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Executive Summary

1 Executive Summary

1.1 National circumstances relevant to greenhouse gas emissions and removals

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 km², it is Europe's seventh largest country. As a result of the country's low population density and geographical extent, the average distances travelled for different purposes can be quite long. The population of Finland was 5.5 million at the end of 2020. According to projections, the population will increase to 5.6 million by 2034 due to net migration but will then decline.

Boreal coniferous forest zone covers nearly all of Finland. Seventy-two per cent of the total land area is classified as forest land, while only some eight per cent is cropland. Finland has more than 34,500 km² of inland water systems, which is about 10 per cent of its total area. Peatlands cover almost a third of the total land area of Finland.

The mean temperature in Finland is several degrees higher than in most other areas at these latitudes because of the influence of the Baltic Sea, the inland waters, and the Gulf Stream. There is considerable regional variation in climate: the mean annual temperature is close to 7 °C in the southwestern archipelago and decreases to below –3 °C in the northern parts of the country.

Finland has an open economy with prominent service and manufacturing sectors. The main manufacturing industries include metal and its electrical and electronics subindustry, and the chemical and forest industries. Foreign trade is important, with exports accounting for about 40 per cent of the gross domestic product (GDP). In 2020, Finland's GDP fell by 2.3 per cent as the Covid-19 pandemic prevailed, but the national economy recovered swiftly and reached the pre-pandemic level in 2021.

Total energy consumption was 1,277 PJ (355 TWh) in 2020. Finnish industry used 38 per cent of the country's total primary energy and 45 per cent of its total electricity. Finland's domestic energy sources are wood-based fuels, hydropower, wind power, waste, peat and heat pumps. Black liquor, the by-product of chemical pulp production, is currently the most significant renewable energy source in Finland.

Renewable energy has increasingly replaced fossil fuels during the 2010s, which is the main reason for the decrease in greenhouse gas emissions, even though energy consumption has grown. In 2020, the share of renewable energy was 44.6 per cent of total final energy consumption. Moreover, more than half of Finland's electricity production was produced with renewable energy sources. Other recent trends in Finland's energy production are the ban on the use of hard coal, which will enter into force in 2029 but will have an effect before then, and the steady increase of wind power capacity. The EU Emissions Trading System has become a significant factor in the energy market and in emissions reduction in the EU.

Transport demand and supply are influenced primarily by developments in the economy, demographic factors, employment patterns and infrastructure provision. Domestic passenger transport, measured in terms of passenger-kilometres, has increased by approximately 16 per cent since 1990, with cars accounting for about 86

per cent of total passenger-kilometres in 2020. Road haulage is the most important form of transport for domestic goods traffic, whereas three quarters of Finland's foreign trade goes by sea. Traffic is becoming more electrified as the number of electric, hybrid and gas-powered passenger cars has recently increased.

Indoor heating is the biggest source of carbon dioxide (CO₂) emissions by households and within the public and service sectors, although the demand for heating energy has decreased as winters have become generally milder in recent decades. The use of district heating and electricity for heating indoor spaces has increased, while the use of heavy fuel oil and light fuel oil has decreased.

Finland's industrial structure has changed since the mid-1990s due to the rapid expansion of the metal products industry, especially electronics. Because of their high energy demand, energy-intensive industries have worked hard to improve their energy efficiency and have succeeded in growing the volume of industrial output more than final energy consumption. All pulp mills produce energy in excess of their own requirements.

Climatic conditions, i.e. the short growing season and harsh winters, 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 country, livestock farming is the only profitable form of agricultural production. Nearly 70 per cent of active farms practice crop production, and 25 per cent have livestock as their main line of farming. The number of active farms has decreased considerably during the last thirty years, while the average agricultural area per farm has increased. Agriculture is the most important employer in the countryside, and alongside forests, is the dominant element of the rural landscape.

Within the EU, the significance of forests for the national economy and society at large is greatest in Finland. The forest sector contribution has been two to five per cent of GDP and some 20 per cent of the export of goods. The volume of the growing tree stock has long been increasing, mainly because of the active and sustainable management of forests, in which the growth in volume has exceeded harvesting volumes and natural drain. In 2020, the total use of roundwood in Finland was 78 million m³. The great majority, that is, 86 per cent, was used in the forest industry, and the rest was used for energy production. Forests absorb a significant proportion of Finland's carbon dioxide emissions. Fluctuating trends in demand for forest industry products and thus in demand for harvested wood have caused considerable variation in net removals from forest land.

The amount of waste deposited in landfill sites has been significantly reduced by effective waste regulation. Biodegradable municipal waste has no longer been deposited in landfills since the prohibition of organic waste in landfill came into force in 2016. In 2020, 41 per cent of municipal waste was recovered as material, and 58 per cent as energy. Solid municipal waste is responsible for most of the greenhouse gas emissions from the waste sector.

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

In 2020, Finland's greenhouse gas emissions totalled 47.8 million tonnes of carbon dioxide equivalent (million tonnes CO₂ eq.). Total emissions in 2020 were

approximately 33 per cent (23.4 million tonnes) below the 1990 emissions level (Table 1.1). Compared to 2019, emissions were approximately nine per cent, i.e. 5.0 million tonnes, lower. Finland's annual greenhouse gas emissions varied considerably from 1990 to 2020 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.

The energy sector is the most significant source of greenhouse gas emissions in Finland and is therefore the key driver behind the trend in emissions. The energy sector includes emissions from fuels used to generate energy, including fuel used in transport and the fugitive emissions related to the production, distribution and consumption of fuels. In 2020, the energy sector accounted for 72 per cent of Finland's total greenhouse gas emissions. The share of transport in energy-related emissions was more than 30 per cent in 2020.

The second largest source of emissions after the energy sector was the agricultural sector, with a share of approximately 14 per cent of the total emissions. Emissions from industrial processes and product use amounted to approximately 11 per cent. Emissions from industrial processes refer to 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 CO₂ emissions from the atmospheric oxidation of CH₄ and NMVOCs to the greenhouse gas emissions is small – about 0.1 per cent of total greenhouse gas emissions in Finland. The land use, land-use change, and forestry (LULUCF) sector in Finland was a net sink throughout the 1990 to 2020 reporting period. The net sink has varied from approximately 13 to 49 per cent of the annual sum of emissions from other sectors, i.e. the total emissions without LULUCF between 1990 and 2020.

Greenhouse gas inventory system

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 by the Climate Change Act. Statistics Finland has overall responsibility for compiling and finalising inventory reports and submitting them to the Secretariat of the UNFCCC and the European Commission. It bears the responsibility for the general administration and quality management of the inventory and communicating with the UNFCCC, coordinating participation in the reviews, and publishing and archiving the inventory results.

In Finland, the national system is established on a permanent footing, and it guides the development of emissions calculation in the manner required by the Kyoto Protocol. The national system is based on laws and regulations concerning Statistics Finland, agreements between the inventory unit and expert organisations on the production of emissions and removal estimates, and related documentation¹. 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

1 In addition to Statistics Finland, Finland's inventory system includes the Finnish Environment Institute (SYKE) and Natural Resources Institute Finland (Luke) expert organisations as well as purchased services from VTT (VTT Technical Research Centre of Finland Ltd).

Table 1.1Greenhouse gas emissions (+) and removals (–) by sector, 1990, 1995, 2000, 2005 and 2010 to 2020 (million tonnes CO₂ eq.)

Sector	Base year	1990	1995	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	Mt CO ₂ eq.															
Energy	53.4	53.4	55.3	53.7	53.7	60.2	52.8	47.5	48.1	44.3	40.6	43.3	40.9	42.1	38.9	34.3
Industrial processes and product use ¹	5.3	5.3	4.9	5.2	5.6	4.8	4.7	4.6	4.4	4.2	4.4	4.7	4.6	4.6	4.4	4.1
F gases	0.1	0.1	0.2	0.7	1.2	1.4	1.4	1.4	1.4	1.3	1.3	1.2	1.1	1.1	1.0	1.0
Agriculture	7.5	7.5	6.7	6.6	6.5	6.7	6.5	6.4	6.5	6.6	6.6	6.7	6.6	6.5	6.6	6.6
Waste	4.7	4.7	4.6	3.8	2.8	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.8	1.7
Indirect CO ₂ -emissions ²	0.2	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	0.1
TOTAL (exl. LULUCF ³)	71.2	71.2	71.8	70.2	69.9	75.7	67.9	62.4	62.8	58.6	55.0	57.9	55.1	56.2	52.8	47.8
TOTAL (exl. LULUCF and indirect CO ₂ emissions)	71.0	71.0	71.6	70.1	69.8	75.6	67.8	62.3	62.7	58.5	55.0	57.9	55.1	56.1	52.7	47.7
LULUCF ³	-13.4	-13.4	-13.2	-15.0	-20.5	-21.7	-22.0	-24.6	-18.3	-20.9	-18.8	-17.7	-16.3	-7.4	-13.6	-17.3

1 excluding F gases

2 indirect CO₂ emissions from NMVOC and CH₄ from fugitive emissions, industrial processes and product use

3 Land use, land-use change and forestry

(Note: Due to rounding, the sum of subtotals does not necessarily equal to total figures.)

submitting the final inventory to the UNFCCC on 15 April, the national inventory report is sent to the inter-ministerial network on climate policy issues for comment.

National registry

The EU Emissions Trading Scheme (EU ETS) began in January 2005 and is mandatory for specific industries in the EU. The EU ETS and wider international emissions trading under the Kyoto Protocol have operated parallel to one another since 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) has been in operation since 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 Climate and Energy Packages for 2020 and 2030, play a key role in the implementation of the above international agreements. At national level, Finland's climate policy is defined in government policies and programmes, and since 2003, ministerial working groups have steered strategic work. In addition, national energy and climate strategies have been prepared since 2001 to implement international and EU commitments, as well as national targets, and to define sectoral policies and measures.

The Climate Change Act lays down provisions on climate change policy planning and the related monitoring and sets the national climate objectives. The Act was reformed in 2022 and now includes new emissions reduction targets: 60 per cent by 2030 and 80 per cent by 2040 compared to the 1990 levels. At the same time, the 2050 target was tightened from 80 per cent to at least 90 per cent, aiming for 95 per cent, by 2050. The reformed Act also includes, the 2035 carbon neutrality target, which was set in the Programme of Prime Minister Sanna Marin's Government in 2019.

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 Economic Affairs and Employment 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 policymaking. Other stakeholders, including industrial and environmental non-governmental organisations (NGOs), research institutes and labour unions, can present their views on climate policy at the Climate Policy Roundtable and the Ministry of the Environment's Climate Arena. A new type of cooperation was initiated in 2019-2021 when 13 sectors and industrial branch organisations produced their own sector-specific roadmaps to low-carbon operation with the support of the Ministry of Economic Affairs and Employment.

Under the UNFCCC, the EU and its Member States committed to achieving a joint quantified economy-wide greenhouse gas emissions reduction target of 20 per cent below the 1990 level by 2020 ("the Cancun pledge"). The commitment was implemented internally in the EU through EU legislation in the 2020 EU Climate and Energy Package and by individual binding annual limitation targets for the Member States for emissions not covered by the EU Emission Trading System (EU ETS). The EU overachieved its reduction target under the Convention, which means that its Member States also fulfilled their emissions reduction obligations.

Finland's emissions reduction target for the second commitment period of the Kyoto Protocol was defined based on its emissions reduction obligation under the EU's Effort Sharing Decision concerning emissions not covered by the EU ETS. In addition, Finland was responsible for the emissions and removals from the LULUCF activities. According to greenhouse gas inventory data, Finland is meeting its emissions reduction commitments for 2013 to 2020. The fulfilment of commitments is ensured after international reviews and the so-called true-up period during 2022 to 2024.

The EU's current emissions reduction target in its joint nationally determined contribution under the Paris Agreement has been raised to of at least 55 per cent by 2030 from the 1990 level. The previous target of 40 per cent was considered insufficient for achieving the EU's carbon neutrality target for 2050. The details of the effort sharing between the Member States, including Finland, are currently being negotiated.

Finland regularly prepares strategies on energy and climate policy. In 2022, three Government Reports were submitted to Parliament, namely the National Climate and Energy Strategy, the Medium-Term Climate Change Policy Plan and the Climate Plan for the Land-Use Sector. The National Climate and Energy Strategy outlines the policy measures by which Finland will meet the EU's climate and energy commitments for 2030 and achieve the targets set in the Climate Change Act for 2030 and 2035. The Medium-Term Climate Change Policy Plan specifies the key measures for achieving the binding emissions reduction targets in the effort sharing sector by 2030. The purpose of the Climate Plan for the Land-Use Sector is to promote the reduction of emissions from land use, forestry, and agriculture, the strengthening of carbon sequestration and carbon storage, and adaptation to climate change in accordance with the Sustainable Development Goals. Most new policies and measures reported in this National Communication are outlined in the above-mentioned Government Reports.

Sectoral policies and measures

A vast majority of the policies and measures reported in the Eight National Communication are already adopted or implemented; they are in other words existing measures. Planned or additional measures are mainly reported for the transport sector, international bunkers, agriculture and F-gases (see Chapter 4).

The main policies and measures in the energy sector include the EU Emissions Trading System (EU ETS), promoting renewable energy sources and energy conservation measures. The EU ETS is an EU-wide domestic measure, while renewable energy and energy efficiency are promoted by various national measures such as investment subsidies, taxation, regulation, energy efficiency audits and agreements and information measures. Finland is phasing out coal in the energy sector by prohibiting its use from May 2029. To accelerate the coal phase-out, a special incentive package to support replacement investments was introduced for energy utilities that undertook to give up the use of coal already by 2025. To reduce greenhouse gas emissions from light fuel oil, an obligation to blend bioliquids with light fuel oil used for heating buildings and for machinery was approved in 2019 and tightened in 2022. The share of biofuel oil increases annually until 2030, from which the share should be 30 per cent. The measures that are estimated to have the largest climate change mitigation impact are promotion of wind power (11.1 million tonnes CO₂ eq. mitigation impact in 2030), Energy Efficiency Agreements (9.5 million tonnes CO₂ eq. in 2030), promotion of wood chips (8.1 million tonnes CO₂ eq. in 2030) and the building regulations for new buildings (6.2 million tonnes CO₂ eq. in 2030).

In the transport sector, a Government Resolution on the Roadmap for Fossil-Free Transport was adopted in 2021. The policy measures can be grouped into following themes: 1) Replacing fossil fuels with alternative transport fuels; 2) improving the energy efficiency of vehicles; and 3) improving the energy efficiency of the transport system. The share of biofuels in road transport will be increased to 34 per cent in 2030. Finland also continues to subsidise electric and gas vehicles and related infrastructure and to promote the use of biogas in transport. For the following measures of the Roadmap for Fossil-Free Transport (2021), the additional emission reduction effect, i.e. in relation to the previous projection, will be around 0.3 million tonnes CO₂ eq. in 2030 for replacing fossil fuels with alternative transport fuels, 0.4 million tonnes CO₂ eq. for improving the energy efficiency of vehicles and 0.1 million tonnes CO₂ eq. for improving the transport system's energy efficiency.

As a member of the European Union, Finland is implementing the EU Emissions Trading System for aviation. Aviation has been included in the EU ETS since 2012 and covers today all intra-European Economic Area flights. Other policies and measures to mitigate emissions from international bunkers include implementing the measures of the International Maritime Organization (IMO) and the International Civil Aviation Organisation (ICAO). Furthermore, in 2021, the Government made Resolutions on reducing greenhouse gas emissions from aviation, as well as maritime and inland waterway transport. The Government Resolutions include measures to reduce greenhouse gas emissions through alternative fuels, energy efficiency, and pricing.

Measures for reducing CO₂ emissions from industrial processes are the EU ETS, investment grants for low-carbon technology and lowering of electricity tax in order to promote electrification. For F-gases, EU regulations constitute the most significant emission reduction measure. In total, the existing measures are estimated to cut F-gas emissions with 3.2 million tonnes CO₂ eq. in 2030.

Within the agricultural sector, the agri-environment-climate measures are part of the Rural Development Programme for Mainland Finland and the EU's Common Agricultural Policy. Agri-environment payments are essential tools for promoting sustainable development in agriculture, and in previous years, some 85 per cent of Finnish farmers have committed themselves to the agri-environment scheme.

The Climate Plan for the Land Use Sector specifies how climate emissions from the land use, land-use change and forestry sector can be reduced, and carbon sinks and reservoirs strengthened. 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. The targeted annual net impact for the new climate measures in the land-use sector is at least three million tonnes CO₂ eq. by 2035.

The general reform of waste legislation that was conducted in 2021 provides the basis for more effective waste management with respect to recycling and reuse, enhanced separate collection of waste, reduction of waste generation, and further reduced landfilling of organic waste, all contributing to reduced greenhouse gas emissions. The National Waste Plan for 2027 that was approved in 2022 includes both a plan to reduce the volume and harmfulness of waste and a waste management plan. The estimated total mitigation impact of waste management measures is 4.1 million tonnes of CO₂ eq. in 2030.

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 Eight National Communication provides updated information on how to minimise adverse impacts.

1.4 Projections and total effect of policies and measures

With measures and with additional measures projections

The “with measures” (WM) and “with additional measures” (WAM) projections are based on data produced for Finland’s latest National Energy and Climate Strategy, the Medium-term Climate Change Policy Plan and the Climate Plan for the Land Use Sector. These reports were prepared in 2022 and policies and measures that have been implemented by July 2022 are included in the WM projection. The WAM projection considers policies and measures that are planned but not implemented before 1 August 2022 in addition to the WM projection.

Contrary to the population forecast used in the projections for the Seventh National Communication, the forecast, used in the projections, estimated that the population will increase only slightly from the current 5.53 million (2020) to 5.57 million in 2030 and will start slowly decreasing in 2031. The average size of households will also decrease slightly, while the number of households is expected to grow from 2.7 million to almost 2.9 million.

The projections consider the Covid-19 pandemic and its assumed effects on the economy. However, the energy crisis following Russia’s unprovoked and unjustified invasion of Ukraine has not been included in the projections, as most of the modelling work was conducted before February 2022. For the LULUCF sector, the most recent results from the national forest inventory on a decline in tree growth were not yet available when the latest annual greenhouse gas inventory submission and the WM projection for the LULUCF sector were prepared. Thus, the estimates of carbon removals in the LULUCF sector will be re-evaluated in future.

Economic growth is expected to recover during 2021, but remains modest at first before picking up later in the 2020s. As the shrinking working-age population cannot generate new growth through labour input, economic growth mainly depends

on technological development and investment. By 2030, the projections expect technological development to generate growth of about 10 per cent compared to 2019 and about 20 per cent by 2040. Growth through capital is about half this. The average GDP growth rate is about 1.5 per cent.

Most of the measures included in the WAM projection of the Seventh National Communication have been implemented and are now part of the WM projection. The most significant of these are the group of measures promoting emissions-free and energy-efficient road transport, ban on the energy use of hard coal, measures phasing out oil heating, and several new measures in agriculture, LULUCF and machinery. The WAM projection includes only a few measures additional to the WM projection such as the estimated impact of planned future measures regarding F-gases and in the agricultural and transport sectors.

The WM projection estimates that the total greenhouse gas emissions (without LULUCF) will be 30 and 25 million tonnes CO₂ eq. in 2030 and 2035, respectively, which equal to reductions of 58 and 65 per cent compared to the 1990 base year. In the WAM projection, the estimated total emissions are 29 and 24 million tonnes for the same years. According to the projections, Finland is on track to achieve the current EU 2030 target for the emissions not included in the EU Emission Trading System.

Total effect of policies and measures

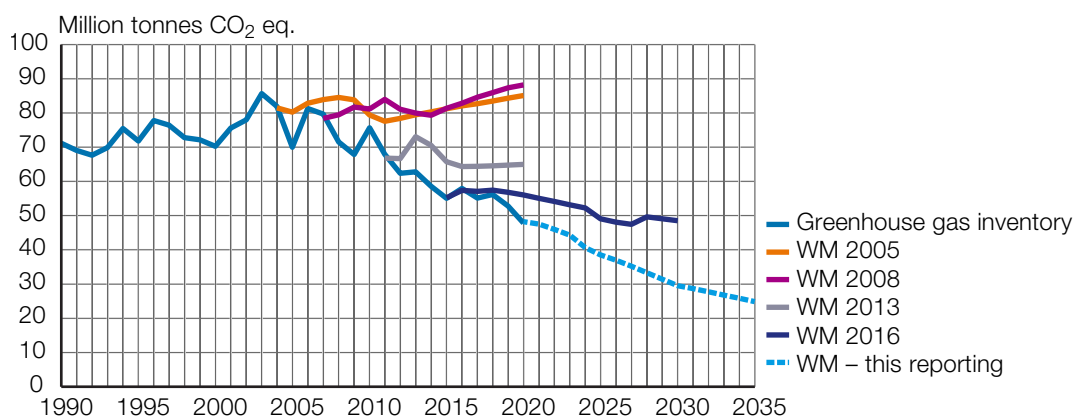
The aggregated estimates for the greenhouse gas reduction impacts on individual WM policies and measures are 25 and 50 million tonnes CO₂ eq. for 2020 and 2030 (without LULUCF) respectively. The WAM measures will increasingly reduce greenhouse gas emissions in the 2020s, reaching an additional annual reduction of approximately 0.8 million tonnes CO₂ eq. in 2030. The small addition of the planned measures results from the fact that most of the previously planned measures (WAM measures) are now labelled as implemented or adopted measures (WM measures). New planned measures are currently in the development stage, and decisions on their implementation will be taken in the coming years.

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 2005, 2008, 2013, and 2016, as well as in this reporting. The WM projections in the national climate and energy strategies projected significantly higher emissions for 2020 than those reported in the latest greenhouse gas inventory and in the projections of this reporting. This suggests that the additional measures implemented in the 2010s have had a substantial impact on total emissions.

The total effect of implementing additional measures can be seen in the emission development trend after 2015, which levelled off in the 2013 and 2016 projections, whereas it continued to increase in the projections from 2005 and 2008. In turn, the WM projection of this reporting points clearly downwards.

Figure 1.1

Greenhouse gas emissions according to the most recent inventory for 1990 to 2020 and in the WM projections of the climate and energy strategies published in 2005, 2008, 2013, and 2016 until 2020 and 2030 respectively, and the WM projection from this reporting.



For comparison purposes, the WM projections from 2005 and 2008 can be considered reasonable WOM (Without Measures) projection substitutes, even though they already include some mitigation measures. The gap between the projections for 2005 to 2008 and the projection of this reporting is up to 40 million tonnes CO₂ eq. in 2020. By 2030, the gap would presumably increase to at least 60 million tonnes CO₂ eq. if the old projections had extended that far into the future. This is well in line with the bottom-up estimation of the total effect of policies and measures considering that not every single measure has been assessed and included in the estimation. The bottom-up approach gives 50 million tonnes CO₂ eq. emissions reduction in 2030, which, when added to the emissions of the WAM projection, would result in an emission level of at least 79 million tonnes CO₂ eq. in 2030 for a WOM projection.

1.5 Vulnerability assessment, climate change impacts and adaptation measures

Climate modelling, projections and scenarios for Finland

The average temperature change in Finland is expected to be 2.7 °C by mid-century and 3.7 °C by the end of the twenty-first century under the SSP2-RCP4.5 scenario representing moderate emissions. This is about 1.6 to 1.8 times higher than global mean warming. The projected increase in annual precipitation is about 11 per cent under SSP2-4.5.

Climate change is expected to result in longer and more frequent heatwaves and diminishing severe cold spells; intensifying heavy rain events in summer; an increasing number of days with precipitation in winter; a shortening snow season and decreasing duration and depth of soil frost, particularly in snow-free areas like roads and airports. Compared with the projections prepared with a model ensemble used in NC7, the summer temperature projections are about 0.7 °C higher at the end of the century.

Vulnerability, risks and climate change impacts

Finland has a long history of climate change impact and risk research, especially in natural resource sectors. The risk of pests and diseases and resulting losses are increasing in forestry, agriculture, and fisheries.

In recent years, there has been an increasing focus on human health research. The most notable health risk is related to the increasing frequency and duration of heatwaves, which threaten to increase future heat-related mortality and morbidity in Finland. The ageing population, increasing number of people living alone, low prevalence of air conditioning, and urbanisation further amplify the effect of heat. However, in global comparison, the health risk in Finland is low.

A recent study concluded that climate change could be expected to have slightly negative effects on the Finnish economy as a whole, expressed as a percentage change in gross domestic product (GDP) over the period between 2020 and 2070. Higher greenhouse gas emissions led to a larger percentage change in GDP.

The preparation of the second national adaptation plan in 2021 to 2022 included an up-to-date assessment of risks and vulnerabilities from three different perspectives: 1) a national risk and vulnerability assessment focusing on sectorial and cross-sectorial risks and vulnerabilities; 2) regional vulnerabilities; and 3) national and local institutional vulnerabilities.

Domestic adaptation policies and strategies

In 2014, Finland adopted the National Climate Change Adaptation Plan 2022, which describes the current national adaptation policy framework. A revised adaptation plan was prepared in 2022 and will steer adaptation work until 2030.

Since 2015, national adaptation planning has been stipulated as part of Finland's Climate Act. The act, revised in 2022, requires that the National Adaptation Plan will be adopted every other electoral period (essentially every eight years), and that it will be evaluated mid-term. The Ministry of Agriculture and Forestry is responsible for coordinating national adaptation overall policy, and each ministry has the responsibility to ensure and follow up its implementation within their own areas of responsibility.

Several administrative branches have developed adaptation action plans. The Ministry of Social Affairs and Health adopted a plan in 2021, the Ministry of Agriculture and Forestry and the Ministry of Defence are updating or developing their plans, and the Ministry of the Environment has already had several rounds of adaptation planning. Furthermore, adaptation has been integrated into broader climate and environmental policy programmes in certain sectors, including transport and communication. The Ministry of Agriculture and Forestry coordinates the development of national guidelines for drought risk management. In the built environment sector, the Land Use and Building Act state that the national land-use guidelines must be considered in regional planning, municipal land use planning, and the operations of authorities. A reform of the Land Use and Planning Act is currently ongoing, and adaptation is one of its main aims. The Finnish Nature Conservation Act, revised in 2022, strengthens the link between climate change adaptation and biodiversity measures.

The financial industry considers climate change in its operations and as part of its risk management activities. The government does not provide any permanent compensation damage schemes in relation to hydro-meteorological events.

Climate resilience is one of the cross-cutting objectives of Finland's international development policy and development cooperation. The integration of the cross-cutting objectives in all development cooperation activities is a binding obligation, either through mainstreaming or targeted action.

Monitoring and evaluation framework

Since 2015, the implementation of the National Adaptation Plan (NAP) 2022 has been supported and monitored by a Monitoring Group for Climate Change Adaptation. The group has representatives from relevant ministries and other authorities, regional and local actors, research institutes, expert organisations in the fire and rescue services, and financial services. Annual monitoring of the NAP has focused on tracking the progress of the actions included in the plan. Between 2018 and 2019, a mid-term evaluation was carried out to assess progress in the implementation of the National Adaptation Plan. In the lead up to updating the plan, a final evaluation was carried out between 2021 and 2022.

Progress and outcomes of adaptation actions

Climate change impacts and risks are receiving increasing attention in all administrative sectors. This is evident in references to climate change in the development of regulation and other policies. The National Adaptation Plan 2022 has positively contributed to goal setting and increasing general awareness of the need for adaptation. However, the sectors have progressed at a different pace in terms of actions and guidelines that will tangibly strengthen the adaptive capacity. Advances have been made in sectors in which weather and climate fluctuations have long been relevant for normal operations such as construction, infrastructure maintenance, and water management. In other fields such as game management, fisheries and healthcare, climate change has only recently gained attention as a phenomenon that requires tangible action.

1.6 Financial, technological and capacity-building support

Finland's international cooperation and actions are grounded in the Paris Agreement on Climate Change and the goals of the 2030 Agenda for Sustainable Development. It is based on the development needs defined by the partner countries and their own development plans. Finland's contribution to international climate finance is channelled as part of financing allocated for development cooperation. The integration of climate change has been one of the cross-cutting objectives of Finland's development policy and development cooperation since 2012. Finland aims to provide long-term support for climate change mitigation and adaptation, development that is low in emissions and climate-resilient, and biodiversity protection.

The total international climate finance allocations were EUR 147 million in 2019 and EUR 131 million in 2020 (Annex 2, Tables 7). Total climate finance allocations are increasing, although there was a slight decrease in 2020 compared to the record figure in 2019. The division between mitigation and adaptation support varies according to year, but Finland aims for balance. In 2019, the division was 64 per cent for mitigation and 36 per cent for adaptation, and in 2020, 59 per cent for mitigation and 41 per cent for adaptation. There has been a significant increase since the baseline figure for overall Finnish climate funding (as grants) in 2009, which was EUR 26.8 million.

Besides providing funds to the operating entities of the financial mechanism of the UNFCCC, Finland provides support through bilateral, regional and other multilateral channels. Funding is directed at both climate change mitigation and adaptation. In addition to grant funding, Finland uses investment-based and loan-based funding to effectively accelerate private-sector investment in climate solutions. Research,

cooperation with universities, and inter-institutional cooperation are also supported. Most Finnish climate finance is provided through multilateral channels.

Finland's development cooperation especially supports the least developed, fragile or conflict-prone countries, taking into account situations where climate change and other serious development challenges slow the achievement of sustainable development goals. The priority for Finland's climate finance is to support the least developed countries (LDC) and small island developing states (SIDS), as they are particularly vulnerable to the impacts of climate change. In 2020, contributions were made e.g. to the Least Developed Countries Fund and to the Climate Risks and Early Warning Systems Initiative, supporting primarily LDCs and SIDS.

The private sector plays a significant role in promoting climate action in developing countries as a developer of new technologies, developer and implementer of projects, and financier. The role of the private sector is particularly important in climate mitigation, which requires more innovative, scalable and commercially viable renewable energy and energy efficiency solutions, as well as other ways to avoid and mitigate GHG emissions. Finland therefore offers different types of funding and services for the private sector on climate, ranging from large-scale climate investments to small grants that help develop climate projects and get them started. Private sector projects in developing countries are being supported by the Finnish Fund for Industrial Cooperation Ltd (Finnfund), for example.

Finland has specific programmes and financial arrangements for transferring environmentally sound technology to developing countries (examples in Annex 2, Tables 8 and 9). 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.

Meteorological cooperation is one of the priority areas of Finland's development cooperation and an important part of Finland's adaptation finance. This cooperation includes weather observation infrastructure and equipment, weather forecasting and warning systems and software, technical assistance and capacity building, delivered by private- and public-sector actors and civil society organisations to develop weather, climate, and early warning services. Finland is a global leader in weather observation technology and systems. Over the years, Finland has transferred technology related to weather observation and climate services through bilateral and regional cooperation and concessional credit arrangements. In addition, Finland is one of the world leaders as a donor in supporting the capacity building of non-Annex I partner countries' national meteorological and hydrological services (NMHS), an example of the capacity-building support Finland offers.

1.7 Research and systematic observation

The state of climate-related research, its funding and its relationship with international cooperation is well established in Finland. The funding for climate-related research has been growing through several public policy instruments and private institutions. The Academy of Finland's and Strategic Research Council's (SRC) funding for climate-change-related research totalled EUR 175 million in the most recent five year period from 2017 to 2021, which indicated a significant increase compared to the EUR 95 million of the previous four-year period from 2013 to 2016.

The Academy of Finland has three ongoing research programmes (Climate Change and Health 2020 to 2023, Value Academy Programme on industrial green chemistry 2020 to 2023, and BioFuture 2017 to 2025) related to climate and energy and special funding for system-level research into climate change and adaptation (2021 to 2024). In addition, the Strategic Research Council has several climate-related programmes that have funded many large consortia, in which research institutes, universities and other actors, including the private sector, join forces in dealing with mitigation and adaptation. In addition, the recovery and resilience plan boosted additional funding for research and development related to the green transition.

Finland has a strong standing in research on climate process and climate system studies, climate modelling and prediction, and paleoclimatology, as well as systematic observations, including atmospheric, ocean, cryosphere, and terrestrial observation systems. Recently, an increasing number of studies has assessed climate change problems from a transdisciplinary perspective and integrated socioeconomic aspects. The arising themes have included energy transitions, the just transition, financial themes, the circular economy and the interrelation between biodiversity and climate change. The interactions between mitigation and adaptation actions are also increasingly recognised.

The Active Open science policy is a tool to overcome barriers to the free and open international exchange of data and information. Universities, state research institutes and other important higher education institutions and organisations have taken several initiatives to improve the openness of science and research. For example, missions of the “Declaration for Open Science and Research 2020 to 2025” seek to promote openness as a fundamental value throughout the research community, strengthen the societal knowledge base and innovation, and improve the quality of scientific research outputs and the educational resources based on them, and the impact of research outputs throughout society. In addition, Open Access (OA) has steadily gained ground in Finland. In 2020, more than 70 per cent of peer-reviewed scientific articles written in Finland were OA publications. Several other initiatives such as “The Year of Research-Based Knowledge” launched by the Ministry of Education and Culture, the Academy of Finland, and the Federation of Finnish Learned Societies in 2021 and “Sofi – Science Advice Initiative of Finland” (2019 to 2021) have promoted and advanced science policy dialogues on climate mitigation and adaptation.

Finland has also been active at the international level in relation to climate-related research as a co-founder or contributor. In the Finnish context, Nordic and Arctic cooperation has had long traditions and retains its important role. In addition, Finland has continued to finance and operate capacity-building programmes around the world in climate observations and research and higher education relevant to climate change mitigation and adaptation, meteorology, and the sustainable management of forests, water and other natural resources. The programmes have increased the endogenous capacities and capabilities of developing countries to tackle these issues through improved technological means and human resources. More than 70 organisations in 25 developing countries have benefitted from capacity building provided by their Finnish counterparts.

1.8 Education, training and public awareness

Climate change is incorporated into the Government’s education and public awareness policies and practices. These policies and practices are under continuous development. Education policies are 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 basic education and upper secondary level education as overarching values and as part of sustainable development education. The present National Core Curriculum for Basic Education was given by the Finnish National Agency for Education in 2014. With this curriculum, sustainability is the overarching task of basic education and is strongly embedded in all elements of the core curriculum. The new National Core Curriculum for Upper Secondary Schools (2019) also highlights several sustainability and climate 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.

Universities provide climate change education as part of various 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 research in this field. Universities, universities of applied sciences 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.

Many higher education and research institutions in Finland provide international training and cooperate with similar and government institutions in developing countries to support institutional development. 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 the sustainable use of natural resources and climate change mitigation. During the last decade, these programmes, which partner programmes in other countries' universities, have trained more than 100 experts, representing more than 50 nationalities.

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 had the official responsibility for coordinating the cooperation on climate change communications. The steering group for climate change communications was appointed for its fourth term in 2022.

Several climate change information best practices are provided as free web-based material. As an example, [Climateguide.fi](https://climateguide.fi) is a national web portal which aims to increase awareness of climate change by providing scientific background information on various aspects of climate change and to support society and citizens in mitigating climate change and adapting to it by presenting tangible means for mitigation and adaptation.

The municipalities play a decisive role as intermediators of information regarding attitudes towards climate issues and enabling changes in people's lifestyles. Many municipalities are committed to reducing their greenhouse gas emissions and encouraging citizens to contribute to combating climate change. A growing number of NGOs also have climate-related activities. NGOs and movements have also combined to conduct climate-change- or energy-related campaigns, some of which have received broad publicity.