are local sites, e.g. industrial plants, while the others are extensive areas, such as lake surroundings or river basins. It has been estimated that a flood with a return period of 250 years could cause damages of up to EUR 550 million.

One of the most vulnerable flood risk areas is the town of Pori at the mouth of the Kokemäki River in south-western Finland. About 15,000 people live in the flood-prone area. The river is known for harmful winter floods and ice breakup jams. A severe summer flood caused damages worth EUR 22 million in Pori in August 2007. This was the most devastating urban flood event ever observed in Finland.

The Flood Risk Management Act (620/2010) came into force on 30 June 2010 and the Government Decree on Flood Risk Management on 7 July 2010. The Act aims to reduce flood risks, prevent and mitigate the adverse consequences caused by floods, and promote the level of preparedness for floods. Its purpose is also to help coordinate flood risk management and the management of river basins, while taking into account the needs relating to the sustainable use and protection of water resources. Among other things, the Act lays down obligations to perform a preliminary assessment of flood risks, specifies significant flood risk areas and aids in the preparation of flood risk management plans.

Adaptation to climate change will be addressed in the River Basin Management Plans to 2021, based on the EU Water Framework Directive. These plans will be adopted by the Government in 2015. One main challenge to achieving good water quality status in surface waters is the reduction of nutrient pollution. As a result of climate change, runoff will increase, causing erosion processes that result in the transport of larger amounts of soil material rich in nutrients to surface waters, thus contributing to eutrophication. Adaptive measures for improving nutrient management are needed in many sectors, particularly in agriculture. Additionally, better risk management of accidental events such as overflows from waste water treatment plants and better management of storm water are needed.

Approximately two thirds of Finns depend on groundwater for their household water supply. If dry periods become longer in summer in southern Finland, groundwater discharges will be reduced. This may also lead to a shortage of dissolved oxygen and high concentrations of dissolved iron, manganese and metals in the groundwater. The shortage of dissolved oxygen may generate ammonium, organic matter, methane and hydrogen sulphide gases, causing the water to taste bad and smell. In wintertime, increasing precipitation and snowmelt will produce fresh and oxygen-rich groundwater.

Climate change impacts on water services can be substantial. More frequent extreme weather events, such as prolonged droughts, storms, heavy rainfall and floods, may cause problems. Storm blackouts will impede water treatment and conveying efforts at various waterworks and wastewater facilities. Flooding and heavy rainfall can lead to surface water flowing directly into intake wells, jeopardising the water quality or causing wastewater overflow.

Essential adaptation measures in water services include intake wells in groundwater bodies with favourable water yields. Wastewater facilities, especially pumps, should be placed outside groundwater areas and flood risk areas. Important adaptation measures also include precautionary means: drawing up preparedness plans, improving cooperation between waterworks, compiling thorough guidelines on land use and further developing and utilising databases and models.

As to the safety of dams, intense rainfall is estimated to increase considerably in Finland. This would cause problems for dams, particularly along small rivers. Because of increased monthly or seasonal precipitation, together with winter snowmelt, the safety of dams along larger rivers will need to be accounted for. However, major problems seem unlikely in this respect because most dams have quite large spillways.

Box 6.2
The Baltic Sea and its coastal areas

Climate change is expected to bring milder winters to the Baltic Sea, meaning less ice cover, warmer summer temperatures, reduced salinity and slower land uplift in relation to sea level – or even a net rise in sea levels. It is not yet clear how these changes in physical conditions will affect marine ecosystems. The impacts of climate change on the Baltic Sea will have wide-ranging socio-economic consequences in relation to navigation, coastal developments, fisheries, insurance policies and recreational activities connected to the sea.

Both the maximum ice cover extent and the probability of severe ice winters will decrease in the Baltic Sea. Some changes will already be seen within the next few decades. After 2040, severe ice winters will be quite rare. Correspondingly, mild and extremely mild ice winters will increase. The average maximum fast ice thickness in the 2040s will be approximately 30 cm less than for the period 1971–2000.

The sea level is an important issue for future coastal safety. Although the northern parts of the Baltic Sea are characterised by considerable isostatic land uplift, coasts further south are at risk. The combination of storm surges and river floods may be particularly problematic, as shown by the case of Pori on the west coast (a severe summer flood in 2007). The issues that will need to be addressed in the future include what level of coastal protection will be needed, how to cope with severe sea and river flood events and, especially, how much the coastal protection will cost. These issues were covered in detail, e.g. in the Climate Change Adaptation Strategy of the Helsinki Metropolitan Area, which was published in 2012.

Finland is also involved in the transnational climate change adaptation strategy for the Baltic Sea Region, which focuses on the sea and coastline. This project aims to build a bridge between climate change research and policy, thus contributing to an improved institutional capacity.

Agriculture

Climate change is projected to improve crop productivity in Finland if the rise in temperature is moderate. The current main field crops might be cultivated further north and many novel crops that are sown in spring and autumn might be introduced into cultivation due to the longer thermal growing season, higher accumulated temperature sum and milder overwintering conditions. However, possible increases in the variability of climatic conditions within and between seasons, more frequent extreme weather events and increased risks for disease and pest outbreaks might increase the risks and cause more uncertainties for agricultural production. The risk of animal diseases may also increase, although it is also expected to remain relatively low in the future. Diseases associated with the poor quality of water may become more common. The increased amount of rainfall might increase the leaching of insecticides and herbicides as well as fertilizers into the water systems. All of these possible changes call for early and powerful adaptation measures to reduce risks induced by climate so that society can benefit from the opportunities.

Due to the highly variable weather conditions typical for high latitudes and the fact that agriculture is always dependent on the ambient weather conditions, farmers in general are well aware of the changes and of the fact that there will likely be more changes in the growing conditions in the future. But they are also ready to react by adopting cultivars as well as cultivation methods and systems that will likely reduce the production risks and increase the resilience of agricultural systems. The existing networks in place for farmers, farmers' associations and training help improve the exchange of knowledge about the means for adapting to climate change and variability. Existing agricultural research has been well designed to support the development of practical adaptation means, and so the step from research to practice has been a relatively easy one. Thereby, research on climate change impacts and the adaptation means available has already provided useful information for farmers and agricultural entrepreneurs.

The recent adaptation measures include risk profiles and emergency plans for various existing and emerging pests and diseases. The climate-related risk assessment has been strengthened by efforts from the Finnish Food Safety Authority Evira, and new projects on the risks caused by plant pests and diseases have been launched. Even though the main drivers for the risk assessment have been the pest and disease risks caused by increasing international trade, the impacts of climate change are also included when relevant. Finnish plant breeding has expanded the breeding strategies to cover novel crops that will most likely be introduced to diversify Finnish crop rotations in the future. Improved disease resistance through plant breeding is an important element in improving Finland's adaptive capacity in the future.

Other essential adaptation means include sustaining the soil structure and conditions by, for example, diversifying crop rotations and favouring crops that provide soil cover for winters that are projected to get wetter; developing sufficient warning systems for the occurrence of pest and disease epidemics; developing year-round water management systems to increase nutrient use efficiency and reduce drought-induced yield variability, especially for environmentally vulnerable regions; and targeting sustainably intensified agricultural systems, e.g. by having sufficient and timely adaptation measures.

Fisheries and game

Climate change and the variables related to it (summer and winter temperatures, ice cover, windiness, salinity and eutrophication) affect the fish populations and catches. The fish react to fairly small and early changes in the temperatures by changing their behaviour, their reproduction patterns, their nutrient intake, their migration patterns and their locations. If the changes are large enough, there may also be changes in the growth of fish populations and in their communities and even in survival, mortality and distribution.

Climate warming might increase the growth rate of some of the Finnish fish species. Fish species that require cold water, including most of the threatened fish species, will suffer from warming. It is also estimated that climate change will increase the 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. Warm winters together with eutrophication will decrease the catches of burbot and whitefish.

The economic value of fish resources available for commercial fishing is estimated to decrease. In winter, a shorter ice period and thinner ice will favour the most important type of commercial fishing: trawling. It will also favour the wintertime seine catching of vendace as well as coastal net fishing. However, the warming of waters favours the appearance of fish diseases and parasites and it will also increase the risks of invasive alien species and their parasites or diseases. Conducting follow-ups and preventing the spread of invasive alien species are important adapting measures in fisheries and game management.

Predicting the impacts of climate change on fish populations for a longer period of time involves significant uncertainties. Because the annual variation in fish populations may be considerable (for example, the variation in the vendace stocks), it is difficult to distinguish between the effects of climate change and other environmental changes. For this reason, long-time follow-ups and further studies are needed.

Game species, just like other animals, have also adapted themselves to variations in both the climate and the environment. Due to climate warming, it is assumed that as the vegetation zones move to the north, the distribution of species that have, over the course of time, become adapted to these conditions will also shift in this direction. In Northern Europe, the species of the Arctic and Siberian fauna are expected to withdraw to the north and east, while the southern European species will move further north.

Moose, the most important game species in Finland, may first benefit from a warmer climate due to an increase in food supply. On the other hand, the heat physiology of the moose is not adapted to a temperate climate. For some game species that change their fur or the colour of their feathers according to the season, the shortened period of snow cover might lead to increased exposure to predatory species. The game stocks may also be severely affected by invasive alien species as well as vector-borne diseases.

Closely monitored follow-ups and accurate game statistics will also provide the basis for sustainable game management and hunting in the future.

Forestry

Towards the end of this century, climate change is expected to increase significantly both the growth and production of Finnish forests, as well as carbon sequestration and carbon stocks in the tree biomass. The growth increase will be larger in the north. Increased tree litter inputs will lead to increased carbon sequestration in the forest soils as well. However, lowered soil water levels caused by increased evapotranspiration may, together with increased temperatures, lead to increased carbon losses from nitrogen-rich organic forest soils. With respect to the main tree species, especially birch (*Betula pendula*, *Betula pubescens*), it is expected to increase its share of the growing stock if its presence is not actively controlled via forest management. In contrast, Norway spruce (*Picea abies*) is expected to suffer from drought in southern Finland on sites with low water-holding capacity. In southern Finland, the natural regeneration of forests may become more difficult due to increased competition from ground vegetation. Drought episodes in early summer can be harmful for the germination of tree seeds, especially in the south.

The risks to forests caused by strong winds are expected to increase in the future because the period of time during which the soil is frozen will be shorter, thus decreasing tree stability from late autumn to early spring, the windiest period of the year. Newly created forest edges and recently thinned stands are the most vulnerable to wind- and snow-induced damage. The risk of wind damage is, on average, strongest among older Norway spruce stands, while young birch and Scots pine stands are the most vulnerable to snow damage. The risk of snow damage to trees could decrease in southern and central Finland since a smaller share of the wintertime precipitation is predicted to fall as snow. This will be the case if westerly winds predominate. Eastern winds can, on the other hand, also result in quite heavy snowfall in the south. This has happened in the last few years. Shorter periods of time during which the soil is frozen may hamper winter harvesting and increase the need for summertime harvesting. Harvesting during periods when the soil is not frozen will increase the risks of root damage and attacks by fungal pathogens, e.g. Heterobasidion. Furthermore, the risk of forest fires may also increase in the future, especially in southern Finland, due to an increase in drought episodes.

Forest damage caused by numerous pest insects and pathogenic fungi will likely increase significantly due to rising temperatures and changes in the amount of precipitation. Among the current forest pests, root-rot (*Heterobasidion annosum*), various leaf and stem pathogenic fungi, bark beetles (*Ips typographus*) and sawflies (*Neodiprion spp.*) are of particular interest, as are voles, moose and deer, since the changing environment may affect their population size. In addition, new pests may appear in the form of invasive species from the south, or previously harmless species may become harmful in conditions where natural resistance has not evolved or no predators exist.

The diversity of forest ecosystems and the distribution areas of species may change as a result of the changing climate. Even entire vegetation zones may move northwards. Such changes may strengthen as a result of increased mineralisation, which can increase soil fertility. The timberline is expected to move slowly further north, with the two most important coniferous trees in economic terms, the Scots and Norway spruce, being in the front line of such a change. The changing tree limit will not be even because the quality of the soil and bedrock can restrict the migration. New species may become established in open areas either after a natural disturbance or after clearcutting and soil preparation. The fastest invaders are species that produce a lot of seeds or spores. After intensive forest management and energy wood harvesting, the fertility of the soil may decrease, which will favour species that thrive in poor soils. This may cause changes at different trophy levels, thereby affecting the abundance of species dependent on the current vegetation.

By the appropriate and gradual adaption of forest management practices and the sustainable use of forest resources, it will be possible to gain from the positive effects and decrease the negative effects of climate change. In terms of forest regeneration, the site-specific selection of species and regeneration methods should be applied. In southern Finland, the cultivation of Norway spruce should be avoided on dry sites. On the other hand, the natural regeneration of Scots pine may become successful even in the north.

Box 6.3
Climate change in Finnish Lapland

Some 24 per cent of Finland's area is located north of the Arctic Circle. The northernmost province, Lapland, covers almost one third of Finland, but the population is only 183,000.

The Sámi people living in Finnish Lapland are Europe's northernmost indigenous people. Nowadays, there are approximately 9,000 Sámi in Finland. However, more than half of them live outside the traditional Sámi areas, all of which are located in the province of Lapland.

The service sector employs 73 per cent of the work force in Lapland, while industry employs 20 per cent and primary production around 6 per cent of the work force. Reindeer husbandry is still an essential activity for the European Arctic regions from both an economic and cultural standpoint. It is particularly important for indigenous communities. Finnish Lapland counts nowadays some 200,000 reindeers, owned by approximately 5,000 herders. Not all of these herders are indigenous Sámi.

The projected climate change for Lapland indicates a particularly significant warming trend, and a considerable increase in precipitation. The shortening of the snow season has become quite evident in recent years, threatening in particular the important Christmas tourist 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.

The impacts of climate change on reindeer populations are expected to be mainly unfavourable. If winters become milder and precipitation increases, the snow may become 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 would increase. The northward advance of the tree line and gradual replacement of lichens with vascular plants may also affect reindeer pastures. Particular habitats may also be lost as a consequence of increasing temperatures and precipitation. Under current projections, there is a high probability that the unique palsa mire habitats will be completely lost by the end of this century.

Almost forty per cent of Finland's hydropower is generated in Lapland. Increased precipitation and more even discharges will be beneficial for hydropower production. Some additional capacity has already been built alongside existing hydropower plants.

Finland's Strategy for the Arctic Region was released in June 2010 and it will be updated in 2014. In October 2012, the Government put in place four spearheads for updating the strategy: namely, Finland is an Arctic country, Finland has Arctic know-how, Finland respects the principles of sustainable development and International co-operation. These are more thoroughly processed through four thematic approaches: education and research; developing business opportunities; environment and comprehensive security; and international co-operation. Finland is also a member of the Arctic Council and the Barents Euro-Arctic Council (see Section 8.1.2). The economic development of the Arctic region and the possible growth in possibilities for navigation via the Northern Sea Route can have considerable economic, social and ecological impacts in Lapland.

Timely and proper management of young stands is needed to maintain the vitality, resistance and health of forests and the resistance of trees to wind- and snow-induced damage. In addition to forest management and climate change, the changes in the tree species proportions and the age structure of forests will affect these risks regionally. Due to the increasing forest growth rate, more frequent and/or heavier thinnings should be applied, which will also make it possible to shorten the rotation length accordingly. In addition to such measures, sophisticated systems for monitoring forest resources and damages at various scales are also needed.

No comprehensive, detailed assessment has yet been made of the economic implications of climate change, nor of the potential costs of the various adaptation measures needed in Finnish forests and forestry. In general, both the implications and the costs are influenced by national and international forest policies and global markets. An important issue in the future may be how to weigh the different conflicting interests in forest management and forestry against one another, which will be crucial for the sustainable management and use of forest resources. A greater use of forest resources is likely in the future, since in Finland a general agreement has been reached to increase the use of renewable, mainly wood-based energy by 2020. Forests or forestry products offer significant possibilities for using carbon storage to control the net emissions of CO_2, in addition to increasing the use of the forest biomass in energy production.

6.3.4 Climate change impacts on and adaptation measures for different sectors of the economy and infrastructure, including human health

Energy

Climate change affects both the supply of and demand for energy. Increased precipitation rates should increase the production of hydropower, which currently covers about one fifth of total electricity generation (see Section 2.6). The impact of climate change on wind power potential is expected to be favourable, but the estimates are quite uncertain and vary from practically no impact to an approximately 10–15 per cent production increase depending on the location. The longer growing period is expected to contribute to increasing the production of wood-based fuels. However, because renewable energy sources are more exposed to extreme weather conditions, the growing share of renewable energy may increase the need to secure a supply of fuel and backup power capacity. In terms of the exploitation of fossil fuel and nuclear energy resources, climate change will only have minor direct impacts.

The demand for energy is expected to decrease in the wintertime as less heating will be needed and increase in the summertime due to the growing need for cooling. This may benefit consumers in the longer term through a decrease in energy consumption. Warming will affect the temperature of cooling water, reducing the efficiency of condensing power plants. The maintenance costs of the energy network may rise due to the extreme weather conditions.The design of the new nuclear power plant units take into account the changing circustamces and the units in operation are undergoing modifications.

In the energy sector, adaptation measures have already been launched. The severe winter and summer storms that have caused extensive and long-lasting power outages in the last few years have brought the operational security of the power supply networks into public discussions. Regulations aimed at improving the security of the energy supply in network fault situations, especially in sparsely populated areas, have recently been included in the revised version of the electricity market legislation. According to the new Electricity Market Act, the distribution network must be designed, built and maintained in such a way that if the network would be damaged due to a storm or snow, the electricity interruption for the customers must not exceed 6 hours in detailed planned areas and 36 hours in other areas. These time limits must be met gradually in a 15 years time period and fully by the end of the year 2028. In addition, the Electricity Market Act includes other measures to improve the electricity network security of supply, for example, a requirement for co-operation between the network companies in interruption situations. The distribution network companies must also prepare a development plan for the network including measures on how to fulfil the 6 and 36 hour time limits for network security of supply. In order to meet the time limits of 6 and 36 hours, a significant increase to the average underground cabling degree of the Finnish electricity distribution networks is needed. The estimated total investments in distribution networks due to the new reguirements are EUR 3,500 million. The Highways Act will be amended to improve the security of the electricity supply, making it easier to install power cables along roadsides. In terms of hydropower plant investments, new turbines have been scaled to better meet the expected changes in water flow conditions.

The National Energy and Climate Strategy (2013) presents various means for improving small-scale electricity production and developing the power system. Provided that a power system is capable of operating in island mode, decentralised power production can improve the reliability of electricity deliveries by dividing the system into regional networks and securing the local power distribution in the cases of, for instance, large storm damages. This is, however, not the case in Finland today, even though the development and introduction of smart-grid technology is common among the network companies. An intelligent electricity network would speed up the repair of storm damages by allowing for automatic fault localisation and isolation, thus minimising the number of customers experiencing long power outages.

Land-use planning and building

In the land use and building sectors, the impacts of climate change are quite well known and the need for adaptation measures is commonly acknowledged. The expected changes in precipitation, wind velocity and temperature constitute a challenge for the construction sector. These stress factors are already having an impact on construction, because buildings have a long lifecycle.

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 related to flooding will create challenges for land-use planning, especially in the vicinity of rivers and lakes, in coastal areas and in 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.

The current legislation on building and other statutes include requirements for taking climate change into consideration. In terms of measures involving new construction, climate change and adaptation will be taken into consideration already during the planning stage. This will also be done through planning guidance. Local conditions that may affect construction are increasingly being taken into account through existing instruments, such as building ordinances and municipal instructions for building. The use of specific local, regional and municipal guidance instruments should be further reinforced.

The most significant measure regarding land use and building was the Government Decision of 13 November 2008 on revising the national land use guidelines. Addressing the challenges posed by climate change was a key theme for the revision, and the new guidelines include, for example, the need to follow objectives concerning adaptations to climate change: in land-use planning, new construction should not be located in areas that are prone to flooding. An exception can only be made if need and impact studies indicate that the risks of flooding can be controlled and that the construction work is in line with sustainable development. Local master planning and detailed planning should take account of the increasing possibility of storms, heavy rainfall and flooding in built areas. The preservation of ecological corridors between protection areas is to be promoted and, where necessary, these areas and other valuable natural areas should also be protected.

The Flood Risk Management Act and the Government Decree on Flood Risk Management regulate flood risk management and the management of river basins, while taking into account the needs relating to sustainable use and the protection of water resources. The Centres for Economic Development, Transport and the Environment bear the main responsibility for the planning of flood risk area management in river basins and coastal areas. Municipalities are responsible for planning how to manage floods in urban areas caused by heavy rainfall. According to the Act, the Finnish Environment Institute will ensure that information on significant flood risk areas, flood hazard maps and flood risk maps, and approved flood risk management plans are made available to the public via information networks.

An examination of possible sea level rising along the shores of the Baltic Sea (coastal flooding) is in progress. On the basis of the results, the guide for the minimum permissible building heights will be renewed this year. The guide will contain recommendations for determining the minimum permissible building height with respect to floods for inland shores and the shores of the Baltic Sea.

Industry and commerce

The Finnish industry is quite energy intensive and the need to mitigate climate change has been more the subject of focus in the industry sector than the need to adapt to it. The need for risk management due to weather variability and extreme weather conditions has been obvious within some weather sensitive branches. So far, it has not been assumed that climate change will bring significant changes to most of the industrial operations, and therefore, adaptation measures have followed the perceived changes so far.

Though many of the industrial processes are considered to be independent of weather and climate changes, they may include stages requiring more precise heat and moisture conditions. In the industrial areas, it is important to be prepared for the risks related especially to heavy rains and floods in cases where, for instance, environmentally harmful substances are stored and used or when process and waste sewers are located in a flood-sensitive area. In the building industry, the risks of strong winds and/or very cold or hot periods should be considered in terms of the workers' health and safety. The industry is very dependent on the electricity supply, and therefore, extreme weather conditions causing long-term power failures will generate a particular weather risk.

The demand for many products and services is weather dependent, and therefore, climate change impacts should be taken into consideration in terms of long-term investments and strategic planning. Changes in the demand are obvious in some branches of the food industry, for instance in the consumption of beverages, ice cream or barbeque products related to hot weather in the summertime. In wintertime, the sales of winter sports equipment and clothing depend on the early winter weather.

The direct and indirect changes in the global markets have an impact on Finland and Finnish companies. For instance, within the food industry significant crop damages in the large global production areas may impact the markets and price of the commodities. Disruptions in logistics may impact the processing, distribution and sales of products.

Some studies on climate change adaptation have been done for the industry sector. They find that climate change may bring opportunities for the industry sector as well. For instance, new products, processes, technologies and know-how related to adaptation can be exploited as part of CleanTech and other business opportunities. However, the need to identify and possibly promote these opportunities has just recently been introduced into wider discussion.

Mining

In 2011, a total of 52 mines and quarries were operating in Finland. The excavation of metallic ore deposits has increased mainly due to a high demand for metals. The yearly volume of mining in 2010–2011 was more than three times the volumes of the early 2000s and the mining volumes are projected to increase four- to fivefold over the 2010–2011 level by 2020.

Climate change affects mining in several ways. For example, mining can be sensitive to weather events. In particular, open pit mining, which requires large spaces of land, can be severely affected by severe weather events, as shown by a number of incidents. The risk of tailing dams failing due to excessive precipitation calls for rigorous risk analysis using a broad spectrum of climate scenarios and sophisticated risk management. The Finnish mining industry is being subject to 'stress tests' to reduce the risk of the types of adverse environmental consequences that climate change can aggravate.

Another aspect is the potential effect on transport and the transport infrastructure. The mining industry is dependent on moving huge amounts of material, and climate change can affect the logistics of these operations.

Transport and communications

Climate change is expected to impact all facets of the transport system: the infrastructure, means of transport and operations. Changes in the soil frost, reductions in the total snow depth, an increase in the amount of precipitation and heavy precipitation events (both water and snow), an increase in soil wetness and floods, changes in vegetation, episodes of soil drying during summertime, extreme storms causing falling timber, and so forth, will all impact road maintenance and the transport infrastructure.

Some of the major impacts are as follows:

- More frequent warm and wet periods, which will increase wear and rutting
- The number of freeze-thaw cycles degrading road surfaces may increase during the coming decades; however, in the latter part of the 21st century they are expected to decrease, except in northern Finland
- Increased snow clearing capacity may be needed if heavy snowfall events become more frequent; however, total annual snow clearance work is expected to decrease in southern Finland in the coming decades, and later on in central and northern Finland
- The need for clearing ice on roads is expected to increase in central and northern Finland
- Groundwater levels will rise due to precipitation increase, leading to a reduction in the carrying capacity of low-level roads, especially during autumn and early winter
- The springtime frost-heave period will take place earlier
- The depth of the ground frost will decrease

Heavy rainfall events cause roads and underpasses to become inundated; they also cause collapses, erosion and the degradation of bridges and culverts, especially along low-volume local roads. In Finland, one of the most relevant losses due to the warming climate is a reduction in the duration of frozen soil, which can support the heavy tracked vehicles and machinery used in, e.g. transportation, by the forest industry.

Climate change and extreme weather as such do not pose any unmanageable risks, but climate change and the combination of a lower level of maintenance and infrastructure repair of roads constitute a real risk for the serviceability of roads. Another risk is associated with contracts between road and street infrastructure owners and maintenance contractors: extreme events requiring additional maintenance efforts pose in practice an unmanageable contract risk that is difficult to price and/or share.

Envisaged actions that will enhance the adaptive capacity of society during the coming decades include developing warning systems and providing information, improving rescue planning, developing maintenance operations and improving structures.

The contracts between maintenance service providers and road and street infrastructure managers should be developed in a manner that enables more flexible extreme weather risk management.

Railway transport is affected by rising temperatures, increasing precipitation, changes in freeze-thaw cycles and snowfall. An increase in the frequency or intensity of strong winds or lightning could significantly impact rail transport. The railway network in Finland is vulnerable, for instance, to frost-heave damage, blizzards and low temperatures as well as to lightning damage to traffic. The vulnerability of railways may also increase if maintenance and repair work efforts are undersized.

Actions to increase the adaptive capacity of the railways include the development of warning systems jointly with weather information providers and other transport operators, improving rescue services and safety information, strengthening the rail structures, improving protection against weather, updating monitoring guidance and maintaining the infrastructure.

Phenomena relevant to marine and inland water transport include strong winds, high waves, heavy snowfall, temperature increases, ice cover, lightning, extremely high/low sea/water levels and floods. All in all, approximately forty potential hazards have been identified that are connected to these weather-related phenomena. Most of them are related to fairway maintenance, charting, traffic control and wintertime seafaring in general.

Climate warming will reduce the amount of ice in the Baltic Sea. However, the amount of ice-breaking assistance for ships also depends on wind conditions. The adaptation actions include, for example, improving the safety equipment, changing the design and procurement practices, and developing information services.

When it comes to weather-related boating accidents on sea and lakes, developing weather information and providing access to it will be a relevant and cost-effective way of increasing safety and saving lives. Similarly, the training of leisure boat users is expected to have rapid, positive impacts.

Most pedestrian accidents take place during wintertime due to slippery conditions. Both for pedestrians and cyclists, the most hazard-prone conditions develop when an icy surface is covered with a thin layer of snow or water. It is estimated that the weather conditions causing slippery conditions may become more frequent in some parts of the country within a short period of time. The development of pavement and property maintenance as well as pedestrian weather services are considered effective measures for limiting the number of slipping and falling accidents. A reduction in accidents could result in large savings for society.

Air traffic will suffer from heavy storms and lightning. The maintenance costs at airports and the use of de-icing chemicals may increase in midwinter.

In telecommunications, the networks that rely on aerial cables may be especially vulnerable to storms and icy rain. The same applies to the automatic safety systems for different modes of transport. These systems can also be damaged by flooding. Ice and wind loads on telecommunications masts may become heavier.

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 dependence on nature and seasonal variation make tourism and recreational activities vulnerable to climate change.

Snow-based activities such as cross-country skiing, alpine skiing, riding snowmobiles and ice fishing are vulnerable to climate change. The vulnerability of cross-country skiing is strongest in southern and western Finland, particularly in the coastal regions. However, at least in the near future, ski resorts in the north may benefit from relatively good snow conditions compared to ski resorts in Europe or southern Finland. An awareness of climate change and the capacity to adapt to it are improving among tourism enterprises, but there are still a lot of regional differences. The type of tourism and its economic importance in the region, the image of tourism and the social and community characteristics of the region define how vulnerable to climate change the region is as a tourism destination.

A warmer and longer summer season would improve the conditions for summer sports and many water-based recreational activities (e.g. boating, swimming and fishing). On the other hand, algal blooms in warmer waters, increased amounts of summer precipitation or extreme weather events may lower the attraction of such activities in summertime.

Insurance

Climate change will affect insurance companies directly in three different ways: through claims, through their investments and through the terms of trade of reinsurance.

Climate change is likely to increase the damage caused by extreme weather, thus indemnities for damages are expected to increase in the future. In addition, insurance companies will face higher levels of uncertainty in their risk estimates, and as a result, they may have to pay higher amounts in damages than anticipated. These changes may be reflected in the insurance premiums and available coverage.

Forests are insured by private insurance companies in Finland. Only about a third of forest owners have insurance against forest damage. On average, some 60-70 per cent of annual compensation in forest insurance is paid for storm damage, thus the annual compensation is highly dependent on the storm activity during the year in question. In December 2011, the Boxing Day storm alone led to compensations totalling nearly EUR 30 million.

Home and property insurance policies in Finland have not traditionally covered damage caused by heavy rainfall or floods. However, if the flooding of a particular river or lake is considered exceptional, it has been possible to date to obtain compensation from the Government. However, the Government has decided to withdraw this insurance programme at the end of 2013. The risk of flood damages will then be carried by the property owner, which will create opportunities for the insurance companies to develop new insurance products. Some insurance companies already offer insurance policies against flood damages that are caused by exceptionally severe weather events.

Weather and climate risks are usually systematic, which means that a large number of claimants are exposed to adverse weather conditions at the same time. The correlation of various weather risks has been studied in Finland regarding crop damages, and the correlation between damages has been found to be high even over long distances. This kind of systematic damage is problematic for insurance companies, and Government compensation schemes are usually validated with this reason. The Government compensates crop damages caused by adverse weather conditions if the damages exceed 30 per cent of the value of a normal harvest. The budgeted amount is EUR 3.4 million per year, but the limit has been exceeded regularly. However, the role of Government as an underwriter is problematic: for political reasons, its ability to aggregate and segregate risks is limited. Thus, the availability of compensation schemes offered by the Government is expected to decrease in the future.

Insurance companies can also buy reinsurance to secure their solvency against systematic risk. The price of reinsurance is expected to increase in the future, which will make it more expensive for insurance companies to protect themselves against large losses. Reinsurers have already started to include the increased risks caused by extreme weather in the premiums they charge insurance companies.

Most of the money inflow to the insurance companies is invested onwards in the capital markets. Climate change will affect many sectors in the future, and thus it will affect the return on the investment as well. When considering the full portfolio of an insurance company, the correlation between claims and a return on investment should not be high so as to avoid situations that threaten solvency. The impact of climate change on the investment portfolio is less evident and has not been studied thoroughly yet.

The insurance sector can also adapt to climate change. In order to be able to insure people against weather and climate-based risks, insurance companies must be able to estimate the risk levels, understand the systematic aspects of the weather and climate risks, be active in mitigating damages through their customers (i.e. by use of deductibles) and diversify risks more effectively. Apart from the threats, climate change may create new business opportunities for insurance companies as well, such as new insurance products, loss prevention technologies, advisory services and risk-management products. Insurance companies can be an important part of the adaptation process by creating new products and innovations that will help society mitigate the adverse effects of climate change.

Most insurance companies are still operating at a low adaptation level; only limited adaptive actions have been taken, sometimes they have even gone against economic objectives, and the majority of research into the economic effects of climate change has been done outside the sector. Interviews with insurance companies in the Nordic countries regarding their climate change adaptation actions revealed that in Finland, environmental issues and climate change had not yet been faced to the same degree as in other Nordic countries.

Health

The increased intensity and frequency of extreme weather events may place additional pressure on the health sector, particularly as the population ages. In Finland, high temperatures will clearly increase heat-related mortality and morbidity in the summertime, when the daily average temperature exceeds +20°C. For example, more than 400 extra deaths occurred during a heat wave in the summer of 2010. The number of days with heat stress will increase both in outdoor and indoor work environments and this will result in the need to revise the instructions regarding work-rest cycles among high-risk groups in the working age population. Also, the thermal control of the built working environment will need to be modified. Among outdoor workers, the need for protection against UV radiation will increase.

During milder winters, the risk of additional mortality from cardiovascular and pulmonary diseases will likely decrease. On the other hand, darker winters, caused by a shorter snow cover period, increased precipitation and cloudiness, may increase cases of winter blues or seasonal affective disorder and their subsequent medical conditions. This means that the lighting control of the built environment should be modified as appropriate. 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. Thinner ice and the shorter duration of ice cover on waterways will be a safety risk. Because of the large degree of climate variability, especially during the wintertime, it is important to be prepared also for cold spells and their adverse health impacts.

Warming might contribute to the northward spread of ticks and tick-borne diseases, such as Lyme disease (borreliosis) and tick-borne encephalitis, but many other factors (social and societal) besides the climate will affect endemicity. A warmer climate would stabilise 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 the density of medium-sized predators (red fox, raccoon dog) could increase the risk of rabies and the chances of alveolar echinococcosis spreading to Finland.

Climate change would gradually influence the plant species and the amount of pollen, and therefore also the number of pollen allergies. While increased exposure to allergens may cause more severe symptoms for sensitive persons, the number of people suffering from pollen allergies is not expected to increase. The risk of forest fires and the possibility of being exposed to fine particle will gradually increase, and thus adverse health impacts will also increase.

Floods may also induce health risks, particularly through contamination of the water supply.

The Ministry of Social Affairs and Heath recently produced a handbook on exceptional situations related to environmental health for environmental health care staff and their cooperation partners, which also includes information about weather and climate-related events. The Finnish Meteorological Institute has been issuing heat-wave and cold-spell warnings since 2011.

Cultural environment

Wooden buildings are typical in Finland and, as wood is sensitive to changes in humidity, measures will be required to control decay. The old town in Rauma and the Petäjävesi wooden church, which are on the UNESCO World Heritage List, are representative of traditional Nordic wooden architecture.

Extreme weather events, such as storms and flooding, will have an impact, for example, on the Suomenlinna Sea Fortress, which is also included on the World Heritage List.

Cultural landscapes and semi-natural habitats will be affected as a result of changes in the biodiversity and in the distribution of species.

Adaptation to climate change may lead to an increased need for safety repairs at restoration and conservation sites. Climate and energy policies, such as increasing the use of renewable energy sources, and energy-saving goals, such as improving the energy efficiency of buildings, may also have significant effects on the cultural environment. It is especially important to develop renovation technologies and methods for modern buildings built since the 1950s in order to avoid health problems and damage to the historical value of the buildings as a result of unsuitable technical solutions.

6.3.5 *Disaster prevention and management*

The standard of security in daily life is in general good in Finland. Only in very rare cases have natural disasters caused serious problems for Finns. However, the growing frequency of storms and extreme weather events will create challenges for rescue services. Storms causing extensive damage to land areas are a major threat because they may disrupt heating, the electricity supply and communications. The ageing of the population and the migration to urban centres, while at the same larger areas remain sparsely populated, need to be taken into account, for example in master planning and other planning.

The Government Resolution of 16 December 2010 on the Security Strategy for Society sets the foundation for preparedness and crisis management for all actors. The strategy defines the operations vital to society and outlines the threat scenarios and disturbances that jeopardize these operations, the strategic tasks of the ministries for securing and guaranteeing that the operations will continue, the criteria for crisis management, implementation tasks and the principles of the exercises. Business actors, NGOs, municipalities and regional government authorities and security research all have a significant role in ensuring the preparedness of society and managing disturbances. The Security Strategy for Society is supplemented and followed up by other strategies and guidance documents relating to preparedness and management of disturbances; these documents have been prepared by the various administrative sectors. Preparation for natural disasters like floods will take place through preparedness planning, exercises, surveillance, information exchange and other cooperation practices and situation descriptions and reports as well as by implementing, for example, the necessary flood protection measures at critical sites.

The purpose of the Act on Security of Supply (1390/1992) is to maintain the basic economic functions required for ensuring people's livelihood, economic life and national defence and the related technical and material preconditions in the event of serious disruptions and emergencies. Preparing for threats to a networked society calls for both material preparedness and securing the continuation of the functioning organisations that are critical for the security of that particular society. In this work, extensive cooperation among companies, public authorities and sectoral organisations is vital.

The Finnish Meteorological Institute has diversified the weather-related warning services for citizens. Besides the traditional storm, wind and forest fire warnings and traffic weather (warnings on poor road conditions) reports, there are now wave and sea level warnings for marine areas. Since 2011, there have been warnings for heat waves and severe cold spells. Weather warnings are given 24 hours before the start of the expected event and early warnings 2–5 days before that. Warnings are also forwarded to other authorities through risk bulletins, while the emergency response centres forward almost real-time information on damages caused by weather events to the round-the-clock weather service of the Finnish Meteorological Institute.

The early warning system for floods coordinated by the Finnish Environment Institute produces forecasts for water bodies and issues flood warnings. The hydrological watershed model system also produces precipitation warnings for water areas and snow load warnings for rooftops. The Finnish Meteorological Institute and the Finnish Environment Institute also forward weather and hydrological warnings to the authorities through a natural disaster warning system (LUOVA). LUOVA is part of the situation report system of the Government and security authorities and was developed as part of the second Internal Security Programme adopted by the Government and the Strategy for Securing the Functions Vital to Society.

Fire and rescue services have been pioneers in climate change adaptation. Practices such as preparedness planning and exercises relating to various extreme weather events have been reinforced. Adaptation has coincided with the changes in preparedness planning, where the focus has shifted from major national crises to solving more everyday crises.

The climate risks and uncertainties are growing, but new solutions are being developed all the time. However, now that extreme weather events are growing in number and society is becoming more vulnerable, the security skills of private citizens should be much better than they are at present. It seems that the trend is the exact opposite: more and more people are 'neohelpless', i.e. their security skills are deteriorating and risk taking is on the increase.

6.4 Global impacts of climate change and international co-operation

Changes taking place in other parts of the world will create a need for adaptation in Finland, too. As outlined in Finland's Fifth National Communication, a study to review the implications of international climate change for Finland (IMPLIFIN) concluded 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. According to a recent synthesis report (How to adapt to inevitable climate change – A synthesis of Finnish research on adaptation in different sectors), the impacts of climate change elsewhere in the world will have implications for Finland through, for example, international trade. Climate change can also contribute to conflicts and migration in developing countries – climate change is considered a threat multiplier. Furthermore, international climate policy and especially EU regulations will have implications for Finnish policy making.

In order to support the most vulnerable developing countries in particular, Finland has integrated climate change concerns with development cooperation (see also Chapter 7). The Finnish development policy guidelines for the environment, which was approved in 2009, already noted that climate change mitigation and adaptation should be addressed in all of the most important sectors of Finnish development cooperation. Furthermore, it was decided to work proactively to reduce natural disasters resulting from climate change through the Hyogo Framework for Action.

In the latest Development Policy Programme (2012), climate sustainability is one of the cross-cutting objectives of Finland's development policy and development cooperation. The need to integrate the cross-cutting objectives with all development cooperation activities is a binding obligation. In addition, the sustainable management of natural resources and environmental protection is one of the priority areas under which climate-change-related support is outlined more broadly. The Development Policy Programme states that the impacts of development cooperation on the climate must be assessed comprehensively ex ante, with the aim being to combat climate change and its adverse effects on development. In its own development cooperation, Finland aims to achieve carbon neutrality as soon as possible. Finland promotes low carbon development and the capacity of its partner countries to adapt to climate change, and it seeks to further the integration of these goals within its partner countries' own development planning. Particular attention will be paid to the roles of women, children and indigenous peoples in adapting to and in combating climate change.

Moreover, the human and economic losses caused by natural disasters are a major obstacle to development. Finland supports long-term measures that reduce the vulnerability of people and communities to natural disasters. Strengthening the capacity of developing countries' own administrations to prepare for natural disasters and investing in disaster risk reduction measures is a necessity. Finland has adopted a climate sustainability tool for assessing and preventing climate change and the risks posed by natural disasters that are caused by climate change. Furthermore, the new project manual for development cooperation includes a disaster risk reduction tool.

Finland has supported the United Nations Office for Disaster Risk Reduction (UNISDR) since 2004. During the period 2008–2010, Finland's support for UNISDR was EUR 0.3 million per year and in 2011 it was EUR 0.6 million. In 2011, a decision was made to raise the level of support, and at present the support level is at EUR 1 million per year (2012–2013). Finland has also participated as an observer in the World Bank Consultative Group of the Global Facility for Disaster Reduction.

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7 Financial resources and transfer of technology

Finland as a developed country Party provides new and additional financial resources to meet the needs of developing country Parties and thus is complying with Article 4.3 of the Climate Convention. This chapter provides information on Finnish financial contributions to international climate-change-related funds and its bilateral and multilateral assistance to developing country Parties. It includes information on activities and programmes under Articles 10 and 11 of the Kyoto Protocol. There is a special focus on resources related to the energy and forestry sectors. These are followed by an account of Finnish activities in the transfer of technology. The chapter ends with a description of two specific projects in Asia and a project targeting 32 countries in Central America, southern and eastern Africa and Asia.

Photo: Feodor Gurvits / Image bank of the Environmental Administration

7 Financial resources and transfer of technology

7.1 Provision of new and additional financial resources

Finland has integrated the goals and objectives of the UNFCCC and the Kyoto Protocol into its development policy, while taking into account the fact that economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties. The Finnish development guidelines for the environment, which were approved in 2009, already stated that climate change mitigation and adaptation should be addressed in all of the most important sectors of Finnish development cooperation. In the latest Development Policy Programme (2012), climate sustainability is one of the cross-cutting objectives of Finland's development policy and development cooperation. Therefore, besides providing funds to the operating entities of the financial mechanism of the UNFCCC and the funds under the Kyoto Protocol, Finland provides support through bilateral, regional and other multilateral channels.

The primary goal of Finland is to support multiannual projects (both bilateral and multilateral) and make multiannual agreements with multilateral institutions. Besides reducing the administrative burden this approach also helps to improve predictability of funding. These multiannual projects and agreements are based on joint planning and dialogue between partners, and thus the support level can also be better tailored to the specific needs and helps to provide resources more adequately than when giving support in a more ad-hoc manner.

In the Copenhagen climate negotiations in 2009, Finland, as part of the EU, committed collectively with other developed countries to provide new and additional resources approaching USD 30 billion for the period 2010–2012, with balanced allocation between adaptation and mitigation. Furthermore, within the context of meaningful mitigation actions and transparency on implementation, developed countries committed themselves to the goal of mobilising jointly USD 100 billion a year by 2020 to address the needs of developing countries. This funding comes from a wide variety of sources, public and private, bilateral and multilateral, including alternative sources of finance.

Finland's overall share of the EU's overall 'fast-start finance' contribution was EUR 110 million during the years 2010–2012. It was decided that this contribution will be counted as Official Development Assistance (ODA), but it will be a part of the new, growing Finnish ODA during 2010–2012. Finland's development aid disbursements in 2008 were EUR 808 million, which was 0.43 per cent of its gross national income (GNI). Its ODA contributions have continued to grow thereafter in real terms; in 2010, Finnish ODA reached more than EUR 1,006 million, which constituted 0.55 per cent of GNI. In 2012, the ODA contributions were 0.53 per cent of GNI, equivalent to EUR 1,027 million.

Finland's Fifth National Communication defined new and additional funding based on the minimum share figure (USD 6.4 million per year) given for Finland in the Bonn Declaration, according to which the European Community and its Member States and five other donor countries committed to providing USD 410 million annually as additional climate change funding for developing countries starting in 2005. After the Copenhagen fast-start finance pledge, Finland decided to use the year 2009 as a baseline for defining new and additional funding. The Finnish commitment of EUR 110 million was implemented through a net increase of Finnish funding directly allocated to developing countries' climate activities in 2010–2012. In comparison, the baseline figure for overall Finnish climate funding in 2009 was EUR 26.8 million.

In 2010, the overall final figure disbursed was approximately EUR 41.7 million. Thus, the final fast-start finance figure (i.e. the net increase) in 2010 was about EUR 14.9 million. For 2011, the figures were around EUR 61.5 million in total and approximately EUR 34.7 million as fast-start finance. For 2012, the figures were about EUR 108.2 million and approximately EUR 81.5 million, respectively.

Finland has contributed additional resources to the Global Environment Facility (GEF) to prevent and mitigate global environmental problems in developing countries. Finland has allocated funds to the GEF since its establishment in 1991. During the fourth replenishment period (July 2006–June 2010), the contribution was EUR 7.8 million per year, with the total Finnish contribution during the period being approximately EUR 31.2 million. During the current fifth replenishment period, the Finnish contribution is EUR 57.3 million in total; EUR 15.0 million per year during the years 2010–2011 and EUR 13.7 million per year during the years 2012–2013.

The GEF divides the funds into environmental focal areas; according to the latest annual report for the years 1991–2010, 32 per cent of the funds have been allocated to the climate change focal area. For calculating climate change relevant to Finland's yearly contribution to the GEF, Finland has used the climate change focal area target allocation outlined in the GEF Council document, GEF/C.40/07, including half of the Sustainable Forest Management/REDD-Plus (SFM/REDD+) programme, which totals approximately 32.6 per cent. The yearly figures are presented in Table 7.1 for 2009–2012. The information for earlier years is presented in the previous National Communications.

Table 7.1
Financial contributions to the Global Environmental Facility (GEF) regarding implementation of the Climate Convention (UNFCCC), and to the climate funds under the GEF.

	2009	2010	2011	2012
	EUR million			
Global Environment Facility	2.2	4.9	4.9	4.4
Least Developed Countries Fund	1.6	1.6	1.6	8.3
Special Climate Change Fund	0.9	0.9	0.9	2.9
Kyoto Protocol Adaptation Fund[1]	–	–	–	–

1 Finland contributed EUR 0.1 million to the start-up phase of the Adaptation Fund (AF) in 2008 (see Section 7.3.8)

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. During the reporting period (2009–2012), Finland's eight long-term partners in development cooperation were Ethiopia, Kenya, Mozambique, Nepal, Nicaragua, Tanzania, Vietnam and Zambia. Five of these countries are officially classified as least developed countries, and all of them are particularly vulnerable to climate change.

Several changes were introduced in 2012. According to the latest Development Policy Programme, Finland focuses its development cooperation on the least developed countries in Africa and Asia. It was decided that Finland's long-term partner countries in the future will be Ethiopia, Kenya, Mozambique, Nepal, Tanzania and Zambia as well as Vietnam, a lower middle-income country that is prone to natural disasters. With Vietnam, Finland is gradually shifting to new cooperation modalities. In the future, Nicaragua will be supported mainly through cooperation with civil society organisations. Furthermore, the specific needs of fragile states are increasingly taken into account. Finland is committed to long-term cooperation with Afghanistan and carries out development cooperation with the Palestinian Territory and South Sudan.

These bilateral partner countries are also the main recipients of climate financing. However, Finland also supports other particularly vulnerable countries through regional co-operation and multilateral institutions. For example, Finland is one of the regular supporters of the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF). In the last National Communication, it was stated that the voluntary support was increased from EUR 1.35 million in 2005 to EUR 2.5 million in total in 2008. The yearly support amounts have stayed at those levels thereafter (see Table 7.1), except for the year 2012, when Finland was able to support these two funds with as much as EUR 11.2 million altogether.

During the years of the fast-start finance period (2010-2012), the amount of support for the least developed countries (LDCs) and Africa was almost the same, on average about 20 per cent of total Finnish climate financing for both. However, this share is a rough estimate, as it does not include all support to LCDs and African countries. For example, the parts of the GEF core support that are allocated to LDCs or African countries are not included in the share presented above. In addition, some regional projects and programmes that are partly relevant to LDCs and African countries have been excluded because it is difficult to estimate the exact share of total project funding that has been allocated to these countries.

The assistance has covered, for example, the forestry and agricultural sectors and capacity building by the various governments, including their environmental administrations. Moreover, national meteorological services, which have a crucial role in producing data and information for adapting to climate change, have also been supported. Finland is one of the major development cooperation donors in the field of meteorology; it aims to strengthen the capacities of the national meteorological institutes (see also Sections 7.3.3. and 8.3.4). During the last 20 years, Finland has carried out development cooperation projects in approximately 100 countries, which amounts to more than USD 60 million in the field of meteorology.

7.3 Provision of financial resources

In the provision of financial resources, Finland has taken into account the 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). Information on activities that specifically address minimising the adverse impacts of response measures on developing countries is provided in Section 4.13.

7.3.1 Multilateral assistance

Finland has supported developing countries' climate actions through multilateral aid, giving core support, for example, to the GEF, LDCF and SCCF. In 2008, Finland decided to contribute EUR 7 million to the Readiness Fund of the World Bank's Forest Carbon Partnership Facility (FCPF), which was again supported with EUR 4 million both in 2011 and in 2012, making the total contribution to the Readiness Fund EUR 15 million. Furthermore, in 2012 Finland provided EUR 0.5 million as start-up support to the Green Climate Fund (GCF).

Finland made a EUR 4.1 million contribution to the World Bank's Partnership for Market Readiness in November 2012. The objective of the Partnership is to develop carbon market capacity in developing countries and countries with economies in transition through the development and piloting of carbon market instruments. Finland actively participates in the Partnership Assembly meetings to foster cost-effective climate change mitigation.

The Multilateral Development Banks have been working together with the OECD Development Assistance Committee (DAC) to harmonise their climate finance tracking systems. As a result of this work, Finland is able to include in its climate finance reporting for 2012 the portion of its core support to these banks that is climate relevant. However, the figures were not yet available at the time this report was written.

One example of the thematic support provided through multilateral institutions is Finland's contribution of EUR 3.5 million to the project 'Making agriculture part of the solution to climate change – Building capacities for Agriculture Mitigation' (2010–2014), implemented by the Food and Agriculture Organization of the United Nations (FAO). The goal of the project is to enable countries to better realise the opportunities of climate change mitigation in agriculture, while at the same time improving food security and increasing the resilience of farming systems. Finland has also supported the FAO's 'Sustainable Forest Management in a Changing Climate' programme through multilateral and bilateral channels. Finland's overall support for the programme amounts to USD 30 million during the period 2009–2014. The programme has five pilot countries on three continents. It includes the development of new methodologies, field test and local capacity development as well as support for other processes, including the United Nations collaborative initiative on Reducing Emissions from Deforestation and Forest Degradation (UN-REDD).

Table 7.2
Financial contributions to multilateral institutions and programmes
(only part of the contribution is related to climate change)

Institution or programme	Contribution (EUR million)			
	2009	2010	2011	2012
Multilateral institutions:				
1. World Bank (WB, IBRD, IDA, IDA-HIPC, MIGA, AMCs)	61.96	88.05	77.00	88.46
2. International Finance Corporation	3.16	2.64	1.89	1.63
3. African Development Bank (Afr.DB, Afr.DF)	29.46	19.77	23.55	36.77
4. Asian Development Bank (AsDB, AsDF)	8.41	7.89	7.14	6.88
5. European Bank for Reconstruction and Development (EBRD, TFs ODA, TFs all, ETC, WBJTF)	0.00	1.00	0.50	1.70
6. Inter-American Development Bank (IDB, IDB Sp.F.)	0.50	1.10	1.43	0.37
7. United Nations Development Programme	25.98	30.61	29.49	29.54
8. United Nations Environment Programme -specific programmes	4.62	8.57	5.64	6.74
9. UNFCCC	0.04	0.02	0.21	0.03
10. Other				
European Development fund (EDF)	42.43	55.35	48.60	42.36
European Community	112.59	96.99	106.51	105.56
Nordic Development Fund	0.00	0.00	0.00	0.00
Montreal protocol	0.60	0.60	0.60	0.73
NFP Facility	0.40	0.30	0.40	0.40
Multilateral scientific, technological and training programmes:				
1. CGIAR	3.00	3.00	4.25	5.00
2. WIDER	0.51	0.98	1.02	1.07
3. PROFOR (WB & FAO)	0.40	0.00	0.70	0.40

7.3.2 Kyoto Mechanisms

In the EU emissions trading scheme, companies may partly meet their emission reduction obligations by using emission units from projects that help reduce emissions in other countries (so-called project mechanisms). The Government may also use project mechanisms (the 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 emissions commitment.

The total budget for the acquisition of emission reductions from the Kyoto Protocol flexible mechanisms is approximately EUR 80 million. Approximately EUR 20 million was invested during the CDM/JI pilot programme, which was in operation from 1999 until early 2006. Approximately EUR 21 million has been allocated for purchasing post-2012 credits. The rest was allocated for the years 2006–2012.

To date, Finland has invested approximately EUR 20.8 million in 12 bilateral projects for purchasing emission reductions during the Kyoto Protocol's first commitment period. In addition, Finland has committed more than EUR 3 million for purchasing emission reductions during the Kyoto Protocol's second commitment period from select bilateral projects. In addition to the bilateral projects, Finland has invested in multilateral carbon funds (Table 7.3). USD 10 million have been invested in the World Bank's Prototype Carbon Fund (PCF), EUR 4.25 million in the Nordic Environmental Financing Corporation's (NEFCO) Testing Ground Facility (TGF), EUR 10 million in the European Bank for Reconstruction and Development's Multilateral Carbon Credit Fund (MCCF), USD 25 million in the Asian Development Bank's Asian Pacific Carbon Fund (APCF), EUR 3 million in the NEFCO Carbon Fund and USD 20 million in the Asian Development Bank´s Future Carbon Fund (FCF).

Table 7.3
Investments in multilateral carbon funds for the 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 emphasises that developments in all countries should be ecologically, socially and economically sustainable. The legally binding obligations that come from the multilateral environmental agreements (MEAs) are taken into account in Finland's development policy. Providing assistance in implementing the MEAs constitutes a long-term investment in building sustainable national development policies and achieving national and international environmental targets. From the standpoint of development cooperation, the implementation of UNFCCC objectives is one of the most important targets.

Finland supports projects and programmes that promote environmentally sustainable development in its partner countries and regions. Within 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.

During the reporting period 2009–2012, the total amount of projects and funding has increased compared to the period reported in the Fifth National Communication (2004–2008). For example, in 2010 more than 150 projects – or interventions to be exact, since the figure also covers some funds – had climate change mitigation and/or adaptation either as a principal or a significant objective, which amounted to overall climate finance figures of approximately EUR 42 million. The yearly figures throughout the reporting period are presented in Section 7.1. The ratio varies from year to year, but generally the bilateral co-operation projects have accounted for about half of all Finnish climate funding.

The form of assistance varied between regions and programmes. The Energy and Environment Partnership (EEP) project, which began in Central America in 2003 and is now being replicated in the Mekong region, southern and eastern Africa, Indonesia and the Andes, accounts for a large number of the mitigation projects related to the energy sector (see Section 7.3.4. and Table 7.7 for further information). In addition, support for forestry projects is substantial (see Section 7.3.5).

With respect to adaptation, the most important element has been capacity building and conducting vulnerability assessments in partner countries. Finland has been quite active in the field of meteorological co-operation (see also Section 8.3.4). For example, Finland has supported co-operation between the Finnish Meteorological Institute (FMI) and the South Pacific

Regional Environmental Programme (SPREP) and Pacific national meteorological services starting from 2009 to improve the capacity of the national meteorological institutes to deliver high-quality weather and climate services and thus to respond to the challenges posed by climate change and extreme weather events. This project was continued and expanded in 2012: it now extends until 2015 and covers 14 Pacific Island countries.

Table 7.4
Finland's bilateral and regional contributions towards implementation of the UNFCCC, 2009–2012 (EUR million)

	Mitigation						Adaptation		
Recipient country/region	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity-building	Coastal zone management	Other vulnerability assessments
Angola				0.08					
Argentina							0.01		
Azerbaijan	0.04								
Bhutan			0.05				0.01		
China	2.29						0.02	0.002	
Colombia			0.02				0.05		
Ecuador	0.47						0.06		
El Salvador							0.003		
Ethiopia					0.57	0.01	0.003		
Guatemala							0.05		
Guinea							0.01		
Honduras	2.27						0.02		
India	0.30			0.005			0.003		
Indonesia	0.77		0.11	0.30					
Jamaica							0.07		
Kenya	0.15		0.91				0.32		
Laos			0.05				0.86		
Malawi							0.07		
Mexico			0.01						
Mongolia							0.05		
Mozambique			0.74				0.75		
Namibia							0.04		
Nepal			0.54		0.23		1.13		
Nicaragua				0.11			0.28		
Nigeria							0.003		
Pakistan								0.20	
Peru			0.03				0.52		
Somalia							0.02		
Sri Lanka	3.99								
Sudan			0.02				0.14		
Tanzania			0.95				0.51		
Trinidad and Tobago							0.07		
Ukraine							0.03		
Viet Nam	1.10		0.96	0.02	0.28		0.55		
Zambia			1.10	0.13			0.23		
Zimbabwe	0.005								
Europe, regional			0.29				0.27		
South of Sahara, regional	7.54		0.66				1.38		
Africa, regional	1.52		1.24						
North & Central America, regional	0.02		0.11						
South America, regional	1.12		0.57				0.09		
America, regional			0.66						
Central Asia, regional							0.26		
Asia, regional	4.15		0.73				0.79		
Oceania, regional							0.50		
Total	**25.734**	**0.00**	**9.752**	**0.655**	**1.079**	**0.011**	**9.156**	**0.202**	**0.00**

Table 7.5
Regional contributions of Finnish official development assistance (ODA) for the implementation of climate-change-related bilateral projects and programmes in 2009–2012 (EUR million)

Regional bilateral	2009	2010	2011	2012
Africa	5.90	7.59	7.90	12.72
Americas	3.37	2.79	4.15	5.97
Asia	4.87	5.29	7.17	8.81
Europe	0.05	0.16	0.45	0.20
Oceania	0.10	0.22	0.18	0.00

7.3.4 Energy sector cooperation

Most of Finland's bilateral development co-operation funds in the energy sector are channelled through five regional Energy and Environment Partnership (EEP) Programmes that currently cover 32 countries in Central America, the Andean region, southern and eastern Africa, the Mekong region and Indonesia (see also Table 7.7). The programmes provide grants as seed funding to project developers through competitive calls for proposals. They support the preparatory phases of sustainable energy investments and also help pilot and scale up business models to increase energy access with a focus on local renewable energy sources and energy efficiency improvements. Finland's funding for the programmes for the years 2009–2012 was approximately EUR 31 million, which was complemented with EUR 22 million from other donors (Austria, EU, UK and the Nordic Development Fund). The project developer's contribution to individual projects varied, but, on average, the ODA funds were able to attract a two- to fourfold increase in the amount of funding from other private and public sources for mitigation purposes. Finland is also co-operating with the IEA's Climate Technology Initiative Private Financing Advisory Network to provide support to project developers. At policy level, Finland has provided support to both Laos and the Southern African Development Community (SADC) region to develop renewable energy strategies.

In addition to EEPs, Finland's bilateral funds have provided concessional credits to Finnish exporters for climate-related projects in developing countries. During the reporting period 2009–2012, new projects were supported to increase solar PV use in rural mountainous areas in Vietnam and to increase the use of industrial-scale biogas in China. In Vietnam, Honduras and Ghana, projects to rehabilitate and expand the electricity grid so as to improve access to energy have been supported (see also Section 7.4).

The Finnish Fund for Industrial Cooperation Ltd. (Finnfund) (see Section 7.3.7) financed, during the reporting period 2009–2012, renewable energy production projects in Laos, Thailand, Honduras, Sri Lanka and Cape Verde and tree-planting projects in Tanzania and Uruguay. In addition, it is an investor 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.

7.3.5 Forestry cooperation

Forestry forms a significant sector in Finland's development cooperation: presently, it constitutes about 4 per cent of the total ODA, or EUR 40 million annually. In the area of development cooperation, Finland has supported sustainable forest management in partner countries, e.g. the preparation and implementation of national forest programmes as well as sector-specific policies and strategies. The forestry cooperation efforts support and complement the other climate-related efforts, especially in areas like carbon sequestration and the specification of indicators supporting effective climate actions as well as in terms of providing practical monitoring, evaluation and verification tools (see also Section 8.3.4).

The participatory approach to forestry has been important in the promotion of sustainable forestry and peoples' livelihoods, especially in bilateral programmes in Tanzania, Zambia, Vietnam, Laos and Nepal. With climate sustainability being one of the cross-cutting objectives of the new Development Policy Program of 2012, climate has become an increasingly important aspect of sustainable forestry. This is reflected in the form of REDD+ and other climate-related efforts, which have been supported through FCPF and FAO, as indicated above. National forest inventories and forest sector information systems have been promoted in partner countries to provide an information base both for sustainable forest management and as baselines for climate-related efforts.

Finland's Development Policy and the guidelines for the forest sector cooperation put increasing emphasis on the good governance of forests, on land issues, on peoples' rights to access, use and participate in forestry as well as on benefit sharing. This is seen as a strategy for sustainable natural resource management, which together with the promotion of an inclusive green economy that promotes employment, is expected to deliver improved livelihoods.

Research networks such as the Center for International Forestry Research (CIFOR), the World Agroforestry Centre (ICRAF) and the International Union of Forest Research Organizations (IUFRO) are supported as channels to provide policy relevant information for international forest policy processes, such as the UN Forum on Forests.

7.3.6 Capacity building support

For the past ten years, Finland has funded an international course on environmental law and diplomacy. This 'Course on Multilateral Environmental Agreements' is organised annually by the University of Eastern Finland in cooperation with UNEP and Finland's partners in developing countries. The course transfers past experience in the field of international environmental law to current and future negotiators of multilateral environmental agreements (MEAs). In addition to teaching environmental law, the course aims to foster contacts between developing and industrialised countries and thus support international environmental negotiations. The course specialises each year in different themes; for instance, in 2010 the theme of the course was climate change and in 2013 the theme is natural resources. Other examples of climate-change-related higher education cooperation are presented in Section 8.3.4.

Finland has also supported the Climate Change and Development Project (CCDP) implemented by the International Union for Conservation of Nature (IUCN) in three countries in eastern/southern Africa: Zambia, Mozambique and Tanzania. The five-year project (2008–2012) evolved out of a one-year pilot phase, which was first implemented in Zambia in 2007 and received an overall Finnish contribution of EUR 2.3 million. The overall goal of the CCDP was to achieve reduced vulnerability and an enhanced adaptive capacity to climate variability and change at local and national levels. The project aimed to ensure that climate-change-related policies and strategies would lead to adaptation activities that would emphasise the role of forests and water resources in supporting people's livelihoods and farming systems.

The Southeast Asia Climate Change Network project has been implemented by the UNEP since 2008; it uses a regional networking approach to improve the development and exchange of knowledge among climate change focal points, national coordinating bodies and climate change professionals. The project supports the sharing of best practices and accelerates the transfer of climate-friendly technologies. The project assists countries in negotiating agreements and helps them to carry out the practical measures associated with climate change. The goal is to strengthen the countries' potential to respond to the challenges posed by climate change over a wide spectrum. The overall support for the project is EUR 4.3 million during the period 2008–2013.

As climate change will hit the world's poorest people the hardest, and as most of the world's poor are women, one of the important themes has been mainstreaming gender considerations as part of climate policy-making efforts. Finland has been supporting the project implemented by the Global Gender and Climate Alliance (GGCA) to strengthen the role of women and mainstream the gender perspective in global climate policy since 2008. Funding has been allocated to support female delegates' participation in climate negotiations. At the second stage, from 2010 onwards, support was also targeted more concretely at the National Adaptation Programmes of Action (NAPA) of developing countries and at their implementation. Support for the project will continue at least during the period of 2012–2014. During this period, the emphasis of the project will be at the national level. Thus far, the total contribution has been EUR 6.8 million for the implementation period of 2008–2014.

7.3.7 Support for private sector cooperation

Private sector projects in developing countries are being supported, for example, by the Finnish Fund for Industrial Cooperation Ltd. (Finnfund) and Finnpartnership (see also Sections 7.4 and 7.3.4). Finnfund is a state-owned company that finances private projects in developing countries by providing long-term risk capital for profitable projects. The funding modalities include equity investments, loans and/or guarantees. It cooperates with Finnish and foreign companies, investors and financiers. Finnpartnership, on the other hand, aims to increase business-to-business cooperation between companies in Finland and in developing countries. About half of the investments made by Finnfund in recent years can be regarded as climate finance because they have been used for projects in renewable energy, to prevent deforestation, to enhance energy and material efficiency or to improve the ability of poor people to adapt to the challenges posed by climate change. Since 2011, Finland has been able to include the climate-change-relevant and ODA-eligible co-operation provided by these institutions in its total climate funding figures. In 2011, Finnfund provided approximately EUR 10 million, which can be included in Finnish public climate funding figures, while Finnpartnership provided approximately EUR 0.1 million. According to rough estimates, the public funding through Finnfund's climate-related projects leverages private funding at a level at least four times that of public funding for the investment. Moreover, the average and median ratio values have been much higher during the past few years: 17 and 15, respectively. While Finnpartnership has not made climate-specific estimates, during the period 2006–2009 the ratio was generally at least six times greater than previously.

7.3.8 Summary of financial resources, including resources under Article 11 of the Kyoto Protocol

A summary of information on financial resources and technology transfer is presented in Table 7.6. In addition to the figures presented in the table, Finland contributed EUR 0.1 million to the start-up phase of the Adaptation Fund (AF) in 2008. In 2010, Finland and the AF made a new agreement on transferring the rest of the unspent start-up funds to the actual trust fund.

Table 7.6
Summary information on financial resources and technology transfer

Official development assistance (ODA)	EUR 927 million in 2009 (0.53 per cent of gross national income (GNI)), EUR 1,006 million in 2010 (0.55 per cent), EUR 1,011 million in 2011 (0.53 per cent), EUR 1,027 million in 2012 (0.53 per cent).
Climate-related aid in bilateral ODA	EUR 12.95 million in 2009, EUR 21.97 million in 2010, EUR 35.35 million in 2011, EUR 33.66 million in 2012 (amounts of the project funding directly directed to climate activities).
Climate-related support programmes	Energy and Environment Partnership (EEP) with Central America, the Making agriculture part of the solution to climate change – Building capacities for Agriculture Mitigation project, the Sustainable Forest Management in Changing Climate project, the Climate Change and Development Project (CCDP), the Southeast Asia Climate Change Network.
Contributions to GEF	EUR 7.8 million in 2009, EUR 15 million in 2010, EUR 15 million in 2011, EUR 13.65 million in 2012.
Pledge for fifth GEF replenishment	EUR 57.30 million in total.
JI and CDM under the Kyoto Protocol	The Finnish Carbon Procurement Programme (Finnder) has contracted 12 bilateral projects: 8 CDM and 4 JI projects (EUR 20.8 million). Alongside purchases from bilateral projects, Finland has invested in the Prototype Carbon Fund (USD 10 million), the Testing Ground Facility (EUR 4.25 million), the Multilateral Carbon Credit Fund (EUR 10 million), the Asia Pacific Carbon Fund (USD 25 million), the Future Carbon Fund (USD 20 million) and the NEFCO Carbon Fund (EUR 3 million). In total, Finland has got credits from about 110 projects at both the bilateral level and through funds.
Other (bilateral/multilateral)	The Global Gender and Climate Alliance (GGCA) project to strengthen the role of women and mainstream the gender perspective in global climate policy. The total contribution is EUR 6.8 million during the implementation period of 2008–2014.

7.4 Activities related to the 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 the transfer of both 'soft' technology, such as 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. The differences between these types of technology are not always clear, and some activities have characteristics of both. In developing countries, the private sector and entrepreneurs play a key role in economic development. During the reporting period, Finnfund (see Section 7.3.7) was a financer of renewable energy production projects in Laos, Thailand, Honduras, Sri Lanka and Cape Verde and tree-planting projects in Tanzania and Uruguay. In addition, Finnfund is an investor 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. In Zambia, Finland is the lead donor in the environmental sector as well as a donor facilitator within the Enhanced Integrated Framework. Finland also supports multiple programmes and projects related to private sector development (PSD) in Zambia, which enhance the mutual synergies between the environmental and PSD sectors.

In addition, Finland is contributing to the Nordic Development Fund (NDF), which supports mitigation and adaptation projects (partly through the Nordic Climate Facility, NCF). The NDF is a joint multilateral development finance institution operating in Denmark, Finland, Iceland, Norway and Sweden that has provided financing for climate-change-related investments since 2009. The NCF is financed by the NDF and it facilitates the exchange of technology, know-how and innovative ideas between the Nordic countries and low-income countries in the sector of climate change. The NDF/NCF grant commitments to climate change throughout the reporting period were approximately EUR 130 million and the disbursements were more than EUR 50 million.

Finland's development policy and development cooperation promote an inclusive green economy, for example by creating public-private partnerships (PPP) for investments that promote development.

Finland also supports the Energy and Environment Partnership (EEP) with Central America, which has established various renewable energy and clean energy projects. The partnership has recently been expanded to the Andean region, southern and eastern Africa, the Mekong region and Indonesia (see also Section 7.3.4 and Table 7.7).

Concessional credits are used primarily for environmental and infrastructure investments under the national development programmes. They have been granted to various renewable energy projects, for example to solar PV projects in Vietnam and Sri Lanka for providing basic energy and water services. In Vietnam, Honduras and Ghana, projects to expand the electricity grid and improve access to energy have been supported, while in China district heating projects have been implemented to improve energy efficiency,

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:
Promoting Modernisation of Hydrometeorological Services in Việt Nam

Purpose:
Increased capacity of the National Hydro-Meteorological Service to reduce natural disaster risks and facilitate the adaptation to climate change of the Vietnamese society

Recipient country	Sector	Total funding	Years in operation
Vietnam	meteorology	EUR 0.5 million	2010–2012

Description:
The project was an institutional collaboration project between Vietnam National Hydro-Meteorological Service (NHMS) and the Finnish Meteorological Institute (FMI). The focus of this project was on increasing the technical capacity of the NHMS and a Central Hydro-Meteorological Forecasting Centre (CHMFC) for the NHMS. Special emphasis was given to the role of the NHMS's regional centres, ministries and emergency officials in the early warning process through shared workshops. Two automatic weather stations were purchased and installed in cooperation with NHMS and FMI experts and databases and information exchange systems for making observations and forecasts were developed, managed and exploited. The project helped CHMFC improve its capacity in risk analysis for natural hazards and its early warning and severe weather forecasting services. The project improved the CHMFC's level of understanding on modern forecasting tools and services through capacity building activities. It also supported the modernisation of the observation network and improved the use of observation equipment for improved services and warning systems. The project aimed to improve the capacity of the CHMFC to serve its customers – regional hydrometeorological centres, ministries, emergency services and the general public – through improved use of state-of-the-art ICT and forecasting tools. A follow-up project will be in operation in 2013–2016.

Indicate factors which led to project's success:
Collaboration of experts of two sister institutions, on-the-job training

Technology transferred:
Two automatic weather stations, meteorological software

Impact on greenhouse gas emissions/sinks:
N/A

Project/programme title:
SUFORD, Sustainable Forestry for Rural Development Project / Scaling-up Participatory Sustainable Forest Management Project

Purpose: To promote sustainable forest management and reduce carbon emissions from forests

Recipient country	Sector	Total funding	Years in operation
Lao PDR	Forest/mitigation	Phase I: EUR 6 million Phase II: EUR 9 million Consolidation Phase III: EUR 10.9 million	Phase I: 2004–2008 Phase II: 2009–2012 Phase III: 2013–2017

Description:
Finnish support for the forest sector in Lao PDR started in 1995 by piloting an approach to the participatory management of production forests called 'Village Forestry'. From 2004 through 2008, the initial phase of the Sustainable Forestry for Rural Development (SUFORD, Phase I) Project was implemented in parallel financing with the World Bank in Production Forest Areas in four provinces. During Phase II, it was expanded into five more provinces. The

overall objective of phase II was to support the sustainable management of natural production forests, including sustainable logging, in order to alleviate rural poverty in the project provinces through improved revenue sharing with villages and to support improved policy, legal and incentive frameworks.

The project has contributed substantially to the development of a Participatory Sustainable Forest Management system for Lao PDR's production forests, which cover approximately one third of the total national production forest area. The project involves working on village development with 723 villages and it has contributed to reducing poverty. Related to this provincial-, district- and village-level work, SUFORD contributes to policy and legal development, including providing support for the establishment of a framework for protecting forests and preparing for REDD+ and other future forest carbon financing efforts.

Important support has been provided to assist in establishing the Department of Forest Inspection (DOFI) and launching its nationwide activities, in drafting a long-term strategy, in developing Forest Management information Systems and in facilitating interagency agreements and capacity-building efforts.

SUFORD was instrumental in contributing to the revision of the law for sharing revenue from timber sales in production forests. When the decree is implemented in full, the financing available to communities and village development funds will become manifold compared to current levels. The project has also supported the forest sector in achieving certification according to Forest Stewardship Council (FSC) standards, and thus it has helped create a supply of certified legal timber. Work is ongoing now with other partners to develop the forest industry's ability to respond to this supply and work towards a Chain-of-Custody certification so that market advantages can be realised.

With respect to REDD, the project supported the Lao delegation to the UNFCCC and contributed to the Lao PDR reporting to the REDD+ partnership secretariat. At the national level, the project has contributed at both the national and village level by helping design a National Forest Monitoring System, pilot soil carbon measurements, produce Reference Levels for Production Forest Areas and monitor the forest cover changes in and around them, address safeguards and design a monitoring system, test the REDD+ demonstration disbursements associated with forest restoration and promote low carbon village development.

Consolidation Phase III (2013–2017) will build and expand upon the progress achieved by implementing participatory approaches to sustainable forest management. It will help (a) explicitly incorporate and monitor forest carbon emission reductions, (b) introduce performance payments for forest carbon sequestration, (c) focus additional efforts on developing sustainable livelihood options and (d) foster inter-agency coordination at a landscape scale.

Indicate factors which led to project's success:
The project is comprehensive in scope and covers national policy, field implementation and capacity development. The project has a good reputation and is well linked with national decision making, including the Parliament.

Technology transferred:
Participatory forest management could provide a sound basis for further developing 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 proven to be cost-effective tools for the assessment.

Impact on greenhouse gas emissions/sinks:
The reduction of the forest cover (and carbon emissions) inside most SUFORD Production Forest Areas has declined or stabilised, whereas it continues to accelerate outside these areas.

Project/programme title:
Energy and Environment Partnership (EEP) Programmes

Purpose:
To increase access to sustainable energy through renewable energy and energy efficiency

Recipient country	Sector	Total funding	Years in operation
32 developing countries in Central America, the Andean region, southern and eastern Africa, the Mekong Region and Indonesia	Energy/mitigation	Finland: EUR 60 million Other donors: EUR 40 million	2003–2016

Description:
The programmes work through competitive calls for proposals that are open to public and private, governmental and non-governmental project developers. The programmes provide grants to entrepreneurs, SMEs and NGOs for developing, piloting and scaling up inclusive business models to increase energy access. The programmes also provide seed money for the preparatory phases of sustainable energy investments, including pre-feasibility and bankable feasibility studies as well as pilot and demonstration activities. The objective is also to influence national and regional policies on renewable energy (RE) and energy efficiency (EE) by means of disseminating the lessons learned from evidence-based solutions in order to contribute to an enabling environment for RE/EE energy entrepreneurs and investment.

Indicate factors which led to project's success:
Wide participation of the private sector, universities, donors and research institutes in the programmes; flexible, demand-driven funding mechanism with close coordination at the national level and with policy priorities set by energy/environmental ministries as steering committee members; capacity-building for project development and business advisory services provided as part of the programme; facilitation of investor interest for the scaling-up phase.

Technology transferred:
Mainly small- and medium-scale biomass, biogas, biofuel, solar, mini-hydro and wind technologies.

Impact on greenhouse gas emissions/sinks:
Significant local emission reductions. A number of CDM projects have also been supported.

More information: http://www.eepglobal.org/

reduce emissions and improve the air quality in cities. During the reporting period 2009–2012, concessional credit disbursements for climate-change-related investments have been around EUR 1 million per year.

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 the EGTT was first established, Finland has participated actively in its work by providing expertise, leadership and financial resources. The latest Finnish chairmanship of the group was held during 2008. At COP 16 in Cancún, the Technology Mechanism was established. This mechanism consists of two parts: the Technology Executive Committee (TEC), which replaces the EGTT, and the Climate Technology Centre and Network (CTCN). Finland has been a member of the TEC since its establishment. Finland has also been instrumental in decisions leading to the mobilisation of the Climate Technology Centre and Network (CTCN), which will come into operation in 2014.

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, and 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. Along with other Finnish actors, Tekes cooperates in ERAfrica, a new EU project aimed at promoting a unified European approach to collaborating with Africa in the field of science and technology research for innovation and sustainable development purposes. ERAfrica forms part of the 7th Framework Programme suite of European research initiatives, and it boasts as its primary objective the creation of a 'European Research Area Network' for the African continent. Finland, together with several other EU countries, is united with African partners (South Africa, Kenya and Egypt) in a core consortium built around a mutual recognition of the value of unifying efforts to strengthen intercontinental research collaboration and promotion. In this regard, ERAfrica aims to serve as a template for interactions between Europe and Africa in the field of science and technology research and as a model for future cooperative ventures between the two continents.

Internet links

Energy and Environment Partnership with Central America, http://www.sica.int/energia http://formin.finland.fi/public/default.aspx?contentid=194470&nodeid=15452&contentlan=1&culture=fi-FI

FAO — Mitigation of Climate Change in Agriculture (MICCA), http://www.fao.org/climatechange/micca/75369/en/

Finder purchasing program for the Kyoto mechanisms, https://www.tem.fi/?l=en&s=3996

Finland's Development Policy Programme 2012, http://formin.finland.fi/public/default.aspx?contentid=251855&nodeid=15457&contentlan=2&culture=en-US

Finnish Business Partnership Programme (Finnpartnership), http://www.finnpartnership.fi/www/en/index.php

Finnish development policy guidelines for the environment 2009, http://formin.finland.fi/Public/default.aspx?contentid=180138

Finnish Fund for Industrial Cooperation Ltd (Finnfund), http://www.finnfund.fi/en_GB/

Finnish Funding Agency for Technology and Innovation (TEKES), http://www.tekes.fi/en/community/Home/351/Home/473

Finnish Meteorological Institute, http://www.fmi.fi/en/

Global Gender and Climate Alliance (GGCA), http://www.gender-climate.org/index.php

Ministry for Foreign Affairs, http://www.formin.finland.fi/public/default.aspx?culture=en-US&contentlan=2

UNEP: Southeast Asia Climate Change Network, http://www.unep.org/climatechange/mitigation/sean-cc/SEANCCHome/tabid/7110/Default.aspx#menu

University of Eastern Finland — UNEP Course on Multilateral Environmental Agreements, http://www.uef.fi/fi/unep/home

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.

Photo: Aarno Torvinen / Image bank of the Environmental Administration

8 Research and systematic observation

8.1 General policy on research

8.1.1 Domestic activities

In 2011, Finland's research and development (R&D) expenditure was more than EUR 7,000 million, or 3.8 per cent of the country's gross domestic product. This is a higher percentage than the average among the OECD countries. In 2011, around 66 per cent of the R&D expenditure was from the private sector, 28 per cent from the public sector and 7 per cent from foreign funding. The architecture of public research funding is described in Figure 8.1. The distribution of public R&D funding in 2011 is presented in Figure 8.2.

In recent years, the number of R&D personnel has remained relatively stable at around 80,000. The increase since 2001 has been 5 per cent. The number of doctoral degrees has tripled in the past twenty years.

Climate change is recognised in the Finnish national research and innovation policy (inter alia in the Research and Innovation Policy Guidelines 2011–2015 of the Research and Innovation Council) as one of the significant challenges currently facing society. Climate change continues to be a priority area in many research programmes and projects (see Sections 8.2 and 8.3 for details). Large cross-sectoral climate change programmes have aimed at increasing an understanding of the scientific basis of climate change as well as the impacts and options for mitigation and adaptation, including addressing environmental and socio-economic questions. In addition,

Figure 8.1
Architecture of public research funding in Finland. The Research and Innovation Council, which is chaired by the Prime Minister, is responsible for the strategic development and coordination of Finnish science and technology policy as well as for the national innovation system as a whole. The Academy of Finland finances high-quality scientific research (EUR 327 million in 2012), acts as a science and science policy expert and strengthens the position of science and research. Tekes – Finnish Funding Agency for Technology and Innovation funds (EUR 570 million in 2012) R&D and innovation activities by companies and research organisations registered in Finland.

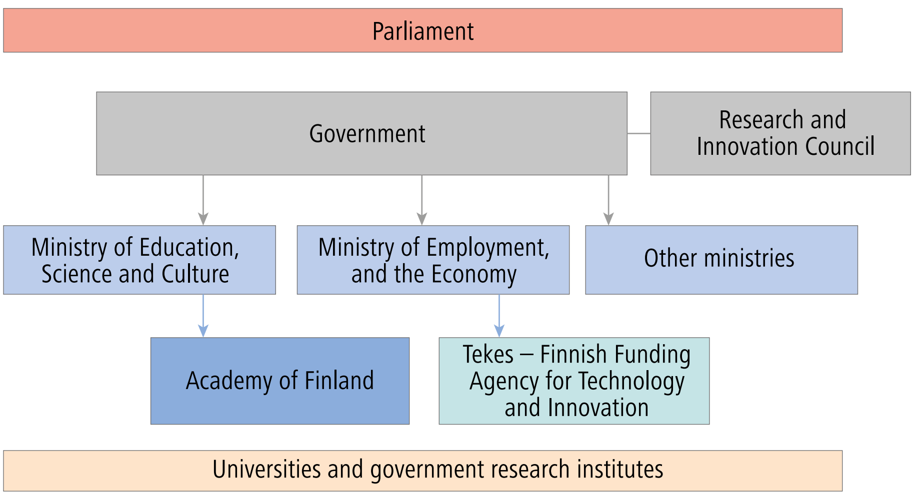
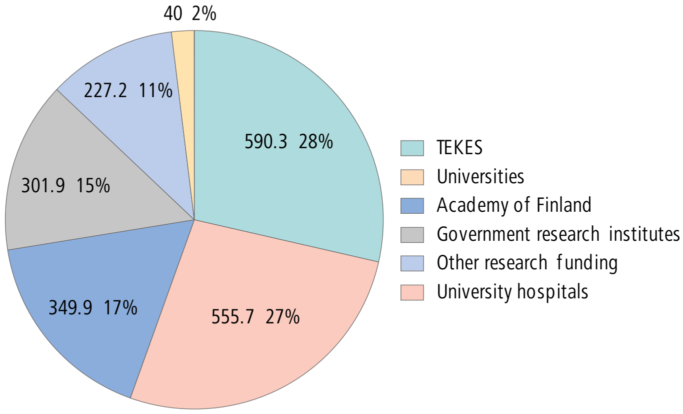


Figure 8.2
Public research funding in Finland in 2011 (EUR million, per cent)



climate change has increasingly been integrated into other environmental, sectoral and technology research programmes and projects.

Climate change has been a priority issue in state-funded sectoral research during the period 2007–2011. Preceded by the Advisory Board for Sectoral Research, the Prime Minister's Office has since 2011 been responsible for coordinating the objectives of state-funded sectoral research. In addition, the Research and Innovation Council plays a key role. The current aim is to strengthen the research activities supporting Government decision making. At the same time, efforts at transforming the state sectoral research institutions into larger entities are also being pursued. Cooperative structures already began to emerge in 2009 when the six research institutions, under the auspices of the Ministry of the Environment and the Ministry of Agriculture and Forestry, formed the LYNET consortium on natural resources and the environment. Climate change is a point of focus of one of four research programmes of the LYNET consortium.

Energy and climate change research is a focal area in public research funding in Finland. Energy research, development and demonstration (RD&D) expenditure has steadily increased in recent years, reaching a peak in 2010 with approximately EUR 270 million in public expenditure, equivalent to 0.16 per cent of GDP, ranking first amongst its OECD peers. In 2011, RD&D fell marginally to EUR 255 million.

Focus on research infrastructures has grown in recent years in Finland. The Academy of Finland coordinates both national research infrastructure investments and participates in European and international research infrastructures. Finland is a member of the Integrated Carbon Observation System (ICOS) (see Section 8.1.2 for more information) network. The ICOS network will be headquartered in Finland and France until 2031.

The Government Programme (2011) states that information resources produced using public funding will be opened up for public and corporate access. In addition, the State of Scientific Research in Finland 2012 report supports activities that promote open access to research knowledge. Most of the research funders and universities in Finland encourage an open approach to publishing and databases. As an example of realising these objectives, the Finnish Meteorological Institute (FMI) is building a new online service that will make it possible to search for, browse and download the Institute's data sets in machine-readable format free of charge. The technical implementation of the online service complies with the requirements laid down in the INSPIRE Directive (2007/2/EC), and the content of the service is wider than that defined in the Directive. The INSPIRE Directive requires that Member States ensure that metadata are created for the spatial data sets and the services that are needed for the establishment of the Infrastructure for Spatial Information within the European Community; this needs to be done for the purposes of Community environmental policies or activities that may have an impact on the environment. A large amount of FMI weather, marine and climate data, e.g. observations, weather prediction model output and climate change scenarios are publicly available.

The Centre of Expertise Programme (OSKE) is a fixed-term government programme (2007–2013) aimed at focusing regional resources and activities on areas of key national importance. The programme promotes the utilisation of knowledge and expertise of the highest standard that exists in different parts of the country. The programme is cluster based, and the clusters entitled Future of the Forest Industry, Energy Technology and Environmental Technology are the most relevant ones for advancing knowledge and expertise in areas pertaining to climate change mitigation and adaptation. A new Innovative Cities (INKA) Programme (2014–2020) will soon replace the OSKE programme. INKA will aim to promote synergies between national and regional innovation activities.

The Strategic Centres for Science, Technology and Innovation (SHOK in Finnish), established in Finland in 2007–2009, are public-private partnerships for speeding up innovation processes. Forty per cent of their funding is from private sources. Companies and research organisations work in cooperation with one another at the SHOKs, carrying out research that has been jointly defined in the strategic research agenda of each centre. Currently, six centres are in operation: the CLEEN Ltd (Energy and the Environment) is most relevant to climate change, but the FIBIC Oy (Finnish Bioeconomy Cluster) and RYM Ltd (Built Environment Innovations) centres also include research topics related to climate change.

New research information is communicated to decision makers, other stakeholders and the general public (see Chapter 9). A major step in this direction was taken when the Ministry of the Environment nominated the Finnish Climate Panel in December 2011 to enhance science-policy interaction between climate and energy policy as well as public discussion (Box 8.1).

According to the Finnish Science Barometer 2010, interest in the environment and nature is not as strong in comparison to the 2007 Science Barometer. Only 66 per cent (72 per cent in 2007) of people considered the environment and nature an interesting topic. Overall, Finns find matters relating to the environment and nature to be the third most interesting topic in science. Thirty-two per cent believe that science will help in stopping or slowing down climate change and 37 per cent feel that science will not offer solutions for climate change mitigation. However, 54 per cent of Finns think that science will have a significant role in solving problems related to energy production.

Box 8.1
Finnish Climate Panel

The idea for the Finnish Climate Panel originated in the 2009 Foresight Report on Long-term Climate and Energy Policy. The report concluded that an expert group is needed to support the Government's decision making in climate policy.

The Ministry of the Environment nominated the Finnish Climate Panel in December 2011 to enhance science-policy interaction between climate and energy policy as well as public discussion (see also Section 4.2.2 for tasks of the panel). Thirteen top researchers from relevant research areas were selected to serve on the Panel based on suggestions by universities and research institutions. The research areas represented on the Panel are climate science, environmental economics, environmental law, adaptation to climate change, education, energy economics, production and consumption, energy systems, the built environment, social policy and agriculture and forestry.

The Climate Panel prepares assessments on topics either proposed by the ministries or chosen by the Panel itself. Policy relevance is the main aim of the panel's outputs, and much emphasis is placed on communicating the results. The Panel works in a multidisciplinary fashion. Developing its working methods has been one of the key tasks during the first term of the Panel.

At the end of its first two-year term, the Panel will have published reports on the following themes:

- Assessment of the need for and opinions about the Climate Act
- Energy system and mitigation actions; summary report with the following sub-reports:
    - Decentralised energy production in the built environment
    - Heat pumps and combined heat and power production as part of the energy system
    - Climate impacts related to the use of forests and forest-based bioenergy
- Current issues in international and EU climate policy
- Environmentally and socially acceptable climate policy for agriculture
- Carbon neutrality
- Black carbon
- Built environment.

8.1.2 International activities

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.

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.

Finnish researchers have recently participated in the Global Forest Expert Panel (GFEP) and the 'Collaborative Partnership on Forests' coordinated by the International Union of Forest Research Organizations (IUFRO) and they have contributed to the report 'Understanding Relationships between Biodiversity, Carbon, Forests and People: The Key to Achieving REDD+ Objectives. A Global Assessment Report'.

Finland has actively participated in the work of the Intergovernmental Panel on Climate Change (IPCC). Finnish experts contributed to the Special Report on Renewable Energy Sources and Climate Change Mitigation (SR-REN) and the Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) both as authors and through participating in the review process for the report. Several experts from Finland served as authors for the IPCC Fifth Assessment Report (AR5) and many more experts participated in the review process. Due to their widespread expertise in greenhouse gas inventories and land-use issues, quite a few Finnish experts served as authors for the supplementary guidance material on methodologies for estimating anthropogenic greenhouse gas emissions by source and removals by sinks resulting from land use, land-use change and forestry: '2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol' and '2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands'. The results of the four-year research programme entitled Greenhouse Impacts of the Use of Peat and Peatlands in Finland (2002-2005) and of subsequent research in Finland have been used to prepare the supplement on wetlands.

In another major effort, Finland is overseeing the implementation and establishment of the ICOS (Integrated Carbon Observation System) organisation, which is a European distributed infrastructure for online, in-situ monitoring of greenhouse gases (CO_2, CH_4 and N_2O) necessary for understanding present-state and future sinks and sources. In 2014, the ICOS will shift from a preparatory phase (2008-2013) to an operational phase running until 2031. The ICOS links research, education and innovation to promote technological developments and demonstrations related to greenhouse gases. The ICOS Head Office is located in Helsinki, with the secondary node being in Paris. The ICOS puts into effect the GHG observations within the global GCOS (Global Climate Observing System) and GEOSS (The Global Earth Observation System of Systems) networks in Europe, and the data can be used to verify greenhouse gas inventories. The partners of ICOS-Finland are the University of Helsinki, the University of Eastern Finland and the FMI. Finnish funding for the ICOS will be around EUR 3 million annually during its operational phase (the ICOS is presented in more detail in Section 8.3.1).

Joint Programming is a European scheme that involves building a new approach with the aim of strengthening research and research funding cooperation in Europe in the interests of addressing certain specific societal challenges. Several of the currently ongoing Joint Programming Initiatives (JPIs) touch upon climate change themes, principally the Agriculture, Food Security and Climate Change (FACCE JPI) and Connecting Climate Knowledge for Europe (JPI Climate) initiatives. Finnish representatives are involved in the JPI governance for these initiatives; there are national support groups as well.

Finnish researchers have actively participated in climate-change-related research under the 7th framework programme of the EU, which started in 2007. By February 2013, more than 40 projects with Finnish participant organisations were being funded, mainly under the sub-programme on the environment. More than half of the Finnish participants were from research organisations, of which the FMI and the University of Helsinki were involved in the largest number of projects. The total cost of the more than 40 projects was approximately EUR 330 million. The projects involved nearly 1,000 organisations from different countries.

NOAK (the Nordic Working Group for Global Climate Negotiations) is a working group under the Nordic Council of Ministers. It was established in 2007 as part of the prime ministers' globalisation initiative and its aim was first to support the preparations for the UNFCCC climate negotiations in Copenhagen in 2009. After Copenhagen, the group received a more permanent status and its mandate was widened to support the climate change negotiations and achieve a global climate agreement with binding and ambitious goals. NOAK produces reports and studies for Nordic and international climate negotiators and it arranges workshops, meetings and side events and engages in projects that assist the negotiations. Finland has been chairing and coordinating NOAK since spring 2011. The chairmanship rotates every two to three years and can be extended, whereas the coordinator status is permanent.

Within the sphere of Nordic co-operation, the Top-level Research Initiative on Climate, Energy and the Environment, launched by the Nordic Council of Ministers in 2008, aims to bring new knowledge and innovation to solve major climate and energy challenges. Two of its sub-programmes, namely 'Effect Studies and Adaptation to Climate Change' and 'Interaction between Climate Change and the Cryosphere', include six Centers of Excellence and ten researcher networks with an overall strong Finnish participation.

Finland is a participant in the Arctic Monitoring and Assessment Programme (AMAP), which is an intergovernmental monitoring and research programme under the Arctic Council. The main goal of AMAP is to provide reliable and sufficient information on the status of, and threats to, the Arctic environment, and to provide scientific advice on actions to be taken in order to support Arctic governments in their efforts to take remedial and preventive actions relating to contaminants. AMAP monitors and assesses levels of pollutants and their effects on the arctic environment. Assessing the impacts of climate change on the Arctic environment is one of the priority areas. AMAP publishes non-technical assessment reports for decision makers and the general public and also more scientific reports. For example, in 2009 AMAP published two non-technical reports on climate change: 'AMAP 2009 Update on Selected Climate Issues of Concern' and 'The Greenland Ice Sheet in a Changing Climate'. In 2011, AMAP published a scientific report called 'The Impact of Black Carbon on Arctic Climate'.

Finland is a member country of the Barents Euro-Arctic Council, which is a forum for intergovernmental and interregional cooperation in the Barents Region. The Barents Region consists of the 13 northern regions of Finland, Sweden, Norway and Russia. In Finland, the regions are Lapland, Oulu and Kainuu. The BEAC is preparing an Action Plan on Climate Change for the Barents Region. The Action Plan will be finalised and adopted in autumn 2013, and it will include a limited number of selected measures and projects and identify concrete actions to be carried out by the working group for the BEAC. Finland, as a chair country of the BEAC Working Group on Environment (WGE) in 2012–2013, has been in a key role to promote the drafting of this Action Plan together with Norway, which is coordinating the work as a chair country of the BEAC in 2012–2013. BEAC WGE is working on the so-called Barents Environmental Hot Spots, where enhanced environmental and cleaner production measures will lead to CO_2 and black carbon reductions, among other things. In addition, the WGE is implementing several climate-relevant activities in the Barents Region, such as conferences and a project covering climate change mitigation and adaptation themes.

Capacity building activities in developing countries related to climate change research and systematic observation are described in Section 8.3.4.

8.2 Research

8.2.1 Major overarching research programmes and funding organisations

Programmes of the Academy of Finland

The first climate change research programmes of the Academy of Finland, SILMU (1990–1995) and FIGARE (1999–2002), funded almost a hundred projects and enhanced knowledge about 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 (see Fifth National Communication).

The currently ongoing Finnish Research Programme on Climate Change (FICCA, 2011–2014), by the Academy of Finland, was launched to respond to the scientific challenges posed by climate change on a broad front. One of the principles underlying the FICCA programme is to support the type of multidisciplinary research that addresses both social and the environmental areas — with the objective being a systemic approach to research problems. In the first call for applications in 2010, eleven research projects consisting of 44 sub-projects were granted funding for 2011–2014. In 2011, international joint calls were launched with Chinese and Russian funding partners and, eventually, six international joint projects were funded for 2012–2014. In the latest 2012 call, researchers were invited to submit applications for development research projects targeted at climate change research, as a result, the Ministry for Foreign Affairs of Finland and the Academy of Finland co-funded seven research projects for 2013–2014. Total funding of FICCA research projects is more than EUR 21 million, of which approximately one half is granted to universities and the other half to research institutes.

The Academy of Finland's Sustainable Energy (SusEn) research programme (2008–2012) was launched to produce new and innovative scientific knowledge about energy technology, energy systems and energy efficiency. Additionally, it was intended to direct research to developing sustainable solutions as well as know-how for identifying future energy system alternatives. The research was carried out from a multidisciplinary perspective, including such fields as bioenergy and nuclear power as well as medical and economic sciences. Future programmes under preparation by the Academy of Finland also include topics relevant for energy and climate.

Programmes of Tekes

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) was followed by the ClimBus programme (Business Opportunities in the Mitigation of Climate Change, 2004–2008; see fifth National Communication). The programmes helped to develop technologies, business concepts, products and services for reducing greenhouse gas emissions on a highly cost-effective basis. The currently ongoing programmes, such as Green Growth (2011–2015) and Groove – Growth from Renewables (2010–2014), generally have a wider scope, but their topics are also relevant for climate change mitigation. The aim of the Green Growth programme is to support the generation of innovations enabling significant leaps in energy and material efficiency and to create a foundation for developing new value networks based on green growth. In May 2013, a total of 46 funded projects were ongoing, about half of which were research projects, while the rest were enterprise projects. Several projects either have climate change mitigation as the core part of the project (for example, the 'Low carbon Finland 2050 Platform' project; see Box 8.3) or cover climate change mitigation in addition to other topics. The Groove – Growth from Renewables programme enhances the business capabilities of Finnish small and medium-sized enterprises working with renewable energy by improving their international competitiveness and by developing networks together with the financier network. Basically all the 71 ongoing or finished projects (in May 2013) contribute to climate change mitigation either by providing more knowledge through research or by supporting the business capabilities of the renewable energy companies. Tekes also funds research programmes co-ordinated by the Strategic Centres for Science, Technology and Innovation (SHOK). The research agenda of the strategic centre CLEEN – Cluster for Energy and Environment - focuses on smart grids, distributed energy systems and energy markets; future combustion engines and power plants; measuring, monitoring and environmental assessment; carbon capture and storage; and energy efficiency. Climate change related research is also carried out in other SHOKs such as FIBIC Oy and RYM Ltd.

The Finnish Environment Cluster Research Programme

The mitigation of climate change and adaptation to it was one of the five key themes of the fourth phase of the Finnish Environment Cluster Research Programme during the period 2006–2009. The programme was jointly financed by the Ministry of Employment and the Economy, the Ministry of Agriculture and Forestry, the Ministry of Transport and Communications and the Ministry of the Environment, which also coordinated the programme. Funding was also received from TEKES and the Academy of Finland.

Altogether, eleven projects dealing with this theme received funding (EUR 0.8 million). Policy relevance was one of the key criteria when selecting the projects. The topics ranged from modelling studies on burden sharing in climate negotiations to concrete assessments of the mitigation of flood risks. Active interaction between the research group and the policy experts of the various ministries took place during the programme.

Some projects in other theme areas of the programme (production and consumption as well as urban structure and living environment) have proven useful for climate policy purposes.

SETUILMU programme

The SETUILMU programme (2010–2011) of the Advisory Board for Sectoral Research funded nine research projects on climate policy. The main research topics addressed the impact assessment of mitigation measures, the coherence of climate policy and other policies, climate and greenhouse gas emission scenarios, and the synthesis of adaptation research. Cooperation between research projects and interaction between research and policy making were emphasised in the programme. Total funding of about EUR 1 million was granted by five ministries.

ISTO research programme on adaptation to climate change

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 on communicating the results in such a way that it is possible to make use 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 adaptation research still requires a great deal of study on the impacts of climate change. The trend in adaptation research is, however, moving from natural science studies towards comprehensive socio-economic studies.

The national adaptation strategy in 2005 emphasised the need for adaptation research. A comprehensive research programme (ISTO) was carried out during the period 2006–2010. The goal of the research programme was to produce information to support the implementation of the national adaptation strategy and to enhance the application of the research results. Research related to extreme weather events was among the priority areas. Some results of the ISTO projects are presented in Chapter 6.

ISTO was jointly funded by the Ministry of Agriculture and Forestry, the Ministry of the Environment and the Ministry of Transport and Communications. Annual funding was EUR 0.5 million. The projects covered the following research areas: climate services, extreme weather events, forestry, agriculture, food production, fish and fisheries, land-use planning and buildings as well as biodiversity. The following themes were also included in ISTO: international dimensions, socio-economic impacts and regional adaptation strategies.

In addition to the mid-term evaluation in 2009, a more comprehensive evaluation was carried out in 2011. The main observations were as follows:
- ISTO strengthened the national research capacity in adaptation research and provided added value in training new researchers and promoting networking;
- Some advances were made in socio-economic research, though the majority of studies continue to be made in the area of natural resources and their use;
- ISTO studies contributed to applied research and to adaptation planning;
- Communication of results has been active and application-orientated information has been disseminated to stakeholders;
- ISTO has contributed to a better understanding of extreme weather events;
- While being geared to application orientation, the quality of research has been high. There is variation in the scientific quality, but at least 200 scientific publications were prepared during the programme period as well as 400 articles for use by laypersons.

The main recommendations for future adaptation research are as follows:
- More and steadier funding for the future
- Strengthening coordinated adaptation research
- Reinforcing communication both internationally and to stakeholders in general
- Strengthening cooperation both within the programme and with international actors.

A summary report in Finnish was also prepared. It draws together the results of the ISTO programme as well as other recent adaptation research. The national steering group for adaptation served as the steering group for the summary report, which enhanced the policy relevance of the outcome. The report has been widely used, inter alia on the national web portal on climate change: Climateguide.fi. Since the ISTO programme ended, adaptation research has continued in research projects funded, for example, by the FICCA programme, by the EU and by the Nordic Research Council (see Sections 8.2.5 and 6.2).

Sitra, the Finnish Innovation Fund

The Finnish Innovation Fund Sitra is an independent public foundation. Its funding comes from the returns on the endowment capital (market value EUR 627 million), which Sitra manages, and from the returns on Sitra's capital investments. Sitra engages in foresight activities and provides funding for surveys, forward-thinking activities, experiments, and shared strategy processes that promote well-being and are ecologically and socially sustainable.

Sitra's Energy Programme (2008–2012) aimed at improving the energy-efficiency of the built environment, increasing energy awareness and creating new business opportunities from the transition that the energy sector is currently undergoing. For example, the programme promoted closely-produced renewable energy, zero-energy buildings, sustainable lifestyles, energy-efficient urban planning and emission reductions at a municipal level.

Together with the Ministry of the Environment and Tekes, Sitra developed the action plan 'ERA17 for an Energy-Smart Built Environment 2017' (see also Section 4.7.1). Sitra has invested a total of approximately EUR 9.1 million in projects carried out as part of the Energy Programme, contributing to some 80 projects. In addition, Sitra has invested in 9 companies and two international funds in the field.

The current projects and fund investments of Sitra include themes that promote climate change mitigation, such as resource efficiency.

Foundations

Some foundations have given considerable emphasis to climate change studies. The Maj and Tor Nessling Foundation is an important funding body in the field of environmental research in Finland. It has specified climate change as one of its focal areas. The activities of the John Nurminen Foundation have made a major contribution to boosting efforts to clean the Baltic Sea, where climate change is also a major challenge. In addition, the Kone Foundation and Maa- ja Vesitekniikan Tuki (the MVTT Foundation) have been active in this area.

8.2.2 Climate process and climate system studies

The FMI has its own research programme entitled Climate Change and a staff of around 80 scientists. With regard to climate process and climate system studies, the emphasis of the programme is on:

- Climate research and services (supplying climate data, studying atmospheric radiation, analysing extreme events, performing climate modelling and scenarios, doing impact and adaptation studies, including socio-economic aspects, and communicating climate change);
- Greenhouse gases (measuring greenhouse gas concentrations and fluxes and interpreting the measurements using modelling tools);
- Aerosols and climate (measuring aerosol properties, modelling aerosol dynamics).

The aerosol-climate research at the FMI concentrates on two main areas: the climatic influences of anthropogenic aerosols in both polluted and pristine regions and the role of natural boreal forest aerosols in the aerosol-climate system (see Box 8.2 on black carbon). It relies on field measurements, modelling, and laboratory work and satellite retrieval. The focus is on investigating:

- Aerosol-cloud interactions
- Aerosol optical properties
- Radiative forcing by atmospheric aerosols
- Atmospheric aerosol formation
- Climatic effects of absorbing aerosols into the atmosphere and snow and ice surfaces.

The FMI operates five stations in Finland that continuously measure climatically important aerosol properties. The most advanced of these is the Pallas-Sodankylä GAW station in northern Finland, where aerosol measurements were started in 1996. Other stations are located in 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 to improve the treatment of aerosol processes in climate models and investigate 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 analyses. In addition, algorithms for retrieving aerosol data from satellites have been developed.

The Universities of Helsinki and Eastern Finland and the FMI host the Finnish Centre of Excellence (CoE) in Physics, Chemistry, Biology and Meteorology of Atmospheric Composition and Climate Change (CoE status in 2002–2007 and 2008–2013). Its main objective is to reduce scientific uncertainties concerning global climate change issues, particularly those related to aerosols and clouds. Its research aims to create a deep understanding of the dynamics of aerosol particles and ion and neutral clusters in the lower atmosphere, with an emphasis on biogenic formation mechanisms and their linkage to biosphere-atmosphere interaction processes, biogeochemical cycles

Box 8.2
Research and Systematic Observation: Black carbon

A relatively large research community in Finland is working on different aspects of air pollution and aerosols. This work includes black carbon and its climatic effects. Relevant national black carbon (BC) measurement data are available from several key emission sectors (e.g. road traffic and domestic combustion).

The black carbon emissions and technological abatement potential have been calculated using the national integrated assessment model FRES (Finnish Regional Emission Scenario). This SYKE model incorporates source-receptor matrices at different spatial scales to assess PM dispersion and the resulting concentrations. The matrices have been developed in cooperation with the FMI. The dispersion from Finnish emission sources are estimated using source-receptor matrices with a spatial resolution of 10 km. In addition, the effect of sources with near-ground emission height, e.g. traffic and domestic combustion, can be assessed using matrices with a 1 km resolution. Long-range transported air pollution from other countries is assessed using EMEP source-receptor matrices.

At the FMI, BC studies are focused on its atmospheric effects and on its deposition on snow and the resulting decrease in snow albedo. Atmospheric BC is continuously monitored at six stations around Finland (Utö (FMI), Helsinki (FMI/UHEL), Virolahti (FMI), Hyytiälä (UHEL), Kuopio (FMI) and the Pallas GAW station (FMI)). The longest continuous time series is from Hyytiälä in central Finland and it dates back to 2004. The results from the monitoring stations show decreasing gradients from south to north and from east to west. The highest values are observed during wintertime. As shown in a recent regional aerosol-climate model study conducted by FMI, this is likely caused by residential wood combustion for heating. BC can be transported to the Arctic and can directly heat the atmosphere when the sun is up and also be deposited into snow and ice surfaces, causing earlier melting of snow and ice in the springtime.

The effect of BC on the surface albedo of snow and the advanced snowmelt has been studied in dedicated experiments during three winters by depositing known amounts of BC on the snow and observing how it affects the albedo and the melting process. BC clearly increases the melting rate and changes the albedo both directly and indirectly by changing the properties of snow as it absorbs sunlight and heats the snow. Laboratory studies are being conducted to find out how direct (absorption and scattering of solar radiation) and indirect (potential to become activated as cloud droplets) effects of BC change with its chemical aging in the atmosphere.

The deposition of atmospheric BC on snow has been studied at the Pallas-Sodankylä GAW station on a weekly basis during the snow season since 2008. Snow is collected for impurity analysis from one location. The snow samples are melted in a microwave oven, then filtered through sterilised micro-quartz filters (55 mm diameter). Dried filters are analysed using a Thermal/Optical Carbon Aerosol Analyzer (OC/EC) for their elemental carbon (EC) and organic (OC) concentrations, following the NIOSH 5040 protocol. These results, published in scientific journals, have shown that the BC concentrations in Sodankylä may sometimes be higher than reported elsewhere in the Arctic due to air masses originating from the Kola Peninsula.

and trace gases. The latest measurement techniques as well as modelling approaches are developed and utilised at the centre. The core activities include:

- Conducting continuous measurements and maintaining a database on atmospheric and ecological mass fluxes;
- Conducting 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. For example:

- At the Environmental Change Research Unit of the University of Helsinki, the central research theme is the development and application of empirical, computational and modelling tools to detect global environmental changes and analyse their ecological and societal impacts. They are particularly interested in longer term climatic changes and their focus is on Arctic environments.

- The Department of Geosciences and Geography at the University of Helsinki has specialised in dendrochronological research. The Dating Laboratory analyses the isotopic and elemental compositions of samples from different environmental archives, which contain detailed information about climate variability. In a joint effort with the Finnish Forest Research Institute (Metla), it has constructed the longest annual pine chronology in the world (7640 years) based on megafossil trees from lake bottoms. The chronology can reveal past changes and variability in northern climate after the last glaciation period. The Institute of Geography focuses on biological indicators in varved lake sediments. These are also studied at the Universities of Eastern Finland and Jyväskylä.
- The Finnish Geological Survey also studies varved sediments, with an emphasis on their physical properties.
- Metla uses tree-ring evidence in research on carbon isotopes and growth rates in the late Holocene period, and the data are used in temperature reconstructions for the northern hemisphere.

8.2.3 Climatic modelling and prediction

The FMI studies climate change using climate models that describe the physical and chemical processes of Earth's climate system. The modelling is based on cooperation with the Max Planck Institute for Meteorology in Hamburg. Components of the European Community Earth System Models (COSMOS) and the ECHAM[1] global climate model family form the basis of the climate modelling. The FMI also develops and uses the regional climate model REMO. Regional climate modelling is used to produce data for evaluating the societal impacts of climate change in northern Europe.

The model development at FMI includes aerosol and cloud parameterisation and related radiative transfer effects as well as atmospheric chemistry greenhouse gas exchanges. The FMI has in-house high performance computing (HPC) facilities for modelling.

For ocean climate research, the FMI utilises a regional set-up based on the NEMO-LIM3 model for estimating climate change and variability in the Baltic Sea and a global set-up for the Arctic Ocean and southern ocean research. A particular interest of the FMI is to develop sea ice dynamics and an ice thickness distribution model.

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 the 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

1 ECHAM is a global climate model developed by the Max Planck Institute for Meteorology.

also been provided by various 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 early and mid 2000, country-specific emission factors for fuel combustion and industrial processes were derived from research and measurement projects. With the introduction of the EU Emissions Trading Scheme, the responsibility for determining accurate emission factors for these sectors has largely been shifted to companies participating in the scheme.

In recent years, the focus of research to support the greenhouse gas inventory has been on developing methods and national parameters for estimating the carbon stock changes in the land use, land-use change and forestry (LULUCF) and agriculture sectors. In particular, methods to estimate carbon stock changes in soils have been developed and improved. The Finnish YASSO model[2] for estimating carbon stock changes in forest soils has been acknowledged internationally and is used in inventory preparation in other countries, too. At present, the Finnish Forest Research Institute, in collaboration with the Swedish agricultural university SLU, is conducting a research project to improve data on litter and dead wood input to forest soils as well as to define the most appropriate way to apply climate data in the model. The aim is to improve the accuracy of the estimates as well as to validate the appropriate use of climate data when applying the model. MTT Agrifood Research Finland has just finished another project to validate and verify that the YASSO model can also be used for assessing agricultural soils.

The research programme entitled Greenhouse Impacts of the Use of Peat and Peatlands in Finland and projects conducted as a follow-up to the programme have provided more accurate emission factors for CO_2, N_2O and CH_4 emissions from organic soils and peat extraction (see also Section 8.2.5).

Efforts to disseminate the results of the research have been made to support other countries in their inventory preparation efforts. In addition to publishing the results in internationals journals, the national emission factors and parameters have been provided to the IPCC Emission Factor Database (EFDB), which is a key source of information for developing countries in particular.

8.2.5 Research on the impacts of climate change, adaptation and mitigation

A large number of research institutes and universities have carried out research on climate change impacts, adaptation and mitigation in Finland. Several research institutions have organised their own climate-change-related programmes or research units. Close cooperation among research institutions is a characteristic feature of Finnish research on climate change impacts, adaptation and mitigation.

National research programmes, such as FICCA, ISTO and CLIMBUS (see Section 8.2.1), have provided funding and common goals for the research. The FICCA programme has had a key role in promoting cooperation between research institutes and universities.

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2 A dynamic decomposition model for assessing soil organic matter and litter developed by the European Forest Research Institute, Finnish Environmental Institute and Finnish Forest Research Institute.

The following presentation will mainly focus on research performed since the publication of the Fifth National Communication. The text aims to provide merely an overview and the descriptions are not exhaustive. More information on the research activities is available at the websites of the research institutes and universities (see the list at the end of Chapter 8).

Since the Fifth National Communication, the number of organisations performing climate change research has increased. Both sectoral research institutes and universities are active producers of new knowledge and of experts. Taking as an example the Academy of Finland's funding for climate change research in 2009–2012, which totalled more than EUR 50 million, nearly 20 organisations served as grant holders during the research period. Of these, the foremost research performer is the University of Helsinki; it is involved in dozens of projects. Of the other universities, the University of Turku, Aalto University and the Universities of Eastern Finland, Oulu and Jyväskylä are runner-ups with several climate change projects each. In addition, Hanken School of Economics, Lappeenranta University of Technology and the University of Lapland have one or a few projects each. Research institutes are also active: the Academy of Finland's scientific research funding has been granted to the FMI, Metla, the Finnish Environment Institute (SYKE), MTT, VTT Technical Research Centre of Finland, the Pyhäjärvi Institute, Pellervo Economic Research PTT, and the Finnish Game and Fisheries Research Institute.

Research on impacts and adaptation

The first national climate change programmes, SILMU and FIGARE, in the 1990s laid the foundation for building Finnish expertise and cooperation in climate change research. The ISTO programme during the period 2006–2010 enhanced work in actual adaptation research as well as in building national networks.

Research on the impacts of climate change and the adaptation of forests and forest management to climate change has been carried out by Metla as part of a six-year research programme, Functioning of forest ecosystems and use of forest resources in changing climate (MIL), which, together with another research programme by Metla (Bio-energy from forests (BIO), 2007–2011), has produced a synthesis report of the results. Currently, the impacts of climate change and the adaptation of forests are being studied in several research projects. Examples of these research projects include 'Plant-soil processes in peatlands under a warming climate (2011–2015)', 'Hydro-biogeochemistry of drained peatlands: impacts of bioenergy harvesting on trace metal transport under different hydrogeological settings (2010–2013)', 'Adaptability of silver birch (Betula pendula Roth) to global warming and changing water regime in future climate (2010–2013)' and 'Role of wood formation and transport capacity in acclimation of aspen and birch to changing climate (2011–2014)' (funded by the Academy of Finland). In 2013, a research programme (the Forests and Water Research and Development Programme (H2O), 2013–2017) was started; it covers the key components of the terrestrial water cycle, from the physiological processes of forest trees to the water cycle at the catchment level of the Baltic Sea. The aims of the H2O programme are to increase an understanding of the effects of climatic factors and their temporal changes on forests, to investigate the effects of forests and forest management on the water cycle and water quality and to find new methods for preventing their detrimental impacts, and to develop and provide new methods and planning tools for the conservation of waters and soils.

Research on the adaptation of agriculture to climate change has been carried out in particular at MTT. The research has included, for example, scenario analysis, adaptation of the food sector and related socio-economic impacts, and forage production in a changing climate.

Research on the impacts of climate change on inland waters, sea areas, water resources, land ecosystems and biodiversity has been carried out at SYKE. SYKE has also carried out climate impacts and risk assessments at different spatial and temporal scales.

Impacts and adaptation in the Arctic are intensively studied at the Arctic Centre at the University of Lapland (the northernmost university in the European Union). The focus is on polar and alpine snow and especially the glacier ice cover over both shorter and longer time scales. The research also covers the impacts of land use and climate change on biodiversity in terrestrial ecosystems and changes in the arctic environment and society.

Adaptation in the urban environment and questions related to the living environment and climate change have been studied inter alia at the VTT Technical Research Centre of Finland, Aalto University and Turku University. Extreme weather events, such as flood risks, are topical issues for urban planning and construction, and the interconnections between mitigation and adaptation activities are also important aspects of the research.

Assessments of climate-change-related risks take place in several of the above-mentioned research streams. The FMI provides expertise and cooperation in several such studies.

Research on climate change mitigation

Systemic and modelling studies on mitigation as well as analyses of mitigation policies are carried out at several sectoral research institutions. Tekes funding is crucial for technology developers who are seeking business opportunities in cleantech.

VTT Technical Research Centre of Finland has a central role in analysing and developing solutions for mitigation. Research efforts range across the key sectors, such as the energy industry, transport and the building sector, and they include developing renewable and other CO_2 neutral energy production options. One of VTT's key areas is work on scenarios and comprehensive assessments of energy policies. Energy Visions 2050, a book published in 2009, presented long-term developments in the energy sector from a global perspective. The options in Finland for a low-carbon future are being studied as part of an ongoing collaborative research project (see Box 8.3).

Mitigation measures in the agriculture sector are studied at MTT. Examples of research topics include the enhancement of sinks in agriculture and horticulture, the impacts of changes in climate and energy policy on agriculture, optimising pig feeding to reduce greenhouse gas production and multi-level integrated modelling and analysis of agricultural systems. MTT has also analysed the carbon footprints of various food products.

The interaction between energy and the forest sectors is important for the future of Finnish energy and climate policy. Metla is addressing these issues in the projects 'Policy measures for sustainable use of natural resources', and 'EU 2020 - Scenarios for the demand and supply of wood-based energy

Box 8.3
Low Carbon Finland 2050

Finland is currently preparing a national 2050 Roadmap (see Box 4.2). A major research effort called the 'Low Carbon Finland 2050 Platform' project is expected to provide relevant background material to the policy process.

The Tekes-funded joint project is being carried out by VTT, VATT, the Geological Survey of Finland (GTK) and Metla. The aim of the project is to identify robust roadmaps for a low carbon and competitive society.

The key aims of the project are to
- Assess strategic natural resources, focusing on forests and minerals
- Produce alternative scenarios on low carbon development paths up to 2050
- Develop a cooperative platform that could function as a future forum for a green economy.

VTT's strategic research project Low Carbon Finland (finalised in 2012) and especially its three scenarios provide a background for the Platform project. The low carbon scenarios describe how the EU low carbon economy targets are strict but within Finland's reach.

and their impacts on the forest sector in Europe'. Special emphasis is put on numerical modelling that combines economic behaviour, policy options and a description of forest resources. In addition, the feasibility, impact and business opportunities of various policy measures promoting carbon sequestration are being examined at a national level by Metla.

ForestEnergy2020 is a five-year (2012–2016) joint research and innovation programme of METLA and VTT. It covers the whole span of the forest energy value chain from biomass production and the supply chain to conversion plants and end use. The economic and ecological implications of all phases of the chain are within the scope of the research.

Climate change policies and measures and their implementation and impacts are extensively studied at SYKE. SYKE also carries out analyses of natural processes related to climate change and the environmental impacts of climate policies and measures, including their effects on carbon sinks.

Socio-economic research

In recent years, an increasing number of studies have assessed climate change problems from a transdisciplinary perspective and integrated various socio-economic aspects. An example is the TOLERATE project, 'The implications of climate change for extreme weather events and their socio-economic consequences in Finland', which is jointly being carried out by the Government Institute for Economic Research (VATT), SYKE, FMI and VTT. TOLERATE was an integrated natural science–social science project for assessing climate-changed-induced changes in extreme weather events and their social-economic consequences at a regional level. Another, more academic, example is the Finnish-Chinese joint project 'China and the EU in the context of global climate change – Analysis of changing economic structures and related policies' (CHEC). The Finnish partners involved in the CHEC project are the University of Turku and the Finland Futures Research Centre.

8.3 Systematic observations

The routine surface and upper air weather observations made by the FMI are the primary source of atmospheric observations relevant to climate change. The observations are archived in databases. The FMI plays also an important role in air chemistry and physical marine observations.

Climate-related observation activities have also been carried out by SYKE. It is responsible for monitoring the physical, chemical and biological state of inland waters. Since 2009, chemical and biological observations in marine areas have also been a part of SYKE's monitoring programme. Some climate-related observations are also made by other research institutes, e.g. Metla and MTT. Several universities also have activities in this area.

Most of the systematic, long-term observational activities are carried out by budgetary funding. However, some of the ongoing, more experimental observations carried out as a part of research projects and partly funded through R&D funding agencies may serve as basis for new systematic observations in the future.

In the sections below, the atmospheric, ocean and terrestrial observation systems are presented. The observation systems covered are those providing climate observations as well as other observations that are relevant for research on climate change impacts, adaptation and mitigation.

8.3.1 Atmospheric observing systems

Systematic meteorological observations have been made in Finland for more than a hundred and fifty years. In April 2013, the observation network is comprised of 3 meteorological observatory stations that include upper-air observations, 180 synoptic stations (of which six include manual observations) and 101 manual precipitation stations. Automation of the network continues.

Synoptic weather messages are for the most part transmitted from automated and semi-automated weather stations every three hours, though automated measurements are also supplied more frequently. Compared to synoptic messages, the observations of clouds and weather phenomena are limited. Observations of rainfall and snow are made once a day at precipitation stations. At some automated stations, precipitation observations are carried out every 10 minutes, which can be combined as hourly values.

The FMI has a network of 8 C-band Doppler radars, which were installed between 1993 and 2005. Between 2009 and 2012, four of the eight radars were replaced with new C-band, dual-polarisation 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 the GCOS in 2008 and the next report will be submitted by 1 January 2014.

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 European Climate Assessment & Dataset (ECA&D), which is a European collection of reliable, long-term climatic observations for climate change research. In addition, daily precipitation data are in use at the Global Precipitation Climatology Centre (GPCC).

In order to highlight the importance of long-lasting observation stations, a list of approximately 20 observations stations throughout Finland was proposed in 2013. These stations will form a minimum network that will be especially well looked after and continue to make observations of different weather parameters and whose continuity will be a priority in the future.

Since the beginning of 2013, the FMI data sets are free for public use. An online service for machine-readable observations will be made available in the summer of 2013. The data provided to the ECA&D is also available for public downloads.

The FMI has maintained a climatological database since 1959 consisting of the following components:

- Station metadata register
- Daily values (including precipitation observations)
- Monthly data
- Synop data
- Hourly values for solar radiation and sunshine hours
- Rawinsonde data
- Normal values
- Automatic weather station data since 1981
- Automatic synop data since 1998
- Mast data since 1986.

The archives are full of observations in analogue form that need to be digitised. The FMI is digitising these data, though currently it is focusing on precipitation and metar (airport) observations. The same work remains to be done for other variables, such as air pressure, wind and snow cover, and also for additional precipitation stations. Compiling daily meteorological series covering a long period is important for impact studies on 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 (EIG EUMETNET) is a grouping of 29 European National Meteorological Services that provides a framework for organising co-operative programmes between its Members in the various fields of basic meteorological activities. These activities include observing systems, data processing, basic forecasting products, research and development and training.

The main mission of EUMETNET is to help its members develop and share their individual and joint capabilities through cooperation programmes that enable enhanced networking, interoperability, optimisation and integration within Europe; its mission is also to enable collective representation with European bodies so that these capabilities can be exploited effectively.

The FMI has hosted the programme, which was established to improve the observation technology for severe weather conditions, and has been actively involved in the work of the European Climate Support Network (ECSN). The FMI is responsible for the Operational Programme for the Exchange of Weather Radar Information (OPERA) as well as for the EUMETNET training programme (EUMETCAL), which provides 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 the 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 have been used in scientific publications and have made 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 for the InGOS and GHG-Europe projects.

Finland is participating in the Integrated Carbon Observation System (ICOS) (see also Sections 8.1.1 and 8.1.2), which is a European research infrastructure for quantifying and understanding the greenhouse gas balance of the European continent and of adjacent regions. Both atmospheric concentrations and fluxes over different ecosystems are measured together with measurements taken over oceans and the Baltic Sea. The ICOS consists of national measuring stations, thematic centres focused on different aspects of atmospheric, ecosystem and aquatic studies, and a top-level organisation, ICOS-EU, which is coordinating the infrastructure.

The mission of ICOS is
- To provide the long-term atmospheric and flux observations required to understand the present state and predict the future behaviour of the global carbon cycle and greenhouse gas emissions.
- To monitor and assess the effectiveness of carbon sequestration or greenhouse gases emission reduction activities on global atmospheric composition levels, including the attribution of sources and sinks by region and sector.
- To set new standards for research instrumentation, measuring protocols and data processing.

The FMI maintains three atmospheric stations at Pallas, Puijo and Utö, which will be ICOS level 1 (top level) stations that continuously measure carbon dioxide, methane and carbon monoxide. Weekly sampling will include a broader selection of species similar to that of the GAW programme. The FMI also maintains five ICOS ecosystem stations that measure greenhouse gas fluxes above forest and wetland ecosystems. Altogether, the national station network now consists of 14 atmospheric and ecosystem stations that are ready to join the ICOS.

Additional observational activities carried out at the FMI are as follows:

- The FMI is responsible for 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.
- 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 Integrated Monitoring programme, which is coordinated by the United Nations Economic Commission for Europe (UNECE), refers to the simultaneous measurements of the physical, chemical and biological properties of an ecosystem over time and across compartments at the same location (stations in 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 a monitoring and warning system for 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 the European Topic Centre on Air Quality.

Aerosols have both direct and indirect effects on the atmosphere. The magnitude of these effects in terms of warming or cooling remains one of the most significant sources of uncertainty in climate models. As a part of the WMO's GAW programme, the scattering, backscattering, absorption and size distribution of aerosols are measured at Pallas. Aerosol optical depth is measured at the Pallas-Sodankylä GAW station and the 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 four AERONET stations in Finland, located in Hyytiälä (run by the University of Helsinki), Helsinki, Kuopio and Sodankylä (all run by the FMI); they are used for measuring aerosol optical depth as well as the microphysical and radiative properties of aerosols in the atmospheric column. The fifth station is at Hada el Sham in Saudi Arabia; it operates as part of the international cooperation between the FMI, King Abdulaziz University and the University of Helsinki.

Finland is a member of the European Space Agency (ESA) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). The ESA is focused on research and development projects and satellite missions, while the EUMETSAT is more orientated towards pre-operational and operational satellite missions. Both are active in the field of climate monitoring. The FMI hosts the EUMETSAT's Satellite Application Facility on Ozone & Atmospheric Chemistry Monitoring, O3SAF. In addition, the FMI participates in the satellite climate data programmes of the WMO, ESA and NASA as well as in the SAF on Climate Monitoring, where the focus is on surface albedo. At the SAF on support to Operational Hydrology and Water Management, the focus is on snow products.

8.3.2 Ocean observing systems

The FMI maintains networks of water level and water temperature observations in Finnish marine areas. There are 13 mareographs located along the Finnish coast and five wave buoys located in open sea areas of the Baltic Sea. 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.

Real-time information on the state of the Baltic Sea is provided by Algaline for the general public, the media and authorities. This 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 using autonomous flow-through measuring systems. The Algaline project is a forerunner in the field of unattended SOOP monitoring. It currently forms a state-of-the-art environmental monitoring system ranging from data collection and assimilation to Internet applications and products.

SYKE also administers the research vessels Aranda and Muikku, which are used for monitoring and research purposes. An information portal, www.balticseaportal.fi, is maintained by SYKE, the FMI and the Ministry of the Environment. SYKE's marine research and monitoring efforts aim to produce information and new solutions that will help decision makers promote the protection and sustainable use of the Baltic Sea. SYKE integrates a wide spectrum of marine, catchment, climate change and socio-economic research. This multidisciplinary research makes use of observations, numerical models, prognoses and socio-economical studies.

8.3.3 Terrestrial observing systems

SYKE is the national centre for monitoring the physical, chemical and biological state of inland waters. Many hydrological data series are quite long, particularly those related to the freezing and break-up of water bodies and the water levels of some large lakes. SYKE's cumulative database contains hydrological data from more than 2,500 sites (23 million results).

In addition, SYKE has water quality data from approximately 64,000 sampling sites and phytoplankton data from about 2,500 sampling sites. Special attention is paid to quality control for the produced data, e.g. by using certified personnel for sampling and standardised chemical analytical methods.

Finland reports terrestrial climate observations to several data bases. For example, runoff data are reported to the Global Runoff Data Centre in Germany and to the Nordic Runoff Data Centre in Sweden. Finland has reported cryospheric data to the National Snow and Ice Data Center (NSIDC) and lake water temperatures to a global project coordinated by the University of Nebraska.

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 from more than 500 water level and discharge observation points. This modelling system has also been extensively used in climate change research projects.

In addition to inland water observations, the monitoring of terrestrial ecosystems aids in detecting changes induced by climate change. Metla engages in phenology monitoring of most common forest trees and dwarf shrubs. Observations are made at 40 sites; the measurements focus on climatic conditions at the sites.

Integrated monitoring has become an important approach in environmental sciences. At SYKE, the multidisciplinary International Cooperative Programme on Integrated Monitoring (ICP IM) is one of the activities set up under the Convention on Long-range Transboundary Air Pollution (CLRTAP) to develop the necessary international co-operation for assessing pollutant effects and emission reductions. The key aim is to quantify the effects on the environment through monitoring, modelling and scientific review using data from catchments or plots located in natural or semi-natural forested areas with minimal disturbance. The international Programme Centre of the ICP IM is also located at SYKE.

Currently, about 60 national monitoring schemes or projects provide data concerning biodiversity in Finland. This monitoring work involves six research institutes: the Finnish Museum of Natural History, MTT, the National Board of Forestry, Metla, the Finnish Game and Fisheries Research Institute and SYKE. This work includes collecting information on the changes taking place in ecosystems and habitats, species and species communities, and genes and genotypes.

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 the years 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.

The forest damage advisory service at Metla (Metinfo) is responsible for answering inquiries and diagnosis about forest damages and diseases and making surveys of the actual damage, diseases and disease prognosis. A report on the forest damage situation is published each year. Metla also systematically collects information on the phenology of tree and forest berry species and prepares annual reports on the condition of the forest and observed damages as a part of a European network for monitoring the condition of the forests. The extent of climatic warming can thus be assessed on the basis of the time series for the bud burst of different tree species. Trends indicating a likely increase in the occurrence of forest damage can be detected to enable preventive measures.

Finland participates in the Sustaining Arctic Observing Networks (SAON) process, which was initiated by the Arctic Council in 2007 and formally established in 2012. Sustained observations are needed because climate change and other environmental changes have serious impacts both inside and outside the Arctic region and the trends indicate that the severity of the impacts will increase in the near future, subjecting Arctic countries and their peoples to new environmental, economic and societal challenges. The SAON process promotes the vision of well-defined observation networks that enable users to have access to free, open and high-quality data, which will help realise pan-Arctic and global value-added services and provide societal benefits. The goal of the SAON process is to enhance Arctic-wide observing activities by facilitating partnerships and synergies among existing observing and data networks and by promoting the sharing and synthesis of data and information. All eight Arctic Council states participate in the SAON process in close collaboration with international research and scientific bodies, including the International Arctic Science Committee (IASC) and the World Meteorological Organization (WMO).

8.3.4 Capacity building in developing countries

For many years, Finland has been operating extensive capacity building programmes around the world concerning climate observations, research, higher education cooperation relevant to climate change mitigation and adaptation, and the sustainable use of forests.

Climate data management systems have been implemented in several developing countries through Finnish development agencies and with considerable financial and personnel support. Institutional support for the capacity building programmes has mainly been channelled 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 FMI is engaged in several projects for the Finnish Ministry for Foreign Affairs, the European Union, the World Bank and other partners to develop the institutional capacities of national meteorological and hydrological services (NMHSs) in developing countries through various activities. In all countries, the national weather service is the de facto official responsible for 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 provides benefits to society through the delivery of more timely and accurate weather and climate services to the public.

Many of the FMI's projects represent a continuation of earlier activities (see the Fifth National Communication). The ongoing FMI capacity building activities include:

- Caribbean SIDS 2010–2012 and 2013–2016: improving regional cooperation and cross-sectoral dialogue for early warning systems designed to improve disaster risk reduction related to the weather and climate hazards facing the small island developing states of the Caribbean through a partnership with the Association of Caribbean States, the Caribbean Meteorological Organization and the Caribbean Institute for Meteorology and Hydrology as part of the SHOCS I and SHOCS II projects.

- Pacific SIDS 2009–2011 and 2013–2017: increasing the capacity of Pacific Small Island Developing States to produce and deliver weather and climate services tailored for the needs of the most vulnerable communities, improving regional coordination for developing early warning systems, improving cooperation with local stakeholders and NGOs in partnership with the Secretariat of the Pacific Regional Environmental Programme, the Secretariat of the Pacific Community and the International Federation of Red Cross and Red Crescent Societies through the FPPICS and FINPAC projects.
- Andes 2013–2016: improving disaster risk reduction efforts in Bolivia, Colombia, Ecuador and Peru through the Regional Andean Programme to Enhance Weather, Water, Climate Services and Development (PRASDES) in partnership with the International Centre for the investigation of El Niño Phenomenon (CIIFEN) and SYKE.
- Central Asia 2010–2013: institutional capacity building and regional training activities for the Central Asian NMHSs (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) through the WMO Regional Training Centre Tashkent to improve weather observations and services and promote cross-border cooperation in the region.
- South East Europe 2012–2014: improved resilience to natural hazards and increased regional cooperation between the national weather, climate and water services through a joint UNISDR and WMO capacity development project aimed at supporting weather and climate services.
- Ecuador and Colombia 2012–2014: individual institutional capacity building projects to improve the quality and quantity of weather and climate observation data as a means of supporting improved weather and climate services.
- Sudan 2012–2014: institutional capacity building to support the modernisation of the Sudan Meteorological Authority and the newly formed South Sudan Meteorological Service, especially in observation and aviation weather services delivery.
- Nepal 2010–2012 and 2013–2016: continuing institutional capacity building project to improve the observation data management and weather forecasting systems at Nepal's Department of Hydrology and Meteorology.
- Vietnam 2010–2012 and 2013–2016: continuing institutional capacity building project to improve the observation data management and weather forecasting systems at the National Hydro-Meteorological Service of Viet Nam.
- Malawi 2012–2014: promoting urban adaptation to climate change in Salima and Lilongwe in Malawi together with the Malawi Red Cross Society through improved early warning and weather services provided by the Malawi Meteorological Service.

In addition to the above-mentioned list of ongoing activities, the FMI will begin capacity building projects in, for example, Bhutan, Bolivia, Tajikistan, Kygryzstan and India in the coming years; the projects will focus on institutional capacity building of the national meteorological (and hydrological) services, including observations, services, data management and strategic planning.

The Finnish Ministry for Foreign Affairs has supported higher education cooperation in developing countries for several years. It has funded two programmes that contribute to the Millennium Development Goals for reducing poverty and supporting sustainable development and that are in line with Finland´s development policy guidelines. Since 2004, the Ministry for Foreign Affairs has funded the North-South-South (NSS) Higher Education Institution Network Programme, the purpose of which is to develop partnerships between HEIs in the North and South and enhance human capacity in all participating countries through interaction and mobility. The Higher Education Institutions Institutional Cooperation Instrument (HEI ICI) Programme, which contributes to capacity development by promoting administrative and educational development in developing countries, was launched in 2009.

A total of 15 applications were functional in 2010–2012. Projects have been implemented mainly in African countries, even though other projects were distributed across the world: Cambodia, Egypt, Indonesia, Kenya, Laos, Namibia, Nigeria, Mozambique, the Palestinian territories, the Republic of South Africa, Sudan, Tanzania, Uganda, Vietnam and Zambia. The projects represent different fields, such as agriculture, business studies and management sciences, education sciences and teacher training, social sciences, natural and medical sciences and engineering, communication and ICT as well as humanities. The majority of the projects have not only contributed to the development of curricula and degree programmes but have also improved teaching quality and pedagogical methods. Some projects have had an explicit objective of organisational development or of improving information systems.

In spring 2013, new projects were approved and a total of 23 projects received funding for the years 2013–2015. For instance, the following projects directly target climate change issues:

- Nepal, Ethiopia: Curricula Development for Efficient Lighting and Renewable Energy Technology – CELRE (Aalto University, EUR 0.3 million)
- Sudan: Landscape Planning and Management Training for the Environment in South Sudan – LAMPTESS (University of Helsinki, EUR 0.5 million)
- Laos, Cambodia, Myanmar: Sustainable Climate Change and Energy Education Development – SUCCEED (University of Turku, EUR 0.4 million)
- Mozambique: Higher education and capacity-development for sustainability (Aalto University, EUR 0.3 million).

The Academy of Finland and the Finnish Ministry for Foreign Affairs annually fund problem-oriented and multidisciplinary development research projects. In 2012, there was an additional targeted call to fund research projects investigating the impacts of climate change in developing countries. The seven two-year projects receiving funding are expected, among other things, to generate knowledge on climate change in developing countries, to increase multidisciplinary knowledge and know-how and promote the establishment of multidisciplinary research environments in developing countries, and to create new research-oriented networks between Finland and developing countries.

Metla has been active in promoting the sustainable use of forest resources in developing countries. The activities have focused on resource assessment and the prediction of forest resources. Metla's activities include

- Mongolia, 2013–2015: Strengthening Research Capacity for Sustainable Forest Management in Mongolia (StreFoMon). The project focuses on capacity building for sustainable forest management in Mongolia, based on silvicultural research.
- Costa Rica, 2010–2012: Capacity Building in Forest Management (CAPFOR) within the Framework of the Mesoamerican Agroenvironmental Programme. The project has concentrated on growth and yield models, the utilisation of data bases and GIS techniques.
- Mozambique, 2012–2014: Forest Research Capacity Strengthening (FORECAS). The project aims to strengthen the capacity of the partner organisations (IIAM and UEM-FAEF) to conduct applied research applicable to local stakeholders, while also striving for sustainable forest management in the use of natural forests
- Kenya, 2013-2014: Improving the capacity for forest resources assessment in Kenya. The project aims to increase the capacity of partner agencies involved in forest and tree resource assessment by strengthening human and technological capabilities to collect, manage and disseminate forest information.
- Soil survey results for Tanzania, 2013. The project contributes to the analysis of soil sample data from National Forest Resources Monitoring and Assessment to estimate soil carbon for different land-use categories and vegetation types.
- Vietnam, 2012–2013: Improving National Forest Assessment and Monitoring Program in Vietnam. The objective is to, based on the current National Forest Inventory Monitoring and Assessment Program of Vietnam, prepare an improved inventory (activities, methodologies, staff, funds, organisation).

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Arctic Centre at the University of Lapland, http://www.arcticcentre.org/?deptid=9015

Arctic Monitoring and Assessment Programme, http://www.amap.no/

Centre of Expertise Programme (under the Ministry of Employment and the Economy), http://www.oske.net/en/

Climate Change Adaptation Research Programme (ISTO), http://www.mmm.fi/en/index/frontpage/climate_change_energy/adaption/adaptation_research.html

Cluster for Energy and Environment (CLEEN), http://www.cleen.fi/en/

Environmental Research Cluster Programme, http://www.ymparisto.fi/default.asp?contentid=105793&lan=en

FICCA research programme on climate change, http://www.aka.fi/en-GB/A/Programmes-and-cooperation/Research-programmes/Ongoing/FICCA/

Finnish Environment Institute (SYKE), http://www.syke.fi/en-US

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IPCC Emission Factor Data Base, http://www.ipcc-nggip.iges.or.jp/EFDB/main.php

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9 Education, training and public awareness

This chapter describes how climate change is included in the educational system of Finland, 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. The role of ministries, local authorities, other public bodies and private agents is explained and many climate change or energy saving campaigns are presented.

Photo: Tapio Heikkilä / Image bank of the Environmental Administration

9 Education, training and public awareness

9.1 General policy

Climate change is firmly anchored in the educational and public awareness policies and practices of the Government, and these policies and practices are under continuous development. Climate change issues are included in basic education and upper secondary level education as part of education on sustainable development. Climate-change-related topics are also addressed by universities and polytechnics (Section 9.2).

The National Energy and Climate Strategy (2013) states that citizens should be provided with up-to-date information on all aspects of the Government's climate and energy policy. Information, guidance, best practices and tools are provided to help consumers make climate friendly choices in their everyday lives (see Section 9.4). International training activities are carried out, for example, by higher education institutions, and capacity building activities are also carried out as part of development cooperation (Section 9.3).

Under the New Delhi Work Programme, launched at the 8th Conference of Parties to the UNFCCC (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 implementing and taking into account national circumstances and priorities. The programme was reviewed at COP 13 in 2007, resulting in a request that the Parties report on their further efforts in implementing the programme.

The activities described in this chapter include Finland's efforts at implementing the New Delhi Work Programme. In particular, the activities of local governments are described in Section 9.4.3 and the activities of NGOs in Section 9.4.4. At the end of this chapter, there are short descriptions and Internet links to the projects, networks and campaigns being carried out by various stakeholders. The Climate Arena, a network for ministries and stakeholders (e.g. industrial and environmental NGOs, research institutes and labour unions) to discuss climate policy, is presented in Section 4.2.3.

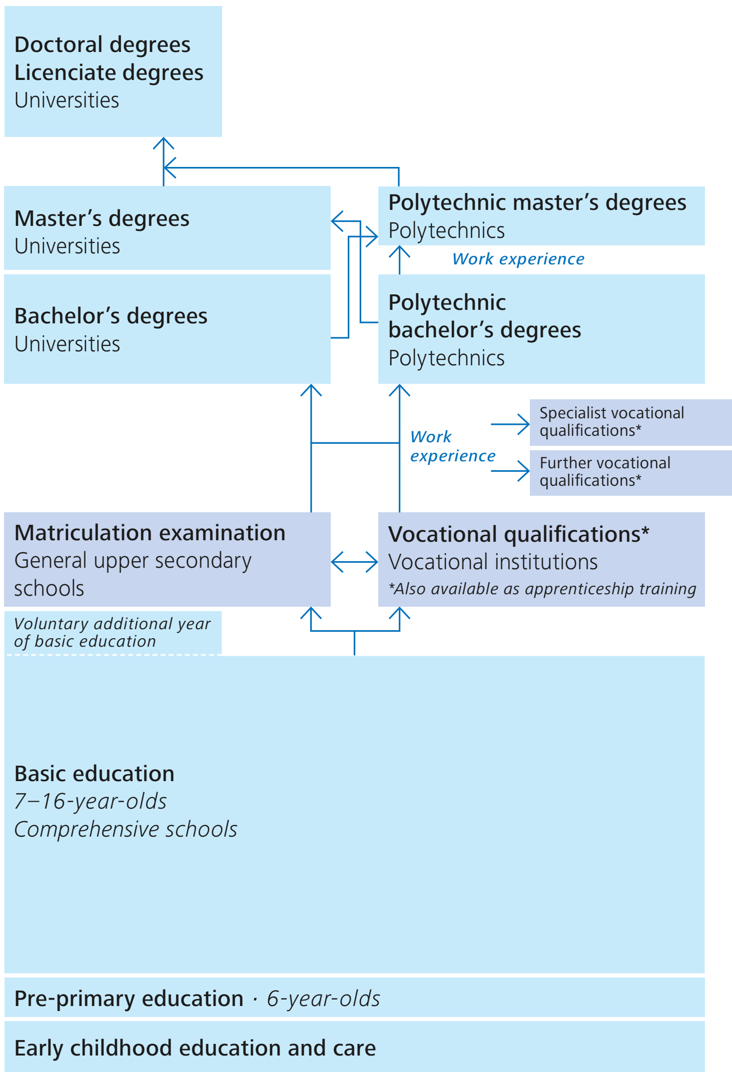
9.2 Education

9.2.1 Education policy

All children in Finland receive compulsory basic education (comprehensive school) between the ages of 7 and 16. Almost all 6-year-olds participate in voluntary pre-primary education. Students who have successfully completed compulsory education are eligible for general (duration 3-4 years) and vocational upper secondary education and training (duration 2-4 years). More than 90 per cent of the relevant age group starts general or vocational upper secondary studies immediately after basic education. Completion of upper secondary education gives students the eligibility to continue to higher education (Figure 9.1).

Higher education is offered by universities and polytechnics. Both sectors have their own profiles. Universities emphasise scientific research and instruction. Polytechnics, also known as universities of applied sciences, adopt a more practical approach. A network of 14 universities and 25 polytechnics covers the whole country. At universities, students first complete the bachelor's degree, after which they may pursue the higher master's degree. As a rule, students are admitted to study for the higher degree. The target time for completing a master's degree is generally five years. Universities also arrange separate master's degree programmes with separate student selections, for which the entry requirement is a bachelor's level degree or correspond-

Figure 9.1
Finnish education system



ing studies. At the universities, students can also study for scientific or artistic postgraduate degrees, which are the licentiate and the doctorate degrees.

It takes approximately 3 to 4 years of full-time study to complete a polytechnic degree. Degree studies provide a higher education qualification and practical professional skills. The annual enrolment in universities is about 20,000 students, almost one third of the age group. Polytechnics admit some 38,000 students annually.

Educational institutions organise education and training intended for adults at all levels of education. Adult education comprises education and training leading to a degree or certificate, liberal adult education and staff-development, and other training provided or purchased by employers as well as labour market training, which is mainly targeted at unemployed people. Efforts have been made to make the provision as flexible as possible in order to enable adults to study and work at the same time.

One of the basic principles of Finnish education is that all people must have equal access to high-quality education and training. Education is free at all levels from pre-primary to higher education (degree education). Currently there is a fixed-term trial of charging tuition fees to citizens of non-EU/EEA countries in master's programmes taught in foreign languages in universities and polytechnics.

The Finnish school system has received high scores in the international PISA (Programme for International Student Assessment) comparison, which is an appraisal of 15-year-olds done every three years organised by the OECD. In 2006, Finland was ranked at the top in scientific literacy, and in 2009, when the PISA comparison focused on reading literacy, a comparison of 65 countries put Finnish schoolchildren third.

All schools in Finland are connected to the Internet. Around 80 per cent of 16 to 74-year-olds reported using the Internet on a daily basis in 2012. All municipalities have at least one free public library. About 70 per cent of Finns use libraries, which is the highest share among EU countries. The circulation of daily newspapers has decreased by 20 per cent during the last decade (355 per 1,000 adults in 2011). At the same time, the use of electronic media has grown rapidly.

9.2.2 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. Many subjects deal with sustainable development and climate change, and they are also dealt with as a cross-curricular theme. Teachers decide upon the context and the manner in which the issues are taught. The teaching should form a systematic learning path, one that progresses 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, evaluate the impacts of their own consumption and adapt their behaviour to support sustainable development. Currently, the Core Curriculum is under revision.

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. Also, the Core Curriculum for Upper Secondary Schools will be revised shortly.

The National Core Curriculum for Upper Secondary Vocational education defines sustainable development as one of its key skills. It is included in the qualification modules with a field-specific emphasis and is assessed as part of vocational skill 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.

The national strategy for education for sustainable development (2006-2014) set targets for compiling sustainable development plans (SD plan) and certifying sustainable development work in schools and educational establishments. The targets specified that all Finnish schools and educational establishments needed to have a SD plan in place by 2010, and that 15 per cent of them will need to have acquired external certification for their sustainable development work by 2014. Currently, around half of the schools have prepared or are preparing a SD plan and the share of external certifications is around 10 per cent.

The main aims of the Sustainable Development Certification of Educational Establishments (see links at the end of chapter) are

- To develop the quality of teaching, the learning environment and the operations of educational establishments,
- To implement education for sustainable development in teaching and the school culture via a comprehensive approach.

The Sustainable Development Certification scheme was started in March 2004 as an environmental certification. In 2010, the environmental criteria and certification system were updated to cover the environmental, economic, social and cultural aspects of sustainability. The criteria apply to basic education and to general and vocational upper secondary education. The new criteria and related self-evaluation tools are based on the principle of a quality circle (plan, do, check, act) and can be applied through quality systems. They provide a systematic tool for the planning of teaching and for constructing sustainable development programmes.

Many projects, networks, campaigns or competitions in and between schools support the teaching on sustainable development and climate change; they give pupils a chance to make use of their knowledge and provide teachers with opportunities for in-service training. Environment Online – ENO, RCE Espoo (Regional Centre of Expertise on Education for Sustainable Development), and Finland's Science Education Centre LUMA are examples of such projects (see Boxes 9.1, 9.2 and 9.3). More information and examples can be found 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 in the present decade with good results.

Box 9.1
Environment Online – ENO

Environment Online – ENO is a global virtual school and network for sustainable development that has been in operation since 2000. The ENO programme is coordinated and maintained by the ENO Programme Association based in the city of Joensuu, Finland.

The ENO Programme Association was represented at the Rio+20 Sustainable Development Summit in June 2012, where it was recognised as being in the top 10 in the 'sustainable cities and innovation' category. The most important recognition was that the ENO '100 Million Trees by 2017' campaign was one of the 10 commitments out of 700 that was mentioned in the Rio Summary of Commitments.

Through the ENO programme, environmental themes are studied throughout the school year and campaigns are arranged simultaneously around the world. More than 10,000 schools from 150 countries have taken part in the programme activities since 2000. Schools have made concrete commitments to the environment; for instance, schoolchildren have planted five million trees so far.

Box 9.2
RCE Espoo –
Regional Centre of Expertise on Education for Sustainable Development

The city of Espoo was the first Finnish city to join the Regional Centre of Expertise on Education for Sustainable Development (RCE) network in 2011. The goals of the RCE Espoo network are to

- Raise awareness of and understanding about well-being and sustainable development and how to act in a sustainable way;
- Integrate sustainable development as a part of education and everyday practices in daycare and all educational institutions;
- Increase the expertise of teachers and other personnel in daycare and educational institutions through offering training, methods and materials;
- Create practices that help every resident in the city to take care of the environment and participate actively in developing the city according to the principles of sustainable development.

The RCE Espoo consists of the city's Education and Cultural Services, its Social and Health Services, its Environment and Technical Services, Omnia (the Joint Authority of Vocational Education in Espoo Region), Laurea Polytechnic, Metropolia Polytechnic, Aalto University, Helsinki University and many associations and private companies dedicated to promoting sustainable development. The RCE programme is an initiative of the United Nations University's Institute of Advanced Studies (UNU/IAS). Within the RCE network, existing formal, non-formal and informal educational organisations are mobilised to deliver education for sustainable development by translating its global objectives into the context of the local communities in which they operate.

9.2.3 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.

Polytechnics also include education related to climate change in their degree requirements and master's degree programmes, such as environmental engineering, energy engineering and sustainable development.

Box 9.3
Science Education Centre LUMA and National LUMA-network

Finland's Science Education Centre LUMA is an umbrella organisation coordinated by the Faculty of Science of the University of Helsinki to bring schools, universities and industries together. LUMA coordinates cooperation between schools, universities, business and industry in Finland. It aims to promote meaningful and relevant learning and studying and teaching on natural sciences, mathematics, computer science and technology. A national LUMA network has also been established. LUMA celebrated its tenth anniversary in 2013.

Supporting lifelong learning for children and young people is centred on activity clubs, summer camps and the virtual club Ksenonit, Science Day and the webzine Luova for young people. The activities aim to deliver positive experiences to children and young people in the LUMA subjects. At the same time, natural interaction with the scientific community at the university is fostered. The centre organises a great number of science clubs and camps each year. The international Millennium Youth Camp has been organised annually since 2010. Subject teachers' and primary education teachers' lifelong learning is supported via workshops, summer courses and an annual LUMA Science Fair.

Climate issues are also included in the sustainable development teaching given as a part of teacher education, which in Finland is a university-level programme for all teachers throughout the education system. The Finnish National Board of Education also funds and organises in-service training for teachers on sustainable development. Nevertheless, only a fraction of 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

Many higher education institutions and research institutions in Finland provide international training and cooperate with research and higher education institutions as well as governmental institutions in developing countries to support institutional development. Some examples are presented below.

Global responsibility is one of the main aims of the strategy for the Internationalisation of Higher Education Institutions in Finland 2009–2015. The higher education institutions are expected to utilise their research and expertise to solve global problems and to consolidate the knowledge base in developing countries. All eligible students, regardless of their nationality, can apply for the higher education degree programmes. Around 20 per cent of degree programmes in higher education institutions are international degree programmes with English as the teaching language. In 2011, the share of international students in polytechnics was 6.2 per cent and in universities 5.2 per cent.

Six out of 12 master's degree programmes at the University of Eastern Finland's (UEF) Faculty of Science and Forestry directly target the sustainable use of natural resources and climate change mitigation. During the past decade, these programmes, run in partnerships with European, North

American, Russian, Chinese, Brazilian and Ghanaian universities, have trained more than 100 experts representing more than 50 nationalities. Furthermore, the UEF Faculty of Science and Forestry trains international climate change specialists in its doctoral programme in forest sciences and its doctoral programme in the biology of environmental change. Furthermore, post-graduate training in arctic biogeochemistry is part of the Nordic Center of Excellence's 'Impacts of a changing cryosphere: Depicting ecosystem-climate feedbacks from permafrost, snow and ice (DEFROST)' network.

The training of experts from developing countries in managing forests and other natural resources is an integral part of the agricultural and forest science programmes at the University of Helsinki. One example is the Viikki Tropical Resources Institute (VITRI), which is part of the Faculty of Agriculture and Forestry; the institute has maintained a strong focus on rehabilitating 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.

The Sustainable Global Technologies (SGT) programme is a multidisciplinary educational programme at the Aalto University School of Engineering. The SGT programme aims to increase awareness, education and research in the fields of sustainability, development and technology. It offers a special module in Sustainable Global Technologies at Aalto University. The SGT programme is an example of a UN Habitat Partner University Initiative; it is also collaborating with the United Nations Environmental Progamme (UNEP). Aalto University is also one of the partnering universities in the Environomical Pathways for Sustainable Energy Services (SELECT) master's degree programme. SELECT is part of the Erasmus Mundus Programme, an EU-funded cooperation and mobility programme that aims to enhance the quality of European higher education and to promote dialogue and understanding between people and cultures through cooperation with third countries. SELECT will be extended to include a doctoral programme as well.

The number of training activities related to development cooperation has increased in recent years. This is partly due to the newly initiated and nationally funded development cooperation programmes, such as the Institutional Capacity Initiative for Higher Education Institutions (HEI-ICI) and the North-South-South Higher Education Institution Network Programme (NSS) (see Internet links at the end of the chapter for more information). Both programmes include projects related to sustainable development and also specifically to climate change.

The UEF currently coordinates NSS and HEI-ICI projects in, for example, West Africa, Ghana, Kenya and Venezuela. The UEF Faculty of Science and Forestry coordinates and participates in various education and research projects that aim at capacity building in the areas of sustainable forest use and environmental studies. Currently, projects are being carried out in West Africa (Sierra Leone and Burkina Faso), Venezuela, Ghana, Uganda, India and Kenya. These projects deal with bioenergy issues and carbon sequestration and concentrate on, for example, strengthening climatic know-how through curriculum development in local universities. VITRI is an active participant in the development of the forestry sector in Sudan, Kenya, Ethiopia, Thailand, Indonesia and Laos.

Seven development research projects on climate change are currently being jointly funded by the Ministry for Foreign Affairs and the Academy of Finland with total of EUR 2 million as part of FICCA, the Academy of Finland's Research Programme on Climate Change (2011–2014). The aim is that the research projects will result inter alia in new cooperation networks, consolidate multidisciplinary scientific knowledge in developing countries and increase the mobility of doctoral students and researchers between Finland and developing countries.

The Finnish Meteorological Institute (FMI) has coordinated several development co-operation projects funded mainly by the Finnish Government. Most of these projects are funded using the Institutional Cooperation Instrument (ICI), which enables small-scale cooperation with partner institutes concentrating mainly on human capacity building. The projects coordinated by the FMI always include a strong training component and the subjects of the training typically include adaptation to climate change. For example, the training has covered adapting to the changes in the intensity and frequency of extreme weather events that require wide-ranging development of early warning services. The sectors that benefit from the training include traffic, agriculture, health and energy production. The FMI also trains researchers from other countries, either in their own countries (for instance, in Africa and Central Asia) or in Finland. More information on climate-change-related capacity building projects being carried out in developing countries is presented in Chapter 7 and Section 8.3.5.

The Nordic office of the Energy and Resources Institute (TERI, India) was established in 2012 at the UEF to promote collaborative activities between organisations in the Nordic region and India on issues related to sustainable forestry, bio-economy and renewable energy. The TERI Nordic office provides a platform where academic and business communities can interact with each other in joint research collaboration and transfer of technological know-how.

The Finnish University Partnership for International Development (UniPID) network is presented in Box 9.4. More information and examples can be found at the end of this chapter.

Box 9.4
The Finnish University Partnership for International Development (UniPID)

UniPID is a partnership network between ten Finnish universities established in 2002. The UniPID collaboration supports Finnish universities in the promotion and implementation of sustainable development in higher education. UniPID fosters the exchange of knowledge between Finnish universities and universities in developing and transition countries. The network works to strengthen institutional partnerships between scholars and institutions in Finland and in the South.

UniPID takes part in many activities to build the capacity of students, researchers, institutions and development networks. Among other things, UniPID offers virtual courses (around 15–20 courses with more than 400 participants annually) free of charge for all students enrolled at universities within the UniPID network. Virtual courses are based on distant learning over the Internet and emphasise the role of discussion and networking between the participants, who are responsible for their own learning.

Besides the virtual studies programme, UniPID promotes and disseminates education and knowledge capacity. It is involved in several EU-funded projects, organises networking and roundtable events, international conferences and seminars and promotes the use of its members' expertise in policy formulation.

9.4 Public awareness

According to the Eurobarometer published in 2012, climate change is considered the most severe environmental threat by the Finns. On the other hand, the concern of Finns over climate change has decreased somewhat since the years 2006–2008. The reasons suggested by recent studies are that concerns about the economy and employment supersede concerns about climate change; global warming seems to occur too slowly and be too far away to continuously dominate public discussion; and the slow progress of global climate negotiations does not maintain the interest of the general public.

Numerous studies have indicated that the Finns know quite well what climate change is and understand the need to curb it. In a recent study, most respondents thought they know enough about climate change, but still half of them stated that they would like to have further information about it.

Recent surveys also indicate that up to 85 per cent of Finns take actions to mitigate climate change. On the other hand, only a quarter of them were able to spontaneously specify some of their actions.

The media coverage of climate change has been extensive in Finland. Partly as a result of the media debate, some issues are considered serious environmental problems by the general public; some risks are amplified while others are attenuated. The representation of climate change issues during the period 1990–2010 in the most widely-read Finnish newspaper, Helsingin Sanomat, was studied in a recent PhD thesis. The results showed that the amount of newspaper content on climate change has generally increased, but that the fluctuation has been considerable. The peaks of the climate coverage have been caused particularly by international policy negotiations and mild and snowless winters. Other contributing factors have included the releases of major scientific reviews, expressions of concern by key actors and the related debate on energy policy. On the other hand, changes in greenhouse gas emissions have only had a marginal impact on the level of coverage.

9.4.1 Climate change communication

Communication on climate change is handled by several different ministries and Government research organisations, each within the sphere of their own tasks and responsibilities. Most communication activities are carried out independently by the various Government bodies and the range of communications actions vary, for example, from press meetings and newsletters to web portals and seminars.

With climate change communication being handled by different organisations, there has been a need for cooperation to ensure that the actions are coordinated. Officially since 2010, the Ministry of the Environment has been coordinating cooperation on climate communications. At the moment, the Steering group for Climate Communications consists of all relevant ministries (the Ministry of Agriculture and Forestry, the Ministry of the Environment, the Ministry of Employment and the Economy, the Ministry of Transport and Communications, the Ministry of Education and Culture, the Ministry for Foreign Affairs), research organisations (the Finnish Environment Institute (SYKE) and the FMI), the Association of Finnish Local and Regional Authorities, Motiva Oy (see Section 9.4.2), and the think tank Demos Helsinki.

The aim of the cooperation is not only to coordinate climate and energy-related communications, but also to accomplish common communications projects and share best practices and expertise. The cooperation makes it possible to consider climate change communication from a wider perspective than that of each individual organisation.

The steering group has introduced a common newsletter called 'Klimaatti'. It is published on the Internet four times a year in Finnish. Each issue features articles on climate change mitigation and adaptation, current research, eco-efficiency, energy consumption, international negotiations and legislation. The newsletter has proven to be an efficient tool for gathering together important information on climate politics and research. At the moment, the group has launched a common project on how to visualise climate change and a project that aims to raise awareness about the IPCC's fifth assessment report. It is also planning media training for climate researchers and experts.

At the end of 2011, the Finnish Ministry of the Environment nominated an interdisciplinary and independent Climate Panel to enhance communication between science and politics in issues related to climate change (see Section 4.2.2 for the role of the panel in policy making and Box 8.1 for its research activities). The Climate Panel has actively participated in public debate on climate change and increased awareness about scientific facts pertaining to climate change. The Climate Panel actively communicates about its work both through the panel's website and the media and in seminars and meetings that it arranges together with relevant interest groups.

Many of the Government organisations provide training for various stakeholders both independently and through the Steering Group for Climate Communications. The FMI has, for example, organised a climate change course for journalists since March 2006. To date, the course has been attended by more than 200 journalists specialising in the economy, science and the environment.

One result of the co-operation between various organisations is the national web portal on climate change, Climateguide.fi, which was launched in 2011. The portal is available in three languages (Finnish, Swedish and English) and it provides scientific background information on different aspects of climate change as well as tangible means for mitigation and adaptation. Climateguide.fi features approximately 250 web articles, checklists, adaptation and mitigation solutions, learning modules, observational and modelled data, and interfaces for data visualisation. The purpose of the website is to raise awareness about climate change and its implications for Finland as well as to support society and citizens in mitigating climate change and in adapting to it. It also serves as a platform through which key Finnish research institutions and projects can disseminate their information in a user-friendly way. Climateguide.fi is especially targeted at decision makers and actors in Finnish municipalities as well as the general public. The portal was originally built as part of a project called Climate Change Community Response Portal (CCCRP), which was financed by the EU Life+ programme. The FMI, SYKE and Aalto University continue to share responsibility for the contents of the web portal as well as for updating and further developing it. There are also plans for more research institutions to join in.

The national IPCC working group coordinates and presents Finnish standpoints in the IPCC reports. It aims to raise awareness about the IPCC's work in Finland and the Finnish contribution to it. The communications department of the FMI is responsible for communication related to the IPCC's activities and works 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. These are put together in cooperation with the Finnish scientific community.

9.4.2 Raising awareness about energy efficiency

Communication on energy efficiency is handled mainly by two ministries – the Ministry of Employment and the Economy and the Ministry of the Environment – and by other Government bodies, research organisations and state-owned companies, such as Motiva Oy. Motiva Oy promotes the efficient and sustainable use of energy and materials by providing information, training and expert services. It furthers energy education through specific projects and campaigns at schools and it supports energy competence development for professionals in different sectors through training and information dissemination and by providing them with adaptable materials. It also coordinates several communication and awareness raising activities (see below).

The ERA17 – for an Energy-Smart Built Environment 2017

The aim of the ERA17 – for an Energy-Smart Built Environment 2017 action plan (see also Section 4.7.1 and Box 4.1) is to make Finland a leader in energy smartness and to have an energy-efficient, low-emission built environment. The action plan is based on five key factors: energy-efficient land use, distributed methods of energy production, steering of construction, ownership and use of real estate, and taking know-how further. There is a strong emphasis on raising public awareness and sharing best practices and expertise. An ERA17 follow-up group has, for example, organised seminars, media conferences and a nation-wide road show and it has published newsletters, reports, etc., on energy efficiency in the built environment.

Energy Awareness Week

Motiva has successfully run the National Energy Awareness Week and the more specific energy awareness week for primary schools since 1996. The week has become an established annual event in October, during which time companies, schools and other organisations and households concentrate on promoting energy efficiency. The week is a means of getting people to think about and voluntarily act in favour of a sensible use of energy and an environmentally conscious way of life.

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 phases to how to save energy and they learn to engage in energy saving actions both at home and in school. Many companies have incorporated the week into their own environmental programmes and implemented voluntary energy saving measures.

Every year, more than 300 companies and organisations participate in the week. The campaign reaches tens of thousands of Finns. In recent years, the Energy Awareness Week has also been expanded abroad through several globally operating Finnish companies.

Motiva provides Energy Awareness Week participants with tools, tips, informative materials and support for distributing information, and it acts as the national media contact point. It also organises seminars to activate different organisations to exchange ideas, collaborate with one another and arrange events together.

The Energy Awareness Week is supported by the Ministry of Employment and the Economy.

Advice and guidance to consumers on sustainable choices

Finnish consumers are provided with advice to support their choices on energy use at home, on renovation and building work, and on mobility issues by networks of experts throughout the country. Provincial advisers give regional consumer energy advice on household energy use, heating and cooling systems, building and the renovation of houses and energy efficient transport and mobility. The network covers sixteen out of eighteen regions in mainland Finland and the Helsinki Metropolitan area. The core of the activity is to provide consumers with high-quality and reliable information to support their energy decisions. The coordinated activity started in 2012 after a two-year piloting period.

Motiva coordinates the consumer energy advice efforts by providing advisers with supportive services, such as a web-portal launched in 2013, training, tools, marketing, promotional and networking assistance, and monitoring and evaluation tools and support. Monitoring results show that in 2012, the advice service reached 15,000 consumers at various events and about 8,500 consumers received personal advice. The volume is expected to grow considerably in coming years. The network of regional advisers meets twice a year to exchange experiences and best practices and for training.

Motiva also manages the public funding provided to regional advisers on behalf of the Ministry of Employment and the Economy. The work is supported by a broad-based advisory steering group chaired by the Ministry of Employment and the Economy, and it includes members from the Ministry of the Environment, the Ministry of Transport and Communications, the Ministry of Agriculture and Forestry, the National Board of Education, the Association of Finnish Local and Regional Authorities and Sitra, the Finnish Innovation Fund.

Mobility management

The Finnish Mobility Management R&D programme is coordinated by Motiva on behalf of the Finnish Transport Agency. Regional projects co-funded by the Agency, the Ministry of Transport and Communication, the Ministry of the Environment and the Fit for Life Programme develop and advance people's mobility choices, thereby contributing to health as well as safety and decreasing negative impacts on the environment and economy. The state subsidy for Mobility Management was introduced in 2012, and it will be used to establish mobility management work in the various regions. The regional projects and established activities provide advice and services to municipalities, companies and consumers. A network of experts working with Mobility Management, the LIVE network, supports the regional actions and enhances the awareness and best practices on sustainable mobility.

Advice on renovation
The advice network on the renovation of buildings, managed by the Ministry of the Environment, gives advice to home owners, tenants, housing associations and real estate managers. The network deals with issues related to tools and it provides advice services, current news and a search engine for finding professional service providers through a website. A key focus of the advice provision is to improve also the energy efficiency of the building when it is renovated.

The networks each have their networking events 1-2 times per year to exchange experiences, best practices and common challenges and for training. To multiply their efforts to provide better service to consumers, the networks also have joint annual networking events to learn about each other's work and experiences and to accumulate collaboration on a regional level.

9.4.3 Local activities

More than one third of Finland's municipalities have a climate strategy or are in the process of preparing one. Those municipalities have incorporated climate change mitigation into their practices (see Section 4.2.5).

The municipalities play a decisive role as inter-mediators of information regarding attitudes towards climate issues and effecting changes in people's lifestyles. Some of the municipalities have already initiated campaigns to encourage citizens to contribute to combating climate change. In the HINKU project (see Section 4.2.5), the local mitigation measures are gathered together in a publicly available database, which can be browsed using an interactive map. The database currently covers nearly 200 measures and includes information on, for example, the achieved emission reductions, investment costs and the payback times for the investments. Practical tips for reducing the carbon footprint of people in everyday life are also provided on the HINKU project's website.

The largest cities in Finland are also active in promoting awareness among their citizens about climate change and in providing energy and climate-change-related advice (see Box 4.1). For example, in the city of Oulu in northern Finland proactive quality control of buildings has been successfully carried out for several years now and the practice is being extended to other cities as well. As part of the proactive quality control, families who are planning to build a single-family house, designers, work supervisors in charge of the project, suppliers and contractors are all provided with information on the technical and architectural quality of the house, including energy efficiency guidelines. Quality control is mainly implemented as instructions for large groups, where experts lead the discussion, and it also involves neighbourhood meetings in small groups.

As another example, Climateinfo (Ilmastoinfo) was founded in autumn 2010 as a joint initiative of the cities in the Helsinki Metropolitan Area and it has been integrated as part of the Helsinki Region Environmental Services Authority (HSY) since the beginning of 2013. Climateinfo aims to affect the carbon footprint of the residents by organising events (such as Energiatehdas and Park(ing) Day), various kinds of discussion forums (such as dinner forums and energy evenings) and campaigns (such as the Reduce a Tonne campaign) and by producing online content. Through practical trials and campaigns, Climateinfo promotes solutions that can change people's behaviour and decrease their impact on the climate. Trials are carried out, for example, in restaurants, shops and places for leisure activities. They are used to find solutions that could be spread cost efficiently across the entire Helsinki Metropolitan Area.

9.4.4 Activities and campaigns of the NGOs

NGOs as well conduct climate-change or energy-related campaigns, some of which have received broad publicity. For example, the Finnish Friends of the Earth (Maan ystävät) runs a campaign called 'The Big Ask' (Polttava Kysymys) to push the Finnish Climate Act. In addition, other NGO´s like WWF, The Finnish Association for Nature Conservation (Suomen Luonnonsuojeluliitto) and Finn Church Aid (Kirkon Ulkomaanapu) run their own climate campaigns.

At the climate awareness website, ilmasto.org, Dodo ry offers schools the possibility to invite a quest speaker to the class to talk about climate change. The umbrella organisation for Finnish civil society organisations who work with development cooperation, Kepa ry, has its own campaign on climate change called 'Expecting Instability' (Luvassa epävakaata). There is also a NGO called Climate Parents (Ilmastovanhemmat ry) that is active in insisting that decision-makers consider the coming generation when deciding on climate issues. Finnish Greenpeace runs a campaign called 'Energy Revolution' (Energiavallankumous), which aims for an overall change in the energy sector.

In 2013, 'EKOenergy', an Ecolabel for Electricity originally developed by the Finnish Association for Nature Conservation, became the first European-wide label for sustainable renewable electricity. The label aims to provide guidance to consumers on making energy choices that are climate friendly and environmentally sustainable. The criteria of the label look at both greenhouse gas emissions and other environmental impacts of renewable energy. Part of the generated profits is used for different climate and environment projects. The EKOenergy network consists of European environmental organizations from 20 countries, which together promote climate-friendly development in the European energy sector.

Also in 2013, World Wildlife Fund Finland started a campaign, which is part of the organization´s global 'Seize your Power' campaign. The campaign´s goals in Finland are to promote the use of solar power by challenging cities and companies to take action, and to empower the youth in taking action for the environment.

9.5 Short descriptions of and Internet links for some projects, networks and campaigns

Climateguide

The Finnish Meteorological Institute (FMI) has trained different stakeholder groups, such as insurance companies, journalists, and school teachers, on various aspects of climate change. It also takes part in a project called TULUVAT, which is funded by the Finnish National Board of Education. As part of the project, the FMI works together with three upper secondary level schools and tests and selects games, models and other information and communication technology (ICT) material (especially the contents of the Climateguide.fi web portal) for education on climate change in Finland. It has also organised lectures and tested ICT in research communication for schools (webinars), which have also been open to the public. http://www.climateguide.fi

EU network 'SUPPORT – Partnership and Participation for a Sustainable Tomorrow'

Finland has participated in the 'SUPPORT — Partnership and Participation for a Sustainable Tomorrow' network, which has worked to enhance the quality of education on sustainable development. As part of the project, more than 30,000 students signed up for the international school campaign, CO2nnect, the theme of which was transport and climate. The project contributed to a deeper understanding of the emission problems related to transportation, including understanding the interconnections between the social, environmental, cultural and economic aspects of the local transport system as well as acquiring skills to actively participate in local democratic processes. By submitting information to the shared database, students also experienced how to use ICT and the Internet interactively for partnership and data analysis purposes and what it is like to collaborate with researchers and generate reliable information. http://www.co2nnect.org/

Nordic Extreme Weather and Natural Hazards programme

Finnish schools have also been involved in the Extreme Weather and Natural Hazards programme funded by the Nordic Council of Ministers. The sustainability learning activity programme consists of two main parts: local registration of extreme weather events and interviews to gauge people's opinions about and attitudes towards climate change and local preparedness. By using this activity programme as a main element, the insurance industry and schools can collaborate on learning. Students learn about weather and climate issues based on their own observations. Together with representatives from the insurance industry, they can discuss natural hazards, risks and local initiatives for preparedness or for preventing weather events. http://www.miljolare.no/en/aktiviteter/klima/ekstremver/

EURONET 50/50 MAX

Euronet 50/50 MAX is a European project co-funded by the Intelligent Energy Europe (IEE) programme that aims to reduce energy consumption in public buildings, mainly by changing the attitudes and behaviour (habits) of the users of these buildings. The 50/50 concept is an innovative energy saving scheme being applied in schools and other public buildings. The concept was tested and rolled out in 55 schools in 9 countries within the framework of the Euronet 50/50 project (2009–2012), which is now in its second round (Euronet 50/50 MAX, 2013–2016) and targeting 13 countries with 500 pilot schools and 48 other public buildings. 50/50 smartly provides a solution for splitting the incentives between schools and municipalities, and it also increases the capacity of public building users to save energy. In addition, the concept fosters collaboration between school communities and their local governments, thereby becoming a powerful tool to achieve the goals of the Covenant of Mayors. http://www.euronet50-50.eu/

Nordic Climate Day

Finnish schools participated to the Nordic Climate Day project, an initiative of the Nordic Ministers of Education. Nordic Climate Day was organised on November 11 during three consecutive years (2009–2011) to create greater awareness and knowledge about the climate and to encourage pupils and teachers to have discussions on the climate through a theme day consisting of different climate-related assignments and competitions. http://klimanorden.org/ (in Swedish)

Nordic Climate Festival

Aalto University hosted a four-day event on climate change and sustainability issues, the Nordic Climate Festival, in August-September 2011. The event was one of the main events organised during the Finnish Presidency of the Nordic Council of Ministers in 2011, and it was supported by, for example, the Finnish Ministry of the Environment, the Ministry for Foreign Affairs and the Ministry of Education and Culture. The festival consisted of open seminars featuring high-level Nordic experts, seven workshop tracks for more than 90 Nordic students from 33 different countries and an open Climate Fair for students, researchers and companies. The event was a success and helped spread knowledge on climate change mitigation and adaptation. The festival was followed up on with a campaign promoting more climate-friendly food at educational institutions in the Nordic countries.

Youth Climate Summit

The Youth Climate Summit was organised for the first time in 2012 in Heureka, the Finnish Science Centre. The summit, which was arranged at the same time as a similar Youth Summit at the Wild Center in New York, brought together 120 participants to discuss and gather ideas on how to mitigate climate change in schools. The students have since promoted the implementation of their initiatives in their own schools with the support of principals and teachers that also took part in the summit. The second Youth Climate Summit will be organised at Heureka in November 2013. The summit was organised in cooperation with the University of Helsinki, the think tank Demos, Sitra — the Finnish Innovation Fund, the cities of Vantaa and Helsinki and WWF Finland.

Multilateral Environmental Agreements Courses

Since 2004, the University of Eastern Finland and United Nations Environment Programme (UNEP) have jointly organised a course on multilateral environmental agreements. Each course is based on a specific theme. In 2010, the thematic focus was climate change. The course seeks to transfer past experiences in the field of international environmental law to future negotiators of environmental agreements. In addition, the course aims to provide a forum to foster North-South cooperation. The course is intended for experienced Government officials engaged in international environmental negotiations. In addition, other stakeholders, such as representatives of non-governmental organisations and the private sector, may apply to the course. Researchers and academics in the field of international environmental law are also eligible. http://www.uef.fi/en/unep/home

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 for reducing their ecological footprint.

The overall aim 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.

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Internet links

Climate awareness web portal, http://ilmasto.org/

Climateguide web portal, http://ilmasto-opas.fi/en/

Climateinfo, http://ilmastoinfo.fi/en/climateinfo-2/

Energy advice web portal (in Finnish), www.eneuvonta.fi

Energy Awareness Week, http://www.motiva.fi/energyawarenessweek

ENO programme, http://www.enoprogramme.org/

ERA 17 – for an energy-smart built environment 2017, http://era17.fi/en/

Finnish University Partnership for International Development (UniPID), http://www.unipid.fi/en/home/

Higher Education Institutions Institutional Cooperation Instrument (HEI ICI), http://www.cimo.fi/programmes/hei_ici

HINKU project, http://www.hinku-foorumi.fi/en_GB/

Motiva, a state-owned company promoting the sustainable use of energy and materials, http://www.motiva.fi/en

National IPCC working group (in Finnish), http://ilmatieteenlaitos.fi/ipcc-ilmastopaneeli

NORTH-SOUTH-SOUTH Higher Education Institution Network Programme, http://www.cimo.fi/programmes/north-south-south

RCE Espoo, http://www.espoo.fi/en-US/Housing_and_environment/Environment_and_nature/Sustainable_Development_Espoo_RCE

Renovation web portal (in Finnish), www.korjaustieto.fi

Science Education Centre LUMA, http://www.helsinki.fi/luma/english/

Sustainable development certification of educational establishments, http://www.koulujaymparisto.fi/sivu.php?id=1820

Abbreviations

AAU	assigned amount unit
AERONET	Aerosol Robotic Network
AF	Adaptation Fund
AFLRA	Association of Finnish Local and Regional Authorities
Afr.DB	African Development Bank
Afr.DF	African Development Fund
A-LA-CARTE	Assessing limits of adaptation to climate change and opportunities for resilience to be enhanced (a research project)
AMAP	Arctic Monitoring and Assessment Programme
AMCs	Advance Market Commitments
AMSR	Advanced Microwave Scanning Radiometer
AnaFgas	Analysis of Fluorinated greenhouse gases in the EU-27 (model)
APCF	Asian Pacific Carbon Fund
AR5	IPCC Fifth Assessment Report
ARD	afforestation (A), reforestation (R) and deforestation (D)
AsDB	Asian Development Bank
AsDF	Asian Development Fund
BAU	business as usual
BC	black carbon
BEAC	Barents Euro-Arctic Council
BIO	Bio-energy from forests (a research project)
CAP	Common Agricultural Policy
CAPFOR	Capacity Building in Forest Management
CAREC	Central American Renewable Energy and Cleaner Production Facility
CCCRP	Climate Change Community Response Portal
CCDP	Climate Change and Development Project
CCP	Cities for Climate Protection
CCPMs	Common and Coordinated Policies and Measures
CDM	Clean Development Mechanism
CELRE	Curricula Development for Efficient Lighting and Renewable Energy Technology
CER	certified emission reduction unit
CH_4	methane
CHEC	China and EU in the context of global climate change – Analysis of changing economic structures and related policies (a research project)
CHMFC	Central Hydro-Meteorological Forecasting Centre
CHP	combined heat and power production
CIFOR	Center for International Forestry Research
CIIFEN	International Centre for the Investigation of El Niño Phenomenon
CLEEN	Cluster for Energy and Environment
ClimBus	Business Opportunities in the Mitigation of Climate Change

CO_2	carbon dioxide
CO_2 eq.	Carbon dioxide equivalent
CoE	Centre of Excellence
CoM	Covenant of Mayors
COP	Conference of the Parties
COSMOS	European Community Earth System Models
CR	a registry software
CRF	Common Reporting Format
CSEUR	Consolidated System of EU registries
CTCN	Climate Technology Centre and Network
CTI	Climate Technology Initiative
d.d. isocline	degree days, sum of growing season daily average temperatures above +5°C
DEFROST	Impacts of a changing cryosphere: Depicting ecosystem-climate feedbacks from permafrost, snow and ice (Nordic Center of Excellence)
DES	Data Exchange Standard
DG CLIMA	Directorate-General for Climate Action
DOFI	Department of Forest Inspection
EBRD	European Bank for Reconstruction and Development
EBRD TFs all	European Bank for Reconstruction and Development – technical co-operation and special funds (all EBRD countries of operations)
EBRD TFs ODA	European Bank for Reconstruction and Development – technical co-operation and special funds (ODA-eligible countries only)
EBRD-ETC	European Bank for Reconstruction and Development – Early Transition Countries Fund
EBRD-WBJTF	European Bank for Reconstruction and Development — Western Balkans Joint Trust Fund
EC	European Commission
ECA&D	European Climate Assessment & Dataset
ECAS	European Commission Authentication Service
ECCP	European Climate Change Programme
ECHAM	global climate model developed by the Max Planck Institute for Meteorology
ECSN	European Climate Support Network
EDF	European Development Fund
EE	energy efficiency
EEA	European Economic Area
EEDI	Energy Efficiency Design Index
EEP	Energy and Environment Partnership
EGTT	Expert Group on Technology Transfer
EIA	environmental impact assessment
EIG EUMETNET	Network of European Meteorological Services
EKOREM	calculation model for energy use of building stock

ELY Centre	Center for Economic Development, Transport and the Environment
EMEP	European Monitoring and Evaluation Programme
ENO	Environment Online
ENVISAT	an earth observation satellite (ESA)
EPBD	Directive on the Energy Performance of Buildings
ERA17	Energy-Smart Built Environment 2017
ERU	emission reduction unit
ESA	European Space Agency
EU	European Union
EU ETS	EU Emissions Trading Scheme
EU FP7	7th Framework Programme of the EU
EUMETCAL	EUMETNET training programme
EUR	euro
EUTL	European Union Transaction Log
EWENT	Changes in exceedance frequency of critical thresholds of weather phenomena for transport systems (a research project)
FACCE JPI	Agriculture, Food Security and Climate Change, Joint Programming Initiative
FAO	Food and Agriculture Organization of the United Nations
FCF	Future Carbon Fund
FCPF	Forest Carbon Partnership Facility
F-gases	fluorinated greenhouse gases (HFCs, PFCs and SF_6)
FIBIC Oy	Finnish Bioeconomy Cluster
FICCA	Finnish Research Programme on Climate Change
FIGARE	Finnish Global Change Research Programme
Finnfund	The Finnish Fund for Industrial Cooperation Ltd
FINPAC	Finnish-Pacific Project to Reduce Vulnerability of the Pacific Island Countries' Livelihoods to the Effects of Climate Change
FM	forest management
FMI	Finnish Meteorological Institute
FMRL	Forest Management Reference Level
FORECAS	Forest Research Capacity Strengthening
FPPICS	Finnish-Pacific Project for Increased Capacity of SPREP and PIC NMS
FRES	Finnish Regional Emission Scenario
FSC	Forest Stewardship Council
GAW	Global Atmosphere Watch
GCF	Green Climate Fund
GCOS	Global Climate Observing System
GDP	gross domestic product
GEF	Global Environment Facility
GEOSS	Global Earth Observation System of Systems
GFEP	Global Forest Expert Panel

GGCA	Global Gender and Climate Alliance
GHG	greenhouse gas
GNI	gross national income
GNP	gross national product
GPCC	Global Precipitation Climatology Centre
GPG	IPCC Good Practice Guidance
GSN	GCOS Surface Network
GTK	Geological Survey of Finland
GUAN	GCOS Upper-Air Network
H2O	Forests and Water Research and Development Programme
ha	hectare
HDD	heating degree day
HEI	Higher Education Institution
HELCOM	Baltic Marine Environment Protection Commission (the Helsinki Commission)
HFC	hydrofluorocarbons
HINKU	Carbon Neutral Municipalities project
HPC	high performance computing
HSY	Helsinki Region Environmental Services Authority
HWP	harvested wood products
IASC	International Arctic Science Committee
IBRD	International Bank for Reconstruction and Development
ICAO	International Civil Aviation Organisation
ICI	Institutional Cooperation Instrument
ICLEI	International Council for Local Environmental Initiatives
ICOS	Integrated Carbon Observation System
ICP IM	International Cooperative Programme on Integrated Monitoring
ICRAF	World Agroforestry Centre
ICT	information and communication technology
IDA	International Development Association
IDA-HIPC	International Development Association - Heavily Indebted Poor Countries Debt Initiative Trust Fund
IDB	Inter-American Development Bank, Inter-American Investment Corporation and Multilateral Investment Fund
IDB Sp.F.	Inter-American Development Fund for Special Operations
IEA	International Energy Agency
IEE	Intelligent Energy Europe
IGBP	International Geosphere-Biosphere Programme
IGOs	intergovernmental organisations
IHDP	International Human Dimensions Programme
IIAM	Mozambique Institute of Agricultural Research

ILARI	Evaluation of impacts of climate change mitigation and climate policy measures on the transport sector (a research project)
ILMAPUSKURI	Improving resilience to climate change and variation induced risks in agriculture (a research project)
ILMI	calculation model for emissions from air traffic
IMO	International Maritime Organisation
IMPAKTI	calculation tool for emission mitigation impact of measures promoting the use of renewable energy
IMPLIFIN	Implications of International Climate Change for Finland (a research project)
INKA	Innovative Cities
INSPIRE	Infrastructure for Spatial Information in the European Community
IPCC	Intergovernmental Panel on Climate Change
ISTO	Climate Change Adaptation Research Programme
ITL	Independent Transaction Log
IUCN	International Union for Conservation of Nature
IUFRO	International Union of Forest Research Organizations
JI	Joint Implementation
JPI	Joint Programming Initiative
JPI Climate	Connecting Climate Knowledge for Europe, Joint Programming Initiative
KASVENER	greenhouse gas and energy balance model for municipalities
LAMPTESS	Landscape Planning and Management Training for the Environment in South Sudan
LDCF	Least Developed Countries Fund
LIDAR	Light Detection and Ranging
LIISA	calculation model for emissions from road transportation
LIPASTO	calculation system to estimate emissions from the transport sector
LNG	liquefied natural gas
LOI	loss on ignition
LULUCF	Land Use, Land-Use Change and Forestry
LUMA	Finland’s Science Education Centre
LUOVA	natural disaster warning system
LYNET	consortium on natural resources and environment
MAL	land-use, housing and transport
MCCF	Multilateral Carbon Credit Fund
MEA	multilateral environmental agreement
MEERI	a calculation model for emissions from waterborne transport
MELA	a forestry model
MEPS	minimum energy performance standards
MetINFO	Forest information services of Metla

Metla	Finnish Forest Research Institute
METSO	Forest Biodiversity Programme for Southern Finland 2008–2016
MIGA	Multilateral Investment Guarantee Agency
MMR	Monitoring Mechanism Regulation
MODIS	Moderate Resolution Imaging Spectroradiometer
MTT	Agrifood Research Finland
MW	megawatt
MVTT	a foundation (Maa- ja Vesitekniikan Tuki)
N_2O	nitrous oxide
NAPA	national adaptation programme of action
NASA	National Aeronautics and Space Administration
NCF	Nordic Climate Facility
NDF	Nordic Development Fund
NEFCO	Nordic Environmental Financing Corporation
NFI	National Forest Inventory
NFP	National Forest Programme Facility
NGO	non-governmental organization
NHMS	Vietnam National Hydro-Meteorological Service
NIR	National Inventory Report
NMHS	national meteorological and hydrological service
NMVOC	non-methane volatile organic compound
NOAA/AUHRR	Advanced Very High Resolution Radiometer of the National Oceanic and Atmospheric Administration
NOAK	The Nordic Working Group for Global Climate Negotiations
NSIDC	National Snow and Ice Data Center
NSS	North-South-South
O3SAF	Satellite Application Facility on Ozone & Atmospheric Chemistry Monitoring
OC/EC	Thermal/Optical Carbon Aerosol Analyzer
ODA	official development assistance
OECD	Organisation for Economic Cooperation and Development
OECD DAC	OECD Development Assistance Committee
OPERA	Operational Programme for the Exchange of Weather Radar Information
OSKE	Centre of Expertise Programme
OTC	over-the-counter (a financial term)
PaMs	Policies and Measures
PCF	Prototype Carbon Fund
PFC	perfluorocarbons
PISA	Programme for International Student Assessment
PJ	petajoule
POLIREM	calculation model for energy use of building stock
PPP	public-private partnerships

PRASDES	Regional Andean Programme to Enhance Weather, Water, Climate Services and Development
ProDOC	Impacts of climate change scenarios (a research project)
PROFOR	The Program on Forests (WB & FAO)
PSD	private sector development
PSO	Public Service Obligations
PYR Ltd.	The Environmental Register of Packaging
QA/QC	quality assurance
QC	quality control
R&D	research and development
RD&D	research, development and demonstration
RADARSAT 1	An Earth observation satellite (Canadian Space Agency)
RAILI	calculation model for emissions from railways
RCE	Regional Centre of Expertise
RCs	Regional Councils
RE	renewable energy
REDD	Reducing Emissions from Deforestation and Forest Degradation
REMA	a model for forecasting the development of energy consumption in the building stock
Rio+20	Sustainable Development Summit in June 2012
RMU	removal unit
RYM Ltd	Built Environment Innovations
SADC	Southern African Development Community
SAON	Sustaining Arctic Observing Networks
SCA	Stock Change Approach
SCCF	Special Climate Change Fund
SD plan	Sustainable Development Plan
SEAP	Sustainable Energy Action Plan
SEEMP	Ship Energy Efficiency Management Plan
SELECT	Environomical Pathways for Sustainable Energy Services
SF_6	sulphur hexafluoride
SFM	Sustainable Forest Management
SGT Programme	Sustainable Global Technologies Programme
SHOCS	Strengthening Hydrometeorological Operations and Services in Caribbean SIDS (a capacity building project)
SHOK	Strategic Centres for Science, Technology and Innovation
SIDS	Small Island Developing States
SILMU	Finnish Research Programme on Climate Change
Sitra	Finnish Innovation Fund
SLU	Swedish agricultural university
SMEs	small and medium-sized enterprises
SOOP	ship-of-opportunity
SPREP	South Pacific Regional Environmental Programme
SREX	Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation

SRREN	Special Report on Renewable Energy Sources and Climate Change Mitigation
StreFoMon	Strengthening Research Capacity for Sustainable Forest Management in Mongolia
SUCCEED	Sustainable Climate Change and Energy Education Development
SUFORD	Sustainable Forestry for Rural Development project
SusEn	Sustainable Energy Research Programme
SYKE	Finnish Environment Institute
TUKES	Finnish Safety and Chemicals Agency
TEC	Technology Executive Committee
Tekes	Finnish Funding Agency for Technology and Innovation
TERI	Energy and Resources Institute
TF	Trust Fund
Tg	teragram
TGF	Testing Ground Facility
TOC	total organic carbon
TOLERATE	The implications of climate change for extreme weather events and their socio-economic consequences in Finland (a research project)
TPES	total primary energy supply
TULUVAT	A project on climate change education in upper secondary level schools
TWh	terawatt hour
UEF	University of Eastern Finland
UEM-FAEF	Faculty of Agronomy and Forest Engineering at Eduardo Mondlane University
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UniPID	Finnish University Partnership for International Development
UNISDR	United Nations Office for Disaster Risk Reduction
UNU/IAS	United Nations University's Institute of Advanced Studies
UR	Union Registry
USD	United States dollar
VAHTI	Compliance Monitoring Data System
WAM	With Additional Measures
VATT	The Government Institute for Economic Research
VATTAGE	Dynamic, applied general equilibrium model of VATT
WB	World Bank Group
WCRP	World Climate Research Programme
WGE	Working Group on Environment
WIDER	World Institute for Development Economics Research

VITRI	Viikki Tropical Resources Institute
WM	with measures
WMO	World Meteorological Organization
WOM	without measures
VR	Finnish Railways
WT	water table level
VTT	Technical Research Centre of Finland
YASSO	a model for estimating carbon stock changes in forest soils

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 1 of 3)

Inventory 2011
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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	**31,718.23**	**203.78**	**17.40**	**1,577.52**	**1,025.91**	**3.08**	**1.38**	**0.00**	**0.00**	**157.09**	**450.75**	**106.58**	**58.25**
1. Energy	**52,070.83**	**16.75**	**3.10**							**154.58**	**449.93**	**77.95**	**48.32**
A. Fuel Combustion — Reference Approach [2]	53,248.12												
Sectoral Approach [2]	51,949.57	15.03	3.10							154.53	449.90	67.46	48.31
1. Energy Industries	24,272.07	1.05	1.08							40.92	19.42	1.02	30.19
2. Manufacturing Industries and Construction	9,514.75	0.79	0.44							35.61	34.75	1.53	10.97
3. Transport	13,014.98	1.76	0.57							58.58	259.40	30.20	1.31
4. Other Sectors	3,743.97	11.16	0.22							16.77	134.72	34.50	4.99
5. Other	1,403.79	0.26	0.79							2.65	1.61	0.21	0.85
B. Fugitive Emissions from Fuels	121.26	1.73	0.00							0.05	0.02	10.49	0.00
1. Solid Fuels	NO	NO	NO							NO	NO	NO	NO
2. Oil and Natural Gas	121.26	1.73	0.00							0.05	0.02	10.49	0.00
2. Industrial Processes	**4,378.83**	**0.43**	**0.44**	**1,577.52**	**1,025.91**	**3.08**	**1.38**	**0.00**	**0.00**	**2.48**	**IE,NA,NO**	**8.57**	**9.93**
A. Mineral Products	1,307.52	NO	NO							0.01	NO	0.50	0.14
B. Chemical Industry	712.66	NO	0.44	NO	NO	NO	NO	NO	NO	1.24	NO	2.59	7.45
C. Metal Production	2,358.64	0.43	NO				NO		C,NO	0.85	IE,NO	0.71	0.86
D. Other Production [3]	NO									0.38	NO	4.77	1.49
E. Production of Halocarbons and SF_6					NA,NO		NA,NO		NO				
F. Consumption of Halocarbons and SF_6				1,577.52	1,025.91	3.08	1.38	0.00	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.

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	**43.19**		**0.09**							**NO**	**NO**	**19.63**	**NO**
4. Agriculture		**90.90**	**12.81**							**0.01**	**0.39**	**NE,NO**	**NO**
A. Enteric Fermentation		76.53											
B. Manure Management		14.35	1.37									NE,NO	
C. Rice Cultivation		NO										NO	
D. Agricultural Soils [4]		NE,NO	11.44									NE,NO	
E. Prescribed Burning of Savannas		NO	NO							NO	NO	NO	
F. Field Burning of Agricultural Residues		0.02	0.00							0.01	0.39	NE,NO	
G. Other		NO	NO							NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	[5] **-24,774.62**	**2.84**	**0.44**							**0.01**	**0.43**	**NA,NE**	**NE**
A. Forest Land	[5] -35,982.67	0.05	0.07							0.01	0.43	NE	
B. Cropland	[5] 6,834.99	NA,NE	0.04							NE	NE	NE	
C. Grassland	[5] 217.01	NE,NO	NE,NO							NE	NE	NE	
D. Wetlands	[5] 1,983.21	2.79	0.34							IE	IE	NE	
E. Settlements	[5] 1,522.73	NA,NE	NA,NE							NA	NA	NA	
F. Other Land	[5] IE,NA,NO	IE,NA	IE,NA							NA	NA	NA	
G. Other	[5] 650.12	NE	NE							NE	NE	NE	NE
6. Waste	**IE,NO**	**92.86**	**0.52**							**IE,NO**	**IE,NO**	**0.42**	**IE,NO**
A. Solid Waste Disposal on Land	[6] NO	84.23								NO	NO	0.11	
B. Waste-water Handling		5.56	0.31							NO	NO	0.25	
C. Waste Incineration	[6] IE	IE	IE							IE	IE	IE	IE
D. Other	NO	3.07	0.21							NO	NO	0.06	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.

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	**2,568.65**	**0.08**	**0.08**							**17.04**	**3.96**	**0.65**	**5.52**
Aviation	1,956.64	0.03	0.07							4.81	3.08	0.31	0.42
Marine	612.01	0.04	0.02							12.23	0.88	0.33	5.10
Multilateral Operations	**NO**	**NO**	**NO**							**NO**	**NO**	**NO**	**NO**
CO_2 Emissions from Biomass	**35,343.59**												

(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

(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

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

Inventory 2011
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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)]	**31,718.23**	**4,279.31**	**5,395.35**	**1,025.91**	**1.38**	**35.82**	**42,456.00**
1. Energy	**52,070.83**	**351.84**	**962.25**				**53,384.91**
A. Fuel Combustion (Sectoral Approach)	51,949.57	315.55	961.52				53,226.64
1. Energy Industries	24,272.07	21.96	334.39				24,628.42
2. Manufacturing Industries and Construction	9,514.75	16.66	136.79				9,668.20
3. Transport	13,014.98	36.93	176.12				13,228.03
4. Other Sectors	3,743.97	234.46	68.81				4,047.25
5. Other	1,403.79	5.54	245.41				1,654.74
B. Fugitive Emissions from Fuels	121.26	36.29	0.72				158.27
1. Solid Fuels	NO	NO	NO				NO
2. Oil and Natural Gas	121.26	36.29	0.72				158.27
2. Industrial Processes	**4,378.83**	**8.95**	**134.97**	**1,025.91**	**1.38**	**35.82**	**5,585.86**
A. Mineral Products	1,307.52	NO	NO				1,307.52
B. Chemical Industry	712.66	NO	134.97	NO	NO	NO	847.64
C. Metal Production	2,358.64	8.95	NO	NO	NO	C,NO	2,367.59
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)]				1,025.91	1.38	35.82	1,063.11
G. Other	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use	**43.19**		**26.63**				**69.83**
4. Agriculture		**1,908.80**	**3,972.31**				**5,881.11**
A. Enteric Fermentation		1,607.03					1,607.03
B. Manure Management		301.37	425.85				727.22
C. Rice Cultivation		NO					NO
D. Agricultural Soils[(3)]		NE,NO	3,546.35				3,546.35
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		0.39	0.12				0.51
G. Other		NO	NO				NO
5. Land Use, Land-Use Change and Forestry[(1)]	**-24,774.62**	**59.57**	**137.61**				**-24,577.44**
A. Forest Land	-35,982.67	1.04	21.19				-35,960.44
B. Cropland	6,834.99	NA,NE	11.65				6,846.63
C. Grassland	217.01	NE,NO	NE,NO				217.01
D. Wetlands	1,983.21	58.53	104.78				2,146.52
E. Settlements	1,522.73	NA,NE	NA,NE				1,522.73
F. Other Land	IE,NA,NO	IE,NA	IE,NA				IE,NA,NO
G. Other	650.12	NE	NE				650.12
6. Waste	**IE,NO**	**1,950.16**	**161.57**				**2,111.73**
A. Solid Waste Disposal on Land	NO	1,768.75					1,768.75
B. Waste-water Handling		116.86	96.52				213.38
C. Waste Incineration	IE	IE	IE				IE
D. Other	NO	64.55	65.05				129.60
7. Other ***(as specified in Summary 1.A)***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Memo Items: [(4)]							
International Bunkers	2,568.65	1.61	26.30				2,596.56
Aviation	1,956.64	0.73	21.39				1,978.76
Marine	612.01	0.88	4.91				617.81
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**35,343.59**						**35,343.59**

Total CO_2 Equivalent Emissions without Land Use, Land-Use Change and Forestry	67,033.43
Total CO_2 Equivalent Emissions with Land Use, Land-Use Change and Forestry	42,456.00

(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 3)

Inventory 2011
Submission 2013 v1.5
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	**53,172.37**	**51,743.69**	**51,028.71**	**52,932.02**	**58,130.58**	**54,702.23**	**60,344.44**	**58,759.16**	**55,469.57**	**54,958.41**
A. Fuel Combustion (Sectoral Approach)	52,953.52	51,535.56	50,810.54	52,665.49	57,964.97	54,531.56	60,189.76	58,563.72	55,326.39	54,830.83
1. Energy Industries	19,057.37	18,818.12	18,578.92	21,289.99	26,193.63	23,917.74	29,590.31	27,201.55	23,945.96	23,434.75
2. Manufacturing Industries and Construction	13,171.56	12,662.14	12,144.35	12,232.09	12,518.95	11,956.17	11,815.18	12,072.84	11,738.16	11,715.54
3. Transport	12,483.40	12,132.78	12,052.49	11,589.23	11,939.03	11,735.32	11,724.60	12,298.25	12,446.97	12,682.81
4. Other Sectors	6,906.97	6,718.54	6,833.25	6,447.14	5,949.94	5,462.21	5,556.30	5,547.00	5,620.46	5,520.37
5. Other	1,334.21	1,203.99	1,201.53	1,107.03	1,363.43	1,460.11	1,503.36	1,444.07	1,574.84	1,477.36
B. Fugitive Emissions from Fuels	218.85	208.13	218.17	266.53	165.61	170.68	154.68	195.44	143.18	127.58
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	218.85	208.13	218.17	266.53	165.61	170.68	154.68	195.44	143.18	127.58
2. Industrial Processes	**3,354.22**	**3,209.77**	**3,089.39**	**3,102.32**	**3,203.45**	**3,125.81**	**3,296.50**	**3,535.69**	**3,545.09**	**3,638.00**
A. Mineral Products	1,267.71	1,096.60	990.82	902.89	957.71	929.11	960.94	987.51	996.01	1,072.72
B. Chemical Industry	150.88	164.69	136.95	123.39	161.31	149.90	161.43	161.79	157.52	154.66
C. Metal Production	1,935.62	1,948.49	1,961.62	2,076.04	2,084.44	2,046.80	2,174.13	2,386.39	2,391.57	2,410.62
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)	**-15,309.16**	**-29,024.60**	**-23,555.92**	**-21,402.71**	**-14,537.21**	**-14,271.85**	**-23,664.86**	**-18,916.47**	**-16,754.13**	**-19,942.33**
A. Forest Land	-22,947.70	-37,421.95	-31,261.33	-29,602.82	-22,136.17	-22,095.74	-31,408.85	-25,848.74	-24,210.70	-27,226.25
B. Cropland	5,650.77	5,073.92	4,914.27	5,198.90	5,189.65	5,507.80	5,599.07	5,723.32	5,827.08	5,873.23
C. Grassland	759.68	749.22	682.73	647.62	620.86	588.58	517.85	529.65	522.69	506.94
D. Wetlands	1,244.25	1,283.22	1,319.17	1,361.37	1,386.30	1,416.61	1,412.21	1,408.89	1,404.62	1,452.87
E. Settlements	929.47	983.71	1,013.91	1,085.41	1,158.50	1,180.71	1,262.57	1,391.97	1,468.68	1,489.32
F. Other Land	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO
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	**41,333.80**	**26,037.37**	**30,657.74**	**34,720.05**	**46,881.39**	**43,636.97**	**40,052.03**	**43,452.10**	**42,334.81**	**38,727.13**
Total CO_2 emissions excluding net CO_2 from LULUCF	**56,642.96**	**55,061.97**	**54,213.66**	**56,122.75**	**61,418.59**	**57,908.81**	**63,716.90**	**62,368.57**	**59,088.94**	**58,669.46**
Memo Items:										
International Bunkers	**2,843.05**	**2,696.93**	**3,047.25**	**2,515.66**	**2,171.82**	**1,957.66**	**2,161.41**	**2,297.06**	**2,683.55**	**2,866.78**
Aviation	1,007.74	948.31	838.29	787.78	829.36	896.99	960.24	997.64	1,022.16	1,094.05
Marine	1,835.31	1,748.62	2,208.96	1,727.88	1,342.46	1,060.67	1,201.17	1,299.42	1,661.39	1,772.73
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass	19,283.91	18,977.38	18,687.89	22,204.62	23,046.43	23,436.63	23,444.46	26,694.92	27,636.59	29,233.49

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSION TRENDS
CO_2
(Part 2 of 3)

Inventory 2011
Submission 2013 v1.5
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**53,145.92**	**58,350.43**	**60,906.16**	**68,429.69**	**64,346.52**	**52,709.56**	**63,955.73**	**61,899.55**	**53,432.36**	**51,409.76**
A. Fuel Combustion (Sectoral Approach)	53,017.98	58,231.61	60,781.98	68,310.70	64,231.99	52,582.45	63,841.63	61,768.41	53,293.06	51,296.14
1. Energy Industries	21,899.22	27,234.56	29,945.95	36,877.02	32,712.49	21,645.60	32,516.85	30,451.41	23,764.41	24,814.73
2. Manufacturing Industries and Construction	11,734.69	11,287.72	10,984.73	11,349.58	11,436.34	11,152.16	11,437.18	11,263.52	10,608.40	8,259.86
3. Transport	12,591.96	12,712.50	12,907.59	13,096.22	13,451.33	13,480.14	13,668.09	14,038.71	13,383.97	12,708.25
4. Other Sectors	5,175.54	5,398.77	5,354.27	5,257.69	5,135.30	4,826.75	4,715.47	4,545.39	4,125.30	4,135.61
5. Other	1,616.56	1,598.06	1,589.43	1,730.19	1,496.54	1,477.79	1,504.04	1,469.38	1,410.97	1,377.69
B. Fugitive Emissions from Fuels	127.93	118.82	124.19	118.99	114.53	127.11	114.10	131.14	139.30	113.62
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	127.93	118.82	124.19	118.99	114.53	127.11	114.10	131.14	139.30	113.62
2. Industrial Processes	**3,641.68**	**3,705.87**	**3,609.72**	**3,835.64**	**4,027.33**	**3,800.48**	**4,021.07**	**4,377.36**	**4,521.96**	**3,599.33**
A. Mineral Products	1,124.42	1,140.18	1,145.01	1,182.70	1,272.93	1,257.21	1,333.95	1,351.09	1,298.13	932.09
B. Chemical Industry	166.65	163.99	181.45	204.73	213.85	171.27	248.96	566.11	700.23	722.02
C. Metal Production	2,350.62	2,401.70	2,283.26	2,448.21	2,540.56	2,372.01	2,438.15	2,460.15	2,523.60	1,945.22
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	72.01	72.40	67.68	64.16	64.80	59.89	60.81	60.65	52.48	47.49
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)	**-20,598.25**	**-23,857.49**	**-24,375.01**	**-24,889.23**	**-25,764.56**	**-30,094.04**	**-34,091.32**	**-25,879.12**	**-29,826.65**	**-39,460.66**
A. Forest Land	-28,703.47	-33,339.03	-33,918.42	-33,965.56	-35,215.32	-40,167.25	-43,905.54	-35,020.56	-40,088.02	-50,845.47
B. Cropland	5,956.06	6,144.58	6,322.66	6,294.31	6,342.23	6,312.75	6,269.84	6,169.66	6,142.87	6,080.34
C. Grassland	458.37	477.87	467.28	401.11	454.36	459.80	433.87	381.17	345.87	259.82
D. Wetlands	1,471.99	1,481.78	1,477.67	1,509.31	1,488.67	1,559.92	1,594.23	1,762.69	1,772.08	1,810.25
E. Settlements	1,485.30	1,692.12	1,712.60	1,760.73	1,997.18	2,080.95	1,967.01	2,038.26	1,880.55	1,621.11
F. Other Land	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO	IE,NA,NO
G. Other	-1,266.51	-314.82	-436.80	-889.13	-831.68	-340.22	-450.72	-1,210.34	119.99	1,613.29
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	**36,261.36**	**38,271.21**	**40,208.55**	**47,440.26**	**42,674.10**	**26,475.90**	**33,946.29**	**40,458.43**	**28,180.14**	**15,595.92**
Total CO_2 emissions excluding net CO_2 from LULUCF	**56,859.61**	**62,128.70**	**64,583.56**	**72,329.48**	**68,438.66**	**56,569.94**	**68,037.61**	**66,337.56**	**58,006.79**	**55,056.58**
Memo Items:										
International Bunkers	**3,113.68**	**2,925.91**	**3,150.32**	**3,171.40**	**2,933.78**	**2,906.90**	**3,225.45**	**3,117.63**	**3,071.55**	**2,352.80**
Aviation	1,063.30	1,089.95	1,077.58	1,113.52	1,282.24	1,290.15	1,434.57	1,655.64	1,792.08	1,570.07
Marine	2,050.38	1,835.96	2,072.74	2,057.89	1,651.53	1,616.75	1,790.88	1,461.99	1,279.47	782.73
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass	29,393.19	28,513.70	30,772.12	31,357.30	32,913.81	30,725.44	34,368.16	33,075.16	33,743.03	30,126.21

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSION TRENDS
CO_2
(Part 3 of 3)

Inventory 2011
Submission 2013 v1.5
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	Change from base to latest reported year
	(Gg)	(Gg)	%
1. Energy	**59,140.92**	**52,070.83**	**-2.07**
A. Fuel Combustion (Sectoral Approach)	59,003.46	51,949.57	-1.90
1. Energy Industries	30,106.36	24,272.07	27.36
2. Manufacturing Industries and Construction	9,733.07	9,514.75	-27.76
3. Transport	13,216.01	13,014.98	4.26
4. Other Sectors	4,442.75	3,743.97	-45.79
5. Other	1,505.27	1,403.79	5.22
B. Fugitive Emissions from Fuels	137.47	121.26	-44.59
1. Solid Fuels	NO	NO	0.00
2. Oil and Natural Gas	137.47	121.26	-44.59
2. Industrial Processes	**4,397.48**	**4,378.83**	**30.55**
A. Mineral Products	1,215.86	1,307.52	3.14
B. Chemical Industry	773.39	712.66	372.32
C. Metal Production	2,408.23	2,358.64	21.85
D. Other Production	NO	NO	0.00
E. Production of Halocarbons and SF_6			
F. Consumption of Halocarbons and SF_6			
G. Other	NA	NA	0.00
3. Solvent and Other Product Use	45.68	43.19	-62.88
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)	**-24,814.47**	**-24,774.62**	**61.83**
A. Forest Land	-35,754.00	-35,982.67	56.80
B. Cropland	6,416.55	6,834.99	20.96
C. Grassland	285.53	217.01	-71.43
D. Wetlands	1,933.20	1,983.21	59.39
E. Settlements	1,681.46	1,522.73	63.83
F. Other Land	IE,NA,NO	IE,NA,NO	0.00
G. Other	622.80	650.12	-168.75
6. Waste	**IE,NO**	**IE,NO**	**0.00**
A. Solid Waste Disposal on Land	NO	NO	0.00
B. Waste-water Handling			
C. Waste Incineration	IE	IE	0.00
D. Other	NO	NO	0.00
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**0.00**
Total CO_2 emissions including net CO_2 from LULUCF	**38,769.62**	**31,718.23**	**-23.26**
Total CO_2 emissions excluding net CO_2 from LULUCF	**63,584.08**	**56,492.84**	**-0.27**
Memo Items:			
International Bunkers	**2,310.72**	**2,568.65**	**-9.65**
Aviation	1,653.51	1,956.64	94.16
Marine	657.20	612.01	-66.65
Multilateral Operations	NO	NO	0.00
CO_2 Emissions from Biomass	35,669.43	35,343.59	83.28

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSION TRENDS
CH_4
(Part 1 of 3)

Inventory 2011
Submission 2013 v1.5
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	se year (19	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	15.14	16.29	16.91	17.60	18.04	18.00	18.45	17.87	17.90	16.91
A. Fuel Combustion (Sectoral Approach)	14.60	14.32	14.24	14.14	14.22	14.20	14.52	14.46	14.43	14.10
1. Energy Industries	0.39	0.41	0.42	0.48	0.58	0.62	0.73	0.76	0.78	0.77
2. Manufacturing Industries and Construction	0.61	0.59	0.57	0.65	0.67	0.69	0.67	0.71	0.69	0.70
3. Transport	4.73	4.49	4.36	4.18	4.02	3.90	3.74	3.60	3.47	3.35
4. Other Sectors	8.71	8.69	8.76	8.72	8.80	8.80	9.19	9.20	9.30	9.08
5. Other	0.16	0.14	0.12	0.11	0.14	0.19	0.19	0.19	0.21	0.20
B. Fugitive Emissions from Fuels	0.53	1.98	2.67	3.45	3.82	3.81	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	3.81	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	**104.61**	**100.66**	**97.83**	**98.39**	**98.92**	**94.50**	**94.76**	**96.48**	**94.31**	**92.86**
A. Enteric Fermentation	92.71	89.13	86.15	86.37	86.40	81.51	81.69	82.63	80.73	79.49
B. Manure Management	11.81	11.52	11.67	12.00	12.51	12.97	13.04	13.83	13.57	13.36
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
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	**2.07**	**1.98**	**2.07**	**2.01**	**2.11**	**2.14**	**2.15**	**2.22**	**2.19**	**2.29**
A. Forest Land	0.19	0.08	0.15	0.05	0.11	0.10	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	1.87	1.90	1.93	1.96	2.00	2.04	2.08	2.12	2.16	2.20
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	**181.45**	**183.42**	**184.19**	**184.09**	**181.41**	**178.50**	**174.08**	**169.33**	**161.74**	**158.05**
A. Solid Waste Disposal on Land	173.11	175.38	176.03	175.68	173.04	169.80	165.36	160.67	153.13	149.51
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	**303.50**	**302.59**	**301.25**	**302.52**	**300.94**	**293.60**	**289.89**	**286.34**	**276.60**	**270.56**
Total CH_4 emissions excluding CH_4 from LULUCF	**301.43**	**300.61**	**299.18**	**300.51**	**298.83**	**291.47**	**287.74**	**284.12**	**274.41**	**268.27**
Memo Items:										
International Bunkers	0.16	0.15	0.18	0.15	0.12	0.10	0.12	0.13	0.15	0.17
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 5.

TABLE 10 EMISSION TRENDS
CH_4
(Part 2 of 3)

Inventory 2011
Submission 2013 v1.5
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000 (Gg)	2001 (Gg)	2002 (Gg)	2003 (Gg)	2004 (Gg)	2005 (Gg)	2006 (Gg)	2007 (Gg)	2008 (Gg)	2009 (Gg)
1. Energy	16.27	17.91	17.81	18.20	17.60	17.62	17.58	17.21	17.24	17.43
A. Fuel Combustion (Sectoral Approach)	13.65	14.68	15.09	15.26	14.98	14.57	14.94	14.78	14.91	15.23
1. Energy Industries	0.73	0.92	1.15	1.33	1.18	0.97	1.18	1.08	1.06	1.00
2. Manufacturing Industries and Constr	0.72	0.67	0.65	0.66	0.68	0.64	0.70	0.66	0.62	0.52
3. Transport	3.15	3.02	2.92	2.79	2.59	2.41	2.24	2.12	1.91	1.84
4. Other Sectors	8.83	9.88	10.15	10.25	10.30	10.30	10.59	10.67	11.09	11.64
5. Other	0.21	0.20	0.21	0.23	0.21	0.25	0.23	0.24	0.24	0.23
B. Fugitive Emissions from Fuels	2.62	3.23	2.72	2.94	2.62	3.05	2.64	2.44	2.33	2.19
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	2.62	3.23	2.72	2.94	2.62	3.05	2.64	2.44	2.33	2.19
2. Industrial Processes	**0.46**	**0.45**	**0.46**	**0.45**	**0.45**	**0.45**	**0.43**	**0.43**	**0.43**	**0.37**
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	0.46	0.45	0.46	0.45	0.45	0.45	0.43	0.43	0.43	0.37
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	**93.27**	**91.82**	**93.12**	**92.68**	**91.80**	**91.64**	**91.67**	**90.60**	**90.06**	**90.28**
A. Enteric Fermentation	79.60	78.59	79.34	78.43	77.56	76.98	77.03	75.98	75.35	75.95
B. Manure Management	13.63	13.21	13.76	14.24	14.22	14.64	14.63	14.59	14.69	14.30
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	0.04	0.02	0.02	0.02	0.02	0.01	0.02	0.03	0.02	0.02
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	**2.26**	**2.37**	**2.38**	**2.35**	**2.28**	**2.36**	**2.42**	**2.43**	**2.53**	**2.63**
A. Forest Land	0.04	0.12	0.13	0.09	0.03	0.07	0.11	0.05	0.06	0.05
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	2.22	2.25	2.25	2.26	2.26	2.29	2.31	2.38	2.47	2.58
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	**148.23**	**141.88**	**131.71**	**123.20**	**116.68**	**106.71**	**109.82**	**105.19**	**100.69**	**96.72**
A. Solid Waste Disposal on Land	139.68	133.31	122.83	114.34	107.73	97.61	100.43	95.78	91.43	88.05
B. Waste-water Handling	6.27	6.19	6.40	6.26	6.25	6.08	6.13	6.14	6.05	5.68
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other	2.28	2.38	2.49	2.59	2.69	3.02	3.26	3.27	3.21	2.98
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	**260.48**	**254.43**	**245.48**	**236.87**	**228.81**	**218.78**	**221.93**	**215.86**	**210.95**	**207.42**
Total CH_4 emissions excluding CH_4 from LULUCF	**258.22**	**252.06**	**243.10**	**234.52**	**226.53**	**216.42**	**219.51**	**213.43**	**208.42**	**204.79**
Memo Items:										
International Bunkers	0.20	0.18	0.18	0.18	0.15	0.15	0.16	0.14	0.13	0.09
Aviation	0.04	0.04	0.03	0.03	0.04	0.03	0.03	0.04	0.04	0.03
Marine	0.15	0.14	0.15	0.16	0.12	0.12	0.13	0.11	0.09	0.06
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSION TRENDS
CH_4
(Part 3 of 3)

Inventory 2011
Submission 2013 v1.5
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	Change from base to latest reported year
	(Gg)	(Gg)	%
1. Energy	18.66	16.75	10.70
A. Fuel Combustion (Sectoral Approach)	16.76	15.03	2.91
1. Energy Industries	1.17	1.05	165.26
2. Manufacturing Industries and Construction	0.70	0.79	30.14
3. Transport	1.79	1.76	-62.84
4. Other Sectors	12.87	11.16	28.20
5. Other	0.24	0.26	70.12
B. Fugitive Emissions from Fuels	1.90	1.73	223.17
1. Solid Fuels	NO	NO	0.00
2. Oil and Natural Gas	1.90	1.73	223.17
2. Industrial Processes	**0.41**	**0.43**	**75.03**
A. Mineral Products	NO	NO	0.00
B. Chemical Industry	NO	NO	0.00
C. Metal Production	0.41	0.43	75.03
D. Other Production			
E. Production of Halocarbons and SF_6			
F. Consumption of Halocarbons and SF_6			
G. Other	NA	NA	0.00
3. Solvent and Other Product Use			
4. Agriculture	**91.77**	**90.90**	**-13.11**
A. Enteric Fermentation	77.37	76.53	-17.45
B. Manure Management	14.38	14.35	21.51
C. Rice Cultivation	NO	NO	0.00
D. Agricultural Soils	NE,NO	NE,NO	0.00
E. Prescribed Burning of Savannas	NO	NO	0.00
F. Field Burning of Agricultural Residues	0.02	0.02	-79.07
G. Other	NO	NO	0.00
5. Land Use, Land-Use Change and Forestry	**2.71**	**2.84**	**37.21**
A. Forest Land	0.03	0.05	-74.38
B. Cropland	NA,NE	NA,NE	0.00
C. Grassland	NE,NO	NE,NO	0.00
D. Wetlands	2.67	2.79	48.72
E. Settlements	NA,NE	NA,NE	0.00
F. Other Land	IE,NA	IE,NA	0.00
G. Other	NE	NE	0.00
6. Waste	**96.45**	**92.86**	**-48.82**
A. Solid Waste Disposal on Land	87.76	84.23	-51.35
B. Waste-water Handling	5.70	5.56	-23.88
C. Waste Incineration	IE	IE	0.00
D. Other	2.99	3.07	199.49
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**0.00**
Total CH_4 emissions including CH_4 from LULUCF	**209.99**	**203.78**	**-32.86**
Total CH_4 emissions excluding CH_4 from LULUCF	**207.29**	**200.94**	**-33.34**
Memo Items:			
International Bunkers	0.08	0.08	-52.65
Aviation	0.03	0.03	31.82
Marine	0.05	0.04	-69.06
Multilateral Operations	NO	NO	0.00
CO_2 Emissions from Biomass			

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSION TRENDS Inventory 2011
N_2O Submission 2013 v1.5
(Part 1 of 3) FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	se year (19	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**3.24**	**3.13**	**3.07**	**3.19**	**3.28**	**3.17**	**3.32**	**3.33**	**3.26**	**3.23**
A. Fuel Combustion (Sectoral Approach)	3.24	3.13	3.07	3.19	3.28	3.17	3.32	3.33	3.26	3.23
1. Energy Industries	0.39	0.43	0.46	0.52	0.60	0.61	0.72	0.71	0.71	0.68
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	0.56	0.56	0.56	0.56	0.57	0.57	0.58	0.59	0.60
4. Other Sectors	0.28	0.27	0.27	0.26	0.25	0.24	0.24	0.24	0.25	0.24
5. Other	1.45	1.36	1.31	1.31	1.32	1.22	1.23	1.19	1.12	1.10
B. Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	0.00	0.00	0.00	0.00	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	**14.44**	**13.45**	**12.33**	**12.59**	**12.66**	**13.23**	**12.93**	**12.83**	**12.61**	**12.44**
A. Enteric Fermentation										
B. Manure Management	1.57	1.46	1.43	1.44	1.46	1.43	1.46	1.50	1.46	1.42
C. Rice Cultivation										
D. Agricultural Soils	12.87	11.99	10.90	11.15	11.20	11.80	11.47	11.34	11.15	11.02
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	**0.33**	**0.31**	**0.28**	**0.27**	**0.30**	**0.29**	**0.30**	**0.32**	**0.32**	**0.32**
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	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
D. Wetlands	0.22	0.23	0.23	0.23	0.24	0.25	0.25	0.26	0.26	0.26
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	**24.09**	**22.26**	**20.60**	**21.14**	**21.57**	**22.13**	**21.99**	**21.86**	**21.34**	**21.04**
Total N_2O emissions excluding N_2O from LULUCF	**23.76**	**21.94**	**20.32**	**20.88**	**21.28**	**21.84**	**21.70**	**21.55**	**21.02**	**20.72**
Memo Items:										
International Bunkers	**0.09**	**0.08**	**0.09**	**0.08**	**0.07**	**0.06**	**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.

TABLE 10 EMISSION TRENDS
N_2O
(Part 2 of 3)

Inventory 2011
Submission 2013 v1.5
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000 (Gg)	2001 (Gg)	2002 (Gg)	2003 (Gg)	2004 (Gg)	2005 (Gg)	2006 (Gg)	2007 (Gg)	2008 (Gg)	2009 (Gg)
1. Energy	**3.15**	**3.32**	**3.40**	**3.57**	**3.45**	**3.08**	**3.39**	**3.31**	**3.11**	**2.92**
A. Fuel Combustion (Sectoral Approach)	3.15	3.32	3.40	3.57	3.45	3.08	3.39	3.31	3.11	2.91
1. Energy Industries	0.66	0.82	0.94	1.06	1.00	0.82	1.07	1.06	0.99	0.94
2. Manufacturing Industries and Construction	0.61	0.59	0.56	0.56	0.59	0.55	0.53	0.50	0.48	0.40
3. Transport	0.59	0.60	0.60	0.60	0.60	0.59	0.59	0.58	0.56	0.56
4. Other Sectors	0.23	0.25	0.25	0.25	0.25	0.24	0.24	0.24	0.23	0.24
5. Other	1.05	1.06	1.04	1.09	1.02	0.88	0.97	0.92	0.85	0.78
B. Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Industrial Processes	**4.40**	**4.17**	**4.30**	**4.54**	**4.83**	**5.24**	**4.64**	**4.77**	**5.09**	**2.56**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical Industry	4.40	4.17	4.30	4.54	4.83	5.24	4.64	4.77	5.09	2.56
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	0.17	0.16	0.14	0.13	0.13	0.15	0.13	0.12	0.11	0.08
4. Agriculture	**12.72**	**12.58**	**12.68**	**12.74**	**12.60**	**12.64**	**12.64**	**12.71**	**13.03**	**12.52**
A. Enteric Fermentation										
B. Manure Management	1.41	1.33	1.37	1.39	1.36	1.36	1.34	1.33	1.31	1.36
C. Rice Cultivation										
D. Agricultural Soils	11.31	11.25	11.30	11.35	11.24	11.28	11.30	11.38	11.73	11.17
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	**0.32**	**0.33**	**0.33**	**0.33**	**0.34**	**0.34**	**0.37**	**0.37**	**0.45**	**0.42**
A. Forest Land	0.03	0.04	0.04	0.04	0.04	0.04	0.06	0.05	0.11	0.08
B. Cropland	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
D. Wetlands	0.27	0.27	0.27	0.27	0.27	0.27	0.28	0.29	0.30	0.31
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	**0.51**	**0.52**	**0.51**	**0.52**	**0.52**	**0.53**	**0.54**	**0.54**	**0.54**	**0.50**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	0.36	0.36	0.34	0.35	0.34	0.33	0.33	0.32	0.33	0.30
C. Waste Incineration	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
D. Other	0.15	0.16	0.16	0.17	0.18	0.20	0.21	0.22	0.21	0.20
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	**21.27**	**21.08**	**21.36**	**21.83**	**21.87**	**21.98**	**21.70**	**21.82**	**22.34**	**19.00**
Total N_2O emissions excluding N_2O from LULUCF	**20.95**	**20.75**	**21.03**	**21.50**	**21.53**	**21.64**	**21.33**	**21.44**	**21.89**	**18.58**
Memo Items:										
International Bunkers	**0.10**	**0.09**	**0.10**	**0.10**	**0.09**	**0.09**	**0.10**	**0.11**	**0.11**	**0.09**
Aviation	0.04	0.04	0.04	0.05	0.05	0.05	0.06	0.07	0.07	0.07
Marine	0.05	0.05	0.05	0.05	0.04	0.04	0.05	0.04	0.03	0.02
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSION TRENDS
N_2O
(Part 3 of 3)

Inventory 2011
Submission 2013 v1.5
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	Change from base to latest reported year
	(Gg)	(Gg)	%
1. Energy	**3.28**	**3.10**	**-4.23**
A. Fuel Combustion (Sectoral Approach)	3.28	3.10	-4.23
1. Energy Industries	1.16	1.08	174.62
2. Manufacturing Industries and Construction	0.45	0.44	-20.56
3. Transport	0.57	0.57	1.26
4. Other Sectors	0.26	0.22	-19.75
5. Other	0.84	0.79	-45.51
B. Fugitive Emissions from Fuels	0.00	0.00	2.80
1. Solid Fuels	NO	NO	0.00
2. Oil and Natural Gas	0.00	0.00	2.80
2. Industrial Processes	**0.54**	**0.44**	**-91.85**
A. Mineral Products	NO	NO	0.00
B. Chemical Industry	0.54	0.44	-91.85
C. Metal Production	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	0.00
3. Solvent and Other Product Use	0.09	0.09	-57.04
4. Agriculture	**13.04**	**12.81**	**-11.28**
A. Enteric Fermentation			
B. Manure Management	1.37	1.37	-12.61
C. Rice Cultivation			
D. Agricultural Soils	11.67	11.44	-11.11
E. Prescribed Burning of Savannas	NO	NO	0.00
F. Field Burning of Agricultural Residues	0.00	0.00	-79.07
G. Other	NO	NO	0.00
5. Land Use, Land-Use Change and Forestry	**0.43**	**0.44**	**32.66**
A. Forest Land	0.07	0.07	-22.63
B. Cropland	0.04	0.04	68.56
C. Grassland	NE,NO	NE,NO	0.00
D. Wetlands	0.32	0.34	50.89
E. Settlements	NA,NE	NA,NE	0.00
F. Other Land	IE,NA	IE,NA	0.00
G. Other	NE	NE	0.00
6. Waste	**0.52**	**0.52**	**-1.61**
A. Solid Waste Disposal on Land			
B. Waste-water Handling	0.31	0.31	-32.87
C. Waste Incineration	IE	IE	0.00
D. Other	0.20	0.21	218.41
7. Other *(as specified in Summary 1.A)*	**NA**	**NA**	**0.00**
Total N_2O emissions including N_2O from LULUCF	**17.90**	**17.40**	**-27.75**
Total N_2O emissions excluding N_2O from LULUCF	**17.47**	**16.96**	**-28.60**
Memo Items:			
International Bunkers	**0.09**	**0.08**	**-5.12**
Aviation	0.07	0.07	67.07
Marine	0.02	0.02	-67.07
Multilateral Operations	NO	NO	0.00
CO_2 Emissions from Biomass			

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSION TRENDS
HFCs, PFCs and SF_6
(Part 1 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	ase year (199	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(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**	**318.35**
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
$c\text{-}C_4F_8$	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_6F_{14}	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 SF6[3] - (Gg CO_2 equivalent)	**114.94**	**82.52**	**45.82**	**30.00**	**31.42**	**71.29**	**72.39**	**70.60**	**56.28**	**49.59**
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSION TRENDS
HFCs, PFCs and SF_6
(Part 2 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs[(3)] - (Gg CO_2 equivalent)	**491.76**	**646.38**	**463.22**	**651.31**	**693.75**	**863.45**	**747.16**	**903.28**	**993.19**	**888.83**
HFC-23	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
HFC-32	0.00	0.01	NA,NO	0.01	0.02	0.02	0.01	0.01	0.03	0.02
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	0.03	0.05	0.03	0.06	0.07	0.08	0.08	0.08	0.10	0.10
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-134a	0.23	0.19	0.13	0.16	0.15	0.21	0.14	0.24	0.24	0.18
HFC-152a	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143a	0.02	0.04	0.04	0.06	0.06	0.07	0.07	0.07	0.08	0.08
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)	0.13	74.90	67.47	67.25	63.48	77.16	78.87	77.11	83.87	82.12
Emissions of PFCs[(3)] - (Gg CO_2 equivalent)	**22.46**	**20.06**	**13.37**	**14.85**	**12.23**	**9.88**	**15.43**	**8.40**	**11.23**	**9.32**
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	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	NA,NO	NA,NO	NA,NO
C_3F_8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
$c\text{-}C_4F_8$	NA,NO	NA,NO	NA,NO	C,NA,NO	NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,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	NA,NO
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	0.51	1.08
Emissions of SF6[(3)] - (Gg CO_2 equivalent)	**53.97**	**53.74**	**57.91**	**61.59**	**58.89**	**65.88**	**70.82**	**52.89**	**51.16**	**49.82**
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSION TRENDS
HFCs, PFCs and SF_6
(Part 3 of 3)

Inventory 2011
Submission 2013 v1.5
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	Change from base to latest reported year
	(Gg)	(Gg)	%
Emissions of HFCs[3] - (Gg CO_2 equivalent)	**1,163.96**	**1,025.91**	**5,796,001.02**
HFC-23	0.00	C,NA,NO	0.00
HFC-32	0.03	0.04	100.00
HFC-41	NA,NO	NA,NO	0.00
HFC-43-10mee	NA,NO	NA,NO	0.00
HFC-125	0.14	0.12	100.00
HFC-134	NA,NO	NA,NO	0.00
HFC-134a	0.25	0.27	100.00
HFC-152a	C,IE,NA,NO	0.00	641.11
HFC-143	NA,NO	NA,NO	0.00
HFC-143a	0.10	0.08	100.00
HFC-227ea	NA,NO	0.00	100.00
HFC-236fa	NA,NO	NA,NO	0.00
HFC-245ca	NA,NO	NA,NO	0.00
Unspecified mix of listed HFCs[4] - (Gg CO_2 equivalent)	66.48	3.03	59,337.25
Emissions of PFCs[3] - (Gg CO_2 equivalent)	**0.75**	**1.38**	**1,865.43**
CF_4	C,NA,NO	C,NA,NO	0.00
C_2F_6	NA,NO	NA,NO	0.00
C_3F_8	NA,NO	0.00	100.00
C_4F_{10}	NA,NO	NA,NO	0.00
$c\text{-}C_4F_8$	C,NA,NO	C,NA,NO	0.00
C_5F_{12}	NA,NO	NA,NO	0.00
C_6F_{14}	NA,NO	NA,NO	0.00
Unspecified mix of listed PFCs[4] - (Gg CO_2 equivalent)	0.75	1.21	1,625.43
Emissions of SF6[3] - (Gg CO_2 equivalent)	**35.07**	**35.82**	**-68.83**
SF_6	0.00	0.00	-68.83

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSION TRENDS
SUMMARY
(Part 1 of 3)

Inventory 2011
Submission 2013 v1.5
FINLAND

GREENHOUSE GAS EMISSIONS	se year (199	1991	1992	1993	1994	1995	1996	1997	1998	1999
	2 equivalent (	2 equivalent (	2 equivalent (	2 equivalent (	2 equivalent (	2 equivalent (	2 equivalent (	2 equivalent (	2 equivalent (	2 equivalent (
CO_2 emissions including net CO_2 from LULUCF	41,333.80	26,037.37	30,657.74	34,720.05	46,881.39	43,636.97	40,052.03	43,452.10	42,334.81	38,727.13
CO_2 emissions excluding net CO_2 from LULUCF	56,642.96	55,061.97	54,213.66	56,122.75	61,418.59	57,908.81	63,716.90	62,368.57	59,088.94	58,669.46
CH_4 emissions including CH_4 from LULUCF	6,373.48	6,354.31	6,326.33	6,352.88	6,319.74	6,165.69	6,087.79	6,013.14	5,808.67	5,681.73
CH_4 emissions excluding CH_4 from LULUCF	6,330.07	6,312.78	6,282.83	6,310.64	6,275.44	6,120.79	6,042.63	5,966.43	5,762.62	5,633.70
N_2O emissions including N_2O from LULUCF	7,467.99	6,899.20	6,387.13	6,553.94	6,687.81	6,859.14	6,817.51	6,777.92	6,615.81	6,522.58
N_2O emissions excluding N_2O from LULUCF	7,364.26	6,801.79	6,300.29	6,471.47	6,595.69	6,770.28	6,725.99	6,679.82	6,515.89	6,424.16
HFCs	0.02	0.05	0.10	0.10	6.52	29.33	77.30	167.77	245.22	318.35
PFCs	0.07	0.08	0.09	0.10	0.12	0.14	0.16	0.18	0.21	27.97
SF_6	114.94	82.52	45.82	30.00	31.42	71.29	72.39	70.60	56.28	49.59
Total (including LULUCF)	**55,290.29**	**39,373.54**	**43,417.20**	**47,657.07**	**59,927.00**	**56,762.56**	**53,107.19**	**56,481.71**	**55,061.01**	**51,327.34**
Total (excluding LULUCF)	**70,452.31**	**68,259.20**	**66,842.79**	**68,935.07**	**74,327.79**	**70,900.64**	**76,635.36**	**75,253.37**	**71,669.16**	**71,123.22**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	se year (199	1991	1992	1993	1994	1995	1996	1997	1998	1999
	2 equivalent (	2 equivalent (	2 equivalent (	2 equivalent (	2 equivalent (	2 equivalent (	2 equivalent (	2 equivalent (	2 equivalent (	2 equivalent (
1. Energy	54,494.93	53,057.00	52,336.71	54,291.79	59,525.91	56,063.48	61,761.38	60,168.08	56,855.99	56,316.31
2. Industrial Processes	5,130.08	4,735.46	4,443.39	4,501.93	4,686.12	4,699.08	4,919.33	5,226.93	5,232.25	5,390.08
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	6,674.33	6,284.14	5,877.72	5,969.01	6,002.11	6,084.25	5,998.04	6,004.85	5,889.87	5,806.57
5. Land Use, Land-Use Change and Forestry[5]	-15,162.01	-28,885.67	-23,425.58	-21,278.00	-14,400.79	-14,138.07	-23,528.18	-18,771.67	-16,608.16	-19,795.88
6. Waste	3,974.60	4,012.10	4,027.41	4,021.92	3,967.08	3,911.06	3,818.65	3,717.79	3,554.78	3,475.23
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)[5]	**55,290.29**	**39,373.54**	**43,417.20**	**47,657.07**	**59,927.00**	**56,762.56**	**53,107.19**	**56,481.71**	**55,061.01**	**51,327.34**

(1) The column "Base year" should be filled in only by those Parties with economies in

(2) Fill in net emissions/removals as reported in table Summary 1.A. For the purposes of

(3) Enter actual emissions estimates. If only potential emissions estimates are available, these

(4) In accordance with the UNFCCC reporting guidelines, HFC and PFC emissions should be

(5) Includes net CO_2, CH_4 and N_2O from LULUCF.

TABLE 10 EMISSION TRENDS
SUMMARY
(Part 2 of 3)

Inventory 2011
Submission 2013 v1.5
FINLAND

GREENHOUSE GAS EMISSIONS	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
	$_2$ equivalent (	**$_2$ equivalent (**	**$_2$ equivalent (**	**$_2$ equivalent (**	**$_2$ equivalent (**	**$_2$ equivalent (**	**$_2$ equivalent (**	**$_2$ equivalent (**	**$_2$ equivalent (**	**$_2$ equivalent (**
CO_2 emissions including net CO_2 from LULUCF	36,261.36	38,271.21	40,208.55	47,440.26	42,674.10	26,475.90	33,946.29	40,458.43	28,180.14	15,595.92
CO_2 emissions excluding net CO_2 from LULUCF	56,859.61	62,128.70	64,583.56	72,329.48	68,438.66	56,569.94	68,037.61	66,337.56	58,006.79	55,056.58
CH_4 emissions including CH_4 from LULUCF	5,470.12	5,342.93	5,155.12	4,974.31	4,805.10	4,594.30	4,660.52	4,533.08	4,429.90	4,355.88
CH_4 emissions excluding CH_4 from LULUCF	5,422.61	5,293.17	5,105.09	4,924.97	4,757.17	4,544.84	4,609.62	4,482.03	4,376.73	4,300.69
N_2O emissions including N_2O from LULUCF	6,594.18	6,534.21	6,622.61	6,767.93	6,778.17	6,814.34	6,726.44	6,763.22	6,924.16	5,891.38
N_2O emissions excluding N_2O from LULUCF	6,494.99	6,432.08	6,519.02	6,664.52	6,673.81	6,709.30	6,612.80	6,647.65	6,785.86	5,759.68
HFCs	491.76	646.38	463.22	651.31	693.75	863.45	747.16	903.28	993.19	888.83
PFCs	22.46	20.06	13.37	14.85	12.23	9.88	15.43	8.40	11.23	9.32
SF_6	53.97	53.74	57.91	61.59	58.89	65.88	70.82	52.89	51.16	49.82
Total (including LULUCF)	**48,893.85**	**50,868.54**	**52,520.79**	**59,910.25**	**55,022.23**	**38,823.74**	**46,166.67**	**52,719.31**	**40,589.77**	**26,791.14**
Total (excluding LULUCF)	**69,345.39**	**74,574.13**	**76,742.18**	**84,646.73**	**80,634.51**	**68,763.29**	**80,093.44**	**78,431.81**	**70,224.95**	**66,064.92**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
	$_2$ equivalent (	**$_2$ equivalent (**	**$_2$ equivalent (**	**$_2$ equivalent (**	**$_2$ equivalent (**	**$_2$ equivalent (**	**$_2$ equivalent (**	**$_2$ equivalent (**	**$_2$ equivalent (**	**$_2$ equivalent (**
1. Energy	54,464.87	59,756.94	62,333.72	69,918.36	65,786.75	54,035.63	65,375.46	63,286.79	54,758.41	52,679.77
2. Industrial Processes	5,582.97	5,726.76	5,488.26	5,980.17	6,298.17	6,374.27	6,301.80	6,829.80	7,165.16	5,348.06
3. Solvent and Other Product Use	124.71	122.00	111.08	104.46	105.10	106.39	100.18	97.07	86.59	72.27
4. Agriculture	5,901.67	5,828.60	5,885.68	5,895.93	5,833.19	5,842.31	5,842.53	5,842.26	5,931.53	5,778.37
5. Land Use, Land-Use Change and Forestry(5)	-20,451.54	-23,705.59	-24,221.39	-24,736.48	-25,612.28	-29,939.55	-33,926.77	-25,712.50	-29,635.18	-39,273.78
6. Waste	3,271.16	3,139.82	2,923.45	2,747.82	2,611.30	2,404.68	2,473.46	2,375.89	2,283.26	2,186.45
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)(5)	**48,893.85**	**50,868.54**	**52,520.79**	**59,910.25**	**55,022.23**	**38,823.74**	**46,166.67**	**52,719.31**	**40,589.77**	**26,791.14**

(1) The column "Base year" should be filled in only by those Parties with economies in
(2) Fill in net emissions/removals as reported in table Summary 1.A. For the purposes of
(3) Enter actual emissions estimates. If only potential emissions estimates are available,
(4) In accordance with the UNFCCC reporting guidelines, HFC and PFC emissions should
(5) Includes net CO_2, CH_4 and N_2O from LULUCF.

TABLE 10 EMISSION TRENDS SUMMARY (Part 3 of 3)

Inventory 2011
Submission 2013 v1.5
FINLAND

GREENHOUSE GAS EMISSIONS	2010	2011	Change from base to latest reported year
	2 equivalent (	2 equivalent (	(%)
CO_2 emissions including net CO_2 from LULUCF	38,769.62	31,718.23	-23.26
CO_2 emissions excluding net CO_2 from LULUCF	63,584.08	56,492.84	-0.27
CH_4 emissions including CH_4 from LULUCF	4,409.86	4,279.31	-32.86
CH_4 emissions excluding CH_4 from LULUCF	4,353.04	4,219.75	-33.34
N_2O emissions including N_2O from LULUCF	5,548.48	5,395.35	-27.75
N_2O emissions excluding N_2O from LULUCF	5,414.54	5,257.74	-28.60
HFCs	1,163.96	1,025.91	5,796,001.02
PFCs	0.75	1.38	1,865.43
SF_6	35.07	35.82	-68.83
Total (including LULUCF)	**49,927.73**	**42,456.00**	**-23.21**
Total (excluding LULUCF)	**74,551.43**	**67,033.43**	**-4.85**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2010	2011	Change from base to latest reported year
	2 equivalent (	2 equivalent (	(%)
1. Energy	60,550.11	53,384.91	-2.04
2. Industrial Processes	5,772.53	5,585.86	8.88
3. Solvent and Other Product Use	73.58	69.83	-60.85
4. Agriculture	5,969.70	5,881.11	-11.88
5. Land Use, Land-Use Change and Forestry(5)	-24,623.70	-24,577.44	62.10
6. Waste	2,185.52	2,111.73	-46.87
7. Other	NA	NA	0.00
Total (including LULUCF)(5)	**49,927.73**	**42,456.00**	**-23.21**

(1) The column "Base year" should be filled in only by those Parties with economies

(2) Fill in net emissions/removals as reported in table Summary 1.A. For the

(3) Enter actual emissions estimates. If only potential emissions estimates are

(4) In accordance with the UNFCCC reporting guidelines, HFC and PFC emissions

(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
• Use the documentation box to provide explanations if potential emissions are

Annex 2

Summary of Common and Coordinated Policies and Measures (CCPMs) of the European Community in Finland, (planned (P), adopted (A) and implemented (I))

EU CCPM	Sector	National PaM	Brief description	Status
Effort Sharing Decision (406/2009/EC)	Cross-cutting	Flexibility measures of the effort sharing decision	Will require amendment to existing acts	P
		Specific PaMs in sectors outside the EU ETS	See below and Section 4.7	I, A, P
EU ETS Directive 2003/87/EC, as amended by Directive 2008/101/EC and Directive 2009/29/EC	Cross-cutting	Emissions Trading Act (683/2004) and amendments (108/2007, 1468/2007, 16/2010 and 311/2011)		I
Directive 2008/101/EC to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community	Aviation	Act on Aviation Emissions Trading Scheme (34/2010)	Emission trading in the civil aviation sector	I
Kyoto Protocol's project mechanisms (2004/101/EC)	Cross-cutting	Act on the Use of the Kyoto Mechanisms (109/2007), Decree on Joint Implementation (913/2007), Decree on the Clean Development Mechanism (915/2007)		I
Ecodesign requirements for energy-using products (Directive 2005/32/EC) and its implementing regulations	Energy	Act on Ecodesign and Energy Labelling (1005/2008, amendment 1009/2010).	Reduction of electricity use via equipment, lighting and appliances	I
End-use efficiency and energy services (Directive 2006/32/EC repealing SAVE Directive (Directive 93/76/EEC)	Energy	Energy efficiency agreements within the transport sector	Energy efficiency within the transport sector (heavy vehicles)	I
		Energy audits	Energy audits are voluntary. They are promoted by 40 to 50 per cent subsidies. Subsidies are given only if the audit is carried out by accredited auditors. The audits are based on models (separate for commercial and public buildings, blocks of flats and the industry and energy sectors) developed by Motiva	I
		Voluntary energy efficiency agreements	The voluntary energy efficiency agreements, which cover the following sectors, are in force until 2016: industries (industrial, energy and private service sectors), municipal sector, oil sector, property sector, transport sector (goods and public) and farms	I
		Promoting energy efficiency (through the Energy Efficiency Directive)	Plans for implementing the required measures and making the necessary changes in legislation are currently under preparation	A
		Energy efficiency in supported farm and rural buildings, reparcelling and the Farm Energy Programme	Improving the energy efficiency of farm buildings and processes, reducing transport, increasing the use of renewable energy sources (biomass)	I

Annex 2
Continued

EU CCPM	Sector	National PaM	Brief description	Status
Directive 2006/126/EC on driving licences	Transport	The Act on Driving Licences 386/2011	Eco-driving education in basic driver training courses	I
Directive 2003/59/EC on the initial qualification and periodic training of drivers of certain road vehicles for the carriage of goods or passengers	Transport	The Act on Professional Qualifications for Truck, Bus and Coach Drivers (273/2007)	Ecodriving education for truck, bus and coach drivers	I
Energy performance of buildings (Directive 2002/91/EC) and Recasting the Energy performance of buildings (Directive 2010/31/EC) amending 2002/91/EC	Energy	Act on Energy Certificates for Buildings (487/2007)	Houseowners are obliged to provide information on energy efficiency	I
		Building regulations (2003,2008, 2010)	Provide minimum standards for new buildings	I
		Renewed building regulations (2012)	Provide minimum standards for new buildings, switch to a full energy-based calculation	I
		Towards nearly zero-energy buildings	Information campaign	I
		Degree on improving the energy efficiency in buildings in terms of renovation and alteration work (4/13)	Provides minimum standards for improving the energy performance of buildings during renovations and alterations	A
		Act on the Inspection of Air-conditioning Systems (489/2007)	Houseowners are obliged to inspect the energy efficiency of cooling equipment	I
RES Directive 2009/28/EC (repealing RES-E Directive 2001/77/EC and Biofuel Directive 2003/30/EC)	Energy	The Act on Production Subsidy for Electricity Produced from Renewable Energy Sources (1396/2010)	The act lays down provisions on a feed-in tariff system, for which power plants fuelled with wind, biogas, forest chips and wood-based fuels that meet the prescribed preconditions could be approved	I
		National act 446/2007 on promoting the use of biofuels for transport Act on Excise Duty on Liquid Fuels (1399/2010), which is the latest revision of Act 1472/1994	Promoting the use of biofuels within the transport sector	I
		Finland's National Forest Programme	The mission is to generate increased welfare through diverse and sustainable forest management. The key principles of the programme include the comprehensive development of existing and new forest-based products and services and the entire value chain, the integration of different uses of forests, and the preservation of the environmental benefits of forests	I
		Improvements in planning and permit processes for wind power	Adjustment of the Land Use and Building Act with respect to planning and making allowances for wind power	A

Annex 2
Continued

EU CCPM	Sector	National PaM	Brief description	Status
Regulation (EC) No 1370/2007 on public passenger transport services by rail and by road	Transport	Finland's Public Transport Act, a national strategy and implementation plan for the promotion of walking and cycling, mobility management, reconciliation of land use, housing and transport	Influencing modal splits by promoting public transport, walking and cycling	I
Regulation No 443/2009 setting emission performance standards for new passenger cars, and Regulation No 510/2011 setting emission performance standards for new light commercial vehicles	Transport	Regulation No 443/2009 setting emission performance standards for new passenger cars, and Regulation No 510/2011 setting emission performance standards for new light commercial vehicles, Car Tax Act (1316/2011), Vehicle Tax Act (1317/2011)	Decreasing the specific emissions of new cars and renewing the whole vehicle fleet	I
F-gas regulation (Regulation 842/2006)	Industrial processes	Government Decree (452/2009) on servicing equipment containing F-gases	Specific competencies are stipulated and regular monitoring of equipment containing F-gases is ensured	I
		Environmental Protection Act/ Regulation of F-gases; modified on 7 Nov. 2008/681	General instrument for regulating F-gases according to the requirements of the relevant EC regulations	I
Regulations related to the Common Agricultural Policy (CAP)	Agriculture	Government decision to implement the Nitrates Directive (1991/676/ EEC)	Decreases greenhouse gas emissions and the use of mineral fertilisers	I
		National implementation of the Common Agricultural Policy	Impacts, e.g. the cultivated area, selection of crops and animal numbers	I
		Support for rural development (Regulation (EC) No 1783/2003, which amends a number of other regulations)	Support for long-term cultivation of grass on organic soils (voluntary)	I
Landfill Directive 1999/31/EC	Waste	Measures for dealing with landfills: Government Decision on landfills (861/1997, revised 2006), and biowaste strategy (2004)	Regulating in particular biodegradable waste and finding solutions to deal efficiently with biowaste	I
		New regulation on landfills	Regulation on landfills; once adopted, it will set quantitative limits on the amount and proportion of organic waste that can be landfilled. When implemented, it will go beyond the Landfill Directive	P
Packaging and Packaging Waste (94/62/EC, 2004/12/ EC, 2005/20/EC)	Waste	Measures to deal with packaging: Government Decision on Packaging and Packaging Waste (962/1997, 1025/2000, 987/2004, 817/2005)	Ensures that packaging recovery obligations are met economically and easily	I
Waste Framework Directive (2008/98/EC), amending Directive on Waste (2006/12/ EE)	Waste	General reform of waste legislation; Act on Waste (646/2011); Decree on Waste (179/2012); Waste Tax Act (1126/2010)	General regulation for waste treatment and waste management aiming at resource efficiency and sustainable solutions in the waste sector	I

Annex 3

Summary of specific actions taken to minimise the adverse impact of response measures in developing countries

Action	Implementation in Finnish policy
(a) The progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions, and subsidies for all greenhouse-gas-emitting sectors, while 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. Starting in January 2011, Finland made a major revision in energy taxation, according to which all fuels are taxed based on their energy and fossil carbon content. Finland is supporting the Government of Cambodia so that it can achieve its climate policy goals through developing Cambodia's capacity for producing energy statistics and conducting energy planning, while taking into account economic, social and environmental sustainability. Finnish development policy guidelines for providing support to developing countries through multinational development banks include criteria that are targeted at removing subsidies to fossil fuels and phasing out the support of fossil-fuel-fired investments by the year 2050.
(b) Removing subsidies associated with the use of environmentally unsound and unsafe technologies.	Finland does not have any support activities in this field.
(c) Cooperating in the technological development of non-energy uses for fossil fuels and supporting developing country Parties to this end.	Finland does not have any support activities in this field.
(d) 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 promoting technologies that emit less greenhouse gases both at the policy and programme/project level, with the main focus being on increased energy efficiency and the promotion of renewable energy instead of fossil fuels. Within the fossil fuel sector, Finland supports methane capture for electricity generation instead of gas-flaring, clean coal technologies and carbon capture and storage at the policy level. At the programme level, support is given to improving the efficiency of energy distribution, for example in Tanzania through automated network control systems and in Mozambique through piloting a rural energy smart grid (with back-up power provided by diesel generators). Several projects for capturing landfill methane for biogas and electricity generation are also supported in Nepal, in Southern and Eastern Africa as well as in the Mekong Region.
(e) Strengthening the capacity of developing country Parties identified in Article 4, paragraphs 8 and 9 of the Convention for improving the efficiency of upstream and downstream activities relating to fossil fuels, while 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. Finland is also supporting Cambodia and Namibia in their efforts to develop comprehensive energy strategies and data and their planning capacity, while taking into account sustainability as well as efficiency issues.

Annex 3
Continued

Action	Implementation in Finnish policy
(f) Assisting developing country Parties that are highly dependent on the export and consumption of fossil fuels in efforts to diversify their economies.	Actions have been undertaken both through support by international organisations such as UNCTAD (United Nations Conference on Trade and Development) and through bilateral partnerships. Examples of bilateral partnerships include providing capacity-building support to the Southern African Development Community (SADC) secretariat to develop a regional renewable energy strategy and action plan as well as providing support to the Lao PDR in its efforts to develop and implement a renewable energy strategy. These policy level programmes aim at diversifying the economies and energy mix of partner countries towards renewable sources that provide local employment and increase energy and income security. Finland is also supporting the Energy and Environment Partnership Programme (EEP) with Central America, which was launched during the United Nations World Summit on Sustainable Development in 2002 and which is being implemented by eight Central American partner countries. Austria and the EU have also joined as donors. In 2009/2010, Finland replicated the EEP model in four other regions: the Mekong Region, which covers the Lao PDR, Cambodia, Vietnam and Thailand; Southern and Eastern Africa, which covers 13 countries: Botswana, Burundi, Kenya, Lesotho, Mozambique, Namibia, Rwanda, Seychelles, South Africa, Swaziland, Tanzania, Uganda and Zambia; the Andean Region, which covers Bolivia, Colombia, Peru and Ecuador; and Indonesia, which initially covers two provinces. The EEP programmes focus on supporting the participating countries in developing, adopting and scaling-up appropriate and affordable renewable energy and energy efficiency technologies for improved energy access and local employment. The programmes support thematic policy studies, feasibility studies and pilot and demonstration projects as well as some R&D&I projects. The projects are being developed and implemented through partnerships between public, private and civil society actors. The regional approach supports South-South co-operation, regional integration and knowledge sharing.

Annex 4

Summary of reporting of the Supplementary information under Article 7, paragraph 2, of the Kyoto Protocol in the NC6

Information reported under Article 7, paragraph 2		NC6 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		5.7
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, 4.1–4.6
Information under Article 10	Art 10a	3.3, 8.2.4
	Art 10b	4.5, 4.7, 6.3
	Art 10c	7.4
	Art 10d	8.3.4
	Art 10e	8, 9
Financial resources		7

Annex 5

Response to the review of Finland's Fifth National Communication

Comment in FCCC/IDR.5/FIN	Finland's response	Where in NC6
27. The ERT recommends Finland to provide information on the GHGs affected by, and the implementing entity or entities of, major individual PaMs in the energy sector.	This information can be found in Table 4.4	4.7.1
59. The ERT recommends that Finland reports emission projections for fuels used in international transport.	Finland has provided a projection for fuels used in international transport.	5.2.2
70. The ERT recommends that Finland reports the expected total effect of its implemented and adopted PaMs.	Finland has provided this information.	5.4
86. The ERT recommends that Finland distiguishes, as appropriate, in more detail between the activities undertaken by the private and public sectors in technology transfer to developing countries.	Finland has addressed activities taken by the private and public sector separately, where possible, as the data on private sector activities is limited.	7
100. The ERT recommends that Finland reports on how it gives priority to the actions taken to implement its commitments under Article 3, paragraph 14, of the Kyoto Protocol or provide an explanation as to why such priority could not be given.	Finland has provided this information.	4.13

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