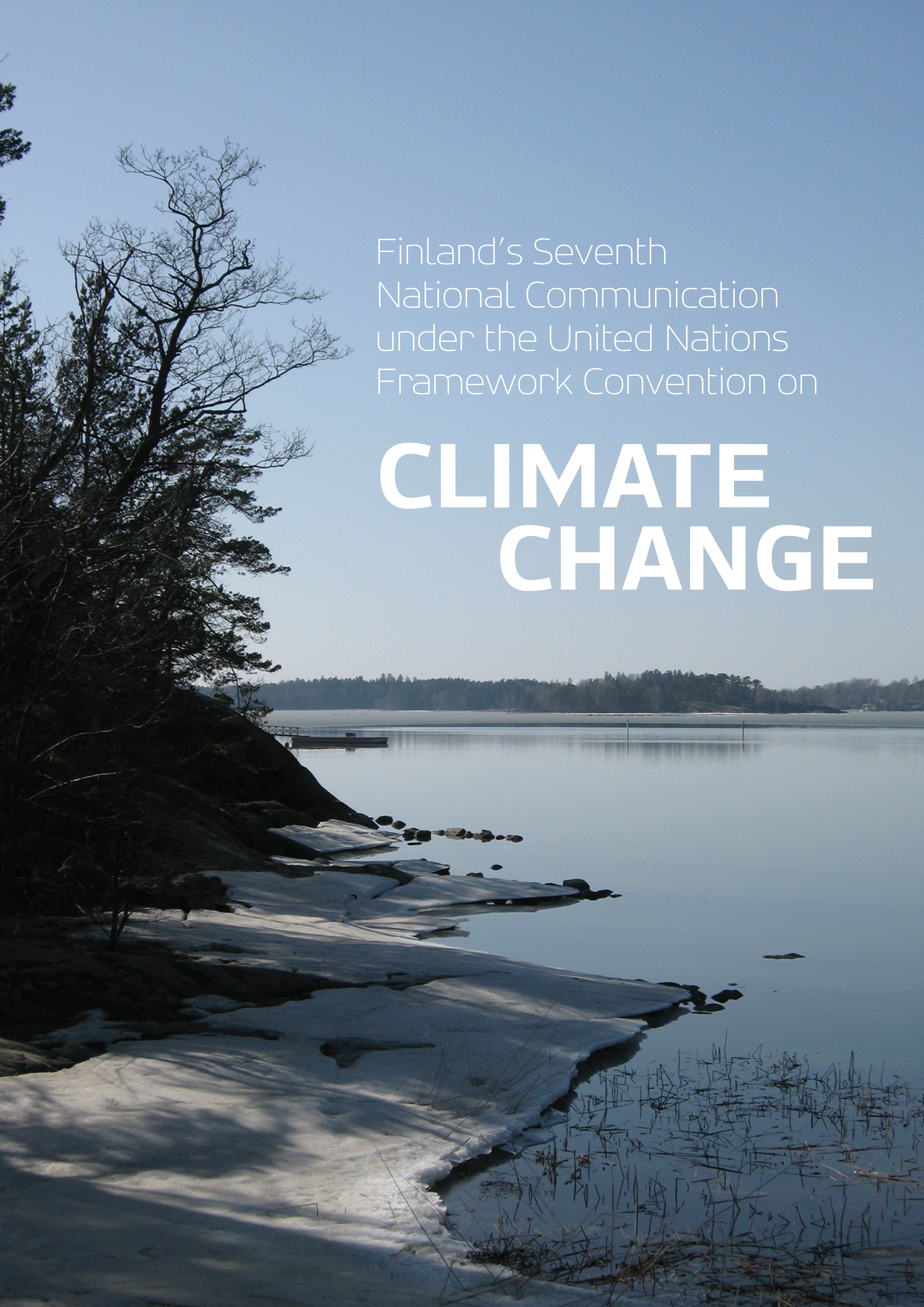

Finland's Seventh National Communication under the United Nations Framework Convention on

CLIMATE CHANGE

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National Communication
under the United Nations
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Committee for Preparing the Seventh National Communication

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1 EXECUTIVE SUMMARY

1.1 National circumstances relevant to greenhouse gas emissions and removals

The population of Finland was 5.5 million at the end of 2015, and according to projections, it will increase to 6.0 million by 2060. 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 338,400 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 9 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 2015, the total energy consumption was 1,301 PJ. Finnish industry used 45 per cent of the country's final energy consumption and 47 per cent of its electricity in 2015. 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 24 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 19.3 and 51.3 million tonnes CO_2 equivalent (CO_2 eq.) during the years 1990–2015, which represents 25–75 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 2015 totalled 55.6 million tonnes CO_2 eq., excluding land use, land-use change and forestry (LULUCF). The total emissions in 2015 were approximately 22 per cent (15.7 million tonnes) below the level for the 1990 emissions. Compared to 2014, the emissions decreased by six 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 85 per cent for the years 1990–2015. CO_2 emissions have decreased by 12.7 million tonnes since 1990. Methane (CH_4) emissions have gone down by 37 per cent from the 1990 level, whereas nitrous oxide (N_2O) emissions have decreased by 27 per cent. In 2015, the F-gas emissions (HFCs, PFCs and SF_6) were nearly 35 times higher than the emissions for 1995 (the base year for F-gas emissions).

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 2015, the energy sector's share (including transport) of the total greenhouse gas emissions was 73 per cent (40.8 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 11.1 million tonnes CO_2 eq. in 2015 (20 per cent of total greenhouse gas emissions). Road transport accounted for 94 per cent of the total domestic transport emissions. The emission level in the transport sector has fluctuated between 11 to 13 million tonnes CO_2 eq. during 1990–2015 being 8 per cent lower in 2015 than in 1990.

The greenhouse gas emissions generated by industrial processes amounted to roughly 6.1 million tonnes CO_2 eq. in 2015 (11 per cent). Emissions from the agricultural sector were some 6.5 million tonnes CO_2 eq. (12 per cent). Waste sector emissions amounted to 2.1 million tonnes CO_2 eq. in 2015 (4 per cent). The LULUCF sector acted as a greenhouse gas sink of 26.0 million tonnes CO_2 eq. in 2015.

Table 1.1
Greenhouse gas emissions (+) and removals (–) by sector, 1990, 1995, 2000 and 2005–2015 (million tonnes CO_2 eq.)

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Energy	53.6	55.3	53.8	53.7	64.8	62.8	54.5	52.6	60.2	52.7	47.5	48.3	44.4	40.8
Indirect CO_2-emissions	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
Industrial processes and product use	5.4	4.9	5.8	6.5	6.5	7.1	7.5	5.7	6.3	6.0	6.0	6.0	5.9	6.1
Agriculture	7.5	6.8	6.5	6.5	6.4	6.4	6.5	6.5	6.6	6.4	6.4	6.5	6.5	6.5
Waste	4.7	4.6	3.9	2.8	2.9	2.8	2.7	2.6	2.6	2.5	2.4	2.3	2.2	2.1
Total (without LULUCF)	71.3	71.8	70	69.6	80.8	79.2	71.2	67.4	75.7	67.7	62.4	63.2	59.1	55.6
Land use , land-use change and forestry [1]	−12.7	−12.4	−21.7	−27.1	−33.4	−25.8	−24.7	−38.0	−27.3	−28.7	−32.3	−26.3	−28.3	−26.0

1 LULUCF, 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.

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 2006 IPCC Guidelines and the IPCC 2013 Supplementary methods and Good Practice guidance arising from the Kyoto Protocol. 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.

The Consolidated System of EU registries (Union Registry) was certified on 1 June 2012 and went into production on 20 June 2012. The changes to the national registry, which have occurred since the last National Communication report are summarized in Table 3.4 of the Chapter 3. In Finland, the Energy 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 based on international agreements: the UNFCCC, the Kyoto Protocol and the Paris Agreement. The common policies of the European Union, such as the EU 2020 and 2030 Climate and Energy Packages have a key role in the implementation of the international agreements mentioned above. At national level Finland's climate policy is defined in government policies and programmes, and since 2003, strategic work has been steered by ministerial working groups. In addition, national energy and climate strategies have been prepared since 2001 to implement the international and EU commitments as well as national targets, 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, energy efficiency and waste management. The Finnish Climate Change Panel, which was nominated for the first time in 2011, strengthens the interaction between research and policy-making. 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.

Finland has fulfilled its commitments under the first commitment period (2008 – 2012) of the Kyoto Protocol. By accepting the Kyoto Protocol's second commitment period (2013 – 2020) in June 2015, the EU, its Member States and Island are committed to reducing their greenhouse gas emissions jointly by 20 per cent compared to the base year. The individual emission reduction obligations of the Member States have been defined in the EU Effort Sharing Decision (ESD). The ESD sets individual binding annual emission reduction or limitation targets for the Member States for emissions not covered by the EU Emission Trading Scheme, ETS, (non-ETS emissions) in the period 2013 – 2020. The ESD defines Finland's reduction obligation for the sources not covered by the EU ETS as 16 per cent of the 2005 emissions.

The Finnish national ratification of the Paris Agreement, adopted in December 2015, was completed in November 2016. The Paris Agreement entails several uniform obligations for all Parties. Instead of specific top-down emission reduction commitments, the Agreement is based on nationally determined contributions to mitigate the emissions. The EU's joint nationally determined contribution under the Agreement is to reduce the greenhouse gas emissions with 40 per cent by 2030 from the 1990 level. The details of the effort sharing between the Member States, including Finland, are being negotiated at present.

Finland prepares regularly strategies on energy and climate policy. The latest strategies were completed in 2001, 2005, 2008, 2013 and 2016.

In 2014, a parliamentary committee on energy and climate issues prepared an energy and climate roadmap towards 2050. The roadmap analysed the means of constructing a low-carbon society and achieving an 80–95 per cent reduction in greenhouse gas emissions from the 1990 level in Finland by 2050.

The 2016 strategy – National Energy and Climate Strategy for 2030 – outlines the actions that will enable Finland to attain the targets specified in the Government Programme of Prime Minister Sipilä (27 May 2015) and adopted in the EU for 2030, and to systematically set the course for a low-carbon society. The 2016 strategy also specifies key measures for achieving the binding emission reduction targets in the effort sharing sector by 2030. These measures are further specified and complemented in the Medium-term Climate Change Policy Plan which was finalized in 2017.

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 in 2020), followed by energy efficiency agreements (6.3 million tonnes in 2020) and promoting wind power (3.6 million tonnes in 2020). For both new and existing buildings, building codes and regulation play an important role. The regulation for the energy performance of new buildings entails the emission reductions of 3.8 million tonnes CO_2 in 2020.

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. in 2020). Promotion of the use of biofuels in transport is estimated to contribute to emission reduction by 2.0 million tonnes CO_2 eq. in 2020.

Most CO_2 emissions from industrial processes are included in the EU ETS. For F-gases EU regulations constitute the most significant emission reduction measure. The F-gas mitigation measures have been able to cut the almost exponential increase in emissions from refrigeration and air-conditioning equipment that started in the mid-1990s.

Within the agricultural sector, most of the measures fall under the sphere of the EU's Common Agricultural Policy, including the Rural Development Programme for Mainland Finland 2014 – 2020 which includes several measures for climate change mitigation and adaptation. The environmental compensation payments, which are part of the programme, cover approximately 86 per cent of Finnish farms and aim, among other things, to decrease the nutrient load on the environment and reduce greenhouse gas emissions.

Within the LULUCF sector, the most important policy measures include legislation, the National Forest Strategy 2025, financial support and extensive public forestry organisations, which promote 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 and reducing the amount of waste disposed to landfills including restrictions on biodegradable waste. Enforcement of the Waste Act and the Decree on Waste will continue to increase recycling and recovery, thus further replacing landfilling, and will contribute to reducing greenhouse gas emissions. 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. As a member of the European Union, Finland is implementing the EU ETS for aviation. Aviation has been included in the EU emissions trading scheme (EU ETS) since 2012. Between years 2013 and 2016, the EU ETS covered flights between aerodromes located in member states of European Economic Area (EEA). In February 2017 the European Commission proposed to continue the intra-EEA scope beyond 2016.

Besides the measures included in the WM projections Finland has decided on several additional measures in order to further reduce the emissions towards 2030. The additional measures are presented in the National Energy and Climate Strategy for 2030 and in the Medium-term Climate Change Policy Plan. The largest emission reductions in the non-ETS sector are planned to be delivered by the transport sector. The transport sector measures include increasing the use of biofuels within the transport sector to 30 per cent by 2030, improving the energy-efficiency of vehicles, and improving the energy-efficiency of transport system by promoting the choices of more environmentally friendly mode of transport and curbing the growth of vehicle kilometres.

The most important additional measures are:

- An operating aid for renewable energy based on a tendering process will be introduced. In 2018–2020, a tendering process for electricity production of 2 TWh would be organised.
- An obligation to blend 10 per cent of bioliquids into light fuel oil used for heating of buildings and into light fuel oil used for machinery.
- Phasing out oil heating in central government premises by 2025 and encouraging all public-sector operators to do the same
- Improving energy efficiency and promoting the use of alternative fuels in machinery. Reductions in F-gas emissions by promoting the alternative low GWP non-HFC technologies in the refrigeration and air conditioning, including criteria for public procurements related to F-gases and information and education campaigns
- Activities relating to reducing emissions from organic soils in the agricultural sector and measures to replace fossil fuels with biogas
- Finland will phase out the use of coal for energy by 2030. During the current government term, a bill will be prepared. The bill will take into account aspects related to the security of energy supply and emergencies.

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 Seventh National Communication provides updated information on how to minimise adverse impacts compared to the Sixth National Communication and the National Inventory Report submitted in 2017.

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. According to the latest projections in transport sector, the GHG emissions start to decline at the end on the current decade and the main reasons for that are the use of biofuels, development in vehicle technology and CO_2-based taxation. 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 are based on the National Energy and Climate Strategy for 2030 from November 2016 and the Medium-term Climate Change Policy Plan from September 2017. The WM projection includes measures that were implemented or adopted before autumn 2016.

Economic growth and the change in the structure of the economy play a key role in the estimation of energy consumption and emissions. The rate of economic growth is determined by the growth rates of labour input and average labour productivity. In the long term, economic growth is determined almost solely by the growth of labour productivity, because labour input cannot grow without bounds. In the short and medium term, however, factors affecting labour input growth matter, too, because changes in labour input affect directly the potential output of the economy. In Finland, the ageing population is the single most significant factor in terms of its effect on labour input and thus development of the national economy in the short and medium term. Another factor that affects 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 5.5 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 2.6 million to 3.0 million during the period.

In 2016, the Finnish economy returned to a growth path after a long period of recession that began in 2009. The growth has been driven by increase in private consumption and recovery of public and private investment. The GDP is assumed to increase in the coming years. In the projections the annual growth during 2016-2020 is on average 1.6 per cent. In the 2020s the growth will be higher, 2.6 per cent per annum on average, as the Government's reforms are starting to pay off and the competitiveness of the Finnish economy increases.

The WM projection estimates that the total greenhouse gas emissions (without LULUCF) in 2020 and in 2030 will be 56 and 48 million tonnes CO_2 eq. respectively, whereas the WAM projection assesses that they will be 56 and 44 million tonnes CO_2 eq., respectively. The additional emission reduction measures in the WAM projection include all planned measures with a few exceptions for which the impact on the energy balance is not yet known.

Finland is in the course of fulfilling its EU 2020 emission reduction goal with the existing policy measures. The effect of the additional measures is aimed at the 2020s and in full at the year 2030 at the latest. With the measures of the WAM projection the renewable energy share will rise to more than 50 per cent of final energy consumption and the use of imported oil for the domestic needs will be cut by half by 2030. This is also the target of the current Government Program.

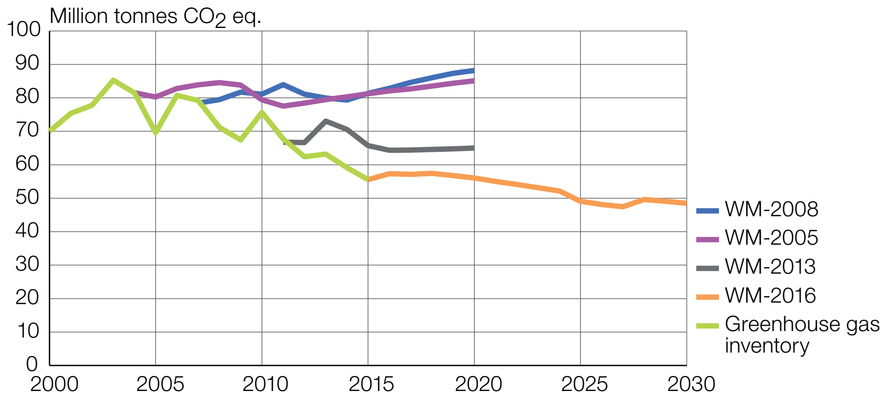
Total effect of policies and measures

The total effect of the policies and measures is estimated by aggregating the impact estimates of individual policies and measures. The impact of already implemented individual policies and measures are 12, 20, 34 and 42 million tonnes CO2 eq. for 2010, 2015, 2020 and 2030 (without LULUCF), respectively. The planned measures will reduce greenhouse gas emissions increasingly in the 2020s reaching an additional annual reduction of 6.3 million tonnes CO2 eq. in 2030.

Figure 1.1 shows Finland's greenhouse gas emissions in the WM projections in the last four national climate and energy strategies, i.e. strategies from the years 2005, 2008, 2013 and 2016. The WM projections in the previous national climate and energy strategies projected significantly higher emissions for 2015 than those reported in the latest greenhouse gas inventory. This suggests that the additional measures implemented in the 2010s have had a substantial impact on the total emissions.

Figure 1.1

Greenhouse gas emissions according to the most recent inventory for 2000-2015 and in the WM projections of the climate and energy strategies published in 2005, 2008, 2013 and 2016 up to 2020 and 2030 respectively.



The total effect of implementing additional measures can be seen in the emission development trend after 2015, which has levelled off in the 2013 and 2016 projections, whereas it continued to increase in the projections from 2005 and 2008.

In the current WM projection, the emissions in 2020 are projected to be about 35 per cent below the projected levels in the 2005 and 2008 WM projections and 14 per cent below the 2013 WM projection.

Supplementarity relating to the Kyoto Protocol mechanisms

During the first commitment period of the Kyoto Protocol, Finland's total national emissions 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.). For the second commitment period, the estimated total effects of the policies and measures for 2020 indicate that the Kyoto target will be met entirely by domestic actions, and any possible use of Kyoto Mechanisms would be supplemental to domestic actions. Therefore, the use of the Kyoto mechanisms has been supplemental in the first commitment period, and is expected to be that also in the second commitment period.

1.5 Climate change impacts, adaptation measures and vulnerability assessment

Climate projections for Finland

The temperature increase in Finland is expected to be more than 1.5–2 times as large as mean warming globally. The temperature change in Finland is expected, on average, to be 2.5°C by mid-century and 3.3°C by the end of the 21st century under the RCP4.5 scenario representing fairly moderate emissions, and 3.5°C and 5.6°C under the RCP8.5 scenario representing high emissions. Both the increases in temperature and precipitation rates will be larger in winter than in summer.

As a consequence of climate change, it is expected that heatwaves will become longer and more frequent; heavy precipitation events will intensify in summer; the number of days with precipitation will increase in winter; the snow season will become shorter and the duration and depth of soil frost will decrease, particularly in snow-free areas like roads and airports.

Vulnerability, risks and climate change impacts

Knowledge on climate change impacts, risks and vulnerabilities is continually accumulated by research activities. Vulnerabilities have been identified in all sectors, but their nature varies. A study of vulnerability in natural resource based sectors was recently completed and research is ongoing at national, Nordic and European scales to improve the evidence base for adaptation policies and measures.

Economic impacts of climate change have been estimated to be considerable for different sectors in Finland, although significant uncertainties and variable risks need to be taken into account. Estimated impacts are potentially beneficial for some sectors, however active and proactive adaptation is required to realise such opportunities. Cross-border effects of climate change is one area where economic impacts are likely to be notable in the future.

Adaptation

Finland was one of the first countries in the world to adopt a National Adaptation Strategy to Climate Change in 2005. The implementation of the strategy was evaluated in 2009 and 2013. The level of adaptation varied between the sectors and the importance for the collaboration between the sectors was recognized. The current national adaptation policy framework is described in the National Climate Change Adaptation Plan 2022 adopted in 2014. Its aim is that the Finnish society has the capacity to manage the risks associated with climate change and adapt to changes in the climate.

National adaptation policy is coordinated by the Monitoring Group on Climate Change Adaptation chaired by the Ministry of Agriculture and Forestry. It is broadly-based, with representatives from the relevant ministries and other authorities, regional and local actors, research institutes, expert organisation in fire and rescue services, and financial services. It monitors and promotes the implementation of the adaptation plan together with a broad network of stakeholders.

Finland's Climate Act was approved in 2015. It stipulates that the Government approves long-term and medium-term strategic mitigation plans and it will approve a national plan on adaptation at least every ten years. Adaptation is also included in the National Risk Assessment 2015 and revised National Energy and Climate Strategy 2016.

Several sectors also have an action plan for adaptation, e.g. the environmental administration, administrative branches of the Ministry of Agriculture and Forestry and the Ministry of Transport and Communication. Most of the municipalities are undertaking systematic climate actions and, although their focus has been on climate change mitigation, adaptation has also been promoted. By the end of 2015, regional flood risk management plans were published for every significant flood risk area, and currently the measures are being implemented. In addition, several bigger cities and municipalities have been active in vulnerability assessment.

Currently, the most advanced sector in adaptation is **water management**, where adaptation has already been integrated into decision-making. Essential measures in water services include intake wells in groundwater bodies with favourable water yields and further emphasis on storm water management. Wastewater facilities, especially pumps, should be placed outside groundwater areas and flood risk areas. Other actions include preparedness planning, regular revision of dam safety, improved cooperation between waterworks, guidelines on land use and further development and utilisation of databases and models.

In the **energy sector**, measures include e.g. intelligent electricity networks which will work as a service platform in transition towards a more decentralised electricity system. Regulations aimed at improving the security of power supply have been included in the revised electricity market legislation.

Current legislation on building and other statutes include requirements for taking climate change into consideration in **land use planning and building**. 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 extreme weather events in built areas. The management of flood risks and river basins is also regulated.

In **agriculture,** concrete risk management measures are being developed in co-operation between the government, producers, research and the private sector to reduce and prevent risks to agricultural production and income. Risk profiles and emergency plans have been made for various existing and emerging pests and diseases. Other adaptation measures include sustaining the soil structure and conditions by diversifying the crops and crop varieties, developing crop rotations and soil cultivation methods, favoring crops that provide soil cover for winters that are projected to get wetter and developing year-round water management systems to increase nutrient use efficiency and reduce drought-induced yield variability. Finnish plant breeding has expanded the breeding strategies to cover novel crops and to improve disease resistance and resilience, which are important elements in improving Finland's adaptive capacity in the future. In the energy sector measures to improve and increase farms' energy self-sufficiency and security of supply have been promoted and implemented.

Within the **forestry sector**, recent modifications to forest legislation take into account climate change adaptation by allowing more diverse forest management and by adjusting annual deadlines for removal of felled timber from forests as a precaution to earlier occurrence of pests. Additional measures promote the use of high quality seed suitable for different climatic conditions, establishment of a network of gene reserve forests and monitoring of the pest and disease situation in forests. The damage contingency plans with appointed regional experts assist rapid harvesting of wind damaged trees. Further adaptation measures include the site-specific selection of species and regeneration methods and awareness raising through means such as forest damage road shows.

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. The Finnish mining industry has been subject to 'stress tests' in order to identify and reduce the risk of adverse environmental consequences, which climate change can aggravate.

The adaptation actions of **transport and communication sector** include improving the safety equipment, proactive planning, developing the design and procurement practices, technical development, developing information services and traffic management, product and market monitoring, as well as co-operation in international regulation development. Improved forecasting models and an early warning system as well as remote monitoring system of the climatic conditions have been developed.

The Roadmap for Growth and Renewal in Finnish **Tourism** for 2015–2025 reacts to the climate change and calls for new, innovative solutions for sustainable tourism products and experiences.

In the **insurance sector,** a new insurance programme for damage caused by exceptional floods was launched in 2013. In 2016, some private insurance companies introduced products which cover risks for extreme weather conditions.

In the **health sector**, a national water safety plan was introduced in 2016 to prevent water-borne epidemics. Measures taken to prevent tick-borne diseases include raising awareness of ways to protect from tick-bites, and providing free vaccines against tick-borne encephalitis in some high-risk areas.

Global impacts of climate change and international cooperation

A recent study on cross-border effects of climate change in Finland identifies seven different impact chains triggered by cross-border impacts: trade impacts, impacts through infrastructure, impacts on finance and insurance, human mobility, ecosystems, geopolitics, and cognitive changes. In many cases the strongest cross-border impacts originate in neighbouring areas.

Finland is a member of the Arctic Council (chair in 2017–2019) and the Barents Euro-Arctic Council (chair 2013–2015) and finds climate change one of the key areas of co-operation. In the context of the Baltic Sea Region cooperation on climate change Finland implements the EU Strategy for the Baltic Sea Region.

Climate sustainability has been one of the binding cross-cutting objectives of Finland's development policy and development cooperation since 2012. Finland has adopted a climate sustainability tool in the annex of its new Manual for Bilateral Programmes for assessing and preventing climate change and the risks posed by natural disasters caused by climate change. Furthermore, the Manual includes a disaster risk reduction tool integrated into the Guidance and Checklist for Climate Sustainability tool.

Finland has been supporting the United Nations Office for Disaster Risk Reduction (UNISDR) since 2004, and has also participated as an observer to 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, the Kyoto Protocol and the Paris Agreement 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. Climate sustainability has been one of the cross-cutting objectives of Finland's development policy and development co-operation since 2012. 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.

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 fast-start finance commitment of EUR 110 million was implemented through a net increase of Finnish funding directly allocated to developing countries' climate activities in 2010–2012 compared to the year 2009. The baseline figure for overall Finnish climate funding (grant) in 2009 was approximately EUR 26.8 million.

While the fast-start finance period is now over, the international public climate finance that Finland has provided has continued to be higher than in the base year used for fast-start finance. The total allocations were about EUR 94 million in 2013, EUR 116 million in 2014, EUR 115 million in 2015 and EUR 43 million in 2016. The division between mitigation and adaptation support varies according to the year, but it is rather balanced. For example in 2016 about 58% was allocated to mitigation and about 42% to adaptation.

During 2013–2014 the government channelled all revenues from the auctioning of ETS allowances to Official Development Assistance activities, including climate finance. These revenues were used during the reporting period e.g. to support the Green Climate Fund (EUR 34.7 million).

Finland attaches particular importance to assisting countries that are least developed, as they are among the countries most vulnerable to climate change. Finland's LDC-partner countries in Africa include Ethiopia, Mozambique, Somalia and Tanzania. In Asia, Finnish bilateral support focuses on the three poorest, fragile states: Afghanistan, Myanmar / Burma and Nepal. Finland supports SIDS countries with regional programs in the Pacific and the Caribbean.

In long-term partner countries the co-operation is based on country programmes that are prepared in consultation with partners and that build on national development plans. The form of assistance varies between regions and programmes. The Energy and Environment Partnership (EEP) project, which began in Central America in 2003 and has since been replicated in the Mekong region, southern and eastern Africa, Indonesia and the Andes, accounts for a large part of the mitigation projects in the energy sector. Also, support for forestry projects (mitigation and adaptation) is substantial.

With regard to adaptation, the most important element has been capacity building in partner countries. Finland has been very active in the field of meteorological co-operation. It has supported, for example, co-operation between the Finnish Meteorological Institute (FMI) and the Secretariat of the Pacific Regional Environmental Programme (SPREP) and the Pacific national meteorological services since 2009.

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. For instance, Finland has supported the work of the Climate Technology Centre and Network (CTCN) with EUR 200,000 in 2015.

Private sector projects in developing countries are being supported, for example, by the Finnish Fund for Industrial Cooperation Ltd. (Finnfund) and Finnpartnership (the Finnish Business Partnership Programme). Both organizations are active in the climate change field. About half of all investments made in recent years can be regarded as climate finance because they have been used for renewable energy projects, as well as projects to prevent deforestation, to support energy and material efficiency, or to improve the ability of poor people to adapt to the challenges posed by climate change.

The Finnish Government considers important that businesses promote sustainable development in their undertakings. In this context the government of Finland has decided to use around 530 million euros during 2016–2019 as investment funding to support programs/projects in line with Finnish development policy, especially to climate mitigation and adaptation and creating sustainable jobs and livelihoods in private sector. The first allocation (EUR 130 million) from this package was made to Finnfund in 2016.

Table 1.2
Summary information on financial resources and technology transfer

Official development assistance (ODA)	2013: EUR 1,081 million (0.53% of GNI); 2014: EUR 1,232 million (0.59% of GNI); 2015: EUR 1,161 million (0.55% of GNI); 2016: EUR 956 million (0.44% of GNI)
Climate-related aid in bilateral ODA	2013: EUR 32 million 2014: EUR 44 million 2015: EUR 39 million 2016: EUR 26 million = amounts of the project funding directly directed to climate activities
Climate-related support programmes	e.g. Energy and Environment Partnership (EEP), Making agriculture part of the solution to climate change – Building capacities for Agriculture Mitigation project, Sustainable Forest Management in Changing Climate project, the Southeast Asia Climate Change Network; more information on projects and more projects available in: http://stats.oecd.org/Index.aspx?DataSetCode=RIOMARKERS
Total contributions to GEF	2013: EUR 13.650 million 2014: EUR 22.025 million 2015: EUR 14.325 million 2016: EUR 7.961 million
Pledge for sixth GEF replenishment	EUR 65 million in total
JI and CDM under the Kyoto Protocol	Finland committed about EUR 12.2 million through ten bilateral projects for the purchase of project units during the prompt start phase and the first commitment period of the Kyoto Protocol. Two of these projects continued generating units also after 2012. Finland also invested in multilateral carbon funds. USD 10 million has 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 Asia Pacific Carbon Fund, EUR 3 million in the Nordic Environment Finance Corporation's NEFCO Carbon Fund and USD 20 million in the Asian Development Bank's Future Carbon Fund. Of these funds, the World Bank's Prototype Carbon Fund, NEFCO's NEFCO Carbon Fund and the Asian Development Bank's Future Carbon Fund continue to generate units for 2013 to 2020.
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 8.9 million during the implementation period 2008 to 2016. The cooperation between the Finnish Meteorological Institute (FMI) and the Secretariat of the Pacific Regional Environmental Programme (SPREP) and the Pacific national meteorological services since 2009 seeks to improve the capacity of 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.

1.7 Research and systematic observation

Climate change has been recognised as an important topic in Finnish research policy for decades. Climate change research policies are cooperatively implemented by several ministries. Large cross-sectoral climate change programmes have aimed at strengthening the scientific understanding of climate change as well as the mitigation and adaptation impacts and options, including their socio-economic and environmental aspects.

The Academy of Finland, the umbrella of the national Research Councils, has three ongoing programmes related to climate and energy: the programme on biobased economy (BioFuture2025, 2017–2020), the Arctic research programme (ARKTIKO, 2014–2018) and the programme on energy transition (New Energy, 2015–2018). Many of the ongoing and recently finished programmes coordinated by Tekes – the Finnish Funding Agency for Innovation are related to the mitigation of climate change through research and development especially on renewable energy, bioeconomy and cleantech. A large number of research institutes, universities and consultants carry out research on climate change impacts, adaptation and mitigation in close cooperation with each other: for instance, nearly 20 organisations served as grant holders for Academy of Finland's funding of EUR 59 million for climate change research in 2013–2016.

The focus in climate change research has gradually shifted from dominantly natural sciences to more comprehensive approaches that include socio-economic studies and inter- and transdisciplinary approaches. The Government's annual plan for joint analysis, assessment and research activities as well as Strategic Research Council with the Academy of Finland are examples of new funding mechanisms that have been introduced to promote multidisciplinary research supporting knowledge based decision making and management. The current Strategic Research Council programmes with projects of particular relevance for climate change include research on energy transition and renewable energy, use of forest resources, offshore wind, circular economy of non-renewable substances, resource efficient food production, climate and resource scenarios as well as urban development. The Finnish Climate Change Panel consisting of scientists representing different areas of expertise continues its work of producing reports on climate change research and of communicating new research information to decision makers.

The Finnish Meteorological Institute (FMI) is an expert in climate change and related issues. With regard to climate process and climate system studies, the emphasis is on climate research and services, greenhouse gases as well as aerosols, clouds, trace gases and climate supported by routine surface and upper air weather observations. The FMI also measures greenhouse gas concentrations at a station in Lapland and monitors physical properties in the Baltic Sea.

The Finnish Environment Institute (SYKE) carries out research on climate change impacts, mitigation and adaptation, including policy evaluation. SYKE is also the national centre for monitoring the physical, chemical and biological state of inland waters. The Natural Resources Institute Finland (Luke) performs climate change related research activities on natural resources, and it does national forest inventories (NFIs) which produce information on the land use, forest resources, growth, condition and biodiversity of forests. About 60 national monitoring schemes or projects provide data of the changes in biodiversity and habitats in Finland.

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. Its main objective is to reduce scientific uncertainties concerning global climate change issues, particularly those related to aerosols and clouds. Finnish research institutes with significant marine components have started a national marine research infrastructure consortium (FINMARI) coordinated by SYKE. Finnish universities and research institutes also have extensive activities in paleoclimatology.

Open science is one of the spearheads of Finnish science policy. An example of current open science actions include free-of-charge online services based on data by the Finnish Meteorological Institute (FMI) and the Finnish Environment Institute (SYKE) and a web portal of Finnish open access journals.

Free and open international exchange of data and information has been further promoted by participation in several international research programmes, networks, data collection schemes, and databases. Finland is overseeing the implementation of two European organizations of distributed research infrastructure: the ICOS (Integrated Carbon Observation System) for online in-situ monitoring of greenhouse gases and ACTRIS (Aerosols, Clouds and Trace gases Research Infrastructure) for monitoring and research on short-lived climate forcers in the atmosphere. Finland has also actively participated in the work the Intergovernmental Panel on Climate Change (IPCC).

Finland has been operating extensive capacity building programmes to promote the exchange of information and know-how as well as to support endogenous capacities and capabilities in developing countries. The capacity building programmes have focused on climate observations, research, higher education cooperation relevant to climate change mitigation and adaptation, and the sustainable use of forests.

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. Education policies are in the responsibility of the Ministry of Education and Culture. Training and public awareness policies are considered in several sectors and by many actors.

Climate change issues are included in the education given on sustainable development in Finland's compulsory basic education system. The present National Core Curriculum for Basic Education was given by the Finnish National Agency for Education in 2014. Many school subjects deal with sustainable development and climate change, and they are also dealt with as a cross-curricular theme. In addition, after basic education level, climate change issues are included in the upper secondary level education.

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 also 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 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. 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 several ministries (the Ministry of Agriculture and Forestry, the Ministry of the Environment, the Ministry of Economic Affairs and Employment, the Ministry for Foreign Affairs, the Prime Minister's Office Finland), research organisations (the Finnish Environment Institute SYKE), the Finnish Meteorological Institute (FMI), VTT Technical Research Centre of Finland Ltd, Natural Resources Institute of Finland (Luke), regionally operating organisations (Centre for Economic Development, Transport and the Environment and the Association of Finnish Local and Regional Authorities), Tekes – the Finnish Funding Agency for Innovation, Sitra the Finnish Innovation Fund, Motiva Ltd (see Section 9.4.2), and the think tank Demos Helsinki. 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.

There are several best practises of climate change information provided as free web based material. To name just two here: the website Climateguide.fi pools practical, studied and reliable information on climate change into one address and in a uniform format. The purpose of the website is to support society and citizens in mitigating climate change, and in adapting to it; the website Climate.now is a multidisciplinary study and teaching module on the basics of climate change. It contains written material, video lectures and interviews, assignments, tests and a guide for teachers that will help anyone familiarise themselves with the basics of the climate change.

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. Government structure as well as population, geographical and climate profiles are illustrated. Thereafter, the characteristics and development of the economy, energy supply and consumption, transport, industry, building stock, urban structure, waste, agriculture and forestry are described.

Photo:
Riku Lumiaro / 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 implements parliamentary decisions, presents legislative proposals to Parliament, directs state administrative activities and represents 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.

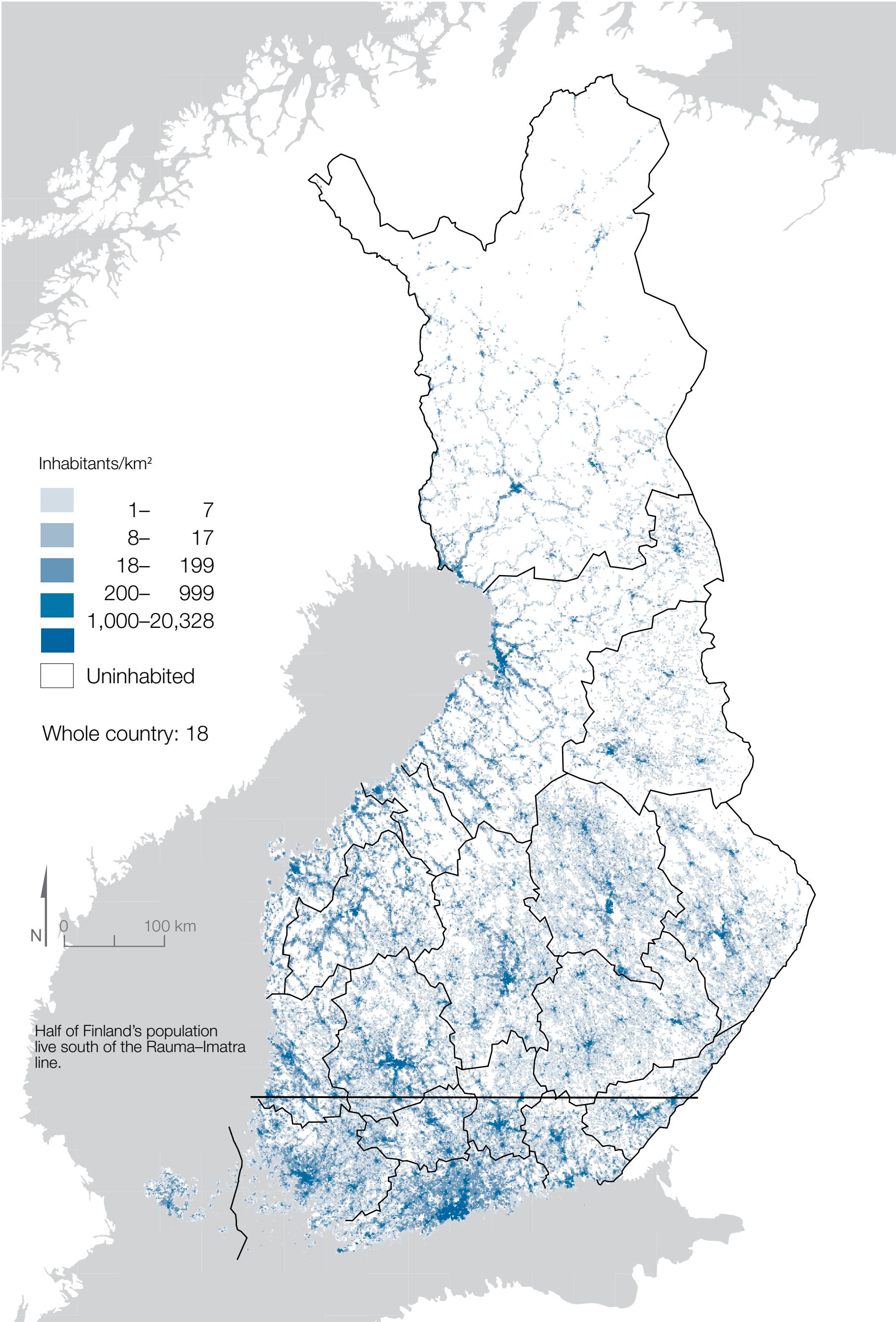
More information about the institutional framework of Finland's climate policy is presented in Section 4.2.

2.2 Population profile

The population of Finland was 5.5 million at the end of 2015. 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 2015, it is estimated that the Finnish population will increase to 6.0 million by 2060. The population density averages 18 inhabitants per km^2, but ranges from two inhabitants per km^2 in northern Finland to 170 inhabitants per km^2 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 distances travelled for different purposes can be quite long.

There is a strong internal migration from rural to urban areas. In the period 1990 to 2015, net migration from rural to urban areas amounted to a total of 152,900 people: 71,000 people during the years 1990 to 1999 and 81,900 people during the years 2000 to 2015. Many rural communities have a declining population, particularly in northern and eastern Finland. In 2015, net migration to urban areas was 8,300 people, which

Figure 2.1
Population density in Finland, 1 January 2015



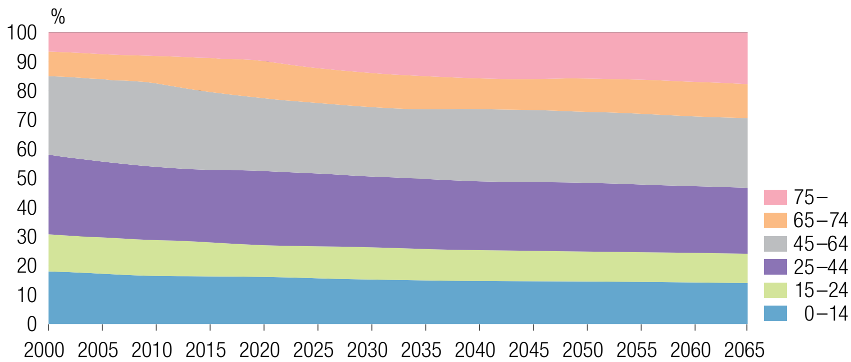
was considerably lower than in the latter half of the 1990s, when it exceeded 10,000 people per year.

The urban population (3.8 million) made up 69.2 per cent of the total population (5.5 million) in 2015. 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 net migration, but also because of municipal mergers, as some 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 2015 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 2015, the proportion of people aged over 65 was 20.5 per cent, while in 1990 it was 13.5 per cent. This trend will accelerate in the coming years and decades. It is estimated that 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 84.2 and men the age of 78.5. 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 to 2065



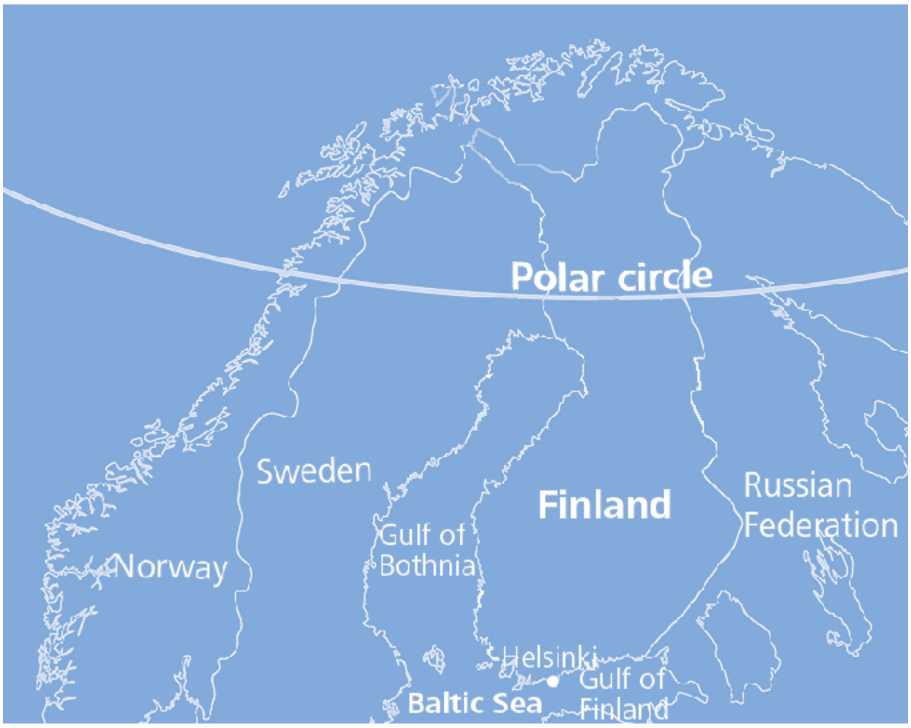
Years 2000–2015 actual, years 2016–2065 projected

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, Finland has a long coastline with numerous islands along the Baltic Sea coast. With a total area of 338,400 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 nine 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 six 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.

Changes in land use since 1990 are shown in Table 2.1. The area of settlements has increased by 20 percent and that of grassland has decreased by nine per cent, whereas changes in areas of other land use categories have been small, one percent or less (Table 2.1).

Table 2.1
Land use in 1990 and 2015

Land use classification[1]	1990 (km^2)	2015 (km^2)	Change %
Forest land	221,097	218,889	–1.0
Cropland	24,722	24,853	0.5
Grassland	2,663	2,426	–8.9
Wetlands	30,068	29,913	–0.5
Settlements	12,225	14,688	20.2
Other land	13,139	13,102	–0.3
Total	**303,915**	**303,873**	
Inland waters	34,520	34,560	
Total with inland waters	338,435	338,433	

[1] The classification is based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Vol.4. Agriculture, Forestry and Other land Use

Source: National Resources Institute Finland (Luke)

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 (66.5°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 the sun never sets. Conversely, in wintertime the northernmost region has two months of uninterrupted darkness.

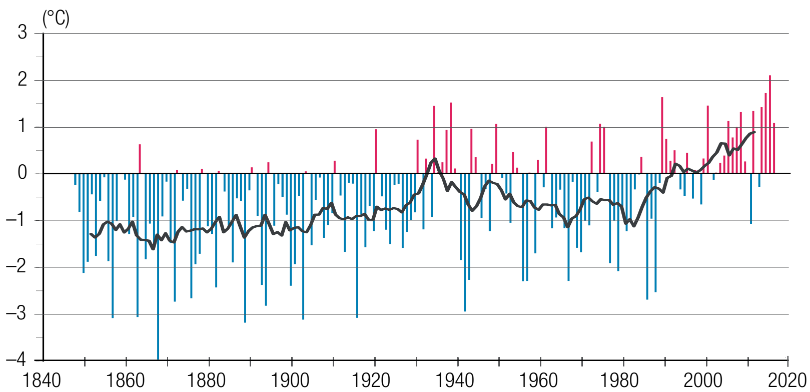
The Finnish climate is characterised by irregular precipitation and typically there are rapid changes in the weather. The mean annual precipitation in southern and central Finland is usually between 600 and 750 mm, except near the coast, where it is slightly lower. In northern Finland, the annual precipitation is 450 to 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 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 to 70 per cent of the annual precipitation is in the form of snow and it remains on the ground for six to seven 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 remains open for the most part, except for the Gulf of Bothnia and the eastern part of the Gulf of Finland.

The most common wind directions (17 to 18 per cent) are from the south and southwest (land areas and sea areas, respectively). The least common wind directions (8 to 10 per cent) are from the east and northeast. Wind comes from all other directions with more or less equal frequency. The average wind speed is three to four m/s inland; it is slightly higher on the coast and five to seven 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 to June to about 80 per cent in September to November.

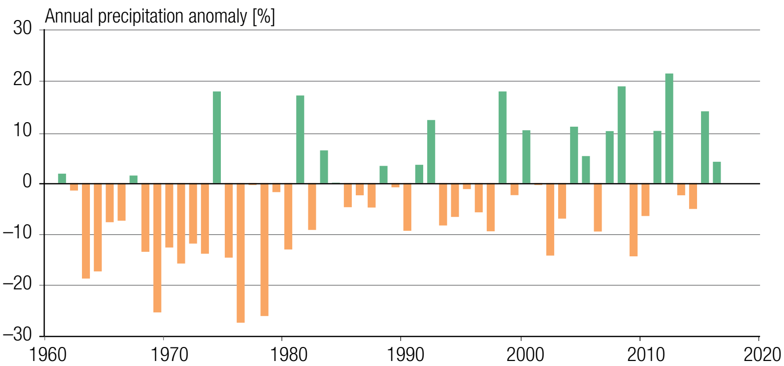
The average annual temperature has increased during the last 150 years by slightly more than one degree (Figure 2.4). The increase has been the greatest in springtime. Winters have become about one degree warmer and summers and autumns about half a degree warmer. Considerable temperature fluctuations 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 winter 2015, 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 change projections suggest that by 2050, one in five winters will be as warm as, or warmer, as the record mild winter of 2015.

Figure 2.4
Annual mean temperature in Finland, 1847 to 2015, presented in anomalies (°C) for the reference period 1981 to 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 to 2015, presented as anomalies (%) for the reference period 1981 to 2010 in terms of mean precipitation



Source: Finnish Meteorological Institute

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 precipitation levels.

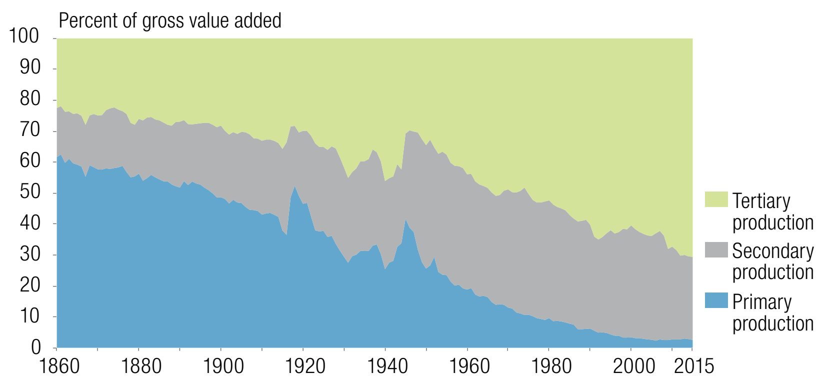
2.5 Economy

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 to 2009 (Figure 2.7). The economy recovered rapidly after the first recession, and between 1994 and 2007 output grew by nearly five per cent and exports by more than 10 per cent per year. The growth rate was lower but still more than three per cent in 2001 to 2007.

During the 2008 to 2009 recession, the Finnish economy contracted by 10 per cent in the peak-to-trough period. By 2015, by the Finnish economy had still not fully recovered from the deep recession that began in 2008. The economy showed healthy growth in 2010 to 2011, but in 2012–2014 it once again contracted. World trade had already recovered to the same levels seen before the financial crisis, but Finnish exports still remained well below their pre-recession levels.

Figure 2.6
Structural changes in economy

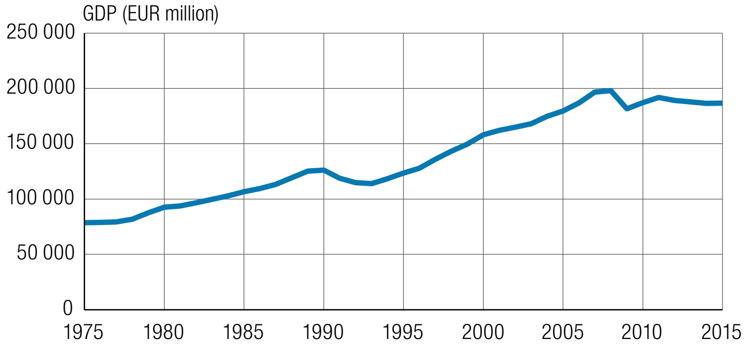


The volume of Finland's GDP gstayed virtually unchanged in 2015. The output of the national economy stood at EUR 187,000 million both in 2014 and 2015. Latest macroeconomic data and projections confirm that the national economy has returned to growth path in 2016. However, it is predicted that the average GDP growth will remain rather moderate in the next few years.

In 2015, net national income grew by 1.4 per cent in real terms, which was clearly more than the gross domestic product because the terms of trade or the ratio between export and import prices improved considerably. The volume of investments grew by 0.7 per cent, and demand in the national economy was mainly maintained by consumption; the volume of which grew by 1.1 per cent.

After a long period of strong growth, Finland's productivity performance weakened sharply amidst the 2008–2009 recession, reflecting not only a weak performance in information and communication technologies but also in the public sector. Over the ten-

Figure 2.7
Gross domestic product 1975 to 2015 (at 2010 prices)

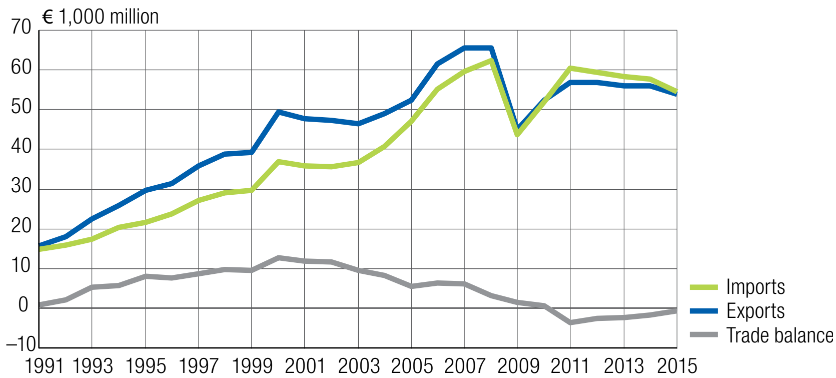


year period before the recession in 1998 to 2007, total productivity trend growth averaged 1.8 per cent per year, whereas from 2008 to 2015 total productivity trend growth has averaged −1.0 per cent per year. Potential output growth is expected to accelerate in the next few years together with the rebounding of total productivity. The growth rate of total productivity is, however, predicted to remain at lower level than in 1998–2007.

Finland's weak export performance (Figure 2.8), which has been especially clear in the information and communication technology (ICT), forestry and metal industries, reflects falling demand 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.

The volume of exports was 42 million tonnes in 2015. 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 degree of refining in exported goods is clearly higher than in imported goods.

Figure 2.8
Finland's exports and imports, 1970 to 2015 (at current prices)



Finland imported nearly 54 million tonnes of goods in 2015. However, almost a quarter, 24 per cent of the weight of the imported goods was biotic, in particular, agricultural and forestry products, refined wood products and food.

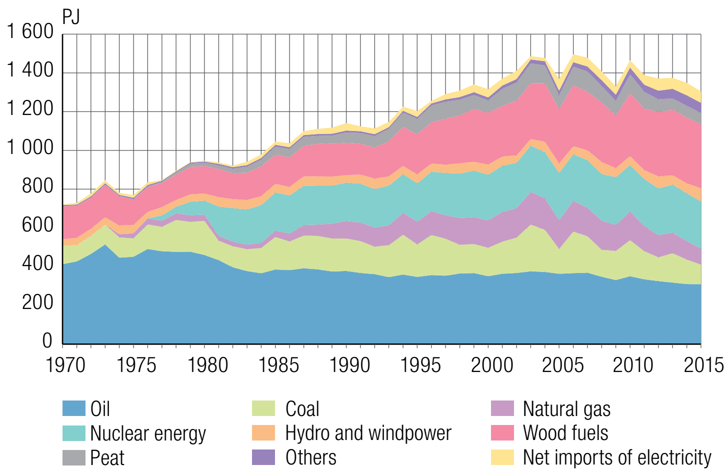
The value of Finland's exports was EUR 77,156 million in 2015 and imports amounted to EUR 76,898 million. Oil products were the most important growth area in exports. The export volumes for many electrical appliances and foodstuffs also increased. The long-term decrease in communication equipment exports continued. Exports to both non-EU countries and other EU countries diminished by one per cent in 2015. Imports from other EU countries declined by one per cent, while imports from non-EU countries stayed at the same level as in the year before.

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 wellbeing of its inhabitants and the country's competitiveness. 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 other cities. The first nuclear power unit was taken into use in 1977, followed by three other units in the years 1979 to 1982. A fifth unit is currently under construction and is expected to be completed in 2018. The 1970s also brought peat into the Finnish energy mix (Figure 2.9).

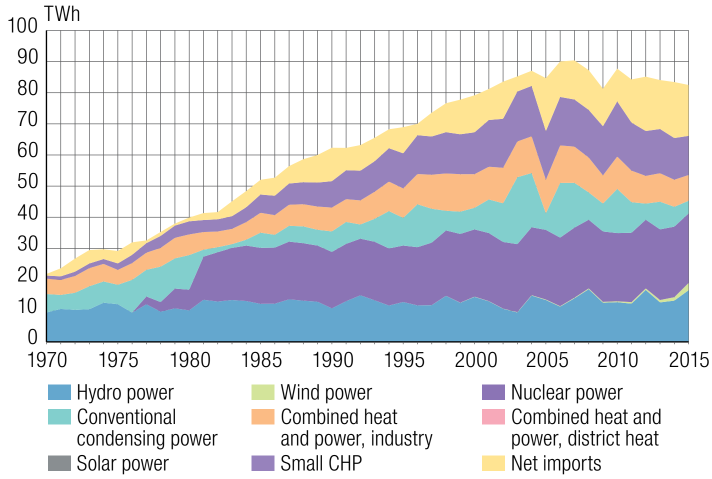
Figure 2.9
Total energy consumption, 1970 to 2015



In 2015, total energy consumption was 1,301 PJ. Finland's domestic energy sources are wood-based fuels, hydropower, wind power, waste and peat. Its energy dependence, calculated as the proportion of imported net energy in the total primary energy supply (TPES), was 47 per cent in 2015. 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 66.2 TWh in 2015. This consisted of combined heat and power production (31 per cent), both in connection with district heat production and by industry for its own use, nuclear power (34 per cent), hydropower (25 per cent), con-

Figure 2.10
Electricity supply by production mode, 1970 to 2015



ventional condensing power (six per cent) and wind power (3.5 per cent) (Figure 2.10). Electricity consumption was 82 TWh.

The power system is interconnected with the power systems in Russia, Sweden, Norway and Estonia. Net imports from the Nordic and Baltic market and Russia vary considerably from year to year, mainly due to variations in hydropower production in the Nordic countries. Between 1990 and 2015, maximum net imports were 18.0 TWh (in 2014) while minimum net imports were 3.7 TWh (1996).

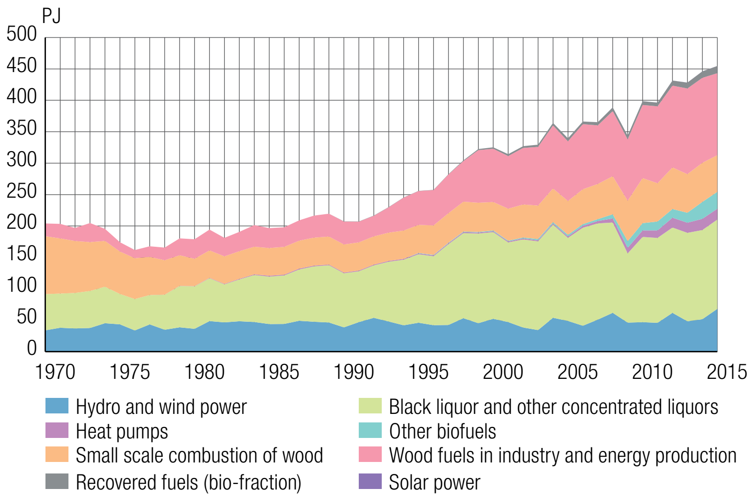
Renewables accounted for 16 per cent of final energy consumption within the EU in 2015. In Finland, the corresponding figure was consistently around 30 per cent for the period 2000 to 2007, but it has increased over the last years, reaching 39 per cent in 2015 (Figure 2.11). In 2010, an extensive package of specific targets concerning different renewable energy sources was launched in order to reach the EU 2020 renewable energy target set for Finland, i.e. 38 per cent of its gross final 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 increased utilisation of heat pumps (see Section 4.5.1). Since 2010, measures have been strengthened and adjusted when needed.

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 one MW in 1992, whereas it climbed to 82 MW in 2005 and reached 630 MW at the end of 2015. By the beginning of 2017, the installed wind power capacity had increased to 1,553 MW.

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 relatively high share of non-fossil energy sources in power and heat production, i.e. hydro, nuclear and biomass sources.

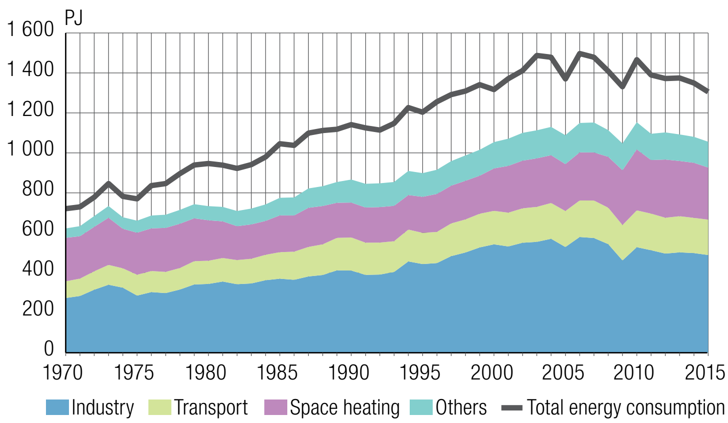
For several decades the use of primary energy, as well as electricity were increasing and they reached their peak values in 2006 to 2007. Demand rose more rapidly than GDP until 1994. Thereafter, both the energy intensity and the electricity intensity of the economy

Figure 2.11
Renewable energy sources, 1970 to 2015



have decreased. The decrease reflects the structural change within the economy from basic industry towards services and less energy-intensive industry. Furthermore, increased energy efficiency has contributed to the positive development of energy intensity. Industry is still the largest energy consuming sector, with a 45 per cent share of final energy consumption in 2015 (Figure 2.12). Space heating accounted for 25 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 47 per cent of electricity, households 27 per cent and services and the public sector consumed 23 per cent of electricity.

Figure 2.12
Total energy consumption and final energy consumption by sector, 1970 to 2015



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 150 and the number of production plants is around 400. To serve Finland's 3.3 million electricity customers, there are currently 72 retail suppliers.

The Finnish electricity wholesale market is part of the Nordic and Baltic power market. For more than a decade, Finland has formed an integrated wholesale electricity market together with Denmark, Norway and Sweden, and in the 2010s Estonia, Latvia and Lithuania joined the common market. The Nordic and Baltic power market is price coupled with the continental electricity markets. Physical day-ahead and intra-day trading takes place in the power exchange Nord Pool. The formulation of area prices and the allocation of cross-border capacity between Finland and the other Nordic and Baltic countries 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 was 67 per cent in 2015. Electricity is also traded on the Over-the-Counter-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 has been relatively isolated and small. Up till now there has been only one importer and wholesale supplier: Gasum Oy. A total of 22.9 TWh of natural gas was consumed in 2015. The largest natural gas user groups are the energy companies, the pulp and paper industry and the chemical industry; together, they use approximately 90 per cent of the gas. There are 22 natural gas retail suppliers and approximately 29,000 retail customers. The retail supply of natural gas covers only about five 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. In October 2016, the promoters of the Balticconnector gas pipeline, Baltic Connector Oy from Finland and Elering AS from Estonia took the final decision to invest in the construction of the Balticconnector gas pipeline. Balticconnector is a gas pipeline between Finland and Estonia that will enable the natural gas markets of the Baltic countries and Finland to be connected, and allow the integration of these markets with the European Union's common energy market. On 11 May 2017, the Government gave a proposal to the Parliament concerning a new Natural Gas Market Act. According to the proposal, the wholesale and retail markets for natural gas will be opened for competition in the beginning of 2020. After that, Finland will apply the EU internal gas market legislation as a whole.

Emissions trading within the EU is a market-based instrument cutting emissions in the energy sector. Finland's Emissions Trading Act (311/2011) 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 (see Section 4.5.1).

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 350,000 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 5,950 km, of which 3,250 km is electrified.

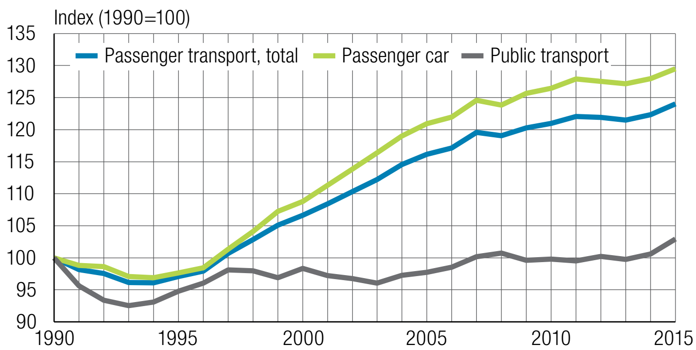
Three quarters of Finland's foreign trade go by sea, most of it from the country's principal ports. Most of Finland's many ports and harbours are small and the traffic flows vary considerably. Icebreakers have an important role to play, with nine of them being responsible for assisting freighters and passenger ships into the 27 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 24 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 29 per cent, and the number of passenger-kilometres by public transport by three per cent (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.

Figure 2.13
Development of passenger-kilometres in domestic transport, 1990 to 2015

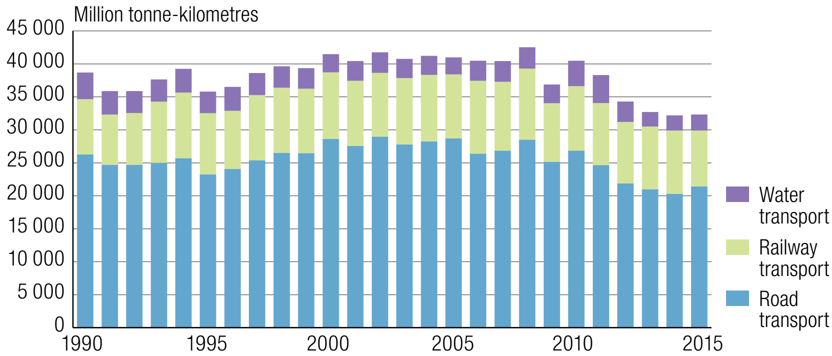


2.7.2 Freight transport

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.

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 26 per cent of all transport, and inland waterways for just under eight per cent. Air transport's share is almost negligible.

Figure 2.14
Tonne-kilometres in domestic goods transport, 1990 to 2015



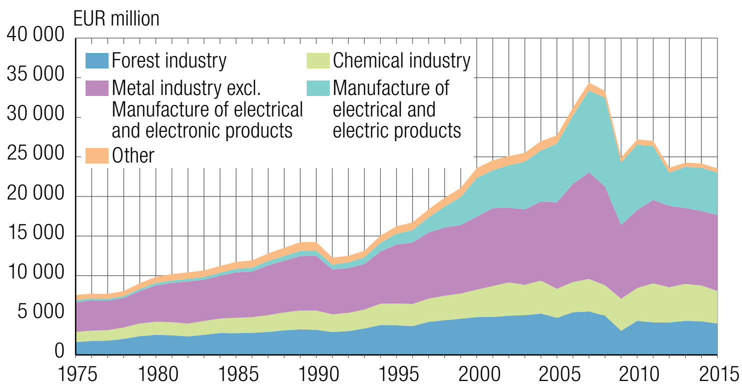
Almost 92 per cent of overseas freight travels by sea, while approximately seven per cent travels by road. Air freight is almost negligible in terms of tonnes, whereas in terms of value it accounts for more than nine per cent of all transport. Products with a high added value, such as electronics, are transported by air.

2.8 Industry

The metal and engineering industry, the electronics and electrical industry, the forest industry and chemical industry are the four 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.

The value of the output of industry was around EUR 77.8 billion in 2015. The value fell by 4.3 per cent from the previous year. The metal industry had a share of 41.4 per cent in total value of sold output, the chemical industry 20.9 per cent, the forest industry 19.8 per cent, and the food industry 10.8 per cent.

Figure 2.15
Output of manufacturing industries by sector, 1975 to 2015 (at 2010 prices)

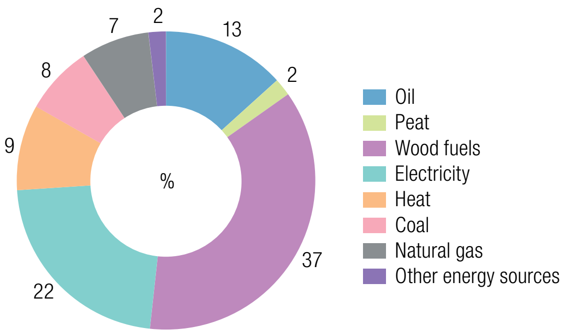


The forest industry, one of Finland's traditional industrial sectors, accounted for six per cent of the GDP in 2000, but by 2015 the share had fallen to 2.3 per cent. This occurred despite the increasing proportion of higher value added products in this sector. The forest industry has undergone structural change as manufacturers have downsized their capacity in certain paper segments. Recently, the export of pulp has increased and several new investments in pulp production are in the pipeline and under consideration. In general, the trend in industrial output at constant prices is fairly similar to that of the GDP. In 2015, a total of 45 mines and quarries were operating in Finland. The yearly volume of mining has been increasing since 2001 from around 30 to almost 90 million tonnes in 2015. The increase is mainly caused by few open pit operations. Expansion of present mines may increase the volume of mining in future.

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.

In 2015, Finnish industry used 46 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 (37 per cent), electricity (22 per cent), oil (13 per cent), purchased heat (nine per cent), natural gas (seven per cent), coal (seven per cent) and other energy sources (four per cent) (Figure 2.16). The forest industry (57 per cent) uses more energy than any other industrial sub-sector; this is followed by the chemical industry (18 per cent) and the manufacturing of basic metals (14 per cent) (Figure 2.17).

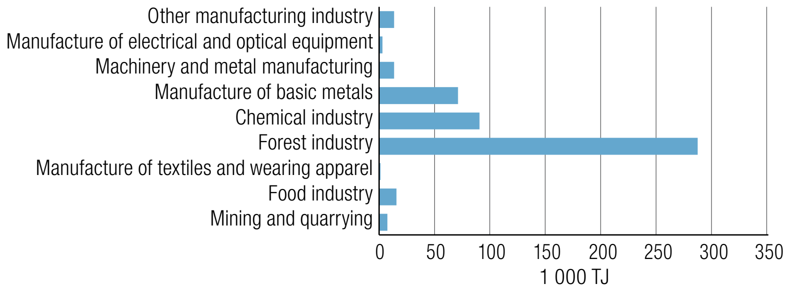
Figure 2.16
Energy use in manufacturing by source, 2015



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 2015 industrial output increased by 41 per cent (measured in terms of value added in 2010 prices), while the final consumption of energy rose by only about 15 per cent.

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.

Figure 2.17
Energy use in manufacturing by industry in 2015



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.

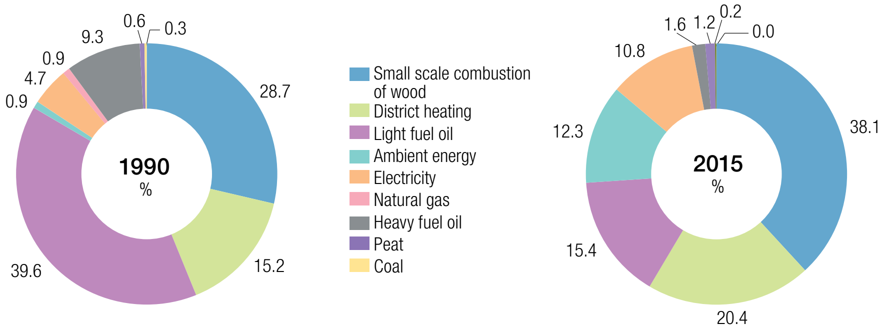
In 2015, the total heated building area amounted to 466 million m^2. Residential buildings accounted for 63 per cent of the area, while office, commercial, public and industrial buildings made up 36 per cent of the area. The remainder consisted of free-time residences, agricultural buildings and other small outbuildings. There were 1,143,000 detached houses, 401,000 dwellings in attached houses (mainly semi-detached and terraced houses) and 1,326,000 dwellings in apartment blocks. The number of dwellings increased by 32 per cent between 1990 and 2015. In addition to this increase in the 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 m^2. By 2015, it had increased by six square meters to 80 m^2. This is driving up the energy requirement for heating.

The figure for residential floor space per person has grown by more than the figure per dwelling. It was 40 m^2 in 2015 compared with 19 m^2 in 1970 and 31 m^2 in 1990. On average, Finns spent one-fifth of their disposable income on housing in the year 2012; since then, there have been no radical changes in the share of income spent on housing. The building stock is fairly new, with only 10 per cent of all buildings having been constructed before 1940. More than 97 per cent of dwellings have flush toilets and more than 98 per cent of them have a sewer and running water.

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 reduced significantly. This is largely due to a tightening of the building regulations, which have been 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, in southern Finland, from 3,200 to 4,700 per year during the years 1981 to 2010. In Sodankylä, in northern Finland, the corresponding range was 5,500 to 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.

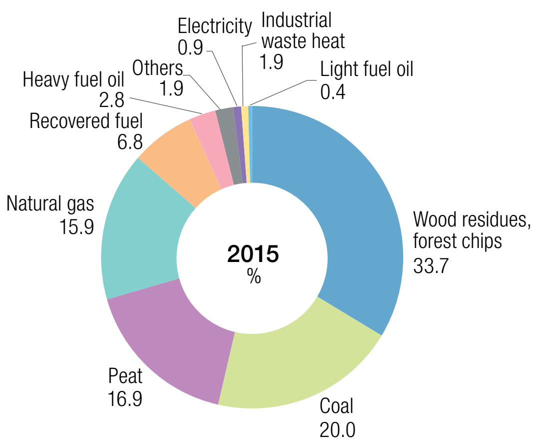
Figure 2.18
Heating energy used in residential, commercial and public buildings, 1990 and 2015



Between 1990 and 2015, the composition of energy sources used for heating changed significantly (Figure 2.19). The use of heavy fuel oil has decreased by 85 per cent and the use of light fuel oil by 55 per cent. At the 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 energy produced by heat pumps was only one per cent in 1990, but in 2015, their share was almost equal to that by oil: 10 per cent. Since 1990 the energy obtained from heat pumps has increased more than tenfold. The increase in the use of heat pumps is due to economic and environmental reasons, as well as to advances in technology. Small-scale combustion of wood has increased by 47 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 more than doubled and district heating increased by 48 per cent since 1990. The share of district heating was 46 per cent of the total heating energy in 2015. 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 2.19). Coal and oil are being replaced by natural gas. Peat, an indigenous fuel, remains competitive especially in inland areas. Government and industry efforts have helped to increase the use of

Figure 2.19
Fuels in district heating production in 2015



forest-based 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 70 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 decrease CO_2 emissions from energy production.

2.9.2 Urban structure

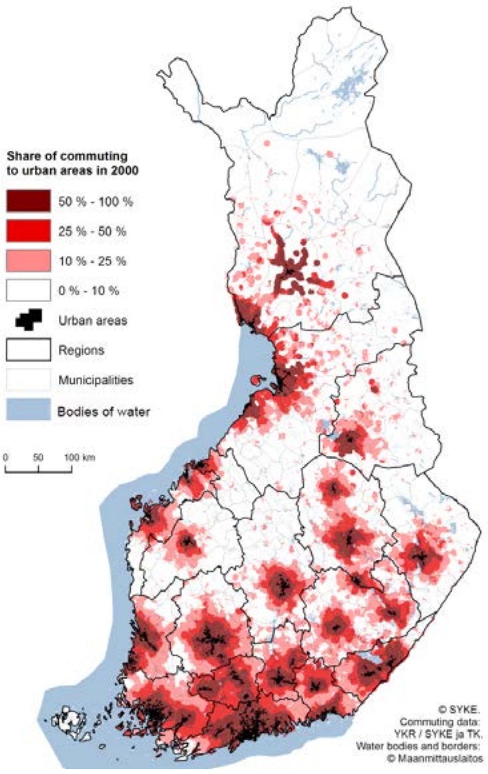
The regional development in Finland has been characterised by increasing differences between regions. Population growth and new jobs have concentrated mainly on a few big growing urban regions, principally Helsinki, Tampere, Turku, Oulu, Jyväskylä and Kuopio. Growth has occurred due to migration, immigration and large shares of young fertile age groups. Middle-sized urban centres have mostly kept the number of population and jobs relatively balanced. In rural areas, however, the population has been declining for many decades. The population of remote villages has been declining steeply, whereas villages closer to the growing urban regions have grown.

In 2015, the combined population of the 34 largest urban areas in Finland was 3.7 million, an increase of 460,000 since 2000. These urban areas contained 68 per cent of the total population in 2015 (63 per cent in 2000), and in 2014 they had 76 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 1.3 per cent of the surface area of the country. In future, population growth is projected to be even more concentrated than before around the largest urban centres, especially in the south of the country.

Finland became urbanised relatively late and the urbanisation process is still continuing. The share of the population in densely built-up areas (urban areas and rural localities) has risen continuously, and these areas accounted for 85.4 per cent of the population in 2015. There are 749 built-up areas covering approximately 2.2 per cent of the land area. In 2000, the corresponding proportion was 1.8 per cent. The population density in these built-up areas was 685 inhabitants per km^2 in 2015. Density has declined by 68 inhabitants per km^2 since 2000 as the lower density fringes of these built-up areas have grown. However, in some of the biggest urban regions, the density has started to rise slightly in the main urban area particularly after 2010. Approximately 64 percent of the inhabitants of all urban areas live in neighbourhoods with a population density of more than 20 inhabitants per hectare. The percentage has declined until 2011, but increased after that by 0.5 per cent. Approximately 67 per cent of the inhabitants of urban areas live in pedestrian or transit zones, and 33 per cent in car-dependent zones in 2015. Compared with the other Nordic and European countries, the population density of these built-up areas is still quite low. It is less than half the population density of comparable areas in Sweden or Norway.

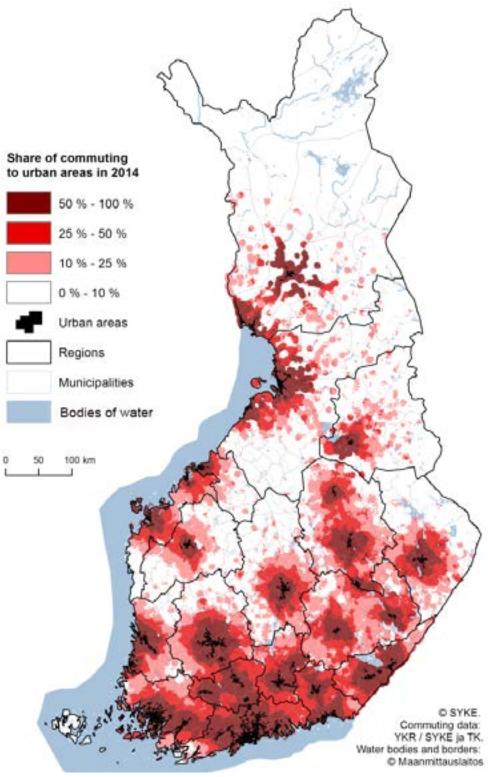
Often there is no distinct boundary between urban and rural areas, as in many cases there are some tight restrictions on construction close to urban areas. This has led to a dispersed and fragmented urban structure. Urban areas have typically expanded inexorably outwards, leading to the creation of unstructured, low-density built-up areas. These low-density districts of built-up areas outside the urban plan cover some 35 per cent of the land surface of the country's urban areas — even in the main growth centres. Low-density development causes problems in terms of arranging services, maintaining infrastructure and planning urban form. Many of the households in these areas need more than one car to manage their daily lives (commuting, school trips, acquiring services, and engaging in free-time activities). Despite the expansion of low-density areas, the share of population living in low-density areas and scattered settlements within urban regions has remained stable since 2000.

Figure 2.20
Share of commuting directed towards city centres, 1990



Source: Finnish Environment Institute (SYKE) and Statistics Finland

Figure 2.21
Share of commuting directed towards city centres, 2014



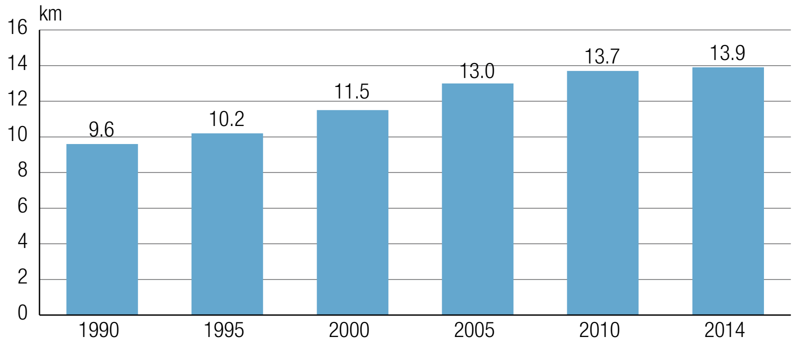
Source: Finnish Environment Institute (SYKE) and Statistics Finland

The average amount of kilometres travelled daily has increased due to the sprawl of residential areas, but also because of increased commuting distances and service-related mobility. Particularly retail trade has concentrated into bigger units, which are partly located on the fringe of urban areas.

The improvement of transport infrastructure has enabled people to travel longer trips to work than before. Commuting areas of cities have expanded significantly. This development can be seen in Figures 2.21 and 2.20, which show the development in commuting to urban areas from 2000 to 2014.

The average daily one-way commuting distance has more than doubled in just 30 years. After 2005, the average distance to work has risen only moderately and after 2010, the change has been minimal. The opportunities to use sustainable means of transport in commuting depend on the commuting distance and the location of both the home and the workplace in relation to public transport services. There are big differences between urban areas in the availability of sustainable options in commuting trips. The share of commuting trips, where sustainable means of transport are available, ranges between 49 and 76 in urban areas of urban regions. In most regions, the share has been declining, but in some regions, a small increase has taken place in the 2010's.

Figure 2.22
Average daily commuting distance, 1990 to 2014



2.10 Agriculture

Farming in Finland is possible as a result of the warming effect of the Gulf Stream, which makes temperatures three to four degrees 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 rainfall in the growing period is 340 to 370 mm in Southern Finland and 220 to 280 mm in Northern Finland. 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 2015, private persons owned more than 86 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 one per cent of farms.

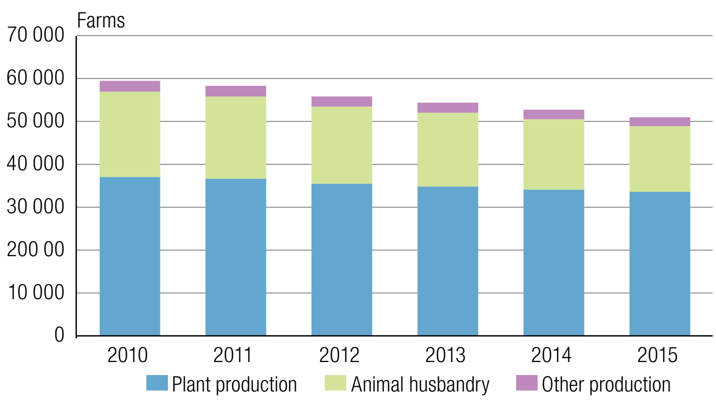
Between 1990 and 2015, the number of active farms fell from 130,000 to 51,000 (Figure 2.23). At the same time, the average farm size increased from 17 to 45 arable hectares. Total agricultural production as well as cultivated area have remained at almost the same level since 1990. In 2015, the utilized agricultural area in use was 22,733 km^2. Structural changes in agriculture have also led to a reduction in greenhouse gas emissions from the agriculture sector (see Section 3.2.4)

More than 60 per cent of the active farms practice crop production as their main line of farming. The share of grassland crops was 30 per cent, while the share of barley was 23 per cent, oats 13 per cent and wheat 11 per cent in 2015. These shares have remained fairly stable since 1990. By comparison, the number of dairy cows decreased in this period from 490,000 to 285,000. Dairy production is the main production line of farming, with just over 15 per cent of the farms engaged in it. Approximately six per cent of farms specialise in beef production and two per cent in pig husbandry, while one per cent of farms are poultry farms. The share of other production lines (sheep and goat husbandry and reindeer herding) is approximately six per cent. About eight per cent of all farms are organic.

In 2015, 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 the role of food materials in the national economy considerably. Agriculture is the most important employer in the countryside and, alongside forests, the dominating element in the rural landscape.

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.

Figure 2.23
Number of farms by production sector, 2010 to 2015



Source: National Forest Inventory at the Natural Resources Institute Finland (Luke)

2.11 Forestry

According to the national classification, forestry land covers 26 million hectares, or 77 per cent of the total area incl. inland waters in 2015. Land classified as forestry land consists of the subcategories of forest land, poorly productive land and unproductive land. Of the total forestry land area, 20 million hectares are 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. The forest sector contribution has been two to five per cent to the Gross Domestic Production and some 20 per cent to export of goods (22 per cent in 2015).

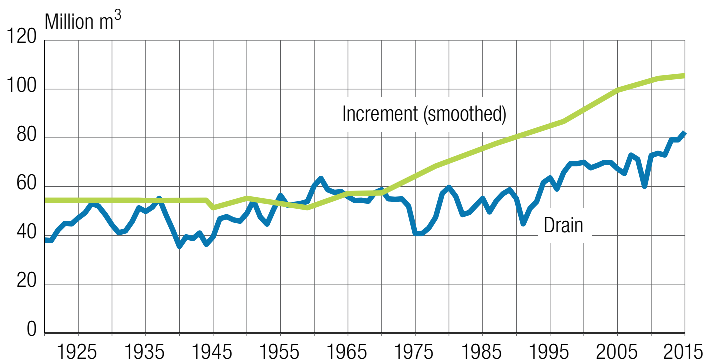
There are approximately twenty indigenous tree species growing in Finland. The most common ones are the Scots pine (Pinus silvestris), Norway spruce (Picea abies) and silver and pubescent birches (Betula pendula and B. pubescens). Usually, two or three tree species dominate a forest stand. More than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

Sustainable forest management is the basis for Finland's forest policy. 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 Strategy 2025 (2014), financing and public forestry extension organisations (see Section 4.4: National forest legislation and programmes).

Finnish forests are managed sustainably. About one-fifth of the forests are regenerated naturally, while the rest is generated artificially by using indigenous tree species with local provenance. According to the Forest Act, measures for the establishment of a new seedling stand have to be completed 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 100,000 hectares annually. Every year, 150 million seedlings are planted in the forests.

The total volume of Finland's forest stock amounts to 2,356 million m3 according to the national forest inventory carried out from 2009 to 2013. The growing stock volume has been increasing for a long time, mainly because of active management of forests and the growth in forest volume has exceeded the harvesting volumes and natural drain (Figure 2.24). In 2015, the total drain was 82 million m^3, while the total increment of

Figure 2.24
Total annual increment and drain of stemwood in Finland since the 1920's



Source: National Forest Inventory at the Natural Resources Institute Finland (Luke) the growing stock was 105.5 million m³. The total drain includes cutting removals, harvesting losses and natural mortality. Of the total area undergoing felling annually, thinning accounts for roughly three-fourths, while other cutting, e.g. clear felling and seed and shelter wood felling, accounts for the rest.

The growing stock has increased almost by 60 per cent in the last 40 years. Pine has contributed most to the increase due to the large number of young stands at 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 seven per cent by private companies and the rest by other owners (in 2015). The average size of a forest holding owned by private individuals is small, approximately 28 hectares, with a minimum size of one hectar. About 13 per cent of Finns are forest owners, i.e. 685 000 Finns with 376,000 forest holdings. The forest management associations provide the forest owners with advisory services on forest management and felling.

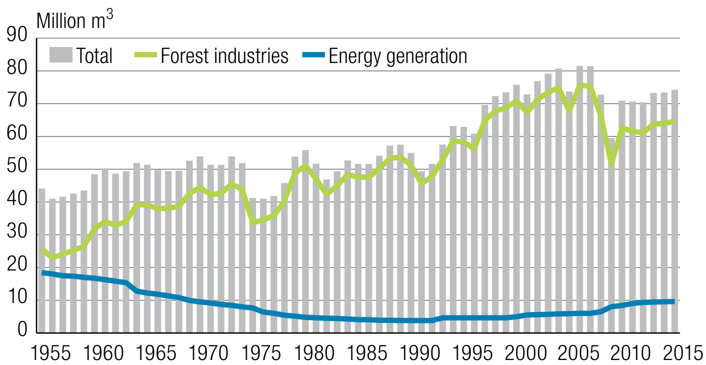
Approximately EUR 300 million is invested every year in forest regeneration, young stand management and other silvicultural practices Investments to forests owned by the non-industrial private owners amount to some EUR 210 million of which more than two-thirds is financed by the owners and the rest is covered by state subsidies. The stumpage earnings paid to private non-industrial forest owners were about EUR 1.7 billion in 2015. More than 89 per cent of Finland's forests are certified according to the national forest certification standard or Forest Stewardship Council standard.

In 2015, the total use of round wood (raw, unmanufactured timber) in Finland was 74.3 million m³. Approximately 87 per cent (64.7 million m³) of this was used in the forest industry and 9.6 million m³ was used for energy production (Figure 2.25).

Forests (trees and soil) absorb a significant proportion of Finland's carbon dioxide (CO2) emissions. The forest sink varied between 19.3 and 51.3 million tonnes CO2 eq. during the years 1990 to 2015, which represents 25 to 75 per cent of Finland's total emissions. The proportion has varied considerably due to fluctuating trends in emissions and forestry activity (see Section 3.2.5).

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.

Figure 2.25
Total roundwood consumption 1955 to 2015



Source: National Forest Inventory at the Natural Resources Institute Finland (Luke)

Twelve per cent of the forest area (forest land and poorly productive forest land), or 2.7 million hectares, is protected or in restricted forestry use. Most of this, 2.2 million hectares, is in northern Finland, where the protected areas altogether account for 19 per cent of the forest area. In the south, the protected area is approximately 0.5 million hectares, which is five per cent of the forest area. Some 80 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 10 per cent.

The National Forest Strategy 2025 and national policies on nature and biodiversity conservation are mutually supportive and coherent. The Forest Biodiversity Programme for southern Finland 2008 to 2025 (METSO) targets both private and state-owned lands. It combines the protection and commercial use of forests. Annual funding for the programme is approximately EUR 13 million for 2008 to 2019 (see also Section 4.4).

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 4.5.7).

In Finland, 106.7 million tonnes of waste were generated in 2015, an increase of 10 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 76.8 million tonnes, or 72 per cent of all waste. The amount of wood waste was 3.9 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 2015 was 2.7 million tonnes. Though accounting for only 2.5 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 quantity of municipal waste has been 2.4 to 2.8 million tonnes per year in Finland after the turn of the millennium. Municipal waste generation in total was 499 kg per capita in 2015, which was the EU average.

The manufacturing industry generated 8.9 million tonnes of waste in 2015. 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.

In 2015, the waste recovery rate was 84.4 per cent, i.e. 44.3 million tonnes of waste was recovered; altogether, 5.6 million tonnes of waste was recovered as material and 4.7 million tonnes as energy. The latter figure comprises mostly wood waste (almost 2.7 mil-

Table 2.2
Waste generation by source and waste category, in 2015

2015	Chemical waste	Wood waste	Mineral waste	Other waste 1)	Total
	1,000 tonnes per year				
Mining and quarrying			76,777		76,777
Manufacturing	561	3,352	2,389	2,603	8,906
Energy Supply	5	213	831	201	1,251
Construction		279	14,637	143	15,060
Service activities and private households	34	84	24	2,689	2,764
Other	18	35	512	1,321	1,351
Total	**618**	**3,963**	**95,170**	**6,957**	**106,709**
of which hazardous waste	394	27	1,345	329	2,098

1) Metallic waste, Glass waste, Paper and cardboard waste, Plastic and rubber waste, Household and mixed waste, Sludges (dry weight)

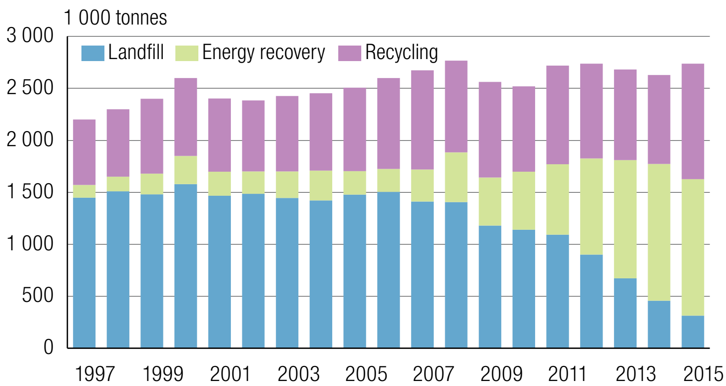
lion tonnes). The wood waste was almost fully recovered, as 0.2 million tonnes of wood waste was recovered as material in addition to the high energy recovery rate.

In 2015 almost 90 per cent, of all municipal waste was recovered as material (40.6 per cent) or energy (47.9 per cent) (Figure 2.26). Biowaste recycling has doubled from 2006 to 2015 mainly due to improved sorting and the separate collection of municipal waste and extension of treatment to anaerobic digestion. 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 2015, 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 2015 it amounted to 11 per cent, or 315 thousand 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 2015, the incinerated amount accounted for 48 per cent of the total municipal waste. The amount of incinerated municipal waste has more than doubled since 2010. All waste incineration plants produce heat and electricity for municipalities and industry.

Figure 2.26
Municipal solid waste treatment in Finland, 1997–2015



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 almost one third of the total land area in Finland, approximately 9.1 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 seven per cent are in southern Finland. Conversely, most of the drainage has occurred in southern Finland. Approximately six million hectares of peatlands have been drained for forestry. About 0.3 million hectares of peatland is in agricultural use. The total area of undrained peatlands is approximately four million hectares.

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.

Peat is a domestically important fuel source, one that currently represents approximately 4 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 65,000 hectares. In 2015, the emissions from peat extraction areas were a source of 2.1 million tonnes CO_2 eq.

In 2012, the Finnish Government approved a resolution 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 and responsible use of mires and peatlands, and it is used to improve the status of the existing network of protected peatlands. As a part of the resolution, a long-term peatland protection and restoration programme will be carried out by 2025.

According to revised Environmental Protection Act (527/2014, 1.9.2014) the peat extraction must be situated to peatlands that have been drained or whose natural state has otherwise been significantly changed in a way that does not cause damage to a nationally or regionally significant nature value. The significant change of natural state is described more detailed by the Environmental Protection Decree (713/2014).

The Mire Conservation Group (2012–2015) identified the most valuable mires nationally in terms of their natural value, that complement best the current network of conservation areas. During 2015–2016 around 36 000 hectare state-owned mire land both in Southern and Northern Finland were protected based on the proposal of the Mire Conservation Group.

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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 1990–2015 by sector. Thereafter, it outlines how the national greenhouse gas inventory is compiled, including a description of the national system, and how the high quality of the inventory is guaranteed. Finally, the national registry and its functioning are explained.

Photo:
Riku Lumiaro / Image bank of the Environmental Administration

3 GREENHOUSE GAS INVENTORY INFORMATION, INCLUDING THE NATIONAL SYSTEM AND THE NATIONAL REGISTRY

3.1 Total greenhouse gas emissions and trends

In 2015, Finland's greenhouse gas emissions totalled 55.6 million tonnes of carbon dioxide equivalent (million tonnes CO_2 eq.). The total emissions in 2015 were approximately 22 per cent (15.7 million tonnes) below the 1990 emissions level. Compared to 2014, the emissions decreased by approximately six per cent (3.6 million tonnes). The emission trends by sector are presented in Figure 3.1 and described in detail in Section 3.2.

Statistics Finland also published instant preliminary data on the greenhouse gas emissions for 2016 in May 2017[1]. The total emissions of greenhouse gases in 2016 corresponded with 58.8 million tonnes of CO_2 eq. Emissions grew by six per cent compared with the previous year but were still 18 per cent lower than in 1990. The instant preliminary data are calculated using rougher data and methodologies than are used for the inventory data in the last inventory submission to the UNFCCC. Therefore, the submitted inventory data (1990 to 2015) are presented and used as the basis for the documentation and conclusions in all chapters in this national communication.

The energy sector is by far the largest producer of greenhouse gas emissions in Finland. 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 2015, the energy sector accounted for 73 per cent of Finland's total greenhouse gas emissions (Figure 3.2). The second largest source of emissions was agriculture, with a share of approximately 12 per cent. Emissions from industrial processes and product use amounted to approximately 11 per cent. Emissions from industrial processes refer to sector emissions that result from the use of raw materials in industrial processes. Emissions from the waste sector amounted to four per cent of total emissions. The contribution of indirect CO_2 emissions from atmospheric oxidation of CH_4 and NMVOCs to the Finnish greenhouse gas emissions is small, about 0.1% of the total greenhouse gas emissions in Finland.

1 http://www.stat.fi/til/khki/2016/khki_2016_2017-05-24_tie_001_en.html

Figure 3.1
Greenhouse gas emissions and removals in Finland by reporting sector (million tonnes CO_2 eq.) and net CO_2 equivalent emissions (emissions plus removals). Emissions are positive and removals negative quantities.

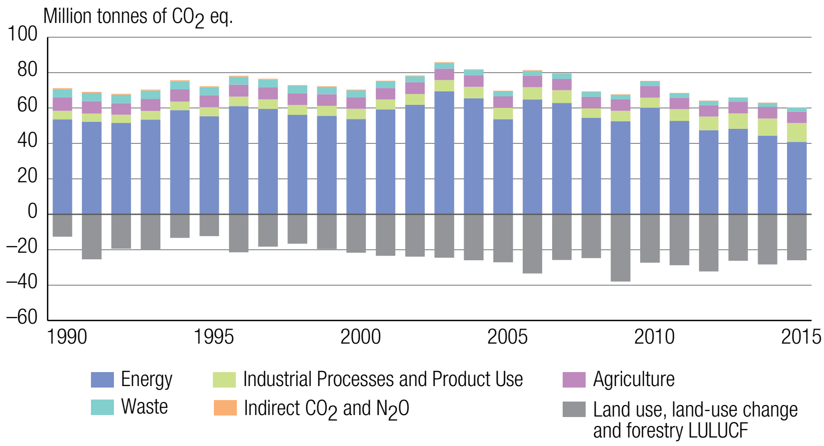
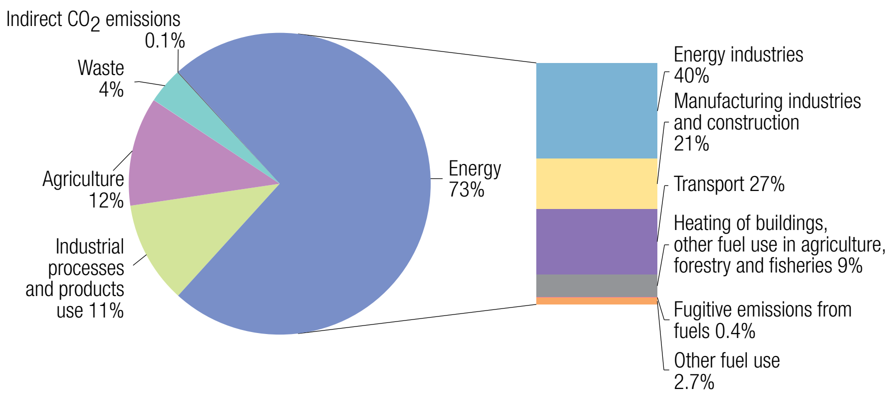


Figure 3.2
The composition of Finnish greenhouse gas emissions in 2015 (LULUCF sector excluded). Due to independent rounding, the sums do not add up.



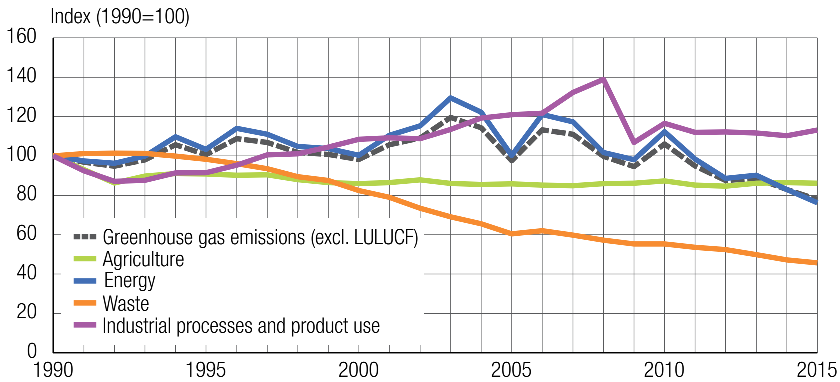
The most important greenhouse gas in Finland is carbon dioxide. The share of CO_2 emissions in total greenhouse gas emissions has varied from 80 per cent to 85 per cent. In absolute terms, CO_2 emissions have decreased by 12.7 million tonnes (i.e. 22 per cent) since 1990. Around 90 per cent of all CO_2 emissions originated from the energy sector in 2015. The amount of energy-related CO_2 emissions has fluctuated much according to the economic trend, the energy supply structure (including electricity imports and exports) and climate conditions. Methane emissions (CH_4) have decreased by 37 per cent from the 1990 level. This is mainly due to the improvements in waste sector and a contraction in animal husbandry in the agricultural sector. Correspondingly, emissions of nitrous oxide (N_2O) have also decreased by 27 per cent; the greatest decline occurred in 2009 when the implementation of a N_2O abatement technology in nitric acid production reduced emissions significantly. Another reason for the decrease of N_2O emissions is the reduced nitrogen fertilisation of agricultural fields. In 2015, the F gas emissions (HFCs, PFCs and SF_6) were nearly 35 times higher than the emissions for 1995 (the base year for F gas emissions). A key driver behind the trend has been the substitution of ozone depleting substances (ODS) by F gases in many applications.

The land use, land-use change and forestry (LULUCF) sector is a net sink in Finland. The net sink has varied from approximately 15 to 55 per cent of the total annual emissions from other sectors during 1990 to 2015. The most important components of the forest sink are the increment of growing stock and the harvest removals. The growth has increased since 1990 from 78 million m^3 to 105.5 million m^3. There is less fluctuation in the growth than in the harvest rates between years. In 2015, the total drain was 82 million m^3 being still at a very high level.

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 40 million tonnes in 2015. The production and use of energy also generate methane and nitrous oxide emissions. The majority of methane emissions originated from the waste and agricultural sectors in 2015. The majority of nitrous oxide emissions originated from agriculture. F-gas emissions originate from the consumption of halocarbons and SF_6 and are reported in the industrial prosesses and product use 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, emissions are influenced each year by the economic situation in the country's energy intensive industries, weather conditions and the volumes of energy produced using renewable energy sources (see trends by sector in Figure 3.3).

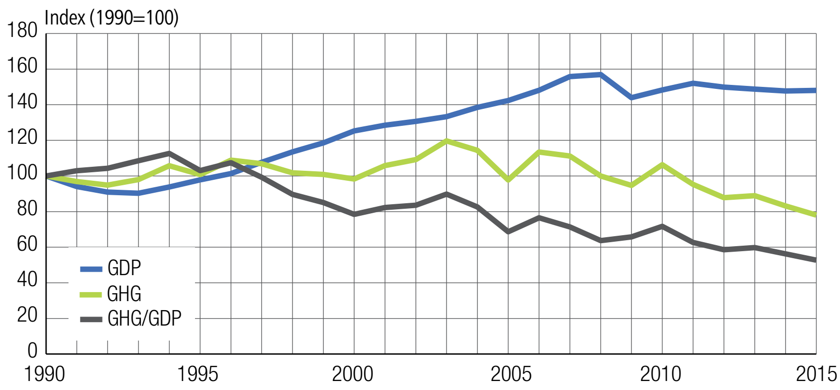
Figure 3.3
Relative development of greenhouse gas emissions by main category relative to the 1990 level (1990=100%)



The trend in greenhouse gas emissions relative to Finland's gross domestic product (GDP) has been declining (Figure 3.4), although annual variations have been large. In the early 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 2015, the GHG /GDP ratio was more than 45 per cent below the 1990 level, indicating that the greenhouse gas intensity of the economy has decreased.

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

Figure 3.4
Greenhouse gas emissions relative to GDP, 1990 to 2015, excluding the LULUCF sector



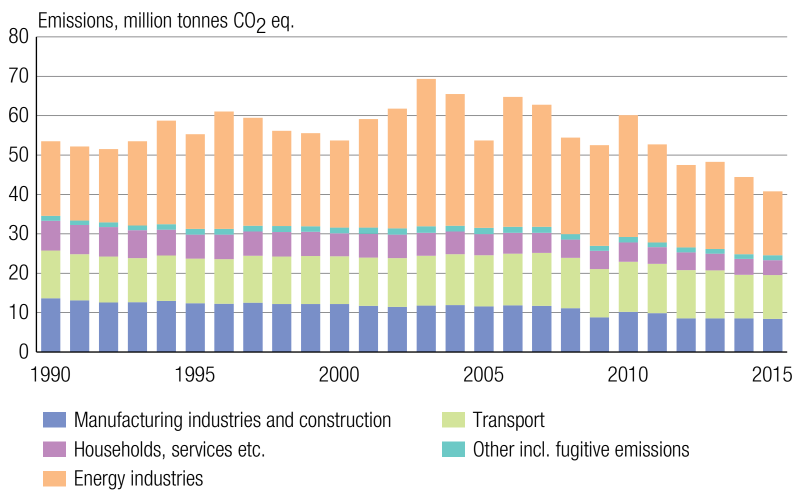
3.2 Greenhouse gas emissions by sector

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 2015, its share of total greenhouse gas emissions, including transport, was 73 per cent (40.8 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 0.4 per cent of the total emissions of the sector.

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. Emissions from the energy sector are strongly affected by the availability of hydropower on the Nordic electricity market. If the annual precipitation in the Nordic countries is lower than usual, hydro-

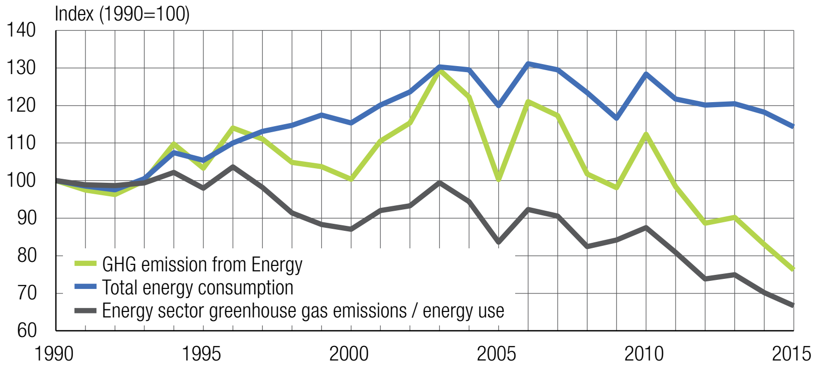
Figure 3.5
Greenhouse gas emissions in the energy sector, 1990 to 2015



power 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 3.5).

In 2015, energy sector emissions were almost eight per cent lower than in 2014, and they were 24 per cent lower than the 1990 level. CO_2 emissions in the energy sector decreased more than the total use of energy (Figure 3.6). Total energy consumption in Finland amounted to 1.3 petajoules (PJ) in 2015, which was three per cent less than in 2014. The biggest reasons for decreasing emissions are the increased shares of forest-based fuels and net imports of electricity, which lowers the condensing power production.

Figure 3.6
Total energy use relative to energy sector greenhouse gas emissions, 1990 to 2015



The use of renewable energy sources increased by two per cent and that of fossil fuels decreased by eight per cent. Final energy consumption in transport remained at the same level and energy consumption in space heating decreased by five per cent from the year before. Final consumption in manufacturing contracted by two per cent.

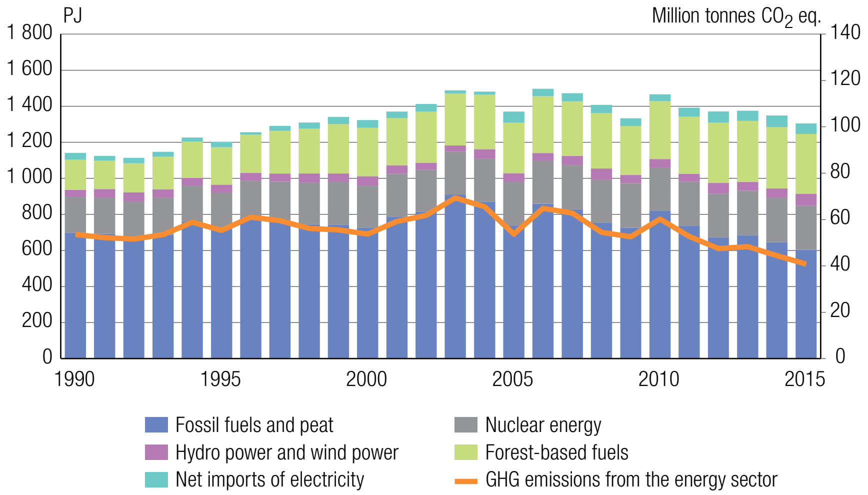
The share of renewable energy in total energy consumption grew to 35 per cent in 2015. The share of forest-based fuels in Finland's total energy consumption continued to grow and was 25 per cent. EU targets for renewable energy are calculated relative to total final energy consumption. Estimated in this manner, the share of renewable energy was over 39 per cent in Finland in 2015. Finland's target for the share of renewable energy is 38 per cent of final energy consumption in 2020, which was reached for the first time in 2014.

The use of fossil fuels went down by eight per cent from the year before. The use of natural gas fell by 14 per cent and that of peat by five per cent from the year before. The consumption of coal (including hard coal, coke, and blast furnace and coke oven gas) decreased by 20 per cent.

In 2015, the production of electricity in Finland amounted to 66.2 terawatt hours (TWh). Production went up by one per cent from the year before. In turn, total electricity consumption went down by one per cent and amounted to 82.5 TWh. Of total electricity consumption, 80 per cent was covered by domestic production and 20 per cent by net imports of electricity from the Nordic countries, Russia and Estonia. Net imports of electricity declined by nine per cent from the year before. Thirty two per cent of domestic electricity production was based on combined heat and power production.

Of all electricity production, 29.5 TWh were produced with renewable energy sources, which is the biggest amount ever. Forty five per cent of electricity production was covered with renewable energy sources, which is the largest share since the 1970s. Over one-half of the electricity produced with renewable energy sources was produced with hydro power, nearly one-tenth with wind power and almost all of the remainder with forest-based fuels. Hydro power was used for producing 16.6 TWh of electricity. More electricity than this has been produced with hydro power only in 2008 and 2012. Seventeen per cent of electricity was produced with fossil fuels, four per cent with peat and 34 per cent with nuclear power (Figure 3.7).

Figure 3.7
Total energy use by energy source (PJ) and energy sector greenhouse gas emissions (million tonnes CO_2 eq.), 1990 to 2015



In 2015, greenhouse gas emissions from energy industries amounted to 16.2 million tonnes and manufacturing industries and construction amounted to 8.4 million tonnes CO_2 eq. The share of energy industries was 40 per cent of the energy sector's total emissions. The corresponding share was 20 per cent for manufacturing industries and construction. These two subsectors together accounted for 44 per cent of total greenhouse gas emissions of Finland. Emissions from the fuels used by different industries have fallen by 24 per cent compared with the emission levels in 1990. This is the result of increased use of biomass by the forest industry in particular.

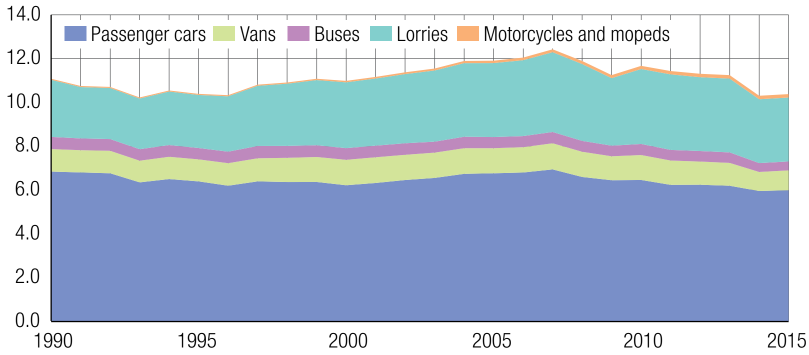
Emissions attributable to energy use by individual households and the service sector accounted for approximately nine per cent of Finland's total emissions. These emissions are down significantly from the 1990 levels. The service sector's emissions have decreased by as much as 58 per cent, and those by households by 60 per cent. This is the result of the changeover from oil heating to district or electric heating (in which case emissions are allocated to energy production plants).

3.2.2 Transport

In 2015, greenhouse gas emissions from transportation amounted to 11.1 million tonnes CO_2 equivalent. Compared to 2014, emissions increased less than one percent in 2015. The changes in activity and in the share of biofuels were small. The emission level in the transport sector has fluctuated between 11 to 13 million tonnes CO2 eq. during 1990–

2015 being eight per cent lower in 2015 than in 1990. The share of the transport sector in total greenhouse gas emissions was approximately 17 per cent (12.1 million tonnes CO_2) in 1990 and 20 per cent in 2015. Road transportation is the most important emission source in transport, covering over 94 per cent of the sector's emissions in 2015. The distribution of road transportation emissions by vehicle type 1990 to 2015 is presented in Figure 3.8.

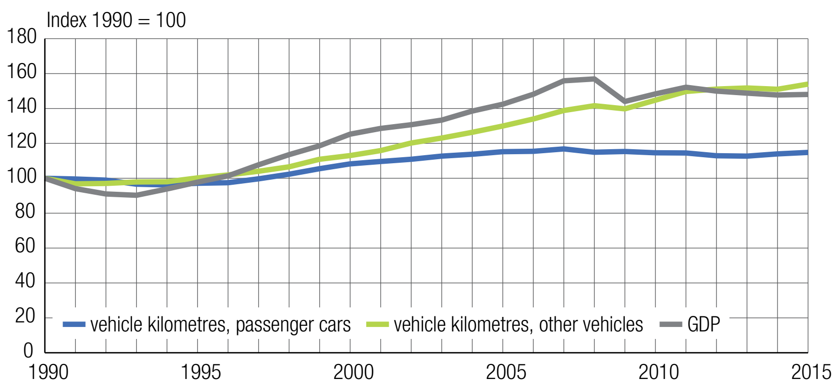
Figure 3.8
Road transport greenhouse gas emissions by vehicle type, 1990 to 2015



Source: VTT, LIPASTO model

During 1990 to 2015, road transport emissions decreased by six per cent regardless of the growth in traffic kilometrage during the same period (Figure 3.9). After the recession in the early 1990s, emissions from road transport increased until 2007 due to the increased kilometrage. In 2008, the emissions deviated from the upward trend. The worldwide economic downturn decreased the kilometrage of all transport modes. At the same time, the change in Finland to CO_2-based taxation of cars caused a transition from gasoline to diesel cars and lowered the specific fuel consumption of new cars, both gasoline and diesel. The downward trend in emissions since 2010 is due to the growing share of biofuels used in road transport and improving fuel efficiency of vehicles. How-

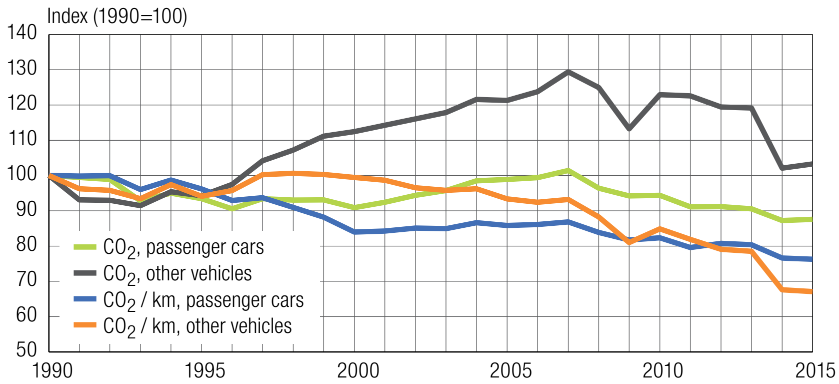
Figure 3.9
Development of traffic volume (vehicle-kilometres, passenger cars and other vehicles) and GDP, 1990 to 2015



Source of kilometreage: VTT, LIPASTO model ever, Finland's per capita CO_2 emissions from transport are higher than in many other EU countries owing primarily to the long distances, transport-intensive industries and travel to and from free-time residences.

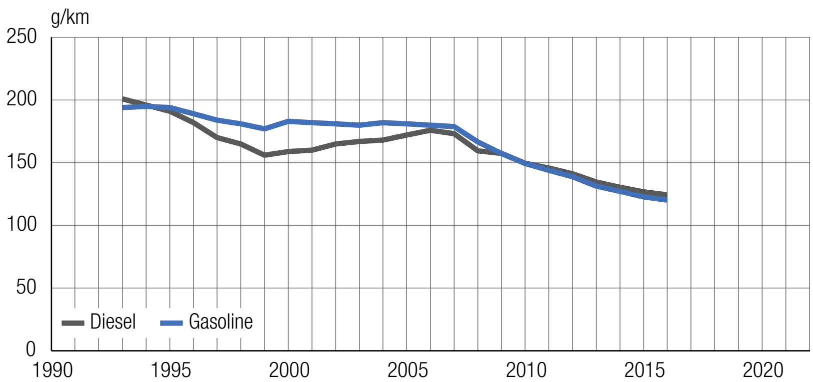
The CO_2 emissions per kilometre driven have decreased both for passenger cars and other vehicles (Figure 3.10). The energy efficiency of new registered cars began to improve in the 1990s, and during 1993 to 2015 the vehicle-specific CO_2 emissions of new registered passenger cars fell 37 per cent (Figure 3.11).

Figure 3.10
Relative development of CO_2 emissions from cars and other vehicles, 1990 to 2015 (CO_2/km=carbon dioxide emissions per vehicle-kilometre)



Source: VTT, LIPASTO model

Figure 3.11
CO_2 emissions (g/km) of new registered cars (gasoline and diesel), 1993 to 2015

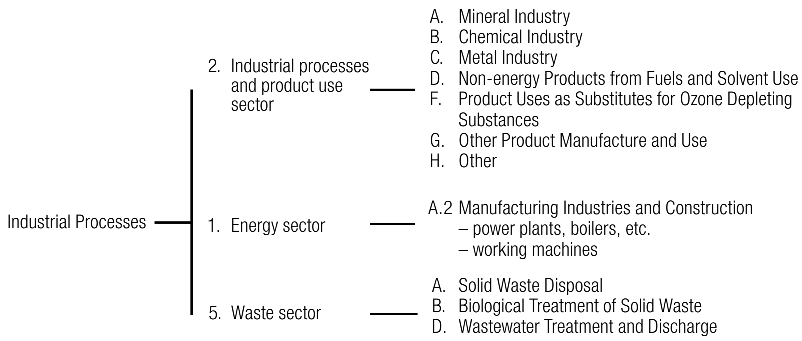


Source: Finnish Transport Safety Agency

3.2.3 Industrial processes and product use

Greenhouse gas emissions from industrial processes and product use contributed 11 per cent to the total greenhouse gas emissions in Finland in 2015, totalling 6.1 million tonnes CO_2 eq. The most important greenhouse gas emission sources of industrial processes and product use in 2015 were CO_2 eq. emissions from iron and steel, hydrogen and cement production with 3.9, 1.4 and 0.8 per cent shares of total national greenhouse gas emissions, respectively.

Figure 3.12
Reporting categories of emissions from industrial process sources in the national greenhouse gas inventory



CO_2 emissions were also generated to produce lime, glass, phosphoric acid, zinc, copper and nickel, as well as in the use of limestone, dolomite, soda ash, lubricant, paraffin vax and urea-based catalyst. 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 and from product use. Indirect CO_2 emissions from CH_4 and NMVOC (non-methane volatile organic compounds) emissions are reported aggregated in national totals.

Fluorinated greenhouse gases, or F-gases, are reported under industrial processes. They are used to replace ozone-depleting substances in refrigeration and cooling devices, as well as in air conditioning devices and as aerosols, and they accounted for 2.9 per cent of total national greenhouse gas emissions and 26 per cent of the greenhouse gas emissions of industrial processes and other product use in 2015.

The emissions resulting from industrial processes and product use 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 3.13).

Figure 3.13
Greenhouse gas emissions from industrial processes, 1990 to 2015

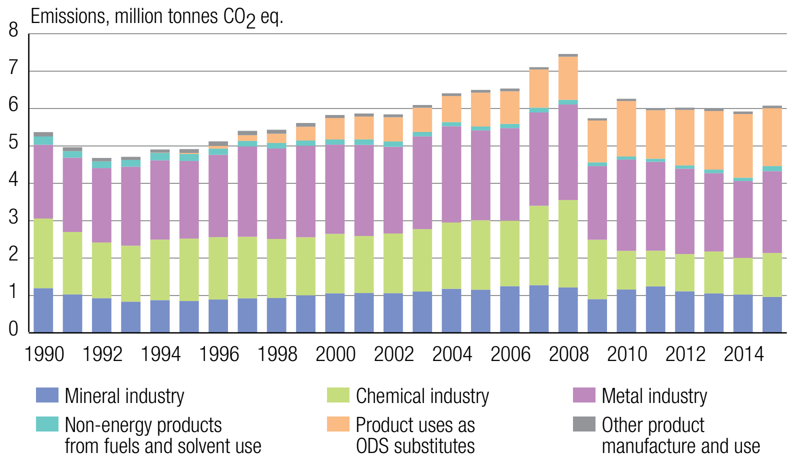
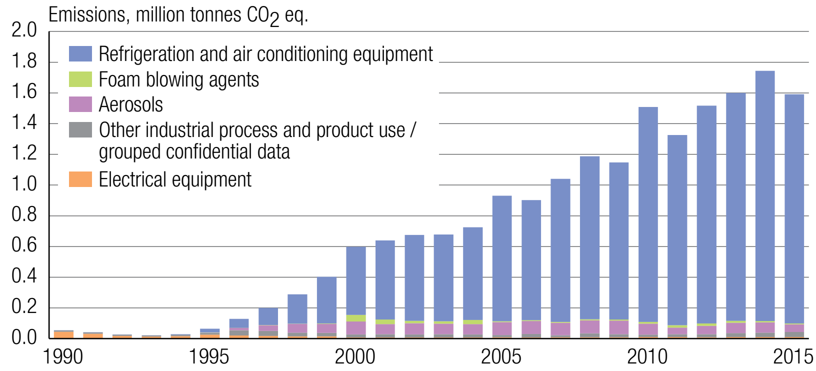


Figure 3.14
F-gas emissions, 1990 to 2015



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 2015, the largest relative change occurred in F-gas emissions, which increased about thirtyfold (Figure 3.14).

Emissions of industrial processes and product use have increased by 13 per cent (0.7 million tonnes CO_2 eq.) since 1990. At the beginning of the time series, some production plants were closed down and that caused a fast decrease in emissions. After this, the production outputs and emissions increased and reached the level of 1990 in 1996. Since then, the overall trend in emissions has been increasing, however. Emissions decreased rapidly in 2009 due to the economic downturn as the demand for industrial products diminished. Emissions started to grow along with production after the recession in 2010.

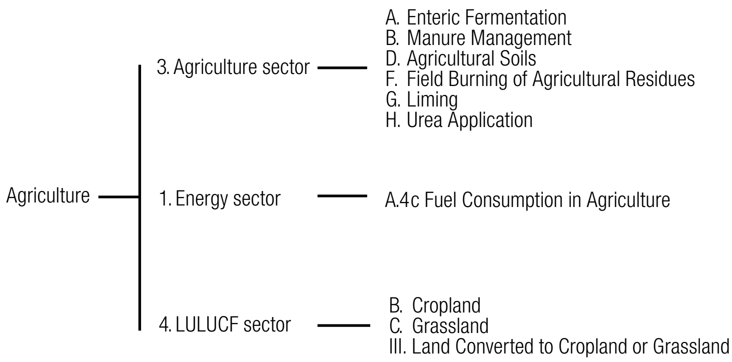
CO_2 emissions have increased by 15 per cent from 1990 to 2015. The reasons are increased production of steel, hydrogen and use of limestone and dolomite. Methane emissions have decreased by 63 per cent. Nitrous oxide emissions have fluctuated during 1990 to 2015; first a fast decrease due to the closing of a nitric acid production plant and after that a slow increase of emissions, the second fast decrease that started in 2009 originated from the implementation of a new N_2O abatement technology in nitric acid production and the decreased demand of fertilisers. Since 1990, nitrous oxide emissions have decreased by 1.3 million tonnes CO_2 eq. (83%).

3.2.4 Agriculture

Emissions from the agriculture sector were approximately 6.5 million tonnes CO_2 eq. in 2015. Agricultural emissions resported under the agricultural sector 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 N_2O emissions from agricultural soils and crop residue burning. Also CO_2 emissions from liming and urea fertilization are included. Emissions from the agriculture are reported also in other sectors of the greenhouse gas inventory such as under the energy and LULUCF sectors (Figure 3.15).

The agricultural sector accounted for approximately 12 per cent of Finland's total greenhouse gas emissions in 2015. In 2015, methane emissions from enteric fermentation were 33 per cent, methane emissions from manure management seven per cent, nitrous oxide emissions from manure management four per cent and nitrous oxide emissions from agricultural managed soils 53 per cent of total agricultural emissions. Liming and application of urea comprise three per cent of emissions, the share of field burning of agricultural crop residues totals 0.04 per cent.

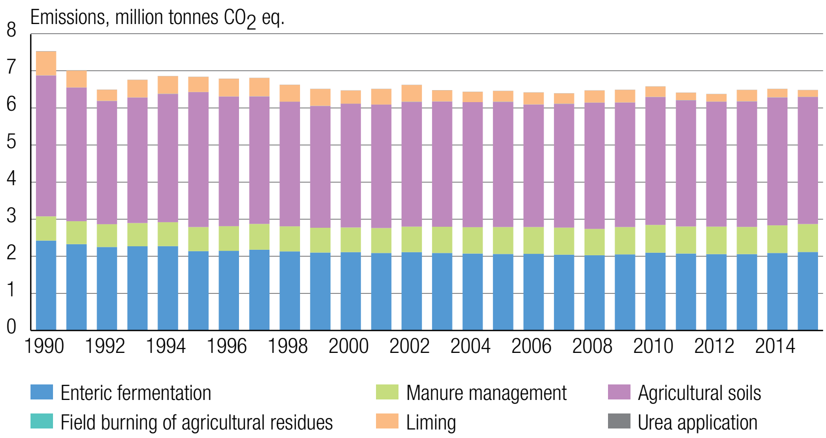
Figure 3.15
Agricultural sources of emissions and their reporting in the CRF categories in the national greenhouse gas inventory



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 also reported. 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 have decreased by about 14 per cent over the period 1990 to 2015 (Figure 3.16). The reduced use of nitrogen fertilisers and improved manure management resulting from measures taken by farmers as part of an agri-environmental programme aiming to minimise nutrient loading to water courses have decreased emissions in the agriculture sector. The amount of mineral fertilisers used has decreased by 37 per cent from 1990 to 2015, which is the most important factor in emission reduction. The decrease in N2O emissions from agricultural soils was 10 per cent in 2015 compared with the 1990 level. Structural changes in agriculture have resulted in an increase in farm size and a decrease in the numbers of domestic livestock. The decrease in the number of livestock is visible in the lower CH_4 emissions from enteric fermentation (Figure 3.16). The emissions have not decreased in proportion to the drop in the number of livestock, however, because milk and meat output and the emissions per animal have increased.

Figure 3.16
Greenhouse gas emissions from agriculture, 1990 to 2015*



* The CH_4 and N_2O emissions from field burning of agricultural residues, as well as CO_2 emissions from urea application are very small and, therefore, not discernible in the figure.

3.2.5 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.

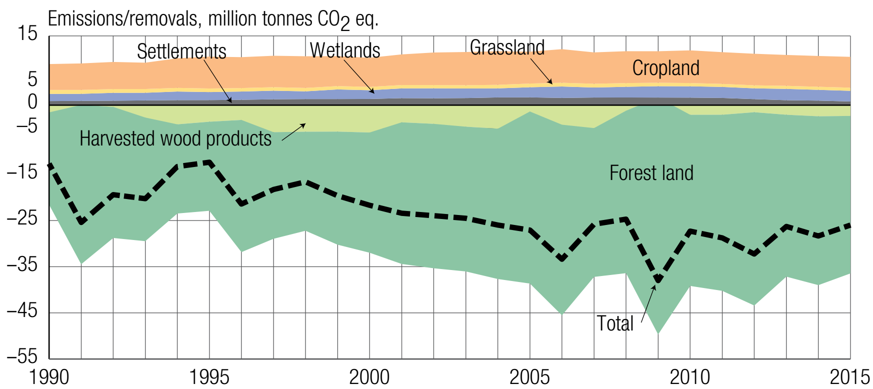
Changes in carbon stocks in six land-use categories covering the whole of Finland are reported in this sector. In accordance with the IPCC guidelines, the changes in different carbon pools, which include above and below-ground biomass, dead wood, litter and soil, are reported for each category. In addition, carbon stock changes of harvested wood products and emissions originating from other sources are reported in this sector, such as CH_4 and N_2O emissions from drained organic forest soils and managed wetlands such as peat extraction areas, emissions from the burning of biomass (forest fires and controlled burning), emissions from nitrogen fertilization of forest land and N_2O emissions resulting from land-use change. Emissions and removals are not reported for unmanaged wetlands and other land.

In 2015, the LULUCF sector as a whole acted as a CO_2 sink for –26.0 million tonnes CO_2 eq. because the total emissions resulting from the sector were smaller than the total removals. The sink in 2015 was 47 per cent of total national emissions excluding the LULUCF sector. In forest land, the largest sink in 2015 was tree biomass: –30.3 million tonnes CO_2 eq. Mineral forest soils were a sink of –12.0 million tonnes CO_2 eq., whereas organic forest soils were a source of 6.2 million tonnes CO_2 eq. Other emission sources in the forest land category are methane and nitrogen oxide emission from drained organic forest lands (2.0 million tonnes CO_2 eq.), nitrogen fertilisation (0.013 million tonnes CO_2 eq.) and biomass burning (0.002 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 2015, roundwood removals reached 68 million m^3 being the highest ever. 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 drained organic soils of forests and croplands. Other emission sources in the LULUCF sector include grasslands, peat production areas, forest fires and nitrogen fertilization of forests.

The trend in emissions and removals from the different land-use categories reported in the LULUCF sector is presented in Figure 3.17.

Figure 3.17
Greenhouse gas emissions (positive values) and removals (negative values) in the LULUCF sector, 1990 to 2015



Harvested wood products

The Harvested Wood Products (HWP) pool was a net sink of 2.3 million tonnes CO_2 in 2015. HWP has been a net sink for the whole reported time series except in 1991 and 2009.

HWP is reported as a carbon stock change in production-based HWP stocks originating from wood harvested in Finland divided in two categories: HWP produced and consumed domestically and HWP produced and exported. HWP comprise of solid wood products (sawn wood and wood panels) and paper products (wood pulp). The production quantity of pulp was used as a proxy for paper and paperboard production. In Finland, 98.7 per cent of wood pulp is used for paper and paperboard production, and 1.3 per cent (part of dissolving wood pulp) for textile and hygiene products, which are exported (percentages are for 2013). Wood pulp production for other purposes than paper and paperboard started mainly in 2012. The annual change of HWP in domestic solid waste disposal sites (SWDS) is not calculated.

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

Under Article 3, paragraph 3 of the Kyoto Protocol, Finland reports emissions and removals from activities afforestation/reforestation (AR) and deforestation (D), and under Article 3, paragraph 4, from forest management (FM). Reporting and accounting of these activities are mandatory for the second commitment period (CP) of the Kyoto Protocol. Finland had also elected forest management as a voluntary activity for the first commitment period. Finland has not elected other voluntary activities under Article 3, paragraph 4 (cropland management, grazing land management, revegetation and wetland drainage and rewetting) for the second commitment period, as was the case in the first commitment period.

Table 3.1
Accounting for the KP LULUCF activities for the second commitment period, tonnes of CO_2 eq.

	2013	2014	2015
Finland's assigned amount for the second commitment period	**240,544,599**		
Total national emissions	63,195,337	59,125,790	55,559,213
ETS emissions without aviation	31,496,743	28,765,587	25,486,758
CO_2 emissions from aviation	186,663	187,557	185,976
Non-ETS emissions[1)]	**31,511,931**	**30,172,646**	**29,886,479**
Non-ETS emissions as cumulative percentage of the assigned amount	**13%**	**26%**	**38%**
Article 3.3 net emissions to be subtracted from the assigned amount[2)]	**3,435,980**	**3,233,289**	**2,923,614**
Article 3.4 net removals (FM)	–56,214,409	–54,381,385	–49,312,939
Finland's FMRL (annual reference)	–20,466,000	–20,466,000	–20,466,000
Technical correction to the FMRL	–13,582,000	–13,582,000	–13,582,000
FM net removals minus FMRL and the technical correction	–22,166,409	–20,333,385	–15,264,939
FM cap[3)]	–19,978,041	–	–
Estimate of net addition to the assigned amount from Article 3.4[2)]	**19,978,041**	**0**	**0**

1) The emissions corresponding to the emission level allocated to Finland in the joint fulfilment agreement by the EU, its Member States and Iceland
2) Finland has chosen end of commitment period accounting for Articles 3.3 and 3.4 wherefore any additions or subtractions to the assigned amount will be done at the end of the commitment period
3) FM cap is –19,978,041 tonnes CO_2 eq for the whole second commitment period. In the table, for each commitment period year the value in this row presents how much of the cap is available for accounting in that year.

Net emissions from Article 3.3 activities i.e. afforestation, reforestation and deforestation were 2.9 million tonnes of CO_2 eq. in 2015. Afforestation and reforestation resulted in a net removal of 0.2 million tonnes CO_2 eq., while deforestation produced a net emission of 3.1 million tonnes of CO_2 eq. The area subject to AR was approximately 173,000 ha at the end of 2015. The area deforested since 1 January 1990 was approximately 391,000 ha, of which 1,400 ha has been reforested.

Net removals as a result of forest management under Article 3.4 were 49.3 million tonnes CO_2 eq. in 2015, including the carbon stock change in the Harvested Wood Products pool. Accounting for the KP LULUCF activities for the second commitment period is presented in Table 3.1.

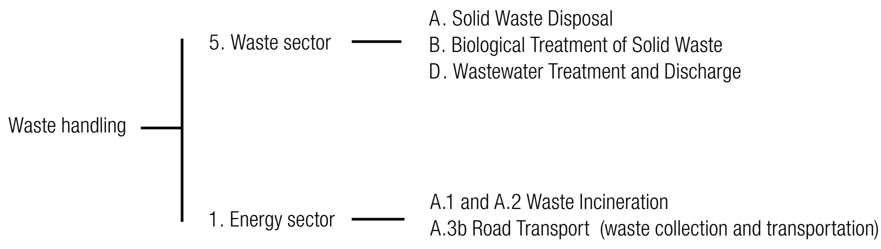
The emissions and removals from ARD lands vary between the years depending on the timing and quantity of the land-use changes, which vary depending on the economy.

Interannual 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 stocks of living biomass, as well as in the amount of carbon in logging residue inputs, but the changes occur at a slower rate than they do for biomass.

3.2.7 Waste

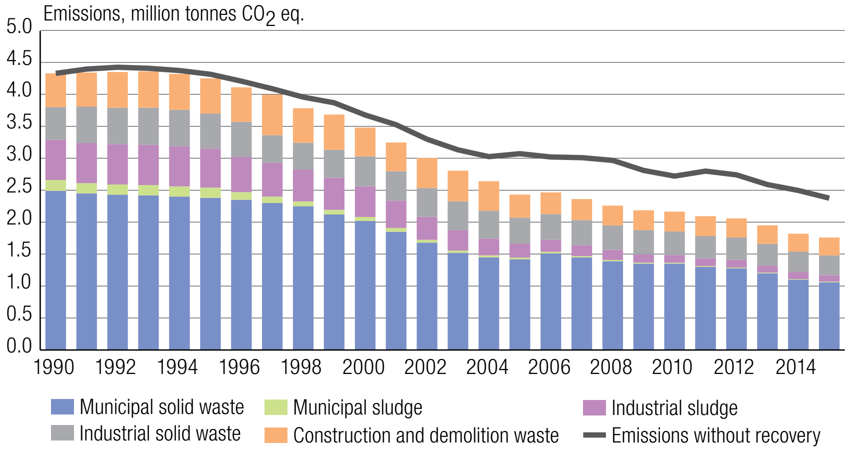
Methane (CH_4) emissions from landfills and CH_4 and N_2O emissions from composting and wastewater treatment are reported under the waste sector (Figure 3.18). Greenhouse gas emissions from the combustion of waste are reported fully in the energy sector, as waste incineration without energy recovery is almost non-existent. Waste sector emissions amounted to 2.1 million tonnes CO_2 eq. in 2015, which accounts for approximately four per cent of Finland's total emissions.

Figure 3.18
Reporting categories of emissions from waste handling in the national greenhouse gas inventory



CH_4 emissions from landfills are the most important greenhouse gas emissions in the waste sector. Solid waste disposal on land contributes nearly 83 per cent, wastewater treatment about 12 per cent and biological treatment (composting and anaerobic digestion) five per cent of the sector's total emissions. Compared to 2014, emissions decreased by three per cent in 2015 and since 1990, these emissions have decreased by 54 per cent. A new Waste Act entered into force in 1994, which has led to a reduction in methane emissions from landfill sites (Figure 3.19). The Waste Act has cut back on the volume of waste deposited at landfills by promoting recycling and reuse, as well as 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

Figure 3.19
Methane emissions from solid waste disposal on land, 1990 to 2015



during that period. CH4 emissions from landfills are expected to decrease further due to the implementation of EU and national policies and measures (see Section 4.5.7).

Emissions from wastewater treatment have also been successfully reduced by 15 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 have more than doubled since 1990, being five per cent of the waste sector's emissions in 2015. The reason for this is increased composting of waste, especially in semi-urban areas, due to separate collection of organic waste. Emissions from anaerobic digestion have also increased significantly in recent years due to the same reason as the increase in emissions from composting. Yet, this emission source is very small being 0.3 per cent of the waste sector's emissions in 2015.

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

3.3.1 Institutional, legal and procedural arrangements

According to the Government resolution of 30 January 2003 on the organisation of climate policy activities of Government authorities, Statistics Finland assumed the responsibilities of the national entity for Finland's greenhouse gas inventory from the beginning of 2005. In 2015, the role of Statistics Finland as the national entity was enforced through the adoption of the Climate Change Act[2].

In Finland, the national system is established on a permanent footing and it guides the development of emission calculation in the manner required by the UNFCCC and the Kyoto Protocol. The national system is based on laws and regulations concerning Statistics Finland, on agreements between the inventory unit and expert organisations on the production of emission and removal estimates, as well as related documentation. Statistics Finland

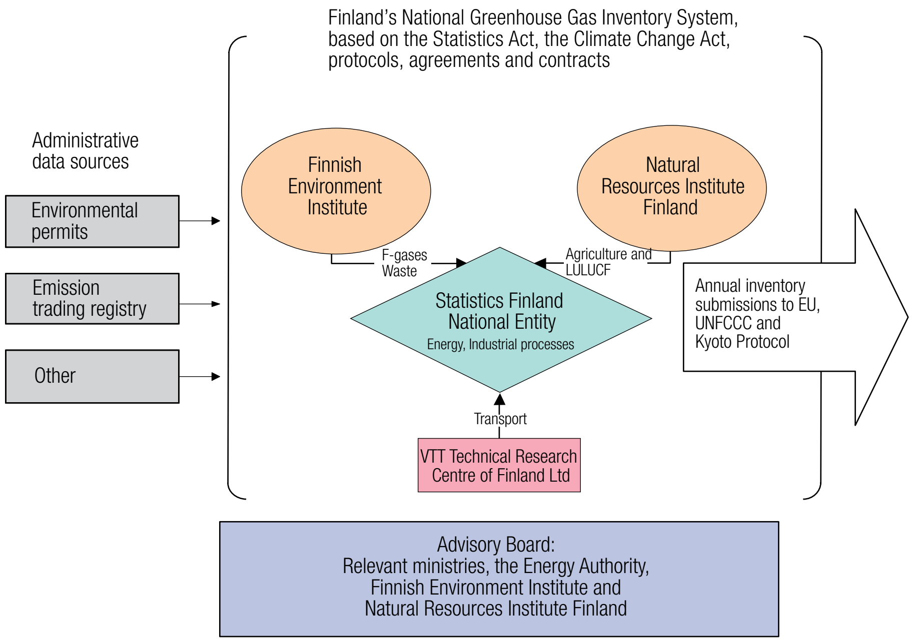
2 609/2015

also has agreements on cooperation and support to the expert organisations participating in Finland's national system with relevant ministries. The national system is designed and operated to ensure the transparency, consistency, comparability, completeness, accuracy and timeliness of greenhouse gas emission inventories. The quality requirements are fulfilled by consistently implementing the inventory quality management procedures. The national system for the greenhouse gas inventory in Finland is presented in Figure 3.20.

The contact person for the national entity and its designated representative with overall responsibility for the national inventory at Statistics Finland is:

Dr Riitta Pipatti,
POB 6 A, FI-00022 Statistics Finland
Tel: + 358 29 551 3543
Email: riitta.pipatti@stat.fi

Figure 3.20
National system for the greenhouse gas inventory in Finland



Statistics Finland as the national entity for the inventory

In its activity as the national entity for the greenhouse gas inventory, the Statistics Finland Act[3] and its amendment[4], and the Statistics Act[5] and its amendment[6] are applied.

Statistics Finland defines the placement of the inventory functions in its working order. The advisory board of the greenhouse gas inventory set up by Statistics Finland ensures collaboration and information exchange in issues related to the reporting of greenhouse gas emissions under the UNFCCC, the Kyoto Protocol and the EU. The advisory board reviews planned and implemented changes in the inventory and the achieved quality. It approves changes to the division of tasks between the expert organisations preparing the inventory. In addition, the advisory board promotes research and review

3 48/1992
4 901/2002
5 280/2004
6 361/2013

projects related to the development of the inventory and reporting, as well as gives recommendations on participation in international cooperation in this area (UNFCCC, IPCC and EU). The advisory board is composed of representatives from the expert organisations and the responsible Government ministries.

Statistics Finland is in charge of the compilation of the national emission inventory and its quality management in the manner intended in the Kyoto Protocol. In addition, Statistics Finland calculates the estimates for the energy and industrial processes (except for F gases: HFCs, PFCs and SF_6) sectors. As the national entity, Statistics Finland also bears the responsibility for the general administration of the inventory and communication with the UNFCCC and the EU Commission, coordinates the review of the inventory, and publishes and archives the inventory results.

Statistics Finland has access to data collected for administrative purposes. Hence by law, Statistics Finland has access to data collected under the EU ETS, regulation on fluorinated gases, the European EPRTR registry and energy statistics regulation. Access to EU ETS data is also ensured through the agreement between Statistics Finland and the Energy Authority. The EU ETS data and data collected under the energy statistics regulation are significant data sources and used both directly and/or for verification in inventory compilation. The use of the EPRTR and data collected under the regulation on fluorinated greenhouse gases have a much more limited role in the inventory preparation.

Statistics Finland approves the inventory before the submissions to the UNFCCC and EU. The draft inventory submission to the EU on 15 January is presented to the advisory board, and before submitting the final inventory to UNFCCC on 15 April, the national inventory report is sent to the inter-ministerial network on climate policy issues for comments.

Responsibilities of the expert organisations

Finland's inventory system includes, in addition to Statistics Finland, the expert organisations the Finnish Environment Institute and the Natural Resources Institute Finland

Table 3.2
Responsibility areas (Common Reporting Format category) and organisation

Area		Organisations
CRF 1.A.	Stationary sources, including fuel combustion in point sources, such as power plants, heating boilers, industrial combustion plants and processes	Statistics Finland
CRF 1.A.	Mobile sources (transport and off-road machinery)	Statistics Finland, VTT Technical Research Centre of Finland Ltd (as a purchased service), Finavia (inventory years 1990 to 2010)
CRF 1.A.	Other fuel combustion (agriculture, households, services, public sector, etc.)	Statistics Finland
CRF 1.B.	Fugitive emissions from energy production and distribution	Statistics Finland
CRF 2.	Emissions from industrial processes and product use	Statistics Finland
CRF 2.	Emissions of F gases	Finnish Environment Institute
CRF 3.	Emissions from agriculture	Natural Resources Institute Finland (Luke)
CRF 4.	Emissions from land use, land-use change and forestry	Natural Resources Institute Finland (Luke)
CRF 5.	Emissions from waste	Finnish Environment Institute
Indirect CO_2	Non-methane volatile organic compounds, NMVOC	Finnish Environment Institute
KP	Activities under Article 3, paragraphs 3 and 4 of the Kyoto Protocol (ARD and FM)	Natural Resources Institute Finland (Luke)

(Luke). Statistics Finland also acquires parts of the inventory as purchased services from VTT (VTT Technical Research Centre of Finland Ltd).

Up to 2009, Finavia (former Civil Aviation Administration) provided emission data on aviation to the inventory. In 2010, Finavia's status in Finland's inventory system changed. Finavia no longer performs the calculations and is not responsible for the related calculations. Statistics Finland has overtaken this task and has been responsible for the calculations since 2010. Finavia continues to support Statistics Finland in the task by providing Statistics Finland with expert advice.

The agreements between Statistics Finland and the expert organisations define the division of responsibilities (sectors/categories covered) and tasks related to uncertainty and key category analyses, QA/QC and reviews. They also specify the procedures and schedules for the annual inventory process coordinated by Statistics Finland. The responsibilities to estimate and report emissions/removals from different sectors/categories of the different expert organisations are based on established practices for the preparation and compilation of the greenhouse gas emission inventory. The scope of these responsibilities is presented in Table 3.2.

All the participating organisations are represented in the inventory working group set up to support the process of producing annual inventories and the fulfilment of reporting requirements. The working group advances collaboration and communication between the inventory unit and the experts producing the estimates for the different reporting sectors, and ensures the implementation of the QA/QC and verification process of the inventory.

The role of responsible ministries and the Energy Authority in the national system

The resources of the national system for the participating expert organisations are channelled through the relevant ministries' performance management (Ministry of the Environment and Ministry of Agriculture and Forestry). In addition, other ministries participating in the preparation of the climate policy advance in their administrative branch that the data collected while performing public administration duties can be used in the emission inventory.

In accordance with the Government resolution, the ministries are responsible for producing the information needed for international reporting on the contents, enforcement and effects of the climate strategy. Statistics Finland assists in the technical preparation of policy reporting. Statistics Finland technically compiles the National Communications and the biennial reports under the UNFCCC. Separate agreements have been made on the division of responsibilities and cooperation between Statistics Finland and the ministries.

The Energy Authority is the National Emissions Trading Authority in Finland. It supervises the monitoring and reporting of the emissions data under the European Emission Trading Scheme (EU ETS) and international emissions trading under the Kyoto Protocol.

The Energy Authority provides the necessary information on emission reduction units, certified emission reductions, temporary certified emission reductions, long-term certified emission reductions and assigned amount units and removals units for annual inventory submissions in accordance with the guidelines for preparation of information under Article 7 of the Kyoto Protocol. This reporting is done using so-called standard electronic tables (SEF) and documentation provided in the National Inventory Report or made publicly available at the website of the Energy Authority. Statistics Finland and the Energy Authority have an agreement on the respective responsibilities.

3.3.2 Annual inventory process

The annual inventory process set out in Figure 3.21 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. 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 (see also Section 3.3.3).

The methodologies, collection of activity data and choice of emission factors are consistent with the guidance in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

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 the subcategories that are the most important in terms of level and trend of the emissions. This list forms the basis for discussions with the sectoral experts on the quality of the estimates and possible needs for improvement on the calculation methodology. 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.

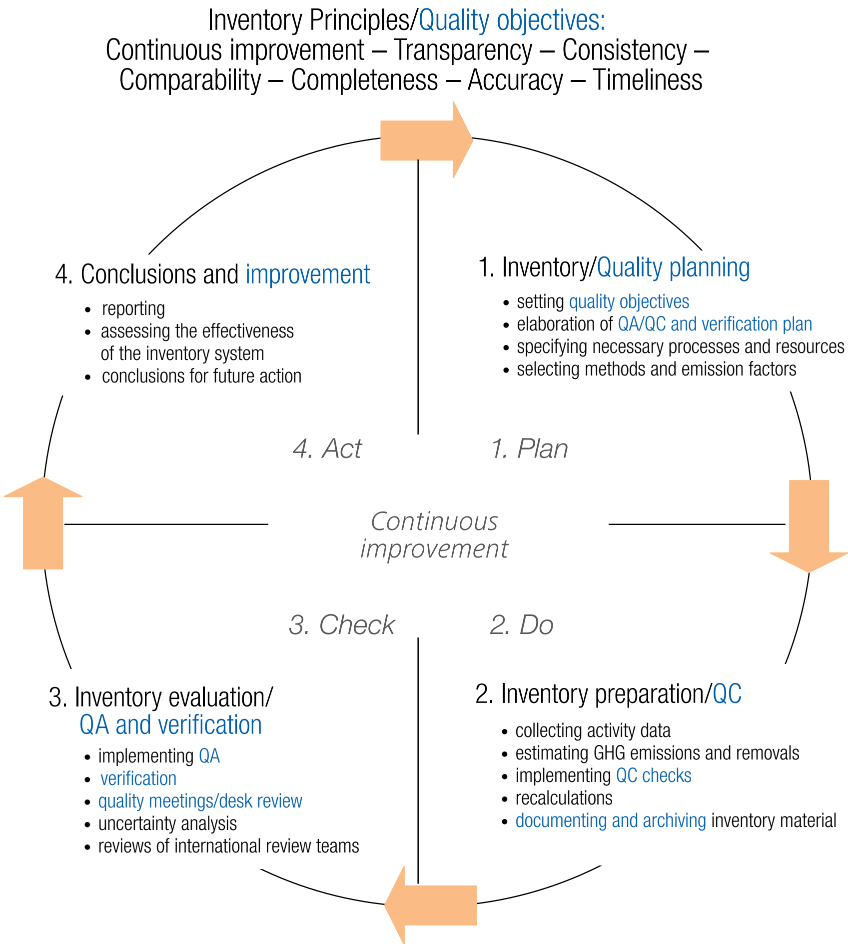
Recalculations are made for the purpose of implementing methodological improvements in the inventory, including changes in activity data collection and emission factors, or for including new source or sink categories within the inventory or for correcting identified errors, omissions, overlaps or inconsistencies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

Figure 3.21
Inventory process and QA/QC management of the inventory



tables and in the National Inventory Report in accordance with 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 also Chapter 8, 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

The objective of Finland's GHG inventory system is to produce high-quality GHG inventories, which 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 starting point for accomplishing a high-quality GHG inventory is consideration of the expectations and requirements directed at the inventory. 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 in conjunction with the inventory process (Figure 3.21). The quality control and quality assurance elements are integrated into the inventory production system, which means that each stage of the inventory process includes relevant procedures for quality management.

The inventory process consists of four main stages: planning, preparation, evaluation and improvement (PDCA cycle) and aims at continuous improvement. A clear set of documents is produced on the different work phases of the inventory. The documentation ensures the transparency of the inventory: it enables external evaluation of the inventory and, where necessary, its replication.

Statistics Finland has the overall responsibility for the GHG inventory in Finland, including the responsibility for coordinating the quality management measures at national level. The quality coordinator steers and facilitates the quality assurance and quality control (QA/QC) and verification process, and elaborates the QA/QC and verification plan. The expert organisations contributing to the production of emission or removal estimates are responsible for the quality of their own inventory calculations. Experts on each inventory sector implement and document the QA/QC and verification procedures.

The inventory planning stage includes the setting of quality objectives and elaboration of the QA/QC and verification plan for the coming inventory preparation, compilation and reporting work. The setting of quality objectives is based on the inventory principles. Quality objectives (Table 3.3) are specified statements about the quality level

Table 3.3
The quality objectives regarding all calculation sectors for the inventory

Quality objectives
1. Continuous improvement
1.1 Treatment of review feedback is systematic
1.2 Improvements promised in the National Inventory Report (NIR) are carried out
1.3 Improvement of the inventory is systematic
1.4 Inventory quality control (QC) procedures meet the requirements
1.5 Inventory quality assurance (QA) is appropriate and sufficient
1.6 Verification of the inventory meet the requirements
1.7 Known uncertainties of the inventory are taken into consideration when planning improvement needs
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 (NIR) 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 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

that is aimed at the inventory preparation with regard to the inventory principles. The objectives aim to be appropriate and realistic while taking into account the available resources and other conditions in the operating environment.

The quality objectives and the planned general and category-specific QA/QC and verification procedures regarding all sectors are set in the QA/QC plan. This is a document that specifies the actions, schedules and responsibilities in order to attain the quality objectives and to provide confidence in the Finnish national system's capability to deliver high-quality inventories. The QA/QC plan is written in Finnish, updated annually, and consists of instructions and a QA/QC form. Instructions include descriptions of, e.g., quality objectives, general and category-specific inventory QC checks, information on quality assurance and verification, schedules, and responsible parties. The QA/QC form addresses the actions to be taken in each stage of the inventory preparation. Sectoral experts fill the QA/QC and verification procedures performed, and the results of the procedures in the form. Discussions in the bilateral quality meetings or feedback given during the quality desk reviews are based on information documented on these forms.

The general and category-specific QC procedures are performed by the experts during inventory calculation and compilation according to the QA/QC and verification plan. The QC procedures used in Finland's GHG inventory comply with the 2006 IPCC Guidelines. General inventory QC checks (2006 IPCC Guidelines, Vol 1, Chapter 6, Table 6.1) include routine checks of the integrity, correctness and completeness of the data, identification of errors and deficiencies, and documentation and archiving of the inventory data and quality control actions. Category-specific QC checks including reviews of the activity data, emission factors and methods are applied on a case-by-case basis focusing on key categories and on categories where significant methodological changes or data revisions have taken place.

The QA reviews are performed after the implementation of QC procedures concerning the finalised inventory. The QA system comprises reviews and audits to assess the quality of the inventory and the inventory preparation and reporting process, to determine the conformity of the procedures taken and to identify areas where improvements could be made. Specific QA actions differ in their viewpoints and timing. The actions include basic reviews of the draft report, quality meetings or quality desk reviews, internal and external audits, peer reviews, EU MMR comparisons and UNFCCC and EU inventory reviews. In addition, emission and activity data can be verified by comparing them with other available data compiled independently of the GHG inventory system. These include measurement and research projects and programmes initiated to support the inventory system, or for other purposes but that produce information relevant to the inventory preparation.

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, as well as UNFCCC and EU review feedback and uncertainty analysis where relevant. In addition, the inventory unit and experts performing the inventory calculations follow the development of the sector. When technologies and practices change, or new activity or research data become available, they evaluate the need for improvements and recalculations to improve the inventory. The methodological changes are communicated to the advisory board for evaluation, and approved by the inventory unit before adopted into production (see also Section 3.3.2).

3.4 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.

Directive 2009/29/EC adopted in 2009, provides for the centralisation of the EU ETS operations into a single European Union registry operated by the European Commission, as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States, who are also Parties to the Kyoto Protocol (26) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries – in particular Decision 13/CMP.1 and Decision 24/CP.8.

The consolidated platform, which implements the national registries in a consolidated manner (including the registry of the EU) is called the Union registry and was developed together with the new EU registry on the basis the following modalities:

Each Party retains its organisation designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;

Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;

Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;

Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;

The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;

The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public is fulfilled by each Party through a publically available web page hosted by the Union registry;

All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:

(a) With regards to the data exchange, each national registry connects to the ITL directly and establishes a secure communication link through a consolidated communication channel (VPN tunnel);
(b) The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes so that those actions cannot be disputed or repudiated;

(c) With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorised manipulation;
(d) The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;
(e) In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Table 3.4
Changes to the Union registry, including changes to Finland's national registry

Reporting Item	Description
15/CMP.1 Annex II.E paragraph 32.(a) Change of name or contact	None, administrator of the Finland's registry: Jouko Hepola Energy Authority Address and phone number are available at homepage http://www.energiavirasto.fi/en/web/energy-authority/home
15/CMP.1 Annex II.E paragraph 32.(b) Change regarding cooperation arrangement	No change of cooperation arrangement occurred during the reported period.
15/CMP.1 Annex II.E paragraph 32.(c) Change to database structure or the capacity of national registry	In 2016, new tables were added to the database for the implementation of the CP2 functionality. Versions of the Union registry released after 6.1.6 (the production version at the time of the last NC submission) introduced other minor changes in the structure of the database. These changes were limited and only affected EU ETS functionality. No change was required to the database and application backup plan or to the disaster recovery plan. No change to the capacity of the national registry occurred during the reported period.
15/CMP.1 Annex II.E paragraph 32.(d) Change regarding conformance to technical standards	Each release of the registry is subject to both regression testing and tests related to new functionality. These tests also include thorough testing against the DES and were successfully carried out prior to each release of a new version in Production. Annex H testing is carried out every year. No other change in the registry's conformance to the technical standards occurred for the reported period.
15/CMP.1 Annex II.E paragraph 32.(e) Change to discrepancies procedures	No change of discrepancies procedures occurred during the reported period.
15/CMP.1 Annex II.E paragraph 32.(f) Change regarding security	The mandatory use of hardware tokens for authentication and signature was introduced for registry administrators.
15/CMP.1 Annex II.E paragraph 32.(g) Change to list of publicly available information	Publicly available information is provided via the Union registry homepage for Finnish registry e.g. https://ets-registry.webgate.ec.europa.eu/euregistry/FI/public/reports/publicReports.xhtml and via the web page of the Energy Authority, e.g. http://www.energiavirasto.fi/en/web/energy-authority/public-reports
15/CMP.1 Annex II.E paragraph 32.(h) Change of Internet address	No change of the registry's Internet address occurred during the reporting period.
15/CMP.1 Annex II.E paragraph 32.(i) Change regarding data integrity measures	No change of data integrity measures occurred during the reporting period.
15/CMP.1 Annex II.E paragraph 32.(j) Change regarding test results	Both regression testing and tests on the new functionality are carried out prior to release of the new versions in Production. The site acceptance tests are carried out by quality assurance consultants on behalf of and assisted by the European Commission. Annex H testing is carried out on an annual basis.

Following the successful implementation of the Union registry, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. Croatia was migrated and consolidated as of 1 March 2013. During the go-live process, all relevant transaction and holdings data were migrated to the Union registry platform and the individual connections to and from the ITL were re-established for each Party.

The changes to the national registry, which have occurred since the last National Communication report are summarized in Table 3.4. For other parts, the description of the functions of the national registry and its conformity with the Data Exchange Standards (DES) under the Kyoto Protocol, reported in Finland's 6th National Communication, Chapter 3, Table 3.4, remains valid.

Literature

2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. & Tanabe K. (eds). Published: IGES, Japan. http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html.

IPCC (2014a) 2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol, Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. & Troxler, T.G. (eds). Published: IPCC, Switzerland. http://www.ipcc-nggip.iges.or.jp/public/kpsg/index.html.

IPCC 2014b 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. & Troxler, T.G. (eds). Published: IPCC, Switzerland. http://www.ipcc-nggip.iges.or.jp/public/wetlands/index.html.

Internet links

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/10116.php

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

Energy supply and consumption, Statistics Finland http://tilastokeskus.fi/til/ehk/index_en.html

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

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 and plans for meeting the related targets. The policies and measures planned, adopted 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: pixhill.com

4 POLICIES AND MEASURES

4.1 Climate policy framework in Finland

Effective climate change policies require global collaboration and actions. Consequently, Finland's climate policy is based on international agreements: the UNFCCC, the Kyoto Protocol and the Paris Agreement. The common policies of the European Union, such as the EU 2020 and 2030 Climate and Energy Packages have a key role in the implementation of the international agreements mentioned above. At national level Finland's climate policy is defined in government policies and programmes, and since 2003, strategic work has been steered by ministerial working groups. In addition, national energy and climate strategies have been prepared since 2001 to implement the international and EU commitments as well as national targets, and to define sectoral policies and measures.

4.1.1 The Kyoto Protocol

In accordance with the Kyoto Protocol, the EU was committed to reducing its emissions by eight per cent in 2008 to 2012 compared to the base year. 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 the 1990 level during the first commitment period of the Protocol, 2008 to 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 to 2012) corresponded to 355,017,545 tonnes CO_2 eq. (or approximately 71 million tonnes CO_2 eq. per year).

Finland fulfilled its commitments under the first commitment period of the Kyoto Protocol. Based on the greenhouse gas inventory for 2008 to 2012, the greenhouse gas emissions were about five per cent below the assigned amount. The assessment for compliance was concluded in 2015, after the review of the final inventory submission and at the end of the true-up 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 to 2020, which continue the commitments established for the first period. By accepting the Kyoto Protocol's second commitment period in June 2015, the EU, its Member States and Iceland are committed to reducing their greenhouse gas emissions jointly by 20 per cent compared to the base year.

The EU and its Member States will fill their part of the joint commitment as follows. Emissions from categories covered by the EU emissions trading scheme (EU ETS) will

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

be reduced by 21 per cent by 2020 from their level in 2005 and emissions not covered by the EU ETS will be cut by approximately 10 per cent from the 2005 level by 2020 within the EU as a whole. The EU ETS emissions reduction commitment is an EU level commitment and Member State specific caps are not defined for the EU ETS emission reductions (for more information see Section 4.1.4 below).

Member States have individual binding annual emission reduction or limitation targets for the emissions not covered by the EU ETS (non-ETS emissions) the period 2013 to 2020. These are set in the EU Effort Sharing Decision (ESD)[3] (also addressed in Section 4.1.4 below). The ESD defines Finland's reduction obligation for the sources not covered by the EU ETS as 16 per cent of the 2005 emissions. This reduction obligation is determined in CO_2 equivalent tonnes in the Commission Decision[4], and adjusted in the Commission Implementing Decision[5] to take into account changes in the coverage of the EU Emission Trading System from 2013 onwards. For Finland these annual adjustments increased the reduction commitment by 2020 by approximately five percentage units.

Finland's emission reduction target for the second commitment period of the Kyoto Protocol has been defined based on its emission reduction obligation under the ESD described above. This target amounts to 240,544,599 tonnes CO_2 eq. and covers the non-ETS emissions only. In addition, Finland will be responsible for the emissions and removals from the LULUCF activities as defined in Decision 2/CMP.7, during the second commitment period.

Finland accepted the Kyoto Protocol's second commitment period on 26 June 2015, soon after the EU.

4.1.2 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.[6] Decrees on JI[7] and the CDM[8] 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 the 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.

3 2009/406/EC
4 2013/163/EU
5 2013/634/EU
6 109/2007
7 91372007
8 915/2007

The Energy 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).

4.1.3 The Paris Agreement

The Paris Agreement was adopted in December 2015 and entered into force in November 2016. The EU ratified the agreement in October. The Finnish national ratification was completed in November 2016.

The Agreement can be seen as a game-changer on the international climate change policy scene. It entails several uniform obligations for all Parties. Instead of specific top-down emission reduction commitments, the Agreement is based on nationally determined contributions to mitigate the emissions.

The EU's joint nationally determined contribution under the Agreement is to reduce the greenhouse gas emissions by 40 per cent by 2030 from the 1990 level. The details of the effort sharing between the Member States, including Finland, are being negotiated at present (more information on the negotiations and the associated policy framework beyond 2020 is presented in the next section).

4.1.4 Climate policy of the European Union

EU legislation and policy programmes have a major effect on Finland's greenhouse gas emissions.

In 2007, the EU heads of state or government agreed on targets to combat climate change via a commitment to reduce greenhouse gas emissions by 20 per cent by 2020 from the emission level in 1990. In the long term, or by 2050, the guideline target involves a reduction of emissions by 80 to 95 per cent. The EU 2020 Climate and Energy Package forms the framework for the EU's climate policy for the period 2013 to 2020.

In order to achieve the 2020 emission reduction target, the EU Member States adopted a binding renewable energy target prescribing that at least 20 per cent of the EU's gross final energy consumption and 10 per cent of the final energy consumed in the transport sector must come from renewable energy sources by 2020.

The EU emissions trading scheme (EU ETS) will deliver most of the emission reductions needed. In 2020, emissions from sectors covered by the EU ETS should be 21 per cent lower than in 2005. The Directive of the European Parliament and of the Council[9] on the emissions trading, which improves and extends the EU's greenhouse gas emission allowance trading scheme, has been implemented in Finland via the legislative arrangements. In Finland, approximately 600 installations are participating in the EU ETS.

The EU agreed in 2008 that all aircrafts taking off and/or landing in the EU would be included in the EU emissions trading starting from 2012. However, the EU has decided to reduce temporarily the scope of the aircrafts ETS to intra-EEA flights from 2013 until 2016. The Directive and its amendments have been implemented in Finland as part of the Act on Aviation Emissions Trading that entered into force on 1 February 2010. Negotiations on the scope of the aviation ETS from 2017 until 2020 are currently underway. The scope of the aviation ETS will most likely continue to be reduced to intra-EEA flights during the following years, too.

According to the EU 2020 Climate and Energy Package, emissions from sectors not included in the EU ETS — such as transport, housing, agriculture and waste — should be cut by approximately 10 per cent from the 2005 level by 2020 within the EU as a whole. The

9 2009/29/EC, amends Directive 2003/87/EC

Effort Sharing Decision (ESD)[10] established binding annual greenhouse gas emission targets for Member States for the period 2013 to 2020. It is up to each Member State to decide how its target will be achieved. 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 three to four per cent of the total emissions for 2005. Domestic measures are also needed to meet the targets. A Member State that fails to meet its annual target will be penalised with an additional eight per cent emission reduction obligation for the following year.

Finland's reduction obligation under the EU ESD for the sectors not covered by the EU ETS is largely the same as the reduction commitment under the second commitment period of the Kyoto Protocol described in Section 4.1.1. However, there are also differences. The commitment under the Kyoto Protocol also covers emissions and removals from the land use, land-use change and forestry activities and applies to the whole commitment period whereas the EU ESD emission allocations are implemented on annual basis. Also, the annual emission allocations under the ESD were adjusted in 2017[11] to take into consideration changes introduced by the implementation of the 2006 IPCC guidelines for national greenhouse gas inventories on the emissions levels in the inventory as these guidelines were applied in inventory reporting after the annual emission allocations under the ESD were agreed upon. These adjustments will not affect the commitment under the Kyoto Protocol. The adjustments which increased Finland's annual emission allocations with more than one percentage unit will apply only to the ESD commitments for the years 2017 to 2020. Finland's target under the ESD is presented in detail in Table 4.1. The table also includes the emissions from non-ETS sectors for the years 2013 to 2015.

Table 4.1
Finland's target path for non-ETS emissions in accordance with the EU Effort Sharing Decision and corresponding emissions for the years 2013 to 2015 (2016 emission data are preliminary).

	2013	2014	2015	2016	2017	2018	2019	2020
Finland's annual emission allocations including adjustments due to changes in the EU ETS coverage	31.8	31.3	30.8	30.3	29.8	29.3	28.8	28.4
Finland's annual emission allocations including also adjustments due to implementation of the 2006 IPCC guidelines					30.2	29.6	29.1	28.5
Non-ETS emissions[1]	31.6	30.1	29.9	31.3[3]				
Distance to the target[2]	–0.2	–1.1	–0.9	1.0[3]				

1 Due to the annual implementation of the EU ESD, the emissions used for assessing compliance are not updated after the compliance assessment. Hence the emissions may differ from the most recent inventory data.
2 Distance to the target is expressed as negative number when actual emissions are below annual emission allocations.
3 Approximate data

The 2020 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. Finland's use of renewable energy already exceeded the 38 per cent target in 2014.

The EU has also agreed on other climate policy measures that strictly speaking do not fall under the 2020 Climate and Energy Package. In order to gather information on greenhouse gas emissions from ships and push forward discussions at the IMO, the EU

10 2009/406/EC
11 2017/1471/EU

has agreed on a regulation on monitoring, reporting and verification of these greenhouse gas emissions. The regulation entered into force on 1 July 2015. In addition, Finland has also been implementing several EU directives and regulations that aim at reducing greenhouse gas emissions from road transport. The process for renewal and updating of this legislation is currently underway.

The EU also has regulation on F-gases[12], covering key applications in which F-gases are used. The revised regulation applies from 1 January 2015. It strengthens the existing measures and introduces a number of far-reaching changes by limiting the total amount of the most important F-gases that can be sold in the EU from 2015 onwards and phasing them down in steps to one-fifth of 2014 sales in 2030; banning the use of F-gases in many new types of equipment where less harmful alternatives are widely available, such as fridges in homes or supermarkets, air conditioning and foams and aerosols, and preventing emissions of F-gases from existing equipment by requiring checks, proper servicing and recovery of the gases at the end of the equipment's life. With the new F-gas Regulation, the EU's F-gas emissions will be cut by two-thirds by 2030 compared with 2014 levels.

The policy framework for the period beyond 2020 is currently in preparation in the EU. By the European Council conclusions in 2014, the EU is committed to reducing total greenhouse gas emissions by at least 40 per cent by 2030, compared to 1990. The reduction target from the 2005 levels in the emissions trading sector is 43 per cent and in the non-emissions trading sector it is 30 per cent. The share of renewable energy in the EU is to be increased to 27 per cent and energy efficiency improved, indicatively, by 27 per cent.

Legislative proposals on these have been presented by the Commission in 2015 and 2016, and they are currently being negotiated by the Members States and the European Parliament. In addition to the reform of the EU's emission trading scheme ETS and the Effort Sharing on non-ETS emissions, for the first time also the land-use, land-use change and forestry sector will be included in the EU's climate policy package. In the Effort Sharing Regulation, Finland's proposed target for emission reductions in 2030 compared to the 2005 level is 39 per cent. The legislative package includes flexibility mechanisms that allow Member States to achieve their targets in a cost-efficient manner.

In order to reach and implement the EU's 2030 Climate and Energy Package as well as the Energy Union targets, the Commission submitted in November 2016 the Clean Energy Package that included eight legislative proposals, a new eco-design working plan and a number of communications and reports, all related to the clean energy transition. The Energy Union policy programme aims at providing EU citizens with reasonably priced, secure and sustainable energy. Negotiations on these legislative proposals are currently underway.

It is also noteworthy that the Commission has the power to start an infringement proceeding against a Member State that fails to fulfil its commitments and obligations under the EU law.

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

12 2014/517/EU

actively participates in the debate on how EU decisions are implemented nationally. The Ministerial Committee on European Union Affairs discusses and decides on Finland's positions on EU and international climate policy issues. In the international climate negotiations Finland negotiates as part of the European Union and consequently follows the common positions of the EU.

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

Since 2003, every Finnish government has appointed ministerial working groups responsible for 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 Economic Affairs and Employment, 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 was updated in 2016, is described in Section 4.3.1.

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 2005. The strategy was evaluated in 2013 and the new Climate Change Adaptation Plan 2022 prepared based on the conclusion of the evaluation (more on the Adaptation Plan in Chapter 6). In addition, climate and energy issues are being taken into consideration in Society's Commitment to Sustainability[13], which was updated by the National Commission on Sustainable Development in 2016. With this commitment, the public sector, together with other actors, pledges to promote sustainable development in all its work and operations. The commitment was updated to respond to the new global agenda for sustainable development, the UN Agenda 2030. In February 2017, the Government gave a report to the Parliament on the implementation of the UN 2030 Agenda for Sustainable Development. The aim is a carbon-neutral, resource-wise and competent Finland.

In terms of the reporting on policies and measures, including on their implementation and effects on emissions, and projections to the European Commission, and to the UNFCCC, the Ministry of Economic Affairs and Employment is responsible for overall co-ordination and compilation of information from different sectors. The sectoral ministries are responsible for the projections and impact assessments concerning their own field. Several expert organisations assist in acquiring data and in the assessments of policies and measures and modelling sector-specific projections. The network of officials gives the final approval concerning the information in the reporting tools and paper report to be submitted. The preparation of the Medium-term Climate Change Policy Plan and the Government's annual climate change report is coordinated by the Ministry of Environment and all relevant ministries are involved in the work. Also, Finnish Government reports to the Parliament once in a year, among other things, the progress of agreed measures in the energy sector.

The latest reporting requirements in the energy and climate sector were imposed by the Climate Change Act of 2015. This act contains provisions on climate policy plans on which

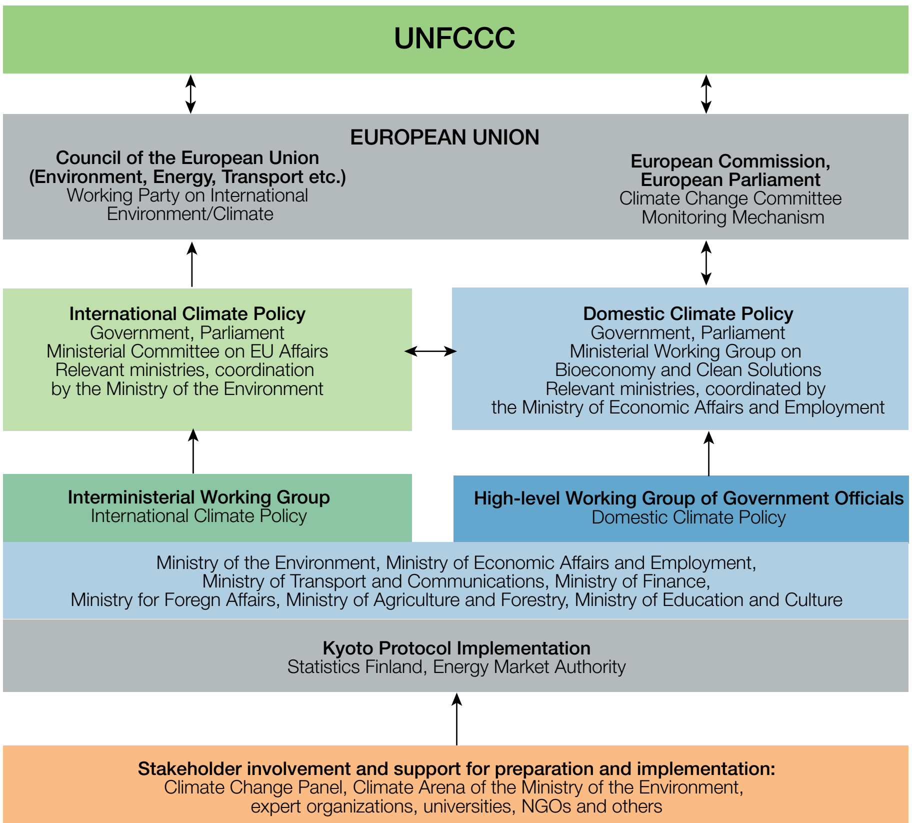
13 http://www.ym.fi/en-US/The_environment/Sustainable_development

the Government will issue a report to the Parliament. The Government's annual climate change reports also inform the Parliament on the achievement of climate targets and the impact of the measures taken. The first annual climate change report will be issued in 2018.

Statistics Finland is the national entity responsible for compiling the Finnish greenhouse gas inventory. Statistics Finland publishes the greenhouse gas inventory data three times every year. The publications include information on monitoring progress with Finland's commitments to reduce its greenhouse gas emissions under the EU and the Kyoto Protocol. The Finnish Environment Institute (SYKE), the Natural Resources Institute Finland (Luke) 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 Authority is the competent authority and the registry administrator for the national emissions trading registry under the Kyoto Protocol 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 Change Panel

The Finnish Climate Change Panel[14] was nominated by the Ministry of the Environment in December 2011. The initially 12-member Panel was tasked to strengthen the

14 www.ilmastopaneeli.fi

interaction between research and policy making. The first two terms of the Panel were approximately two years each, during which the Panel published reports on several topics relevant to climate policy making, such as the Climate Change Act, Energy system and emission reduction measures, Carbon neutrality, Black carbon, Environmentally and socially sustainable climate policy in agriculture, Climate education; Adaptation to climate change; risks, responsibilities and costs, and Climate impacts of forestry. The mid-term evaluation of the Panel recommended that the Panel should make more efforts in communicating its messages, and relevant action was taken accordingly.

The legal base for the Finnish Climate Change Panel was established when the Climate Change Act came into force in summer 2015. The Panel is appointed as an independent body to support planning and decision making of climate policy. The Government nominated the current 15-member Panel in January 2016 for a term of four years. The policy advisory role of the Panel has become stronger. Panellists have been invited to comment the National Energy and Climate strategy for 2030 (afterwards also referred to as National Energy and Climate Strategy) in relevant Committee hearings in the Finnish Parliament. The Panel's advice has also been sought during the preparation of the Government's first Medium-term Climate Change Policy Plan. The Panel has continued its work with LULUCF related issues by facilitating discussion on the climate impact of forestry and has also published reports on Cleantech and on transport.

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.

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. In addition, the Ministry of the Environment organises regular stakeholder meetings in advance of all major UNFCCC negotiations.

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[15] 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 15 Centres for Economic Development, Transport and the Environment (ELY Centres) are currently responsible for the regional implementation and development tasks of the government. Regional environmental strategies guide environmental and land-use planning.

15 621/1999

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 five regional offices and promotes sustainable forest management as well as enforces forestry legislation.

All Regional Councils have included climate and energy issues in their strategies – either as separate climate strategy documents or as a theme in comprehensive regional strategies. Finnish regions are different and the climate change strategies also differ. For example, forest-rich regions typically emphasise opportunities in bioenergy production, and regions with urban areas highlight issues related to transport.

Since April 2016 the reform of regional government according to the government policy outline has been under preparation. The reform will bring changes to the organisation of climate change related tasks in the regions.

The role of municipal authorities in both mitigation and adaptation is widely recognised in Finland. They have significant responsibilities in land-use and transport planning and in providing public transport and waste management services. Some Finnish 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 also grant 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.

The trend of urbanisation is still ongoing in Finland. It is estimated that there are annually about 20,000 new inhabitants in urban areas, the Helsinki region growing most. According to a recent study by VTT on the mitigation potential in the non-ETS sector, the per capita emissions in these in big cities are lower than those in small municipalities. In bigger cities there are options for directing the growth in passenger traffic volumes to more environmentally friendly transport modes. Another factor that contributes to emissions reductions is that CHP can be more widely used and that emissions from CHP production in big installations are included in the EUETS sector.

The Association of Finnish Local and Regional Authorities (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). ALFRA updated information on climate mitigation action in municipalities in 2015[16]. Nearly all municipalities with more than 30,000 inhabitants are active in the climate action.

Networking of municipalities is proceeding well in Finland. More municipalities are joining the networks and new ways of supporting local action are developed. Table 4.2 shows the key features of the main climate networks in Finland. Examples of activities in the networks are presented below.

The most common climate change mitigation measures carried out in the municipalities have been related to extending the district heating network, using renewable energy, improving energy efficiency and developing a biking infrastructure.

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16 The report analyses climate action taken in municipalities and regions and presents recommendations for future work. http://shop.kunnat.net/product_details.php?p=3159 (in Finnish)

Table 4.2
Key features of the main municipal climate networks and campaigns in Finland

Campaign/ network/ partnership	Participants	Targets, goals	Activities
Cities for Climate Protection campaign (coordinated by ALFRA)	56 municipalities and 2 joint municipal authorities	Every municipality sets its own target	Estimation of emissions Target setting Plan for emissions reductions Implementation, monitoring The network's support to the municipalities ALFRA provides expert support and training
Carbon Neutral Municipalities project (HINKU)	HINKU has grown during 2008 to 2017 from a group of five small municipalities to a network of 39 municipalities of different sizes and covers a population of 680,000	HINKU municipalities are committed to cutting municipal emissions by 80% by 2030 and encouraging local actors towards carbon neutrality.	Green Economy solutions are sought to boost the economy and employment. Monitoring of both GHG and financial scores Promoting commitments by municipal leaders Activating people and enterprises Developing, testing and multiplying solutions. Good practices in the HINKU Folder (a net tool)
Covenant of Mayors	EU-wide initiative Helsinki*, Espoo*, Tampere*, Vantaa*, Turku*, Oulu*, Lahti, Jyväskylä, Vaasa, Joensuu, Kainuu Region	At least 40% GHG reductions by 2030; Commitment to improve energy efficiency and use of renewables	Energy efficiency in the built environment Adaptation to climate change
Mayors' Climate Network	The six largest Finnish cities have their own network in the context of the Covenant of Mayors' initiative		Responding to the climate challenge in growing cities
Smart Clean	Helsinki, Espoo, Vantaa; Kauniainen, Lahti, Uusimaa Region and other actors	Aiming at building the metropolitan Helsinki area into an internationally known reference area for ecological and smart solutions	Projects on transport and traffic, building, energy, waste, water as well as consumer-cleantech
Smart Retro	Lahti, Stockholm, Oslo; also other Nordic cities	Networking cities and local start-ups to work with intelligent solutions.	Themes: e.g. retrofitting buildings, digitalisation, sharing economy
Fisu (Finnish Sustainable Communities); network of forerunners	Forssa, Ii, Jyväskylä, Kuopio, Lahti, Lappeenranta, Turku, Vaasa	Aiming at carbon neutrality, zero waste and globally sustainable consumption by 2050.	A joint vision and roadmap prepared by the municipality, enterprises and other local actors for fulfilling the targets a joint roadmap.
		Aiming to strengthen the municipal and local economy, create jobs and build sustainable welfare	The actors recognise new opportunities for cooperation and new ways for action.
Energy efficiency agreements	Energy efficiency agreements for municipalities between ALFRA, the Ministry of Economy and Employment and the Energy Authority. Individual municipalities make contracts with the Energy Authority.	Finland meets its commitments under the EU energy efficiency requirements with the agreements and thus reduces GHG emissions. Many municipalities also participate in respective energy efficiency agreements for enterprises.	The government gives grants to energy audits and investments for improving energy efficiency.

More than 130 municipalities (out of a total 320) have joined the voluntary energy efficiency agreements or programmes (see Section 4.5.1) and are thus committed to reducing municipal energy consumption rates.

The Carbon Neutral Municipalities project (HINKU) aims to create solutions that have economic and social benefits as well as environmental advantages. When the project was launched in 2008, five small municipalities were committed to an 80 per cent reduction in greenhouse gas emissions from the level of 2007 by 2030. Currently the HINKU project includes 39 municipalities, with total of 678,200 inhabitants, the four largest HINKU municipalities having population over 50,000. A large group of companies and experts are involved as partners.

During 2007 to 2017 the municipalities in the HINKU network reduced their emission by 29 per cent, on average, and it is estimated that they are on track to the 2030 goal. The most important measures have been to replace fossil fuels with renewable energy sources; improvements in energy efficiency of buildings and reduction in consumption of energy. The HINKU Forum[17] provides, e.g., sharing of information, support to the preparation of projects and initiatives.

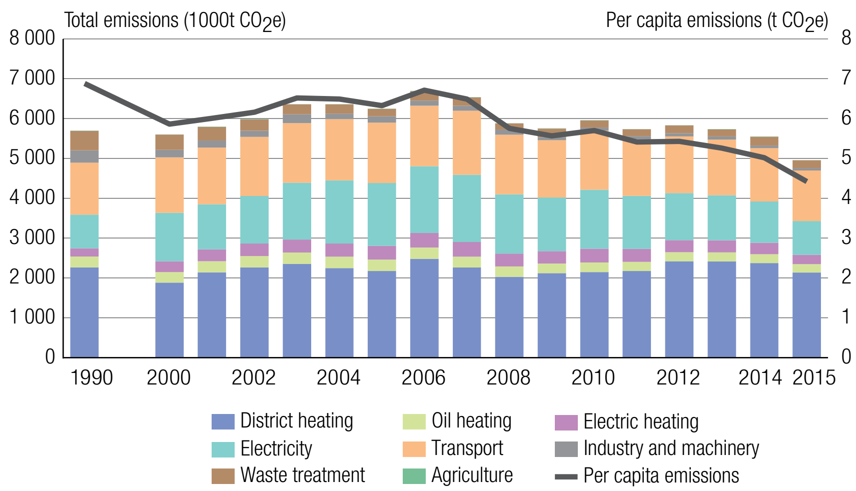
A novel element of HINKU is joint procurement of solar power systems. This started as a successful pilot project in four small communities. SYKE has later launched a joint procurement of solar power systems, inviting all municipalities and municipal enterprises in Finland to increase their use of solar power. The solar power stations are to be leased, as a result municipalities do not need to invest in the plants themselves or accrue any additional operating costs. There is interest in municipalities for joint procurements of electric cars and efficient led lighting systems as well.

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 Table 4.2).

The Finnish Sustainable Communities (FISU) are aiming at carbon neutrality, zero waste and globally sustainable consumption. Integrating climate and other relevant goals at the municipal level brings synergies to local actors and businesses. Developing new types of cooperation is central in FISU actions.

The Helsinki Metropolitan Area climate strategy of climate change mitigation to the year 2030 is a joint strategy of the four cities in the metropolitan region which aim to be carbon neutral in 2050. Individual cities in the area have their own targets as well. Figure 4.2 below shows the trend in greenhouse gas emissions in the metropolitan area in 1990 to 2015. The combined greenhouse gas emissions of Helsinki, Espoo, Vantaa and Kauniainen have been declining since the approval of the Helsinki Metropolitan Area Climate Strategy in 2007.

Figure 4.2
Trend in greenhouse gas emissions in the metropolitan area in 1990 to 2015



17 http://www.hinku-foorumi.fi/en-US

Both HINKU and ALFRA have compiled information on climate action in municipalities. Real-life cases from, e.g. installation of renewable energy systems, energy efficiency measures in municipal buildings are presented. Information on costs, pay-back times, etc., is also available in many cases. In several HINKU municipalities, the information on potential cost savings has been instrumental in switching away from oil-based heating systems.

4.3 Strategies and plans

4.3.1 National energy and climate strategies

Finland's long-term objective is to be a carbon-neutral society. Besides the long-term objective Finland has national and EU-level energy and climate targets and commitments for 2020 and 2030 under the UNFCCC, Kyoto Protocol and the EU. The Government regularly prepares strategies and plans for achieving these energy and climate targets.

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. The report Energy and Climate Roadmap 2050 published by the Parliamentary Committee on Energy and Climate Issues in October 2014 serves as a strategic level guide on the journey towards the long-term target of carbon neutrality. The Energy and Climate Roadmap 2050 is discussed further in Section 4.3.2.

Finland has prepared five strategies on energy and climate policy, which were completed in 2001, 2005, 2008, 2013 and 2016. The focus of the 2008 and 2013 strategies is on policy measures for achieving the 2020 targets. The 2016 strategy - National Energy and Climate Strategy for 2030 - outlines the actions that will enable Finland to attain the targets specified in the Government Programme of Prime Minister Sipilä (27 May 2015) and adopted in the EU for 2030, and to set systematically the course for achieving an 80 to 95 per cent reduction in greenhouse gas emissions by 2050. The 2016 strategy was submitted to the Parliament as a Government Report on 24 November 2016. An extensive background report (in Finnish) adds further detail to the Government report.

The National Energy and Climate Strategy for 2030 discusses the key starting points and objectives of the Government Programme goals, the adequacy of current measures for meeting its targets (the basic scenario) and measures by which its targets can be attained (the policy scenario). The strategy also specifies the key measures for achieving the binding emission reduction targets in the effort sharing sector by 2030. These measures are complemented and specified in the national Medium-term Climate Policy Plan published in 2017. Additionally, the strategy examines the possibility of transitioning into an economy fully based on renewable energy by 2050.

The Government Programme of Prime Minister Sipilä sets ambitious targets in the energy sector. It aims for increasing the share of renewable energy to over 50 per cent of final consumption, increasing self-sufficiency to over 55 per cent, phasing out the use of coal in energy production, halving the domestic use of imported oil, and bringing the share of renewable transport fuels up to 40 per cent (23.5 per cent of the fuel energy content). An effort will be made to achieve all this by 2030.

With minor exceptions, Finland will phase out the use of coal for energy. The share of transport biofuels will be increased to 30 per cent (of the fuel energy content), and an obligation to blend light fuel oil used in machinery and heating with 10 per cent of bioliquids will be introduced. The minimum aim is to have 250,000 electric and 50,000 gas-powered vehicles on the roads. The electricity market will be developed at the regional and the European level. The flexibility of electricity demand and supply and, in general, system-level energy efficiency will be improved. Technology neutral tendering processes will be organised in 2018 to 2020, based on which aid will be granted to cost-effective new electricity production from renewable energy.

With the additional measures outlined in the strategy the share of renewable energy in the final consumption is expected to increase to approximately 50 per cent and the self-sufficiency in energy to 55 per cent by 2030. The share of renewable energy use in transport will clearly exceed the Government Programme target. The domestic use of imported oil will be halved as planned. The greatest non-ETS sector reductions in emissions will be achieved in the transport sector, and this is also the foundation of the medium-term climate policy plan of 2017.

Based on the National Energy and Climate Strategy for 2030, Finland will take measures to achieve the energy and climate targets and objectives. The relevant ministries are responsible for implementing the measures and also for monitoring and evaluating them. 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 Regulation[18]. The biennial report on policies and measures and projections has been compiled in cooperation with the Ministry of Economic Affairs and Employment (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 and Natural Resources Institute Finland (LUKE).

In the Government's yearly report to the Parliament, mitigation measures and the emission development are evaluated on a general level. Other energy and climate reporting activities include a yearly report to the Parliament on the implementation of the Medium-term Climate Policy Plan and reporting once per government term on the national adaptation plan constructed based on the Finnish Climate Change Act[19].

4.3.2 Energy and Climate Roadmap 2050

A parliamentary committee on energy and climate issues issued in 2014 an energy and climate roadmap towards 2050. The roadmap analysed the means of constructing a low-carbon society and achieving an 80 to 95 per cent reduction in greenhouse gas emissions from the 1990 level in Finland by 2050.

An extensive research project titled 'Low Carbon Finland 2050 platform' completed in cooperation with a number of research institutes was used as a background material for preparing the Roadmap. This project created four scenarios for low-carbon development paths until 2050.

The roadmap discusses energy production and energy systems, use of energy, agriculture and forestry and carbon sinks, the waste sector and multidisciplinary measures

18 2013/525/EU
19 609/2015

that cut across several sectors. The Roadmap states that the measures Finland must take in any case in order to reduce greenhouse gases emissions by 80 to 95 per cent are related to renewable energy, energy efficiency and cleantech solutions.

According to the Roadmap, issues that are important for Finland when transitioning into a carbon-neutral society include safeguarding the security of supply of energy under all conditions, profitable forest biomass use, carbon sink calculation rules, replacing fossil transport fuels with bio-based fuels and securing the competitiveness of society. The building of a carbon-neutral society requires actions on all levels, and efforts must be made to reduce greenhouse gas emissions in all sectors, even if their possibilities of doing so vary.

Rather than selecting or proposing a delineated pathway towards 2050, the Roadmap examines different alternatives and their impacts on the cost effectiveness of reducing emissions and the competitiveness of Finnish society.

The Energy and Climate Roadmap 2050 also serves as a Low-Carbon Development Strategy for Finland in the reporting on policies and measures under the EU regulation on a mechanism for monitoring and reporting greenhouse gas emissions and for other information[20].

4.3.3 Medium-term Climate Change Policy Plan

The Climate Change Act[21] that entered into force in June 2015 contains a provision on a climate change policy planning system that includes a Medium-term Climate Change Policy Plan adopted by the Government once every government term. The Medium-term Climate Change Policy Plan shall include an action plan that proposes the measures for the reduction of anthropogenic greenhouse gas emissions and mitigation of climate change in the effort sharing sector (sectors outside emissions trading), and projections of greenhouse gas emissions and the effects of policy measures on the emissions. The preparation of the Plan is coordinated by the Ministry of the Environment and all relevant ministries are involved in the work. The annual climate change report, which will be presented to the Parliament every year, will contain information on the implementation of the policy measures contained in the Medium-term Climate Change Policy Plan.

The first Medium-term Climate Change Policy Plan was finalised during 2017. Alongside the National Energy and Climate Strategy for 2030, adopted at the end of 2016, this plan implements the climate policy objectives of the Government Programme. The Medium-term Climate Change Policy Plan specifies and complements the emission reduction measures outlined in the National Energy and Climate Strategy. It also examines links between different sectors and cross-cutting themes, such as the role of consumption and local climate action. The plan takes into account the energy policy measures included in the strategy, because they will impact the development of emissions.

The Medium-term Climate Change Policy Plan sets a target for reducing greenhouse gas (GHG) emissions by 39 per cent in the effort sharing sector by 2030 compared to the 2005 level and determines the measures for achieving the target. The target is based on the European Union's (EU) 2030 target of reducing emissions by at least 40 per cent compared with 1990 levels and is in line with the Finland's long-term climate goal. As the existing measures are not sufficient to achieve the 2030 target, additional measures are identified in the plan. The greatest emission reduction potential is identified in the transport sector. In addition, the plan includes measures to reduce emissions in the agriculture, waste and machinery sectors as well as emissions from building-specific heating and F gas emissions.

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20 2013/525/EU
21 609/2015

4.4 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 (–19.300 million tonnes CO_2[22]) set for Finland for the second commitment period of the Kyoto Protocol (2013 to 2020).

The means for steering the use of forests include legislation, Finland's National Forest Strategy 2025 (NFS), 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[23] and the Act on the Financing of Sustainable Forestry.[24] 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. Acts on timber measurement and jointly owned forests, as well as on some forest organisations have recently been updated.

The Forest Act sets requirements for the regeneration and conservation of certain key 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 Forest Act was amended in 2013. The updated law allows 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 were also renewed, parallel to the Forest Act process.

The Government Report on Forest Policy 2050 was adopted in 2014. The report, conducted in a participatory process, outlines a long-term vision and strategic objectives for the management of forests and the main measures to be taken. The vision of the Forest Policy Report, Sustainable forest management is a source of growing welfare, stresses the diverse welfare derived from forests and the fact that the utilisation of forests offers solutions to the needs of the people and society. Finland's National Forest Strategy (NFS), adopted by the Government in February 2015 and operationalising Government policy, specifies the main objectives for forest policy and forest-based business and activities until 2025. The vision was drawn from the Forest Policy Report 2050, including three strategic objectives to make the vision come true are: 1) Finland is a competitive operating environment for forest-based business, 2) Forest-based business and activities and their structures are renewed and diversified, and 3) Forests are in active, economically, ecologically and socially sustainable, and diverse use. The strategy is implemented by eleven key projects.

According to the NFS, climate change mitigation and adaptation in forests are supported by diversifying forest management. Forests' viability, i.e. growth and health will be maintained and enhanced through active forest management. Over the long term, forest management techniques must be adapted to new and changing climate conditions. Timely and careful forest management can improve the growth but also the resistance of growing stock to damage while safeguarding the ecosystem services of forests and producing wood biomass sustainably. Forests as a carbon sink have been a significant means of mitigating climate change in Finland.

The NFS is implemented and monitored in broad cooperation between the public and private sectors. The Ministry of Agriculture and Forestry, supported by the Forest

22 Assuming instantaneous oxidation for harvest wood products (HWP)
23 1093/1996 (amendment 1085/2013)
24 1093/1996

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 4.5.6.

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 2014 to 2025 (the METSO programme), both of which are integral parts of the range of instruments in the NFS 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. The programme is being implemented through ecologically efficient, voluntary and cost-effective means. A Government decision-in-principle in 2014 sets goals for METSO up to 2025 that 96,000 ha of private and 13,000 ha state-owned forests will be conserved on permanent or temporary basis.

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 was liberalised by a new act on forest management associations.[25] A private forest owner may also 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 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, the projects may concern landscape management, preventing damage to waters and the restoration of ditched areas.

4.5 Sectoral policies and measures

4.5.1 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.

25 534/1998 (amendment 1090/2013)

The 'with measures' (WM) projection includes all energy policy measures implemented before autumn 2016. 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 emissions.

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 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 efficient measures 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 sections. A list summarising the policies and measures can be found in Table 4.3 at the end of this section. Energy taxation and tax-related subsidies are described in Section 4.6.

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 2012, 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 more than one tenth of EU ETS emissions in Finland (Table 4.4).

Table 4.4
Greenhouse gas emissions in the emission trading (ETS) sector and non-emission trading sector in Finland in 2005, 2008 to 2010, 2013, 2014 and 2015, million tonnes CO_2 eq. The ETS figures do not include emissions from aviation in the EU ETS as their coverage under the trading scheme is not consistent with the national greenhouse gas inventory. Also, total national emissions (also for 1990) and emissions from domestic aviation are presented.

	1990	2005	2008	2009	2010	2013	2014	2015
ETS	NA	33.1	36.2	34.4	41.3	31.5	28.8	25.5
of which energy	NA	29.6	31.8	30.9	37.3	27.6	25.1	21.6
industrial processes	NA	3.5	4.3	3.4	4.1	3.9	3.7	3.9
Non-ETS	NA	36.2	34.7	32.8	34.1	31.5	30.2	29.9
Domestic aviation	NA	0.3	0.3	0.2	0.2	0.2	0.2	0.2
Total	**71.3**	**69.6**	**71.2**	**67.4**	**75.7**	**63.2**	**59.1**	**55.6**

The share of EU ETS emissions with respect to the total greenhouse gas emissions in Finland was 46 to 50 per cent between the years 2013 and 2015 (Table 4.4). This share is clearly higher than the EU-28 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. A steady decrease is also foreseen in the future in the emissions from district heating and combined heat and power (CHP) production. Several condensing power plants have been decommissioned or moth-balled in recent years. The emissions from industry are not expected to change dramatically. Consequently, the EU ETS sector emissions are 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 promotion of renewables and energy efficiency. However, some yearly variations to this trend can occur due to variations, for example, in the Nordic energy market and in weather conditions.

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.

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. Energy efficiency agreements covered approximately 65 per cent of the total energy consumption in Finland at the end of 2016.

The third generation of energy efficiency agreements for industries, municipalities, property and building sector and the oil sector have commenced for the period 2017 to 2025[26]. They are mainly the responsibility of the Ministry of Economic Affairs and Employment. Responsibility for the action plan for rental housing properties in the property and building sector agreement lies in the Ministry of the Environment. These agreements are the successors of the second agreement generation in 2008 to 2016 (rental housing properties 2010 to 2016, commercial properties 2011 to 2016) and the first generation of agreements in 1997to 2007 (then called energy conservation agreements).

In 2010, an energy efficiency agreement was also launched in the agriculture sector under the Ministry of Agriculture and Forestry. The agreement was updated in 2016 for the period 2016 to 2020. Farms have received energy advice in the scope of the Farm Energy Programme in 2010 to 2015. In 2015 to 2020 energy advice is given in the sphere of the Rural Development Programme for Mainland Finland[27]. Energy efficiency meas-

26 http://www.energiatehokkuussopimukset2017–2025.fi/en/

27 The programme covers the territory of Finland excluding the Åland Islands

ures in agriculture are farm reparcelling to cut down energy use in farm traffic, support to fresh grain silos where energy use for drying of grain is avoided as well as support to investments to unheated cattle buildings and heat recovery from pig slurry, see Table.4.3.

Total annual savings in force from measures implemented under the energy efficiency agreements since 1997 within the industry, energy, municipal, property and building sectors were approximately 16.6 TWh per year at the end of 2015. Almost 85 per cent of these savings came from end use sectors and one fourth of the savings were electricity. The savings were equal to about 4.5 per cent of Finland's total energy consumption (362 TWh in 2015). Additional energy savings have been achieved as a result of the energy efficiency agreement for the oil sector, covering oil heated buildings, amounted to 1.4 TWh energy savings in 2015.

CO_2 reductions under the industrial, municipal, property and building, and oil sectors energy efficiency agreements were in total approximately 6.3 million tonnes CO_2 per year at the end of 2015 (based on a marginal emissions rate of 600 kg CO_2/MWh for electricity). It is estimated that by the end of 2020, the emissions reduction will be 7.9 million CO_2 tonnes per year, and 8.4 million tonnes per year by 2030 when taking into account the start of the new agreements period at the beginning of 2017 (see Table 4.3).

The energy efficiency agreements are especially important for implementing the Energy Efficiency Directive (EED)[28]. Monitoring and calculation methods for energy efficiency agreements are described in Annex 2 of the National Energy Efficiency Action Plans (NEEAPs) of the Energy Efficiency Directive[29].

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.

Since June 2014, energy audit activities are divided into two categories: mandatory energy audits for all large companies governed by the Energy Efficiency Act[30] based on the requirements in the EU Energy Efficiency Directive and voluntary subsidised energy audits for other operators (the Energy Audit Programme). Subsidies cannot anymore be granted for large companies under the mandatory energy audit requirement.

The Energy Audit Programme is a voluntary programme. The Ministry of Economic Affairs and Employment provides a 40 to 50 per cent subsidy for conducting energy audits on commercial and public buildings and in the industrial and energy sectors provided that the applicants do not fall into the scope of the mandatory audits. 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 Economic Affairs and Employment, there are energy audits intended for farms which are subsidised by the Ministry of Agriculture and Forestry.

By the end of 2015, the estimated savings in energy achieved by conducting voluntary energy audits in the service, municipal and industry sectors were approximately 1.8 TWh per year. About 90 per cent of the savings originated in the industry sector. The corresponding CO_2 reduction was 0.56 million tonnes CO_2 per year (based on a marginal emissions rate of 600 kg CO_2/MWh for electricity). The emissions reduction of the energy

28 2012/27/EC
29 https://ec.europa.eu/energy/sites/ener/files/documents/fi_neeap_2017_en.pdf
30 1429/2014

efficiency measures conducted based on the proposals in the voluntary energy audits is estimated to be 0.33 million CO_2 tonnes per year by the end of 2020 and 0.28 million tonnes per year by the end of 2025. While a vast majority 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.

Monitoring and calculation methods for the voluntary energy audit programme are described for different sectors in Annex 2 of the National Energy Efficiency Action Plans (NEEAPs) of the Energy Efficiency Directive [29].

Renewable energy

Finland aims to increase the share of renewable energy in final energy consumption to 38 per cent by 2020 (this was reached in 2014 and the share was 39.3 per cent in 2015). This increase in the share has been achieved by reducing energy consumption and increasing the use of renewables. Forest-based fuels, liquid biofuels, wind power and heat pumps will contribute most to the target.

The sliding feed-in tariff system for the production of electricity from renewable energy sources came into force on 25 March 2011 under a Government Decree. The subsidy varies on the basis of a three-month electricity market price or the market price of emission allowances. The aid scheme concerns government support for electricity production based on wind power, biogas, forest chips and other forest-based fuels.[31]

The objective is to increase the production of wind power to five TWh by the year 2020. In 2015, the wind power production was approximately 2.3 TWh and in 2016 approximately 3.1 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 2020 by three million tonnes CO_2 (Table 4.3). 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. 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 is 7.6 million tonnes in 2020 and 9.9 million tonnes in 2030.

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.

Other measures to promote renewables 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 4.5.

Renewable energy policies and measures for the transport sector are described in Section 4.5.2.

31 258/2011

Figure 4.3
Historic development and WM projection for renewable energy, TWh

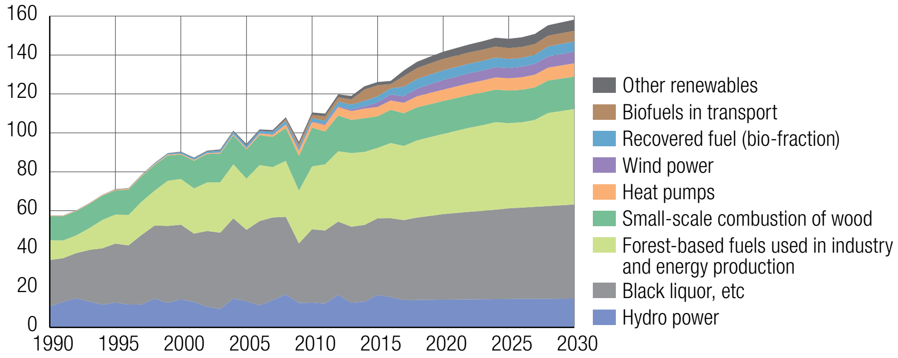

Table 4.5
Historic development and WM projection for renewable energy, TWh

	2005	2010	2015	2020	2025	2030
Black liquor and other concentrated liquors	36.7	37.7	39.5	44	47	48
Industrial wood residues	21.2	19.8	21.7	21	22	24
Forest chips	6.0	13.8	15.8	22	24	29
Small-scale combustion of wood excl. forest chips	14.2	18.6	14.9	17	17	17
Hydro power	13.4	12.7	16.6	14	15	15
Heat pumps	0.6	2.9	4.8	6	6	7
Wind power	0.2	0.3	2.3	5	5	6
Biofuels for transport	0.0	1.7	5.7	6	6	5
Recovered fuel (bio-fraction)	1.3	1.7	3.2	5	5	5
Other renewables	0.7	1.3	1.6	2	2	2
Total	**94.3**	**110.5**	**126.1**	**142**	**148**	**158**

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 72 TWh in 2015 (25 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 have been less than 3.5 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)[32] aims to reduce CO_2 emissions by improving the energy efficiency of buildings. The directive was implemented in Finland by a regulation that came into force at the beginning of 2008. This legislation on the energy efficiency of buildings includes the following:

- Act on Energy Certification of Buildings[33]
- The Ministry of the Environment Decree on Energy Certification of Buildings[34]
- Act on Inspection of Air-conditioning Systems[35]
- Amendments to the Land Use and Building Act,[36] which was expanded to cover energy efficiency requirements and details on how energy efficiency should be calculated[37].

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 (2003) 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).[38] The 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 regulation favours the utilisation of district heating and renewable energy when defining the energy performance of a building as a whole. Also, due to the implementation of the Directive on the Energy Performance of Buildings, EPBD, the regulation for the energy efficiency of the existing building stock was given in February 2013 and this Ministry of the Environment Decree[39] on improving the energy performance of buildings undergoing renovation or alteration came into force in June 2013.

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 forest-based energy (pellets, small-scale firewood). Due to the overall reductions in the Government's budget, these subsidies have now been ceased.

The State also supports the low-income households with an optional subsidy of 25 per cent covering costs for improving energy economics and using renewable energy sources in heating. A tax incentive scheme for domestic employment of various service providers has been in effect since 2001. A household may deduct 15 per cent of personnel salary costs or 45 per cent of company-provided services from personal taxation. Although the deduction can be applied to various type of work carried within a household, the emphasis has been on encouraging households to make improvements and alterations in heating system and installing systems using renewable energy sources. At the moment, the annual maximum for tax deduction is EUR 2,400/person.

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

32 2002/91/EC
33 487/2007
34 765/2007
35 489/2007
36 1129/2008
37 488/2007
38 2010/31/EU
39 4/2013

according to the actual water use, which provides a direct price signal for inhabitants. The requirement was 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 building maintenance issues.

Systematic and well-timed building 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 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 increases rapidly in Finland and will continue to do so in the next two decades. The reason is that, among other things, a large amount of the building stock needs 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 has 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 to 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. The implementation is ongoing. In 2015 a follow-up was made. As a result, many effective actions were recognised and the programme was estimated to have reached its aims in a good manner. For the following years, focus areas were defined: promoting planned real estate management, improving the cost efficiency and customer-orientation of renovation services and developing skills for repair work and its education.

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 land use, decentralised energy production, building policies, use and ownership of real estate and know-how for the years 2013 to 2014. The actions within the programme were continued for 2015 to 2017. The programme is ongoing and it ends in 2017. For the last year of action, weight is put on spreading good practices and assessing the procedure.

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 (235 kg CO_2/MWh) and with a mean marginal emission coefficient in the case of electricity (600 kg CO_2/MWh).

The emission reduction impacts of the policy measures are presented in Table 4.3. The regulation for the energy performance of new buildings entails the largest emission reductions, namely 3.8 million tonnes CO_2 by 2020 and 6.7 million tonnes CO_2 by 2030. Most of the emission reduction will take place in the EU ETS sector through the reduced use of electricity and district heat.

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 to 2012.

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. It is estimated that the emission reductions due to improvements in energy performance in renovations and alterations will be 0.4 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. 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 0.06 million tonnes CO_2 in 2020 and 0.1 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.

Building 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.

Existing 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

Renewable energy

Finland's first offshore wind farm was granted a EUR 20 million investment subsidy in 2014. The planned total capacity of the wind farm was 40 MW. This project aimed to demonstrate wind power technologies suitable for winter conditions in the Baltic Sea area where, for example, ice conditions can be very challenging due to pack ice.

An amendment to the Production Aid Act entered into force on 26 October 2015. The aim of the legislative amendment is the controlled closure of the feed-in tariff scheme. No further applications will be accepted once the wind power capacity 2,500 MVA has been reached on the basis of approval and quota decisions. Following the amendment to the Production Aid Act, the total capacity of wind power plants will no longer be released for re-use. The approval of a wind power plant for a total capacity in accordance with the feed-in tariff scheme (2,500 MVA) requires a quota decision. The quota decisions are in force only until 1 November 2017. The last quota decision was made in December 2016.

In August 2017, some 2,000 MVA of wind power had been approved for the feed-in tariff scheme. Due to amendments made to the Production Aid Act in 2015, the total capacity of wind power plants approved to the feed-in tariff scheme will not reach 2,500 MVA. The total capacity will be approximately 2,300 MVA.

Operating aid for renewable energy based on a tendering process will be introduced as a transition period solution. In 2018 to 2020, a tendering process that concerns electricity production of two TWh will be organised. The details of the tendering process will be published later.

Energy use in residential and other buildings

In the building sector, additional measures are under preparation. Nearly zero-energy (NZEB) regulations for new buildings will enter into force in 2018. According to the Government report on the National Energy and Climate Strategy for 2030 there is an obligation to blend 10 per cent of bioliquids into light fuel oil used for heating of buildings. A decision of the types of policy instruments which are going to be applied to fulfil this PAM have not been made yet. A commitment to phase out oil heating in the public sector is included in the Medium-term Climate Change Policy Plan.

Machinery

The Government report on the National Energy and Climate Strategy for 2030 includes an obligation to blend 10 per cent of bioliquids into light fuel oil used for machinery. A decision of the types of policy instruments which are going to be applied to fulfil this PAM has not been made yet.

Additional measures are included in the Medium-term Climate Change Policy Plan, mainly to improve energy efficiency. The measures include, for example, the following:

- Promotion of biogas in machinery
- Changes in the taxation of light fuel oil
- Promotion of energy efficient and low emission machinery through public procurements
- Promotion of energy efficient use of machinery through information and advisory action
- Strengthening of the information base related to machinery.

Phase-out of coal

The National Energy and Climate Strategy for 2030 outlines that Finland will phase out the use of coal for energy by 2030. No new power plants burning hard or brown coal will be built, nor will any replacement investments based on coal be made. Once the existing plants based on pulverised fuel combustion have been decommissioned, coal will only be used as a backup fuel in exceptional situations.

Table 4.3

Policies and measures according to the WM (marked with*) and WAM projections in the energy sector (excluding transport)

Name of policy or measure/mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of imple-mentation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact in kilotonnes CO_2 equivalent[1)]							
								1995	2000	2005	2010	2015	2020	2025	2030
* Implementation of the emission trade system in Finland	Increase in renewable energy (Energy supply), Efficiency improvement in industrial end-use sectors, reduction of GHG emissions (Industrial processes)	CO_2, N_2O	Economic, Regulatory	Implemented	This PaM is the implementation of the ETS in Finland and the object is reduction of greenhouse gas emissions. National implementation in Finland is carried out with national act of emission trade (311/2011) and degrees which are given under that act.	2005	Ministry of Economic Affairs and Employment	0	0	NA	NA	NA	NA	NA	NA
* Promoting wind power	Increase in renewable energy (Energy supply)	CO_2	Economic, Fiscal, Regulatory, Planning	Implemented	Measures implemented since 1996 include investment subsidies for wind power plants, electricity tax subsidies, feed-in tariff (since 2011), information measures, support for land-use planning and adjustment of land use and building act.	1996	Ministry of Economic Affairs and Employment, Ministry of the Environment, Regional councils, Municipalities	0	NA	NA	177	1,385	3,000	3,180	3,600
* Promoting wood chips	Increase in renewable energy (Energy supply)	CO_2	Economic, Fiscal, Information	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 Economic Affairs and Employment, Ministry of Agriculture and Forestry	NA	NA	NA	5,199	5,304	7,629	8,609	9,934
* Promoting biogas in electricity and heat production	Increase in renewable energy (Energy supply), Enhanced CH_4 collection and use (Waste), Improved treatment technologies (Waste)	CO_2, CH_4	Economic, Fiscal, Regulatory	Implemented	Measures implemented since 1997 include investment subsidies, electricity tax subsidies and feed-in tariff.	1997	Ministry of Economic Affairs and Employment, Ministry of the Environment	0	NA	NA	169	202	388	367	352
* Promoting solar power	Increase in renewable energy (Energy supply)	CO_2	Fiscal, Economic, Information	Implemented	Solar electricity self-consumers exempted from grid fees and electricity taxes up to 100 kVA system size or 800 MWh yearly production, investment subsidies for municipalities and companies, household tax deduction from solar system installation work and information mesasures.	2015	Ministry of Economic Affairs and Employment, Ministry of Finance	0	0	0	0	0	86	227	386

Table 4.3 Cont.

Name of policy or measure/mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of imple-mentation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact in kilotonnes CO_2 equivalent[1)]							
								1995	2000	2005	2010	2015	2020	2025	2030
* Act on Ecodesign and Energy Labelling (1005/2008, amendment 1009/2010)	Efficiency improvement of appliances	CO_2	Regulatory	Implemented	Improvement of energy efficiency of energy-using products by minimum efficiency requirements	2009	Ministry of Economic Affairs and Employment	0	0	0	NA	613	2,555	2,555	2,555
* Energy Audit Programme	Efficiency improvements of buildings, Efficiency improvement in services/ tertiary sector, Efficiency improvement in industrial end-use sectors	CO_2	Economic, Information	Implemented	Subsidies for energy audits in industry and in public and private services. Harmonised audit models. Qualification system for auditors. Quality control and monitoring of audits.	1992	Ministry of Employment and the Economy	61 (2)	437 (14)	734 (24)	683 (40)	561 (33)	326 (22)	277 (22)	322 (20)
* Energy Efficiency Agreements 1997-2007, 2008–2016 and 2017–2025 (Voluntary energy efficiency agreements)	Efficiency improvements of buildings, Efficiency improvement in services/ tertiary sector, Efficiency improvement in industrial end-use sectors, Reduction of losses (Energy supply), Efficiency improvement in the energy and transformation sector (Energy supply), Other energy consumption (processes)	CO_2	Voluntary/ negotiated agreements	Implemented	The agreements cover industry, energy sector, municipalities, private services, property and building sector and oil heated buildings. Energy Efficiency Agreements are described in the National Energy Efficiency Actionplan for Energy Efficiency Directive.	1997	Ministry of Employment and the Economy, Ministry of the Environment	0	841 (NA)	2,494 (NA)	4,179 (419)	6,321 (473)	7,912 (495)	7,841 (403)	8,415 (279)
* Consumer energy advice	Efficiency improvements of buildings, Efficiency improvement of appliances, Efficiency improvements in transport	CO_2	Information	Implemented	An energy advice infrastructure for consumers has been under construction since 2010. Regional projects are financed to provide advice through local events, personal advice and a national website.	2010	Ministry of Employment and the Economy	0	0	0	NA	NA	NA	NA	NA
* Act on energy certificates for buildings	Efficiency improvements of buildings, Information dissemination	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	NA
* Act on inspection of energy efficiency of cooling equipment for building, act (489/2007)	Efficiency improvements of buildings	CO_2	Regulatory	Implemented	Obligation to inspect cooling equipments to keep them energy efficient	2007	Ministry of the Environment	0	0	0	NA	NA	NA	NA	NA
* Building regulations (2003, 2008, 2010)	Efficiency improvements of buildings	CO_2	Regulatory	Implemented, expired (the policy is expected to continue to have an effect on greenhouse gas emissions)	Provides minimum standards for new buildings	2003	Ministry of the Environment	na	na	221 (17)	648 (26)	1,660 (35)	1,660 (35)	1,660 (35)	1,660 (35)

Table 4.3 Cont.

Name of policy or measure/mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of imple-mentation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact in kilotonnes CO_2 equivalent[1)]							
								1995	2000	2005	2010	2015	2020	2025	2030
* Renewed Building regulations (2012)	Efficiency improvements of 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	724 (15)	2166 (45)	3608 (75)	5050 (105)
* Information dissemination and campaigns targeted to residents and other users of buildings	Efficiency improvements of buildings, Demand management/reduction	CO_2	Information	Implemented	New energy regulations and other energy use related matters, retrofitting, renovating and maintaining buildings have been disseminated to both professionals and consumers through versatile means like seminars, building fair events, presentations, articles and webpages.	2001	Ministry of the Environment, The dedicated state owned company Motiva						NA	NA	NA
* Act (132/1999) and Decree (895/1999) on Land use and Building applied to reduce emissions due to land use and urban form	Demand management/ reduction	CO_2	Regulatory, Planning	Implemented	Regional and municipal planning are directed by national land-use guidelines. Land-use planning creates the preconditions for a sound and vital residential and living environment and supports the availability of services and transport. Finland's land-use planning system, defined by law, gives municipalities a high degree of autonomy in local land-use planning, which can also be used to reduce greenhouse gas emissions. The law specifies also the general conditions concerning building, further provisions are issued in the National Building Code.	1999	Ministry of the Environment	0	NA	NA	NA	NA	NA	NA	NA
* Ministry of the Environment Decree (4/13) on improving the energy performance of buildings undergoing renovation or alteration.	Efficiency improvements of buildings	CO_2	Regulatory	Implemented	Provides minimum standards for improving energy performance of buildings in renovations and alterations	2013	Ministry of the Environment	0	0	0	0	108 (17)	396 (57)	711 (91)	1049 (120)
* Decree on water measurement instruments	Efficiency improvements of buildings, Demand management/reduction	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)	33 (3)	51 (5)	68 (7)

Table 4.3 Cont.

Name of policy or measure/mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of imple-mentation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact in kilotonnes CO_2 equivalent[1)]							
								1995	2000	2005	2010	2015	2020	2025	2030
* Long term planned real estate maintenance	Efficiency improvements of buildings	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 implemen-tation, strengh-tening since 2000	Ministry of the Environment	0	0	0	NA	NA	NA	NA	NA
* Fresh grain silos (no energy used for drying)	Energy efficiency in agricultural sector	CO_2	Economic	Implemented	Support to fresh grain silos (drying of grain avoided)	2008	Ministry of Agriculture and Forestry	0	0	0	NA	NA	6	9	12
* Energy efficiency of unheated cattle buildings and heat recovery in pig farms	Energy efficiency in agricultural sector	CO_2	Economic	Implemented	Support to investments to unheated cattle buildings and heat recovery from pig slurry	2008	Ministry of Agriculture and Forestry	0	0	0	NA	NA	3	6	8
* Farm reparcelling to cut down energy use	Energy efficiency in agricultural sector	CO_2	Economic	Implemented	Support to farm reparcelling leading to reduced farm traffic	1995	Ministry of Agriculture and Forestry	NA	NA	NA	NA	NA	82	95	108
* Farm Energy Programme and energy advice to the farms	Energy efficiency in agricultural sector	CO_2	Economic, Information	Implemented	Subsidies for the preparation of Farm Energy Plans and for other energy advice.	2010	Ministry of Agriculture and Forestry	0	0	0	0	NA	6	9	10
Towards zero-energy buildings	Efficiency improvements of buildings	CO_2	Regulatory, Information	Adopted	The preparation for the regulation and information programme for moving towards nearly zero energy buildings	2018	Ministry of the Environment, A number of companies/ businesses/ industrial associations	0	0	0	0	0	NA	NA	NA
Promoting the use of bioliquids in machinery	Low carbon fuels	CO_2	Fiscal, Regulatory	Planned	An obligation to blend light fuel oil used in machinery with 10 per cent of bioliquids	2019	Ministry of Economic Affairs and Employment	0	0	0	0	0	0	100	200
Phasing out coal in energy production	Switch to less carbon-intensive fuels (Energy supply)	CO_2	Regulatory	Planned	A bill will be prepared for phasing out the use of coal for energy use. The bill shall take into account aspects related to the security of energy supply and emergencies.	2019	Ministry of Economic Affairs and Employment	0	0	0	0	0	0	0	600
Phasing out oil heating in public sector	Emission reductions in building-specific heating	CO_2	Other	Planned	Commitment to phase out oil heating in central government premises by 2025 and encouraging all public-sector operators to do the same	2021	Relevant ministries	0	0	0	0	0	0	130 (130)	130 (130)

Table 4.3 Cont.

Name of policy or measure/mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of imple-mentation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact in kilotonnes CO_2 equivalent[1)							
								1995	2000	2005	2010	2015	2020	2025	2030
Promoting the use of bioliquids in heating of buildings	Low carbon fuel	CO_2	Regulatory, Fiscal	Planned	An obligation to blend 10 % of bioliquids into light fuel oil used for heating of buildings. A decision of the types of policy instruments which are going to be applied to fulfill this PAM have not been made yet.	2019	Ministry of Economic Affairs and Employment	0	0	0	0	0	0	70	110
Promoting the use of biogas in agriculture	Increase in renewable energy	CO_2	Economic	Planned	The target is to replace fossil fuels with biogas in agriculture	2021	Ministry of Agriculture and Forestry	0	0	0	0	0	0	155	310
Improving energy effiency and promoting the use of alternative fuels in machinery	Reducing emissions from machinery by improving energy efficiency and promoting the use of alternative fuels or power sources	CO_2	Information, fiscal, other	Planned	Promoting the use of biogas in machinery, increasing the share of energy-efficient and low emission machinery through public procurement, promoting the energy-efficient use of machinery through information and training.	2021	Ministry of Environment	0	0	0	0	0	0	130	250

NA = Not available

1) The values in brackets are estimated impacts in the non-ETS sector.

During the current government term, a bill will be prepared for the transition period during which the use of coal for energy use is phased out. The bill will take into account aspects related to the security of energy supply and emergencies.

There has been a declining trend in the use of coal for energy for over 10 years, and the calculations of the basic scenario indicate that this trend continues. Without additional measures, the share of coal is estimated to be some 1 to 2 per cent of the total energy consumption, i.e. 3 to 7 TWh, in 2030.

Summary of policies and measures

A summary of the policies and measures in the energy sector is presented in Table 4.3.

4.5.2 Transport

Policies and measures in the WM projection

Policies and measures within the transport sector under the WM projection are outlined in Table 4.6 at the end of this section. The WM projection includes all measures that were in use in the transport sector to cut down the emissions in June 2016. 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 compared to 2005. The measures also contribute to achieving the EU's Effort Sharing Decision target.

The WM projection contains the following measures: 1) promoting the use of biofuels within the transport sector, 2) improving the energy-efficiency of vehicles, and 3) improving the energy-efficiency of transport system by promoting the choices of more environmentally friendly modes of transport and curbing the growth of vehicle kilometres. 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 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 greenhouse gas inventory. The methods used for impact assessment are documented in Finland's second National Energy Efficiency Action Plan (NEEAP 4).

Promoting the use of biofuels

The amendment to the national act on promoting the use of biofuels within the transport sector[40] came into force on 1 January 2011. The biofuel distribution obligation was six per cent for 2011 to 2014, followed by a phased increase to 20 per cent by 2020. 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.

In 2015, approximately 12 per cent of all transport fuels used were biofuels in actual terms. The measure achieved an estimated 1.5 million tonnes CO_2 reduction in transport-related greenhouse gas emissions in 2015. It is expected that biofuels will account for 20 per cent (double counting included) of all fuels consumed in transport in 2020. This would consist of first-generation biofuels (seven per cent of all road transport fuels sold) and second-generation biofuels (6.5 per cent of all road transport fuels sold). Bio-

40 446/2007

fuels would, in other words, replace 13.5 per cent of fossil fuels in transport in 2020, but as the contribution of second-generation biofuels is considered to be twice that made by other biofuels, the calculated share of all road transport biofuels would be 20 per cent. This means that the related emission reduction in the transport sector would be an estimated 1.6 to 1.7 million tonnes of CO_2 in 2020 depending on the eventual biofuels consumption.

In the Climate Policy Programme for the Transport Sector, the aim for improving the energy-efficiency of vehicles is that by 2020 specific emissions of new cars sold in Finland would be near the EU target (95 g/km; the current level in 2015 was at around 124 g/km and in 2016 around 121 g/km), and that the rate of vehicle fleet renewal would be around six to seven per cent a year. In the updated programme, the target is also that 50 per cent of new cars sold will be able to use alternative fuels in 2020.

The regulation of the European Parliament and of the Council[41] setting emission performance standards for new passenger cars (a binding CO_2 standard for passenger cars) entered into force in June 2009. The objective of the regulation is to establish manufacturer-specific emission performance standards for new passenger cars registered in the Community. It sets the target for the average CO_2 emissions for new passenger cars at 95 g/km by 2020. A corresponding regulation[42] for light commercial vehicles 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 Union. Furthermore, the European Commission has initiated the work for proposals for CO_2 emission targets for new cars for the period beyond 2020 until 2030. The Commission is also making preparations for legislation on monitoring and reporting of heavy-duty vehicle fuel consumption and CO_2 emissions.

In Finland, the tax on passenger vehicles consists of several elements that are differentiated according to vehicle-specific emissions (CO_2 g/km). Initially, at the event of the first registration, a one-time tax ("Car Tax") is paid. For that registration tax, the lowest tax rate (3.8 per cent) applies to cars with zero CO_2 emissions, while the highest tax rate (50 per cent) applies to cars with CO_2 emissions exceeding 360 g/km. Furthermore, the basic part of the vehicle tax, which is paid annually, is also differentiated according to CO_2 emissions of each vehicle similarly to the registration tax. This basic part of the emission-based annual vehicle tax is EUR 106 to 654 per year, depending on the car's specific CO_2 emissions. The second part of the annual tax is based on the type of fuel the cars uses. Petrol-fuelled cars have no additional tax. Cars fuelled with diesel, methane (LPG) or electricity have an additional annual tax (fuel fee) that is relative to the mass of the car ("mass in running order"), but not to the specific CO_2 rate itself. However, the CO_2 rate and vehicle mass have a certain correlation.

Finland has also been active to provide people with more information about the CO_2 emissions of passenger cars. Examples of this include the energy label for cars, the online car comparison engine produced by the Finnish Transport Safety Agency Trafi, which enables potential car buyers or used-car owners to compare different car models based on fuel consumption and CO_2 emissions[43] and the Choosing a Car website[44].

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 can be as much as 2.1 million tonnes in 2020.

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41 2009/443/EU
42 2011/510/EU
43 http://autovertaamo.trafi.fi/?lang=en
44 https://www.motiva.fi/ratkaisut/kestava_liikenne_ja_liikkuminen/nain_liikut_viisaasti/valitse_auto_viisaasti (only in Finnish)

During the period 2007 to 2015, the average CO_2 emissions of new cars decreased by some 30 per cent. The average CO_2 emissions in 2015 were 123 g/km for new petrol-driven passenger cars and 127 g/km for diesel-driven passenger cars (see Chapter 3, Figure 3.11). A total of some 109,000 new cars were sold in 2015 (the goal was 150,000). The emission reduction effects of new low-emission cars were estimated at approximately 0.2 million tonnes CO_2 in 2015 and 0.3 million tonnes CO_2 in 2016.

Improving the energy-efficiency of the transport system

According to the Climate Policy Programme for the Transport Sector, the energy efficiency in transport should be improved. This can be achieved through means such as energy efficiency agreements (2008–2016), eco-driving, and public sector vehicle and transport service procurement. Energy efficiency in the transport sector can also be improved by developing new services. Intelligent transport and the use of information technology (IT) will help to improve both the traffic safety and fluency as well as achieving the environmental targets in the transport sector. It also creates significant business opportunities for companies.

At the beginning of 2017, the energy efficiency agreements in the transport sector were substituted with the Responsibility Model[45], the target of which is to promote responsible and sustainable transportation. The Responsibility Model is a voluntary based management system taking into account finance, safety, quality and environmental aspects, including energy efficiency. The Responsibility Model has been developed by the transport administration in cooperation with the transport sector.

In 2013, the Ministry of Transport and Communication prepared a decree[46] on new maximum masses and dimensions of heavy goods vehicles and vehicle combinations. The decree raises the maximum allowed height of a vehicle from 4.2 to 4.4 meters and the maximum allowed mass from 60 to 76 tonnes. The decree entered into force on 1 October 2013. The goal of this update was to improve the energy efficiency in road freight transport and consequently to improve Finland's economic competitiveness as well. The update is also estimated to reduce the total CO_2 emissions in the transport sector by around 1.5 per cent annually.

According to the National Energy and Climate Strategy, the aim is to reduce the number of car journeys with no passengers but only the driver, and to halt the increase in the use of passenger cars in urban areas regardless of growth in population. For that aim, the current self-service market, where people own a vehicle and self-cater for their transport and mobility needs, has to be replaced by a service market, where people do not own vehicles anymore, but buy transport and mobility services.

In practice, the development of new service models and the revolution of the transport market will be promoted by reforming and relaxing the current legislation on the transport market through the introduction of a unified regulatory act (Transport Code). The Transport Code will provide a better response to user needs, facilitate companies' access to the market and promote the interoperability of different parts of the system. At the same time, the deployment of new technologies, digitalisation and new business concepts will be encouraged. The reform will be implemented in three stages. The first stage includes provisions on road transport and better interaction between all modes of transport. Later stages include provisions on air, sea and rail transport markets, as well as on transportation services. The first phase of the reform is intended to enter into force on 1 July 2018, to enable the transport sector to prepare for the new rules. The Transport Code envisages that essential data on transport services are made open, laying

45 https://www.trafi.fi/en/road/commercial_transport/responsibility_model_for_road_transport_enterprises
46 407/2013

down provisions for the interoperability of different ticket and payment systems. This is expected to facilitate combinations of different transport services.

Another measure to improve the energy efficiency of the transport system is to coordinate transport and land use as well as promote the conditions for walking, cycling and public transport, especially in urban areas. The target is a 30 per cent increase in the number of journeys taken by walking and cycling by 2030, and a notable reduction in the short-range car use.

Finland's Public Transport Act[47] was reformed in 2009 to comply with the requirements of the EU's 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 the transition period, competent authorities must organise public transport in their area. In the implementation of the Public Transport Act, particular attention is paid to introducing a nation-wide 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 passenger rate of public transport. The year 2016 was record breaking for public transport in large and mid-sized cities: the number of public transport journeys increased by as much as 14 per cent. A national strategy and implementation plan for the promotion of walking and cycling, covering the period 2011 to 2020, was released in 2011. This strategy is aimed at increasing the share of trips made walking or cycling. The target is that by 2020, the share of walking and cycling rises from the current 32 per cent to 35 to 38 per cent in the modal split, and the proportion of short trips made by passenger cars decreases correspondingly.

The popularity of public transport, walking and cycling is also promoted through Mobility Management, which was made a national-level project in 2010. Mobility Management is a broad concept, the objective of which is to reduce dependence on the private car for personal transport. The basic means of achieving this are offering better information about alternative transport modes and more attractive services. The central aim is to encourage actors that generate traffic to develop various ways to promote public transport, cycling, walking, car pooling and car sharing. The Mobility Management work at the regional level has been supported through R&D calls for projects, and through a EUR 0.9 million appropriation included in the 2015 and 2016 Budgets.

Policies and measures in the WAM projection

Table 4.6 sets out the main policies and measures included in the WAM projection for the transport sector. The WAM projection is based on the National Energy and Climate Strategy for 2030 and contains the following measures: 1) promoting the use of biofuels in the transport sector (additional measure), 2) improving the energy-efficiency of vehicles (additional measures), and 3) improving the energy-efficiency of the transport system (additional measure).

Promoting the use of biofuels (additional measure) includes increasing the physical share of biofuel energy content in all fuels sold for road transport (30 per cent by 2030). It has been estimated that the additional potential emission reduction effects of the use of biofuels in the transport sector will be as much as 1.5 million tonnes CO_2 by 2030.

Improving the energy-efficiency of vehicles (additional measures) includes very stringent CO_2 standards for new cars and light commercial vehicles (i.e. reaching 64 g CO_2/km for cars and 106 g CO_2/km for light commercial vehicles in 2030). It has been estimated that the emission reduction effects of improving the energy-efficiency of vehicles will total around one million tonnes CO_2 by 2030.

47 869/2009

Improving the energy-efficiency of the transport system (additional measure) includes reducing the number of car journeys with only the driver, and to halt the increase in the use of passenger cars in urban areas regardless of a growth in population. It has been estimated that the emission reduction effects of improving the energy-efficiency of the transport system will be as much as 0.3 million tonnes CO_2 by 2030.

Summary of policies and measures

A summary of the policies and measures in the transport sector is presented in Table 4.6.

4.5.3 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. At the ICAO Assembly in October 2016, a global carbon offsetting scheme for international aviation was adopted. By this decision, aviation became the first industrial sector to have a global market-based measure scheme in place. Under the Carbon Offsetting Scheme for International Aviation (CORSIA), aircraft operators will be required to purchase offsets for the growth in CO_2 emissions covered by the scheme. CORSIA aims to address any annual increase in total CO_2 emissions from international civil aviation above 2020 levels.

In July 2011, 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 regulation has 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. These measures were implemented in the national legislation[48] of Finland at the end of 2014. The impacts of these measures on the emissions of ships have not yet been evaluated.

At EU level, the Regulation on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport (MRV Regulation)[49] entered into force in 2015. In August 2017, companies shall submit ship-specific monitoring plans to verifiers for approval. The first monitoring year will be 2018. From 2019, by 30 April each year, companies shall submit to the Commission verified annual emission reports. Aviation has been included in the EU emissions trading scheme (EU ETS) since 2012. Between 2013 and 2016, the EU ETS covered flights between aerodromes located in the member states of the European Economic Area. In February 2017, the European Commission proposed to continue the intra-EEA scope beyond 2016.

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. Anyway, 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.

48 1113/2014
49 2015/757/EU

Table 4.6
Policies and measures according to the WM (marked with *) and WAM projections in the transport sector

Name of policy or measure/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	Estimate of mitigation impact in kilotonnes CO_2 equivalent							
								1995	2000	2005	2010	2015	2020	2025	2030
* Promoting biogas in road transportation	Low carbon fuels/electric cars	CO_2, CH_4	Fiscal	Implemented	Biogas in road transportation is excise duty free.	2011	Ministry of Finance	0	0	0	0	NA	8	14	25
* Promoting the use of biofuels in the transport sector	Low carbon fuels	CO_2	Regulatory, Fiscal	Implemented	The annual minimum share of biofuels, measured from the total energy content of petrol, diesel and biofuels delivered for consumption shall be 6 per cent in 2011–2014 and then be gradually raised to 20 per cent in 2020. This includes so-called double-counted biofuels, the actual share of biofuels is estimated to be 13.5 per cent in 2020. Biofuels are also promoted through tax subsidies.	2008	Ministry of Employment and the Economy, Ministry of Finance	0	0	0	700	1,554	1,520	1,467	1,436
* Improving the energy-efficiency of vehicles	Efficiency improvements of vehicles	CO_2	Regulatory, Fiscal, Information	Implemented	The target is, that specific emissions of new cars sold in Finland would be near the EU objective (95 g/km) in 2020; the rate of vehicle fleet renewal would be around 7 per cent (150,000 new cars) a year, 50 per cent of new cars sold would be able to use alternative fuels. There are three main measures to get to these targets: 1) EU-legislation, 2) the Finnish taxation (car tax, annual vehicle tax and fuel tax) and 3) information steering. The target group is the buyers of a new car.	2008	Ministry of Transport and Communications, Ministry of Finance	0	0	0	NA	232	545	837	907
* Improving the energy-efficiency of transport system	Modal shift to public transport or non-motorized transport, Demand management/reduction	CO_2	Regulatory, Information, Planning, Economic	Implemented	The objective is that in 2020 100 million more journeys are made by public transport and 300 million more on foot or by bicycle than at present, which means an increase of about 20 per cent in the numbers of these journeys.	2009	Ministry of Transport and Communications, Municipalities	0	0	0	NA	NA	300	NA	NA

Table 4.6 Cont.

Name of policy or measure/mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of implementation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact in kilotonnes CO_2 equivalent							
								1995	2000	2005	2010	2015	2020	2025	2030
* Improved regulation of the development of major retail centres	Demand management/ reduction	CO_2	Regulatory, Planning	Implemented	Strenghtening of available policy instruments in the land use and building act to avoid disruptive land-use development and increased transportation needs due to construction of retail centres based on private car transportation	2000	Ministry of the Environment, Regional councils, Municipalities	0	0	NA	NA	NA	NA	NA	NA
Promoting the use of biofuels in the transport sector	Low carbon fuels	CO_2	Regulatory	Planned	The target is to increase the physical share of biofuel energy content in all fuels sold for road transport to 30 per cent by 2030	2019	Ministry of Economic Affairs and Employment	0	0	0	0	0	NA	637	1,476
Improving the energy-efficiency of vehicles	Efficiency improvements of vehicles	CO_2	Regulatory	Planned	The target is to influence the drafting of EU legislation applicable to car manufactures in order to achieve very stringent CO2 standards for cars and light commercial vehicles, so that the specific consumption and emissions of new cars and vans will be reduced by approximately 30% from their 2020 levels by 2030. Estimated mitigation impact also includes the National Energy and Climate Strategy for 2030 goal to have a minimum of 250,000 electric and 50,000 gas-powered vehicles on the roads in 2030.	2019	Ministry of Transport and Communications	0	0	0	0	0	NA	403	978
Improving the energy-efficiency of transport system	Modal shift to public transport or non-motorized transport, Demand management/reduction	CO_2	Regulatory	Planned	The aim is to reduce the number of solo car journeys and to halt the increase in the transport performance of cars in urban areas regardless of a growing population by promoting the conditions for walking, cycling, public transport and new travel services, especially in urban areas. The target is at a 30 per cent increase in the number of journeys taken by walking and cycling by 2030.	2019	Ministry of Transport and Communications	0	0	0	0	0	NA	214	301

NA = not available

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

As a member of the European Union, Finland is implementing the EU ETS for aviation. In 2016 Finland issued 493,036 aviation emission allowances free of charge to aircraft operators administered by the Finnish Transport Safety Agency and sold 110,500 aviation emission allowances at the common auction platform. Intra-EEA emissions of aircraft operators administered by Finland amounted to 988,675 tonnes of CO_2 in 2016. The Ministry of Transport and Communications is actively involved in EU policymaking to enhance the effectiveness of the EU ETS for aviation.

As a Member of the EU and European Civil Aviation Conference ECAC, Finland has submitted its State Action Plan for International Aviation CO_2 Emissions in order to communicate to ICAO information on Finland's activities to address CO_2 emissions from international civil aviation.

Policies and measures in the WAM projection

The Directive of the European Parliament and of the Council on the deployment of alternative fuels infrastructure entered into force in October 2014[50]. According to the Directive, all Member States must draft a national policy framework for the development of an alternative transport fuel market and deployment of a related infrastructure by November 2016. The national policy framework must specify the alternative transport fuels and their distribution infrastructure targets for 2020 and 2030 as well as the measures by means of which the targets will be achieved.

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.

The working group's proposal for a plan for a distribution network for alternative transport fuels was published in November 2016. According to the proposal, in maritime transport the objective is to decrease greenhouse gas emissions by 40 per cent by 2050 (compared to 1990) with measures including the use of LNG (liquefied natural gas) and biofuels. In aviation the objective is 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.

At IMO member states have come to an agreement on a three-step approach to decreasing greenhouse gas emissions from international shipping. The first step is to compile data on fuel consumption, following the mandatory data collection system (DCS). The second step is to analyse the data and the third step is to consider how to reduce GHG emissions from international shipping. During the Marine Environment Protection Committee session (MEPC70) in 2016 IMO member states also approved a Roadmap for Developing a Comprehensive IMO Strategy on Reduction of GHG emissions from Ships. The Strategy should be finalised by MEPC72 in 2018. According to the Roadmap, by 2023 IMO member states should come to an agreement on a final strategy on short, medium, and long-term measures, taking into account the results from the IMO Data Collection System.

The Black Carbon (BC) emissions also have a huge impact on climate change, especially in the polar areas. Finland is committed to decreasing BC emissions in the polar regions and supports legally binding regulations on black carbon that are currently

50 2014/94/EU

lacking in the Polar Code. The Finnish Transport Safety Agency Trafi together with the Finnish Meteorological Institute (FMI) and VTT Technical Research Centre of Finland Ltd are conducting studies to test the candidate measuring methods and collect data on BC emissions from shipping. Preliminary results are introduced in IMO, but more research work is needed before any regulations to limit BC emissions can be considered.

Summary of policies and measures

A summary of the policies and measures for international bunkers is presented in Table 4.7.

4.5.4 Industrial processes and product use

The most significant CO_2 emissions from industrial processes and product use are included in the EU ETS and are covered in Section 4.5.1. 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 and product use. Since 2013, nitric acid production is included in the EU ETS, and therefore, the mitigation impact of measures relating N_2O emissions has not been estimated for future years. Therefore, the policies and measures described in this section are those mitigating F-gases.

Policies and measures in the WM projection

The amount of emissions from F-gases (HFC, PFC, SF_6) was about three per cent of total emissions in 2015. 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 peak level of SF_6 emissions. The most important regulations affecting the amount of these gases are the F-gas regulation[51] and the directive relating to HFC emissions from air-conditioning systems in motor vehicles.[52] Also, technical development has affected the development of emissions. F-gases are not produced in Finland.

The WM projection for F-gases includes the impacts of the EC regulation and the EC directive referred to above. Emissions from refrigeration and air conditioning equipment are expected to decline due to measures and technical changes leading to smaller charges and decreased leakage implemented under these regulations. Key drivers of the F-gas regulation in cutting the emissions are the phase down of HFCs that can be placed on the EU market and the bans on the use of HFCs in different applications. They will lead to a replacement of HFCs with low GWP alternatives in most applications.

Emissions from electricity distribution equipment have declined heavily as a result of voluntary actions by the industries. Only a slight increase in emissions is assumed in the future but the peak level of emissions in the 1990s will not be reached. Restrictions forced by the EC regulation have a decreasing effect on emissions from foam blowing, aerosols and other sources. The emissions from foam blowing and aerosols are expected to decrease in the future. The emissions from other sources are expected to stay quite steady. Emissions from refrigeration and air-conditioning equipment account for more than 90 per cent of Finnish F-gas emissions, and therefore the projected overall emission trend is declining.

The mitigation measures have been able to cut the almost exponential increase in emissions from refrigeration and air-conditioning equipment that started in the mid-1990s.

51 2014/517/EC
52 2006/40/EC

Table 4.7
Policies and measures according to the WM (marked with *) and WAM projections for international bunkers

Name of policy or measure/mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of implemen-tation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact in kilotonnes CO_2 equivalent							
								1995	2000	2005	2010	2015	2020	2025	2030
*Energy Efficiency Design Index (EEDI) for new ships; Ship Energy Efficiency Management Plans (SEEMP)	To save energy and reduce emissions	CO_2	Regulatory	Imple-mented	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	NA
*Aviation Emissions Trading	To reduce emissions	CO_2	Regulatory	Imple-mented	Aviation is included in EU emissions trading	2012	Ministry of transport and communications	0	0	0	0	NA	NA	NA	NA
*Maritime Transport MRV Regulation	To reduce emissions from international shipping	CO_2	Regulatory	Imple-mented	In order to reduce CO_2 emissions from shipping at EU level, a system for monitoring, reporting and verification (MRV) of CO_2 emissions based on the fuel consumption of ships has been set up as a first step of a staged approach for the inclusion of maritime transport emissions in the EU's greenhouse gas reduction commitment.	2015	Ministry Transport and Communications	0	0	0	0	NA	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, economic, information	Planned	The use of alternative fuels in marine transport is promoted.		Ministry of Employment and Economy, Ministry of Transport and Communications, Finnish Trasport Safety Agency Trafi	0	0	0	0	NA	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, Ministry of Transport and Communications, Finnish Trasport Safety Agency Trafi	0	0	0	0	NA	NA	NA	NA
Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)	To offset and reduce emissions	CO_2	Regulatory	Adopted	Global market-based measure scheme for international aviation was adopted in ICAO	2021	Ministry of Transport and Communications	0	0	0	0	0	0	NA	NA
Regulations on Black Carbon (BC)	Mitigate GHG-emissions and decrease BC emissions in the polar regions	BC	Regulatory	Planned	To introduce legally binding regulations on black carbon in the Polar Code.		Ministry of Transport and Communications	0	0	0	0	0	NA	NA	NA
IMO data collection system (DCS) and Roadmap for Developing a Comprehensive IMO Strategy on Reduction of GHG-emissions from Ships	To reduce emissions from international shipping	CO_2	Regulatory	Planned	To collect data on fuel consumption and consider measures to reduce GHG-emissions from international shipping.	2023	Ministry Transport and Communications	0	0	0	0	0	0	NA	NA

NA = not available

Policies and measures in the WAM projection

The WAM projection of F-gases is based on additional measures that are expected to promote the alternative low GWP non-HFC technologies in the refrigeration and air conditioning equipment sector in addition to the F-gas regulation. These additional measures include criteria for public procurement that are related to F-gases and information and education campaigns.

It is estimated that the emission reduction achieved by these additional measures will be 0.3 million tonnes CO_2 eq. in 2030.

Summary of policies and measures

A summary of the policies and measures in the industrial processes and product use sector is presented in Table 4.8.

4.5.5 Agriculture

Policies and measures in th WM projection

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.

Some of the effective climate policy measures may conflict with agricultural policy objectives and measures, such as securing the availability of food and animal welfare and reducing the 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 14 per cent over the period 1990 to 2015 mainly due 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.

There are measures in the CAP aiming to reduce greenhouse gas emissions. The agri-environmental payment programme has been part of the Rural Development Programme for Mainland Finland[53] 2007 to 2013. In the new Rural Development Programme for Mainland Finland 2014 to 2020 the agri-environmental payment programme is replaced by environmental compensation payments. They are essential tools for promoting sustainable development in agriculture, and 86 to 90 per cent of Finnish farmers have participated in them.[54] Their objectives are to decrease the 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 and other air emissions as well as to adapt to climate change. One measure to reduce emissions from organic soils is support to long-term cultivation of grass on organic soils.

53 The programme covers the territory of Finland excluding the Åland Islands.
54 Rural Development Programme for Mainland Finland 2014–2020 is based on a European Parliament and Council Regulation (EU) no 1303/2013 and 1305/2013)

Table 4.8
Policies and measures according to the WM (marked with *) and WAM projections in the industrial processes and product use sector

Name of policy or measure/mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of imple-mentation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact in kilotonnes CO_2 equivalent							
								1995	2000	2005	2010	2015	2020	2025	2030
*Revised Environmental Protection Act (423/2015) and the related Government Decree (766/2016)	Reduction of emissions of fluorinated gases, Replacement of fluorinated gases by other substances	HFC, PFC, SF_6	Regulatory	Imple-mented	National implementation of of the EU F-gas regulation 517/2014	2015	Ministry of the Environment	0	0	IE	IE	IE	IE	IE	IE
*Improved enforcement of F gas regulations	Reduction of emissions of fluorinated gases, Replacement of fluorinated gases by other substances	HFC, PFC, SF_6	Regulatory, Information	Imple-mented	Enhance cost-effective compliance monitoring: further support and information for inspectors, targeted information dissemination on new regulations to different groups of stakeholders	2015	Ministry of the Environment, Finnish Environment Institute, Finnish Safety and Chemicals Agency	0	0	IE	IE	IE	IE	IE	IE
*The EU-wide measures of Regulation 517/2014/EU	Reduction of emissions of fluorinated gases, Replacement of fluorinated gases by other substances	HFC, PFC, SF_6	Regulatory	Imple-mented	The EU-wide measures of regulation 517/2014 where no national implementation takes place (e.g. phase-down schedule on placing on the market of HFCs, enhanced leackage prevention and bans on certain equipment)	2015	Ministry of the Environment	0	0	IE	IE	IE	IE	IE	IE
*Aggregated impact of the policies and measures in the WM scenario		HFC, PFC, SF_6			Regulation 517/2014/EU replaced the first F-gas regulation 842/2006/EU that was adopted in 2006. The estimated aggregated impact includes also the effect of the regulation from 2006.	2006		0	0	745	1,008	1,423	1,821	2,259	2,763
Criteria for public procurement containing F-gases	Reduction of emissions of fluorinated gases, Replacement of fluorinated gases by other substances	HFC, PFC, SF_6	Information, Other	Planned	Criteria for public procurement containing F gases to promote the transition from HFC technologies to alternative low GWP technologies	2017	Ministry of Environment, Finnish Environment Institute	0	0	0	0	0	IE	IE	IE
Information and education campaign to promote alternative non-HFC technologies and recovery of F-gases	Reduction of emissions of fluorinated gases, Replacement of fluorinated gases by other substances	HFC, PFC	Information	Planned	Information and education campaign to promote alternative non-HFC technologies and recovery of F gases	2017	Ministry of the Environment, Finnish Environment Institute	0	0	0	0	0	IE	IE	IE
Aggregated impact of the policies and measures in the WAM scenario		HFC, PFC, SF_6						0	0	0	0	0	2	241	324

NA = not available
IE = included elsewhere

In the Rural Development Programme 2014 to 2020 there are several measures for climate change mitigation and adaptation: environment compensation payments for incorporation of slurry, recycling of nutrients and organic matter, environment management of grassland, cultivation of catch crops, plant cover on arable land in winter and use of organic mulch for horticulture crops and seed potato to increase the amount of carbon in arable soil. Agricultural investment aid can be targeted to controlled subsurface drainage and more efficient handling, storage and use of manure. There is also a support system for investments in renewable energy, for example, in biogas plants. As a part of the programme advisory services will be provided regarding the cross-compliance conditions, greening payments, climate change mitigation and adaptation, biodiversity, protection of water and soil, environment payments, maintaining agricultural land, organic production and issues related to environmental efficiency, including more efficient energy use and renewable energies. Implementation of the Rural Development Programme 2014 to 2020 started in 2015.

The Climate Programme for Agriculture ("Steps towards environmentally-friendly food")[55] was finalised in November 2014 and it is under implementation. The Climate Programme for Finnish Agriculture prepared by the Ministry of Agriculture and Forestry aims to further enhance the sustainability of the Finnish food system, which is founded on profitable food production and responsible consumption. By improving sustainability in a comprehensive way, it is also possible to increase the profitability of production. The objective is to improve the energy and material efficiency and reduce emissions per litre or kilogram of production. The Climate Programme for Finnish Agriculture presents a total of 76 measures to facilitate the adaptation of food production and consumption to climate change and/or to mitigate the climate change. Key measures identified in the Climate Programme for mitigation are carbon sequestration into soil, measures relating to the use of peatlands, handling and treatment of manure, more accurate nitrogen fertilization, improvements in energy efficiency, and production and consumption of renewable energy.

Making use of the agricultural nutrients project[56] is a three-year pilot programme (2016 to 2018). This programme is part of the government key project for the circular economy, introduced in the government programme. It conveys information on the funding possibilities related to the recycling of nutrients and essential research knowledge to practical operators. It identifies the bottlenecks in nutrient recycling and facilitates their elimination as well as promotes the networking and new experiments of nutrient recycling operators. It is also possible to fund advanced nutrient recycling investments.

The Rural Development Programmes for Mainland Finland have been the main instruments to implement climate change mitigation and adaptation measures in the agriculture sector. Rural Development programmes are evaluated as defined in the Parliament and Council regulation[57]. At programme level Finland has defined an evaluation plan and an implementation plan for evaluating climate change issues.

Policies and measures in the WAM projection

New measures are identified in the Medium-term Climate Change Policy Plan. The Sector Plan for agriculture includes activities relating to reducing emissions from organic soils, for example, intensification of long-term grass cultivation and afforestation on organic soils. There are also new measures to replace fossil fuels with biogas in agriculture.

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55 http://mmm.fi/documents/1410837/1867349/Climate_programme_agriculture_WEB_03072015.pdf/1a6f135c-068c-48aa-ad00-787562628314
56 http://mmm.fi/en/recyclenutrients
57 1305/2013/EU (rural development regulation)

Summary of policies and measures

A summary of the policies and measures in the agriculture sector is presented in Table 4.9.

4.5.6 Land use, land-use change and forestry

Policies and measures in the WM projection

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

- Conserving and enhancing carbon storages and sinks
- Creating new carbon storages and sinks
- Substitution, i.e. replacing fossil-based energy, raw materials and products with renewable 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 to 2015, it was between 12.4 and 38.0 million tonnes CO_2 eq. In 2015, the net sink was 26.0 million tonnes CO_2 eq.

The largest sink in the LULUCF sector is forest land. The tree growth removes more CO_2 from the atmosphere than is released as the result of harvesting and natural mortality. In 2015, the net removals were 30.3 million tonnes CO_2 eq. These net removals have varied much annually, from 19.3 to 51.3 million tonnes CO_2 eq. during the period 1990 to 2015. The interannual 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 105 million cubic metres, of which 99 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 Strategy 2025 (NFS), financial support and extensive public forestry organisations. For more information on these, see Section 4.4.

The studies by the Finnish Natural Resources Institute (Luke) indicate that Finnish forests will act as a net sink in the future, too. The objective for the forests' carbon sink (incl. trees and soil) set out in the NFS is to maintain the sink at a level of at least 13.5 to 20 million tonnes CO_2 eq. per year up to 2025. The harvesting of wood is targeted to increase by 10 to 15 million cubic metres a year. The objectives and measures in the National Energy and Climate Strategy for 2030 are consistent with the policy defined in the NFS 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.[58] The global economic development will greatly influence the achievements of the NFS goals.

The national measures are set out in the NFS59. The measures, consistent with the National Energy and Climate Strategy for 2030, include implementing the following strategic projects in order to secure the climatic advantages provided by forests and to ensure the availability of renewable raw materials:

- Forest-related information and e-services of the future. The project will develop a next-generation forest related information system and a process for keeping the information resources up to date.
- Statistics on the renewing forest-based business and activities. Collection of statistics on the interfaces between the forest, energy and chemical industries, nature tourism,

58 2001/77/EC and 2009/28/EC
59 http://mmm.fi/en/nfs

Table 4.9

Policies and measures according to the WM (marked with *) and WAM projections in the agriculture sector

Name of policy or measure/mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of imple-mentation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact in kilotonnes CO_2 equivalent							
								1995	2000	2005	2010	2015	2020	2025	2030
*Implementation of the Nitrates Directive (1991/676/EEC)	Reduction of fertilizer/manure use on cropland, Improved animal waste management systems	N_2O	Regulatory	Imple-mented	Decreases greenhouse gas emissions and the use of mineral fertilisers.	2014	Ministry of Agriculture and Forestry	0	0	0	0	NA	NA	NA	NA
*Implementation of Common Agricultural Policy: EU direct payments	Activities improving grazing land or grassland management, Improved management of organic soils	CH_4, N_2O	Economic, Regulatory	Imple-mented	As from 2015 new environmental requirements have been incorporated into the single payments under the Common Agricultural Policy of the EU. 30 per cent of the direct payments are tied to the so-called greening. There are three greening measures that the farmers must implement in their eligible area: crop diversification, preserving permanent grassland and requirement concerning ecological focus area.	2014	Ministry of Agriculture and Forestry	0	0	0		NA	NA	NA	NA
*Implementation of Common Agricultural Policy: The Rural Development Programmes for Mainland 2014–2020 (Regulation (EU) no 1303/2013 and 1305/2013)	Reduction of fertilizer/manure use on cropland, Improved livestock management, Improved animal waste management systems, Activities improving grazing land or grassland management, Improved management of organic soils	CH_4, N_2O	Economic, Regulatory	Imple-mented	"The Rural Development Programme for Mainland Finland 2014-2020 is an essential tool for promoting sustainable development in agriculture. Environmental compensation payments are part of the programme. Agri-environmental payment programme covers about 86 per cent of farms in Finland. 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. Measures: environment management of grasslands: riparian zones, perennial environment grasslands, nature management field grasslands, controlled subsurface drainage investments and management measures for them."	2014	Ministry of Agriculture and Forestry	0	0	0	0	NA	NA	NA	NA
*Climate Programme for Finnish Agriculture – Steps Towards Climate Friendly Food	Reduction of fertilizer/manure use on cropland, Improved livestock management, Improved animal waste management systems, Activities improving grazing land or grassland management, Improved management of organic soils, Increase in renewable energy (Energy supply), Efficiency improvement in the energy and transformation sector (Energy supply), Prevention of deforestation (LULUCF), Multi-sectoral policy	CO_2, CH_4, N2O	Information, Research, Economic, Regulatory	Imple-mented	The Climate Programme for Finnish Agriculture presents a total of 76 measures to facilitate the adaptation of food production and consumption to climate change and/ or to mitigate the change. The selection of the measures was based on the most recent scientific research results and views of various experts involved in the food system. By implementing the measures put forward in the programme we will achieve more climate friendly food production and consumption.	2014	Ministry of Agriculture and Forestry	0	0	0	0	NA	NA	NA	NA
Activities of organic soils	Additional activities improving grassland management, improved management of organic soils, afforestation	N_2O	Economic	Planned	The target is to reduce emissions from organic soils (long term grass cultivation and afforestation)	2021	Ministry of Agriculture and Forestry						0	225	450
Promoting the use of biogas	Increase in renewable energy	CH_4	Economic	Planned	The target is to replace fossil fuels with biogas in agriculture	2021	Ministry of Agriculture and Forestry	0	0	0	0	0	0	25	50

NA = not available

forestry-related services and other forest-based business and ecosystem services will be improved.
- Development of active forest management, entry of timber to the market and forest ownership structure. Underpinned by studies, forestry taxation and legislation will be developed to support active forest management, entry of timber to the market and a change in the forest ownership structure.
- New incentive schemes and resource-efficient forest management. The project will prepare a future incentive scheme for forest management that promotes active and resource efficient forest use and welfare derived from non-market benefits.

With regard to agricultural soils, CO_2 emissions and removals from croplands and grasslands are not expected to be subject to large changes in the WM projection by 2030. The CO_2 emission reductions due to increasing the area of perennial crops on organic soils and due to other measures in the Rural Development Programme (see Section 4.5.5) are presented in Table 4.10 below.

Policies and measures in the WAM projection

For cropland and grassland the measures in the National Energy and Climate Strategy for 2030 include developing farming to increase sinks and launching a relating pilot project, developing measures to monitor soil carbon sequestration in agricultural soils and studying the influence of CAP to soil carbon and prepare proposals how in the renewal of CAP, farmers could be encouraged to increase sinks.

Measures which are identified in the Medium-term Climate Change Policy Plan relating to reducing emissions from organic soils from the agriculture sector also have effects on emissions from the LULUCF sector.

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) was voluntary for Parties during the first commitment period. During the second commitment period, forest management (FM) has become a mandatory activity. Finland had elected to apply FM already in the first commitment period but has not elected other voluntary activities for neither commitment period. The accounting for the emissions and removals under Article 3, Paragraphs 3 and 4 was be done at the end of the first commitment period, and will be done so also for the second commitment period.

Based on a study by the Natural Resources Institute (Luke), Article 3.3 activities are estimated to cause net emissions for the period 2013 to 2020. 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 2012-to 2015, the emissions were, on average, 3.2 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, agriculture and infrastructure (e.g. roads and transmission lines). The emissions under Article 3.3, estimated to be around 24 million tonnes for the whole commitment period, will be subtracted from Finland's assigned amount at the end of the commitment period.

The FM net sink between 2013 and 2015 has been approximately 53.3 million tonnes CO_2 eq. per year. These net removals for FM include the net removals from harvested wood products, which were have been, on average, 18.1 million tonnes during

2013 to 2015. Net removals from forest management vary significantly based on the overall economic situation. The NFS estimates that the annual carbon sink of forests (incl. trees and soil but excl. HWP) will remain at a level of at least 13.5 to 20 million tonnes CO_2 eq. by 2025 if logging increases by 10 to 15 million cubic metres a year, as is currently projected. The policy defined in the NFS regarding the increase in industrial roundwood and energy wood is consistent with the National 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.

The net emissions from FM will be compared to the reference level established for Finland (−20.466 million tonnes CO_2 eq.) in decision 2/CMP.2 adjusted with the technical correction (−13.583 million tonnes CO_2 eq. in Finland's latest inventory submission). A higher sink will result in RMU units which can be used to meet the reductions target, a lower sink will mean subtraction of assigned amount units equal to the difference between FM and reference level removals. Additional RMU units can be received only up to a value of 3.5 per cent of the 1990 national total emissions without the LULUCF sector. Finland's cap value for the FM sink is −19.978 million tonnes CO_2 eq. Based on the recent inventory data, it is likely that Finland can issue RMU units equal to this value at the end of the commitment period. However, due to pending technical corrections to the reference level and uncertainties in the harvesting amounts, this estimate is still uncertain.

The information provided in Section 4.4 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.

Summary of policies and measures

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

4.5.7 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,[60] Waste Directive[61] and Waste Framework Directive.[62] The first Waste Tax Act[63] 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[64] 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[65] regarding what to include in the waste list. The industrial landfills are under

60 1999/31/EC
61 2006/12/EC
62 2008/98/EC
63 495/1996
64 1126/2010
65 2000/532/EC

Table 4.10
Policies and measures according to the WM (marked with *) and WAM projections in the LULUCF Sector

Name of policy or measure/mitigation action	Objective and/or activity affected	GHG(s) affected	Type of instrument	Status of imple-mentation	Brief description	Start year of imple-mentation	Implementing entity or entities	Estimate of mitigation impact in kilotonnes CO_2 equivalent							
								1995	2000	2005	2010	2015	2020	2025	2030
*National Forest Strategy 2025	Conservation of carbon in existing forests, Enhancing production in existing forests, Increasing the harvested wood products pool, Enhanced forest management, Strengthening protection against natural disturbances, Substitution of GHG-intensive feedstocks and materials with harvested wood products. Contribute to increase in renewable energy supply (Energy)	CO_2, CH_4, N_2O	Economic, Regulatory, Fiscal	Imple-mented	The National Forest Strategy's (NFS) vision is to create welfare through sustainable forest management. It has the strategic objectives to improve competitive operating environment for forest-based business, to renew and diversify forest-based business and activities, and to enhance active, economically, ecologically and socially sustainable and diverse use of forests. Implementation of the Bioeconomy Strategy and the Energy and Climate Strategy has substantial links with achieving the objectives of the NFS.	2015	Ministry of Agriculture and Forestry	0	0	0	0	0	NA	NA	NA
Activities of organic soils	Additional activities improving grassland management, improved management of organic soils, afforestation	CO_2	Economic	Planned	The target is to reduce emissions from organic soils (long term grass cultivation and afforestation)	2021	Ministry of Agriculture and Forestry	0	0	0	0	0	0	570	1,140

NA = not available

taxation as well. The waste tax was EUR 40 per tonne in 2011 and EUR 50 per tonne in 2013. In 2015 it was raised to EUR 55 per tonne[66], and in 2016 to EUR 70 per tonne.

Enforcement of the Waste Act[67] and the Decree on Waste[68] will continue to increase recycling and recovery, thus further replacing landfilling, and will contribute to reducing greenhouse gas emissions as well. The Decree on Packaging and Packaging Waste[69] is also intended to increase recycling. The restrictions on landfilling of biodegradable municipal waste have been made stricter over a number of years. The Decree on Landfills[70] generally restricts the amount of biodegradable and other organic waste to less than 10 per cent total organic carbon (TOC) after 2016 except for building waste where the 10 per cent rule enters into force in 2020. From 2016 until the end of 2019, the limit value for organic carbon content in building waste is set to 15 per cent. These restrictions are expected to increase incineration of waste from current levels. According to the National Energy and Climate Strategy for 2030, additional efforts will be taken to enforce the restrictions on the landfilling of biodegradable waste.

The monitoring of the effectiveness of the policies and measures affecting waste are based on statistics and modelling that follows 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 1990 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 1990 would represent the average emission level without measures. This assumption is conservative as the amount of waste would probably have changed and the gradual accumulation of waste would have increased CH_4 emissions. The average emissions from the waste sector in 1990 to 1995 were approximately 4.7 million tonnes CO_2 eq but by 2010 significant reductions of more than 2 million tonnes CO_2 eq had been achieved.

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 were 54 per cent lower in 2015 than in 1990 and will decrease further in the WM projection (See Chapter 5, 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 WAM projection, has now been included in the WM projection, leading to an additional reduction in emissions relative to those reported earlier. Currently no additional measures are scheduled for the waste sector. Hence, there is no separate WAM projection.

Summary of policies and measures

A summary of the policies and measures in the waste sector is presented in Table 4.11.

66 1072/2014
67 646/2011
68 179/2012
69 518/2014
70 331/2013

Table 4.11
Policies and measures according to the WM (marked with *) and WAM projections in the waste Sector

Name of policy or measure/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	Estimate of mitigation impact in kilotonnes CO_2 equivalent							
								1995	2000	2005	2010	2015	2020	2025	2030
Government decision on packaging and packaging waste 962/1997, 1025/2000, 987/2004, 817/2005, 2014/518*	Demand management / reduction, Enhanced recycling, Waste incineration with energy use, Reduced landfilling	CO_2, CH_4	Regulatory	Implemented	The Decision is specifying the criteria and markings on packaging waste. It is basically regulatory, but also economic by specifying the system for handling packaging waste. The key actor is the Environmental Register of Packaging PYR Ltd, which is a non-profit firm, operating in conjunction with producer organisations in the packaging sector. It helps firms registered with PYR and the authorities to fulfil packaging recovery obligations economically and easily.	1997	Ministry of the Environment	0	IE	IE	IE	IE	IE	IE	IE
Government decree on landfills (861/1997, revised 2006), Biowaste strategy (2004)*	Demand management /reduction, Enhanced recycling, Reduced landfilling, Enhanced CH4 collection and use, Improved treatment technologies	CH_4	Regulatory	Implemented	Regulation on biodegradable waste	1997	Ministry of the Environment, Regional and local environmental authorities	0	IE	IE	IE	IE	IE	IE	IE
General reform of waste legislation; Act on Waste (646/2011); Decree on Waste (179/2012); Waste Tax Act (1126/2010)*	Demand management / reduction, Enhanced recycling, Enhanced CH_4 collection and use, Improved treatment technologies, Improved landfill management, Waste incineration with energy, Reduced landfilling	CO_2, CH_4	Regulatory, Economic, Information, Planning	Implemented	The reform provides the basis for more effective waste management with respect to recycling, reduced landfilling of organic waste, enhanced collection of CH_4 and regulated incineration, all contributing to reduced greenhouse gas emissions. The reform combines all different types of policy instruments from planning (mandatory waste plans) to regulation (basis for restrictions on landfills) and economic instruments (waste tax).	2012	Ministry of the Environment, Regional and local environmental authorities	0	0	0	0	IE	IE	IE	IE
New Decree on Landfills (331/2013)	Improved landfill management, Reduced landfilling	CH_4	Regulatory	Adopted	Regulation on landfills setting quantitative limits on amount and proportion of organic waste in land fill waste. Implementing and going beyond landfill directive.	2016	Ministry of the Environment, Regional and local environmental authorities	0	0	0	0	0	IE	IE	IE
Agregated impact of the above policies and measures		CO_2, CH_4						75	821	1,848	2,088	2,538	2,870	3,166	3,361

IE = included elsewhere

4.5.8 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 significant solutions that concern cutting emissions in the urban structure are associated with sustainable urban development: the urban structure and effective functioning of urban subregions, coordination of land use and transport, creating preconditions for renewable energy production and enabling a low-emission lifestyle. In urban subregions, the preconditions for this include good public transport services and a network of pedestrian and cycling routes, a living and well-functioning city centre and good accessibility of recreational and green areas. Effective urban subregions are a prerequisite for a thriving business life and Finland's competitiveness. There may be significant differences between the practical solutions used to reduce emissions in different parts of the country.

Preconditions for increasing wind power production include coordinating wind power construction with land use in the surrounding areas, giving sufficient consideration for negative impacts and ensuring local acceptability. In order to promote planning, the Land-Use and Building Act contains specific provisions on local master plans that apply to wind power construction directly. Rapid progress has been made in recent years in land-use planning for wind power construction. An amendment to the Land-Use and Building Act (1.4.2017) for the installation and construction of solar panels and solar collectors harmonises and streamlines the permit procedure so that permit consideration would only be required for solar panels or collectors that have significant impacts on the townscape or the environment.

The most recent National Energy and Climate Strategy for 2030 includes policy objectives that aim to minimise greenhouse gas emissions related to land use and the urban structure.

The National Energy and Climate Strategy for 2030 specifies the following policy objectives in relation to the spatial structure and related land-use planning:

- The effectiveness of land use and mobility in urban subregions will be promoted by developing legislation and the land-use planning system, by updating the national land use objectives, and through agreements between the central government and municipalities. Transport infrastructure implementation will be linked to land-use planning and construction with the aim of reducing emissions.
- In growing urban subregions, new construction will primarily be directed to areas with existing services and public transport. Outside growing urban centres, land use steering will be developed taking into account the need to develop areas, new trends of the natural resources economy and the strive for local energy production. Rural centres and villages will be strengthened to safeguard the local availability of services.
- In land-use planning and construction, and when making efforts to develop the steering of these sectors, preparation is made for utilising solar power.

In land-use planning, Finland will prepare to utilise extensively the country's wind power potential. In order to minimise the negative impacts of wind power plants, an effort will primarily be made to centralised wind power construction in large units at a sufficient distance from permanent housing.

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 in the energy sector, for example, through its effects on transport and the heating of buildings. 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.

4.6 Energy taxation and related measures

4.6.1 Energy taxation

Energy taxes are a substantial revenue source for the Government. They generate around EUR 4,600 million annually, or more than 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, local emissions and sulphur content of fuels (see Table 4.12 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 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 gas oil, biofuel and heavy fuel oils and electricity used for agricultural purposes. The CO_2 component is based on the lifetime 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.

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 health 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 the EU Directive[71] on the promotion of clean and energy-efficient road transport vehicles.

Energy taxation rules include exemptions and reduced tax rates resulting in tax expenditure. Fuel for commercial aviation and shipping are not taxed. Peat is taxed at a lower rate.

In transport, diesel fuel accounts for more than 50 per cent of CO_2 emissions and energy content. Diesel and corresponding biofuels are taxed at lower rates than gasoline and corresponding biofuels, leading to a tax expenditure compared to the taxes levied on gasoline. To compensate the difference, an annual propelling force tax is levied on diesel passenger cars and vans. 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.

71 2009/33/EC

Table 4.12
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	Electricity, I[4]	Electricity, 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	–	–	–
1.1.2014	66.61	49.31	15.99	18.93	131.53	11.38	4.9	1.89	0.69			
1.1.2015	67.45	50.26	18.39	21.84	153.24	15.36	3.4	2.24	0.69			
1.1.2016	67.45	50.26	21.05	25.08	177.36	17.34	3.4	2.24	0.69			
1.4.2016	67.45	50.26	21.05	25.08	177.36	17.34	1.9	2.24	0.69			
1.1.2017	69.57	52.67	22.52	26.83	189.84	18.53	1.9	2.24	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	–	–	–	–	–	–
1.1.2014	50.36	30.7	6.65	7.59	47.1	4.45	–	–	–	–	–	–
1.1.2015	51.2	31.65	6.65	7.59	47.1	6.65	–	–	–	–	–	–
1.1.2016	51.2	31.65	6.65	7.59	47.1	6.65	–	–	–	–	–	–
1.1.2017	52.19	32.77	7.05	8.05	49.93	7.05	–	–	–	–	–	–
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	–	–	–	–	–	–
1.1.2014	16.25	18.61	9.34	11.34	84.43	6.93	–	–	–	–	–	–
1.1.2015	16.25	18.61	11.74	14.25	106.14	8.71						
1.1.2016	16.25	18.61	14.4	17.49	130.26	10.69						
1.1.2017	17.38	19.9	15.47	18.78	139.91	11.48						
Energy tax [7]												
1.1.2011	–	–	–	–	–	–	1.9	1.69	0.69	–	–	–
1.1.2013	–	–	–	–	–	–	4.9	1.69	0.69			
1.1.2014	–	–	–	–	–	–	4.9	1.89	0.69			
1.1.2015	–	–	–	–	–	–	3.4	2.24	0.69			
1.1.2016	–	–	–	–	–	–	3.4	2.24	0.69			
1.4.2016	–	–	–	–	–	–	1.9	2.24	0.69			
1.1.2017	–	–	–	–	–	–	1.9	2.24	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, data centers, mining, professional greenhouses (also agriculture through tax rebates)
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

* see the full tax table: http://ec.europa.eu/taxation_customs/tedb/taxDetails.html?id=4077/1496136747
All rates based on energy content, local emissions and CO_2-emissions. For example liquid biofuels have lower tax rate per litre thanks lower energy content and emissions.

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 electricity in 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, that is, to compensate the difference between the taxation of diesel and gasoline.

4.6.2 Government expenditure on energy and climate policy

Government appropriations for the energy and climate policy are discussed and the relevant decisions are made within the central government spending limits in the General Government Fiscal Plan, coordinated with other expenditure needs of the public economy.

Table 4.13 shows a compilation of funding related to the energy and climate policy for 2017 to 2030 in the budget for 2017 and the General Government Fiscal Plan for 2017 to 2020. Table 4.14 provides initial estimates of the completely new funding needs arising from the new measures proposed in the National Energy and Climate Strategy for 2030 in 2017 to 2020 and 2021 to 2030. A significant part of strategy implementation costs would be realised after 2020.

The most important new funding needs arise from subsidising renewable energy. It is proposed that the current energy aid scheme be continued after 2020, and a general increase of EUR five million is proposed in the relevant budget authority.

Table 4.13
Funding under the current General Government Fiscal Plan in accordance with the Government report on the National Energy and Climate Strategy for 2030

	EUR million				
Appropriation	2017	2018	2019	2020	2021–2030 Total
MINISTRY OF ECONOMIC AFFAIRS AND EMPLOYMENT					
Investment subsidies for renewable energy and new energy technologies	40	40			
Operating aid for electricity from renewable energy sources	245	305	305	245	1,340
MINISTRY OF AGRICULTURE AND FORESTRY					
Rural Development Programme:					
Certain agri-environment payment measures					
Balanced use of nutrients 1)	103.2	103.2	103.2	103.2	
Incorporation of slurry into fields 1)	7.4	7.4	7.4	7.4	
Control of runoff waters 1)	6.0	6.0	6.0	6.0	
Environment management grasslands 1)	35.4	35.4	35.4	35.4	
Wetland management 1)	0.5	0.5	0.5	0.5	
Advice 1)	4.0	4.0	4.0	4.0	
Renewable energy investments	9.0	9.0	9.0	9.0	
TOTAL appropriations (national funding)	**385**	**445**	**405**	**345**	**1,340**

	EUR million				
Budget authority	2017	2018	2019	2020	2021-2030
Ministry of Economic Affairs and Employment					
Energy aid (32.60.40.)	35	35	35	35	
TOTAL budget authority	**35**	**35**	**35**	**35**	**0**

1) Contains 42% of EU co-funding

Table 4.14
Estimate of new funding needs arising from the proposed measures

Appropriation	EUR million 2017	2018	2019	2020	2021–2030 Total
MINISTRY OF THE ENVIRONMENT					
Piloting of digital mobility services. Ministry of the Environment + Ministry of Transport and Communications	0.5	0.5	0.5	0.5	
Market experiments related to low-carbon business and service platforms (e.g. former railway stations as hubs)	2.5	2.5	2.5	2.5	
Guidance by information to promote wood construction		2	2	2	
MINISTRY OF AGRICULTURE AND FORESTRY					
Additional needs of R&D related to sink policy measures	0.75				
MINISTRY OF ECONOMIC AFFAIRS AND EMPLOYMENT					
Production aid for renewable electricity (new aid scheme based on a tendering process)				13	265
MINISTRY OF TRANSPORT AND COMMUNICATIONS					
Promoting energy-efficient vehicles (electricity and gas)		25	25	25	25
TOTAL appropriations	**4**	**30**	**30**	**43**	**290**

Budget authority	EUR million 2017	2018	2019	2020	2021–2030
MINISTRY OF ECONOMIC AFFAIRS AND EMPLOYMENT					
Energy aid		5	5	5	400
Major new energy technology projects (incl. biorefineries)			60	60	240
TOTAL appropriations	**0**	**5**	**65**	**65**	**640**

4.7 Use of Kyoto mechanisms

The use of Kyoto mechanisms is one option to meet Finland's national emission reduction commitments of the Kyoto Protocol. It includes the use of project mechanisms (the Clean Development Mechanism (CDM) and Joint Implementation (JI)) or acquiring assigned amount units (AAU) through international emissions trading.

Finland's Government activities to provide Kyoto mechanisms started in the form of the CDM/JI pilot programme from 1999 until early 2006, followed by the Kyoto mechanism purchase programme that covers the period 2006 to 2020. The total budget for the acquisition of emission reductions from the Kyoto Protocol flexible mechanisms has been approximately EUR 70 million. The programme includes 10 bilateral projects and investments in several multilateral carbon funds.

In total, in the first Kyoto commitment period Finland procured approximately 6.2 million tonnes of project units. These units have been carried over to the second commitment period. The Kyoto mechanisms purchase programme will continue to deliver project units until 2020 through existing investments in carbon funds and one ongoing bilateral CDM project. A total of four million tonnes of project units are expected to be generated by the end of 2020. No decision on the use of Kyoto mechanisms for compliance purposes in the second commitment period of the Kyoto Protocol has been made.

In the EU emissions trading scheme, companies may partly meet their emission reduction obligations by using international credits from the Clean Development Mechanism (CDM) and Joint Implementation (JI). In the first Kyoto commitment period the operators used 12.3 million tonnes CERs and 4.1 million tonnes ERUs.

In the period 2008 to 2020, stationary installations and aircraft operators have an International Credit Entitlement (ICE) limit in use, i.e. the installations/aircraft operators can exchange eligible credits (CER/ERU) up to the maximum amount allowed by EU legislation. The allowances (EUAs) obtained in exchange can be used freely for compliance and trading. For the Finnish operators the Credit Entitlement limit is totally about six million tonnes.

4.8 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. Also, the report of the parliamentary committee from 2014, the Energy and Climate Roadmap 2050, analysed the means of constructing a low-carbon society and achieving an 80 to 95 per cent reduction in greenhouse gas emissions from the 1990 level in Finland by 2050. The background material for the 2014 roadmap included four scenarios on alternative development paths for a low-carbon society up to 2050 made by the Low Carbon Finland 2050 platform research project.

A large proportion of current Finnish climate and energy policies also contributes 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 also yields 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. 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, also have long-term emission reduction effects provided that the measure has triggered investments.

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.

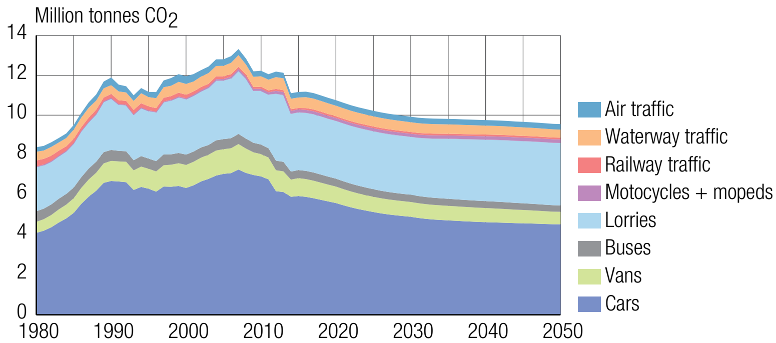
The impact of policies and measures on the longer-term trend (up to 2050) in greenhouse gas emissions from transport have been studied in the ILARI project (2010 to 2012) and its updates (2015 and 2016). The impacts of different policy packages have been compared to a baseline scenario based on statistics and forecasts on transport volumes and vehicle fleets provided by the Finnish Transport Agency and the Finnish Transport Safety Agency, energy efficiency forecasts for vehicles provided by VTT Technical Research Centre of Finland and the national calculation system for measuring traffic exhaust emissions and energy consumption in Finland, LIPASTO.

In the 2015 update the difference between the projected transport volumes and actual reporting by the Finnish Transport Agency were taken into account. This resulted in a decrease in the previously estimated passenger car vehicle kilometres. Furthermore, the transport volumes for heavy goods vehicles were adjusted to be higher and the development of the energy efficiency was re-evaluated to be more modest than previously estimated.

According to the projections, transport volumes continue to grow over the forecast period, whereas the GHG emissions start to decline at the end of the current decade (see Figure 4.4). The main reasons for emission reductions are the use of biofuels, development in vehicle technology and CO_2-based taxation. The effect is greatest on passenger cars. Emissions from heavy goods vehicles are expected to grow slightly due to economic growth and more modest energy efficiency expectations.

Uncertainties in the projections include reaching the vehicle energy efficiency targets, the renewal rate of the vehicle fleet and the use of alternative fuels.

Figure 4.4
Projection on longer-term trend in the greenhouse gas emissions in transport



4.9 Mitigation benefits other than greenhouse gas reduction

Environmental impact assessments (EIAs) have been made for all of Finland's national energy and climate strategies and for the Medium-term Climate Change Policy Plan. The EIAs include a general examination of the benefits and adverse impacts of the strategies and the Medium-term Climate Change Policy Plan, specifically evaluating the relationship between measures for climate mitigation and air pollution. In addition to climate change and air pollution, the National Energy and Climate Strategy and the Medium-term Climate Change Policy Plan affect biodiversity and waters, and people's health and living conditions. The details of the practical implementation of the alignments are essential. They instruct, among other things, how increased use of wood effects on biodiversity and what the impacts on the welfare of different population groups are.

The amount of air pollution is expected to decrease due to the alignments proposed in the strategy and the Medium-term Climate Change Policy Plan. However, the risks for health caused by air pollution still remain significant. At present, the emissions from power plants have only a small effect on air quality. The alignments, which decrease vehicle mileage or increase the use of gas-powered or electric cars, are significant in decreasing small particle emissions. The effect on the air quality of densely populated areas is dependent on the development of passenger mileages and how they are distributed.

In general, measures that reduce greenhouse gas emissions will also reduce air pollution. Small-scale wood burning is an exception, however. In Finland, most of solid forest-based fuels are used in CHP plants and in regional heating plants, but also the use of firewood in households and in the heating of farm and service buildings is considerable. In addition to methane and black carbon, which contribute to global warming, small particles having negative health impacts are also released from small-scale wood burning. The alignments of the strategy and the Medium-term Climate Change Policy Plan concerning small-scale wood burning do not cause notable changes to the present state. It is, nevertheless, possible to affect the emissions by technical standards, innovations and information guidance.

According to the National Energy and Climate Strategy and the Medium-term Climate Change Policy Plan, the use of biofuels will be increased in transport, buildings and machinery through distribution obligations. The scale of the impacts of biofuel production will be highly dependent on the raw materials used and the total resources needed for production of biofuels, such as energy, materials and productive land area. The main domestic feedstocks in the future biofuel production in Finland are expected to be e.g. biodegradable wastes, forest industry residues (e.g. sawdust), other industrial residues and logging residues. By using biofuels made from domestic raw materials, Finland can reduce its dependence on crude oil. If the future biofuel production in Finland would be based on a larger scale on forest biomass, the potential impacts of the production and use of biofuels are going to be assessed together with the general goal of increasing harvesting volumes in Finland, and other potential impacts on forest sinks, forest biodiversity and water bodies.

4.10 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, are minimised. Applicable notification requirements under international trade conventions are also followed. Finland takes into account knowledge on and understanding of the possible adverse 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 Sixth National Communication and latest National Inventory Report (NIR).

All major policies and activities undergo environmental impact assessments, including impacts in other countries. Environmental impact assessments have been carried out for all national energy and climate strategies, including the latest one published in 2016. The assessments have identified on a qualitative level the kind of impacts that the measures may have. A lifecycle analysis of fuel imports takes into account impacts arising outside Finland. 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. The Manual for Bilateral Programmes (2016) includes the Guidance and Checklist for Climate Sustainability[72]. 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. In the implementation of its development policy (2016), Finland will take urgent action to combat climate change and its impacts[73]. Finnish development cooperation activities take into account climate change mitigation and giving support to climate change adaptation and disaster preparedness. Today, climate financing is part of Finland's development cooperation funding and disaster risk management is also covered by our development cooperation.

The overarching goal of Finland's development policy is the eradication of extreme poverty. Regarding the minimisation of adverse social impacts, the Ministry for Foreign Affairs commissioned a study some years ago 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 in 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.

72 http://formin.finland.fi/public/default.aspx?contentId=259204&nodeId=15445&contentlan=2&culture=en-US

73 http://formin.finland.fi/public/default.aspx?contentid=341918&nodeid=49540&contentlan=2&culture=en-US

- 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.

Finland promotes policy coherence for development at the national and EU levels and especially in relation to the implementation of the Agenda 2030. Finland implements the recommendations of the OECD, and piloted the OECD's tool for policy coherence in the theme of food security and the right to food in 2012 to 2013. Policy coherence on other themes, such as trade and development, tax and development, migration and development, and security and development, have been strengthened both nationally and internationally. The Government submitted a communication to the Parliament on aid effectiveness and policy coherence for development in 2014.

Finland has consistently and for a long time worked to reform harmful fossil fuel subsidies for both climate and wider environmental, social and economic reasons. We are part of the Friends of Fossil Fuel Subsidy Reform (FFFSR), playing an active role in all relevant policy areas on behalf of the reform. Furthermore, in Tax and Development Finland's Action Programme 2016 to 2019 we recognise the fossil fuel subsidy reform as part of the wise management of public resources[74].

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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.

Photo:
Riku Lumiaro / 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 are based on the National Energy and Climate Strategy for 2030 and the Medium-term Climate Change Policy Plan. The Energy and Climate Strategy was presented by the Government in November 2016. The Medium-term Climate Change Policy Plan was approved in September 2017. The projections were formulated in 2016 and 2017 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 energy and climate related policy measures already implemented and adopted are continued. The WM projection represents a development path that would be likely to take place if no new energy or climate policy measures were adopted. Most of the measures included in the WAM projection of the Sixth National Communication have been implemented and are now part of the WM projection. The most significant new, implemented policy measures affecting future emissions compared to the Sixth National Communication are a regulation ensuring improvements of energy and resource efficiency in renovation and alteration of buildings and a new regulation reducing the amount of organic waste disposed to landfills.

In previous National Communications it has been assumed that Finland will be self-sufficient in electricity on a yearly basis from 2020 onwards. During the last years domestic conventional generation capacity has, however, been shut down and while Finland is part of the integrated Nordic-Baltic electricity market self-sufficiency in electricity supply is no longer a feasible aim nor a reasonable assumption. This change in the assumptions affects the emission projections (both WM and WAM projections) by cutting and smoothening out the total emissions.

The 'With Additional Measures' projection (WAM) includes a set of cost-efficient additional energy and climate policy measures that the Government has agreed upon in order to attain the targets specified in the Government Programme and adopted in the EU for 2030.

The WAM projection includes new measures particularly to reduce the use of fossil fuels, to promote renewable energy, to improve energy efficiency as well as to further reduce greenhouse gas emissions in the non-energy sectors. These WAM measures are described in Chapter 4.

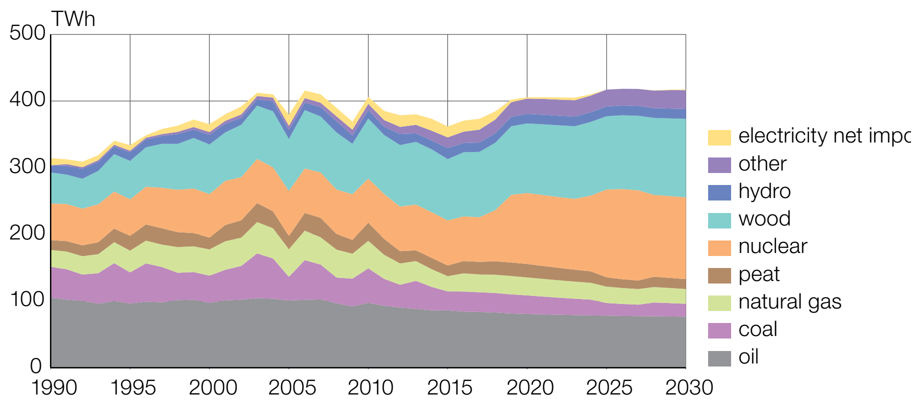
Economic growth and the change in the structure of the economy play a key role in the estimation of energy consumption and emissions. The rate of economic growth is determined by the growth rates of labour input and average labour productivity. In the long term, economic growth is determined almost solely by the growth of labour productivity, because labour input cannot grow without bounds. In the short and medium term, however, factors affecting labour input growth matter, too, because changes in labour input affect directly the potential output of the economy. In Finland, the ageing population is the single most significant factor in terms of its effect on labour input and thus development of the national economy in the short and medium term. 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 5.5 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 2.6 million to 3.0 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 VATT Institute for Economic Research[1].

In 2016, the Finnish economy returned to a growth path after a long period of recession that began in 2009. The growth has been driven by increase in private consumption and recovery of public and private investment. Foreign trade still accounts for a very significant share of total output, even though the level of exports has not yet returned to the same level as in years preceding the global recession in 2009. The Finnish economy has experienced a structural change in the 2010s, where the role of services has increased and traditional industries have been forced to adapt to changes in global demand and competition. The Government is carrying out major reforms in order to cut expenditures of the public sector and to bring the Finnish economy onto a path of sustainable growth and higher employment. The impact of the reforms is included in the economic growth assumptions of the WM and WAM projections. Due to the Government's reforms the economic growth expectation after 2020 is clearly higher than in the assumptions used in the Sixth National Communication. The starting level is due to the prolonged recession, however, lower. The economy is expected to reach the same level as in the projections of the Sixth National Communication around 2030.

Gross final energy consumption is leveled off in the projections as a result of increased energy efficiency in all sectors. The WAM projection includes additional energy efficiency measures particularly in transport, but also an increased energy use in biorefineries. Altogether the gross final consumption level is therefore about the same in the WAM projection as in the WM projection – just over 310 TWh in the 2020s. Nevertheless, the energy related emissions are substantially lower in the WAM projection. The lower emissions are the result of policy measures that replace fossil fuels with renewables and electricity.

Figure 5.1
Historical development (1990 to 2015) and WM projection (up to 2030) of the primary energy supply, TWh



1 http://vatt.fi/suomen-talous-2015-2030-laskelmia-politiikkatoimien-vaikutuksista

Despite the flat final consumption projection the primary energy consumption varies clearly in the projections. The main reason for this is the substantial changes in domestic nuclear power production (increase in late 2010s and mid-2020, decreases in the late 2020s), which replaces or is replaced by electricity import. Expressed in primary energy, the value of nuclear power is three-fold that of imported electricity, despite the same amount of electricity fed to consumption. 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 2016 to 2030. 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 estimates of the International Energy Agency (IEA 2015).

Table 5.1
Assumptions of the WM projection

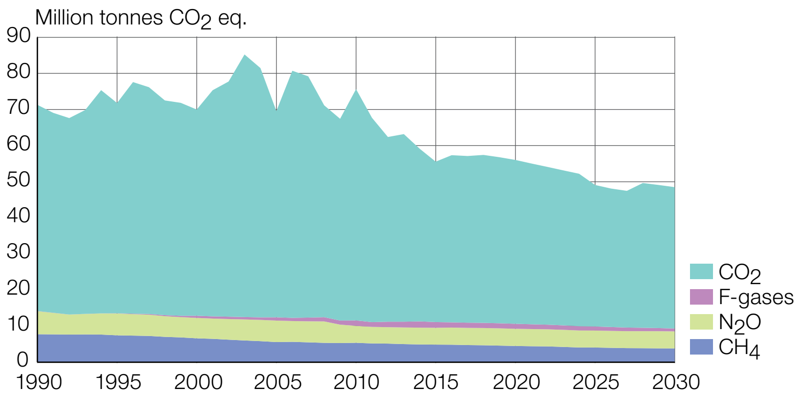
Parameter	Trend 2016–2030
GDP growth	2.3 per cent annually
Structure of economy	Increasing share of services
Structure of industry	Less capital and energy intensive
Population growth	Increasing 0.4 per cent annually
Population structure	Ageing
Technology development	Gradual introduction of improved and more energy efficient technology

5.2 'With Measures' projection

5.2.1 Total effects

Total emissions in the WM projection for the years 1990 to 2030 are shown in Figure 5.2 (total emissions without the LULUCF sector)[2] and Table 5.2 (without and with the LULUCF sector). Compared with the base year of 1990, the total greenhouse gas emissions without LULUCF are projected to be 21 per cent lower in 2020 and 32 per

Figure 5.2
Greenhouse gas emissions without LULUCF by gas according to the latest greenhouse gas emission inventory (1990 to 2015) and the WM projection (up to 2030), million tonnes CO_2 eq.



2 Unless otherwise specified, total emissions refer to total national emissions without LULUCF

Table 5.2
Greenhouse gas emissions according to the most recent inventory data (1990 to 2015) and the WM projection (2020 to 2030)

	GHG emissions and removals (kilotonnes CO_2 eq.)								
	1990	1995	2000	2005	2010	2015	2020	2025	2030
Sector									
1. Energy	53,558	55,328	53,755	53,715	60,166	40,816	41,441	34,870	34,509
2. Industrial processes and product use	5,370	4,914	5,827	6,497	6,260	6,076	6,349	6,471	6,493
3. Agriculture	7,525	6,838	6,466	6,457	6,576	6,481	6,611	6,446	6,378
4. Land use, land-use change and forestry(5)	–12,672	–12,369	–21,710	–27,068	–27,297	–25,991	–10,644	–4,274	–4,221
5. Waste	4,672	4,596	3,850	2,823	2,583	2,134	1,629	1,311	1,112
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
Gas									
CO_2 emissions without net CO_2 from LULUCF	56,949	58,124	57,026	57,031	64,007	44,382	45,392	39,204	39,157
CO_2 emissions with net CO_2 from LULUCF	41,466	43,026	32,679	27,473	34,449	16,205	33,168	33,495	33,514
CH_4 emissions without CH_4 from LULUCF	7,746	7,448	6,614	5,576	5,373	4,875	4,498	4,069	3,817
CH_4 emissions with CH_4 from LULUCF	9,285	8,903	7,963	6,783	6,352	5,795	4,771	4,208	3,952
N_2O emissions without N_2O from LULUCF	6,377	6,040	5,660	5,956	4,696	4,659	4,757	4,700	4,727
N_2O emissions with N_2O from LULUCF	7,649	7,314	6,948	7,239	5,979	5,925	6,064	5,996	6,013
HFCs	0	27	559	892	1,485	1,547	1,343	1,085	751
PFCs	0	0	13	16	1	7	4	4	4
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF_6	52	37	26	22	22	38	36	37	38
NF_3	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (without LULUCF)	71,125	71,676	69,899	69,493	75,585	55,507	56,031	49,098	48,493
Total (with LULUCF)	58,453	59,307	48,189	42,425	48,288	29,516	45,387	44,825	44,272
Indirect CO_2 emissions	165	129	104	85	69	52	NE	NE	NE
Total (without LULUCF, with indirect)	**71,291**	**71,805**	**70,003**	**69,578**	**75,654**	**55,559**	**NE**	**NE**	**NE**
Total (with LULUCF, with indirect)	**58,618**	**59,436**	**48,293**	**42,510**	**48,356**	**29,568**	**NE**	**NE**	**NE**

NO = not occurring, NE = not estimated
1) Indirect emissions are not included in the above emissions/removal estimates by sector and gas

cent lower in 2030. Correspondingly, the CO_2 emissions are projected to be 20 per cent lower in 2020 and 31 per cent lower in 2030. CH_4 emissions are expected to continue to decline steadily being 42 per cent lower in 2020 and 51 per cent lower in 2030 than in 1990. 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. The emissions in the EU ETS sector have reached their peak in the mid-2000s and are expected to decline further. In 2015, emissions in the EU ETS sector counted for 46 per cent of the total greenhouse gas emissions, whereas the non-ETS sector counted for 54 per cent. 2015 was warmer than average years, which reduced the heating demand and lowered the emission level of the EU ETS sector more than the emission level of the non-ETS sector. The split between EU ETS and non-ETS sector emissions is expected to remain roughly in the same order of magnitude during the current and next decade even though a slightly slower decline in the non-ETS emissions is expected.

The emissions from the non-ETS sector have steadily decreased since 2005 and the decrease is expected to continue (Figure 5.4). In the WM projection, the emissions from the non-ETS sector in 2020 are 15 per cent and in 2030 22 per cent below the 2005 level when taking into account the change of scope of the EU ETS. The development of the

Figure 5.3
The split of greenhouse gas emissions between the EU ETS sector and the non-ETS sector (2005 to 2015) based on the latest greenhouse gas inventory and the WM projection (up to 2030). The development of the total emissions without the LULUCF sector is also presented.

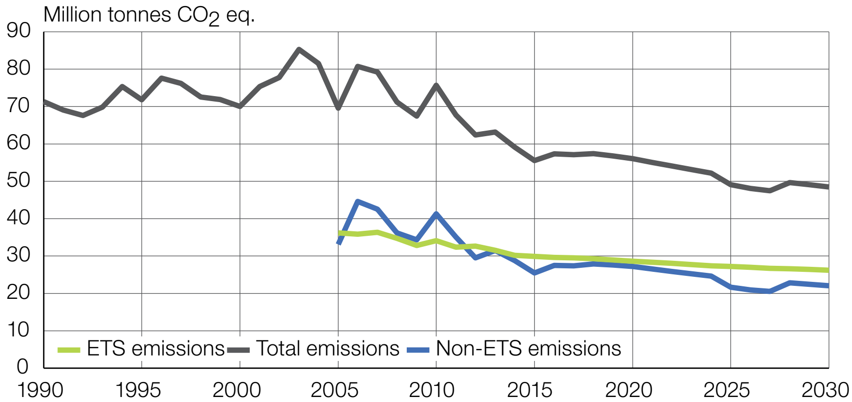
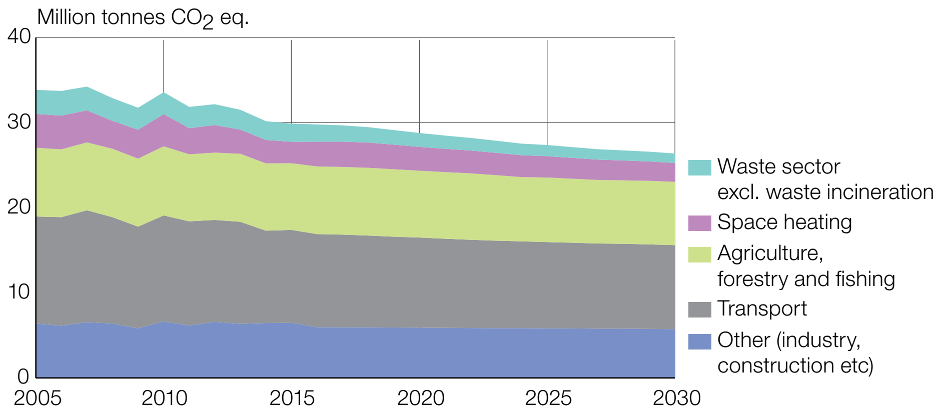


Figure 5.4
Emissions in the non-ETS sector (corresponding to EU ETS scope of 2013) by category (2005 to 2015) based on the latest greenhouse gas inventory and the WM projection (up to 2030)



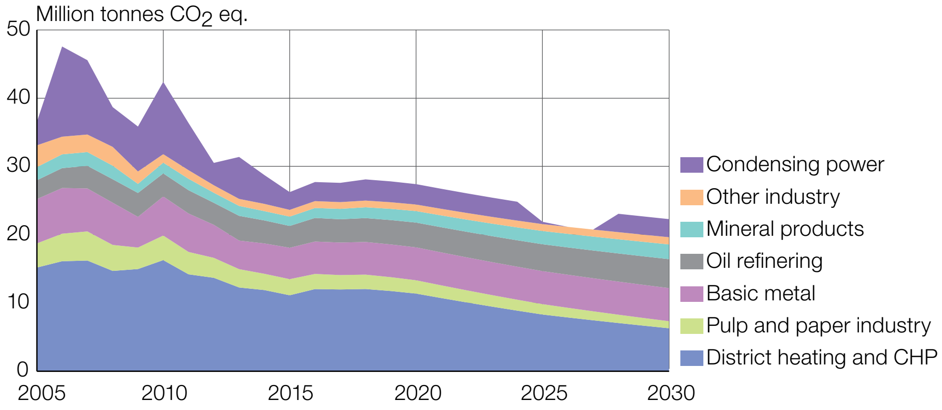
emissions by branch in the EU ETS sector for the years 2005 to 2030 is illustrated in Figure 5.5. The curves include both energy and process related emissions from sources included in the EU ETS in 2013.

The development of total emissions with regard to the number of inhabitants, primary energy use and economic development is presented in Table 5.3.

Table 5.3
Greenhouse gas emission intensity based on the latest greenhouse gas inventory for 2010 to 2015 and the WM projection for 2020 to 2030

	2010	2015	2020	2025	2030
Emissions per capita, tonnes CO_2 eq. /capita	14.1	10.1	10.0	8.5	8.3
Emissions per GDP, kg CO_2 eq./EUR	0.40	0.30	0.32	0.25	0.22
Emissions per primary energy, tonnes CO_2 eq./MWh	0.19	0.15	0.14	0.12	0.12

Figure 5.5
Emissions in the EU ETS (corresponding to EU ETS scope of 2013) sector according to the greenhouse gas inventory (2005 to 2015) and the WM projection (up to 2030)



5.2.2 Sectoral emissions

Energy

The energy sector is strongly affected by policy measures to reduce the emissions, to enhance energy efficiency and to increase the share of renewable energy sources. Both the supply and demand sides are facing significant changes, part of the changes results from policy measures, part from technological development and development of the energy and fuel markets. As many of the changes involve or concern investments like power plants, the effects are robust and long lasting.

In the WM projection, the most significant future changes in electricity and heat production are the startup in 2018 of a 1600 MW nuclear power plant unit currently under construction, one additional nuclear power plant unit in the mid-2020s and the increase in the use of renewable energy sources, mainly wind power and biomass in CHP plants. All these changes reduce emissions. In the WM projection, Finland remains a net importer of electricity during the projected period except for a few years right after mid-2020s when Finland can be self-sufficient in power supply. During that period the generation from the new nuclear and wind power plants is expected to replace some domestic conventional power generation resulting in a reduction of domestic greenhouse gas emissions.

Factors affecting the future energy demand are first of all energy efficiency measures, but also the economic development and structural changes within the industry. According to the WM projection, energy used for heating of residential and service sector buildings is decreasing 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. District heat production from heat-only plants is expected slightly to increase its share at the expense of combined heat and power production, which is struggling with the feasibility due to low electricity prices.

The historical and projected emissions from the energy sector (excl. transport) 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. Most of the energy production as well as the industrial energy use belong to the EU Emission Trading Scheme (see Figure 5.5).

Table 5.4
Historical (1990 to 2015) and projected (2020 to 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	2015	2020	2025	2030
Total emissions, million tonnes CO_2 eq.	41.3	43.8	41.5	40.6	47.3	29.6	30.7	24.6	24.5
CO_2	40.7	43.2	40.8	39.9	46.5	28.9	29.8	23.7	23.6
CH_4	0.3	0.2	0.2	0.2	0.3	0.2	0.4	0.4	0.4
N_2O	0.4	0.4	0.5	0.5	0.6	0.5	0.5	0.5	0.5

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. Future years are in the projections assumed to be standard years (i.e. long-term average plus impact of climate change) with respect to heating demand and hydro levels. Full load hours equaling average historical figures are assumed for condensing power. In reality, the emissions will continue to vary from one year to another but to a lesser extent due to decreased specific emissions in both district heat and power generation. The CO_2 emissions from both district heating and industrial energy use are declining steadily in the WM projection.

The importance of CH_4 and N_2O emissions within the energy sector is quite small. Less than 10 per cent of all CH_4 emissions in Finland come from incomplete combustion of fuel, which is mainly caused by fireplaces and small heating boilers. CH_4 emissions from power and heating plants are 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 fossil fuels for machinery and driers, space heating of buildings and industry outside the EU ETS. In the WM projection, the emissions from individual heating of residential and commercial buildings decline from 2 million tonnes CO_2 eq. to 1.4 million tonnes CO_2 eq. in 2030. The emissions from machinery are expected to remain approximately at their current level, i.e. 2.4 to 2.5 million tonnes CO_2 eq., even though the use of machinery is expected to increase over time. The reasons for this favourable development are more efficient equipment and a more efficient use of the equipment. Also the emissions from non-ETS industrial energy use stay around the current level of 0.6 million tonnes CO_2 eq. in the WM projection despite an increase in activity. The energy-related emissions from agriculture and forestry are today 1.4 million tonnes CO_2 out of which 0.8 million tonnes CO_2 eq. comes from machinery. By 2030 the energy-related emissions in agriculture and forestry are expected to decrease to 1.1 million tonnes CO_2 eq. The expected energy savings from energy advice within agriculture are 24 GWh/a and the corresponding CO_2 emission reductions 6 kt/a in 2020. In 2030, the estimated energy savings impact is 40 GWh/a and emission reductions 10 kt/a assuming same activity levels beyond 2020.

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 in June 2016 (see also Section 4.5.2).

According to the WM projection, even though the total vehicle mileage will increase, the emissions are expected to decline by 2020 (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 13.5 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 to 1.5 per cent annually.

Table 5.5
Historical (1990 to 2015) and projected (2020 to 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	2015	2020	2025	2030
Total emissions, million tonnes CO_2 eq.	12.1	11.3	12.1	12.9	12.7	11.1	10.8	10.3	10.0
CO_2	11.8	11.1	11.9	12.8	12.6	11.0	10.6	10.2	9.9
CH_4	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
N_2O	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Industrial processes and other product use

The main factors affecting the development of emissions from industrial processes and product use include changes in industrial production and measures applied for reducing emissions. The global recession reduced the emissions from the sector in 2009, after which they have stayed at an approximately 20 per cent lower level compared to the peak year 2008.

In the WM projection the emissions are expected to increase slightly until mid-2020s as industrial production increases (Table 5.6). CO_2 emissions from industrial processes are mainly caused by the manufacturing of iron and steel, cement, lime and hydrogen. 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.

Table 5.6
Historical (1990 to 2015) and projected (2020 to 2030) greenhouse gas emissions from industrial processes and other product use based on the latest greenhouse gas inventory and the WM projection, respectively

	Historical						WM projection		
	1990	1995	2000	2005	2010	2015	2020	2025	2030
Total emissions, million tonnes CO_2 eq.	5.4	4.9	5.8	6.5	6.3	6.1	6.3	6.5	6.5
CO_2	3.7	3.4	3.9	4.0	4.6	4.2	4.7	5.1	5.4
CH_4	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0
N_2O	1.7	1.5	1.4	1.6	0.2	0.3	0.2	0.2	0.3
	0.1	0.1	0.6	0.9	1.5	1.6	1.4	1.1	0.8

The WM projection for F-gases includes the impacts of the EU regulation on F-gases[3] and the EC directive relating to emissions from air-conditioning systems in motor vehicles[4]. 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 have declined heavily as a result of voluntary actions of the industries. A slight increase of emissions is assumed in the future but the peak level of emissions in the 1990's will not be reached.

3 2014/517/EU
4 2006/40/EC

Restrictions forced by the EU regulation have a decreasing effect on emissions from foam blowing, aerosols and other sources. The emissions from foam blowing and aerosols are expected to decrease in the future. The emissions from other sources are expected to stay quite steady. Emissions from refrigeration and air-conditioning equipment account for more than 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.

Agriculture

In recent years, the changes in the emissions from agriculture have been small. Under the WM projection, the emissions are expected to increase slightly (two per cent between 2005 and 2020), as nitrogen (N) and organic soils are estimated to be increasing sources (Table 5.7).The decline in livestock numbers and N fertilization will slightly lower the total emissions after 2020 and the total greenhouse gas emissions from agriculture will be one per cent lower in 2030 compared to 2005.

Energy-related emissions related to agriculture are reported in the energy sector and not included in Table 5.7.

Table 5.7
Historical (1990 to 2015) and projected (2020 to 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	2015	2020	2025	2030
Total emissions, million tonnes CO_2 eq.	7.5	6.8	6.5	6.5	6.6	6.5	6.6	6.4	6.4
CO_2	0.6	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2
CH_4	2.8	2.5	2.5	2.5	2.6	2.6	2.6	2.5	2.4
N_2O	4.1	3.9	3.6	3.6	3.7	3.7	3.8	3.7	3.7

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).

Table 5.8
Historical (1990 to 2015) and projected (2020 to 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	2015	2020	2025	2030
Total emissions and removals, million tonnes CO_2 eq.	–12.7	–12.4	–21.7	–27.1	–27.3	–26.0	–10.6	–4.3	–4.2
CO_2	–15.5	–15.1	–24.3	–29.6	–29.6	–28.2	–12.2	–5.7	–5.6
CH_4	1.5	1.5	1.3	1.2	1.0	0.9	0.3	0.1	0.1
N_2O	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3

The WM projection for forestry is based on the National Forest Strategy (NFS) 2025, which estimates that the carbon sink of forests (including trees and soil but excluding HWP) will remain at a level of at least 13.5 to 20 million tonnes CO_2 eq. per annum during the period 2025 to 2030. The estimate is based on the assumption that loggings will increase by 10 to 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 NFS.

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 sink of 2.3 million tonnes CO_2 eq in 2015.[5] In the WM projection, the HWP sink has been assumed to remain at the 2015 level during 2020 to 2030.

With regard to agricultural soils, CO_2 emissions and removals from croplands and grasslands are not expected to be subject to large changes by the year 2030 according to the WM projection.

Waste

Greenhouse gas emission projections for the waste sector include CH_4 from landfills, CH_4 and N_2O emissions from biological treatment of waste 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[6] and national legislation[7] and strategies aimed at reducing the amount of waste and minimising the amount of waste disposed at landfills.

Table 5.9
Historical (1990 to 2015) and projected (2020 to 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	2015	2020	2025	2030
Total emissions, million tonnes CO_2 eq.	4.7	4.6	3.9	2.8	2.6	2.1	1.6	1.3	1.1
CH_4	4.6	4.5	3.7	2.7	2.5	2.0	1.5	1.2	1.0
N_2O	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

CH_4 emissions will 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 about two thirds of the 2020 level.

N_2O emissions from biological treatment of waste were 0.04 million tonnes CO_2 eq. and from waste water treatment 0.08 million tonnes CO_2 eq. in 2015. In the WM projection these emissions are expected to remain at approximately the current level up to 2030.

International bunkers

According to the most recent greenhouse gas emission inventory, the fuel consumption for international aviation was 26,818 TJ and for international marine transportation 11,832 TJ in 2015. The annual growth rate by 2030 is estimated at 2 per cent for international marine transportation and 3 per cent for international aviation. Based on these assumptions and using the emissions in 2015 as the basis, the total greenhouse gas emissions from bunker fuels are projected to be 3.3 million tonnes CO_2 eq. in 2020 (1.0 million tonnes

5 HWP figure is presented here as according to the Convention reporting.
6 Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste
7 Government Decree on Landfills 331/2013

CO_2 eq. from marine and 2.3 million tonnes CO_2 eq. from aviation bunkers). The corresponding total estimate for 2030 is 4.3 million tonnes CO_2 eq. (1.2 million tonnes CO_2 eq. from marine and 3.1 million tonnes CO_2 eq. from aviation bunkers).

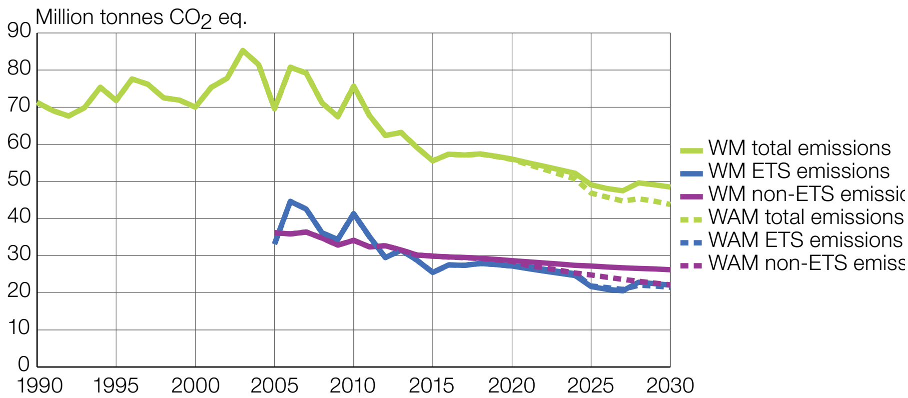
These projected emissions of marine and aviation bunkers do not take into account the impact of the measures presented in Table 4.6 which aim at improving energy efficiency and increasing the use of alternative fuels.

5.3 'With Additional Measures' projection

With the existing policy measures Finland is on track to meet its 2020 emission reduction and renewable energy targets. The effect of the additional measures is aimed at the 2020s and in full at the year 2030 at the latest. With a few exceptions all the planned measures described in Chapter 4 are included in the WAM projection. Measures for which the impact on the energy balance is not known have not been included in the WAM projection. These are 1) phasing out oil heating in the public sector, 2) reducing emissions from machinery by improving energy efficiency and promoting the use of alternative fuels or power sources, and partly 3) promoting the use of biogas.

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.

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 2016 to 2030 and historical emissions for 1990 to 2015 based on the most recent inventory



The total greenhouse gas emissions in 2030 are estimated to be 48 million tonnes CO_2 eq. in the WM projection and 44 million tonnes CO_2 eq. in the WAM projection. The additional emission reduction measures in the WAM projection will mainly affect the non-ETS 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 building sector, additional measures are under preparation. Nearly zero-energy (NZEB) regulations for new buildings will come in force in 2018. According to the National Energy and Climate Strategy for 2030 is an obligation to blend 10 per cent of bioliquids into light fuel oil used for heating of buildings. A decision of the types of

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 2020 to 2030, million tonnes CO_2 eq. (the greenhouse gas emissions in 2010 and 2015 are based on the most recent inventory and shown for comparison)

	2010	2015	2020	2025	2030
CO_2	64.1	44.4	45.3	37.2	34.8
CH_4	5.4	4.9	4.5	4.1	3.8
N_2O	4.7	4.7	4.8	4.7	4.7
F-gases	1.5	1.6	1.4	0.9	0.5
Total	75.7	55.6	55.9	46.8	43.8
difference to WM			–0.1	–2.3	–4.7

policy instruments which are going to be applied to fulfil this PAM have not been made yet and these measures are therefore not yet included in the WAM projection.

In the transport sector, the estimated additional total emission reductions in the WAM projection are 2.8 million tonnes CO_2 in 2030. The potential emission reduction impact of promoting the use of biofuels (additional measure) in the WAM projection is 1.5 million tonnes CO_2 eq. in 2030 compared to the WM projection. The emission reduction effects of improving the energy-efficiency of vehicles (additional measures), should total some 1.0 million tonnes CO_2 eq. in 2030. The potential emission reduction impact of improving the energy-efficiency of the transport system (additional measure) is 0.3 million tonnes CO_2 eq. in 2030.

The WAM projection for F-gases is based on additional measures that are expected to promote the alternative low-GWP non-HFC technologies in the refrigeration and air conditioning equipment sector in addition to the F-gas regulation. These additional measures include criteria for public procurement related to F-gases and information and education campaigns. It is estimated that the emission reductions achieved by these additional measures will be 0.3 million tonnes CO_2 eq. in 2030.

In the waste sector, no significant additional measures are planned. The implementation of the existing measures will push the emissions to a very low level.

In the agricultural sector the estimated additional total emission reductions in the WAM projection are 0.5 million tonnes CO_2 eq. in 2030. The main reductions are based on activities planned to be put into practice on organic soils, for example by intensifying long-term grass cultivation and reforestation. The potential emission reduction impact concerning N_2O emissions is 0.45 million tonnes CO_2 eq. in 2030. Use of biogas produced in the agriculture sector to replace fossil fuels is a new measure which will reduce CH_4 emissions in the agriculture sector in 2030 by 0.05 million tonnes CO_2 eq and in the energy sector in 2030 by 0.3 million tonnes CO_2 eq.

Measures identified to reduce N_2O emissions from organic soils will have effects also on the CO_2 emissions from the LULUCF-sector.

5.4 Total effect of policies and measures

The aggregated estimates for the greenhouse gas reduction impacts of already implemented individual policies and measures presented in Chapter 4 are 12, 20, 34 and 42 million tonnes CO_2 eq. for 2010, 2015, 2020 and 2030 (without LULUCF), respectively. The planned measures will reduce greenhouse gas emissions increasingly in the 2020s reaching an additional annual reduction of 6.3 million tonnes CO_2 eq. in 2030. The total effect of the policies and measures by gas is shown in Table 5.11.

Table 5.11
The total effect of the policies and measures (PaMs) calculated based on estimated impact of PaMs (see Tables 4.3–4.11, excluding Table 4.7 and Table 4.10) for the year 2015, 2020 and 2030 (million tonnes CO_2 eq). The total emissions in 2015 based on the most recent inventory are also given for comparison.

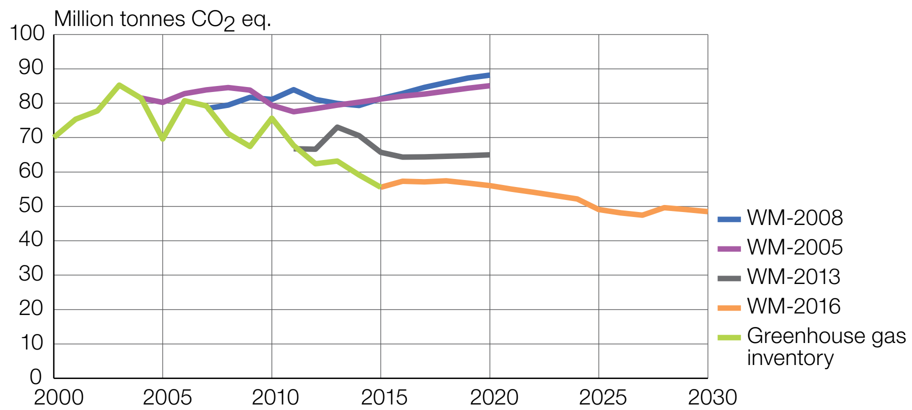
	Total emissions in 2015	Implemented measures			Planned measures		
		Total effect of PaMs in 2015	Total effect of PaMs in 2020	Total effect of PaMs in 2030	Total effect of PaMs in 2015	Total effect of PaMs in 2020	Total effect of PaMs in 2030
CO_2	44.4	18.8	28.9	36.2	0	0	5.5
CH_4	4.9	0	2.9	3.4	0	0.0	0.05
N_2O	4.7	0	0	0	0	0.0	0.5
F-gases	1.6	1.4	1.8	2.8	0.0	0.0	0.3
Total	55.6	20.2	33.6	42.4	0.0	0.0	6.3

The total effect of policies and measures contains noticeable uncertainties. The impact estimates of individual policies and measures are not fully additive, which may result in an overestimation of the mitigation impact in certain sectors. The overlapping effect of measures has been paid due attention to for example in the case of simultaneous increase of biofuel content and energy efficiency in the transport sector and in heating. The mitigation impact has, however, not been estimated for all policies and measures. Consequently, the total emission reduction can be larger than the reported total effect.

Figure 5.7 shows Finland's greenhouse gas emissions in the WM projections in the last four national climate and energy strategies, i.e. strategies from the years 2005, 2008, 2013 and 2016. The WM projections in the previous national climate and energy strategies projected significantly higher emissions for 2015 than those reported in the latest greenhouse gas inventory. This suggests that the additional measures implemented in the 2010s have had a substantial impact on the total emissions.

The main difference between the projections shown in Figure 5.7 is that in the newest projection, many measures from previous WAM projections have been implemented and then included in the WM projection. Major additional measures that have been implemented since the Sixth National Communication concern energy efficiency improvements in the existing building stock and reduced deposition of biodegradable waste in landfills. The projections differ mostly compared to the previous National Communication in terms of waste treatment, road transport, space heating of buildings, and electricity supply. In

Figure 5.7
Greenhouse gas emissions according to the most recent inventory for 2000 to 2015 and in the WM projections of the climate and energy strategies published in 2005, 2008, 2013 and 2016 up to 2020 and 2030 respectively.



addition, the global recession and the structural adjustment of the Finnish forest industry have been taken into consideration in the 2013 and 2016 strategy but not in the previous ones. Finland is not, according to the energy and climate strategy from 2016, any longer aiming at self-sufficiency of electricity supply as there is no rational for it in a power market that is rapidly integrated regionally as well as on a European-wide level. Part of the condensing power assumed in the projections of earlier years is in reality substituted with electricity import. The current WM and WAM projections try to reflect the international electricity exchange in a realistic manner. Without an aim of self-sufficiency the domestic greenhouse gas emissions in electricity supply are somewhat lower and have smaller yearly variations.

The total effect of implementing additional measures can be seen in the emission development trend after 2015, which has levelled off in the 2013 and 2016 projections, whereas it continued to increase in the projections from 2005 and 2008.

In the current WM projection, the emissions in 2020 are projected to be about 35 per cent below the projected levels in 2005 and 2008 WM projections and 14 per cent below the 2013 WM projection.

5.5 Economic impacts

VTT Technical Research Centre of Finland Ltd has assessed the impacts of the policy measures[8] of the National Energy and Climate Strategy for 2030 on the energy system and national economy.

The impact assessment compares the impacts of the new policy measures of the WAM scenario to the development in the WM scenario. For the economic impact assessment, a dynamic applied general equilibrium model that describes the economy from the perspective of decisions made by households, companies and the public sector is used.

In the WAM scenario, reductions in greenhouse gas emissions will mainly be achieved by means of energy system and non-ETS sector measures. The impacts of emissions trading are already taken into account in the WM scenario. However, the structure of both the production and consumption change in the WAM scenario, which has an impact on the budgetary position of the public sector. In addition, the support required by biorefineries increases public expenditure, while the growing share of biofuels and a slower transport performance reduces the fuel tax accrual. In the modelling, it is assumed that budget neutrality is achieved by a small increase in commodity tax (for example, through value added taxation).

In addition to the impacts associated with central government finances, increasing the share of biofuels by means of the distribution obligation will also push transport costs up, as the price of renewable diesel is higher by some 33 cents/l than the price of fossil fuels. As an estimate, this would mean that with a blending ratio of 30 per cent, diesel users would incur an annual additional cost of EUR 200 million compared to the current prices. Similarly, replacing light fuel oil with bioliquids in heating and machinery will increase the users' costs. A blending ratio of 10 per cent in light fuel oil will increase the fuel oil price by some 6 cents/l, or 8 per cent. If the oil consumption of an oil-heated low-rise building is 3 000 l a year, the annual cost impacts will be approx. EUR 180 million. As regards machinery, the cost increase ensuing from the blending obligation would primarily affect businesses and agriculture. The increase in fuel oil costs will be approx. 8 per cent, or similar to the cost increase of oil heating. The absolute effects will, however, depend on company size and machinery use.

The impact of the WAM measures on the national economy in 2030 is shown in Table 5.12.

8 http://tietokayttoon.fi/julkaisu?pubid=16902

Table 5.12
The impact of the WAM measures on the national economy

	Change compared to the WM scenario, per cent	Impact on the domestic product compared to the WM scenario, percentage points
Domestic product	–0.59	
Private consumption	–0.40	–0.23
Investments	–0.85	–0.10
Public consumption	0.00	0.00
Exports	–1.75	–0.76
Imports	–1.33	0.49

The domestic product in 2030 is in the WAM scenario approx. 0.6 per cent smaller than in the WM scenario. This is caused by lower private consumption and investments than in the WM scenario and a slowing down of foreign trade. The decline in exports affects the domestic product most. On the other hand, imports also decline, which increases the domestic product.

While the change in employment in the national economy as a whole is put at -0.15 per cent, it is expected that primary production and energy supply sectors preserve their current employment levels.

More employment is created especially in the production of biofuels and bioenergy. The increase in the biorefining of forest raw materials (300 ktoe) increases employment by 2,000 person-years. In other biorefining sectors, the increase (300 ktoe) is estimated to be 150 person-years. It is expected that the 2 TWh increase in wind power capacity will create 400 person-years' worth of employment.

As coal use is phased out, chip and pellet boilers and heat pumps will replace coal in the heat production. The quantitative impact on employment is, however, difficult to estimate.

5.6 Sensitivity analysis of the projections

Energy use and hence the greenhouse gas emissions are sensitive for the assumptions made on economic growth. Sensitivity analysis has therefore been carried out for the WM projection varying the economic growth of industry and service branches as well as the building sector. No sensitivity analysis on the transport sector was made, but generally, a lower economic growth would have both a reducing and an increasing impact on the energy use for transport. On one hand, the need for transport is likely to be lower, but on the other hand, the renewal of the transport fleet slower. In the sensitivity analysis, the energy use in the transport sector is kept unchanged.

The manufacturing industry uses about 45 per cent of the country's final energy consumption and 47 per cent of the electricity. The forest industry has a significant impact on the energy sector, including renewable energy production, energy consumption and production. Iron and steel production is another energy-intensive branch, the development of which influences the projections noticeably. The energy balances projections of these branches are based on product group specific volume estimates. Both branches develop generally positively in the WM projection, even though some product groups continue to decrease (e.g. manufacturing of paper).

In the sensitivity analysis the annual growth of the volumes in forest industry and metal industry is 1 percentage point less than in the WM scenario from 2017 onwards. This lower growth reduces the energy consumption in the forest and metal industry with 4 TWh in 2020 and 12 TWh in 2030 compared to the WM scenario. Corresponding values for electricity consumption reduction is 1 TWh in 2020 and 3 TWh in 2030.

Both branches produce a part of their power themselves, so the net effect on the country's electricity balance is somewhat smaller.

A lower economic growth projection for the building sector has also been formed. The effect of a lower economic growth on construction and on the use of heating sources was assessed. The analysis is presented in a report published by the Finnish Environment Institute. Economic growth has a considerable influence on two factors, namely on renovation of existing buildings and on construction of new buildings. Economic growth affects indirectly also the demolition of buildings. In times with low economic growth there are less energy efficiency improvements done in existing buildings. On the other hand, the total building stock increases slower due to less construction activity, but at the same time fewer old and less energy efficient buildings are replaced. All in all, the energy demand of the building sector decreases slower in the projection with low economic growth than in the WM projection.

In addition to the branches and sectors mentioned above, the development of the other industry and service branches was varied by lowering the annual growths with 1 percentage point from the WM assumptions. No dynamic effects were taken into account. The overall effect of a lower economic growth results in a cease of the final energy consumption increase already after 2018. In 2030 the final energy consumption would be only 290 TWh and the total energy consumption 387 TWh. The greenhouse gas emissions would be 4 Mt CO_2 eq. lower than in the WM projection. Most of the emission reduction would, however, take place in the ETS sector, only 0.4 Mt CO_2 eq. in the non-ETS sector.

The main results of the sensitivity analysis are presented in Table 5.13.

Table 5.13
Main results from the sensitivity analysis on how the economic growth rate affects the overall energy balance and greenhouse gas emission

	2015	2020		2030	
	Historical	WM	Lower growth	WM	Lower growth
Primary energy consumption, TWh	363	407	398	418	387
Final energy consumption, TWh	294	311	303	313	290
Electricity consumption, TWh	82	88	85	91	85
Share of renewables in final energy consumption, %	39.3	43	43	47	47
GHG emissions, million tonnes CO_2 eq.	55.6	56	55	48	44
of which non-ETS emissions, Mt CO_2 eq.	29.9	29	29	26	26

5.7 Supplementarity relating to the Kyoto Protocol mechanisms

Finland's total greenhouse gas emissions in the 2008–2012 commitment period were 338,353,531 t CO_2 eq, approximately 5 per cent lower than the assigned amount, which was 355,017,545 tonnes CO_2 eq. Finland met its commitment by retiring 338,353,531 Kyoto Protocol units at the end of commitment period.

Of the total amount, 12,273,471 were CERs and 4,088,755 were ERUs. These Kyoto Protocol mechanisms units were units acquired by Finnish ETS operators which, according to EU ETS legislation, were entitled to cover a part of their EU ETS obligations through Kyoto Protocol mechanisms.

Finland did not retire any Kyoto Protocol mechanisms units to cover its emissions from non-ETS sector. The CERs and ERUs acquired through the Government purchase programme were carried over to the second commitment period of the Kyoto Protocol.

Finland has requested 14,018,572 AAUs, 6,798,242 CERs and 2,917,220 ERUs to be carried over to the second commitment period of the Kyoto Protocol. The AAU amount includes 10,000,000 AAUs transferred by the European Union from the Union Registry to Finland's holding account[9]. The transfer was made for the purpose of enabling Finland's compliance with its commitments in the second commitment period under the Kyoto Protocol after international LULUCF accounting rules were changed by Decision 2/CMP.7.

The estimated total effects of the policies and measures for 2020 mentioned in the Section 5.4 indicate that the Kyoto target for the second commitment period will be met entirely by domestic actions, and the possible use of Kyoto Mechanisms would be supplemental to domestic actions.

5.8 Methodology

5.8.1 Approach and responsibilities

The reported WM and WAM projections are integrated energy and climate projections that were originally compiled in 2016 for the preparation of the National Energy and Climate Strategy for 2030.The preparation of the strategy was coordinated by the Ministry of Economic Affairs and Employment under the Ministerial Working Group on Bioeconomy and Clean Solutions.

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 Economic Affairs and Employment, 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 ministries have consulted expert organisations for acquiring data, assessments of policies and measures and modeling of sector-specific projections. Following authorities and expert organisations contributed to the reporting in 2017: the Energy Authority, Finnish Environment Institute (SYKE), VTT Technical Research Centre of Finland Ltd, Motiva Ltd, Tampere University of Technology, Natural Resources Institute Finland, Finnish Transport Safety Agency, VATT Institute for Economic Research, Benviroc Ltd and Statistics Finland.

The main models and methods used in the work are briefly described in Section 5.8.3. The Ministry of Economic Affairs and Employment 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 agriculture and land use, land-use change and forestry sectors.

9 Commission Implementing Decision 2014/224/EU

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 5.5 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 2.6 million to approximately 3.0 million by 2035. At the same time, however, the average size of households will decrease. The number, structure and location of households will have an impact on the energy demand.

The GDP is assumed to increase in the coming years. In the projections the annual growth during 2016 to 2020 is on average 1.6 per cent. In the 2020s the growth will be higher, 2.6 per cent per annum on average, as the Government's reforms are starting to pay off and the competitiveness of the Finnish economy increases.

The activities that will sustain most growth in production in the 2020s are expected to be machinery and equipment manufacturing, forest industry, and financial and insurance business.

The international fuel price estimates are taken from the IEA's World Energy Outlook publication (IEA 2015). The price of crude oil is assumed to be USD 80/barrel in 2020 and USD 113/barrel in 2030. The price of natural gas is the corresponding years assumed to be USD 27/MWh and USD 38/MWh, respectively. Emission allowance prices are expected to rise in 2020 to EUR 15/ t CO_2 and in 2030 to EUR 30/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 5.15–5.18.

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

		Historical						Projected		
	Unit	1990	1995	2000	2005	2010	2015	2020	2025	2030
Population	Million inhabitants	4.99	5.11	5.18	5.25	5.38	5.50	5.63	5.75	5.85
Gross Domestic Product	Million EUR, 2010 prices	126,000	123,000	158,000	180,000	187,000	187,000	201,000	229,000	260,000

Table 5.15
Primary energy by energy source and gross final energy in 2010, 2015 and in the WM projection for 2020 to 2030, TWh

	2010	2015	2020	2025	2030
Oil, incl. bio-fraction	97	86	81	78	77
Hard coal	40	17	15	11	7
Coke, blast furnace and coke oven gas	12	11	15	16	17
Natural gas	41	23	27	25	22
Nuclear energy	66	68	106	114	123
Net imports of electricity	11	16	2	2	1
Hydropower	13	17	14	15	15
Wind and solar power	0	2	5	6	7
Peat	27	16	20	17	15
Wood fuels	90	92	104	111	118
Others	10	15	15	16	17
Total energy consumption	407	363	407	411	418
Final energy consumption	319	294	311	312	313

Table 5.16
Energy sources for district heat and combined heat and power production in 2010, 2015 and in the WM projection for 2020 to 2030, TWh

	2010	2015	2020	2025	2030
Hard coal	14	12	10	5	2
Oil	3	1	1	1	1
Natural gas	23	11	12	10	8
Peat	12	9	12	9	8
Wood fuels	12	16	20	25	29
Other renewables	1	2	4	4	4
Other	2	3	3	4	5
Total	66	54	63	59	57

Table 5.17
Electricity supply in 2010, 2015 and in the WM projection for 2020 to 2030, TWh

<table>
<tr><th></th><th>2010</th><th>2015</th><th>2020</th><th>2025</th><th>2030</th></tr>
<tr><td>Hydro power</td><td>13</td><td>17</td><td>14</td><td>15</td><td>15</td></tr>
<tr><td>Wind and solar power</td><td>0</td><td>2</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>Nuclear energy</td><td>22</td><td>22</td><td>35</td><td>43</td><td>40</td></tr>
<tr><td>CHP, district heat</td><td>18</td><td>13</td><td>15</td><td>13</td><td>12</td></tr>
<tr><td>CHP, industry</td><td>10</td><td>8</td><td>11</td><td>12</td><td>12</td></tr>
<tr><td>Condensing power</td><td>14</td><td>4</td><td rowspan="2">tot. 7</td><td rowspan="2">tot. 1</td><td rowspan="2">tot. 6</td></tr>
<tr><td>Net imports</td><td>11</td><td>16</td></tr>
<tr><td>Total supply</td><td>88</td><td>82</td><td>88</td><td>89</td><td>91</td></tr>
</table>

Table 5.18
Energy sources in transport in 2010, 2015 and in the WM projection for 2020 to 2030, TWh

	2010	2015	2020	2025	2030
Motor gasoline, fossil	18	16	14	12	11
Diesel fuel, fossil	27	24	24	24	24
Liquid biofuels	2	6	6	6	5
Electricity	0.7	0.7	0.8	1.0	1.2
Other	4	3	3	3	3
Total	51	49	48	46	45

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. It is estimated that the share of bio-based fuels will increase to 13.5 per cent in 2020 and remain at this level thereafter.

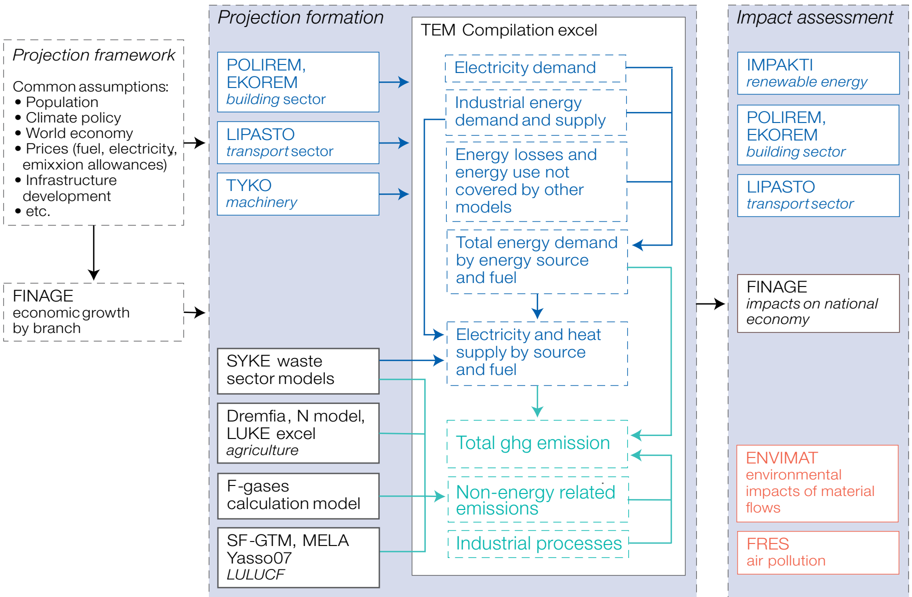
The landfilling of waste is increasingly replaced with recycling and energy recovery. In 2010, the amount of municipal waste incinerated at waste incineration plants was approximately 244,000 tonnes. Several new waste incineration plants have been constructed in recent years and in 2015 the incinerated amount was already more than 900,000 tonnes. The WM projection estimates that from 2020 onwards, the amount of municipal waste incinerated at waste incineration plants will be more than 1,240,000 tonnes per annum. In addition, co-incineration plants are expected to use 420,000 tonnes of waste-based fuels annually. Currently waste co-incineration is included in the emissions trading sector. The transfer of all waste incineration to the emission trading sector will be explored.

Assumptions and data sources for the different sectors are presented in more detail in the background report that was prepared for the National Energy and Climate Strategy for 2030.

5.8.3 Description of models and methods

A fairly large number of models are applied for the preparation of the greenhouse gas emission projections and for impact assessment of policy measures. Individual models that are central for energy and greenhouse gas emission projections are described in the sections below. The relationship and data flow between the different models is shown in Figure 5.8. Data from sector specific models are compiled by the Ministry of Economic Affairs and Employment in the module named 'TEM Compilation excel' in Figure 5.8 The same excel is used for calculating the projected energy balances and greenhouse gas emissions of the industry and the electricity and district heat production. The methodology for this is presented below under the heading 'Energy demand and production'.

Figure 5.8
Schematic diagram of the relationship and data flow between the different models applied in the projections and impact assessment of policy measures.



Buildings

The impacts of policies and measures in the WM projection were estimated using EKOREM and POLIREM models. 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 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. The model is further developed and a calculation and visualization approach for energy use and greenhouse gas emissions is presented.

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[10] 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 uses official energy and building stock statistics of Finland and 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. These two modelling tools have been used for previous National Communications

Energy demand and production

The Ministry of Economic Affairs and Employment 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 (auto producer plants), as well as on assumptions about electricity net imports. Information on existing and planned power plants and their possible dismantling and construction schedule, respectively, is used. Studies including extensive market simulations performed by Pöyry Management Consulting Oy in 2016 have been used for the projections of electricity and district heat supply.

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

10 U-values (sometimes referred to as heat transfer coefficients or thermal transmittances) are used to measure how effective elements of a buildings fabric are as insulators. That is, how effective they are at preventing heat from transmitting between the inside and the outside of a building

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. Since 2015, the road traffic submodel LIISA includes also a more detailed template for calculating the projections and implications of alternative powertrain and energy options called ALIISA. 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, but re-adjusted by VTT in 2015, as described in Section 4.8. With this re-adjustment, the fuel consumption was assumed to decrease by 3.5 per cent in vehicles using both petrol and diesel yearly. The changes in the vehicle fleet are taken into account based on the estimated annual sales of new vehicles and the scrappage rate, being for cars about 7 per cent of the fleet size and corresponding to an average vehicle age of 11 to 12.5 years. 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.

Machinery

Emissions for machinery are estimated with TYKO-model which is part of the LIPASTO model. TYKO is a deterministic model that gives results of emissions and the amounts of fuels used. The emissions for the following gases are calculated: carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx), Particles (PM), methane (CH_4), nitrous oxide (N_2O), sulphur oxide (SO_2), carbon dioxide (CO_2). The time period of the calculations is 1980-2040 and the model includes 50 types of machinery.

The calculation is based on the following key elements: performance and related emission factors (g/kWh) and fuel usage (g/kWh). The method is widely used, for example, in the Non-Road model used by US EPA (Environmental Protection Agency) and in the CORINAIR Off-Road Vehicle and Machines model. It has been adjusted to Finnish circumstances, e.g. for age and attrition of the machinery. The method is in compliance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories and EMEP/EEA Emission Inventory Guidebook.

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). A completely new calculation model for F-gas emissions and emission projections in the refrigeration and air conditioning equipment sector was built during 2016. The model covers the years 1990 to 2050 and is divided into fifteen different subsectors (equipment types). The emissions estimation methodology in the model is the Tier 2 emission factor approach of the 2006 IPCC Guidelines (Volume 3, Section 7.5).

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 model has been frequently used in evaluating impacts of agricultural and agri-environmental policies. For this reason the model has also been continuously updated and re-validated based on available statistical information on, e.g., input and output prices, food consumption, use of inputs, production, land use and productivity in agriculture. Parameters and principles of agricultural policy have been updated annually as well when necessary. The results from Dremfia were fed into the calculation models (Luke excel in Figure 5.8), which are used for the greenhouse gas emission inventory (see the most recent National Inventory Report for details). Dremfia produces most of the input data for the greenhouse gas projections 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 variables (not included as such in the Dremfia model) 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 projections are based on statistics and modelling following IPCC guidelines. The scenario tool is thus primarily an emissions calculation model, which is complemented with expert judgments on how rapidly the measures will affect the waste sector. The same basic modelling tool has been used in previous National Communications.

The projection 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 (landfilling, biological treatment, incineration, recycling). Emissions from wastewater treatment, composting and anaerobic digestion 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[11]. 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 Yasso07 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). Yasso07 model and methods of the greenhouse gas inventory were used to estimate carbon stock changes also for cropland and grassland.

Economic effects

FINAGE is a dynamic, applied general equilibrium (AGE) model of the Finnish economy. FINAGE is based on the MONASH-model developed at the Centre of Policy Studies. MONASH-style models are used in countries ranging from China and South Africa to the United States and Australia. In Europe, models based on MONASH have been developed for Denmark, Finland, and the Netherlands. VATTAGE, a precursor of FINAGE, is described in detail in in Finland's sixth National Communication[12].

Several factors explain the popularity of MONASH. The main ones are the advanced and user-friendly software packages that facilitate data handling and the set-up of complicated policy simulations, and that also allow a very detailed post-simulation analysis of simulation results. MONASH-type models are also very adaptable to analyses of different types of policies and different time frames. In forward-looking policy analysis, MONASH-type models offer a disciplined way to forecast the baseline devel-

11 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

12 http://unfccc.int/files/national_reports/annex_i_natcom/submitted_natcom/application/pdf/fi_nc6[1].pdf

opment of the economy. They also allow the user to replicate and explain the historical development of an economy in great detail, which is not true for most AGE models.

In FINAGE, there are normally three types of inter-temporal links connecting the consecutive periods in the model: (1) accumulation of fixed capital; (2) accumulation of financial claims; and (3) lagged adjustment mechanisms, notably in the labour markets and 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 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.

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YASSO model, http://en.ilmatieteenlaitos.fi/yasso

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, different sectors of the economy and society. The chapter includes an outline of efforts to assess vulnerability. The national framework of adaptation to the impacts of climate change is explained. The expected impacts are described together with adaptation measures in each sector. Finally, international aspects of Finnish adaptation are briefly discussed.

Photo: Riku Lumiaro / Image bank of the Environmental Administration

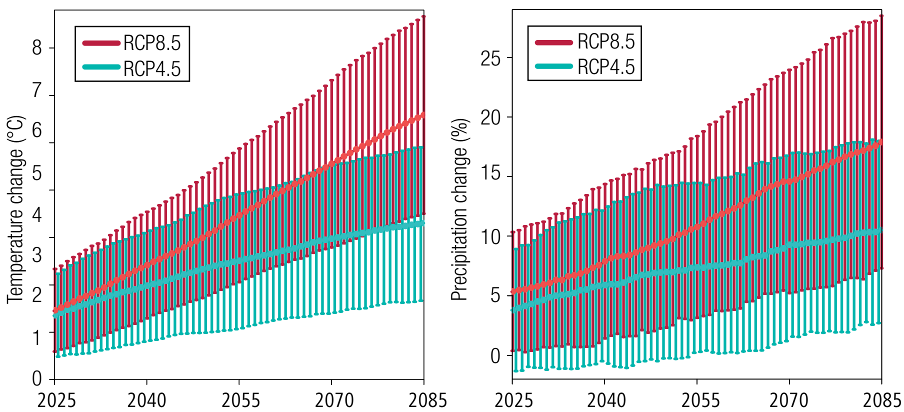
6 CLIMATE CHANGE IMPACTS, ADAPTATION MEASURES AND VULNERABILITY ASSESSMENT

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 (referred to as the "forcing" of the climate), (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 (90 per cent confidence intervals) for the future evolution of annual mean temperatures and precipitation rates in Finland for two forcing 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, on average, to be 2.5°C by mid-century and 3.3°C by the end of the 21st century under the RCP4.5 scenario, and 3.5°C

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 1981 to 2010. The thick solid lines represent the multi-model 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)



and 5.6°C under the RCP8.5 scenario, respectively. The average temperature increase in Finland is expected to be 1.5 to 2 times as large as mean warming globally. The projected increase in precipitation is substantial as well. Both forcing scenarios lead to quite a similar evolution of temperatures and precipitation rates until about the 2030s. 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 also fairly large.

Both the increases in temperatures and precipitation rates will be larger in winter than in summer (Figure 6.2). If the RCP8.5 scenario were realized, the January mean temperature would increase by 4 to 11°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.

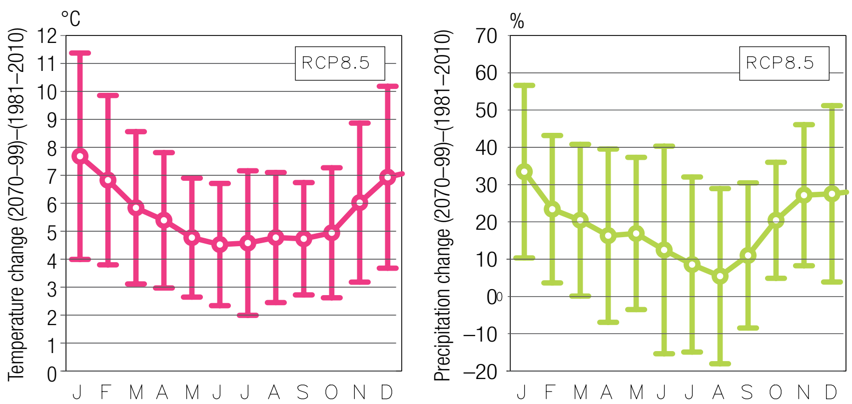
Compared to the climate scenarios generated by the previous model ensemble (which was used to prepare the IPCC's 4th Assessment Report), the present mean summer temperature projections are as much as 1°C higher. This can be deduced by comparing the RCP4.5 and SRES B1 scenarios; the evolution of greenhouse gas concentrations is nearly equal in both scenarios. Conversely, winter temperature projections and precipitation scenarios for all seasons are fairly similar in the two groups of models.

The new temperature and precipitation projections were not published until February 2013, and hence most of 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 models) include the following:

- Heatwaves will become longer and more frequent, whereas severe cold spells will gradually diminish.
- Heavy precipitation events will intensify in summer.
- The number of days with precipitation will increase in the winter.
- The snow season will become shorter and the snow water equivalent will decrease on average, particularly in southern Finland.

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 multi-model mean projection. The 90 per cent confidence interval for the change is denoted by vertical bars. The changes are presented for the period 2070 to 2099, relative to 1981 to 2010, under the RCP8.5 scenario.



- 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.
- Wind speeds may remain nearly unchanged but inter-model scatter is large. This does not rule out the possibility of increasing frequency of strong winds, especially in the coastal areas.

6.2 Assessment of risks and vulnerability to climate change

This section provides an overview of recent activities in assessing risks and vulnerabilities to climate change in Finland. It provides a foundation for the following section 6.3 that describes adaptation actions in response to both observed and anticipated climate impacts, risks and vulnerabilities in different sectors of the society. This section is primarily based on recently completed and ongoing research activities (see also Chapter 8).

Risk and vulnerability assessments have been carried out in national research projects and programmes, and as part of Nordic and European research efforts. Research outputs contribute to a better understanding of key vulnerabilities and risks related to climate change. This type of knowledge is instrumental as a basis for adaptation measures, as is also called for by the National Plan for Adaptation to Climate Change 2022.

Completed national research programmes include the National Climate Change Adaptation Research Programme (ISTO, 2006 to 2010) that funded 28 studies on the vulnerability and a number of synthesis studies, and the Academy of Finland funded Finnish Research Programme on Climate Change (FICCA, 2011 to 2014) that included five projects specifically addressing climate change risks and vulnerability. A recently completed national project on Proactive management of weather and climate related risks (ELASTINEN, 2015 to 2016) generated new information on climate risk management particularly for urban areas and the energy, water and agriculture sectors. The project also assessed costs and benefits of climate risk management and cross-border impacts of climate change on Finland. A follow-up project is currently ongoing (SIETO, 2017 to 2018).

Other recent and ongoing studies of risks and vulnerability include the following:

- Water: mapping of significant flood hazard and risk areas (legal requirement based on national implementation of the EU Floods Directive); hydrological and climate modelling (FICCA research project ClimWater).
- Forest: impacts of high winds, heat spells, drought, snow and frozen ground, and winter temperatures, also research projects on uncertainties, and risks to forests and forestry (ADAPT and ongoing FORBIO projects).
- Biodiversity: species and dynamic vegetation modelling of butterflies and birds; adaptation options available for conservation planning including legal and economic constraints (FICCA research project A-LA-CARTE)).
- Agriculture: studies on changes in cultivated areas of crop species, introduction of novel crops for cultivation and changes in crop rotations at regional and national level (PeltoOptimi and OPAL-Life projects). 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. A recently completed research project focused on means to improve resilience to climate change and variation induced risks in agriculture (ILMAPUSKURI).

- Natural resource sectors: thorough analysis of vulnerability of natural resources sectors (agriculture, forestry, game and fisheries and reindeer management) was carried out as a part of the State of Adaptation Assessment project (SOPEUTUMISEN TILA project).
- Infrastructure and the built environment: variability in hydropower reservoirs and predictability of hydropower production in the Nordic countries; sensitivity of urban real estate price formation to changes in exposure to climate risks; forecasting methodology for extreme weather event frequencies (FICCA research project RECAST).
- Health: studies on the health effects of heatwaves, including identification of vulnerable population groups and evaluation of preparedness in health care facilities; evaluation of health risks posed by compromised drinking water quality due to climatic and other factors (CONPAT project); ongoing work on vulnerability of the elderly to climate change (PLUMES project).
- Arctic region: identifying different risks (posed by climate change but also geopolitical and security-related risks) and opportunities for marine transport and tourism in the Arctic; socio-economic scenario-based assessment for the Eurasian Arctic (MERMAID research project); impacts of climate change on the Artic environment, ecosystems and societies (FICCA research project CLICHE). The Arctic region and in particular the Barents Region was also studied in a recently completed project Adaptation Actions for a Changing Arctic (AACA).
- Social vulnerability at local level: Analysis of social vulnerability to climate change in the Helsinki metropolitan area (Helsinki Region Environmental Services Authority, HSY).
- Uncertainties: improving the treatment of key uncertainties in climate change impact, adaptation and vulnerability analysis, with a focus on Finland and two sectors, agriculture and human health (ongoing PLUMES project).

Finnish research institutes have participated in numerous European funded research projects that have generated relevant information for developing adaptation policies and measures in Finland. These include EU FP7 projects BASE, ToPDAd, EWENT, OPENNESS and IMPRESSIONS. Finnish researchers also contributed to joint work between the MEDIATION project and UNEP's Global Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA) to develop the PROVIA/MEDIATION Adaptation Platform for climate change adaptation methods and tools. Finnish research institutes have participated in several European Joint Programming Initiatives (JPIs), for example, work on agricultural model intercomparison and improvement for studying climate risks to agriculture and adaptation responses (MACSUR). Finnish research institutes also participate in Nordic Centres of Excellence (NCoE) with relevance to risk and vulnerability, such as the NCoE NORDRESS on societal security and natural hazards.

Tools to help actors consider possible impacts and vulnerabilities have been developed and have also been made available through the web portal Climateguide.fi. The most recent feature is a vulnerability mapping tool (based on results of the MAVERIC project) that illustrates how vulnerable cross-country skiing or the elderly population could be to impacts of climate change in different parts of Finland. For example, indicators of projected future exposure of the elderly to heat, cold and slippery conditions under a changing climate in different parts of the country can be combined with indicators of adaptive capacity and mapped nationally. Climateguide.fi also allows stakeholders to get access to spatially disaggregated information on climate projections and projected impacts.

6.3 Climate change impacts and adaptation measures

This section is an update of Finland's Sixth 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 Economic impacts

Climate change has a direct impact on nature, 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. Cross-border effects of climate change is one area where economic impacts are likely to be notable in the future. Section 6.4 describes the pathways through which such indirect impacts are expected to affect Finland. According to a study, economic impacts of climate change have been estimated to be considerable for different sectors in Finland (Table 6.1.) although significant uncertainties need to be taken into account. These estimated impacts are potentially beneficial for some sectors, however, it must be noted that active adaptation is required to realise such opportunities. For example, it is estimated that gradual changes, such as the increase in average temperatures, may benefit some natural resource sectors, such as agriculture, forestry and outdoor recreation business and tourism. Active and proactive adaptation are needed in these sectors because uncertainties related to future variability of the climate and to impacts are

Table 6.1
Sectoral estimates of the economic impacts of climate change in Finland (positive economic impact figures denote a net benefit) from a study on 'How to adapt to inevitable climate change – A synthesis of Finnish research on adaptation in different sectors' (Ruuhela et al. 2012).

Sector	Economic impacts
Tourism	By 2020, EUR 107 million; by 2050, EUR 107 million; by 2080, EUR 107 million (changes in net value added).
Insurance	Weather and climate risks increasing, no overall estimates on economic impacts.
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.
Forestry	By 2020, EUR 75 million; by 2050, EUR 150 million; by 2080, EUR 250 million (changes in net value added).
Biodiversity	No economic estimates. An estimate of EUR 10,000 million regarding negative impacts within Europe.
Health and welfare	No economic estimates.
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.
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.
Energy sector	By 2020, EUR –37 million; by 2050, EUR –73 million; by 2080 EUR –141 million (changes in net value added).

considerable and risks are variable, e.g. risks of damages caused by invasive alien species, pests and diseases. 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 conditions of different sectors.

The water sector is estimated to be most affected by the climate change impacts. In the current climate, the direct costs from heavy rain events, with a 10 per cent annual probability, have been calculated to amount to several million euros on average. More rare flood events, such as severe fluvial flooding, with a one per cent probability or less, have the potential to cause direct costs of EUR 100 million and over in the current climate. Climate change has been estimated to have the potential to add 15 to 20 per cent direct damage cost potential in some river basins in Finland over the next three decades in current built-up areas, while careless land use planning may aggravate the effect. Furthermore, the indirect economic costs of weather events may be higher than the direct costs, but these build up more slowly depending on how effectively an affected region recovers, and how strongly the affected region is interdependent with other regions. Additionally, droughts can cause major losses of up to EUR 100 million under the current climate in Finland (Table 6.3).

Storms that cause large damages 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. Table 6.2 contain damages and economic losses due to some major storms and severe weather events experienced in 2010 to 2015. These weather events caused significant losses mainly due to damage to infrastructures, i.e. powerlines, buildings, and forests, and interruptions to vital services like electricity distribution and

Table 6.2
Damages and costs of thunderstorms and wind storms in Finland in 2010 to 2015 (Gregow et al. 2016).

Name of the storm	Tapani storm	Thunderstorms Asta, Veera, Lahja and Sylvi	Eino storm	Valio storm
Duration	Dec 26–28, 2011	Jul 29 – Aug 8, 2010	Nov 17, 2013	Oct 2–3, 2015
Number of injured people	–	40–50	2	1
Volume of storm-felled trees (m^3)	3.5 million	8.1 million	1.5 million	0.5–1.5 million
Value of storm-felled trees (EUR)	120 million	not known	60 million	20–50 million
Losses to forest owners (EUR)	25–30 million	not known	30 million	not known
Impacts to electricity distribution (number of households without electricity)	570,000	481,000	200,000	232,000
Compensations paid by the electricity network companies (EUR)	40 million	10.3 million	not known	9 million
Repair costs of electricity networks (EUR)	30 million	22 million	not known	8 million
Number of damaged buildings	665	not known	99	91
Compensations paid by the insurance companies (EUR)	100 million	82 million	30 million	not known

Table 6.3
Costs of the damages in euros caused by droughts in Finland in 2002 to 2003 (Gregow et al. 2016)

Drought	Damages to water supply	Damages to hydro-power production	Damages to agriculture	Damages to forestry	Damages to building stock
Drought 2002–2003*	8 million	50 million	15 million	2 million	million

* between August 2002 and April 2003 precipitation in southern Finland was less than half compared to the average

transport. The repair costs of electricity networks caused by the four recent storms exceed the estimated costs within the energy sector assessed to be realized by 2020 in Table 6.1. The climate change impacts, economical and other, have been taken into account in the energy sector: For example, recent legislation on the electricity markets sets requirements for the maximum duration of interruptions in electricity supply for the distribution system operators, which will imply investments up to EUR 3,500 million in infrastructure. Improvement of power supply infrastructure has already began. Some of the general changes in society, such as the population ageing, will further reinforce the impacts of climate change and require changes in the adaptation measures.

6.3.2 National adaptation strategy and the current level of adaptation

Finland was one of the first countries in the world to adopt a policy to guide climate change adaptation (Finland's National Strategy for Adaptation to Climate Change 2005). The second evaluation of the implementation of the adaptation strategy in 2013 found that overall progress had been made compared to the first evaluation in 2009: Climate change impacts are recognized in most of the sectors and adaptation measures identified in the strategy have been launched. The 2013 evaluation included recommendations for the revision of the strategy such as further promotion of cooperation between authorities and other actors in different sectors and administrative levels, as well as further promotion of regional and local adaptation measures. The evaluation also recommended clarification of the division of labour and responsibilities between the state, municipalities and private sector. For the revision of the national adaptation strategy, a further study of the impacts of the climate change and vulnerability of sectors was conducted in 2013. Vulnerabilities were identified in all sectors, but the nature of the expected impacts and vulnerabilities varied. The recommendations from the evaluation of the previous strategy and the vulnerability analysis in 2013 were considered in the preparation of the National Climate Change Adaptation Plan 2022 (Government Resolution on 20 November 2014), which describes the current national adaptation policy framework.

The aim of the adaptation plan is that the Finnish society has the capacity to manage the risks associated with climate change and adapt to changes in the climate. Based on the aim, the following objectives are to be achieved by the year 2022:

A. Adaptation has been integrated into the planning and activities of both the various sectors and their actors.
B. The actors have access to the necessary climate change assessment and management methods.
C. Research and development work, communication, and education and training have enhanced the adaptive capacity of society, developed innovative solutions and improved citizens' awareness on climate change adaptation.

The international repercussions of climate change are also taken into account in the national work. The Monitoring Group on Climate Change Adaptation was appointed in 2015 replacing the Coordination Group for Adaptation to Climate Change. The monitoring group is broadly-based, with representatives from the relevant ministries and other authorities, regional and local actors, research institutes, expert organisation in fire and rescue services, and financial services. Different research and development projects have produced essential implementation tools for the National Climate Change Adaptation Plan. The projects produced comprehensive knowledge on the impacts of climate change and vulnerability in different sectors (e.g. ISTO, ELASTINEN, SIETO, see Section 6.2 and Table 6.4). Table 6.4 summarises the status of the twelve main elements of the National Climate Change Adaptation Plan 2022 and includes short descriptions and examples of the current level of adaptation since 2014.

Finland's Climate Act was approved on 6 March 2015. It provides a framework for planning, implementing and assessing climate policies and improves cooperation among government offices in mitigation and adaptation. The law stipulates that the Government approves long-term and medium-term strategic mitigation plans and it will approve a national plan on adaptation at least every ten years. Adaptation is also included in the revised National Energy and Climate Strategy 2016.

The awareness of the climate risks and vulnerability of different sectors has increased recently (Chapter 6.2). Several sectors also have an action plan for adaptation (Table 6.4). For instance, the adaptation plan of the environmental administration was updated in 2016, covering the built environment, natural environment and water resources sectors. The action plan for the adaptation to climate change of the Ministry of Agriculture and Forestry 2011 to 2015 will be revised in 2017 to 2018, building on a comprehensive

Table 6.4
The fields of action in the National Climate Change Adaptation Plan 2022 and the current level/status of the work in 8/2017.

The fields of action (main elements) in the adaptation	Status	Description/ examples
1. Studies on climate resilience are conducted at national level.	In progress, completed for some sectors.	Vulnerability assessment of natural resources (2017) VAT* updated
2. Action plans for administrative sectors are formed and implemented, taking international repercussions of climate change into account.	In progress, needs more action, completed for some sectors.	• Climate Programme. for Finnish Agriculture – Steps towards Climate Friendly Food (2014) • Ministry of Environment Action Plan (2016) • The Energy and Climate Programme of The Finnish Defence Forces - objectives and measures (2014)
3. Drafting of regional and local adaptation studies is promoted.	In progress, completed for some regions.	• Vulnerability analysis of HSY* 2016 • Flood risk maps • Projects KUJA and KUJA2 (2014–2019) on continuity management of municipalities
4. Adaptation is promoted in international cooperation.	In progress	e.g.during the presidency of the Arctic Council (2017–2019)
5. Adaptation is included in EU policies and international region-based cooperation projects.	In progress	Implementation of the EU Adaptation Strategy (2013) Council of the Baltic Sea States (The Baltic 2030 Action Plan 2017)
6. Climate risk assessment and management are improved.	In progress	Research projects ELASTINEN 2015 to 2016, SIETO 2017 to 2018
7. Instruments applicable to the management of financial risks caused by climate change are developed.	In progress, completed for some sector	Study on Insurances (crop and flood) by the Finnish Climate Change Panel 2016
8. Adaptation research is reinforced.	Coming 2017	Plan for Research Programme 2017 (Tapio)
9. Business opportunities related to adaptation are developed.	Needs more action, in progress	Report 2016 (Tapio), cooperation with FIBS* and CLC* 2017
10. Tools to support regional adaptation work are developed.	In progress, completed for some sectors	Municipalities (ELASTINEN 2015 to 2016), Climate resilience tools for the public and private sector (Tapio 2016)
11. Communication on adaptation is developed.	In progress	Communication Action Plan 2017 by the Ministry of Agriculture and Forestry
12. Education and training content on adaptation is developed.	Needs more action	Study and teaching module Climate.now as MOOC* platform

* VAT = National land use guidelines, HSY = The Helsinki Region Environmental Services Authority,
FIBS = Finnish corporate responsibility network, CLC= Climate Leadership Council,
MOOC = the Massive Open Online Course platform of University of Helsinki. http://www.ilmastonyt.fi/studies.html

study of vulnerability and adaptation in agriculture, forestry, fisheries, game and reindeer husbandry sectors that was completed in 2017.

A significant share of adaptation measures are implemented at the regional and local level. Various measures promoting the preparedness for climate change, such as flood protection, have already been implemented on regional or municipal level quite a long time ago, though they have not been seen as adaptation measures as such. 16 out of 18 regions have published a climate strategy, which include a certain degree of adaptation. Two regions have decided to include climate and energy issues directly in the regional program in order to give them more emphasis and thus to make resources more efficient. In 2017, most of the 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 promoted further. By the end of 2015, regional flood risk management plans were published for every significant flood risk areas (16 areas), and currently the implementation of identified measures is going on. In addition, several bigger cities and municipalities have been active in adaptation especially in the area of HSY, i.e. the city of Helsinki (in vulnerability assessment) and the city of Vantaa (nature based solutions in runoff water management).

The monitoring of the National Climate Change Adaptation Plan 2022 has been developed together with various stakeholders. The monitoring and evaluation of adaptation to climate change has been promoted in 2015 to 2017 by building a national adaptation monitoring framework and its indicators in cross-sectoral work. In particular, climate change related risks to the society and its various functions are emphasized. Indicators include, e.g. risks to human health and adaptation measures executed in flood risk areas. Assembling of the indicators was completed and released in May 2017.

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) are at different stages in the adaptation. The most advanced sector is water management, where adaptation has already been integrated into decision making, and digital monitoring and risk management process have been developed. 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. In addition, the recent study on vulnerability of natural resources sectors included assessment of various risks such as the risks of alien species and local weather and climate risks.

The target to improve climate resilience in terms of everyday actions also improves 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 climate and risk assessment in general.

In future, the awareness of the importance of climate change adaptation alongside mitigation needs to be increased. 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. Although the main elements of the National Climate Change Adaptation Plan 2022 have broadly facilitated implementation and follow-up of adaptation measures in different fields of the society, there is need for further cross-sectoral cooperation and stakeholders' action to enhance climate resilience.

6.3.3 Climate change impacts on and adaptation measures for nature and natural resources

Biodiversity

Climate change is expected to increase the total number of species in the Finnish flora and fauna and will cause a turnover of species. Furthermore, considerable changes are likely to occur in the distribution patterns of species and habitats. Overall, the magnitude of warming in the boreal region is expected to be twice the global average, which will amplify the impacts for biodiversity and ecosystems in the region. Observed changes in species distribution are already aligned with the predictions of species-climate models.

A longer growing season and milder winters may lead to a rapid proliferation of a number of southern species that thrive in a warmer climate. Rare species currently living at the northernmost extreme of their distribution could become more common and many native species in the south could find favourable living conditions further north in the warming climate. In southern Finland, some invasive species could threaten the habitats of native species and the invasive species populations may expand rapidly if they lack natural enemies. However, many species may not be able to track changes in the climate due to low dispersal ability of individuals and fragmentation of preferred habitats. 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. Northern boreal species of forests, mires and Arctic mountain habitats are threatened and predicted to decline due to the warming climate (see also Box 6.1).

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 increase the collection of residues and small diameter round wood and thus 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, water birds 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.

Protected area networks of natural habitats alleviate the negative effects of climate change and provide resilience in preserving declining species of conservation concern. Intensive land use, such as forestry, strengthens the influence of climate change on biodiversity, because many species of natural habitats, such as mires and old-growth forests are negatively affected both by climate change and forestry. However, climate change also affects protected areas, which calls for consideration and anticipation of changes in conservation planning. A study on the viability of Finnish protected area networks in a changing climate is currently ongoing. Furthermore, ecological corridors are important for species adapting to climate change. The Green Belt of Fennoscandia (GBF) is one of Europe's most important ecological corridors and work is ongoing to promote ecological connectivity in the GBF.

Box 6.1

PRISTINE PEATLANDS

In southern Finland, an integral part of the boreal landscape are raised bogs, mire complexes with nutrient-poor and acidic ombrotrophic (deposition-fed) centres and minerotrophic (additionally fed by water inputs from the catchment) lags. In the north, these are replaced by aapa mires with characteristic extensive wet minerotrophic centres. The range of peatland habitats found within these mire complexes 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 between peatland types and years, being generally faster in ombrotrophic bogs than minerotrophic fens.

Summertime warming would increase evapotranspiration and lead to lowered water-table levels (WT) in peatlands. Further, the number of exceptionally dry summers is expected to increase. Lowered WTs may have a greater impact on peatland ecosystems than the warming itself. On the other hand, precipitation is also assumed to 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. Warming accompanied with drying would greatly affect the structure and functioning of pristine peatlands. The raised bog zone could migrate northwards while the northern aapa mires would retreat further north. Shifts from sedge-dominated fen habitats to Sphagnum-dominated bogs that characterise the raised bog systems could take place faster than at present. Species adapted to wet conditions would decline, as would species adapted to open habitats as peatland forests could largely replace open mires in all but the most nutrient-poor habitats. Consistent droughts during late summer, in particular, enable development of tree stands. In northernmost Lapland the palsas are in danger of thawing with the warming climate, and are already declining.

Switches from minerotrophy to ombrotrophy could accelerate carbon sequestration in the peat soil. However, drying will also lead to carbon losses from peat, caused by accelerated decomposition. Whether these soils would continue to function as carbon sinks depends on whether the litter inputs from the changed vegetation are large enough to more than compensate the enhanced decomposition. Judging on data from drained peatland forests, this would be most likely in the middle region of the soil nutrient gradient. Considerable variation in WT could lead to a state of “consistent disturbance”, where productivity and carbon sequestration are low, while carbon may be continually lost from the old deposits.

Changes in methane emissions will depend on changes in WT and vegetation. Mere warming may increase these emissions, but opposite results have also recently been observed in warming studies. Drying and 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, on the load of organic and inorganic matter from catchments.

In 2012, the Finnish Government approved a resolution on sustainable and responsible use and protection of mires and peatlands. The resolution directs human activities to peatlands which have been drained or whose natural state has otherwise been significantly changed, implements sectoral policies and measures for sustainable use, and improves the status of the existing network of protected peatlands. Under the resolution, a long-term peatland protection and restoration program will be carried out by 2025. ■

Water resources

According to results of climate change studies, annual runoff will, on average, increase moderately, but seasonal changes will be large. Winter discharges will increase significantly, particularly in southern and central Finland. The changes in runoff together with warmer temperatures will cause changes in nutrient loads, water quality, algal blooms and the aquatic environment.

Floods caused by spring snowmelt will decrease in southern and central Finland, but may remain at their present level in northern Lapland. Since most floods in Finland are at present spring floods, the flood risks may decrease in many locations. However, autumn and winter floods caused by precipitation will increase especially in large lakes and their outflow rivers.

Discharges during summer and early autumn will mostly decrease and droughts can become more severe due to earlier spring and increases in evapotranspiration. Low water levels can for instance decrease the recreational value of lakes and rivers. Water quality can also be negatively affected by changes in floods and droughts. Low flows boost concentrations of bacteria, algae and toxins in surface waters. High flows and intense rainfall increase erosion and the leaching of nutrients from catchments into watercourses and coastal waters.

Approximately two thirds of Finns depend on groundwater for their household water supply. If dry periods become longer in summer in southern Finland, groundwater levels will be reduced. This may also lead to a shortage of dissolved oxygen and high concentrations of dissolved iron, manganese and other metals in the groundwater. The shortage of dissolved oxygen may generate ammonium, organic matter, methane and hydrogen sulphide gases, causing the water to taste and smell bad. In wintertime, increasing precipitation and snowmelt will produce fresh and oxygen-rich groundwater.

Climate change impacts on water services can be notable. More frequent, extreme weather events, such as prolonged droughts, storms, heavy rainfall and floods, may cause problems. Storm blackouts can 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 actions also include precautionary measures including preparedness planning, improved cooperation between waterworks, guidelines on land use and further development and utilisation of databases and models. Revision of the Water Service Act in 2014 clarified requirements and responsibilities of water service providers in regard to preparedness and storm water management.

The safety of dams will need to be considered since intense rainfall is estimated to increase considerably in Finland. Increased extreme precipitation would cause problems for dams particularly along small rivers. Increases in floods are projected to be largest on dams where summer or autumn floods are the largest floods used as design floods. Dams where spring floods are design floods, climate change influence may vary as precipitation increases, but snow amounts decrease. However, major problems seem unlikely in this respect because most dams have quite large spillways. Lake regulation management strategies and permit changes are already becoming necessary for many of the regulated lakes in response to shifts in the hydrological regime induced by climate change. On several lakes, projects on changing regulation rules are ongoing and are at least partly prompted by recent mild winters and projected climate change.

Flood Risk Management Plans to 2021 (based on the EU Floods Directive) take into account adaptation to climate change. Their objective is to reduce flood risks, prevent and mitigate the adverse consequences caused by floods, and promote the level of preparedness for floods. Their 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. The first cycle of flood risk management planning ended in December 2015 when 12 catchment scale and four coastal flood risk management plans to 2021, covering all significant flood areas, were approved. At the end of 2016, altogether 16 of a total of 410 suggested measures had been implemented. Plans and measures will be updated every six years. The responsibility for storm water and melt water flood risk management lies with municipalities.

Adaptation to climate change is also addressed in the River Basin Management Plans to 2021, based on the EU Water Framework Directive. These plans were updated and

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. 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.

Due to the large natural climate variability in the region, detection of the global climate warming signal from the observational time series of the Baltic Sea is limited only to directly temperature related time series like sea ice extent and existence of severe ice seasons. These are also projected to experience considerably reduction during the next 50 years. Correspondingly, mild and extremely mild ice winters will become more frequent. The average maximum fast ice thickness in the 2040s will be approximately 30 cm less than for the period 1971 to 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. In order to serve coastal societies, the Finnish Meteorological Institute (FMI) has provided site-specific guidelines of extreme water levels for coastal long term planning.

Climate change has been projected to affect the ecosystem of the Baltic Sea through at least two mechanisms: by increasing the water temperature, and increasing the freshwater runoff into the Baltic Sea, which leads to a decrease in the salinity level of the Baltic Sea.

Increasing temperature enhances biological processes and may increase the intake of harmful substances in organisms. Increasing temperature probably also alleviates the spreading of non-indigenous species originating from more southern seas. Also, due to the increase of atmospheric CO_2, it has been projected that the pH of the seawater will decline, which may affect the living conditions of bivalves with calcium-containing shells.

Salinity is also a fundamental factor in the Baltic Sea, because many organisms live at the edge of their salinity tolerance levels. Recent modelling suggests that the distribution areas of marine species like bladderwrack, blue mussel and eelgrass will be significantly reduced if the surface water salinity decreases. Reduction of these habitat forming species will affect the structure and functioning of the ecosystems, and may decrease the ecosystem services, e.g. fish yield, provided by these habitats.

Climate change has also been predicted to worsen eutrophication of the Baltic Sea, because of increasing nutrient runoff into the sea. A recent study has shown how climate change affects agricultural practises (crops, cultivars, land use), how climate affects the hydrological cycle, and how soils and lakes retain nutrients under a changing climate. The results show that climate change increases nitrogen loading into the sea, but that economic factors (e.g. crop and fertilizer prices) affect the outcome significantly, and that by farm level adaptation to climate change, a significant reduction in nutrient loading can be achieved. ■

adopted by the Government in December 2015 for 2016 to 2021. The main objective is to achieve good ecological and chemical status in surface and ground waters taking into account climate change. Adaptive measures for improving nutrient management, better risk management of accidents such as overflows from waste water treatment plants and better management of storm water are ongoing in many sectors. Additionally, many natural water retention measures are suggested in recently updated plans.

Agriculture

Climate change is projected to improve crop productivity in Finland if the rise in temperature is moderate and if the adaptation measures are implemented in a timely manner. The current main field crops might be cultivated further north and many novel crops 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 cause more uncertainties for agricultural production. Seasonal unevenness of precipitation may further increase and cause substantial challenge for sustainable development of agricultural systems. Early summer drought may become more frequent and interfere with crop growth and yield formation, while, again, increasing rains outside the growing season may put soils and their functionality at risk and also increase the leaching of pesticides and nutrients into the water systems, that are particularly vulnerable as one-third of the field parcels in Finland are located next to waterways. The risk of animal diseases may also increase, although it is expected to remain relatively low in the future. Diseases associated with the poor quality of water may become more common. 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 imminently prone to them, farmers have always faced severe production and income risks, which are, however, likely to increase in the future climates. On the other hand farmers in general are well aware of the measures needed by them to cope with weather constraints. An indication of farmer's readiness is that they have already responded to changed conditions by adopting later maturing cultivars and crops, introducing winter rapeseed, as well as starting sowings earlier than couple of decades ago. Further development of cultivation methods and systems is needed to reduce risks and increase the resilience and competitiveness of agricultural production in a changing climate. The existing networks in place for farmers, farmers' associations and extension services help to improve the exchange of knowledge about the means for adapting to climate change and variability. Agricultural research has been well designed to support and prioritise the development of primary adaptation measures. 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. Climate-related risk assessment has been strengthened by efforts from the Finnish Food Safety Authority Evira. 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. These, coupled with improved disease resistance and resilience through plant breeding, are important elements 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 developing soil cultivation methods, 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 and diversified agricultural systems. From these, development of monitoring and alarm systems to better cope with increased plant disease and pest risks have progressed further (at the Natural Resources Institute Finland (Luke)) in addition to being successful in breeding for improved disease resistance, e.g. in the main cereal crop, spring barley by private plant breeding companies. Also breeding for more nutrient use efficient cereals have been demonstrated to be very successful, which is important as development and implementation of water management systems are not yet timely and economically feasible for farmers. Diversification of crop rotations have not yet taken place at large scale, though green fallows and nature managed fields have become more common land use alternatives in agriculture since the end of the 1990s, which is important as they provide soil cover for winter time with high precipitation and increased risks for soil deterioration, erosion and nutrient leaching. However, farmers are very interested in diversification of crop rotations and they have introduced, e.g. maize and winter rapeseed for cultivation as novel crops, in addition, to expanding production of late maturing spring wheat and faba beans. All these changes have been supported and monitored by a number of recent or on-going research projects in collaboration with, e.g. farmers, extension services, farmers' unions, policy makers and private companies.

In the energy sector to better adapt to exceptional weather conditions measures to improve and increase farms' energy self-sufficiency and security of supply have been promoted and implemented.

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 populations react to fairly small and early changes in the temperatures by changing their migration and feeding behaviour, reproduction patterns and locations. If the changes are large enough, there may also be changes in the growth of fish populations and in species composition in fish communities, and also changes in survival, mortality and distribution.

Climate warming will increase the growth rate of some of the Finnish fish species. 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 due to increasing run-off. This will increase eutrophication, which has already affected fish stocks, especially in coastal waters. Generally, eutrophication increases the total fish biomass, but decreases species richness. Warm winters together with eutrophication will decrease the catches of e.g. turbot 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 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.

Anadromous fish species, like Atlantic salmon, are expected to suffer from climate warming due to their complex life cycle covering migrations between freshwater and marine environments. There is already evidence from the Baltic Sea area that increased water temperatures may decrease the survival of salmon during the early phase of sea migration.

Predicting the impacts of climate change on fish populations over a longer period of time involves significant uncertainties. Because the annual variation in fish populations may be considerable (for example, the variation in 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.

Climate change related factors are also affecting the conditions of aquaculture, mainly based on salmonid fish production in Finland. In coastal waters of the Baltic Sea, warmer winters with little or no ice cover can help the practical work in fish farms but more frequently occurring extreme weathers such as storms may be harmful. In inland waters, increasing temperatures may enhance the productivity of fish culture in northern Finland. In the southern part of the country, the situation may be opposite, especially for fish farming in upper reaches of watercourses.

Game species, just like other animals, have 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. Many southerly distributed species are expected to increase markedly in numbers during coming years. These include species already common in southernmost part of the country, such as white-tailed deer, roe deer, European hare and raccoon dog. The most recent invader from southeast is wild boar, which has rapidly increased to high densities right outside the border of Finland. The main threat is that wild boar could transfer a dangerous disease, African swine fever, to western Finland, where that largest commercial piggeries are located. There, the disease would lead to catastrophic events with large economic losses.

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 the colour of their fur or feathers according to the season, the shortened period of snow cover might lead to increased exposure to predatory species.

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. The Natural Research Institute Finland (Luke) monitors game richness and abundance based on game surveys carried out together with the Finnish Wildlife Agency and voluntary hunters. Monitoring is also the basis for fast management decisions required for adaptation to the changing conditions, including reactive action to invasive alien species. Monitoring in Finland is at high level right now, but new programmes will be needed, such as the one for wild boar launched in 2017. National management plans have been completed for most game species, including the latest for wolverine and grouse in 2014. One approach to help game species to adapt to changing conditions is habitat management and restoration, which have been studied at Luke and game management districts. In addition, several adaptive measures are developed by the Finnish Wildlife Agency and funded by the Ministry of Agriculture and Forestry to limit the damage caused by game to agriculture, forests, reindeer herding and traffic.

Reindeer husbandry

Herding of semi-domesticated reindeer together with fishing and hunting are the oldest and most traditional means of livelihood in northern Finland. At present, there are 54 reindeer herding co-operatives in the whole reindeer management area, which covers around one-third of the total land area of Finland. There are some 4,400 reindeer owners and the total number of reindeer in winter is around 200,000 reindeer.

Unfavourable changes in the reindeer pasture environment form a complex problem, which is largely connected both to intensified reindeer grazing and to the expanding impacts of competitive land use forms deteriorating, fragmenting and reducing pastures. However, the ongoing changes in weather, snow, precipitation and other natural conditions in the pasture environment are also causing increasing concerns and problems. Changing weather and snow conditions can also delay the seasonal herding tasks such as gathering reindeer to round-ups.

Warming winters have been observed to increase the frequency of exceptional snow and weather conditions, during which wet snow freezes into hard ice and snow layers. These icy layers decrease availability and quality of natural food, such as lichens, and also decrease the condition, calf percentage and productivity of reindeer. In addition, warmer and rainier summers and autumns may decrease the quality of natural food for reindeer by increasing the growth of mould on plants due to microfungi or by increasing the amount of phenols in plants due to raised ultra-violet radiation. On the other hand, earlier snow melting during spring improves food accessibility and thus the condition of reindeer after harsh winter. When winter temperatures increase, survival of larvae of insect herbivores (*Epirrita autumnata* and *Operophtera brumata*) in winter will also improve, which increases their outbreak risk. Herbivore outbreaks can damage mountain birch forests considerably and also deteriorate reindeer summer pastures.

Increasing summer temperatures and precipitation may increase the level of insect harassment during summer and the associate stress for reindeer. At the same time, the prevalence and outbreak risk of different parasites may also increase or totally new parasites and diseases causing problems for reindeer can emerge. Increasing temperatures and precipitation will probably also increase forest growth, but negatively affect the abundance of lichens in northern Finland.

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 increase will be larger in the north. Increased tree litter inputs will lead to increased carbon sequestration in 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*, *B. pubescens*), it is expected to increase its share of the growing stock. 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 and planting of seedlings, 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. The risk of wind damage is, on average, strongest among older Norway spruce stands, while young birch and Scots pine stands are most vulnerable to snow damage. The risk of snow damage to trees could decrease in southern and western Finland since a smaller share of the wintertime precipitation is predicted to fall as snow. On the other hand, the maximum snow loads on trees can increase in eastern and northern Finland. 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. root-rot (*Heterobasidion annosum*). 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, 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.

By appropriate and gradual adaption of forest management practices and 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. 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 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.

A greater use of forest resources is likely in the future. The Bioeconomy Strategy (prepared in a project set up by the Ministry of Employment and the Economy in 2014) relies on renewable natural resources, and is projected to increase wood harvests. Also, in fulfilling the EU's Renewable energy directive, Finland has set a target to increase the use of renewable, mainly wood-based energy by 2020. Active forest management enables also active adaptation to climate change in forestry.

Adaptation to climate change in forestry is being studied as a part of many research programs and projects in Finland. A recent study focused on the challenges of adaptation in the different sectors based on natural resources, including forests and forestry. In addition, research on sustainability, climate-neutrality or resource-efficiency in forestry, provides information to support adaptation.

An evaluation of importance of various risks was made in vulnerability analysis by the Natural Resources Institute Finland (Luke) in 2017. Alien pests and pathogens were identified as the most important threats to forests. Potential damages by insects were identified as another important source of risk. The increased difficulty of forest operations due to soft terrain was singled out as third in importance. Luke also disseminates information on adaptation issues as a part of services. The forest damage advisory service at Luke is monitoring forest pests and diseases and the damage they make. The service supports the decision-making of forest owners and administrators by answering inquiries and making diagnosis and prognosis about forest pests and diseases. Also, forest damage road shows are made to increase the knowledge of forest owners about potential threats to their forests.

Recent modifications to forest legislation in 2014, i.e. to the Forest Act and the Act on Forest Damages, take into account climate change adaptation by allowing more diverse forest management and by adjusting timber removal deadlines to earlier occurrence of pests. In addition, Finland's National Forest Strategy 2025 (2015) contains measures related to adaptation. One of the foremost targets of the genetic improvement set in the Forest Tree Breeding Programme 2050 (2008) is the adaptation of future reforestation materials to climate change. The use of high quality seed, suitable for different climatic conditions, is promoted by establishment of new seed orchards. New deployment area maps that take into account climate warming predictions have been released in 2017 for improved seeds and seedlings of pine and are under preparation for spruce. In addition, an establishment program for a network of gene reserve forests has been set up. The Finnish Forest Centre's forest damage contingency plan with appointed regional experts assists rapid harvesting of wind damaged trees in order to prevent consequential damage. Forest road maintenance planning has been developed to take into account exceptional weather and soil conditions.

6.3.4 Climate change impacts on and adaptation measures for different sectors of the economy and infrastructure, including human health

Energy

Weather-related threats like storms, lightning strikes and floods in Finland are the major source of weather and climate risks for the energy sector. The problem is also long-term exceptional occurrences, such as long frost periods and exceptional ice conditions, long-term snowfalls and snow loads, long warm periods and frost delay. Long periods of drought reduce hydropower production capacity. This is important in Finland because hydropower has its own central role as a controlling force, and more widely because the Scandinavian rainfall determines the electricity price on the Nordic power exchange. Infrastructure is slowly renewing due to long-term investment, so stoppages caused by electricity disruptions will be experienced for a long time.

The common electricity market is undergoing a transition where the electricity production system is increasingly decentralised and the importance of variable renewable energy, including wind and solar power, grows. At the same time, the thermal power capacity used to ensure the balance between supply and demand is declining. Due to variable renewable electricity production, the increased need for balancing supply and demand during different times of the day will require more flexibility in electricity consumption and production. Active participation of consumers in the market through smart solutions is needed to bring flexibility to the energy systems. Flexibility can be increased through electricity storage, interaction between the electricity and other energy systems, including electric transport, district heating and the gas market. Smart metering, genuine and sufficiently strong price signals in the electricity market, as well as real time power markets, are essential for attracting necessary investments.

Adaptation measures have already been launched in the energy sector. 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. The revised electricity market act includes regulations aimed at improving the security of the energy supply in network fault situations, especially in sparsely populated areas. According to the Electricity Market Act from 2013, the distribution network must be designed, built and maintained in such a way that if the network were damaged due to a storm or snow, the electricity interruption for the customers should not exceed six hours in detailed planned areas and 36 hours in other areas. These time limits must be met gradually over a 15 year time period and fully by the end of 2028. In addition, the Electricity Market Act includes other measures to improve the electricity network security of supply, for example, a requirement for cooperation 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 six and 36 hour time limits for network security of supply. In order to meet the time limits of six 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 requirements will be EUR 3,500 million. The Highways Act will be amended 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.

In response to the 2011 Fukushima nuclear accident, risk and safety assessments ('stress tests') were carried out on all EU nuclear power plants. First at a national level and then at EU level.

Intelligent electricity networks will work as a service platform in transition towards a more decentralised and carbon-neutral electricity system. Almost all users of electricity in Finland have smart meters, which allow customers to participate in a variety of markets, improve security of supply, and cost-effectively create new business opportunities for companies. A broad-based working group appointed by the Ministry of Economic Affairs and Employment is preparing concrete actions through which intelligent networks could serve the customers' possibilities of participating actively in the electricity market and help maintain the general security of supply.

Constant renewal is expected in the energy sector, which is reflected especially in many system level developments. Improving the reliability of the electricity networks will be necessary in our highly electricity-dependent society. When fossil fuels are phased out, the subsidised increase in weather-dependent electricity production, or wind and solar power, in the electricity market will have a massive impact on the entire system. Uncoordinated production, on the other hand, will create challenges related to price trends in the electricity market and thus the profitability of other power plants. Managing the power balance in the face of strong fluctuations in uncoordinated production will be another major challenge.

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. Expected changes in precipitation, wind velocity and temperature constitute a challenge for the construction sector. These stress factors already have 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 flood prone areas. Increased heavy rainfall will be a challenge for storm water management, especially in areas with high degree of surfaces sealed with impermeable materials.

Current legislation on building and other statutes include requirements for taking climate change into consideration. For new construction, climate change and adaptation are taken into consideration already during the planning stage 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. This is especially important in vulnerable areas, such as the archipelago where construction is particularly affected by environmental conditions.

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 guidelines include the need to follow objectives concerning adaptation 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 caused by heavy rainfall in urban areas. 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. Much of this information is provided through the operational Flood Centre managed jointly by the Finnish

Environment Institute and the Finnish Meteorological Institute. Research has shown that public disclosure of detailed flood risk maps generates quite accurate housing price corrections in affected and neighbouring city areas. Zoning indicated by flood risk maps also steers adaptive urban growth more cost-efficiently than pertinent urban zoning.

An assessment of possible sea level rise along the shores of the Baltic Sea (coastal flooding) has been completed and consequently, the guide for Flood preparedness in building was updated in 2014. The guide contains recommendations for determining the lowest building elevations in inland shore areas and along the shores of the Baltic Sea.

Industry and commerce

The Finnish industry is energy-intensive and the need to mitigate climate change has been the subject of focus in the industry sector more 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.

Climate change risks for industry are related to, e.g. power supply, storage and use of environmentally harmful substances, and the building industry. The challenges for industry and commerce also include the challenges identified for land-use planning and building, as well as transport and communications that are essential for most types of industry. Some adaptation needs will require significant investment.

Studies on adaptation needs for industry suggest that adaptation to climate change presents an opportunity for the industry sector. 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

The operational and environmental safety of a mining operation must be secured at all times. This requires energy supply, infrastructure system, mining operations and water management system. According to a stress test conducted by the Ministry of Environment some years ago a key challenge for the mines is being able to manage sudden and/or large amounts of excess water. Surface waters and process waters on a mine site must be collected and treated accordingly before they are discharged outside the area, so water management systems must have the capacity to manage even exceptional situations.

All aspects of risks caused by climate change must be addressed and taken to consideration in the mine planning stage. Risks and threats to a mining operation are analysed in the mining safety permit that is required from all operating mines according to the Mining Act. A mining safety permit requires identifying of all risks that the operation can face, and also how the risks and the eventual consequences are mitigated and avoided.

The mining operator is responsible for the internal rescue plan. The rescue plan specifies how to manage eventual incidents and how environmental and human accidents in such situations are prevented.

Transport and communications

Climate change is expected to impact all facets of the transport system: the infrastructure, modes 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, storms causing falling timber, and so forth, will all impact road and railroad infrastructure as a whole and, especially, the maintenance.

Some of the major impacts (both negative and positive) are as follows:

- More frequent warm and wet periods, which will increase wear and rutting of roads especially during winter. Long heatwaves can also disrupt repair works on tracks.
- 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 in roads and railroads may be needed if heavy snowfall events become more frequent; however, total annual snow clearance work is expected to decrease in southern Finland in coming decades, and later on in central and northern Finland. For railways, heavy snowfall events are challenging and require snow removal from tracks (e.g. rail points) and trains. Heavy snowfall events may also affect driving conditions and traffic flow.
- The need for clearing ice on roads is expected to increase in central and northern Finland.
- Groundwater levels may 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 ground frost will decrease and the period of ground frost will shorten.

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 to road and rail infrastructure, but climate change and the combination of a lower level of maintenance and infrastructure repair constitute a real risk for the serviceability of roads and railroads. Maintenance of structures and the condition of railways while floods and rainfall increase and ground frost diminishes are taken into account in new investments as far as possible. Structures are maintained and managed within the budget appropriations for basic road and railroad management. A related risk is associated with contracts between railroad, 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. The contracts between maintenance service providers and railroad, road and street infrastructure managers should be developed in a manner that enables more flexible extreme weather risk management. The Finnish Transport Agency (FTA) has updated the disruption and response times in its new maintenance contracts.

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 and high temperatures, as well as to lightning damage to e.g. traffic signalling and communication systems. The vulnerability of railways may also increase if maintenance and repair work efforts are undersized.

Envisaged actions that will enhance the adaptive capacity of the transport sector during the coming decades include developing warning systems with tailored guidance on transport impacts, developing maintenance operations, improving protection against weather, and maintaining the infrastructures. Also planning specifications should be revised.

Phenomena relevant to marine and inland water transport include strong winds, strong currents, high waves, heavy rain and snowfall, temperature increases, ice cover changes, lightning, extremely high/low sea/water levels and floods. These can cause short term disturbances and safety hazards and also have longer term effects. All in all, approximately forty potential hazards have been identified that are connected to these weather-related phenomena. Most of them are related to waterway maintenance, charting, traffic services and wintertime seafaring in general.

The FTA has inventoried sensitive areas as regards flood risks in southern Finland in connection with preparedness exercises and preparedness plans. The Ministry of Agriculture and Forestry, the Finnish Environment Institute (SYKE) and Regional Environment Centres survey flood risk areas. Flood hazard and flood risk maps for the 21 areas of potential significant flood risk in Finland are included in the flood map service.

Climate warming will reduce the amount of ice in the Baltic Sea. The FTA has participated in research on trends in the ice conditions of the Baltic Sea. In the MERSU research project, the Finnish Transport Safety Agency (Trafi) together with the Finnish Meteorological Institute (FMI) is making forecasts on future developments of ice conditions in the Baltic Sea area in order to estimate the need of ice-breaking assistance for mercantile ships during winter months in the future. However, the amount of ice-breaking assistance for ships also depends on wind conditions.

The adaptation actions include, for example, improving the safety equipment, proactive planning, developing the design and procurement practices, technical development, developing information services and traffic management, product and market monitoring, as well as cooperation in international regulation development. The FTA has developed adaptation actions, like improved forecasting models and an early warning system, together with the FMI. A remote monitoring system of the climatic conditions has been developed. The FTA has prepared a forecast for maritime transport in 2030.

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 winter 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 slipperiness may become more frequent in some parts of the country in the first half of this century. 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.

The FTA's winter management guidelines are implemented for main roads throughout the country. The FTA has tested potassium formate in de-icing of roads in winter in various places where the risk has been estimated as high. Implementation of the theme programme on groundwater protection for main roads is completed and a new programme is being prepared.

Air traffic will suffer from heavy storms, strong winds, changes in wind direction and lightning. The maintenance costs at airports and the use of de-icing chemicals may increase in mid-winter.

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. Overall telecommunication network problems and power outages cause delays and cancellations. Especially railway transport requires electricity to operate, and power outages can lead to total closure on a specific railway route, which affects the entire railroad network and the transport system. The FTA has continued intensified removal of trees posing risks for railways. The new Railway Act allows removal of risk trees in the railroad safety area (max. 30 meters on both sides of the railroad). Communication systems can also be damaged by flooding. Ice and wind loads on telecommunications masts may become heavier.

The FTA has also studied the improvement of redundancy in communication networks to remove accuracy problems, which has indirect impacts on ensuring the functioning of wire networks. Transition from serial transmission to IP based communication using fibre optics is on-going.

Tourism and recreation

Finland is an attractive destination for tourists mainly because of its nature. 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 central Europe or southern Finland. The 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.

The Roadmap for Growth and Renewal in Finnish Tourism for 2015 to 2025 reacts to the climate change. The roadmap states the role of tourism as a cross-sectoral industry and its potential to enhance a shift towards more sustainable, cleaner, lower-carbon economic growth to minimize the effects of climate change. At the same time, the roadmap calls for new, innovative solutions for sustainable tourism products and experiences.

Insurance

Climate change is likely to increase damages 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 than anticipated amounts in damages. These changes may be reflected in the insurance premiums and available coverage. Climate change will affect insurance companies directly in three different ways: through claims, through their investments and through the terms of trade of reinsurance.

Forests are insured by private insurance companies in Finland. Some 40 per cent of forest owners have insurance against forest damages. Forest insurance products offered by insurance companies provide variable cover against damages caused by for example storms, snow loads, forest fires, floods, pests and fungal diseases. On average, some 60 to 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 in each year. For instance, in December 2011, the Boxing Day storm alone led to compensations totalling nearly EUR 30 million.

A new insurance programme for damage caused by exceptional floods was introduced at the end of 2013. The programme replaced the old government-based system and extended the coverage from fluvial to all types of floods. Private insurance companies offer home and property insurances that cover damage caused by exceptional floods, as well as severe weather events. A great majority of households and property owners have this insurance. The Flood Centre operated by SYKE and the FMI offers an early warning system for floods, including daily watershed forecasts and online flood warnings, and gives estimates on the exceptionality of occurred flood and weather events.

There is a state aid system for commercial fishing in case of a loss or damage of fishing equipment or vessel in Finnish marine waters. Eligible causes of loss or damage include storms and ice, with a maximum vessel length of 12 meters.

The Government compensation scheme for crop damages ended at the end of 2015, and the following year some private insurance products, which cover risks for extreme weather conditions have been introduced on the market by private insurance companies. Approximately, less than one per cent of the whole arable area has been insured in (the first year) 2016. At the moment, there is no state aid to make the insurances more attractive for farmers.

New guidelines for the state aid by the European Union have restricted the possibility for governmental compensation of damages caused by plant pests in agricultural or horticultural production, thus no compensation has been paid since 2014. Adjustment of the compensation scheme for forest pests to the new guidelines has not yet been carried out. Private insurance products covering losses caused by plant pest outbreaks have not been introduced on the market so far, although some private insurance companies have shown interest.

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.

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 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.

Health

Effects of climate change on health will be significantly less drastic in countries with highly developed economy and technological and institutional infrastructure such as Finland than in developing countries. However, climate change will affect health and wellbeing also in Finland via multiple pathways. Maintaining and strengthening existing public health and other infrastructure, including housing, transport and energy, and preventing poverty are crucial for successful adaptation.

Increasing summertime temperature and, especially, increased frequency and duration of heatwaves threatens to increase heat-related mortality and morbidity in future in Finland. The aging population, increasing number of people living alone and low prevalence of air conditioning further amplify the effect of heat. Heat poses a challenge also for occupational health. The number of days with heat stress will increase both in outdoor and indoor work environments and this will result in a need to revise the instructions regarding work-rest cycles among high-risk groups. The thermal control of the built working environment will also need to be modified.

Milder winters will most likely lead to a lower number of cold-related mortality from cardiovascular and pulmonary diseases. On the other hand, because of the large climate variability during wintertime, society and individuals will have to stay prepared for cold spells in future, too. During wintertime, darkness and icy walkways and roads also lead to adverse health impacts. Darker winters in future, caused by a shorter snow cover period, increased precipitation and cloudiness, may increase cases of winter blues or seasonal affective disorder and subsequent medical conditions. The number of days when the temperature hovers around 0°C will also increase, and may lead to increased number of slipping injuries and traffic accidents. Thinner ice and the shorter duration of ice cover on waterways will be a safety risk.

Changing climate, together with ecological factors (e.g. density of key host species), contributes to the northward spread of ticks, and consequently may result in increased incidence of tick-borne diseases, which also depends on social and societal factors. Increased incidence of Lyme disease (borreliosis) and tick-borne encephalitis has already been observed in Finland. Changes in ecosystems associated with warmer climate will most likely affect the spread of other infectious diseases as well. For example, warmer winters may lead to less pronounced population fluctuations of small rodents, which might decrease incidence of some rodent-borne diseases. On the other hand, the anticipated increase in the number of medium-sized predators such as red fox and raccoon dog may increase the risk of rabies and *Echinococcus multilocaris* spreading to Finland.

Changes in hydrology, such as an increased number of heavy precipitation events and wintertime flooding, may increase the number of water epidemics in future. Leaching of nutrients into waterways due to increased precipitation, together with higher summer time temperatures, increases the risk of algal blooming. Warming climate may also increase the risk of infectious diseases spreading via swimming water.

Increased precipitation and higher temperatures threaten to increase the risk of crop diseases and pests, which may require increased use of biocides further leading to human exposure to chemicals; increased efforts are also needed to prevent health risks related to mycotoxins in crops. The same changes in climate may also increase the risk of moisture damage in buildings and further aggravate microbial indoor air problems. Finally, climate change may lead to increased exposure to allergenic pollen and, therefore, more severe symptoms via changes in the distribution of plant species and increased amount of pollen.

An increasing number of adaptation measures has been taken to reduce the risk of adverse health effects of climate change. For example, the Ministry of Social Affairs and Health has produced a handbook on exceptional situations related to environmental health, which also includes information about weather and climate-related events. The

Finnish Meteorological Institute nowadays issues warnings on, e.g. heatwaves and cold spells and icy walkways.

As a basis for improving adaptation to heatwaves, research has recently been conducted to evaluate preparedness in health care facilities, identify vulnerable population groups, and refine exposure-response curves. A recent government decree on housing conditions (2015) introduced upper limit values for indoor temperature during summertime. The National Institute for Health and Welfare has increased general awareness of the health risk posed by high summer time temperatures, issues advice during intense heatwaves, and has recently weighed the need and possibilities of setting up a heat-health warning system in Finland.

The main effort to prevent water-borne epidemics in future has been the introduction of a national water safety plan in 2016: a framework for risk assessment and management for drinking water that will gradually become obligatory for water utilities. Measures to adapt to the spread of ticks include raising general awareness of ways to protect from tick-bites, and providing free vaccines against tick-borne encephalitis in areas with especially high incidence of the disease.

Cultural heritage

Cultural heritage sites are places where the combined influence of natural forces and human activity and the evolution of culture are visible. Cultural heritage sites are strongly linked to climate. Increasing humidity and rising temperatures may damage many sites of cultural interest, whether on land, underground, or in water. Traditional livelihoods and architecture originally developed to reflect local climate and the associated native species. Climate change is threatening to make our environment unfriendly to cultural heritage sites that have adapted to past climatic conditions. Climate change may also affect cultural heritage sites indirectly through mitigation measures. There are seven UNESCO World Heritage Sites in Finland.

Traditionally, wooden buildings are typical in Finland. As wood is sensitive to changes in humidity, measures are 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.

The Sámi people living in Finnish Lapland are the only recognised indigenous people of Europe. There are approximately 10,000 Sámi in Finland. According to projections, the climate in northern Finland will warm faster than the rest of the country, so the Sámi will be faced with the impacts of climate change sooner than other Finns. The severity of these impacts is affected by a close relationship with nature. Changes in reindeer husbandry will have notable cultural consequences. Sámi reindeer herding is characterised by close and tight connections to the utilised animal, resources and nature, and understanding of local conditions and several interactions in the natural environment. Along with climate change, the traditional local game species such as ptarmigan can suffer and their population may collapse. New game species probably migrate further north which, on the other hand, may introduce new kind of game to the Sámi hunting grounds. Suddenly changing weather conditions can also endanger berry crop.

Traditional knowledge of nature and the Sámi calendar are subject to change. The Sámi people who have practised traditional occupations are used to great changes in the nature and weather conditions during the year. Similar to other indigenous people, the

Sámi have extensive experience-based traditional knowledge of nature as the guiding line in their life and actions. Since natural conditions both vary and change faster than before, traditional signs will probably not predict future weather and conditions reliably enough, and traditional experiences and knowledge may not give enough means and ways for adaptation. Long term predictions are even harder to make. There is a danger that the traditional knowledge with respect to reindeer husbandry, for example, will lose considerable part of its previous value.

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, electricity supply and communications. The ageing of the population and the migration to urban centres, while, at the same time, larger areas remain sparsely populated, need to be taken into account, for example in master planning and other planning.

Legislation sets the foundation for preparedness and crisis management for all actors. According to the Emergency Powers Act, the Government, the state administrative authorities, state businesses and other state authorities, as well as municipalities shall ensure, by means of emergency plans, prior preparation of emergency operations and other measures, that their duties will be performed with the least amount of disruption also in emergency conditions. Preparedness for emergency conditions shall be managed, supervised and coordinated by the Government and by each Ministry in its field of operations.

According to the Rescue Act, the owner and occupants of a building and the business and industrial operators shall prevent and, when necessary, take measures to protect people, property and environment in dangerous situations.

In addition, state and municipal authorities, agencies and enterprises are obliged under the Rescue Act to take part in the planning of rescue operations under the direction of rescue departments, and to take action in accidents and dangerous situations so that rescue operations can be carried out in an effective manner.

The purpose of the Act on Security of Supply, on the other hand, is to maintain the basic economic functions required for ensuring people's livelihood, economic life and national defence 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 security.

In addition to legislation, there are two other relevant documents: First, the Government Resolution of 16 December 2010 on the Security Strategy for Society defines the operations vital to society and outlines the threat scenarios and disturbances that jeopardise 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 in various sectors. Preparation for natural disasters like floods will take place through preparedness planning, exercises, surveillance, information exchange, and other cooperation practices and situation reports, as well as by implementing, for example, the necessary flood protection measures at critical sites. An updated Security Strategy for Society was published in October 2017.

Second, Finland's first National Risk Assessment published in December 2015 is based on Union Civil Protection Mechanism, which binds all EU Member States. Protection under the Union Mechanism covers primarily people, but also the environment and property, against all kinds of natural and man-made disasters. These include the consequences of acts of terrorism, technological, radiological or environmental disasters, marine pollution and acute health emergencies. The National Risk Assessment included 21 scenarios that defined what might endanger vital functions of society or cause serious problems for people, property or environment. Five of these scenarios are related to extreme weather conditions. The National Risk Assessment is updated every three years. With regards to climate change adaptation, the National Risk Assessment should be developed in a way that also future development will be analysed.

Related to the National Risk Assessment, there is also a national platform for disaster risk reduction. This network consists of 20 organisations. The goal of the national platform is to implement the Sendai Framework for Disaster Risk Reduction and its priorities for action in Finland, i.e. understanding disaster risks, strengthening disaster risk governance to manage disaster risk, investing in disaster risk reduction for resilience and enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction.

The purpose of previously mentioned laws and other documents and arrangements is to develop a more resilient society. The national risk management system that consist sof four essential elements, prevention, early warning solutions, effective response and recovery measures, aims at a resilient society.

As far as warning systems are concerned, the Finnish Meteorological Institute (FMI) has diversified the weather-related warning services for citizens. Besides the traditional warnings on strong winds, severe thunderstorms, forest fire danger, and poor road conditions, there are now wave and sea level warnings for marine areas, as well as warnings for heatwaves and severe cold spells. Since February 2017, the FMI has renewed its warning system by introducing five-day warning maps, which also include the flood warnings of the National Flood Centre (joint organisation of the FMI and the Finnish Environment Institute (SYKE) established in 2014). Lead times up to five days give the citizens a possibility to prepare earlier and better for dangerous weather situations. Warnings are also disseminated to civil defence authorities through severe weather outlooks. Reciprocally, the emergency response centres share real-time information on damages caused by weather events to the 24/7 duty forecasters of the FMI. In addition to flood forecasts, SYKE's hydrological watershed model system also produces precipitation warnings for sub-basins and snow load warnings for roofs. The FMI and SYKE also issue severe weather and hydrological warnings to the civil defence authorities through a natural disaster warning system (LUOVA). It is a part of the situation report system of the Government and security authorities and was developed as a part of the second Internal Security Programme adopted by the Government and the Strategy for Securing the Functions Vital to Society. All in all, 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.

6.4 Global impacts of climate change and international cooperation

In 2016, the Prime Minister's office published a study on cross-border effects of climate change in Finland. The study identifies seven different cross-border impact chains triggered by climate change, which have impacts also in Finland. These are (1.) Trade impacts: the availability of raw materials and goods; price fluctuations; regional changes in relative advantages in the competition for market shares and production; changes in the conditions of export (2.) Impacts through infrastructure: changes in travel routes and long distance connections; changes in communication routes (3.) Impacts on finance and insurance: changes of financial markets and flows and investment possibilities; changes in insurance possibilities and premiums (4.) Human mobility: changes in the living conditions outside of Finland impacting human mobility; changes in seasonal weather impact tourism (5.) Ecosystems: climate change impacts on the living environment outside Finland and the mobility of species; changes in the hydrology of cross-border rivers; changes in the long distance drifting of air pollution; (6.) Geopolitics: changes in international politics impact international and regional processes and politics including multilateral climate change negotiations (7.) Cognitive changes: impacts through information exchange and education; changes outside national borders alter domestic significance and motivate domestic action; promotion of the need to develop education and public awareness. The identified cross-border impact chains illustrate clearly the global nature of climate change and its effects. In many cases the strongest cross-border impacts originate in neighbouring areas, but long distance cross-border impacts are not excluded. The recognition of cross-border impacts is an additional justification for international cooperation to address the consequences of climate change wherever significant adverse impacts occur.

Climate change with the associated risks and opportunities is a major driver of change in the Arctic region. Finland is a member of the Arctic Council and the Barents Euro-Arctic Council (BEAC) and finds climate change research, mitigation and adaptation actions as key areas of co-operation in the two Councils. Finland chaired the Barents Euro-Arctic Council in 2013 to 2015. Currently, Finland chairs the Arctic Council for the two-year period from 2017 to 2019.

The Barents Action Plan on climate change was adopted by the Meeting of Barents Environment Ministers in 2013 in Inari, Finland and its implementation and follow-up started during the Finnish BEAC chairmanship. Finland has, e.g. funded and participated in projects focused on regional climate strategies, made a regional inventory on black carbon emissions and co-funded a climate coordinator for the BEAC Secretariat.

In the Arctic Council, Finland has provided expertise and funding in, e.g. following areas of cooperation: assessments of impacts and adaptation tools to climate change in the Arctic (such as Snow, Water, Ice and Permafrost in the Arctic, Arctic Resilience Report, Adaptation Actions for a Changing Arctic), scientific work on short-lived climate pollutants (incl. some UNFFCC regulated GHGs and black carbon), production of recommendations targeted to methane and black carbon mitigation and projects on pollution prevention, including projects reducing emissions of climate pollutants. These will be further emphasised during the Finnish chairmanship in the Arctic Council.

In the context of the Baltic Sea Region (BSR) cooperation on climate change Finland implements the EU Strategy for the Baltic Sea Region (EUSBSR). In the 2015 Action Plan, the strategy has a horizontal action "HA Climate". This action aims at:

1. Facilitating integrative cross-sectorial policy discussions and alignment of policies in the Baltic Sea Region countries, including mainstreaming of climate change mitigation and adaptation into relevant sectoral policies;

2. Promoting low emission and climate resilient development through targeted strategic investments and integrated planning;
3. Promoting regional cooperation in creating and empowering the EU climate and energy policy development and implementation by ensuring secure energy supply and efficiently using potential of renewable energy sources and promoting energy efficiency;
4. Promoting sustainable production and consumption-oriented measures and economy measures such as resource efficiency and sustainable lifestyles in order to lower the region's carbon footprint;
5. Increasing coordination and synergy among initiatives and projects dealing with climate adaptation and mitigation in the Baltic Sea Region by consolidating findings and disseminating good examples, methods and experiences in the field as well as clustering already existing activities and projects and promoting science-policy-business dialogues.

The main actions of HA Climate, which also Finland is implementing, are low emission development and climate change adaptation. HA Climate is linked to the Baltic Sea Region Climate Adaptation Strategy and its Action Plan (www.baltadapt.eu) and the BSR climate change dialogue platform.

Climate sustainability has been one of the cross-cutting objectives of Finland's development policy and development cooperation since 2012. The integration of the cross-cutting objectives in all development cooperation activities is a binding obligation. In addition, sustainable management of natural resources and environmental protection is one of the priority areas of the Development Policy of Finland (2016) under which climate change related support is outlined more broadly. Finland promotes low carbon development and the capacity of its partner countries to adapt to climate change, and furthers integration of these goals into partner countries' own development planning. Particular attention will be paid to the roles of women, children and indigenous peoples in adapting to and 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 is a necessity. Finland has adopted a climate sustainability tool for assessing and preventing climate change and the risks posed by natural disasters caused by climate change. Furthermore, the new Manual for Bilateral Programmes (2016) includes a disaster risk reduction tool integrated into the Guidance and Checklist for Climate Sustainability and Disaster Risk Reduction (DRR) analysis.

Finland has been supporting the United Nations Office for Disaster Risk Reduction (UNISDR) since 2004. The current level of funding is EUR one million per year. Finland has also participated as an observer to the World Bank Consultative Group of the Global Facility for Disaster Reduction.

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Climate-Proof City – The Planner's Workbook, http://ilmastotyokalut.fi/en/

Finnish Meteorological Institute, http://en.ilmatieteenlaitos.fi/

Finnish Meteorological Institute, weather warnings, http://en.ilmatieteenlaitos.fi/warnings

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Flood risk management, http://www.ymparisto.fi/en-US/Waters/Floods/Flood_risk_management/Flood_risk_management_planning/Flood_risk_management_plans

Ministry of Agriculture and Forestry, adaptation, http://mmm.fi/en/nature-and-climate/climate-change-adaptation

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7

FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

Finland supports developing countries in their efforts to combat against climate change. This chapter provides information on Finnish financial contributions to the Financial Mechanism of the Convention and to other multilateral funds and programmes as well as on bilateral support to developing countries. There is a special focus on resources related to the energy and forestry sectors as well as on capacity building. In addition, this chapter provides information related to private sector cooperation. It also includes information on Kyoto Mechanisms.

Photo: Matti Nummelin / UM

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. Climate sustainability has been one of the cross-cutting objectives of Finland's development policy and development cooperation since 2012. The latest development policy, which has been outlined in the Government Report on Development Policy, published in February 2016, takes account, among others, of the current situation in developing countries, the goals of the UN 2030 Agenda for Sustainable Development and the binding climate convention and the Paris Agreement. Finnish development policy strives to strengthen the rights of the most vulnerable, promote gender equality, and improve climate change preparedness and mitigation. 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.

Finland's development aid disbursements in 2013, the first year of the reporting period, were EUR 1,081 million, which was 0.53 per cent of its gross national income (GNI). Its Official Development Assistance (ODA) contributions continued to grow in the following year and reached EUR 1,232 million, which constituted 0.59 per cent of GNI. As part of the general government adjustment measures the government decided in 2015 on substantial cuts on the appropriations for development cooperation starting from 2016. The ODA figures for 2016 amounted to EUR 956 million (0.44 per cent of GNI). As such, the cuts also have had some implications to the climate related support provided to developing countries.

After the Copenhagen fast-start finance pledge, Finland decided to use 2009 as a baseline for defining new and additional funding. The Finnish fast-start finance commitment of EUR 110 million was implemented through a net increase of Finnish funding directly allocated to developing countries' climate activities in 2010 to 2012 compared to 2009. The baseline figure for overall Finnish climate funding (grant) in 2009 was approximately EUR 26.8 million.

While the fast-start finance period is now over, the international public climate finance that Finland has provided has continued to be higher than in the base year used for fast-start finance. The total allocations were about EUR 94 million in 2013, EUR 116 million in 2014, EUR 115 million in 2015 and EUR 43 million in 2016. The division between mitigation and adaptation support varies according to the year, but it is rather balanced. For example, during the reporting period in 2014 about 54 per cent was allocated to mitigation and about 46 per cent to adaptation, and in 2015, about 57 per cent and 43 per cent, respectively. In 2016, about 58 per cent was allocated to mitigation and about 42 per cent to adaptation.

During 2013 to 2014, the government channelled all revenues from the auctioning of ETS allowances to Official Development Assistance activities, including climate finance. These revenues were used during the reporting period among others to support the Green Climate Fund (EUR 34.7 million), the Forest Carbon Partnership Facility (Readiness Fund, EUR 3 million) and the Adaptation Fund (EUR 5 million).

According to the new Development Policy Report, the Finnish Government considers important that the business sector promotes sustainable development in its field, respecting the best practices and obligations of corporate social responsibility. Therefore, particular focus is placed on responsible private sector engagement and mobilising private sector finance and expertise. This tendency is also present in the Paris pledge by Finland[1], stating that "Finland intends to provide over half a billion euros in new investment funding for developing countries over the next four years, a substantial part of which will contribute to climate finance". The first allocation (EUR 130 million) from this investment package was made in 2016 to Finnfund (Finnish Fund for Industrial Cooperation Ltd.), which is a state-owned development finance institution. Finnfund has a strong mandate to support climate relevant projects (see also Section 7.3.7). Reporting of the resources directed to Finnfund is outflow-based, i.e. the capitalisation of Finnfund materialises in the Finnish climate reporting only when Finnfund has invested the funds to developing countries. That will take place in the next few years.

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 it was first established in 1991. During the fifth replenishment period, Finland's contribution was EUR 57.3 million in total: EUR 15.0 million per year during 2010 to 2011 and EUR 13.7 million per year during 2012 to 2013. The negotiations for the sixth replenishment period (July 2014 to June 2018) ended in spring 2014 during which Finland pledged EUR 65 million.

The GEF divides the funds by environmental focal areas; according to the latest annual report, 31 per cent of the funds were allocated to the climate change focal area between 1991 and 2012. To calculate the relevant part of climate change funding out of the overall Finnish yearly contribution to the GEF5, 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 allocation, totalling approximately 32.6 per cent. For GEF6 reporting, Finland uses shares based on the indicative focal area programming targets as agreed in the replenishment negotiations (about 28%). However, it should be noted that according to GEF reports as much as 55% of the total funding was climate relevant in 2013, which gives a better picture of the multiple benefits achieved through GEF funding. The yearly figures are presented in Table 7.1.

1 UNFCCC; List of Recent Climate Funding Announcements; http://newsroom.unfccc.int/financial-flows/list-of-recent-climate-funding-announcements/

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

	2013 EUR million	2014	2015	2016
Global Environment Facility	4.4	6.2	4.0	2.2
Least Developed Countries Fund	5.6	6.0	1.6	
Special Climate Change Fund	1.9	2.9	0.9	
Adaptation Fund		5.0		

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. Nearly all of Finland's development cooperation partner countries count among the least developed countries (LDCs) in Africa and Asia. Many of them are also regarded as fragile states that have been or are in danger of turning into unstable societies, and have the greatest need for assistance. Some of Finland's partner countries have achieved progress and they have become or are about to become middle-income countries. This will allow gradual scaling-down of aid and gearing the focus towards, for example, providing an important type of expertise.

Finland's LDC-partner countries in Africa include Ethiopia, Mozambique, Somalia and Tanzania. Zambia is about to reach middle-income level, enabling Finland to move on to more diversified forms of cooperation with it. Finland also provides support to Kenya and small-scale support to Eritrea. In Asia, Finnish bilateral support focuses on the three poorest, fragile states: Afghanistan, Myanmar / Burma and Nepal. With Vietnam, which has now achieved the status of a lower-middle income country, Finland is gradually shifting from development cooperation to other forms of cooperation in areas such as trade, research and education. Finland will increase its support to the Middle East and North Africa where instability and large numbers of refugees pose great problems. Finland also supports the Palestinian Territory, Ukraine as well as the poorest Central Asian countries, Kyrgyzstan and Tajikistan. Finland supports SIDS countries with regional programs in the Pacific and the Caribbean.

Bilateral partner countries are also the main recipients of climate financing. However, Finland also supports other particularly vulnerable countries through regional cooperation and multilateral institutions. For example, Finland has been one of the regular supporters of the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF). During the reporting period Finland has provided support to the LDCF about EUR 13.2 million altogether and to the SCCF about EUR 5.7 million (see Table 7.1).

The assistance has covered, for example, the forestry and agricultural sectors and capacity building to various governments, including their environmental administrations. Moreover, national meteorological services, which play 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 8.4). Finland has carried out development cooperation projects in over 100 countries, which amounts to more than USD 100 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 (see Sections 7.1. and 7.2.). Furthermore, in 2012, Finland provided EUR 0.5 million as start-up support to the Green Climate Fund (GCF). During the reporting period, the negotiations for the Initial Resource Mobilisation (IRM) of the GCF were held. Finland announced its aim to support the GCF during the IRM period, in total, with EUR 80 million and pledged EUR 34.7 million for 2015. As mentioned before, Finland also contributed EUR 5 million to the Adaptation Fund in 2014.

In 2007, Finland decided to start contributing to the Readiness Fund of the World Bank's Forest Carbon Partnership Facility (FCPF). During the reporting period, Finland made additional allocation of EUR 3 million making the total contribution to the Readiness Fund EUR 18 million.

Finland contributed EUR 4.1 million 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 developing and piloting carbon market instruments. Finland actively participates in the Partnership Assembly meetings to foster cost-effective climate change mitigation. The first phase of the PMR will end in 2020 and discussions on a possible second phase have started.

The Multilateral Development Banks have been working together and with the OECD DAC to harmonise their climate finance tracking systems. As a result of this work, Finland has included the portion of its core support to these banks that is climate relevant in its climate finance reporting from 2012 onwards.

As an example of the thematic support provided through multilateral institutions, Finland has contributed EUR 6.4 million to the project 'Making agriculture part of the solution to climate change – Building capacities for Agriculture Mitigation', which was implemented by the Food and Agriculture Organization of the United Nations (FAO) for 2010 to 2015. The goal of the project was to enable countries to better realise opportunities for climate change mitigation in agriculture while at the same time improving food security and increasing the resilience of farming systems.

An example of Finland's effort to promote sustainable use of forest resources and to support development countries' capacity to collect, analyse and use reliable information on their forest resources is FAO's 'Sustainable Forest Management in a Changing Climate' programme. The Finnish funded EUR 15.3 million programme (2009 to 2017) implemented capacity development activities on three continents (Tanzania, Zambia, Vietnam, Peru and Ecuador) and has very strong linkages with the bilateral projects in Zambia and Tanzania. In addition to the direct country support, the programme has established a platform for developing and sharing forest monitoring and assessment related tools and methods. The Open Foris open source tool for forest data collection, analysis and dissemination (www.openforis.org) is used in over 50 countries.

The programme has been implemented in close collaboration with FAO's other forest monitoring related programs, such as Global Forest Resource Assessment (GFRA), United Nation's Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (UN-REDD) and National Forest Monitoring and Assessment program (NFMA). During its duration (2009 to 2017) the Programme has also engaged a number of international and national institutes, e.g. the Natural Resources Institute Finland (Luke), USFS, CATIE, JRC, in supporting these capacity building activities.

Furthermore, Finland supported the Adaptation for Smallholder Agriculture Programme (ASAP) launched by the International Fund for Agricultural Development (IFAD) with EUR 5 million in 2014. The programme channels climate finance to smallholder farmers so they can access the information tools and technologies that help build their resilience to climate change. The programme is working in more than thirty developing countries, using climate finance to make rural development programmes more climate-resilient.

Finland also contributes to the Nordic Development Fund (NDF), which is a multilateral development finance institution established by the five Nordic countries (Denmark, Finland, Iceland, Norway and Sweden). Since 2009, NDF focuses on climate change and development in low-income countries and flexibly uses grants and other innovative forms of support in financing projects. For the period 2013 to 2016, NDF has approved financing for 47 projects to a total value of EUR 161.5 million. Disbursements totalled EUR 128.9 million.

Table 7.2
Financial contributions to multilateral institutions and programmes*, EUR million

	2013	2014	2015	2016
Multilateral institutions				
1 World Bank (WB, IBRD, IDA, IDA-HIPC, MIGA, AMCs)	100.44	122.63	147.01	66.69
2 International Finance Corporation	0.00	0.00	0.10	0.05
3 African Development Bank (Afr.DB, Afr.DF)	40.69	63.11	36.31	24.31
4 Asian Development Bank (AsDB, AsDF)	5.25	5.25	5.25	5.25
5 European Bank for Reconstruction and Development (EBRD, TFs ODA, TFs all, ETC, WBJTF)	1.70	2.70	1.80	1.00
6 Inter-American Development Bank (IDB, IDB Sp.F.)	2.87	1.49	0.70	9.68
7 United Nations Development Programme	40.17	43.70	37.69	22.80
8 United Nations Environment Programme -specific programmes	8.44	6.72	7.57	2.02
9 UNFCCC	0.04	0.13	0.34	0.03
10 Other:				
European Development Fund (EDF)	47.07	47.79	49.98	52.78
European Community	114.01	113.61	122.81	157.87
Nordic Development Fund	3.47	3.47	3.48	0.00
Montreal Protocol	0.69	0.69	0.77	0.77
Green Climate Fund (GCF)	0.00	0.00	34.70	0.00
Scientific programmes:				
1 CGIAR	5.05	12.25	4.07	0.70
2 WIDER	2.90	2.43	3.19	2.67
3 IUFRO	0.30	0.30	0.00	0.40

* Share of funding directly related to climate change varies

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.

Finland's Kyoto mechanism purchase programme covers the period 2006 to 2020. The total budget for the acquisition of emission reductions from the Kyoto Protocol flexible mechanisms is approximately EUR 70 million. Approximately EUR 20 million was invested during the CDM/JI pilot programme, which was in operation from 1999 until early 2006. The rest was allocated in 2005 to 2012.

Finland committed about EUR 12.2 million through ten bilateral projects for the purchase of project units during the prompt start phase and the first commitment period of the Kyoto Protocol. Two of these projects continued generating units also after 2012. As part of its purchase programme, Finland also invested in multilateral carbon funds. USD 10 million has 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 Asia Pacific Carbon Fund, EUR 3 million in the Nordic Environment Finance Corporation's NEFCO Carbon Fund, and USD 20 million in Asian Development Bank's Future Carbon Fund. Of these funds, the World Bank's Prototype Carbon Fund, NEFCO'S NEFCO Carbon Fund and the Asian Development Bank's Future Carbon Fund continue to generate units for 2013 to 2020.

In total, in the first Kyoto commitment period Finland procured approximately 6.2 million tonnes of project units. These units have been carried over to the second commitment period. The Kyoto mechanisms purchase program will continue to deliver project units until 2020 through existing investments in carbon funds and one ongoing bilateral CDM project. A total of 4 million tonnes of project units is expected to be generated by the end of 2020. No decision on the use of Kyoto mechanisms for compliance purposes in the second commitment period of the Kyoto Protocol has been made.

7.3.3 Bilateral assistance to developing countries

The goal of Finland's development policy is the eradication of poverty and inequality, and the promotion of sustainable development. 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.

In long-term partner countries (see Section 7.2.), the cooperation is based on country programmes that are prepared in consultation with partners and that build on national development plans. Finland supports projects and programmes that promote environmentally sustainable development in its partner countries and regions. The ratio varies according to the year, but generally, the bilateral cooperation projects have accounted for close to one-half of all Finnish climate funding.

Table 7.3
Finland's bilateral and regional contributions towards implementation of the UNFCCC, 2013 to 2016 (EUR million)

	Mitigation						Adaptation		
	Energy	Transport	Forestry	Agriculture	Waste management	Industry	Capacity building	Coastal zone management	Other vulnerability assessments
Total	**42.64**	**0**	**19.75**	**0.50**	**1.96**	**0.30**	**24.92**	**0.12**	**7.98**
Afghanistan							0.05		
Argentina	0.04								
Bangladesh	0.02								
Bhutan							0.42		
Bolivia							0.62		
Brazil							0.01		
Cameroon							0.04		
China (People's Republic of)	3.36				1.52				
Colombia			0.01				0.44		
Ecuador					0.01		0.32		
Egypt	0.01						0.30		
Ethiopia							4.71		0.02
Ghana	0.70								
Guatemala									
Guinea									
Indonesia	2.76		0.14	0.26			0.16		
Kenya	16.74		0.68	0.21			2.70		
Kyrgyzstan							1.41		
Lao People's Democratic Republic			0.67						
Madagascar							0.04		
Mali							0.08		
Mexico	0.03		1.96						
Mongolia			0.12						
Namibia							0.04		
Nepal	0.16						2.00		0.40
Nicaragua							0.02		
Peru			0.03				0.02		
Philippines					0.02				
Sri Lanka	1.01		0.01						
Sudan							0.01		
Tajikistan							0.69		
Tanzania			0.83				2.37		0.01
Thailand									
Tunisia							0.02		
Tuvalu	0.06								
Uganda							0.06		
Viet Nam	0.08		1.33		0.41		0.86	0.12	0.03
West Bank and Gaza Strip							1.10		
Zambia			1.04			0.30	1.53		
Africa, regional	0.30		7.53	0.02			1.62		
America, regional			1.82						
Asia, regional	6.46		2.03				1.83		
Central Asia, regional									
Far East Asia, regional									
Middle East, regional									
North & Central America, regional	1.37						0.36		
Oceania, regional									3.78
South & Central Asia, regional									
South America, regional	3.77		1.35						3.74
South Asia, regional									
South of Sahara, regional	5.77		0.18				1.10		

The form of assistance varies between regions and programmes. The Energy and Environment Partnership (EEP) project, which began in Central America in 2003 and has since been replicated in the Mekong region, southern and eastern Africa, Indonesia and the Andes, accounts for a large part of the mitigation projects in the energy sector. Also, support for forestry projects is substantial.

With regard to adaptation, the most important element has been capacity building in partner countries. Finland has been very active in the field of meteorological cooperation. It has supported, for example, cooperation between the Finnish Meteorological Institute (FMI) and the Secretariat of the Pacific Regional Environmental Programme (SPREP) and the Pacific national meteorological services since 2009, which seeks to improve the capacity of 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. The project was continued in 2012 and extended until 2017; it now covers 14 Pacific island countries.

Besides the examples provided in the report on climate relevant bilateral cooperation, more examples and information about the projects can be found on OECD's webpages (http://stats.oecd.org/Index.aspx?DataSetCode=RIOMARKERS).

Table 7.4
Regional contributions of Finnish official development assistance (ODA) for the implementation of climate-change-related bilateral projects and programmes in 2013 to 2016 (EUR million)

	2013	2014	2015	2016
Total	**29.99**	**46.67**	**35.19**	**26.75**
Africa	14.97	26.97	20.04	15.07
America	3.97	7.51	2.75	3.12
Asia	10.55	10.81	11.68	7.33
Europe				
Oceania	0.49	1.39	0.73	1.23

7.3.4 Energy sector cooperation

Most of Finland's bilateral development cooperation funds in the energy sector are channelled through five regional Energy and Environment Partnership (EEP) Programmes that currently cover 18 countries in southern and eastern Africa and the Mekong region (see also Table 7.6). Regional programmes in Central America, Indonesia and the Andes ended in 2013, 2014 and 2016 respectively. 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 focus on local renewable energy sources and energy efficiency improvements. Finland's funding for the programmes for 2013 to 2016 was approximately EUR 41 million, which was complemented with EUR 25 million from other donors (Austria and UK). The project developer's contribution to individual projects varied, but on average, the ODA funds were able to attract a two-fold increase in the amount of funding from other private and public sources. Finland is also cooperating with two energy related multi-donor trust funds, EUEI-PDF and ESMAP, offering energy-related technical assistance to developing countries.

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 2013to 2016, a new project was supported to expand the electricity grid so as to improve access to energy in Honduras (see also Section 7.4). The Finnish Fund for Industrial Cooperation Ltd. (Finnfund) (see Section 7.3.7) financed, during the reporting period 2013 to 2016, renewable energy production projects in Kenya, Thailand, Honduras, and Cape Verde and tree-planting projects in Tanzania and Uganda. 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 three per cent of the total ODA, or EUR 15 to 20 million annually. In the area of development cooperation, national forest inventories and forest sector information systems constitute the most important thematic areas that have been promoted in partner countries to provide an information base both for sustainable forest management and as baselines for climate-related efforts. Such inventories have recently been completed in Nepal, Tanzania and Zambia, and another will start in Myanmar in 2017. In Vietnam, a comprehensive forest information and monitoring system, including a digital interface has been set up to contribute to sustainable forest planning and management. In addition, small-scale inventories, pilots or methodological systems' improvements have been supported in Ecuador, Kenya, Peru and Vietnam. With Finnish support, the FAO has developed a free-of-charge Open Foris software program for collection, storage and analysis of field data, as well as for interpretation of satellite images and other remote sensing material.

Finland has also 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, Laos and Nepal. With climate sustainability being one of the cross-cutting objectives of the new Development Policy Program of 2016, 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. Finland's Development Policy and the guidelines for forest sector cooperation put emphasis on a rights-based approach to development, good forest governance, land issues, peoples' rights to access, use and participate in forestry, the participation of women in decision-making and gender equality, just benefit sharing, as well as private sector involvement in cooperation. The research network of the International Union of Forest Research Organizations (IUFRO) is supported as a channel to provide policy relevant information for international forest policy processes, such as the UN Forum on Forests. Funding through the Forest and Farm Facility hosted by the FAO promotes sustainable forest and farm management by supporting local, national, regional and international producer and indigenous peoples' organisations and platforms for effective engagement in policies and investments that meet the needs of local people.

7.3.6 Capacity-building support

Finland supports capacity building among non-Annex I parties in several types of projects. Most of the Finnish bilateral projects that have a climate-related objective as their principal or significant objective also include a capacity-building component. Finland also supports several multilateral climate-related funds (such as LDCF, SCCF, FCPF and the World Bank's Partnership for Market Readiness), which include a strong capacity-building component in their activities. As an example, Finland is one of the world leaders as a donor in supporting capacity building of non-Annex I partner countries' hydro-meteorological services at all levels. During the reporting period, the most important capacity support programmes for hydro-meteorological institutions are ongoing in the Pacific, Caribbean, Himalayan and Central Asian regions (see also chapter 8.4.). Finland has also supported FAO's programme on making agriculture part of the solution to climate change, in which capacity building has a prominent role. Some examples of projects with strong capacity-building components are provided below.

For the past 13 years (since 2004), Finland has funded an international course on environmental law and diplomacy. The support is expected to continue also in coming years. This 'Course on Multilateral Environmental Agreements' is organised annually by the University of Eastern Finland in cooperation with UNEP and 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), including the UNFCCC. In addition to teaching environmental law, the course aims to foster contacts between developing and industrialised countries and thus support international environmental negotiations. Each year, the course specialises in different themes: in 2013, the theme was natural resources, in 2014, environmental security, in 2015, climate change and in 2016, effectiveness of MEA's. Most courses have included some components related to climate change.

The Southeast Asia Climate Change Network project implemented by UNEP started in 2008. It used 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 supported the sharing of best practices and acceleration of the transfer of climate-friendly technologies. The project assisted countries in negotiations pertaining to agreements and helped them carry out the practical measures associated with climate change. The goal was to strengthen the countries' potential to respond to the challenges posed by climate change over a wide spectrum. The overall support for the project was EUR 4.3 million in 2008 to 2016.

As climate change will most strongly affect the world's poorest people, and since most of them are women, one of the important themes has been mainstreaming gender considerations into the climate policy-making agenda. Since 2008, 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. The project that consisted of four phases ended in 2016; the overall support from Finland was EUR 8.9 million in 2008 to 2016. The project focused on advocacy for the establishment and implementation of gender-responsive actions on climate change through a series of activities that included participating in UNFCCC formal meetings, supporting directly the Convention's Secretariat, technical support to Parties and stakeholders, and incorporating gender equality and women's empowerment criteria in climate finance mechanisms. The Women Delegates Fund administered by WEDO supported travel and enhanced leadership and negotiations skills of women delegates. IUCN facilitated development of national climate change and gender action plans (ccGAPs) bringing the total number to 21. UNDP supported mainstreaming gender on national level through, e.g. development of guidelines and training programs.

The project cooperation between Finland and the South Centre in the field of climate change started in 2011. The project in question run from 2011 to 2013 with total support of EUR 700,000. The general objectives of the programme were firstly, at national level, to assist developing countries in national preparations for engagement in national and international climate change policies and actions; and secondly, at international level, to assist developing countries to engage constructively and effectively in developing and shaping the international policy framework of cooperation in addressing the global climate crisis. In 2014, the cooperation was continued with three years with a broader over-arching theme being strengthening sustainable development globally and in developing countries, climate change still being one of the sub-themes.

7.3.7 Support for private sector cooperation

As there are no appropriate data collection systems in place and due to confidentiality clauses related to some private sector data at the moment Finland does not estimate nor report regularly climate related private finance mobilised. Instead, Finland currently focuses on following and actively participating, when possible, in multilateral discussions on the subject. However, as stated in our Second Biennial Report, a very rough estimation was made in 2013 based on which Finland could mobilise yearly about USD 0.5 to 1.8 billion private climate finance to developing countries. This should be taken only as a very initial estimation, which may not be comparable to other estimations.

Private sector projects in developing countries are being supported, for example, by the Finnish Fund for Industrial Cooperation Ltd. (Finnfund) and Finnpartnership (the Finnish Business Partnership Programme; 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, mezzanine, 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.

As outlined in previous National Communications, both organisations are active in the climate change field. About half of all investments made in recent years can be regarded as climate finance because they have been used for renewable energy projects, as well as projects to prevent deforestation, to support 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 climate change cooperation and ODA-eligible cooperation projects with these institutions in its total climate funding figures. During the reporting period, the record year was 2014 when Finnfund provided approximately EUR 21 million, which can be included in Finnish public climate funding. During the same year, Finnpartnership contributed around EUR 130,000 to climate funding. According to rough estimates, the public funding through Finnfund's climate-related projects leverages private funding at a level of about two to three times that of Finnfund's funding for investment, and the ratio can even be higher. Finnpartnership has not made climate-specific estimates, but for projects that were granted support between 2007 and 2012 the ratio was generally at least six times as great.

As mentioned in Section 7.1., the Finnish Government considers it important that businesses promote sustainable development in their own fields. In this context, the government of Finland has decided to use around EUR 530 million during 2016 to 2019 as investment funding to support programmes/projects in line with Finnish development policy, especially to climate funding and creating sustainable jobs and livelihoods in the private sector. The first allocation (EUR 130 million) from this package was made in 2016 to Finnfund.

Other climate finance and technology transfer activities presented below, such as the Energy and Environment Partnership (EEP), have also leveraged private finance. In the case of the EEP programme in Africa, the leverage ratio is 1:2.01 and a total of about EUR 114 million was mobilised by December 2016, including also other sources than private finance. Furthermore, 30% of supported projects have been scaled up or replicated after the EEP engagement.

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, including resources under Article 11 of the Kyoto Protocol, can be found in Table 7.5 below.

Table 7.5
Summary information on financial resources and technology transfer

Official development assistance (ODA)	2013: EUR 1,081 million (0.53% of GNI); 2014: EUR 1,232 million (0.59% of GNI); 2015: EUR 1,161 million (0.55% of GNI); 2016: EUR 956 million (0.44% of GNI)
Climate-related aid in bilateral ODA	2013: EUR 32 million 2014: EUR 44 million 2015: EUR 39 million 2016: EUR 26 million = amounts of the project funding directly directed to climate activities
Climate-related support programmes	e.g. Energy and Environment Partnership (EEP), Making agriculture part of the solution to climate change – Building capacities for Agriculture Mitigation project, Sustainable Forest Management in Changing Climate project, the Southeast Asia Climate Change Network; more information on projects and more projects available in: http://stats.oecd.org/Index.aspx?DataSetCode=RIOMARKERS
Total contributions to GEF	2013: EUR 13.650 million 2014: EUR 22.025 million 2015: EUR 14.325 million 2016: EUR 7.961 million
Pledge for sixth GEF replenishment	EUR 65 million in total
JI and CDM under the Kyoto Protocol	Finland committed about EUR 12.2 million through ten bilateral projects for the purchase of project units during the prompt start phase and the first commitment period of the Kyoto Protocol. Two of these projects continued generating units also after 2012. Finland also invested in multilateral carbon funds. USD 10 million has 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 Asia Pacific Carbon Fund, EUR 3 million in the Nordic Environment Finance Corporation's NEFCO Carbon Fund and USD 20 million in the Asian Development Bank's Future Carbon Fund. Of these funds, the World Bank's Prototype Carbon Fund, NEFCO's NEFCO Carbon Fund and the Asian Development Bank's Future Carbon Fund continue to generate units for 2013 to 2020.

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 8.9 million during the implementation period 2008 to 2016. The cooperation between the Finnish Meteorological Institute (FMI) and the Secretariat of the Pacific Regional Environmental Programme (SPREP) and the Pacific national meteorological services since 2009 seeks to improve the capacity of 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.

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 7.6). 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 technologies 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 Thailand, Honduras, Sri Lanka, Kenya and Cape Verde and tree-planting projects in Tanzania and Uganda. 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. 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. Regional Energy and Environment Partnership (EEP) programmes with southern & eastern Africa and Mekong countries support various renewable energy and clean energy projects and specifically address technology transfer. Concessional credits are used primarily for environmental and infrastructure investments under national development programmes. They have been granted to a waste disposal plant with a landfill gas collection system in Vietnam and various renewable energy projects. In Vietnam, Honduras and Kenya, projects to improve electricity distribution in order to improve access to energy have been supported. Finland also supported PPPs on Combined Heat and Power production in Ukraine with EUR 125,000 in 2016.

During the reporting period 2013 to 2016, concessional credit disbursements for climate-change related investments have been around EUR 2 million per year. In addition, Finland has supported technology transfer and development through multilateral funds such as the Global Environment Facility (GEF) and the Nordic Development Fund (NDF).

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. Finland has supported the work of the CTCN with EUR 200,000 in 2015.

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 cooperation ended during the reporting period.

Table 7.6

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:
Reduced Vulnerability of the Pacific Island Country Villagers' Livelihoods to the Effects of Climate Change – 'FINPAC'

Purpose:
Improved capacity of the Pacific Island Country National Meteorological and Hydrological Services to deliver weather, climate and early warning services in cooperation with, and for the benefit of, villagers in Pacific communities.

Recipient Countries	Sector	Total Funding	Years in operation
14 Pacific SIDS (Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu).	Meteorology	EUR 3.8 million	2013 to 2017

Description:
The FINPAC Project was a regionally coordinated project targeting the most pressing needs of Pacific Islands' communities in coming years: adapting to the effects of climate change. The project covered the entire value chain of Early Warning Services and Weather Forecast Services from the NHMS's (National Hydro-Meteorological Service) to the end-users at local village level. Special emphasis was given to improving the NHMS's capacity to produce modern, high quality forecast and warning services, as well as to building capacity of the end-users to utilise and interpret the services that NHMS's in the region offer. During the project, six SmartMet workstation and server software were installed into selected countries in the region to improve the NHMSs capacity to produce forecast services, jointly with SmartAlert software to improve the early warning services and products. SmartMet is a forecaster workstation and a tool for automated weather forecast production and SmartAlert a forecaster tool for issuing and disseminating weather warning information. With the new tools, NHMSs were able to improve their forecast and early warning services and to launch new modern product formats in new dissemination channels. The project also contributed to improving the observation data quality in the region by acquisition of observation station spare and replacement parts.

Indicate factors which led to the project's success:
Regional collaboration of the NHMSs, persistent capacity building and training of the new systems focusing to ensure the sustainability of the installed systems, local partner in project management

Technology transferred:
Six units of SmartMet weather forecaster workstation and automated forecast production software, six units of SmartAlert weather warning software, one new automatic weather station and observation station spare parts

Impact on greenhouse gas emissions/sinks:
N/A

Project/programme title:
Energy and Environment Partnership (EEP) Programmes

Purpose:
To increase access to sustainable energy through renewable energy and energy efficiency

Recipient Countries	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	2013 to 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. Currently, only the programmes in Africa and Mekong countries are in operation, covering 18 countries.

Indicate factors which led to the 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 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/en

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 Countries	Sector	Total Funding	Years in operation
Lao PDR	Forest/ mitigation	Phase I: EUR 6 million Phase II: EUR 9 million Consolidation Phase III: EUR 7.4 million	2004 to 2017 Phase I: 2004 to 2008 Phase II: 2009 to 2012 Phase III: 2013 to 2017

Description:
Finnish support to the forestry sector in Lao PDR started in 1995 with the Forest Management and Conservation Project (FOMACOP), which piloted an approach to participatory management of production forests called 'Village Forestry'. From 2004 to 2008 the initial phase of the Sustainable Forestry for Rural Development (SUFORD) Project was implemented in the form of parallel financing from the World Bank, undertaking Participatory Sustainable Forest Management (PSFM) in Production Forest Areas (PFAs). The SUFORD project supported PSFM in four provinces (Savannakhet, Kham-

mouane, Saravane and Champassack). In 2009, the Project was expanded into five more provinces (Bolikhamxay, Vientiane, Sayaboury, Attapeu and Sekong). 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 Consolidation Phase III will be implemented (with funding from Finland) in 2013 to 2017. The overall objective of the Project is to institutionalise ”improved forest governance and environmentally, socially and economically sustainable forest management practices for the mitigation of climate change, protection of biodiversity and enhancing contribution of the forestry sector to national and local economies and poverty reduction”. The project development objective is “to contribute to national REDD+ efforts to reduce carbon emissions from forests by expanding the national program of PSFM in Production Forest Areas (PFAs) and developing and piloting Landscape-PSFM in four provinces”. 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. The project has contributed at both 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 to 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 the 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 in many outside areas. Recently (2015 to 2017) the project has contributed to the reduction of illegal logging and timber trade in Lao PDR.

Internet links

Energy and Environment Partnership with Central America,
https://www.sica.int/energia/index_en.aspx
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/

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 Fund for Industrial Cooperation Ltd (Finnfund),
http://www.finnfund.fi/en_GB/

Finnish Funding Agency for Technology and Innovation (TEKES),
https://www.tekes.fi/en/

Finnish Meteorological Institute,
http://www.fmi.fi/en/

Global Gender and Climate Alliance (GGCA),
http://www.gender-climate.org/index.php

Government Report on Development Policy: One World, Common Future – Toward sustainable development 2016,
http://formin.finland.fi/public/default.aspx?contentid=341918&nodeid=49540&contentlan=2&culture=en-US

Ministry for Foreign Affairs,
http://www.formin.finland.fi/public/default.aspx?culture=en-US&contentlan=2

Sustainable Forestry for Rural Development Project Scaling Up (SUFORD-SU) project
http://www.suford.org/?lang=en

UNEP: Southeast Asia Climate Change Network,
http://drustage.unep.org/energy/projects/sean-cc

UNFCCC; List of Recent Climate Funding Announcements,
http://newsroom.unfccc.int/financial-flows/list-of-recent-climate-funding-announcements/

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 in developing countries.

Photo: Aarno Torvinen / Image bank of the Environmental Administration

8 RESEARCH AND SYSTEMATIC OBSERVATION

8.1 General policy on research

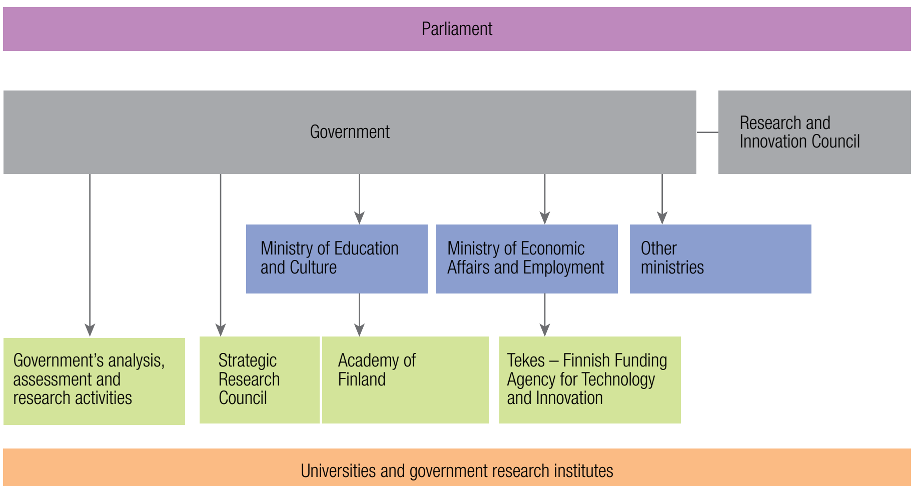
8.1.1 Domestic activities

In 2015, Finland's research and development (R&D) expenditure was EUR 6,100 million, or 2.9 per cent of the country's gross domestic product. Although national R&D expenditure has been declining since 2011, it is still a higher percentage than the average among the OECD countries. In 2015, around 67 per cent of the R&D expenditure was by the private sector, nine per cent by the public sector and 24 per cent by the higher education sector.

Of R&D funding, 53 per cent was from the private sector, 21 per cent from the public sector, 12 per cent from the higher education sector, and 14 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 decreased slightly and it is at around 76,000 (2015). The decrease since 2011 has been a few per cent. The number of R&D personnel with a doctoral degree has more than tripled since 1995.

Figure 8.1
Architecture of public research funding in Finland.

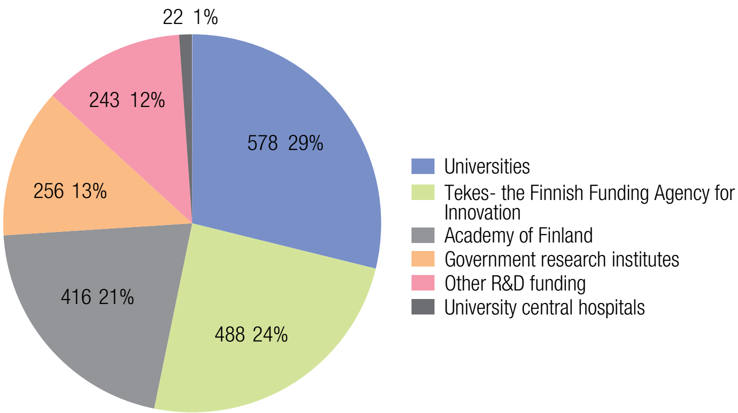


The Research and Innovation Council, chaired by the Prime Minister, supports the Government in developing and combining visionary science, technology and innovation (STI) policy. The Academy of Finland is the umbrella of the national Research

Councils, and it finances high-quality scientific and strategic research (EUR 415 million in 2015, including Strategic Research Council's part of EUR 55 million). Tekes – the Finnish Funding Agency for Innovation provides innovation funding for companies, research organisations, and public sector service providers (EUR 488 million in 2015). The Ministries' joint analysis, assessment and research activities, coordinated by the Government, generate information that supports decision-making, working practices and management by knowledge.

Climate change has been recognised as an important topical subject in Finnish research policy for decades. Climate change research policies are cooperatively implemented by several ministries and climate change continues to be a priority area in many research programmes and projects (see Section 8.2 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 of environmental and socio-economic questions. Research in general has been partly shifted to concern larger views and to promote knowledge-based decision-making and management. In addition, the cross-cutting nature of climate change has been integrated into many environmental, sectoral and technology research programmes and projects.

Figure 8.2
Public research funding in Finland in 2015 (EUR million; per cent)



Finland's Government Programme (2015) has five strategic priorities composed of 26 key projects. Climate change is related to the priority of Bioeconomy and clean solutions, and its key project of Towards carbon-free, clean and renewable energy cost-efficiently.

The new instrument of the Government's annual plan for joint analysis, assessment and research activities generates information that supports decision making, working practices and management by knowledge. Climate change related research subjects have been on the plan since its presence from 2014. Subjects are clearly linked to the information needs and topics in the Government's decision-making processes.

Focus on research infrastructures has grown in recent years in Finland. The Academy of Finland coordinates national research infrastructure investments, as well as participates in European and international research infrastructures. As an international example, Finland is a member of the Integrated Carbon Observation System (ICOS) network. The ICOS network is headquartered in Finland since 2014. Finland is also leading the implementation of the Aerosols, Clouds and Trace gases Research Infrastructure (ACTRIS), which is scheduled to be operational in 2020, and the statutory seat of ACTRIS will be in Finland. See Section 8.1.2 for more information.

Box 8.1
OPEN DATA SETS EXAMPLE

As an example of realising the open science objectives, the Finnish Meteorological Institute (FMI) and the Finnish Environment Institute (SYKE) have set up online services that make it possible to search for, browse and download the Institutes' data sets in machine-readable format free of charge. The technical implementation of the online services 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. FMI Open Data Service usage has been growing annually, currently there is about 10,000 registered software developers and users and over 440,000 data downloads per day (5.2 req/s). Data is utilised in various economic sectors in Finland, e.g. Public, Energy, IT and Education. SYKE's open data policy applies to its data and register assets. SYKE's open data includes versatile information on water resources, surface and ground waters, the Baltic Sea, environmental load and distractions, the valuable natural environment, land cover and the built environment. SYKE's open data can be found at http://www.syke.fi/opendata. ■

Open science is one of the spearheads of Finnish science policy and it is promoted by all means necessary (see an example in Box 8.1). The Ministry of Education and Culture has outlined that Finland will become one of the leading countries in open science and research by 2017. Operating models should contain a variety of premises for openness, such as to meet the requirements for digital preservation to serve open research and science. The objective is to have open access to all scientific publications by 2020. In the future, Statistics Finland will be preparing annual impact reports on Open Data to Finnish society.

In addition to the open science policy within the country, Finland has been operating extensive capacity building programmes to promote the exchange of information and know-how as well as to support endogenous capacities and capabilities in developing countries. The capacity building programmes have focused on climate observations, research, higher education cooperation relevant to climate change mitigation and adaptation, and the sustainable use of forests (see Chapter 8.4). Free and open international exchange of data and information has been further promoted by participation in several international research programmes, networks and data collection schemes and databases (see Chapters 8.1.2, 8.2 and 8.3). Publishing research results in peer-reviewed international journals is advocated in all fields of research. A thorough window to the Finnish open access journals is available at www.journal.fi. Furthermore, there are scientific open access journals with a climate and ecosystems related focus, published by the Finnish research institutes, societies and universities, such as Boreal Environment Research and Silva Fennica that promote free international access to research results for their part.

The new instrument of the Strategic Research Council (SRC) at the Academy of Finland was founded in 2014 as a new research funding body. It funds high-quality research in areas of high societal significance. The research aims at finding concrete solutions to grand challenges that require multidisciplinary approaches. An important element of such research is active collaboration between those who produce new knowledge and those who use it. The SRC prepares approximately yearly a proposal on key strategic research themes and priorities to be approved by the Finnish Government.

Communication on new research information to decision-makers, other stakeholders and the general public is very important (see Chapter 9). The Finnish Climate Change

Panel was nominated by the Ministry of the Environment for the first time in 2011 to enhance science-policy interaction between climate and energy policy, as well as public discussion. The Finnish Climate Change Panel has been an active knowledge producer and partner in the field (Box 8.2).

According to the Finnish Science Barometer 2016 the public's expectations are optimistic on science and the world view. Science is believed to be the answer to many important issues. As an example, the barometer argument that "the progress of climate change is a real and serious threat, which requires efficient action from political decision-makers" is supported by the majority (84%). The percentage of those who disagree is almost marginal (6%). Although the mitigation of climate change is seen as a relatively difficult task, optimism about the solutions has increased. One reason for this could be the Paris Agreement resulting from international climate negotiations, and its good media coverage.

Box 8.2

THE FINNISH CLIMATE CHANGE PANEL

The Finnish Climate Change Panel was nominated by the Ministry of the Environment in December 2011. The 12-member Panel was tasked to strengthen the interaction between research and policy making. The panel served two approximately two year terms and published reports on several topics relevant to climate policy making (e.g. The Climate Change Act, Energy system and emission reduction measures, Carbon neutrality, Black carbon, Environmentally and socially sustainable climate policy in agriculture, Climate education, Adaptation to climate change, risks, responsibilities and costs). The mid-term evaluation of the Panel recommended that the panel should make more effort in communicating its messages, and relevant action was taken accordingly.

The legal base for the Finnish Climate Change Panel was established when the Climate Change Act came into force in summer 2015. The Panel is appointed as an independent body to support planning and decision-making of climate policy. The Government nominated the Panel in January 2016. The policy advisory role of the Panel has become stronger. Panellists have e.g. been invited to comment on the 2016 Energy and Climate Strategy in relevant committee hearings in the Finnish Parliament. The Panel's advice has also been sought during the preparation of the Government's first Mid-term Climate Change Policy Plan. The Panel has continued its work with LULUCF related issues, and has published a report on Cleantech. ■

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 the World Weather Watch at an operational level through the synoptic network of surface and upper-air stations, as well as to the Global Atmosphere Watch.

Finland has actively participated in the work of the Intergovernmental Panel on Climate Change (IPCC). 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'. Finnish experts will participate as authors in the preparation of the IPCC Special Report on 1.5 °C Global Warming and the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories starting in 2017.

In another major effort, Finland is overseeing the implementation 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 November 2015, the European Commission officially launched ICOS ERIC, the Integrated Carbon Observation System European Research Infrastructure Consortium. 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. 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 Finnish Meteorological Institute (FMI). Finnish funding for the ICOS will be around EUR three million annually during its operational phase (more information on ICOS in Section 8.3.1).

Finland is also leading the implementation and establishment of the ACTRIS (Aerosols, Clouds and Trace gases Research Infrastructure) organisation, which is a European distributed research infrastructure for near-surface monitoring and research on short-lived climate forcers in the atmosphere. These are the other crucial group of components (besides greenhouse gases) for determining the atmospheric component of climate warming. ACTRIS is currently in a preparatory phase, and is scheduled to be operational starting from 2020. ACTRIS links research, education and innovation to promote data use, technological developments and demonstrations related to atmospheric components; aerosols, clouds and trace gases. The ACTRIS Head Office is planned to be located in Helsinki, with a secondary node in Rome, Italy. The partners of ACTRIS-Finland are the FMI, the University of Helsinki, the University of Eastern Finland and Tampere University of Technology. Finnish funding for ACTRIS will be around EUR five million annually during its operational phase (ACTRIS 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 currently ongoing Joint Programming Initiatives (JPIs) touch upon climate change themes, principally the Agriculture, Food Security and Climate Change (FACCE JPI), Connecting Climate Knowledge for Europe (JPI Climate) and Water Challenges for a Changing World (Water JPI). There are also several ERA-NETs, some of them under the umbrellas of JPIs, which touch upon the climate change issues. Examples of these include WaterWorks2014 and WaterWorks2015 (under Water JPI), ERA-NET Plus on Climate Smart Agriculture (under FACCE-JPI), ERAfrica, BiodivERsA and ERA-NET Cofund for climate services (ERA4CS). Finnish representatives are involved in the governance of these initiatives and there are national support groups as well. Finnish researchers have also succeeded in several joint calls of these initiatives. Finnish researchers have actively participated in climate-change related research under Horizon 2020 Work Programmes 2014 to 2016. By

March 2017, more than 56 projects with Finnish participant organisations were being funded, under six activities of the Work Programmes of the European Commission. The Technical Research Centre of Finland Ltd (VTT) and the Finnish Meteorological Institute (FMI) were involved in the largest number of projects. The total cost of the projects was approximately EUR 502 million. Five projects are led by a Finnish coordinator.

From 2008 until 2016, Finland was a member of the Top-level Research Initiative (TRI), a major Nordic venture for climate, energy and the environment. TRI comprised six programmes, each of which have launched thematic calls using appropriate funding instruments. Types of calls launched included Centres of Excellence in research and top-level research networks. TRI initiative has not only generated considerable new knowledge about climate change, it has also educated a large generation of young climate researchers.

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 permanent status and its mandate was widened to contribute to an ambitious and effective implementation of the UNFCCC and its Paris Agreement, with a Nordic perspective. NOAK produces studies for Nordic and international climate negotiators and arranges workshops supporting the negotiations. Finland was the chair of NOAK in years 2011–2014 and has been the coordinator of NOAK since 2011.

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 2016, AMAP published jointly with the WCRP Climate and Cryosphere (CliC) Project, and the International Arctic Science Committee (IASC) 'The Arctic Freshwater System in a Changing Climate' and in 2015, the AMAP Assessment: Human Health in the Arctic, which deals extensively with climate change related issues. AMAP's latest climate change related report was an updated report on Snow, Water, Ice and Permafrost in the Arctic (SWIPA 2017). The report serves as an arctic contribution to the IPCC special report on 'Oceans and Cryosphere' (due in 2019) and the Assessment Report 6 (due in 2021). Relating to adaptation to climate change and other drivers of change, AMAP produced three regional Adaptation Actions for a Changing Arctic Report including the Barents area (2017). Finland chaired the AMAP Working Group in 2015 to 2017 and Finland is currently chairing the Arctic Council (2017–2019). During this period, Finland will lead the Arctic Council Expert Group on Black Carbon and Methane that aims to improve circumpolar knowledge of the emissions and mitigation actions.

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 Action Plan on Climate Change for the Barents Region was adopted in autumn 2013 and includes a number of measures and projects and identifies concrete actions to be carried out by the working group for the BEAC. The BEAC Working Group on Environment (WGE) focuses on the so-called Barents Environmental Hot Spots, where enhanced environmental and cleaner production measures will lead to CO_2 and black carbon emission reductions, among other things. In addition, the WGE is implementing several climate-relevant activities in the Barents Region, such as promoting regional climate strategies, enhancing the network of protected areas, and arranging conferences and projects covering climate change mitigation and adaptation themes. More details on the climate research carried out in the Arctic can be found in Box 8.3.

Capacity building activities in developing countries related to climate change research and systematic observation are described in Section 8.3.4.

Box 8.3
CLIMATE RESEARCH IN THE ARCTIC

Arctic Research Policy and Goals
Finland's Strategy for the Arctic Region defines objectives for Finland's Arctic policy. With respect to research, the policy is to invest in expertise and to gain knowledge of northern areas. A diversified array of Arctic research is conducted by higher education institutions and by research institutes. Expertise is also possessed by many companies. Arctic research policy is cooperatively implemented by several ministries.

International cooperation is seen as very important. Finland is an active member in the Arctic Council and its Working Groups. Finland has, for example, contributed significantly in the Arctic Council's Arctic Monitoring and Assessment Programme AMAP and to its recent reports related to climate change.

Arctic Research Funders
Many sectoral ministries are involved in funding and steering of Arctic research in higher education institutes and research institutes.

The Academy of Finland, as a national research funding agency, funds high-quality scientific research projects. The Academy of Finland is also a stakeholder in Arctic research priorities.

Tekes – the Finnish Funding Agency for Innovation offers funding for research and development conducted by Finnish companies, research organisations, and public sector service providers.

Major Arctic Research Initiatives
ARKTIKO. The national research programme ARKTIKO (2014 to 2018) aims to study and understand the changing factors that affect the development of the Arctic region, the process of transformation, and the dynamics of change.

Arctic Seas Programme. The primary goal of this national programme is to strengthen Finland's reputation as an internationally attractive centre of Arctic "know-how."

Universities in Lapland and Oulu strategically prioritise the Arctic region. Most Finnish universities and other academic institutions have research programmes focusing on the Arctic, the North, and cold climate regions.

Arctic Centre. The Arctic Centre conducts internationally recognised and highly regarded multidisciplinary research on the Arctic region. Its emphasis on science communication and on public exhibitions improves the visibility of Finland's Arctic expertise, and increases international access to Arctic information.

The Finnish Meteorological Institute's (FMI) research focuses on understanding various climate forcing mechanisms and feedbacks in the Arctic, as well as linkages between the Arctic warming and mid-latitude weather. Processes in the atmospheric boundary layer, snow and atmosphere-sea ice-ocean interactions are studied to improve capabilities to model weather and climate.

The Finnish Environment Institute SYKE brings expertise in research to various projects in northern areas and in the Arctic Council's work. The Institute's expertise in environmental research focuses in particular on impacts and scenarios of climate change and ways of securing sustainable development in arctic areas jointly with other research organisations, such as the Natural Resources Institute LUKE, that has particular expertise in the use and management of renewable natural resources.

Arctic Research Infrastructure

The several field stations operated by universities and research institutes are bases for field campaigns and long-term follow-up studies with Arctic focus and in the Arctic area. The long term continuous measurements provide unique monitoring and research material, e.g. on greenhouse gases, atmospheric aerosols, clouds and trace gases (by FMI at Pallas, Finland, and Tiksi and Baranova in Russia). Similarly, operational observations are needed to study feedback processes like polar ozone and arctic snow.

The Finnish National Satellite Data Centre, located in Sodankylä north of the Arctic Circle, is an excellent location for receiving data from all polar orbiting spacecraft. The centre collaboratively provides Arctic satellite data and products for international research and operational entities.

The Finnish Marine Research Infrastructure (FINMARI) supports polar oceanography and sea ice research, e.g. the ocean and sea ice processes and climate interactions in the polar oceans to support developing and improving of forecasts and operative models and services.

R/V Aranda is an ice-reinforced research vessel (ice classification Super A1) mostly operating in the Baltic Sea but it has also made expeditions to the Arctic Ocean. Finland has a fleet of icebreakers of which several are multipurpose vessels capable of offshore tasks including serving as research platforms.

Finland also has special infrastructure for large-scale laboratory studies of arctic conditions. The Aalto University operates a large-scale ice tank infrastructure, which can produce sea ice at model scales. In addition, there is a special test facility for icebreakers operated in Helsinki by a privately owned shipyard. ■

8.2 Research

8.2.1 Major overarching research programmes and funding organisations

Government plan for analysis, assessment and research

In 2014, the Government adopted an approach based on annual plans for analysis, assessment and research which underpins policy decision making and steers studies and research towards specific priority areas selected by the Government. The resources available for implementing the plan amount approximately to EUR 10 million. During 2014 to 2017 there are several projects relating to climate change (see Table 8.1), altogether about EUR 2.3 million. The projects have been conducted by many different organisations: Universities, research institutes and consultants.

Programmes of the Academy of Finland

The recently finished Finnish Research Programme on Climate Change (FICCA, 2011 to 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 was to support the type of multidisciplinary research that addresses both social and environmental areas — with the objective being a systemic approach to research problems. In the first call for applications in 2010, eleven research projects were granted funding for 2011 to 2014. In 2011, international joint calls were launched with Chinese and Russian funding partners and, eventually, six international joint projects were funded for 2012 to 2014. In the 2012 call, researchers were invited to submit applications for development research projects targeted at climate change research, and as a result, the Ministry for Foreign Affairs of Finland and the Academy of Finland co-funded seven research projects for 2013 to 2014. The total funding of the

Table 8.1
Climate change related projects in the Government plan for analysis, assessment and research in 2014 to 2017.

Projects, themes	Duration	EUR	Decision making process
EU 2030; several projects, themes: • Effects of the EU's climate and energy targets for 2030. • Which policy measures and other measures are effective in achieving the targets set in the 2030 Energy and Climate Package of the EU? • Impact of the amendments to the Emissions Trading Directive on Finnish industry, energy production and economy	2014 to 2017	1,500,000	Support for: • EU 2030 policy • Preparation and evaluation of Energy and Climate Strategy
Climate negotiations, themes: • How should Finland prepare for the obligations imposed by the international climate agreement?	2016	150,000	Support for international climate negotiations
Adaptation; several projects, themes: • Adaptation actions for a changing Arctic • Proactive management of weather and climate related risks • Assessment of risks and vulnerability to climate change	2014 to 2017	650,000	Support for: • Adaptation strategies and such • Arctic cooperation, strategic work

FICCA research projects was around EUR 17 million, of which approximately one-half was granted to universities and the other half to research institutes.

Sustainable Governance of Aquatic Resources (AKVA, 2012 to 2016) aimed to tackle the scientific challenges related to water. The Nordic climate and environment was one of the programme's major challenges specified by the Academy Board. Several projects, including joint calls with international partners, have received funding from AKVA.

The Academy of Finland has three ongoing Programmes related to climate and energy:

The Academy Programme on a biobased economy (BioFuture2025, 2017 to 2020) was launched in order to support the creation of a new knowledge base and to promote major scientific breakthroughs through new ways of doing science. A biobased economy is evolving alongside the fossil-fuelled economy, promising solutions that will help curb climate change and excessive natural resource consumption. In the first call for applications in 2016, ten research consortium projects were granted funding for 2017 to 2020.

The Arctic Academy Programme (ARKTIKO, 2014 to 2018) aims to study and understand the change factors affecting the development of the Arctic region, the transformation process, and the dynamics of change. The programme has four themes: Good quality of life in the north, Economic activity and infrastructure in Arctic conditions, The northern climate and environment, and Cross-border Arctic policy. ARKTIKO has funded 20 extensive international research projects and two international joint projects.

The Academy Programme New Energy (2015 to 2018) harnesses scientific methods to resolve complex issues related to the great energy transition. Several projects, including joint calls with international partners, have received funding from New Energy.

The Strategic Research Council (SRC) at the Academy of Finland provides funding for long-term and programme-based research to produce knowledge to solve society's grand challenges that require multidisciplinary approaches. The SRC prepares approximately yearly a proposal on key strategic research themes and priorities to be approved by the Finnish Government. An important element of such research is active collaboration between those who produce new knowledge and those who use it.

The Government decides on the research needs to be explored and decides the final themes, which the SRC then formulates into research programmes and funding calls. SRC programmes run for three to six years. Programmes that include projects of particular relevance for climate change are the following:

- Disruptive Technologies and Changing Institutions (Energy transition and renewable energy)
- A Climate-Neutral and Resource-Scarce Finland (Energy transitions, use of forest resources, off shore wind, circular economy of non-renewable substances, resource efficient food production).
- Security in a Networked World (Climate and resource scenarios)
- Urbanising Society (Urban form, smart cities)

Programmes of Tekes

The Finnish Funding Agency for Innovation (Tekes) has coordinated major research and development programmes on the mitigation of climate change. The BioRefine – New Biomass Products Programme (2008 to 2011) developed business related to new value-adding products or new process or business concepts that utilise biomass in a variety of forms, as well as technologies, equipment production and services. The Green Mining Programme's main objective was to make Finland a global leader of the sustainable mineral industry by 2020. Green Growth (2011 to 2015) and Groove – Growth from Renewables (2010 to 2014), generally had a wider scope, but their topics were also relevant for climate change mitigation. The aim of the Green Growth programme was 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. The Groove – Growth from Renewables programme enhanced 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. Ongoing programmes CleanWeb (2016 to 2018) and BioNets (2016 to 2018) have connections to the mitigation of climate change. The objective of CleanWeb is to create rapidly scalable cleantech businesses and accelerate access to the markets. This involves leveraging digitalisation and new innovations and practices to transform the cleantech sector into a reformed, competitive growth industry. The aim of the BioNets programme is to advance Finland's bio and circular economy by generating innovative and international business ecosystems, new business development platforms and new bioeconomy solutions, services and actors. The goal is to pilot solutions at an early stage together with customers. Basically all of the 756 ongoing or finished projects and their volume of EUR 290 million (2011 to 2017) contribute to climate change mitigation either by providing more knowledge through research or by supporting the business capabilities of renewable energy companies.

Sitra, the Finnish Innovation Fund

The Finnish Innovation Fund Sitra is a future fund that collaborates with partners from different sectors to research, trial and implement new ideas that shape the future. The aim is for Finland to be a pioneer in sustainable wellbeing. Sitra investigates, explores and develops operating models in close cooperation with other responsible operators to support public administration.

One of Sitra's three theme areas is promoting a resource-wise and carbon-neutral society. The aim is to make Finland a trailblazer for a new society based on a sustainable economy by 2019. The process of drawing up Finland's road map for a circular economy was led by Sitra. The road map was published in autumn 2016. The first trials of this road map – the key projects and pilots – have already been launched. Between 2013 and 2016, practical tools were developed to help companies make their businesses carbon neutral.

Sitra has invested a total of approximately EUR 16.2 million in projects carried out as part of the Resource-wise and Carbon-neutral Society theme area, contributing to over 150 projects. In addition, Sitra has invested in several companies and funds and on 31 December 2016, had investments in six companies and eight international funds in the field. The current projects and fund investments of Sitra include themes that promote climate change mitigation, such as the circular economy.

Foundations

Several foundations have given considerable emphasis to climate change studies and environmental studies. An indicative but not a complete list of those foundations is: the Atmosmare Foundation, the Finnish Cultural Foundation, the John Nurminen Foundation, the Kalevi Sorsa Foundation, the KAUTE Foundation, the Kone Foundation, the Lammi Biological Station Environmental Studies Foundation, the Maa- ja Vesitekniikan Tuki Foundation, the Maj and Tor Nessling Foundation, the Marjatta and Eino Kolli Foundation, the Metsämiesten Säätiö Foundation, the Swedish Cultural Foundation in Finland, the Tiina and Antti Herlin Foundation, the Walter and Andrée de Nottbeck Foundation, and the Väinö Tanner Foundation.

8.2.2 Climate process and climate system studies

The Finnish Meteorological Institute FMI has a staff of around 80 scientists working with climate change and related problems. 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, clouds, trace gases and climate (measuring properties of aerosols, clouds, trace gases and their interactions both in situ and remotely, modelling aerosol dynamics and aerosol-cloud interactions).

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. 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, cloud and trace gas 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 to 2007, 2008 to 2013, and 2014 to 2020). 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 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, as well as conducting focused experiments and modelling to understand the observed patterns.

Paleoclimatology

Finnish universities and research institutes have extensive activities in paleoclimatology and they cooperate in several research areas. Studies are mostly based on good natural archives in Finland and polar areas.

At the Environmental Change Research Unit (ECRU) of the University of Helsinki, the central research theme is the development and application of empirical, computational and modelling tools to detect global climatic and environmental changes and analyse their ecological and societal impacts. The ECRU is particularly interested in centennial to millennial-scale climatic changes with a focus on Arctic environments. The research is largely based on proxies stored in natural archives (peatlands, lake and marine sediments, ice cores). Specific research themes include carbon cycling, climate development and extreme climatic events, past black carbon deposition in the European Arctic, Arctic sea ice history, past peatland and lake dynamics. Intensive data handling and data compilations are a key element of research at ECRU. The research of the ECRU is also a part of wider international research programs.

The Department of Geosciences and Geography at the University of Helsinki works on climate reconstructions based on biological indicators in lake sediments. The Geological Survey of Finland studies varved sediments, with an emphasis on their physical properties.

At the Geoscience Research Unit of the University of Oulu, the objectives under paleoceanographic and -climatological research are to produce important threshold values in geochemical (incl. isotopic fingerprint) and sedimentological proxy information on past climate warming events and related loss of ice in the North in time scales from hundreds to hundreds of thousands of years. Polar marine sediment records (e.g. Central Arctic Ocean and Prydz Bay and Wilkes Land in Antarctica), as well as terrestrial glacial-interstadial deposits in the Eurasian Arctic also document transitions between different climate states well, including abrupt events on timescales of decades to a few centuries. The research is conducted under international research programmes. The Space Climate Research Unit of the University of Oulu studies the long-term (up to a few hundred years) evolution of the Sun and the effects of solar magnetic activity to the space around the Sun, including the Earth. All possible long-term series of observations made by satellite and ground-based instruments to study solar effects to the Earth's atmosphere and climate are in use. The solar wind affects the climate and atmosphere, especially at high latitudes. Studies are related to questions like how these mechanisms influence the atmosphere and how relevant they are to climate change.

The Natural Resources Institute Finland (Luke; previously the Finnish Forest Research Institute Metla) has constructed the longest annual pine tree-ring chronology in the world (5634 BC to AD 2016s) based on megafossil trees recovered from lake bottoms. This chronology has been used for reconstructions of past summer temperature changes and variability in the northern climate after the last glaciation period. In general, the paleoclimate research conducted at the Natural Resources Institute Finland is focussed on constructing tree-ring chronologies for reconstructions of past temperature and precipitation variability in Finland and adjacent areas and for contributing to the efforts of reconstructing the past climate variability at Hemispheric and global scales in international cooperation. Tree-ring chronologies and the paleoclimate reconstructions are used for analysing the impacts of natural forcing factors (solar activity and explosive volcanism) and the effects of ocean-atmospheric circulation on climate variability. The paleoclimate expertise of Luke contains the fieldwork and laboratory work with subfossil wood materials (tree-ring dating, blue intensity/latewood maximum density, wood anatomy) needed to build the long tree-ring chronologies.

The Laboratory of Chronology (LC) of the Finnish Museum of Natural History analyses the isotopic and elemental compositions of samples from different environmental archives. The LC has led efforts to construct radiocarbon and stable isotope chronologies from Finnish subfossil materials for the late and mid Holocene times. The aim is to constrain the temperature-cloud-irradiance interrelationships and their dependence of North Atlantic variability in the ocean-atmospheric circulation. Furthermore, abrupt climatic and environmental anomalies are tracked down by multiproxy methodologies and the interaction between nature and people is addressed.

8.2.3 Climatic modelling and prediction

The FMI studies climate change using climate models that describe the physical and chemical processes of the Earth's climate system. The modelling is based on participation in the EC-Earth earth system model collaboration. The FMI is also continuing to use the ECHAM global climate model family. ECHAM is a global climate model developed by the Max Planck Institute for Meteorology. The FMI also develops and uses the regional climate models HARMONIE-Climate and 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 also been provided by various consortiums, including other ministries, national funding organisations, such as the Academy of Finland, and the private sector.

In recent years, the focus of research to support the greenhouse gas inventory has been on developing and improving methods and national parameters for estimating the carbon stock changes, in soils in particular, in the land use, land-use change and forestry (LULUCF) and agriculture sectors. The Finnish Yasso model for estimating carbon stock changes in soils (developed by the European Forest Institute, the Finnish Environment Institute and the Finnish Forest Research Institute, currently the Natural Resources Institute Finland (Luke)) has been acknowledged internationally and is used in inventory preparation in other countries, too. Several national and international projects have enabled the current use of Yasso in estimating carbon stock changes of most land use classes in Finland. Several research projects conducted by universities and research institutes have provided more accurate emission factors for CO_2, N_2O and CH_4 emissions from organic soils and peat extraction.

In addition, a recent project at the Natural Resources Institute (Luke) on harvested wood products estimated carbon content of different domestic products and allocated harvests since 1990 to different forest-related activities under the Kyoto Protocol, i.e. to afforestation and reforestation, deforestation and forest management. Methodology for identification of land use and land use change has also been further developed. An ongoing development project on the Finnish normative manure system will provide an updated Nitrogen mass flow model to calculate nitrous oxide emissions from manure management (the Finnish Environmental Institute and the Natural Resources Institute Finland).

Furthermore, an ongoing project at the Finnish Environment Institute (SYKE) funded by the Nordic Council of Ministers aims to improve the F-gas inventories in the Nordic countries by joint comparison and verification of the emission estimation methodologies, emission factors and other parameters and assumptions used in different countries. The project will also provide estimates of the strengths and weaknesses of the inventories and, e.g. the applicability of the national emission factors and other parameters to other countries.

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

This sub-chapter mainly focuses on research performed since the publication of the Sixth National Communication. The text aims to provide 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).

In research on climate change, the focus has gradually shifted from dominantly natural sciences to more comprehensive approaches that include socio-economic studies and inter- and transdisciplinary approaches. The aim is to be able to understand better complex interactions between a wide range of climate change impacts and adaptation and mitigation measures. Active research on possible measures to address climate change has emerged. The interactions between mitigation and adaptation actions are also increasingly recognised

A large number of research institutes and universities carry out research on climate change impacts, adaptation and mitigation in Finland. Several research organisations have set up their own climate-change-related programmes or research units. Climate change research is closely connected to other themes, such as bioeconomy and circular economy, resilience, studies of societal transitions, energy research, transport research, consumer studies and also ecological research. Education and training of experts are an integral part of the research activities.

Close cooperation among research organisations is a characteristic feature of Finnish research on climate change impacts, adaptation and mitigation. National research programmes (see Section 8.2.1), have provided funding and common goals for the research.

Taking as an example the Academy of Finland's funding for climate change research in 2013 to 2016, which totalled more than EUR 59 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 over 40 projects. Of the other universities, the University of Eastern Finland, the University of Oulu, and the Universities of Turku are runner-ups with several climate change projects each. In addition, Aalto University, the University of Jyväskylä, the University of Tampere, Åbo Akademi University, Tampere University of Technology and Lappeenranta University of Technology 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 (almost 30 projects), the Natural Resources Institute Finland (Luke) including former Metla and MTT, the Finnish Environment Institute (SYKE), the Geological Survey of Finland (GTK), VTT Technical Research Centre of Finland, the National Institute for Health and Welfare (THL) and the International Institute for Applied Systems Analysis.

The Ministry of Agriculture and Forestry and the Ministry of the Environment are funding the Research Programme for Environmental impacts of agriculture (MATO) during 2016 to 2020. One of the aims of the MATO programme is to enhance adaptation and mitigation. For example, one project is aiming at modelling the carbon sequestration potential of soil amendments in agricultural soils.

Finnish research organisations (for instance SYKE, VTT, FMI) have also been active in adaptation and mitigation research in the European context. Several studies on adaptation have been funded/launched within the EU's framework programme. Finnish research partners are also active in several ERA-Net -programmes initiated under the Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI). The Natural Resource Institute Finland (Luke) is among the coordinators of the Knowledge Hub FACCE MACSUR, which brings together the excellence of research in modelling grasslands, livestock, crops, farms, and agricultural trade in order to improve the modelling of climate change impacts on European agriculture and in order to illustrate to political decision-makers how climate will affect regional farming systems and food production in Europe. The five-year project started in June 2012. SYKE leads the working group on effects under the COST Action Innovations in Climate Governance (INOGOV) that explores social science solutions for addressing climate change.

Research on impacts and adaptation

Examples on how the projects of the Government plan for analysis, assessment and research instruments have been able to enhance multidisciplinary research are the projects ELASTINEN and SIETO (see also table 8.1). ELASTINEN was a joint project by the Finnish Meteorological Institute, the University of Helsinki, the Finnish Environment Institute SYKE, the Natural Resources Institute Finland Luke, the Finnish National Institute for Health and Welfare and Gaia Consulting Oy, examining the state of weather and climate risk management in Finland and assessing ways to manage risks and the role of a range of parties. The SIETO project aims at improved weather and climate risk assessment and operational models merging expertise from both natural and environmental, as well as human and socio-economic sciences.

The objective of ELASTINEN was also to decrease the vulnerability of Finnish society and increase its adaptive capacity to changing climate, enhancing the implementation of the National Climate Change Adaptation Plan

Several studies on the impacts of climate change and adaptation on forestry and agriculture have been carried out in the Natural Research Institute Finland Luke. In 2016, a detailed vulnerability and risk assessment for agriculture, forestry, fisheries, game management and reindeer husbandry was carried out. Other relevant, ongoing research projects and programmes include the Forests and Water Research and Development Programme (H2O), 2013 to 2017, aiming to increase the 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, to find new methods for preventing 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 focused, for example, on 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 studies of climate impacts, vulnerabilities and risks at different spatial and temporal scales, including analyses of adaptation to climate change as a societal process and studies of scenarios for climate change impacts. Examples include Marine Spatial Planning in a Changing Climate (MARISPLAN) and Pathways Linking Uncertainties in Model Projections of Climate and its Effects (PLUMES) funded by the Academy of Finland.

Impacts and adaptation in the Arctic are intensively studied at the Arctic Centre at the University of Lapland which is the northernmost university in the European Union. The research focuses on global change, sustainable development, anthropology and governance, including an international glaciology group specialised in climate change and modelling the impacts of climate change on Arctic and Antarctic ice masses, extreme events and global sea level.

Adaptation in the urban environment and questions related to the living environment and climate change have been studied. 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.

The National Institute for Health and Welfare studies the health and welfare impacts of climate change with special focus on inequalities, especially vulnerable population groups and measures that should be taken to enhance resilience and preparedness to changes.

A study by the Climate Change Panel (Box 8.2 on the Climate Change Panel) in 2016 examined the risks, costs and responsibilities of the climate change using crop and flood damages as case 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. An increasing number of studies have assessed climate change problems from a transdisciplinary perspective and integrated various socio-economic aspects. The Strategic Research Council has funded large consortia, where research institutes, universities and other actors, including the private sector, join forces in dealing with technology and energy disruptions and resource efficiency. Tekes funding has been important 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 key sectors, such as the energy industry, transport and the building sector, including system analysis on climate impact of the different technologies, assessments on greenhouse gas impacts, as well as 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.

Climate change policies and measures and their implementation and impacts are also extensively studied at SYKE. Specific topics include the environmental impacts of climate policies and measures, including their effects on carbon sinks and air quality. Life cycle analyses are extensively used in the work. SYKE further analyses energy and other transitions aiming for a low carbon society and the renewal of manufacturing. Studies of energy policy explore ways of managing the increasing share of renewables in the energy mix. Transition studies explore how industrial renewal can contribute to mitigation and how policies influence innovation. The economics of climate change mitigation has been explored by, for example, the Government Institute for Economic Research (VATT), that has shown that subsidies for energy intensive industries are inefficient use of public funds, the University of Oulu, that together with VATT and SYKE has explored the economics of intermittent energy use, VTT, which runs models of the energy system and Luke, that has developed a combined forestry and energy model.

An emerging field of research is the study of 'mitigation experiments', often focusing on local or regional solutions for reducing greenhouse gas emissions, switching to renewable energy resources or improving energy efficiency. These studies explore the potential of 'bottom up' solutions that can contribute to more ambitious mitigation goals at local or regional level than those set at national or EU levels. The studies examine both technical and governance aspects of the experiments. Special research focus has been devoted to the 'carbon neutral municipalities' (Hinku) that have become an expanding municipality and private actor driven network testing out and scaling up innovative solutions for climate change mitigation. The Finnish Environment Institute has provided research-based support for the network.

The Natural Resources Institute Finland studies mitigation measures in the agriculture and forest sectors. Examples of research topics include the enhancement of sinks in agriculture and horticulture, the impacts of changes in climate and energy policy on agriculture, and multi-level integrated modelling and analysis of agricultural systems. In the forest sector, the climate and energy research focuses on the interaction and coherence of different policies that have an impact on the management and use of forests. Special emphasis is put on numerical modelling that combines economic behaviour, policy options and a description of forest resources. As a project example, researchers from the Natural Resources Institute Finland (Luke) and FMI explore the possibilities of optimising forest management for timber production and climate change mitigation, accounting for the trade-offs between carbon and albedo, and climate policy and the economic objectives of forest utilisation in the Academy of Finland funded OPTICA project. In addition, the feasibility, impact and business opportunities of various policy measures promoting carbon sequestration are being examined at a national level.

Developing technology in carbon capture and storage is mostly done commercially in Finland. Applying CCS technology is still in demonstration state. Related research is conducted for instance at Aalto University and Åbo Akademi University. From Finland's point of view, especially interesting is so called bio-CCS (BECCS) that would be used in energy plants utilising biomass or forest industry waste. VTT Technical Research

Centre of Finland has developed CLC (Chemical Looping Combustion) technology on bio-CCS together with other Nordic partners. Carbon capture and use (CCU) is also an emerging technology. VTT together with Lappeenranta University of Technology (LUT) have a project (NeoCarbon) aiming at producing synthetic biofuel by extracting CO_2 from air or combustion gas.

Research on assessing, evaluating and monitoring climate action

Policies and other societal actions to strengthen mitigation and adaptation are regularly reported to the UNFCCC and the EU (Chapter 4), but, in addition, there is dedicated research aiming at creating more systematic and better quality controlled information on the contribution of policies to transformative societal change. Such assessments and evaluations of policies have in particular been initiated by the Strategic Research Council (SRC) and the dedicated Government's analysis, assessment and research activities. The latter have, for example, included research-based assessment of the Government's Energy and Climate Strategy (see Table 8.1). These operational studies for policy development are linked with more strategic research on climate and energy issues through studies focusing on technological disruption in energy, such as the projects BC-DC focusing on intermittent energy, SET analysing energy transitions, and EL-TRAN examining the required changes in the electricity system. These projects evaluate current systems and also provide assessments of alternative future pathways.

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, including atmospheric composition. The FMI also carries out physical marine observations.

Climate-related observation on hydrology and the chemical and biological state of inland and marine waters, as well as terrestrial biodiversity is carried out or coordinated by SYKE. Climate-related observations on forests, agricultural areas and fisheries are made by the Natural Resources Institute Luke. Several universities also have activities in this area.

Most of the systematic, long-term observational activities are carried out by budgetary funding. However, ongoing, more experimental observations carried out as a part of research projects are, to a significant degree, funded through external R&D funding and they 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

The meteorological observation network of the FMI is comprised of 86 manual precipitation stations and 180 automatic weather stations (AWS), of which two include upper-air observations. AWSs offer a comprehensive set of parameters essential for climate studies (e.g. temperature, pressure, relative humidity, precipitation (liquid and solid), wind, solar radiation). Observation records are distributed as synoptic weather messages mainly every 10 minute and via Global Telecommunication System hourly. The FMI has been responsible of aviation weather observations of Finnish airports since 2012. A dual polarisation

Doppler radar network gives comprehensive coverage over Finland offering a wide range of climate and operative applications for the society.

The FMI participates in the Global Climate Observing System (GCOS) Surface Network (GSN) with three stations. One station (Sodankylä) is also part of the GCOS Upper-Air Network and the GCOS Reference Upper-Air Network (GUAN and GRUAN, respectively). Since 2013, the FMI's data sets have been free for public use via an online service (see 8.1.1).

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).

The FMI has maintained a climatological database since 1959, including data from climatological normal values to near real time values for certain observations. In addition to the electrical data records, a significant amount of climatological data dating back nearly 200 years in time is still in paper format and being digitised.

The FMI is actively participating in the activities of the network of European Meteorological Services (EIG EUMETNET). The activities of the EUMETNET include observing systems, data processing, basic forecasting products, research and development, and training.

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, ozone, air pollutants and aerosols 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 in Antarctica since 1988.
- 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, ICOS in particular.

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 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 gas 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 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.

Finland is leading the implementation of Aerosols, Clouds and Trace Gases Research Infrastructure (ACTRIS), and will be participating in it once it will be ready (2020 onwards). ACTRIS provides high quality data on atmospheric components, and other services for supporting scientific research and science-based policy making. ACTRIS consists of national observing stations, international central facilities focused on data flows and calibration services for different types of instruments, and a top-level organisation, which is coordinating the infrastructure.

ACTRIS provides:
- Advanced facilities for national and international atmospheric science research programmes, enabling a leading role for Europe and member countries. This lowers the barrier for new and innovative environmental science projects.
- Long-term calibrated and reliable reference observations of key atmospheric parameters; aerosols, clouds and trace gases, providing comprehensive comparison data for improvement of air quality, pollutant dispersion, satellite retrievals, and weather and climate forecast models.
- Standardisation and development of new observational methods in atmospheric science to meet future needs; establishment of a common and globally competitive research framework.

The Finnish site selection for ACTRIS is not yet done, but the preliminary list of FMI sites includes Pallas, Puijo and Utö. Furthermore, the FMI is leading the preparation of part of the ACTRIS Data Centre (CloudDataNet) and the setting up of the ACTRIS Head Office.

Additional climate related 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. 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, Kuopio, Hyytiälä and Helsinki, as well as at the Argentinian Marambio Antarctic station. The results are regularly submitted to the World Data Centre for Aerosols and AERONET database (NASA).

Finland is a member of the European Space Agency (ESA) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). The FMI hosts the EUMETSAT's Satellite Application Facility on Ozone & Atmospheric Chemistry Monitoring, O3SAF.

8.3.2 Ocean observing systems

Finnish research institutes with significant marine components have started a national marine research infrastructure consortium (FINMARI) coordinated by the Finnish Environment Institute SYKE. The aim is to facilitate international and national use of experimental resources efficiently. This is done in close cooperation with other international and national infrastructures and ESFRI's such as ICOS, EMBRC and EURO-ARGO.

The infrastructure includes research infrastructures of three Finnish research institutes, three universities, and a state-owned shipping company. The infrastructure network consists of several field stations, research vessels and multi-purpose icebreakers, laboratory facilities, ferryboxes, fixed measurement platforms and buoys in the Northern Baltic Sea. FINMARI is listed as a nationally essential research infrastructure on 'Finland's Strategy and Roadmap for Research Infrastructures 2014–2020' by the Finnish government. FINMARI provides a hub for the ocean observing system in Finland and through the hub, access can be gained to both the infrastructure and the data that it produces.

SYKE participates in the joint Baltic Sea environmental monitoring programme (HELCOM Combine), which produces long-term data on the Baltic Sea ecosystem. The operative state monitoring of off-shore sea areas is carried out by SYKE (chemical and biological parameters, contaminants) and FMI (physical parameters). The monitoring network covers the Gulfs of Bothnia and Finland, as well as the northern Baltic Proper. Physical and chemical monitoring is conducted at about 60 sampling stations during three annual cruises with R/V Aranda. In addition, e.g. phyto- and zooplankton and benthic macrofauna are monitored at some of the stations and cruises. In the Gulf of Bothnia and the northern Baltic Proper, the off-shore monitoring is arranged in coordination with the Swedish Meteorological and Hydrological Institute (SMHI), and in the Gulf of Finland in cooperation with Estonian and Russian research institutes. The monitoring of in-shore and coastal waters is carried out by regional environmental authorities together with SYKE. The marine monitoring data serves, for example, the national implementation of EU/ Marine Strategy Framework Directive and Water Framework Directive and the work of HELCOM. The open data set stored in SYKE's databases has been utilised also, e.g. in evaluating the observed climate change effects in the Baltic Sea. Additionally, data is delivered, e.g. to the databases of the International Council for the Exploration of the Sea (ICES), the European Environment Agency (EEA) and EMODnet/ DG MARE.

SYKE also delivers near real-time information on the state of the Baltic Sea through Algaline that serves research, the general public, media and authorities. Algaline 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.

The FMI is responsible for monitoring physical properties of the Baltic Sea. The FMI network includes 14 water level stations at the coast, as well as regular temperature and salinity sounding stations and wave buoys in the open sea areas of the Baltic Sea. For the sea ice monitoring, FMI conducts sea ice and snow thickness measurements in the fast ice areas and utilises sea ice observations from several satellites.

FMI is contributing to the global Argo program by providing float to the Baltic Sea and North Atlantic monitoring via the Euro-Argo Research Infrastructure. For enhancing climate research and monitoring in the Baltic Sea, FMI together with the other partners of the Finnish Marine Infrastructure Consortium FINMARI has established the Utö Atmospheric and Marine Research Station.

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.

Flood forecasting at SYKE is based on the Watershed Simulation and Forecasting System. Its main component is a hydrological model representing the cycle and balance of water in a catchment. The forecasts are made daily from more than 500 water level and discharge observation points. Simulated hydrological data with over 20 variables from 1962 up to the present are available from the user interface of the system. Access to historical data is based on a yearly maintenance fee. The modelling system is extensively used in climate change research projects. The climate change related data and simulations are produced on demand. The hydrological simulation system also includes a nutrient simulation component by which quite extensive water quality related information (concentration and loads of N, P and sediments) that provides historical data series, and climate change simulation data can be produced on demand.

SYKE water quality data covers the country and important watersheds, as well as special small scale watersheds for baseline monitoring. All data are subject to systematic quality control, including the use of standardised methods for analysis.

Finland reports terrestrial climate observations to several international databases. 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) in the United States and lake water temperatures to a global project coordinated by the University of Nebraska.

In addition to inland water observations, the monitoring of terrestrial ecosystems aids in detecting changes induced by climate change. Integrated monitoring has indeed become an important approach in environmental sciences. At SYKE, the multidisciplinary International Cooperative Programme on Integrated Monitoring (UNECE ICP IM) is one of the activities set up under the Convention on Long-range Transboundary

Air Pollution (CLRTAP) to develop the necessary international cooperation for assessing pollutant effects and emission reductions. The key aim is to quantify the integrated effects of air pollution and climate change 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 located at SYKE. SYKE further participates in the UNECE ICP Waters and ICP Modelling & Mapping (ICP M&M) activities, which also cover monitoring and assessment of climate change effects.

SYKE acts as a coordinating body for the Finnish Long-Term Socio-Ecological network (FinLTSER), which brings together the Finnish research sites and scientists that conduct research on long-term socio-ecological processes and problems in a coordinated Finnish research infrastructure. The FinLTSER also belongs to the Europe-LTER and international LTER (ILTER) networks. The FinLTSER presently consists of nine highly instrumented sites/research platforms, representing the main ecosystems (marine, terrestrial, lake, sub-arctic, urban) in Finland, which provide a national infrastructure for long-term site-based ecosystem and biodiversity research in Finland, including climate change impacts.

Currently, about 60 national monitoring schemes or projects provide data concerning biodiversity in Finland. This monitoring work involves three research institutes: the Finnish Museum of Natural History, Luke and SYKE. This work includes collecting information on the changes taking place in ecosystems and habitats, species and species communities, and genes and genotypes. Monitoring data dealing with changes in biodiversity and habitats are compiled on a website. SYKE organises national butterfly (since 1999) and moth (since 1993) monitoring schemes, providing information about the effects of climate change on species occurrences.

Luke performs national forest inventories (NFIs), which produce reliable information on land use, forest resources, growth, condition and biodiversity of forests. NFIs are based on statistical sampling. The most recent NFI was done in the 2009 to 2013 and consisted of approximately 60,000 sample points. Eleven NFIs have been completed since the 1920s, providing internationally unique time series on the development of land use and forest resources. The twelfth NFI was started in 2014 and the field work will be completed in 2018.

The forest damage advisory service at Luke is responsible for monitoring forest pests and diseases and the damage they make. The service supports the decision making of forest owners and administrators by answering inquiries and making diagnosis and prognosis about forest pests and diseases. A report on the forest damage situation is published each year. Luke also collects information on the phenology of tree and forest berries. The extent of climatic warming can thus be assessed on the basis of the time series for the bud burst of different tree species.

Luke participates in UNECE ICP Forests Level II intensive monitoring, which is the key for providing insight into causes affecting the condition of forest ecosystems and into effects of different stress factors, including climate change. The results are reported on an annual basis.

Finland participates in the Sustaining Arctic Observing Networks (SAON). The SAON was established on the initiative of the Arctic Council and the International Arctic Science Committee (IASC). The purpose of the SAON is to support and strengthen the development of multinational engagement for sustained and coordinated pan-Arctic observing and data sharing. In 2014, the SAON established two committees: the Arctic Data Committee and the Committee on Observations and Networks. The vision of the SAON is that users should have access to free, open and high quality data that will realise pan-Arctic and global value-added services and provide societal benefits. The ongoing projects include an atmospheric observations initiative and participation in the EU project PolarNet for optimisation of existing monitoring and modelling programmes.

SYKE monitors the environment of Finland and the surrounding areas using data from Earth Observation (EO) satellites. Water quality and temperature in the Baltic Sea, snow extent, and lake ice are currently monitored operationally (i.e. products are generated when new data become available, practically almost every day as to the moderate resolution satellites such as Sentinel 3). For inland lakes, the operational methods are under development. Land cover, land use and phenology products are generated at a slower pace (one per year to every six years). Land and cryosphere products are SYKE's contribution to the Copernicus services. Operational processing of EO data is carried out in cooperation with the Finnish Meteorological Institute at the National Satellite Data Centre. At the moment, SYKE's EO R&D concentrates on algorithm development for EU's Sentinel 1, 2 and 3 satellite series.

The surveillance system of invasive alien species has been developed to collect and record data on the occurrence of invasive alien species, to estimate how their populations have increased or shifted location but also to measure the effectiveness of the management measures. The work in mostly done by integrating new elements to the existing inventories and monitoring systems. Also, citizens can report their observations of alien species to the Vieraslajit.fi internet portal including geospatial information.

8.4 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. The programmes have increased the endogenous capacities of developing countries to tackle these issues through improved technological means and human resources. In many instances national funding and support have also increased thanks to the momentum of the cooperation and an increased visibility through the programmes.

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 Sixth National Communication). The ongoing FMI capacity building activities include:

- Complementary Project to the SIDS- Caribbean Project and SHOCS I and II (COPS), 2010 to 2011 and 2013 to 2015: Improving the operational capacity of the NMHSs in the Caribbean Region to provide weather and climate services; and enhancing the role of the Association of Caribbean States, and improving the capacity of the NHMSs and Disaster Management Agencies for the governance of the early warning process.

- Pacific SIDS 2009 to 2011 and 2013 to 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.
- Sudan and South Sudan 2012 to 2014 and 2016 to 2018: 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.
- Sri Lanka 2016 to 2018: Severe Storm Warning Service for Sri Lanka (SSWSS): developing a real time service system based on lightning location data and weather models, and its marketing and business model development for Sri Lanka. The service system provides warnings of approaching thunderstorms to various platforms (www, mobile apps) from zero to six hours and at best up to 10 days ahead.
- Macedonia 2015 to 2017: Further strengthening the capacities for effective implementation of the acquis in the field of air quality. Strengthening the capacity for the central environmental laboratory in Macedonia; strengthening the capacity for performing emission inventories and dispersion modelling; supporting the environmental policy and planning and implementation of Clean Air Action Plans; and strengthen the capacities for health impact assessment of air pollution to human health.
- Azerbaijan 2017 to 2019: Upgrading the national environmental monitoring system of Azerbaijan on the basis of EU practices, including a legislative and institutional framework, development of technical systems, capacity building and training, and real case tests of the practical implementation of the system.
- Nepal 2015 to 2018: Detailed design of the Department of Hydrology and Meteorology of Nepal, procurement and implementation support in order to enhance the capacity to mitigate climate-related hazards by improving the accuracy and timeliness of weather and flood forecasts and warnings.
- Kyrgyzstan 2014 to 2017: Improving the capacity of the Agency on hydrology and meteorology of Kyrgyzstan to deliver weather, climate, and environmental information and early warning services for the benefits of the Kyrgyz society.
- Tajikistan 2014 to 2017: Improving the capacity of the Agency on hydrology and meteorology of Tajikistan to deliver weather, climate, and environmental information and early warning services for the benefits of the Tajik society.
- Jamaica 2017: Improving Climate Data and Information Management: Providing advisory services for capacity building and finalising specifications of a weather radar.
- Bhutan 2017: Installing the FMI weather information system SmartMet to improve the real time weather forecasting capacity of the Department of Hydro-Meteorological Service of Bhutan.
- South East Europe: 2012 to 2014 and 2016 to 2017: Establishing a multi-hazard early warning advisory system through a joint USAID/OFDA and WMO capacity development project aimed at supporting weather and climate services.

- The Bahamas 2017 to 2018: Installing the FMI weather information system SmartMet to improve the real time weather forecasting capacity of the Bahamas Meteorology Department in collaboration with Vaisala.
- Chile 2017: Designing a technological institution and environmental reference center for Chile in collaboration with the Finnish Environment Institute SYKE and the Technical Research Centre of Finland VTT.

In addition to the above-mentioned list of ongoing activities, the FMI is planning new capacity building projects in, for example, India, Nepal, Vietnam, Bhutan, Myanmar, and Kenya 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 to 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 to 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).

In spring 2017, an additional 20 projects were approved for the years 2017 to 2020. Of these projects, the following directly target climate change issues:

- Tanzania, Mozambique, Ethiopia: Promoting Education and Research on Energy Efficient Lighting and Renewable Energy for Sustainable Development – EARLI (Aalto University, EUR 0.6 million)
- Kyrgyz Republic: Capacity Building in Fisheries and Aquaculture Education in the Kyrgyz Republic – FishEDU (University of Eastern Finland, EUR 0.5 million)
- Tanzania: Geospatial and ICT Capacities in Tanzanian Higher Education Institutions – Geo-ICT (University of Turku, EUR 0.7 million)
- Colombia, Peru: Native Crops for Sustainable and Innovative Food Futures in Peru and Colombia – HEI-ICI-PECOLO (University of Turku, EUR 0.6 million)
- Kenya: Building Higher Education and Research Capacity to Address the Physical Activity and Nutrition Transition in Kenya: The Kenya-Finland Education And Research Alliance – KENFIN-EDURA (University of Helsinki, EUR 0.5 million)
- Myanmar, Laos, Thailand: Partnership for Forestry Higher Education Cooperation in Mekong Region – PARFORM (University of Helsinki, EUR 0.6 million)
- Mozambique: Sustainable Management of Natural Resources in Mozambique – SuMaNatuRe (University of Jyväskylä, EUR 0.6 million)
- Kenya: Improving capacity, quality and access of Geoinformatics Teaching, Research and Daily Application in Taita Taveta County, Kenya – TAITAGIS (University of Helsinki, EUR 0.7 million)

The Academy of Finland and the Finnish Ministry for Foreign Affairs have annually funded problem-oriented and multidisciplinary development research projects. During 2013 to 2014, seven projects were funded from an additional targeted call to fund research projects investigating the impacts of climate change in developing countries. The two-year projects generated knowledge on climate change in developing countries, increased multidisciplinary knowledge and know-how, and promoted the establishment of multidisciplinary research environments in developing countries, as well as created new research-oriented networks between Finland and developing countries. A list of the funded projects:

- India: Black and brown carbon influence on climate and climate change in India – from local to regional scale (Finnish Meteorological Institute, EUR 0.3 million).
- Mozambique: Private agricultural investments and land use change impact on the adaptive capacity of local communities to climate change in Mozambique (consortium of University of Helsinki and Pellervo Economic Research Institute, EUR 0.2 million and EUR 0.2 million).
- Tanzania and Nepal: Towards Responsive Governance in Climate Change Adaptation and Mitigation? Comparative case study in Tanzania and Nepal (University of Eastern Finland, EUR 0.3 million).
- China and Nepal: Impact of climate change on water quality: a Himalayan case study (Lappeenranta University of Technology, EUR 0.2 million).
- China: Aquatic ecosystems in a changing climate – introducing a cost-effective tool to guide management options in poorly developed countries (University of Helsinki, EUR 0.2 million)
- Laos and Cambodia: Redefining energy and climate policies in least developed countries: Analysing institutions and initiatives in the Mekong region (RECLAIM) (University of Turku, EUR 0.4 million)
- Malawi and Zambia: Study on risk management of extreme weather related disasters and climate change adaptation in Malawi and Zambia (SAFE-MET) (Finnish Meteorological Institute, EUR 0.3 million)

The Natural Resources Institute Finland, Luke 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. Luke's activities include:

- Cambodia, Laos, Thailand, 2013 to 2015: Bamboo fuel chip production for renewable energy. Making technically and financially viable demand-driven business model for (bamboo) biomass fuel chip production in trans-boundary supply chains available for renewable energy applications, ready for up-scaling, and attractive to private sector investments.
- Kenya, 2013 to 2015: Improving the capacity in forest resources assessment in Kenya IC-FRA. Improving forest inventory methods to respond to the expanded information needs on forest and tree resources on different scales.
- Mongolia, 2013 to 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.
- Mozambique, 2016 to 2018: FORECAS 2 Capacity building on novel approaches in sustainable management of forest and wood resources in Mozambique. Improving knowledge on the value chains of lesser-utilised wood species for small-sized business and industries increased, utilisation of the wood laboratory facilities, and information dissemination and promotion of national and regional networking of IIAM and UEM-FAEF.
- Myanmar, 2017 to 2020: Improving the Capacity of the Myanmar National Forest Inventory IC-MNF. This project aims to collect national level baseline information required for REDD+ and to institutionalise the Monitoring, Reporting and Verification (MRV) system.
- Tanzania, 2016 to 2018: INFORES Implementation support of results and data of first National Forest Resources Monitoring and Assessment (NAFORMA) at regional and local level in Tanzania. Strengthening the capacity of direct beneficiary organisations on NAFORMA maintenance and data dissemination, and improved capacity on multisource forest data processing and GIS. Improved capacity of forest inventory and management oriented research in SUA and TAFORI.
- Africa 2015 to 2019: Support programme for the Southern African Network for Biosciences (SANBio); BioFISA phase II. Extending the network activities and capacity building for sustainable network operations beyond 2016.

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Internet links

Aalto University ice tank http://icetank.aalto.fi/en/

Academy of Finland research programmes,
http://www.aka.fi/en/research-and-science-policy/academy-programmes/

Academy of Finland strategic research programmes,
http://www.aka.fi/en/strategic-research-funding/programmes/

ACTRIS - The European Research Infrastructure for the observation of Aerosol, Clouds, and Trace gas. http://www.actris.eu/

The Agricultural Model Intercomparison and Improvement Project (AgMIP):
http://www.agmip.org

Algaline,
http://www.jarviwiki.fi/wiki/Algaline?setlang=en

Arctic Centre at the University of Lapland,
http://www.arcticcentre.org/EN

Arctic Monitoring and Assessment Programme (AMAP), http://www.amap.no/

Environmental monitoring at the Finnish Environment Institute (SYKE) and the environment administration, including National environment monitoring strategy & development program MONITOR 2020
http://www.syke.fi/en-US/Research__Development/Production_of_environmental_information

http://www.ymparisto.fi/en-US/Envibase

http://www.syke.fi/en-US/Research__Development/Research_and_development_projects/Projects/National_environment_monitoring_strategy__development_program_MONITOR_2020

EUMETNET http://eumetnet.eu/

FACCE-MACSUR,
http://www.macsur.eu

FICCA research programme on climate change,
http://www.aka.fi/en/research-and-science-policy/academy-programmes/completed-programmes/ficca/

Finnish Climate Change Panel, www.ilmastopaneeli.fi

Finnish Environment Institute (SYKE),
http://www.syke.fi/en-US

Finnish Food Safety Authority Evira,
https://www.evira.fi/en/

The Finnish Institute of International Affairs,
http://www.fiia.fi/en/home/#tab1

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Finnish Marine Research Infrastructure – FINMARI,
https://www.finmari-infrastructure.fi/

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http://www.wmo.int/pages/prog/arep/gaw/gaw_home_en.html

Government Institute for Economic Research (VATT) – research, http://www.vatt.fi/en/research/

Government's annual plan and projects for joint analysis, assessment and research activities, http://vnk.fi/en/government-s-analysis-assessment-and-research-activities

ICOS Finland, http://eng.icos-infrastructure.fi/

IPCC Emission Factor Data Base, http://www.ipcc-nggip.iges.or.jp/EFDB/main.php

National Institute for Health and Welfare (THL), https://www.thl.fi/en/web/thlfi-en

Natural Resources Institute Finland (Luke), http://www.luke.fi

Nordic Working Group for Global Climate Negotiations (NOAK), http://www.norden.org/en/nordic-council-of-ministers/council-of-ministers/nordic-council-of-ministers-for-the-environment-mr-m/institutes-co-operative-bodies-and-working-groups/working-groups/the-nordic-working-group-for-global-climate-negotiations-noak

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SAON – Sustaining Arctic Observation Networks, http://www.arcticobserving.org/

Sitra, The Finnish Innovation Fund, https://www.sitra.fi/en/#

Top-Level Research Initiative, a Nordic research and innovation initiative on climate, energy and environment http://www.toppforskningsinitiativet.org/en

Tekes (the Finnish Funding Agency for Innovation) programmes: https://www.tekes.fi/en/programmes-and-services/tekes-programmes/

Universities – list of Finnish Universities, http://minedu.fi/en/universities

Universities of Applied Sciences in Finland – list, http://minedu.fi/en/universities-of-applied-sciences

VTT Technical Research Centre of Finland Ltd – research, http://www.vtt.fi/research/?lang=en

9
EDUCATION, TRAINING AND PUBLIC AWARENESS

This chapter describes how climate change is included in the educational system of Finland from basic education to universities. That is followed by a portrayal of international training activities, including training of experts from developing countries. Finally, raising public awareness is discussed. The roles of ministries, local authorities, other public bodies as well as non-governmental organizations and other relevant stakeholders are explained. Several climate change or energy saving campaigns are presented, as well.

Photo: pixhill.com

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 overarching values and part of education on sustainable development. Climate-change-related topics are also addressed by both universities and universities of applied sciences (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).

The national Medium-term Climate Change Policy Plan, in accordance with the Climate Change Act was approved by the Finnish Government in September 2017. It includes, e.g., an action plan presenting measures for mitigating greenhouse gas emissions resulting from human activity in sectors not included in the emissions trading scheme of the EU. It also mentions knowledge base and educational needs for furthering climate change policy.

Under the Doha Work Programme, launched at the 18th Conference of Parties to the UNFCCC (COP 18) in 2012, 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 Doha 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 activities described in this chapter include Finland's efforts at implementing the Doha 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.

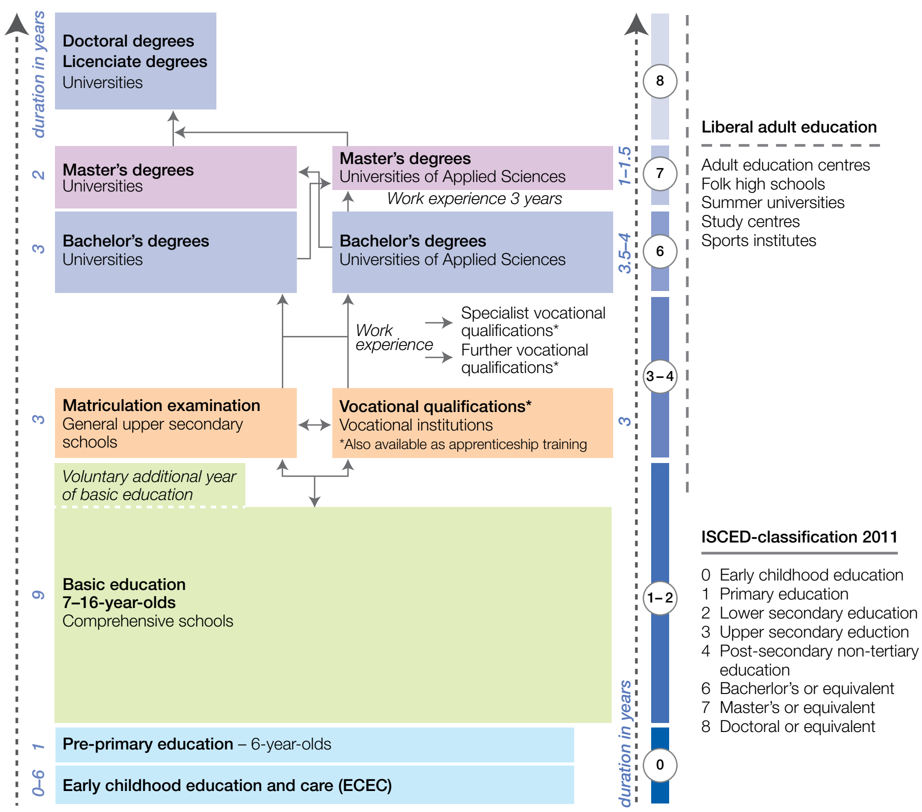
9.2 Education

9.2.1 Education policy

All children in Finland receive compulsory basic education (comprehensive school) between the ages of 7 and 16. All 6-year-olds participate in pre-primary education. Students who have successfully completed compulsory education are eligible for general (duration three to four years) and vocational upper secondary education and training (duration two to four 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 universities of applied sciences (UAS). Both sectors have their own profiles. Universities emphasize scientific research and instruction. UASs, also known as polytechnics, adopt a more practical approach. A network of 14 universities and 23 UASs 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 corresponding studies. At the universi-

Figure 9.1
Education system in Finland



ties, students can also study for scientific or artistic postgraduate degrees, which are the licentiate and the doctorate degrees.

It takes approximately three to four years of full-time study to complete a university of applied sciences 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. UASs admit some 33,000 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 citizens must have equal access to high-quality education and training. Education is free at all levels from pre-primary to higher education (degree education). Tuition fees are charged from citizens of non-EU/EEA countries in university and UAS programmes given in foreign language.

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 and 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. In 2015, with 73 countries participating, Finland was ranked fifth.

All schools in Finland are connected to the Internet. Around 90 per cent of 16 to 74-year-olds reported using the Internet on a daily basis in 2015.

All municipalities have at least one free public library and there are 790 public libraries (2014). 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 school 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 grades.

The National Core Curriculum for Basic Education entered into force in 2014. With this curriculum, sustainability is not only one cross-curricular theme supported by some of the values in the value basis. Instead, it is the overarching task of basic education and strongly embedded in all elements of the core curriculum. The new core curriculum, with its focus on promoting a sustainable lifestyle, represents a holistic approach to sustainability. This approach covers all dimensions of sustainability, as well as students' and the school community's developing competencies, and their safety and well-being. Sustainability is also one of the seven transversal competences in the curriculum. Climate change is especially involved in the subject level in geography and biology education.

The new National Core Curriculum for Upper Secondary Schools (2015) also highlights a number of sustainability and climate-related issues. Students (aged 16 to 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. Climate change is especially involved in the subject level in geography and biology education.

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 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.

Teacher's Climate Guide (openilmasto-opas.fi) is a free and open climate education website for subject teachers working in secondary schools and high schools. It presents climate change separately from the perspective of each subject taught at school and also offers photo material, assignments and general information on climate change and climate education.

Box 9.1

SMART KALASATAMA – SMART CITY DISTRICT OF HELSINKI

Smart Kalasatama, a brownfield district in Helsinki, is a vivid Smart City experimental innovation platform to cocreate smart and clean urban infrastructure and services. Smart Kalasatama is developed flexibly and through piloting, in close cooperation with 200+ stakeholders including residents, companies, city officials and researchers. The Kalasatama district will offer a home for approximately 25,000 residents and jobs for 10,000 people by 2035. Currently, there are 3,000 people living in the area.

Kalasatama's energy services are built around the concept of a carbon-neutral future. Utilizing the latest smart grid technologies, the user of electricity can also be its producer. The grid enables real time smart metering for households, a network of electric vehicles and new storage solutions for electricity. A solar power plant already exists in the area and the whole neighbourhood is connected to the district heating and cooling grid.

The Smart Kalasatama program is running an ambitious innovation platform, where more than 25 innovative infrastructures and building projects are on-going. In addition to that, Smart Kalasatama is hosting innovative agile experimentation projects, where mainly start-ups codevelop their new smart solution prototypes with residents. For instance, several projects related to smart waste management, smart minigrids and mobility as a service (MaaS) are experimented.

During the spring of 2017, a set of climate positive pilots was tested in Kalasatama in the fields of green solutions, electric cars, parking, local solar power production and reducing consumer's carbon footprint using real-time calculator within households. ■

Box 9.2
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 of 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. ■

Many projects, networks, campaigns or competitions in and between schools support the teaching of 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 also Boxes 9.1 and 9.2). 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.

9.2.3 Climate change in higher education and climate change training

Universities provide climate change education as 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.

UASs 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.

Climate.now is a multidisciplinary study and teaching module on the basics of climate change. It contains written material, video lectures and interviews, assignments, tests and a guide for teachers that will help anyone familiarise themselves with the basics of climate change. Climate.now is located at the Massive Open Online Course (MOOC) platform of the University of Helsinki. It is freely accessible to everyone.

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 Agency for Education also funds and organises in-service training for teachers on sustainable development for EUR 700,000 (2014 to 2016). Nevertheless, only a fraction of the country's teachers outside the natural sciences have adequate pedagogical expertise in sustainable development and climate change. Various activities for advancing sustainable development exist (for example see Box 9.3).

Box 9.3
FINNISH UNIVERSITY PARTNERSHIP
FOR INTERNATIONAL DEVELOPMENT (UNIPID)

The Finnish University Partnership for International Development (UniPID) is a partnership network between Finnish Universities. UniPID was established in response to the Johannesburg Summit on Sustainable Development in 2002, where institutional partnerships for development were encouraged. Following this Summit, in December 2002, representatives from eleven Finnish universities assembled at the University of Jyväskylä and decided to include and promote international development as a part of their international strategies.

UniPID was thereafter created to provide the strategic coordination required to build ties and increase cooperation between Finnish universities in the field of international development cooperation. 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. Through international partnerships, UniPID links Finnish universities to European and global policy debates and development networks. The network works to strengthen institutional partnerships between scholars and institutions in Finland and in the South.

The network builds university capacities through the sharing of scientific knowledge, cooperation on common interests, understanding of development impacts, gathering and dissemination of information, and supporting long-term exchange and cooperation. These activities are essential in accomplishing true sustainable development and equal-footing partnerships both in the North and the South. ■

Universities, UASs 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 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 UASs 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 programmes in forest sciences and 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 University of Eastern Finland (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 at 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 were jointly funded by the Ministry for Foreign Affairs and the Academy of Finland with total of EUR two million as part of FICCA, the Academy of Finland's Research Programme on Climate Change (2011–2014). The research projects resulted, as planned, in new cooperation networks, consolidated multidisciplinary scientific knowledge in developing countries and increased the mobility of doctoral students and researchers between Finland and developing countries.

The Finnish Meteorological Institute (FMI) has coordinated several development cooperation 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 8.4.

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 9.3. More information and examples can be found at the end of this chapter.

9.4 Public awareness

According to the Finnish Climate Barometer 2015 survey, Finns consider climate change to be a major global threat, and wish decision-makers would adopt more active climate policies and companies would develop new solutions for mitigating climate change.

A majority of Finns agree that Finland should reduce its emissions regardless of what other countries are doing. Citizens consider it important for Finland to be a pioneer in the adoption of emission reduction technologies and believe that developing new expertise and technical solutions can improve Finland's competitiveness and create new jobs. The respondents would also like Finland to increase the use of renewable energy, such as solar power, wind power and biofuels, even at the cost of making energy more expensive.

Conducted before the Paris climate negotiations in 2015, the survey concluded that over 80% of the respondents agreed that international negotiations should swiftly lead to a new global agreement on climate change for reducing global emissions. According to Finns, the most important decisions affecting climate change are made by large developing countries, such as China and India, and by the United States.

However, Finns have not significantly changed their own behaviour in order to mitigate climate change. Only just over one-third of the respondents considered climate impacts when deciding on purchases. On the other hand, the respondents felt that there is a great need for new low-emission services: over 80% considered them to be very or rather important in solving the problem of climate change.

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 peaks of climate coverage have been caused particularly by international policy negotiations, such as the Paris COP21, and mild winters. Other contributing factors have included the releases of EU and government policies on emissions reductions, releases of major scientific reviews, expressions of concern by key actors and the related debate on energy policy.

9.4.1 Climate change communication

Communication on climate change is handled by several different ministries, government research organisations, as well as communities and civil society actors, each within the sphere of their own tasks and responsibilities. Most communication activities are carried out independently by the various bodies and the range of communication actions vary, for example, from stakeholder meetings and seminars to social media campaigns, press releases and visual communication.

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 Economic Affairs and Employment, the Ministry for Foreign Affairs, the Prime Minister's Office Finland), research organisations (the Finnish Environment Institute (SYKE), the Finnish Meteorological Institute (FMI), VTT Technical Research Centre of Finland Ltd, Natural Resources Institute of Finland (Luke)), regionally operating organisations (Centre for Economic Development, Transport and the Environment and the Association of Finnish Local and Regional Authorities), Tekes – the Finnish Funding Agency for Innovation, Sitra the Finnish Innovation Fund, Motiva Ltd (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 communication, but also to accomplish common communication 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 publishes an online magazine 'Klimaatti' focusing on analytical feature articles providing concrete solutions for climate change mitigation and adaptation. Also featured are themes of eco-effiency, energy consumption, biodiversity and international negotiations.

The group has also produced an extensive package of inforaphics and visual statistics to raise awareness about the IPCC's fifth assessment report (http://climateguide.fi/ipcc) and Finland's climate policy (http://climateguide.fi/climate-policy-infographics). The material has been widely thanked and used by the media, universities and researchers alike. In early 2016, the campaign was also rewarded by the Institute of the Languages of Finland as an exemplary work making climate change and related government policies more understandable, and interesting, for the general public.

Encouraging the public to participate in the planning of Finland's climate policies continued in 2016 with an open online platform energiajailmasto.fi on which anyone regardless of their background could comment on the planned climate strategies and measures of emissions reduction.

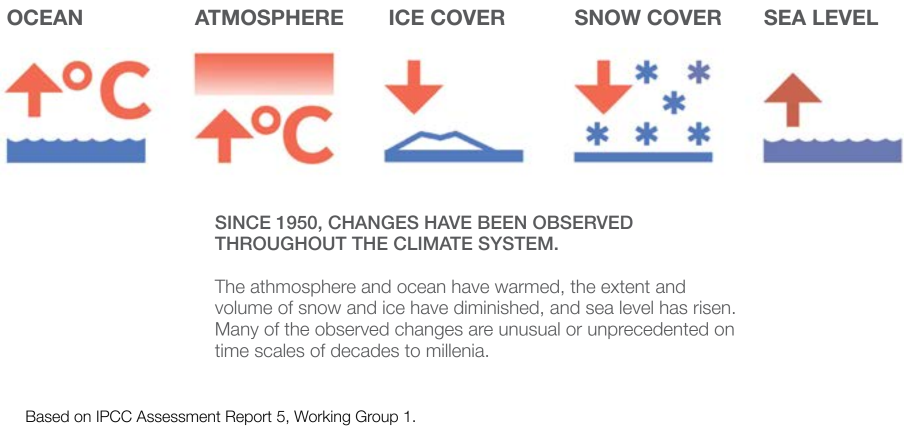
Nominated by the Finnish Ministry of the Environment at the end of 2011, the interdisciplinary and independent Climate Change Panel of researchers and academians aims to enhance communication between science and politics in issues related to climate change (see Section 4.2.2 for the role of the panel in policy making and Box 8.2 for its research activities). The Finnish Climate Change Panel has actively participated in public debate by releasing statements, organizing discussions and interacting with the media, decision-makers and other stakeholders.

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 cooperation between various organisations is the national web portal on climate change, Climateguide.fi, which was launched in 2011. Most of the information in 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, mapping tools, interactive visualizations, videos, and learning excercises. It also provides current information on ongoing news, processes, research, and events. 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 the general public and decision-makers and actors, especially in Finnish municipalities. The FMI and SYKE 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. Climateguide.fi is also the home for the infographics produced by Finnish research institutions and ministries in 2013 to 2015 (Figure 9.2).

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.

Figure 9.2
Observed changes in the climate system – an example of the infographics made on the basis of the results of the IPCC's Fifth Assessment Report and published in the Finnish climate portal Climateguide.fi.



9.4.2 Raising awareness about energy efficiency

Communication on energy efficiency is handled mainly by two ministries, the Ministry of Economic Affairs and Employment and the Ministry of the Environment, and by other government bodies, research organisations and state-owned organisations, e.g. Motiva Ltd. Motiva Ltd is a fully state-owned company working closely with government bodies, that 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. Motiva 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 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. ERA17 has put strong emphasis on raising public awareness and sharing best practices and expertise. Numerous projects have been launched and implemented throughout Finland, seminars and events have been organised, and reports and newsletters published on the results of the actions toward a more enegy-efficient built environment. The ERA17 period will come to an end in the end of 2017.

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 sustainable use of energy. 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.

About 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, and how to save energy. They learn to engage in energy saving actions both at home and in school. Every year, more than 300 companies and organisations participate in the week. Most of them have incorporated the week into their own environmental programmes and implement voluntary energy saving measures.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 Finnish Energy Authority.

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. Regional advisers give 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 of thirteen regional advisers reaches about 75% of Finnish consumers. The core of the activity is to provide consumers with high-quality and reliable information and tools to support their energy decisions. Consumers are provided also with on-line energy advice on Facebook @Asiaaenergiasta. 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 website and Facebook page, training, tools, marketing, promotional and networking support. The network of regional advisers meets annually to exchange experiences and best practices, and for training.

The work is supported by a broad-based advisory steering group chaired by the Finnish Energy Authority, and it includes members from the Ministry of Economic Affairs and Employment, the Ministry of the Environment, the Ministry of Transport and Communications, the Ministry of Agriculture and Forestry, the Association of Finnish Local and Regional Authorities, and the Energy Industry.

Mobility management

The Finnish Mobility Management R&D programme is coordinated by Motiva on behalf of the Finnish Transport Agency. The Agency is also the main funder of local mobility projects. The state subsidy for Mobility Management was introduced in 2012 and has been used to establish mobility management work in various regions. The regional projects and established activities provide advice and services to municipalities, companies and consumers. In the end of 2016, the national Network of Mobility Management had over 600 members covering municipalities, national authorities, private sector and NGOs. In addition to the environmental aspects of Mobility Management (MM), the health benefits have gained strong recognition lately and more focus has been put on the workplace MM on a national level. This has meant that other benefits such as company responsibility, well-being and image have also been recognized more strongly as the key benefits of MM. In the end of 2016, the first R&D funding for workplace MM was launched, the funding coming from Finnish Transport Agency, Finnish Transport Safety Agency, Fit for Life Program and The Finnish Innovation Fund Sitra.

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 provides advice and oline tools, for example, for finding professional service providers and for proper recycling of construction materials. A key focus of the advice is to improve the energy efficiency of the building when it is renovated. Each of the networks arrange networking events one to two 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 regional energy advisers and renovation advisers 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 intermediators 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 Carbon Neutral Municipalities (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. To this day, HINKU constitutes a group of 36 pioneering municipalities. They have volunteered to greening their economies and acting as laboratories for sustainable development. These municipalities have brought together mayors, businesses, citizens and experts to create and carry out solutions to reduce greenhouse gas emissions. The involved municipalities are committed to an 80 per cent emission reduction target by 2030 from the level of 2007. The preliminary results are encouraging: new businesses and jobs have been established while emissions have already reduced by 29%. At the same time, new energy solutions and procurement policies have led to considerable cost savings.

Another indication of the determination at the local level is the FISU network – Finnish Sustainable Communities. FISU municipalities form a group of forerunner communities committed to becoming carbon-neutral and waste-free, as well as curbing overconsumption by 2050, or earlier. The network shares best practices and knowledge about new opportunities in the field. The FISU communities develop their policies and procedures together in peer support, thereby enabling a quicker transition than if doing it alone.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 also Section 4.2.5). 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.

Finland is one of the few European countries where voluntary means, such as the voluntary Energy Efficiency Agreement scheme, have proven to work and yield profits. Energy savings and energy efficiency have been improved through agreements drawn between the Government and industrial/municipal associations since the 1990s. The Energy Efficiency Agreement for the Municipal Sector is an agreement between the Ministry of Economic Affairs and Employment, the Energy Authority, and the Association of Finnish Local and Regional Authorities on increasing the efficient use of energy in the municipal sector. Municipalities, cities and joint municipal authorities sign their own Energy Efficiency Agreement, in which they commit themselves to the actions and targets specified in the Energy Efficiency Agreement for the Municipal Sector. At the end of 2016, the coverage of Finnish municipalities within the agreement scheme was 77% of the total Finnish population, 70% of the building volume and 47% of the Finnish area. In 2015, in the whole energy efficiency agreement scheme (covering also industry, energy and the prpoperty sector), the savings generated from energy efficiency measures equal 3.9 percent of Finland's total energy consumption in 2015. The scheme reduced annual carbon dioxide emissions (CO_2) by approx. 4.3 million tonnes and energy costs by a total of approx. EUR 500 million (www.energyefficiencyagreements2017-2025.fi). 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 familiarise residents and small and medium enterprises (SMEs) with the climate strategy of the cities of the Helsinki Metropolitan Area and provide support and guidance with practical measures. The four themes of the activity are energy-efficiency and renewable energy, food, transportation and consumption. 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.

The Helsinki Metropolitan Smart & Clean Foundation started operation in June 2016 by Helsinki Metropolitan Area cities and Sitra, in partnership with the Finnish state and the Helsinki–Uusimaa Regional Council, several companies and research organisations and major Finnish companies aiming to turn the Helsinki capital region into a test bed for smart and clean solutions. The foundation has an operating period of five years. The foundation develops new forms of collaboration and innovation activities between the public sector, cities, companies, residents and the scientific world. New technologies and services are tested in different areas of the city and the best ones will be exported and will create thriving businesses. For example, new services in mobility and living will increase the quality of life and mitigate climate change, they will boost the circular economy and smart solutions will reduce food waste. Small and large actions build permanent changes, and the doers, as well as the beneficiaries, are both citizens, cities and businesses (https://smartclean.fi/en/smart-clean/).

Motiva assists municipalities and other public entities as a Focal Point for Sustainable and Innovative Public Procurement giving advice and consultancy to public procurers around sustainable and cleantech procurements covering all stages of the procurement process. The service is based on provision of product group specific procurement guidance and advice according to the knowledge base and ambition level of the procuring entity. Motiva offers tools and guidelines, suggests criteria to be used in procurements and gives advice for market dialogue, and collects and disseminates best practices and success stories, and coordinates the national network on Green Public Procurements (http://www.motivanhankintapalvelu.fi/in_english).

9.4.4 Activities and campaigns of the NGOs

NGOs also conduct climate-change or energy-related campaigns, some of which have received broad publicity. For example, the Finnish Friends of the Earth (Maan ystävät) runned a campaign called 'The Big Ask' (Polttava Kysymys) to push the Finnish Climate Act. In addition, other NGO´s like the World Wide Fund for Nature (WWF Finland), the Finnish Association for Nature Conservation (Suomen Luonnonsuojeluliitto), Finn Church Aid (Kirkon ulkomaanapu) and the Guides and Scouts of Finland (Suomen Partiolaiset) run their own climate campaigns.

At the climate awareness website, ilmasto.org, Dodo ry offers schools the possibility to invite a guest speaker to the class to talk about climate change. The umbrella organisation for Finnish civil society organisations who work with development cooperation, Kepa ry, had 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 [r]evolution' (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 Europe-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.

Coal-free Finland is a campaign at a municipality and city level to shut down coal plants in municipalities across Finland in which citizens have decided to take action against the use of coal. The campaign is working in collaboration with the Finnish Friends of the Earth and the Finnish Nature League and is run by volunteers from a variety of backgrounds. The campaign's methods include lobbying and advocacy, participating in public debate, and awareness-raising among citizens and stakeholders.

WWF Finland developed an environment management system for offices. Office premises hold a key position in energy consumption and in sustainable solutions. The Green Office network is suited to offices – both large and small – in private companies, the public sector and other organisations. The network includes 433 offices from 156 organisations with a total of nearly 62,000 employees.

Earth Hour is a worldwide movement for the planet organized by the World Wide Fund for Nature (WWF). The event is held worldwide annually encouraging individuals, communities, households and businesses to turn off their non-essential electric lights for one hour, from 8:30 to 9:30 p.m. towards the end of March, as a symbol of their commitment to the planet. WWF Finland has participated in the movement since 2007.

In 2013, WWF 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 to take action for the environment.

Nature League (Luonto-Liitto in Finnish) is a nation-wide non-governmental nature and environmental protection organization for children and the youth. The Nature League arranges environmental education for children and the youth in the form of afternoon clubs and nature camps.

FEE Finland (Finnish Foundation for Environmental Education) enhances a sustainable way of life by the means of environmental education. FEE Finland is a part of an international FEE (Foundation for Environmental Education) network, which consist of 73 member countries. FEE Finland coordinates the Green Key programme in Finland and enhances environmental education collaboration.

9.5 Short descriptions and Internet links of some projects, networks and campaigns

Climate Guide

The website Climateguide.fi pools practical, studied and reliable information on climate change into one address and in a uniform format. The purpose of the website is to support society and citizens in mitigating climate change, and in adapting to it. The website helps understand phenomena related to climate change, and structure information. The aim is to allow anyone needing information on climate change to find it rapidly and easily. Another aim is to enable Finnish research institutions, authorities and expert organisations to make their climate change information and services more easily available to society.
http://climateguide.fi

Climate Now

Climate.now is a multidisciplinary study and teaching module on the basics of climate change. It contains written material, video lectures and interviews, assignments, tests and a guide for teachers that will help anyone familiarise themselves with the basics of the climate change. You can complete the study module independently or as part of your higher education studies. The scope of the whole module is five credits. In addition to teachers and students, the material can also be used by companies, other organisations and media.
http://www.climatenow.fi/

Teacher's Climate Guide

The Teacher's Climate Guide is a free and open climate education website for subject teachers working in secondary schools and high schools. It presents climate change separately from the perspective of each subject taught at school and also offers photo material, assignments and general information on climate change and climate education. At the moment, the material exists only in Finnish, but hopefully it will get translated into other languages in the near future.

According to research, teachers are lacking skills in climate education and knowledge on climate change. In addition, existing teaching materials have been insufficient and teachers have had a hard time seeing how climate change is connected to the educational content in their subject. The project was funded by the Maj and Tor Nessling foundation. Dozens of educational and climate professionals contributed to the work in workshops and online.
http://openilmasto-opas.fi/english/

Writing competition for upper level of comprehensive school students on Climate Change.

The writing competition is arranged by Finnish Energy, which is a branch organisation for the industrial and labour market policy of the energy sector and Motiva Ltd – a Finnish state-owned company that provides a wide range of expertise and services designated to improve resource efficiency throughout society.

The subject matter for the essays should be the mitigation measures that will be used during the coming 100 years and what Finland looks like after the hundred years. Have the mitigation measures been effective enough and what does it mean for everyday life in Finland?
http://www.vuodenilmastoteko.fi/kirjoituskilpailu.html

Youth Climate Summit

The Finland Youth Climate Summit 2016 gathered 66 middle school students from all over Finland to create a climate action plan for their schools. The themes were energy efficiency, renewable energy and food. While the students were creating the plans, teachers and principals learned how to support the students with their projects and how to include the projects in the curriculum. In addition, the students sent a video message to COP21 to encourage them to make a strong Climate Agreement.

The Youth Climate Summit was created in Adirondacks, USA. The aim is to give an opportunity to young people to make an impact on their own future by offering tools to make change and a channel to create environmental awareness. This was the 4th Youth Climate Summit arranged in Finland, and it was carried out in cooperation with Nuorten Akatemia (Youth Academy), WWF, Schneider Electric and Heureka.
http://ilmasto.org/ilmari-hanke-vie-ilmastokeskustelun-kouluihin/nuorten-ilmasto-huippukokous

University of Eastern Finland (UEF) – United Nations Environment Programme (UNEP) Course on Multilateral Environmental Agreements

The UEF-UNEP Course on Multilateral Environmental Agreements (MEAs) is a high profile two-week course on MEAs, international environmental law-making and diplomacy. It is organised annually in cooperation between the University of Eastern Finland and UNEP, with a changing course venue and theme each year.

The aim of the course is to equip present and future negotiators of multilateral environmental agreements with the information and experiences of others in the area of international environmental law-making in order to improve the impact and implementation of these key treaties.

The course is intended for experienced government officials engaged in international environmental negotiations. Other stakeholders, such as representatives of NGOs and the private sector, researchers and academics in the field of international environmental law are also eligible. Starting from 2004, the course has had a total of 399 participants from 121 different countries.
https://www.uef.fi/web/unep

Teachers' Climate Change Forum

Teachers from all corners of the world met at the first ever Teachers' Climate Change Forum on 26 November 2016 to share their good practices and innovative approaches on climate change education via inspiring video presentations and to learn from each other.

The Teachers' Climate Change Forum is a virtual forum organized by LUMA Centre Finland. At the forum, teachers interested in climate change education have the opportunity to share their practical experience and learn from each other. The Director of the LUMA Centre Finland acts as the chair for the forum.
http://www.luma.fi/en/news/2016/12/01/some-great-practices-on-climate-change-education/

EURONET 50/50 MAX

EURONET 50/50 MAX mobilized energy savings in public buildings through the implementation of the 50/50 methodology in 525 schools and over 50 other public buildings in 13 EU countries. The nine-step methodology increased energy awareness of the building users (close to 100,000 pupils and 7,000 teachers) and actively involved them in energy saving actions. Achieved financial savings are shared equally between the building users and the local authority which covers the energy bills. The project was supported by the European Commission through the Intelligent Energy Europe (IEE) programme.
http://euronet50-50max.eu/en/

The Carbon Neutral Municipalities project (HINKU)

The Carbon Neutral Municipalities project brings municipalities, businesses, citizens and experts together to create and carry out solutions to reduce greenhouse gas emissions. The municipalities involved are committed to reduce greenhouse gas emissions more extensively and rapidly than EU targets and schedules would require. The project aims to create solutions that have economic and social benefits as well as environmental advantages.
http://www.hinku-foorumi.fi/en-US

MONIMET

MONIMET is a project about Climate Change Indicators and Vulnerability of Boreal Zone Applying Innovative Observation and Modeling Techniques (2013 to 2017). The coordinating beneficiary of the project is the Finnish Meteorological Institute (FMI). Other associated beneficiaries are the Natural Resources Institute Finland (Luke), the Finnish Environment Institute (SYKE) and the University of Helsinki (UHEL).
http://monimet.fmi.fi/index.php?style=warm

YLE Oppiminen (YLE Learning)

In 2015, the Finnish broadcasting company (Yle) produced learning material to teachers about climate change.
http://yle.fi/aihe/artikkeli/2015/12/15/ilmastonmuutos

Training projects 'Our Safe Village' and '72 Hours'

The Finnish National Rescue Association (SPEK) has trained approximately 150 villages during 2014 to 2016 in preparedness for different disruptions caused by, among others, abrupt weather events. The 'Our Safe Village' instructors organise regional safety training events together with the regional rescue and village associations. The villagers receive support and instruments, such as training materials, for local contingency planning. The 'Our Safe Village' training concept was developed through the projects financed by the Fire Protection Fund.

The 72 Hours concept steers people to set up a 72h preparedness kit: self-preparedness for three days can dramatically assist the authorities' relief efforts. As of spring 2017, SPEK has trained 72h preparedness instructors to organise training events in urban communities. In addition to the training, SPEK is responsible for providing materials as well as social media and network services. The 72h training concept was developed by the Committee for Home Emergency Preparedness and financed by the National Emergency Supply Agency.
http://www.spek.fi/In-English/Safety-Information/Preparedness/Self-preparedness

Projects KUJA and KUJA2 on continuity management of municipalities, local and regional authorities

The objective of the project KUJA 'The continuity management of municipalities' (2014 to 2016) was to develop the capacity of the local actors to ensure the disruption-free functioning in all situations, including during weather and climate change related disruptions. The tools produced during the project support the development of preparedness and continuity management, as well as the protection of citizens' well-being. With the project KUJA2 'The continuity management of local and regional authorities' (2017 to 2019) the scope was widened to include provinces. Provinces will have an important role in the coordination of regional preparedness after the major health, social services and regional government reform in 2019. KUJA2 aims to strengthen the interconnectedness of municipalities, regional authorities and their key stakeholders and to promote common understanding related to preparedness. Both projects have been implemented in cooperation between the Association of Finnish Local and Regional Authorities and the Finnish National Emergency Supply Agency.

Climate resilience tools by Tapio

Climate resilience tools for the public and private sectors were released at the end of 2016, compiled by the Tapio Consulting Services and funded by the Ministry of Agriculture and Forestry. These tools include a variety of good practices, guides and measures used by public and private sector actors to implement measures in the different aspects of climate resilience. The concept also presents good examples on how to secure climate resilience and how to assess it.

Citizens Climate Pledge

Citizens Climate Pledge is an NGO-led initiative that encourages individual citizens to announce their personal commitment to cut half their carbon footprint within ten years. Launched in 2015 in Finland, Citizens Climate Pledge aims to bring the citizens into the center of the societal transition to low-carbon development. Today the initiative has more than 2500 signatories, the present and two former Presidents of Finland, leaders of Finland's largest corporations, musicians, artists and top athletes amongst them. Citizens Climate Pledge grew global in 2016, when the Finnish initiators launched the international version together with UNFCCC. Now it is possible for any global citizen to commit to join a global movement of action on climate change.
https://climatepledge.global/

Literature

Doha Work Programme on the Article 6 of the Convention (2012) UNFCCC (COP) 2012 http://unfccc.int/resource/docs/2012/sbi/eng/l47.pdf

Government report on the National Energy and Climate Strategy for 2030 (2017) Publications of the Ministry of Economic Affairs and Employment of Finland 12/2017. http://urn.fi/URN:ISBN:978-952-327-199-9

Finnish National Commission on Sustainable Development, Sub-committee for Education (2006) Strategy for Education and Training for Sustainable Development and Implementation Plan 2006–2014, Helsinki, Finland. http://www.oph.fi/download/47693_engnetKekekajako.pdf

National Core Curriculum for General Upper Secondary Schools 2015, Finnish National Board of Education 2016, Publications 2016/8.

National Core Curriculum for Basic Education 2014, Finnish National Board of Education 2014, Publications 2016/5.

Strategy for the Internationalisation of Higher Education Institutions in Finland 2009–2015 (2009) Publications of the Ministry of Education, Finland 2009:23. https://julkaisut.valtioneuvosto.fi/handle/10024/77779

The Climate Barometer 2015 survey, Ministry of the Environment Press release 16-04-2016. http://www.ym.fi/en-US/Finns_want_more_effective_measures_for_m(33191)

Internet links

Climate awareness web portal, http://ilmasto.org/

Climateguide web portal, http://Climateguide.fi

Climateinfo, http://ilmastoinfo.fi/en/climateinfo-2/

Energy Awareness Week, https://www.motiva.fi/en/public_sector/training_and_communication_in_the_improvement_of_energy_efficiency

ERA 17 – for an energy-smart built environment (2016) http://era17.fi/en/

Finnish University Partnership for International Development (UniPID), http://www.unipid.fi/en/home/

HINKU project, http://www.hinku-foorumi.fi/en-US

Motiva, a state-owned company promoting the sustainable use of energy and materials, http:// https://www.motiva.fi/en

National IPCC working group (in Finnish), http://ilmatieteenlaitos.fi/suomen-ipcc-tyoryhma

RCE Espoo, http://www.rcenetwork.org/portal/espoo (in Finnish)

Science Education Centre LUMA, http://www.luma.fi/en/

Sustainable development certification of educational establishments, http://www.koulujaymparisto.fi/sivu.php?id=1820

Teacher's Climate Guide http://openilmasto-opas.fi/english/

The Association of Finnish Local and Regional Authorities https://www.localfinland.fi/

ANNEX 1

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

Inventory
2015
Submission
2017 v1
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs[1]	PFCs[1]	Unspecified mix of HFCs and PFCs[1]	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)					(kt)			
Total national emissions and removals	16205.06	231.80	19.88	1547.41	6.62	NO	0.00	NO	130.38	335.64	85.27	40.93
1. Energy	39998.97	11.31	1.79						126.19	332.78	61.82	29.97
A. Fuel combustion Reference approach(2)	40126.57											
Sectoral approach(2)	39890.72	9.84	1.79						126.09	332.76	52.61	29.96
1. Energy industries	15952.63	0.99	0.83						29.20	19.22	0.96	18.83
2. Manufacturing industries and construction	8287.06	0.87	0.47						33.59	34.74	2.21	6.71
3. Transport	11011.76	0.86	0.26						44.85	81.77	10.70	0.20
4. Other sectors	3543.35	7.01	0.20						16.36	195.88	38.58	3.49
5. Other	1095.92	0.12	0.02						2.08	1.17	0.16	0.73
B. Fugitive emissions from fuels	108.25	1.46	0.00						0.09	0.02	9.21	0.00
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	108.25	1.46	0.00						0.09	0.02	9.21	0.00
C. CO_2 Transport and storage	NA,NO											
2. Industrial processes and product use	4200.86	0.01	0.95	1547.41	6.62	NO	0.00	NO	1.91	0.03	23.01	10.96
A. Mineral industry	962.52								0.04	NO	NO	0.01
B. Chemical industry	916.24	NA,NO	0.87	NO	NO	NO	NO	NO	1.05	NO	2.44	6.72
C. Metal industry	2185.71	0.00	NO				NA,NO		0.67	NO	0.32	3.22
D. Non-energy products from fuels and solvent use	136.39	0.01	0.00						0.15	0.03	16.33	0.15
E. Electronic industry				NO,IE	NO,IE	NO	NO,IE	NO				
F. Product uses as substitutes for ODS				1544.17	4.42							
G. Other product manufacture and use	NO	NO	0.08	NO	NO	NO	0.00	NO	NO	NO	NO	NO
H. Other[3]	NO	NO	NO	3.24	2.20		0.00		0.00	NO	3.92	0.86
3. Agriculture	181.85	103.34	12.47						2.28	2.67	NE,NA,NO	NO
A. Enteric fermentation		84.70										
B. Manure management		18.57	0.97								NE	
C. Rice cultivation		NO									NA,NO	
D. Agricultural soils		NE,NO	11.50						2.21	NE	NE,NO	
E. Prescribed burning of savannas		NO	NO						NO	NO	NO	
F. Field burning of agricultural residues		0.08	0.00						0.07	2.67	NE	
G. Liming	179.75											
H. Urea application	2.10											
I. Other carbon-contining fertilizers	NA											
J. Other	NO	NO	NO						NO	NO	NO	NO
4. Land use, land-use change and forestry (4)	-28176.62	36.80	4.25						0.01	0.16	NE	NE
A. Forest land (4)	-36095.36	33.75	3.79						0.00	0.14	NE	
B. Cropland (4)	6665.66	IE,NA	0.04						NE,IE	NE,IE	NE	
C. Grassland (4)	681.79	0.00	0.01						0.00	0.02	NE	
D. Wetlands (4)	2128.33	3.05	0.33						NE,NA	NE,NA	NE	
E. Settlements (4)	775.97	NE,NA	0.07						NE,NA	NE,NA	NE	
F. Other land (4)	NO,NA	NA	NA						NA	NA	NE	
G. Harvested wood products	-2333.01											
H. Other (4)	NA	NA	NA						NA	NA	NE	NE
5. Waste	NE,NO,IE	80.34	0.42						NE,NO,IE	NE,NO,IE	0.44	NE,NO,IE
A. Solid waste disposal (5)	NO	70.66							NO	NO	0.10	
B. Biological treatment of solid waste (5)		2.76	0.15						NO	NO	0.05	
C. Incineration and open burning of waste (5)	NE,NO,IE	NE,NO,IE	NE,NO,IE						NE,IE	NE,IE	NE,IE	NE,IE
D. Wastewater treatment and discharge		6.93	0.27						NO	NO	0.29	
E. Other (5)	NO	NO	NO						NO	NO	NO	NO
6. Other (please specify)(6)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items:[7]												
International bunkers	2883.11	0.10	0.08						24.47	4.30	0.90	1.10
Aviation	1963.08	0.02	0.05						7.77	2.10	0.22	0.52
Navigation	920.02	0.08	0.02						16.70	2.20	0.68	0.58
Multilateral operations	NO	NO	NO						NO	NO	NO	NO
CO_2 emissions from biomass	38690.95											
CO_2 captured	138.28											
Long-term storage of C in waste disposal sites	54650.70											
Indirect N_2O			0.61									
Indirect CO_2	52.00											

(1) The emissions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), unspecified mix of HFCs and PFCs and other fluorinated gases are to be expressed as carbon dioxide (CO_2) equivalent emissions. Data on disaggregated emissions of HFCs and

(2) For verification purposes, Parties are requested to report the results of their calculations using the Reference approach and to explain any differences with the Sectoral approach in the documentation box to table 1.A(c). For estimating national total emi

(3) 2.H. Other includes pulp and paper and food and beverages industry.

(4) For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(5) CO_2 from 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.

(6) If reporting any country-specific category under sector "6. Other", detailed explanations should be provided in Chapter 8: Other (CRF sector 6) of the national inventory report (NIR).

(7) Parties are asked to report emissions from international aviation and international navigation and multilateral operations, as well as CO_2 emissions from biomass and CO_2 captured, under Memo Items. These emissions should not be included in the na

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS

(Sheet 1 of 1)

Inventory 2015
Submission 2017 v1
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Unspecified mix of HFCs and PFCs	NF_3	Total
	CO_2 equivalent (kt)								
Total (net emissions)[(1)]	16205.06	5794.97	5924.84	1547.41	6.62	37.55	NO	NO	29516.44
1. Energy	39998.97	282.67	534.70						40816.34
A. Fuel combustion (sectoral approach)	39890.72	246.08	534.10						40670.90
1. Energy industries	15952.63	24.76	248.01						16225.40
2. Manufacturing industries and construction	8287.06	21.85	140.44						8449.35
3. Transport	11011.76	21.38	77.81						11110.95
4. Other sectors	3543.35	175.16	60.40						3778.91
5. Other	1095.92	2.94	7.43						1106.29
B. Fugitive emissions from fuels	108.25	36.59	0.61						145.44
1. Solid fuels	NO	NO	NO						NO
2. Oil and natural gas	108.25	36.59	0.61						145.44
C. CO_2 transport and storage	NA,NO								NA,NO
2. Industrial processes and product use	4200.86	0.15	283.59	1547.41	6.62	37.55	NO	NO	6076.18
A. Mineral industry	962.52								962.52
B. Chemical industry	916.24	NA,NO	258.63	NO	NO	NO	NO	NO	1174.87
C. Metal industry	2185.71	0.00	NO			NA,NO			2185.71
D. Non-energy products from fuels and solvent use	136.39	0.15	0.87						137.40
E. Electronic Industry				NO,IE	NO,IE	NO,IE	NO	NO	NO,IE
F. Product uses as ODS substitutes				1544.17	4.42				1548.59
G. Other product manufacture and use	NO	NO	24.09	NO	NO	10.85	NO	NO	34.94
H. Other	NO	NO	NO	3.24	2.20	26.70			32.14
3. Agriculture	181.85	2583.57	3715.56						6480.97
A. Enteric fermentation		2117.43							2117.43
B. Manure management		464.18	287.91						752.09
C. Rice cultivation		NO							NO
D. Agricultural soils		NE,NO	3427.04						3427.04
E. Prescribed burning of savannas		NO	NO						NO
F. Field burning of agricultural residues		1.96	0.61						2.57
G. Liming	179.75								179.75
H. Urea application	2.10								2.10
I. Other carbon-containing fertilizers	NA								NA
J. Other	NO	NO	NO						NO
4. Land use, land-use change and forestry[(1)]	-28176.62	920.06	1265.79						-25990.77
A. Forest land	-36095.36	843.75	1127.96						-34123.65
B. Cropland	6665.66	IE,NA	11.71						6677.37
C. Grassland	681.79	0.01	1.51						683.31
D. Wetlands	2128.33	76.30	99.57						2304.20
E. Settlements	775.97	NE,NA	22.05						798.02
F. Other land	NO,NA	NA	NA						NO,NA
G. Harvested wood products	-2333.01								-2333.01
H. Other	NA	NA	NA						NA
5. Waste	NE,NO,IE	2008.52	125.20						2133.72
A. Solid waste disposal	NO	1766.41							1766.41
B. Biological treatment of solid waste		68.89	43.97						112.85
C. Incineration and open burning of waste	NE,NO,IE	NE,NO,IE	NE,NO,IE						NE,NO,IE
D. Waste water treatment and discharge		173.22	81.23						254.46
E. Other	NO	NO	NO						NO
6. Other ***(as specified in summary 1.A)***	NO	NO	NO	NO	NO	NO	NO	NO	NO

Memo items:[(2)]									
International bunkers	2883.11	2.60	22.36						2908.08
Aviation	1963.08	0.62	15.98						1979.68
Navigation	920.02	1.99	6.38						928.39
Multilateral operations	NO	NO	NO						NO
CO_2 emissions from biomass	38690.95								38690.95
CO_2 captured	138.28								138.28
Long-term storage of C in waste disposal sites	54650.70								54650.70
Indirect N_2O			182.16						
Indirect CO_2 [(3)]	52.00								
Total CO_2 equivalent emissions without land use, land-use change and forestry									55507.21
Total CO_2 equivalent emissions with land use, land-use change and forestry									29516.44
Total CO_2 equivalent emissions, including indirect CO_2, without land use, land-use change and forestry									55559.21
Total CO_2 equivalent emissions, including indirect CO_2, with land use, land-use change and forestry									29568.44

(1) For carbon dioxide (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

(2) See footnote 7 to table Summary 1.A.

(3) In accordance with the UNFCCC Annex I inventory reporting guidelines, for Parties that decide to report indirect CO_2, the national totals shall be provided with and without indirect CO_2.

TABLE 10 EMISSION TRENDS
GHG CO_2 eq emissions
(Sheet 1 of 6)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[(1)]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	(kt CO_2 eq)													
Total (net emissions)[(2)]	58452.91	58452.91	43475.83	48058.32	49447.63	61896.87	59307.12	56030.98	57812.22	55783.12	52153.41	48188.59	51845.23	53737.97
1. Energy	53557.84	53557.84	52203.24	51568.25	53519.75	58793.89	55328.25	61074.91	59489.69	56163.11	55555.41	53754.85	59187.23	61782.94
A. Fuel combustion (sectoral approach)	53434.81	53434.81	52051.48	51392.38	53279.19	58634.27	55160.68	60915.40	59304.48	56015.08	55433.28	53633.43	59056.18	61656.98
1. Energy industries	18969.25	18969.25	18788.03	18607.65	21353.52	26343.19	24031.16	29781.90	27394.93	24148.96	23607.72	22137.73	27566.06	30394.87
2. Manufacturing industries and construction	13662.91	13662.91	13138.90	12601.15	12697.71	12972.89	12408.69	12272.35	12555.98	12199.45	12172.82	12209.83	11759.34	11442.26
3. Transport	12101.30	12101.30	11725.55	11638.68	11183.63	11539.08	11337.91	11338.79	11901.28	12033.76	12242.17	12127.53	12244.67	12427.23
4. Other sectors	7565.22	7565.22	7386.44	7497.39	7089.83	6573.28	6083.97	6175.10	6161.70	6235.39	6144.03	5791.08	6016.35	5970.52
5. Other	1136.12	1136.12	1012.56	1047.50	954.49	1205.83	1298.94	1347.26	1290.58	1397.52	1266.54	1367.26	1469.76	1422.10
B. Fugitive emissions from fuels	123.03	123.03	151.76	175.87	240.56	159.62	167.58	159.50	185.21	148.03	122.13	121.42	131.05	125.96
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	123.03	123.03	151.76	175.87	240.56	159.62	167.58	159.50	185.21	148.03	122.13	121.42	131.05	125.96
C. CO_2 transport and storage	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Industrial Processes	5370.16	5370.16	4966.37	4677.25	4708.42	4906.23	4913.67	5121.08	5402.29	5431.28	5614.31	5827.36	5866.30	5842.07
A. Mineral industry	1195.90	1195.90	1027.71	929.91	836.81	876.54	853.04	892.18	924.53	933.77	1007.26	1059.03	1064.39	1061.61
B. Chemical industry	1861.86	1861.86	1672.17	1488.40	1495.29	1616.77	1669.13	1670.37	1646.94	1578.25	1550.73	1588.64	1526.72	1597.11
C. Metal industry	1975.53	1975.53	1986.47	1990.83	2112.78	2121.28	2075.60	2197.95	2413.71	2418.71	2447.65	2388.29	2439.22	2317.35
D. Non-energy products from fuels and solvent use	219.66	219.66	175.06	177.58	178.72	197.60	187.31	167.61	152.16	147.60	141.58	137.87	144.11	143.48
E. Electronic industry	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE
F. Product uses as ODS substitutes	0.01	0.01	0.02	0.03	0.17	5.21	26.57	73.69	149.50	249.00	365.27	571.58	611.54	648.37
G. Other product manufacture and use	109.50	109.50	97.02	82.67	78.50	81.20	91.15	85.75	81.98	79.27	79.32	62.23	59.14	55.21
H. Other	7.70	7.70	7.91	7.83	6.14	7.63	10.88	33.54	33.46	24.68	22.50	19.73	21.17	18.95
3. Agriculture	7525.30	7525.30	7007.27	6490.64	6756.46	6854.10	6837.79	6787.49	6805.54	6620.73	6509.90	6466.33	6511.77	6615.73
A. Enteric fermentation	2422.95	2422.95	2326.74	2250.44	2270.63	2272.58	2140.70	2146.05	2178.03	2131.31	2100.90	2112.68	2090.61	2112.93
B. Manure management	654.67	654.67	618.70	616.52	627.58	648.21	646.79	666.15	694.92	677.52	667.34	665.21	671.62	687.04
C. Rice cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural soils	3796.30	3796.30	3600.62	3321.19	3381.36	3456.51	3636.68	3493.80	3437.20	3356.80	3285.53	3333.99	3326.55	3365.28
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	4.02	4.02	3.66	3.03	3.77	3.62	3.35	3.66	3.60	2.70	2.53	3.60	3.14	3.26
G. Liming	642.01	642.01	455.16	296.88	472.14	472.49	409.67	477.26	490.96	451.61	452.82	350.01	418.92	446.22
H. Urea application	5.35	5.35	2.39	2.58	0.98	0.69	0.60	0.58	0.83	0.80	0.78	0.84	0.93	0.99
I. Other carbon-containing fertilizers	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry[(2)]	-12672.35	-12672.35	-25427.45	-19416.44	-20268.53	-13324.93	-12368.91	-21443.50	-18252.70	-16614.16	-19618.45	-21709.98	-23410.33	-23933.88
A. Forest land	-20009.14	-20009.14	-34515.69	-28397.10	-26784.73	-19320.17	-19294.02	-28635.04	-23097.79	-21450.51	-24496.34	-26049.33	-30684.88	-31287.23
B. Cropland	5601.08	5601.08	5738.38	5871.69	5702.74	6410.20	6909.10	6696.17	6808.47	6867.51	6481.49	6312.45	6634.08	7047.10
C. Grassland	863.16	863.16	849.01	820.35	815.58	791.76	775.72	753.42	762.68	736.90	725.39	716.00	735.24	715.13
D. Wetlands	1551.88	1551.88	1530.00	1707.36	1655.33	1867.35	1742.78	1792.64	1868.06	1674.57	2089.08	1896.90	2114.87	2158.81
E. Settlements	884.07	884.07	920.50	959.57	1023.62	1080.71	1087.91	1155.30	1260.72	1314.63	1315.57	1336.74	1510.50	1482.49
F. Other land	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA
G. Harvested wood products	-1565.63	-1565.63	48.24	-380.67	-2682.90	-4156.71	-3592.63	-3208.12	-5856.95	-5760.05	-5736.35	-5924.82	-3722.71	-4052.78
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Waste	4671.95	4671.95	4726.40	4738.63	4731.53	4667.58	4596.31	4491.01	4367.40	4182.14	4092.25	3850.03	3690.26	3431.11
A. Solid waste disposal	4327.75	4327.75	4384.59	4400.82	4391.98	4326.01	4245.11	4133.90	4016.84	3828.31	3737.86	3492.09	3332.66	3070.63
B. Biological treatment of solid waste	44.10	44.10	49.52	55.56	59.79	64.01	72.98	82.38	83.08	88.14	93.22	97.91	102.95	107.96
C. Incineration and open burning of waste	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE
D. Waste water treatment and discharge	300.10	300.10	292.28	282.25	279.76	277.56	278.22	274.73	267.48	265.70	261.17	260.03	254.65	252.53
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items:														
International bunkers	2865.99	2865.99	2718.70	3071.70	2535.81	2189.31	1973.53	2179.04	2315.91	2705.56	2891.00	3139.34	2950.12	3175.65
Aviation	1016.29	1016.29	956.34	845.43	794.47	836.44	904.64	968.49	1006.23	1030.97	1103.49	1072.48	1099.41	1086.82
Navigation	1849.70	1849.70	1762.36	2226.27	1741.34	1352.87	1068.90	1210.55	1309.68	1674.58	1787.51	2066.86	1850.72	2088.84
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass	19333.60	19333.60	19010.45	18704.73	22233.93	23112.38	23480.25	23459.30	26746.63	27403.80	29663.01	29486.39	28474.50	30852.86
CO_2 captured	NO	NO	NO,NA	NO,NA	0.86	20.07	54.15	73.54	106.08	127.68	156.47	181.77	177.15	176.34
Long-term storage of C in waste disposal sites	37785.27	37785.27	39123.77	40334.09	41438.78	42456.86	43405.85	44279.05	45095.90	45864.24	46594.67	47315.29	47996.76	48624.41
Indirect N_2O	422.89	422.89	399.96	384.33	385.99	385.63	356.35	362.24	357.19	339.44	336.53	323.19	326.42	324.19
Indirect CO_2 [(3)]	165.38	165.38	155.40	148.07	140.67	136.57	129.35	121.26	114.94	111.53	107.29	103.97	104.77	95.87
Total CO_2 equivalent emissions without land use, land-use change and forestry	71125.26	71125.26	68903.28	67474.77	69716.17	75221.80	71676.03	77474.48	76064.92	72397.28	71771.86	69898.57	75255.56	77671.85
Total CO_2 equivalent emissions with land use, land-use change and forestry	58452.91	58452.91	43475.83	48058.32	49447.63	61896.87	59307.12	56030.98	57812.22	55783.12	52153.41	48188.59	51845.23	53737.97
Total CO_2 equivalent emissions, including indirect CO2, without land use, land-use ch	71290.64	71290.64	69058.68	67622.84	69856.84	75358.38	71805.38	77595.74	76179.85	72508.81	71879.15	70002.55	75360.33	77767.72
Total CO_2 equivalent emissions, including indirect CO2, with land use, land-use chang	58618.29	58618.29	43631.23	48206.40	49588.30	62033.44	59436.47	56152.24	57927.15	55894.66	52260.70	48292.56	51950.00	53833.84

Note: All footnotes for this table are given at the end of the table on sheet 6.

TABLE 10 EMISSION TRENDS
GHG CO_2 eq emissions
(Sheet 1 of 6)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
	(kt CO_2 eq)													%
Total (net emissions)(2)	60660.28	55410.34	42425.22	47266.57	53337.44	46385.00	29373.94	48287.81	38898.46	30057.66	36859.69	30735.96	29516.44	-49.50
1. Energy	69374.40	65494.81	53714.93	64817.79	62822.13	54488.14	52563.66	60165.64	52716.99	47484.45	48326.60	44434.03	40816.34	-23.79
A. Fuel combustion (sectoral approach)	69248.16	65376.63	53571.78	64696.87	62684.18	54335.88	52436.58	60023.94	52589.53	47341.34	48207.36	44317.48	40670.90	-23.89
1. Energy industries	37463.28	33396.59	22143.66	33028.35	31032.96	24503.91	25608.17	30943.60	24860.69	20882.77	22166.84	19611.06	16225.40	-14.46
2. Manufacturing industries and construction	11817.12	11913.73	11619.08	11878.60	11724.11	11112.38	8851.18	10187.68	9872.91	8566.40	8562.69	8559.01	8449.35	-38.16
3. Transport	12626.46	12958.55	12936.06	13094.16	13435.02	12784.47	12212.82	12717.75	12525.68	12213.16	12192.14	11052.97	11110.95	-8.18
4. Other sectors	5865.48	5760.54	5424.76	5306.39	5154.57	4678.60	4646.55	4953.98	4272.20	4544.04	4212.84	4045.67	3778.91	-50.05
5. Other	1475.81	1347.23	1448.22	1389.36	1337.52	1256.52	1117.86	1220.93	1058.06	1134.97	1072.85	1048.77	1106.29	-2.63
B. Fugitive emissions from fuels	126.24	118.18	143.14	120.92	137.94	152.26	127.08	141.70	127.46	143.11	119.24	116.56	145.44	18.22
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and natural gas and other emissions from energy production	126.24	118.18	143.14	120.92	137.94	152.26	127.08	141.70	127.46	143.11	119.24	116.56	145.44	18.22
C. CO_2 transport and storage	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
2. Industrial Processes	6095.00	6406.00	6497.24	6535.87	7105.46	7459.57	5738.31	6260.15	6014.66	6023.52	5995.93	5921.01	6076.18	13.15
A. Mineral industry	1107.50	1180.33	1157.21	1248.53	1275.41	1217.27	902.01	1158.25	1247.68	1111.89	1054.53	1025.12	962.52	-19.51
B. Chemical industry	1667.94	1771.83	1854.69	1754.94	2123.61	2336.11	1588.96	1036.93	949.47	995.30	1122.62	982.50	1174.87	-36.90
C. Metal industry	2479.17	2574.63	2403.65	2472.49	2494.78	2553.51	1968.86	2439.49	2377.35	2285.28	2095.07	2053.23	2185.71	10.64
D. Non-energy products from fuels and solvent use	118.13	111.01	103.15	114.53	131.38	126.77	101.37	85.14	82.84	83.97	97.10	89.25	137.40	-37.45
E. Electronic industry	NE,NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	0.00
F. Product uses as ODS substitutes	649.11	697.41	906.30	871.75	1018.79	1153.64	1118.34	1481.49	1297.66	1487.95	1563.56	1704.93	1548.59	11358205.26
G. Other product manufacture and use	51.45	50.60	57.06	51.28	49.27	47.08	38.74	42.31	41.25	40.21	37.50	37.87	34.94	-68.09
H. Other	21.69	20.20	15.18	22.35	12.21	25.18	20.03	16.54	18.41	18.92	25.55	28.10	32.14	317.60
3. Agriculture	6476.98	6434.47	6457.30	6414.82	6390.74	6469.37	6487.93	6576.22	6410.69	6373.21	6483.94	6510.80	6480.97	-13.88
A. Enteric fermentation	2091.39	2076.12	2061.71	2065.24	2045.08	2030.19	2053.15	2098.94	2076.37	2058.61	2060.41	2090.68	2117.43	-12.61
B. Manure management	705.79	709.26	727.46	723.09	727.56	707.78	735.60	748.16	729.77	740.33	732.94	744.98	752.09	14.88
C. Rice cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Agricultural soils	3373.81	3369.07	3374.19	3301.85	3337.98	3402.05	3356.75	3448.28	3400.27	3368.87	3382.36	3448.61	3427.04	-9.73
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field burning of agricultural residues	3.04	3.01	2.95	2.63	2.88	2.80	2.72	1.85	2.17	2.13	2.87	2.62	2.57	-36.17
G. Liming	301.90	275.91	289.86	320.64	275.46	325.01	338.26	277.41	199.54	201.61	304.38	222.21	179.75	-72.00
H. Urea application	1.04	1.11	1.14	1.37	1.78	1.54	1.44	1.57	2.57	1.67	0.98	1.69	2.10	-60.84
I. Other carbon-containing fertilizers	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
4. Land use, land-use change and forestry(2)	-24511.57	-25988.75	-27067.70	-33399.55	-25775.33	-24707.00	-37998.07	-27297.44	-28746.06	-32272.67	-26278.60	-28336.47	-25990.77	105.10
A. Forest land	-31361.95	-32567.94	-37273.60	-41297.50	-32237.23	-35191.56	-51337.04	-37082.01	-38146.27	-41875.29	-35076.68	-36578.07	-34123.65	70.54
B. Cropland	7195.49	7275.42	6902.37	7278.88	6797.20	6905.83	6823.70	7083.62	6872.06	6839.27	6689.64	6670.74	6677.37	19.22
C. Grassland	712.04	768.86	800.88	813.64	813.46	805.38	753.78	704.66	656.38	653.79	662.03	664.86	683.31	-20.84
D. Wetlands	2077.21	1964.73	2197.60	2474.01	2171.65	2317.85	2459.68	2457.12	2391.78	2342.30	2457.76	2339.18	2304.20	48.48
E. Settlements	1527.80	1668.22	1679.45	1563.90	1648.10	1658.79	1640.98	1624.51	1558.28	1299.49	1065.22	978.34	798.02	-9.73
F. Other land	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
G. Harvested wood products	-4665.04	-5101.08	-1377.23	-4235.82	-4971.26	-1206.33	1658.22	-2088.77	-2081.39	-1535.39	-2079.55	-2414.58	-2333.01	49.01
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
5. Waste	3225.47	3063.80	2823.46	2897.64	2794.45	2674.92	2582.11	2583.25	2502.17	2449.14	2331.82	2206.60	2133.72	-54.33
A. Solid waste disposal	2858.53	2693.28	2440.20	2510.87	2394.48	2285.67	2201.35	2193.96	2105.66	2067.96	1952.20	1825.49	1766.41	-59.18
B. Biological treatment of solid waste	112.05	116.52	130.60	134.65	147.00	138.00	138.47	143.63	145.98	127.30	129.74	128.53	112.85	155.90
C. Incineration and open burning of waste	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NE,NO,IE	NE,NO,IE	0.00
D. Waste water treatment and discharge	254.90	254.00	252.66	252.12	252.97	251.25	242.29	245.66	250.53	253.88	249.89	252.58	254.46	-15.21
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Memo items:														
International bunkers	3197.04	2956.68	2930.60	3251.36	3142.99	3096.46	2372.31	2330.02	2590.24	2256.73	2339.85	2210.19	2908.08	1.47
Aviation	1123.10	1293.26	1301.26	1446.83	1669.69	1807.29	1583.46	1667.58	1973.23	1904.55	1965.73	1937.01	1979.68	94.79
Navigation	2073.93	1663.42	1629.34	1804.53	1473.30	1289.17	788.85	662.44	617.00	352.18	374.12	273.18	928.39	-49.81
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO_2 emissions from biomass	31482.48	33112.10	30946.14	34577.70	33375.17	34268.66	30752.71	36396.69	35992.81	37546.16	38409.81	39464.57	38690.95	100.12
CO_2 captured	188.91	208.06	186.73	211.83	233.99	213.20	184.96	197.62	179.59	146.64	139.81	142.65	138.28	100.00
Long-term storage of C in waste disposal sites	49234.64	49822.08	50428.27	51070.55	51678.73	52232.48	52695.93	53164.85	53602.46	53981.06	54284.11	54498.88	54650.70	44.63
Indirect N_2O	338.03	319.68	280.01	303.69	287.70	262.42	237.89	250.39	229.30	216.66	210.20	196.94	182.16	-56.93
Indirect CO_2 (3)	92.87	90.64	85.01	85.15	84.67	75.88	66.00	68.66	61.89	59.01	57.05	53.35	52.00	-68.56
Total CO_2 equivalent emissions without land use, land-use change and forestry	85171.85	81399.09	69492.92	80666.12	79112.78	71091.99	67372.00	75585.25	67644.52	62330.33	63138.29	59072.44	55507.21	-21.96
Total CO_2 equivalent emissions with land use, land-use change and forestry	60660.28	55410.34	42425.22	47266.57	53337.44	46385.00	29373.94	48287.81	38898.46	30057.66	36859.69	30735.96	29516.44	-49.50
Total CO_2 equivalent emissions, including indirect CO2, without land use, land-use ch	85264.72	81489.73	69577.93	80751.27	79197.45	71167.87	67438.00	75653.91	67706.40	62389.34	63195.34	59125.79	55559.21	-22.07
Total CO_2 equivalent emissions, including indirect CO2, with land use, land-use chang	60753.15	55500.99	42510.23	47351.72	53422.11	46460.87	29439.94	48356.47	38960.34	30116.67	36916.73	30789.31	29568.44	-49.56

Note: All footnotes for this table are given at the end of the table on sheet 6.

TABLE 10 EMISSION TRENDS

CO_2

(Sheet 2 of 6)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[(1)]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	(kt)													
1. Energy	52642.27	52642.27	51272.52	50630.70	52543.82	57789.74	54336.92	60042.61	58463.62	55150.58	54575.46	52812.96	58172.93	60761.83
A. Fuel combustion (sectoral approach)	52530.78	52530.78	51169.06	50520.86	52386.92	57723.31	54262.33	59977.85	58360.40	55086.64	54520.31	52754.49	58119.97	60700.33
1. Energy industries	18843.01	18843.01	18651.33	18460.49	21185.15	26149.66	23833.72	29548.82	27162.88	23917.16	23378.08	21921.04	27297.32	30082.98
2. Manufacturing industries and construction	13478.23	13478.23	12966.66	12441.50	12519.52	12789.08	12227.29	12088.21	12354.50	12003.93	11971.59	12006.39	11563.49	11256.70
3. Transport	11827.48	11827.48	11462.87	11383.44	10937.61	11300.94	11105.29	11111.66	11678.32	11819.45	12035.00	11930.68	12055.20	12249.42
4. Other sectors	7258.20	7258.20	7086.25	7198.40	6799.71	6289.85	5810.28	5895.61	5887.07	5962.67	5882.17	5542.71	5748.62	5703.11
5. Other	1123.85	1123.85	1001.95	1037.02	944.94	1193.77	1285.75	1333.55	1277.62	1383.44	1253.47	1353.66	1455.34	1408.11
B. Fugitive emissions from fuels	111.49	111.49	103.46	109.84	156.89	66.43	74.60	64.76	103.22	63.94	55.15	58.48	52.96	61.50
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	111.49	111.49	103.46	109.84	156.89	66.43	74.60	64.76	103.22	63.94	55.15	58.48	52.96	61.50
C. CO_2 transport and storage	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
2. Industrial processes	3659.35	3659.35	3477.42	3332.77	3314.43	3431.06	3377.15	3519.82	3748.41	3754.41	3851.37	3861.83	3931.99	3835.51
A. Mineral industry	1195.90	1195.90	1027.71	929.91	836.81	876.54	853.04	892.18	924.53	933.77	1007.26	1059.03	1064.39	1061.61
B. Chemical industry	270.23	270.23	289.75	236.06	187.71	237.38	262.90	263.59	259.36	255.64	256.15	277.88	285.54	314.31
C. Metal industry	1975.53	1975.53	1986.47	1990.83	2112.77	2121.28	2075.60	2197.95	2413.71	2418.71	2447.65	2388.29	2439.22	2317.35
D. Non-energy products from fuels and solvent use	217.69	217.69	173.49	175.98	177.13	195.86	185.62	166.10	150.81	146.29	140.32	136.64	142.84	142.24
E. Electronic industry														
F. Product uses as ODS substitutes														
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	647.36	647.36	457.55	299.46	473.12	473.18	410.27	477.83	491.79	452.40	453.60	350.85	419.85	447.21
A. Enteric fermentation														
B. Manure management														
C. Rice cultivation														
D. Agricultural soils														
E. Prescribed burning of savannas														
F. Field burning of agricultural residues														
G. Liming	642.01	642.01	455.16	296.88	472.14	472.49	409.67	477.26	490.96	451.61	452.82	350.01	418.92	446.22
H. Urea application	5.35	5.35	2.39	2.58	0.98	0.69	0.60	0.58	0.83	0.80	0.78	0.84	0.93	0.99
I. Other carbon-containing fertilizers	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry [(2)]	-15482.67	-15482.67	-28216.46	-22187.17	-23016.88	-16069.20	-15097.98	-24158.42	-20959.16	-19309.63	-22286.74	-24346.21	-26025.79	-26518.89
A. Forest land	-22674.23	-22674.23	-37158.59	-31017.96	-29383.05	-21910.88	-21863.88	-31188.42	-25639.07	-23974.29	-26989.74	-28511.96	-33121.09	-33691.66
B. Cropland	5592.17	5592.17	5730.09	5862.31	5695.86	6402.84	6900.43	6687.97	6800.25	6856.16	6470.73	6304.59	6624.06	7036.97
C. Grassland	861.95	861.95	847.77	819.11	814.30	790.44	774.38	752.11	761.30	735.68	724.07	714.76	733.93	713.74
D. Wetlands	1432.72	1432.72	1409.24	1584.17	1529.29	1738.41	1610.11	1657.04	1729.18	1533.16	1944.48	1750.27	1965.91	2009.34
E. Settlements	870.36	870.36	906.79	945.86	1009.61	1066.70	1073.61	1141.00	1246.12	1299.73	1300.07	1320.95	1494.11	1465.51
F. Other land	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA
G. Harvested wood products	-1565.63	-1565.63	48.24	-380.67	-2682.90	-4156.71	-3592.63	-3208.12	-5856.95	-5760.05	-5736.35	-5924.82	-3722.71	-4052.78
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Waste	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE
A. Solid waste disposal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Biological treatment of solid waste														
C. Incineration and open burning of waste	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE
D. Waste water treatment and discharge														
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other ***(as specified in summary 1.A)***	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo items:														
International bunkers	2839.72	2839.72	2693.75	3043.24	2512.50	2169.38	1955.73	2159.25	2294.79	2680.68	2863.84	3110.16	2922.80	3146.74
Aviation	1007.73	1007.73	948.28	838.29	787.76	829.37	896.99	960.24	997.65	1022.15	1094.07	1063.28	1089.98	1077.56
Navigation	1832.00	1832.00	1745.48	2204.95	1724.74	1340.01	1058.74	1199.00	1297.14	1658.53	1769.77	2046.88	1832.82	2069.18
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass	19333.60	19333.60	19010.45	18704.73	22233.93	23112.38	23480.25	23459.30	26746.63	27403.80	29663.01	29486.39	28474.50	30852.86
CO_2 captured	NO	NO	NO,NA	NO,NA	0.86	20.07	54.15	73.54	106.08	127.68	156.47	181.77	177.15	176.34
Long-term storage of C in waste disposal sites	37785.27	37785.27	39123.77	40334.09	41438.78	42456.86	43405.85	44279.05	45095.90	45864.24	46594.67	47315.29	47996.76	48624.41
Indirect N_2O														
Indirect CO_2 [(3)]	165.38	165.38	155.40	148.07	140.67	136.57	129.35	121.26	114.94	111.53	107.29	103.97	104.77	95.87
Total CO_2 equivalent emissions without land use, land-use change and forestry	56948.99	56948.99	55207.49	54262.93	56331.37	61693.97	58124.35	64040.26	62703.82	59357.39	58880.44	57025.65	62524.76	65044.55
Total CO_2 equivalent emissions with land use, land-use change and forestry	41466.32	41466.32	26991.03	32075.75	33314.49	45624.78	43026.36	39881.85	41744.66	40047.76	36593.69	32679.44	36498.97	38525.67
Total CO_2 equivalent emissions, including indirect CO2, without land use, land-use change and forestry	57114.37	57114.37	55362.89	54411.00	56472.05	61830.55	58253.70	64161.52	62818.75	59468.92	58987.73	57129.62	62629.53	65140.42
Total CO_2 equivalent emissions, including indirect CO2, with land use, land-use change and forestry	41631.71	41631.71	27146.43	32223.83	33455.16	45761.35	43155.72	40003.10	41859.59	40159.30	36700.98	32783.42	36603.74	38621.54

Note: All footnotes for this table are given at the end of the table on sheet 6.

TABLE 10 EMISSION TRENDS

CO_2

(Sheet 2 of 6)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
	(kt)													%
1. Energy	68321.90	64482.27	52784.88	63834.73	61862.16	53562.48	51676.58	59169.38	51811.87	46589.62	47449.60	43588.58	39998.97	-24.02
A. Fuel combustion (sectoral approach)	68265.88	64427.23	52714.46	63776.47	61781.25	53465.35	51601.87	59072.97	51724.08	46487.76	47370.45	43504.85	39890.72	-24.06
1. Energy industries	37110.67	33064.98	21872.49	32678.50	30687.51	24181.76	25299.20	30564.79	24511.62	20562.76	21844.54	19311.61	15952.63	-15.34
2. Manufacturing industries and construction	11630.10	11719.39	11437.48	11703.18	11555.15	10951.41	8716.03	10035.63	9721.95	8415.84	8409.94	8405.04	8287.06	-38.52
3. Transport	12461.20	12805.98	12794.06	12961.88	13309.28	12670.54	12106.73	12612.28	12422.67	12113.93	12093.71	10954.08	11011.76	-6.90
4. Other sectors	5602.70	5503.49	5176.70	5057.03	4905.03	4417.45	4372.79	4650.98	4020.19	4271.55	3959.83	3795.20	3543.35	-51.18
5. Other	1461.19	1333.39	1433.74	1375.88	1324.28	1244.18	1107.12	1209.29	1047.65	1123.68	1062.42	1038.92	1095.92	-2.49
B. Fugitive emissions from fuels	56.02	55.04	70.42	58.26	80.91	97.13	74.71	96.41	87.79	101.87	79.15	83.73	108.25	-2.91
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and natural gas and other emissions from energy production	56.02	55.04	70.42	58.26	80.91	97.13	74.71	96.41	87.79	101.87	79.15	83.73	108.25	-2.91
C. CO_2 transport and storage	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
2. Industrial processes	4018.88	4198.35	3955.59	4207.08	4602.61	4715.22	3798.18	4559.13	4527.05	4315.94	4157.57	3944.49	4200.86	14.80
A. Mineral industry	1107.50	1180.33	1157.21	1248.53	1275.41	1217.27	902.01	1158.25	1247.68	1111.89	1054.53	1025.12	962.52	-19.51
B. Chemical industry	315.05	333.27	292.40	372.43	702.06	818.63	826.67	876.79	819.72	835.37	911.56	777.47	916.24	239.06
C. Metal industry	2479.17	2574.63	2403.65	2472.48	2494.78	2553.51	1968.86	2439.49	2377.35	2285.28	2095.06	2053.23	2185.71	10.64
D. Non-energy products from fuels and solvent use	117.16	110.12	102.34	113.64	130.36	125.81	100.64	84.59	82.30	83.41	96.41	88.67	136.39	-37.35
E. Electronic industry														
F. Product uses as ODS substitutes														
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
3. Agriculture	302.94	277.02	290.99	322.01	277.24	326.55	339.71	278.98	202.11	203.28	305.36	223.91	181.85	-71.91
A. Enteric fermentation														
B. Manure management														
C. Rice cultivation														
D. Agricultural soils														
E. Prescribed burning of savannas														
F. Field burning of agricultural residues														
G. Liming	301.90	275.91	289.86	320.64	275.46	325.01	338.26	277.41	199.54	201.61	304.38	222.21	179.75	-72.00
H. Urea application	1.04	1.11	1.14	1.37	1.78	1.54	1.44	1.57	2.57	1.67	0.98	1.69	2.10	-60.84
I. Other carbon-containing fertilizers	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
4. Land use, land-use change and forestry (2)	-27065.27	-28510.24	-29558.58	-35869.24	-28210.48	-27098.48	-40318.60	-29558.45	-30942.89	-34463.19	-28469.17	-30526.82	-28176.62	81.99
A. Forest land	-33732.25	-34904.26	-39577.57	-43575.15	-34479.45	-37383.78	-53455.88	-39133.35	-40132.56	-43852.68	-37053.40	-38553.40	-36095.36	59.19
B. Cropland	7183.92	7263.38	6891.34	7265.74	6786.80	6894.24	6814.01	7070.30	6860.23	6826.87	6678.01	6658.70	6665.66	19.20
C. Grassland	710.54	767.28	799.18	811.85	811.52	803.42	751.79	702.74	654.56	652.13	660.39	663.23	681.79	-20.90
D. Wetlands	1927.34	1814.40	2045.32	2319.92	2014.07	2156.03	2293.73	2288.17	2220.33	2169.04	2282.81	2163.25	2128.33	48.55
E. Settlements	1510.21	1650.04	1660.38	1544.23	1627.84	1637.93	1619.52	1602.46	1535.93	1276.84	1042.57	955.99	775.97	-10.85
F. Other land	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	0.00
G. Harvested wood products	-4665.04	-5101.08	-1377.23	-4235.82	-4971.26	-1206.33	1658.22	-2088.77	-2081.39	-1535.39	-2079.55	-2414.58	-2333.01	49.01
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
5. Waste	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NE,NO,IE	NE,NO,IE	0.00
A. Solid waste disposal	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
B. Biological treatment of solid waste														
C. Incineration and open burning of waste	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NE,NO,IE	NE,NO,IE	0.00
D. Waste water treatment and discharge														
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Memo items:														
International bunkers	3167.94	2931.02	2904.33	3222.45	3115.22	3069.47	2351.73	2309.86	2568.00	2237.54	2319.95	2191.45	2883.11	1.53
Aviation	1113.56	1282.23	1290.19	1434.60	1655.60	1792.08	1570.10	1653.51	1956.64	1888.55	1949.24	1920.76	1963.08	94.80
Navigation	2054.38	1648.79	1614.15	1787.86	1459.62	1277.39	781.63	656.34	611.37	348.99	370.70	270.69	920.02	-49.78
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO_2 emissions from biomass	31482.48	33112.10	30946.14	34577.70	33375.17	34268.66	30752.71	36396.69	35992.81	37546.16	38409.81	39464.57	38690.95	100.12
CO_2 captured	188.91	208.06	186.73	211.83	233.99	213.20	184.96	197.62	179.59	146.64	139.81	142.65	138.28	100.00
Long-term storage of C in waste disposal sites	49234.64	49822.08	50428.27	51070.55	51678.73	52232.48	52695.93	53164.85	53602.46	53981.06	54284.11	54498.88	54650.70	44.63
Indirect N_2O														
Indirect CO_2 (3)	92.87	90.64	85.01	85.15	84.67	75.88	66.00	68.66	61.89	59.01	57.05	53.35	52.00	-68.56
Total CO_2 equivalent emissions without land use, land-use change and forestry	72643.72	68957.63	57031.47	68363.82	66742.01	58604.25	55814.47	64007.49	56541.03	51108.85	51912.53	47756.98	44381.68	-22.07
Total CO_2 equivalent emissions with land use, land-use change and forestry	45578.45	40447.39	27472.89	32494.59	38531.53	31505.77	15495.87	34449.04	25598.14	16645.66	23443.36	17230.16	16205.06	-60.92
Total CO_2 equivalent emissions, including indirect CO2, without land use, land-use change and forestry	72736.58	69048.28	57116.48	68448.97	66826.68	58680.13	55880.47	64076.15	56602.92	51167.86	51969.58	47810.33	44433.68	-22.20
Total CO_2 equivalent emissions, including indirect CO2, with land use, land-use change and forestry	45671.32	40538.04	27557.89	32579.74	38616.20	31581.65	15561.87	34517.70	25660.03	16704.67	23500.41	17283.51	16257.06	-60.95

Note: All footnotes for this table are given at the end of the table on sheet 6.

TABLE 10 EMISSION TRENDS

CH_4

(Sheet 3 of 6)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[(1)]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	(kt)													
1. Energy	15.04	15.04	15.99	16.39	16.73	16.94	16.63	16.80	16.05	15.87	14.72	13.88	15.11	14.57
A. Fuel combustion (sectoral approach)	14.61	14.61	14.08	13.77	13.41	13.22	12.92	13.03	12.80	12.52	12.05	11.38	12.00	12.01
1. Energy industries	0.39	0.39	0.41	0.43	0.48	0.58	0.62	0.73	0.77	0.78	0.83	0.74	0.92	1.15
2. Manufacturing industries and construction	0.65	0.65	0.63	0.60	0.69	0.71	0.73	0.71	0.75	0.72	0.73	0.75	0.71	0.69
3. Transport	4.51	4.51	4.20	4.01	3.75	3.53	3.37	3.23	3.13	2.97	2.81	2.61	2.50	2.32
4. Other sectors	8.91	8.91	8.72	8.62	8.39	8.28	8.05	8.20	8.01	7.89	7.52	7.13	7.72	7.69
5. Other	0.15	0.15	0.12	0.11	0.10	0.13	0.15	0.16	0.15	0.17	0.15	0.15	0.16	0.16
B. Fugitive emissions from fuels	0.43	0.43	1.91	2.62	3.32	3.71	3.70	3.77	3.25	3.35	2.67	2.50	3.11	2.56
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.43	0.43	1.91	2.62	3.32	3.71	3.70	3.77	3.25	3.35	2.67	2.50	3.11	2.56
C. CO_2 transport and storage														
2. Industrial processes	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
A. Mineral industry														
B. Chemical industry	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA
C. Metal industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Non-energy products from fuels and solvent use	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
E. Electronic industry														
F. Product uses as ODS substitutes														
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	111.83	111.83	107.30	104.37	105.62	106.41	101.41	102.19	104.31	101.98	100.61	101.10	100.55	102.02
A. Enteric fermentation	96.92	96.92	93.07	90.02	90.83	90.90	85.63	85.84	87.12	85.25	84.04	84.51	83.62	84.52
B. Manure management	14.78	14.78	14.12	14.26	14.68	15.40	15.68	16.23	17.07	16.65	16.49	16.48	16.83	17.40
C. Rice cultivation	NO	NO	NO	NO	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	NE,NO	NE,NO	NE,NO	NE,NO
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	0.12	0.12	0.11	0.09	0.12	0.11	0.10	0.11	0.11	0.08	0.08	0.11	0.10	0.10
G. Liming														
H. Urea application														
I. Other carbon-containing fertilizers														
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	61.55	61.55	60.79	60.21	59.46	58.87	58.20	57.52	56.89	56.14	55.11	53.94	52.90	51.78
A. Forest land	59.60	59.60	58.80	58.17	57.37	56.72	55.99	55.24	54.55	53.76	52.67	51.46	50.38	49.23
B. Cropland	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA
C. Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Wetlands	1.95	1.95	1.99	2.04	2.09	2.15	2.21	2.27	2.33	2.38	2.44	2.48	2.53	2.55
E. Settlements	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA
F. Other land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G. Harvested wood products														
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Waste	182.98	182.98	185.16	185.71	185.48	182.94	179.86	175.57	170.64	163.06	159.42	149.58	143.20	132.83
A. Solid waste disposal	173.11	173.11	175.38	176.03	175.68	173.04	169.80	165.36	160.67	153.13	149.51	139.68	133.31	122.83
B. Biological treatment of solid waste	1.03	1.03	1.16	1.30	1.40	1.49	1.70	1.93	1.95	2.06	2.18	2.29	2.41	2.54
C. Incineration and open burning of waste	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE
D. Waste water treatment and discharge	8.84	8.84	8.62	8.38	8.40	8.40	8.35	8.28	8.01	7.86	7.73	7.61	7.48	7.46
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CH_4 emissions without CH_4 from LULUCF	309.86	309.86	308.46	306.48	307.84	306.30	297.91	294.56	290.99	280.91	274.76	264.57	258.87	249.42
Total CH_4 emissions with CH_4 from LULUCF	371.41	371.41	369.25	366.69	367.30	365.17	356.11	352.08	347.88	337.06	329.87	318.51	311.78	301.19
Memo items:														
International bunkers	0.15	0.15	0.14	0.18	0.14	0.11	0.09	0.10	0.11	0.14	0.16	0.18	0.16	0.17
Aviation	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Navigation	0.14	0.14	0.13	0.16	0.13	0.10	0.07	0.09	0.09	0.12	0.14	0.15	0.14	0.16
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass														
CO_2 captured														
Long-term storage of C in waste disposal sites														
Indirect N_2O														
Indirect CO_2 [(3)]														

Note: All footnotes for this table are given at the end of the table on sheet 6.

TABLE 10 EMISSION TRENDS

CH_4

(Sheet 3 of 6)

Inventory
2015
Submission
2017 v1
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
	(kt)													%
1. Energy	14.62	13.86	13.59	13.35	12.95	13.10	13.10	13.96	12.06	12.62	11.96	11.67	11.31	-24.83
A. Fuel combustion (sectoral approach)	11.82	11.35	10.70	10.86	10.69	10.92	11.02	12.18	10.50	11.00	10.39	10.39	9.84	-32.61
1. Energy industries	1.32	1.22	1.00	1.22	1.13	1.10	1.05	1.21	1.10	1.06	1.06	1.08	0.99	152.36
2. Manufacturing industries and construction	0.71	0.72	0.67	0.72	0.71	0.68	0.58	0.74	0.83	0.82	0.84	0.88	0.87	35.23
3. Transport	2.09	1.91	1.76	1.63	1.51	1.30	1.18	1.11	1.03	0.96	0.92	0.89	0.86	-81.03
4. Other sectors	7.54	7.34	7.09	7.14	7.19	7.70	8.10	8.99	7.42	8.03	7.45	7.42	7.01	-21.39
5. Other	0.17	0.17	0.17	0.15	0.15	0.14	0.12	0.13	0.13	0.14	0.12	0.11	0.12	-20.08
B. Fugitive emissions from fuels	2.79	2.51	2.89	2.49	2.26	2.18	2.08	1.79	1.56	1.61	1.57	1.29	1.46	236.93
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and natural gas and other emissions from energy production	2.79	2.51	2.89	2.49	2.26	2.18	2.08	1.79	1.56	1.61	1.57	1.29	1.46	236.93
C. CO_2 transport and storage														
2. Industrial processes	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-47.86
A. Mineral industry														
B. Chemical industry	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NO,NA	NA,NO	NA,NO	0.00
C. Metal industry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	79.80
D. Non-energy products from fuels and solvent use	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	-48.41
E. Electronic industry														
F. Product uses as ODS substitutes														
G. Other product manufacture and use	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
3. Agriculture	101.79	101.43	101.51	101.40	100.68	99.37	100.80	102.75	101.16	100.58	100.56	102.06	103.34	-7.59
A. Enteric fermentation	83.66	83.04	82.47	82.61	81.80	81.21	82.13	83.96	83.05	82.34	82.42	83.63	84.70	-12.61
B. Manure management	18.04	18.29	18.95	18.71	18.79	18.07	18.59	18.73	18.04	18.17	18.05	18.35	18.57	25.59
C. Rice cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Agricultural soils	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	0.00
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field burning of agricultural residues	0.09	0.09	0.09	0.08	0.09	0.09	0.08	0.06	0.07	0.07	0.09	0.08	0.08	-36.17
G. Liming														
H. Urea application														
I. Other carbon-containing fertilizers														
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
4. Land use, land-use change and forestry	50.59	49.38	48.29	47.20	46.04	43.76	41.47	39.14	36.88	36.82	36.84	36.84	36.80	-40.21
A. Forest land	48.02	46.79	45.67	44.54	43.31	40.96	38.59	36.21	33.90	33.81	33.81	33.80	33.75	-43.37
B. Cropland	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	0.00
C. Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-79.00
D. Wetlands	2.56	2.58	2.62	2.66	2.72	2.80	2.88	2.93	2.97	3.00	3.03	3.04	3.05	56.30
E. Settlements	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	NE,NA	0.00
F. Other land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
G. Harvested wood products														
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
5. Waste	124.42	117.89	107.92	110.86	106.49	101.83	98.23	98.21	94.85	92.86	88.17	83.03	80.34	-56.09
A. Solid waste disposal	114.34	107.73	97.61	100.43	95.78	91.43	88.05	87.76	84.23	82.72	78.09	73.02	70.66	-59.18
B. Biological treatment of solid waste	2.63	2.73	3.06	3.17	3.47	3.26	3.28	3.42	3.49	3.06	3.12	3.10	2.76	167.51
C. Incineration and open burning of waste	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NE,NO,IE	NE,NO,IE	0.00
D. Waste water treatment and discharge	7.45	7.42	7.25	7.26	7.24	7.14	6.89	7.03	7.14	7.08	6.96	6.91	6.93	-21.61
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total CH_4 emissions without CH_4 from LULUCF	240.83	233.18	223.02	225.62	220.12	214.30	212.13	214.92	208.08	206.06	200.69	196.76	195.00	-37.07
Total CH_4 emissions with CH_4 from LULUCF	291.42	282.55	271.31	272.82	266.16	258.06	253.60	254.06	244.95	242.88	237.53	233.61	231.80	-37.59
Memo items:														
International bunkers	0.18	0.14	0.15	0.16	0.14	0.12	0.08	0.08	0.07	0.05	0.06	0.05	0.10	-30.57
Aviation	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	70.83
Navigation	0.16	0.12	0.12	0.14	0.11	0.10	0.06	0.05	0.05	0.03	0.03	0.02	0.08	-41.34
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO_2 emissions from biomass														
CO_2 captured														
Long-term storage of C in waste disposal sites														
Indirect N_2O														
Indirect CO_2 (3)														

Note: All footnotes for this table are given at the end of the table on sheet 6.

TABLE 10 EMISSION TRENDS

N_2O

(Sheet 4 of 6)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[(1)]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	(kt)													
1. Energy	1.81	1.81	1.78	1.77	1.87	1.95	1.93	2.05	2.10	2.07	2.05	2.00	2.14	2.20
A. Fuel combustion (sectoral approach)	1.81	1.81	1.78	1.77	1.87	1.95	1.93	2.05	2.09	2.07	2.05	1.99	2.13	2.20
1. Energy industries	0.39	0.39	0.42	0.46	0.52	0.60	0.61	0.72	0.71	0.71	0.70	0.67	0.82	0.95
2. Manufacturing industries and construction	0.57	0.57	0.53	0.49	0.54	0.56	0.55	0.56	0.61	0.60	0.61	0.62	0.60	0.56
3. Transport	0.54	0.54	0.53	0.52	0.51	0.50	0.50	0.49	0.49	0.47	0.46	0.44	0.43	0.40
4. Other sectors	0.28	0.28	0.28	0.28	0.27	0.26	0.24	0.25	0.25	0.25	0.25	0.24	0.25	0.25
5. Other	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
B. Fugitive emissions from fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C. CO_2 transport and storage														
2. Industrial processes	5.56	5.56	4.86	4.42	4.61	4.85	4.94	4.94	4.88	4.66	4.56	4.59	4.34	4.47
A. Mineral industry														
B. Chemical industry	5.34	5.34	4.64	4.20	4.39	4.63	4.72	4.72	4.66	4.44	4.34	4.40	4.17	4.30
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Non-energy products from fuels and solvent use	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E. Electronic industry														
F. Product uses as ODS substitutes														
G. Other product manufacture and use	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.18	0.17	0.16
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	13.70	13.70	12.98	12.02	12.22	12.49	13.06	12.60	12.44	12.14	11.88	12.04	12.01	12.14
A. Enteric fermentation														
B. Manure management	0.96	0.96	0.89	0.87	0.87	0.88	0.86	0.87	0.90	0.88	0.86	0.85	0.84	0.85
C. Rice cultivation														
D. Agricultural soils	12.74	12.74	12.08	11.14	11.35	11.60	12.20	11.72	11.53	11.26	11.03	11.19	11.16	11.29
E. Prescribed burning of savannas	NO	NO	NO	NO	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	0.00	0.00	0.00	0.00
G. Liming														
H. Urea application														
I. Other carbon containing fertlizers														
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4. Land use, land-use change and forestry	4.27	4.27	4.26	4.25	4.23	4.27	4.28	4.29	4.31	4.34	4.33	4.32	4.34	4.33
A. Forest land	3.94	3.94	3.94	3.92	3.91	3.94	3.93	3.93	3.95	3.96	3.95	3.95	3.95	3.94
B. Cropland	0.03	0.03	0.03	0.03	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.03	0.03	0.03
C. Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Wetlands	0.24	0.24	0.24	0.24	0.25	0.25	0.26	0.26	0.27	0.27	0.28	0.28	0.29	0.29
E. Settlements	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06
F. Other land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G. Harvested wood products														
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Waste	0.33	0.33	0.33	0.32	0.32	0.32	0.33	0.34	0.34	0.35	0.36	0.37	0.37	0.37
A. Solid waste disposal														
B. Biological treatment of solid waste	0.06	0.06	0.07	0.08	0.08	0.09	0.10	0.11	0.12	0.12	0.13	0.14	0.14	0.15
C. Incineration and open burning of waste	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE
D. Waste water treatment and discharge	0.27	0.27	0.26	0.24	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.22
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total direct N_2O emissions without N_2O from LULUCF	21.40	21.40	19.95	18.54	19.02	19.60	20.27	19.94	19.75	19.22	18.86	18.99	18.86	19.18
Total direct N_2O emissions with N_2O from LULUCF	25.67	25.67	24.21	22.78	23.26	23.87	24.54	24.22	24.06	23.56	23.19	23.31	23.19	23.51
Memo items:														
International bunkers	0.08	0.08	0.07	0.08	0.07	0.06	0.05	0.06	0.06	0.07	0.08	0.08	0.08	0.08
Aviation	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Navigation	0.05	0.05	0.05	0.06	0.05	0.04	0.03	0.03	0.03	0.04	0.05	0.05	0.05	0.05
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass														
CO_2 captured														
Long-term storage of C in waste disposal sites														
Indirect N_2O	1.42	1.42	1.34	1.29	1.30	1.29	1.20	1.22	1.20	1.14	1.13	1.08	1.10	1.09
Indirect CO_2 [(3)]														

Note: All footnotes for this table are given at the end of the table on sheet 6.

TABLE 10 EMISSION TRENDS

N_2O

(Sheet 4 of 6)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
	(kt)													%
1. Energy	2.31	2.24	1.98	2.18	2.14	2.01	1.88	2.17	2.03	1.94	1.94	1.86	1.79	-0.90
A. Fuel combustion (sectoral approach)	2.30	2.23	1.98	2.18	2.13	2.01	1.88	2.17	2.02	1.94	1.94	1.86	1.79	-0.89
1. Energy industries	1.07	1.01	0.83	1.07	1.06	0.99	0.95	1.17	1.08	0.99	0.99	0.91	0.83	113.02
2. Manufacturing industries and construction	0.57	0.59	0.55	0.53	0.51	0.48	0.40	0.45	0.44	0.44	0.44	0.44	0.47	-16.67
3. Transport	0.38	0.35	0.33	0.31	0.30	0.27	0.26	0.26	0.26	0.25	0.25	0.26	0.26	-51.71
4. Other sectors	0.25	0.25	0.24	0.24	0.23	0.23	0.24	0.26	0.22	0.24	0.22	0.22	0.20	-28.26
5. Other	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.02	0.02	0.02	-13.46
B. Fugitive emissions from fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-10.25
1. Solid fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
2. Oil and natural gas and other emissions from energy production	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-10.25
C. CO_2 transport and storage														
2. Industrial processes	4.69	4.97	5.41	4.79	4.91	5.22	2.66	0.65	0.54	0.64	0.80	0.78	0.95	-82.89
A. Mineral industry														
B. Chemical industry	4.54	4.83	5.24	4.64	4.77	5.09	2.56	0.54	0.44	0.54	0.71	0.69	0.87	-83.75
C. Metal industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
D. Non-energy products from fuels and solvent use	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-48.37
E. Electronic industry														
F. Product uses as ODS substitutes														
G. Other product manufacture and use	0.15	0.14	0.16	0.14	0.13	0.13	0.10	0.11	0.10	0.10	0.09	0.09	0.08	-62.64
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
3. Agriculture	12.18	12.15	12.18	11.94	12.07	12.28	12.18	12.51	12.35	12.27	12.30	12.53	12.47	-8.98
A. Enteric fermentation														
B. Manure management	0.85	0.85	0.85	0.86	0.87	0.86	0.91	0.94	0.94	0.96	0.95	0.96	0.97	1.00
C. Rice cultivation														
D. Agricultural soils	11.32	11.31	11.32	11.08	11.20	11.42	11.26	11.57	11.41	11.30	11.35	11.57	11.50	-9.73
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
F. Field burning of agricultural residues	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-36.17
G. Liming														
H. Urea application														
I. Other carbon containing fertlizers														
J. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
4. Land use, land-use change and forestry	4.33	4.32	4.31	4.33	4.31	4.35	4.31	4.30	4.28	4.26	4.26	4.26	4.25	-0.45
A. Forest land	3.93	3.91	3.90	3.91	3.89	3.92	3.87	3.85	3.82	3.80	3.80	3.79	3.79	-4.01
B. Cropland	0.04	0.04	0.04	0.04	0.03	0.04	0.03	0.04	0.04	0.04	0.04	0.04	0.04	31.44
C. Grassland	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	31.43
D. Wetlands	0.29	0.29	0.29	0.29	0.30	0.31	0.32	0.32	0.33	0.33	0.33	0.33	0.33	41.55
E. Settlements	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.07	60.87
F. Other land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
G. Harvested wood products														
H. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.00
5. Waste	0.39	0.39	0.42	0.42	0.44	0.43	0.42	0.43	0.44	0.43	0.43	0.44	0.42	28.44
A. Solid waste disposal														
B. Biological treatment of solid waste	0.16	0.16	0.18	0.19	0.20	0.19	0.19	0.20	0.20	0.17	0.17	0.17	0.15	139.60
C. Incineration and open burning of waste	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NO,NE,IE	NE,NO,IE	NE,NO,IE	0.00
D. Waste water treatment and discharge	0.23	0.23	0.24	0.24	0.24	0.24	0.23	0.23	0.24	0.26	0.25	0.27	0.27	2.66
E. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
6. Other *(as specified in summary 1.A)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total direct N_2O emissions without N_2O from LULUCF	19.56	19.75	19.99	19.33	19.56	19.94	17.14	15.76	15.35	15.28	15.47	15.61	15.63	-26.94
Total direct N_2O emissions with N_2O from LULUCF	23.88	24.07	24.29	23.66	23.87	24.29	21.44	20.06	19.63	19.54	19.73	19.87	19.88	-22.54
Memo items:														
International bunkers	0.08	0.07	0.08	0.08	0.08	0.08	0.06	0.06	0.07	0.06	0.06	0.06	0.08	-0.68
Aviation	0.03	0.04	0.04	0.04	0.05	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.05	94.84
Navigation	0.05	0.04	0.04	0.04	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.02	-55.43
Multilateral operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
CO_2 emissions from biomass														
CO_2 captured														
Long-term storage of C in waste disposal sites														
Indirect N_2O	1.13	1.07	0.94	1.02	0.97	0.88	0.80	0.84	0.77	0.73	0.71	0.66	0.61	-56.93
Indirect CO_2 (3)														

Note: All footnotes for this table are given at the end of the table on sheet 6.

TABLE 10 EMISSION TRENDS

HFCs, PFCs, SF_6, and NF_3

(Sheet 5 of 6)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[(1)]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	(kt)													
Emissions of HFCs and PFCs - (kt CO_2 equivalent)														
Emissions of HFCs - (kt CO_2 equivalent)	0.02	0.02	0.03	0.04	0.18	5.23	26.59	73.71	149.64	249.04	335.98	559.46	591.88	633.57
HFC-23	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	0.00	0.00	0.00	NO,IE	NO,IE	NO,IE
HFC-32	NO	NO	NO	NO	NO	NO	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-125	NO	NO	NO	NO	NO	0.00	0.00	0.00	0.01	0.02	0.02	0.03	0.05	0.05
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	NO	NO	NO	NO	0.00	0.00	0.01	0.03	0.06	0.09	0.12	0.21	0.13	0.12
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-143a	NO	NO	NO	NO	NO	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.04	0.05
HFC-152	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-152a	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.03	0.02	0.03	0.00	0.00
HFC-161	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-227ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO,IE	NO,IE	NO,IE
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-365mfc	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO,IE	NO,IE	NO,IE
Unspecified mix of HFCs[(4)] - (kt CO_2 equivalent)	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.15	0.04	2.69	0.27	67.54	73.90
Emissions of PFCs - (kt CO_2 equivalent)	0.21	0.21	0.24	0.27	0.31	0.36	0.42	0.48	0.55	0.63	35.69	13.23	22.68	16.50
CF_4	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE
C_2F_6	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE
C_3F_8	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	0.00	0.00	0.00	0.00
C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
$c\text{-}C_4F_8$	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
$C_{10}F_{18}$	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
$c\text{-}C_3F_6$	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of PFCs[(4)] - (kt CO_2 equivalent)	0.21	0.21	0.24	0.27	0.31	0.36	0.42	0.48	0.55	0.63	3.71	0.84	0.96	0.96
Unspecified mix of HFCs and PFCs - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of SF_6 - (kt CO_2 equivalent)	52.48	52.48	40.16	25.67	19.75	23.86	36.98	54.16	50.11	38.62	30.76	26.06	25.53	25.34
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Emissions of NF_3 - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
NF_3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Note: All footnotes for this table are given at the end of the table on sheet 6.

TABLE 10 EMISSION TRENDS

HFCs, PFCs, SF_6, and NF_3

(Sheet 5 of 6)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
	(kt)													%
Emissions of HFCs and PFCs - (kt CO_2 equivalent)														
Emissions of HFCs - (kt CO_2 equivalent)	634.71	687.28	892.12	855.60	1010.69	1147.31	1109.75	1485.40	1300.45	1488.81	1561.77	1699.34	1547.41	6440749.30
HFC-23	0.00	NO,IE	NO,IE	NO,IE	0.00	0.00	0.00	0.00	NO,IE	NO,IE	0.00	0.00	0.00	100.00
HFC-32	0.00	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.03	100.00
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-125	0.05	0.06	0.07	0.07	0.07	0.09	0.09	0.13	0.11	0.13	0.13	0.14	0.14	100.00
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-134a	0.12	0.11	0.19	0.16	0.31	0.32	0.29	0.37	0.33	0.35	0.40	0.43	0.36	100.00
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-143a	0.05	0.05	0.07	0.06	0.07	0.07	0.08	0.11	0.09	0.11	0.12	0.13	0.12	100.00
HFC-152	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-152a	0.00	0.00	0.00	0.00	0.04	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	9147.28
HFC-161	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-227ea	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	0.00	100.00
HFC-236cb	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-236ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
HFC-245fa	NO	NO	NO	NO	NO,IE	NO,IE	NO,IE	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-365mfc	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	0.00	0.00	0.00	0.00	0.00	100.00
Unspecified mix of HFCs[(4)] - (kt CO_2 equivalent)	70.98	69.39	84.49	86.07	2.54	8.68	3.04	10.54	11.41	13.73	8.14	4.84	3.24	31109.86
Emissions of PFCs - (kt CO_2 equivalent)	18.32	14.39	15.97	19.21	10.21	13.93	11.58	1.06	2.30	5.66	6.66	10.30	6.62	3095.21
CF_4	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	0.00
C_2F_6	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	0.00	100.00
C_3F_8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO	0.00	0.00	0.00	0.00	0.00	100.00
C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
$c\text{-}C_4F_8$	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	NO,IE	0.00
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
$C_{10}F_{18}$	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
$c\text{-}C_3F_6$	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Unspecified mix of PFCs[(4)] - (kt CO_2 equivalent)	1.27	0.77	1.17	1.31	0.65	0.67	1.41	1.06	1.61	2.04	3.15	2.92	2.20	960.71
Unspecified mix of HFCs and PFCs - (kt CO_2 equivalent)	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Emissions of SF_6 - (kt CO_2 equivalent)	25.57	23.84	22.19	27.56	19.17	26.66	26.71	21.79	23.67	22.16	30.70	34.25	37.55	-28.45
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-28.45
Emissions of NF_3 - (kt CO_2 equivalent)	NO,NE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
NF_3	NO,NE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00

Note: All footnotes for this table are given at the end of the table on sheet 6.

TABLE 10 EMISSION TRENDS

SUMMARY

(Sheet 6 of 6)

GREENHOUSE GAS EMISSIONS	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	CO$_2$ equivalent (kt)													
CO$_2$ emissions without net CO$_2$ from LULUCF	56948.99	56948.99	55207.49	54262.93	56331.37	61693.97	58124.35	64040.26	62703.82	59357.39	58880.44	57025.65	62524.76	65044.55
CO$_2$ emissions with net CO$_2$ from LULUCF	41466.32	41466.32	26991.03	32075.75	33314.49	45624.78	43026.36	39881.85	41744.66	40047.76	36593.69	32679.44	36498.97	38525.67
CH$_4$ emissions without CH$_4$ from LULUCF	7746.42	7746.42	7711.44	7662.02	7695.90	7657.51	7447.74	7364.02	7274.85	7022.85	6868.90	6614.29	6471.77	6235.46
CH$_4$ emissions with CH$_4$ from LULUCF	9285.28	9285.28	9231.23	9167.25	9182.51	9129.35	8902.80	8801.90	8697.00	8426.47	8246.71	7962.87	7794.39	7529.84
N$_2$O emissions without N$_2$O from LULUCF	6377.14	6377.14	5943.92	5523.84	5668.64	5840.87	6039.96	5941.85	5885.94	5728.74	5620.09	5659.89	5618.94	5716.43
N$_2$O emissions with N$_2$O from LULUCF	7648.59	7648.59	7213.14	6789.33	6930.39	7113.29	7313.96	7218.89	7170.25	7020.59	6910.58	6947.54	6911.78	7007.05
HFCs	0.02	0.02	0.03	0.04	0.18	5.23	26.59	73.71	149.64	249.04	335.98	559.46	591.88	633.57
PFCs	0.21	0.21	0.24	0.27	0.31	0.36	0.42	0.48	0.55	0.63	35.69	13.23	22.68	16.50
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF$_6$	52.48	52.48	40.16	25.67	19.75	23.86	36.98	54.16	50.11	38.62	30.76	26.06	25.53	25.34
NF$_3$	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (without LULUCF)	71125.26	71125.26	68903.28	67474.77	69716.17	75221.80	71676.03	77474.48	76064.92	72397.28	71771.86	69898.57	75255.56	77671.85
Total (with LULUCF)	58452.91	58452.91	43475.83	48058.32	49447.63	61896.87	59307.12	56030.98	57812.22	55783.12	52153.41	48188.59	51845.23	53737.97
Total (without LULUCF, with indirect)	71290.64	71290.64	69058.68	67622.84	69856.84	75358.38	71805.38	77595.74	76179.85	72508.81	71879.15	70002.55	75360.33	77767.72
Total (with LULUCF, with indirect)	58618.29	58618.29	43631.23	48206.40	49588.30	62033.44	59436.47	56152.24	57927.15	55894.66	52260.70	48292.56	51950.00	53833.84

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	CO$_2$ equivalent (kt)													
1. Energy	53557.84	53557.84	52203.24	51568.25	53519.75	58793.89	55328.25	61074.91	59489.69	56163.11	55555.41	53754.85	59187.23	61782.94
2. Industrial processes and product use	5370.16	5370.16	4966.37	4677.25	4708.42	4906.23	4913.67	5121.08	5402.29	5431.28	5614.31	5827.36	5866.30	5842.07
3. Agriculture	7525.30	7525.30	7007.27	6490.64	6756.46	6854.10	6837.79	6787.49	6805.54	6620.73	6509.90	6466.33	6511.77	6615.73
4. Land use, land-use change and forestry[5]	-12672.35	-12672.35	-25427.45	-19416.44	-20268.53	-13324.93	-12368.91	-21443.50	-18252.70	-16614.16	-19618.45	-21709.98	-23410.33	-23933.88
5. Waste	4671.95	4671.95	4726.40	4738.63	4731.53	4667.58	4596.31	4491.01	4367.40	4182.14	4092.25	3850.03	3690.26	3431.11
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including LULUCF)[5]	58452.91	58452.91	43475.83	48058.32	49447.63	61896.87	59307.12	56030.98	57812.22	55783.12	52153.41	48188.59	51845.23	53737.97

[1] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the COP. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

[2] Fill in net emissions/removals as reported in table Summary 1.A. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

[3] In accordance with the UNFCCC reporting guidelines, for Parties that decide to report indirect CO2 the national totals shall be provided with and without indirect CO$_2$.

[4] In accordance with the UNFCCC reporting guidelines, HFC and PFC emissions should be reported for each relevant chemical. However, if it is not possible to report values for each chemical (i.e. mixtures, confidential data, lack of disaggregation), this row could be used for reporting aggregate figures for HFCs and PFCs, respectively. Note that the unit used for this row is kt of CO$_2$ equivalent and that appropriate notation keys should be entered in the cells for the individual chemicals.

[5] Includes net CO$_2$, CH$_4$ and N$_2$O from LULUCF.

TABLE 10 EMISSION TRENDS

SUMMARY

(Sheet 6 of 6)

GREENHOUSE GAS EMISSIONS	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
	CO_2 equivalent (kt)													(%)
CO_2 emissions without net CO_2 from LULUCF	72643.72	68957.63	57031.47	68363.82	66742.01	58604.25	55814.47	64007.49	56541.03	51108.85	51912.53	47756.98	44381.68	-22.07
CO_2 emissions with net CO_2 from LULUCF	45578.45	40447.39	27472.89	32494.59	38531.53	31505.77	15495.87	34449.04	25598.14	16645.66	23443.36	17230.16	16205.06	-60.92
CH_4 emissions without CH_4 from LULUCF	6020.84	5829.44	5575.57	5640.47	5502.98	5357.52	5303.23	5373.04	5201.95	5151.51	5017.15	4919.05	4874.90	-37.07
CH_4 emissions with CH_4 from LULUCF	7285.52	7063.85	6782.85	6820.39	6653.94	6451.61	6340.02	6351.50	6123.83	6071.93	5938.14	5840.17	5794.97	-37.59
N_2O emissions without N_2O from LULUCF	5828.69	5886.51	5955.60	5759.45	5827.72	5942.31	5106.26	4696.47	4575.12	4553.35	4609.48	4652.52	4659.05	-26.94
N_2O emissions with N_2O from LULUCF	7117.71	7173.59	7239.20	7049.22	7111.90	7239.71	6389.99	5979.02	5850.06	5823.44	5879.05	5921.74	5924.84	-22.54
HFCs	634.71	687.28	892.12	855.60	1010.69	1147.31	1109.75	1485.40	1300.45	1488.81	1561.77	1699.34	1547.41	6440749.30
PFCs	18.32	14.39	15.97	19.21	10.21	13.93	11.58	1.06	2.30	5.66	6.66	10.30	6.62	3095.21
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
SF_6	25.57	23.84	22.19	27.56	19.17	26.66	26.71	21.79	23.67	22.16	30.70	34.25	37.55	-28.45
NF_3	NO,NE	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total (without LULUCF)	85171.85	81399.09	69492.92	80666.12	79112.78	71091.99	67372.00	75585.25	67644.52	62330.33	63138.29	59072.44	55507.21	-21.96
Total (with LULUCF)	60660.28	55410.34	42425.22	47266.57	53337.44	46385.00	29373.94	48287.81	38898.46	30057.66	36859.69	30735.96	29516.44	-49.50
Total (without LULUCF, with indirect)	85264.72	81489.73	69577.93	80751.27	79197.45	71167.87	67438.00	75653.91	67706.40	62389.34	63195.34	59125.79	55559.21	-22.07
Total (with LULUCF, with indirect)	60753.15	55500.99	42510.23	47351.72	53422.11	46460.87	29439.94	48356.47	38960.34	30116.67	36916.73	30789.31	29568.44	-49.56

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Change from base to latest reported year
	CO_2 equivalent (kt)													(%)
1. Energy	69374.40	65494.81	53714.93	64817.79	62822.13	54488.14	52563.66	60165.64	52716.99	47484.45	48326.60	44434.03	40816.34	-23.79
2. Industrial processes and product use	6095.00	6406.00	6497.24	6535.87	7105.46	7459.57	5738.31	6260.15	6014.66	6023.52	5995.93	5921.01	6076.18	13.15
3. Agriculture	6476.98	6434.47	6457.30	6414.82	6390.74	6469.37	6487.93	6576.22	6410.69	6373.21	6483.94	6510.80	6480.97	-13.88
4. Land use, land-use change and forestry[5]	-24511.57	-25988.75	-27067.70	-33399.55	-25775.33	-24707.00	-37998.07	-27297.44	-28746.06	-32272.67	-26278.60	-28336.47	-25990.77	105.10
5. Waste	3225.47	3063.80	2823.46	2897.64	2794.45	2674.92	2582.11	2583.25	2502.17	2449.14	2331.82	2206.60	2133.72	-54.33
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0.00
Total (including LULUCF)[5]	60660.28	55410.34	42425.22	47266.57	53337.44	46385.00	29373.94	48287.81	38898.46	30057.66	36859.69	30735.96	29516.44	-49.50

(1) The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the COP. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

(2) Fill in net emissions/removals as reported in table Summary 1.A. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(3) In accordance with the UNFCCC reporting guidelines, for Parties that decide to report indirect CO2 the national totals shall be provided with and without indirect CO_2.

(4) In accordance with the UNFCCC reporting guidelines, HFC and PFC emissions should be reported for each relevant chemical. However, if it is not possible to report values for each chemical (i.e. mixtures, confidential data, lack of disaggregation), this row could be used for reporting aggregate figures for HFCs and PFCs, respectively. Note that the unit used for this row is kt of CO_2 equivalent and that appropriate

(5) Includes net CO_2, CH_4 and N_2O from LULUCF.

ANNEX 2

Summary of reporting of the Supplementary information under Article 7, paragraph 2, of the Kyoto Protocol in the NC7

Information reported under Article 7, paragraph 2	NC7 section
National system in accordance with Article 5, paragraph 1	3.3
National registry	3.4
Supplementarity relating to the mechanisms pursuant to Article 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 – 4.4
Information under Article 10	
Art 10a	3.3, 8.2.4
Art 10b	4.3 to 4.5, 6.3
Art 10c	7.4
Art 10d	4.10, 8.3, 8.4
Art 10e	6.4, 8.3, 8.4 and 9.3
Financial resources	7

ANNEX 3

Recommendations in FCCC/IDR.6/FIN	Finland's response in NC7	Where in NC7
78. During the review week, Finland informed the ERT that the BAU scenario does not fully correspond to the 'without measures' scenario as defined by the reporting guidelines and that values presented in the BAU scenario are outdated. The ERT recommends that Finland improve the transparency of the information on the total effects of PaMs currently presented in Table 5.11 of the NC6, by updatig it in its next submission. As was also stated in the NC6, an alternative to estimating the total effects of PaMs is to use the aggregated estimated effect of individual PaMs per sector as presented in the NC6 in tables 4.4 (energy), 4.5 (transport), 4.7 (industrial processes), 4.8 (agriculture), 4.9 (LULUCF) and 4.10 (waste) while trying to limit the overlapping effects of these PaMs to the greatest extent possible in order to reduce overestimation of the total effect of PaMs.	Finland has improved the description of the estimation of the total effect of PaMs. Also, Finland has used the alternative approach to estimate the total effect of PAMs suggested by the ERT during the review of its 6th NC.	Sections 5.2.1 and 5.4
88. However, the ERT noted that Finland did not clearly distinguish between technology transfer activities undertaken by the public sector and those undertaken by the private sector. During the review, Finland elaborated on the difficulty in distinguishing activities undertaken by the public and private sectors. The ERT recommends that Finland continue to explore ways to improve the transparency of reporting on such information in its NC.	Finland has improved the transparency of reporting on distinguishing between technology transfer activities undertaken by the public sector and those undertaken by the private sector.	Section 7.3.4, as well as other sections in Chapter 7
91. During the review week, Finland provided more information on its support for the development and enhancement of the endogenous capacities and technologies of developing countries. In bilateral cooperation, Finland ensures country ownership through negotiations with partner countries, and thus the priorities of these countries are taken into account. The project documents are agreed upon by the partner countries. The ERT recommends that Finland improve the transparency of reporting by providing more information on the support, development and enhancement of endogenous capacities and technologies of developing countries to improve transparency in the next NC.	Finland has improved the transparency of reporting on the support, development and enhancement of endogenous capacities and technologies of developing countries.	Sections 8.1 and 8.4

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