Statistics Finland

Ympäristöministeriö
Miljöministeriet
Ministry of the Environment

Finland's Fifth Biennial Report
under the UNFCCC

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Contents

1 Introduction

Finland's fifth biennial report (BR5) under the UNFCCC has been elaborated in accordance with the UNFCCC biennial reporting guidelines for developed country Parties contained in Decision 2/CP.17 (Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention, Document: FCCC/CP/2011/9/Add.1) as adopted by the Conference of the Parties at its seventeenth session. The additional requirements for reporting of financial information in biennial reports in Decision 9/CP.21 have also been taken into account.

Information provided on greenhouse gas emissions and trends is consistent with the information in Finland's greenhouse gas inventory submission in 2022[1].

The EU and its Member States are committed to a joint quantified economy-wide emission reduction target of 20 per cent by 2020, compared to 1990 levels. Therefore, Finland and other Member States of the EU, have not submitted individual economy-wide emission reduction targets to the UNFCCC secretariat. The details of the EU joint target under the UNFCCC are clarified in the document *Additional information relating to the quantified economy-wide emission reduction targets contained in document FCCC/SB/2011/INF.1/Rev.1* (FCCC/AWGLCA/2012/MISC.1) and in the EU's fifth biennial report under the UNFCCC.

This biennial report provides information on EU's and its Member States' achievement of their joint and quantified economy-wide emission reduction target of 20 per cent by 2020, Finland's contribution to the joint EU emission reduction target, including information on the target, Finland's historical emissions and projected emissions.

Furthermore, the report includes information on Finland's provision of financial, technological and capacity-building support to Parties not included in Annex I to the Convention.

The information to be reported electronically in the Common Tabular Format (CTF) in accordance with Decision 19/CP.18 adopted by the Conference of the Parties on its eighteenth session and contained in the document FCCC/CP/2012/8/Add.3, and Decision 9/CP.21, has been submitted to the UNFCCC.

Custom footnotes of the CTF tables are also included in Annex 2 of this textual part of the fifth biennial report as auxiliary information because due to technical difficulties some of custom footnotes are difficult to read in the CTF tables.

[1] Finland's 2022 greenhouse gas inventory submission under the UNFCCC, https://unfccc.int/ghg-inventories-annex-i-parties/2022

2 Information on greenhouse gas emissions and trends

This section of Finland's biennial report under the UNFCCC contains summary information on the national greenhouse gas emissions and emission trends in accordance with the UNFCCC Annex I reporting guidelines[2]. The information is consistent with Finland's most recent annual inventory submission to the UNFCCC where more detailed information on the greenhouse gas emissions and their estimation can be found. Information on the greenhouse gas emissions and removals in the land use, land-use change and forestry (LULUCF) sector is also provided, even if this sector is not included in the EU joint target under the Convention.

Also, summary information on the national inventory arrangements in accordance with the UNFCCC Annex I inventory reporting guidelines is included, as well as changes to these arrangements since Finland's Fourth Biennial Report (BR4) under the UNFCCC.

2.1 Total greenhouse gas emissions and trends

In 2020, Finland's greenhouse gas emissions totalled 47.8 million tonnes of carbon dioxide equivalent (million tonnes CO_2 eq.). The total emissions in 2020 were approximately 33 per cent (23.4 million tonnes) below the 1990 emissions level. Compared to 2019, the emissions were approximately 9 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 emission trends by sector are presented in Figure 2.1, described in detail in Section 2.2 and included in CTF Table 1. Please see Annex 1 of Finland's Eight National communication and Finland's latest National Inventory Report (2022) for more information.

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 (Figure 2.2). The second largest source of emissions was agriculture sector, with a share of approximately 14 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 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, because greenhouse gas removals in the sector exceeded emissions. 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. The most important components of the forest sink are the tree biomass growth and biomass removed from forests due to felling. Based on the National Forest Inventory (NFI), the increment of growing stock has increased since 1990 from 78 million m^3 to 103 million m^3. There is less fluctuation between years in the estimated tree biomass growth, contrary to the harvest rates. In 2020, the total drain was 83 million m^3.

For the LULUCF sector, the most recent results 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. Results from the first three years (2019–2021) of the current, ongoing 13th national forest inventory showed that the annual increment of the growing stock, i.e. tree growth, has declined compared to the

[2] Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories'. Decision 24/CP.19. (FCCC/CP/2013/10/Add.3).

previous, 12th national forest inventory (2014–2018). A lower tree growth indicates lower removals in the forest land and may also mean a smaller carbon sink in the LULUCF sector. Estimates of carbon removals in the LULUCF sector will be re-evaluated in future.

Figure 2.1 Greenhouse gas emissions and removals in Finland by reporting sector (million tonnes CO2 eq.) and total net CO2 equivalent emissions (emissions plus removals). Emissions are positive and removals negative quantities.

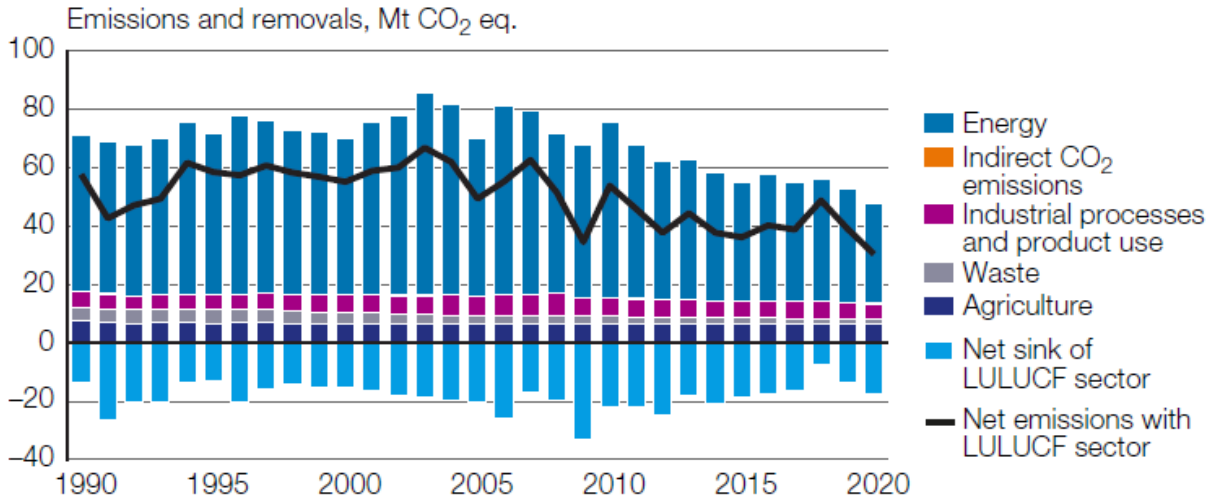
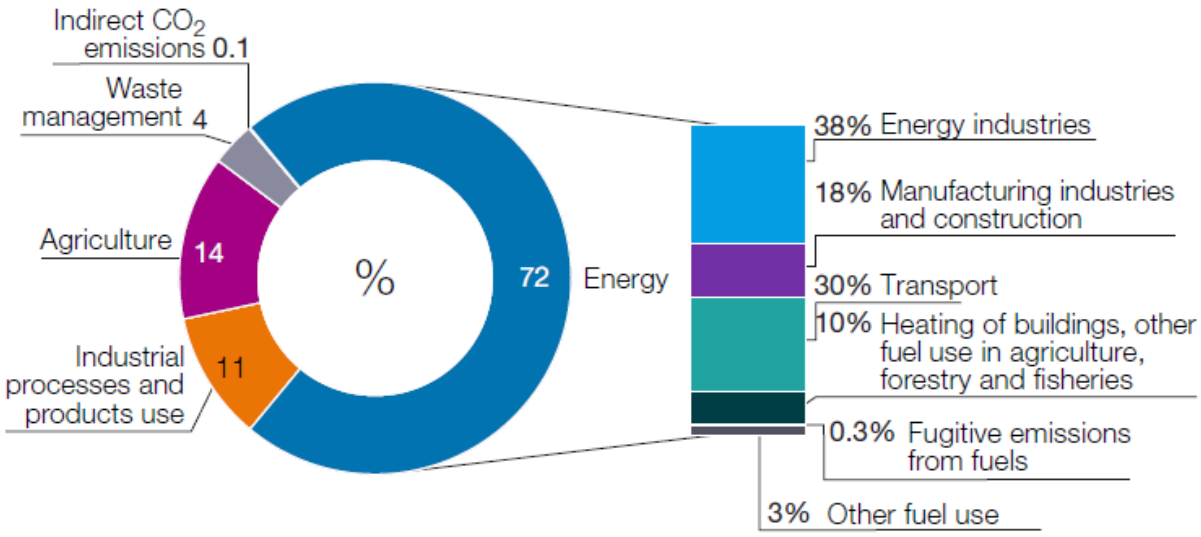


Figure 2.2 The composition of Finnish greenhouse gas emissions in 2020 (LULUCF sector excluded).*



* The sums do not add up because of independent rounding.

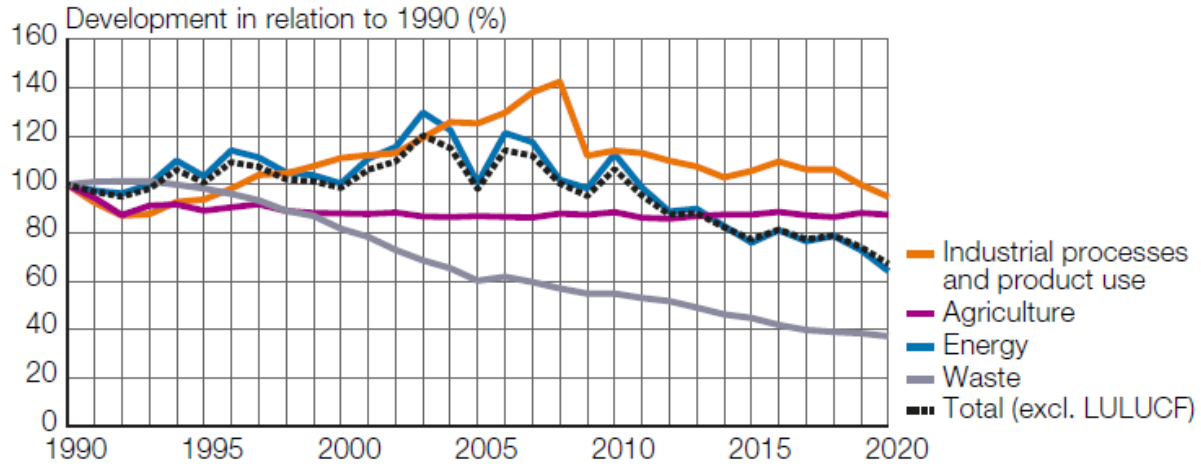
The most important greenhouse gas in Finland is carbon dioxide. The share of CO_2 emissions in total greenhouse gas emissions has varied from 79 per cent to 85 per cent. In absolute terms, CO_2 emissions are 19.4 million tonnes (i.e. 34 per cent) smaller than in 1990. The majority (89 per cent) of the CO_2 emissions originates from energy production based on the combustion of fossil fuels and peat. The CO_2 emissions from wood combustion are reported as a memo item in the CTF tables but are not included in the total national emissions, because they are reported as a loss from woody biomass stock in the LULUCF sector. The amount of energy-related CO_2 emissions has fluctuated greatly according to the economic trend, the energy supply structure (including electricity imports and exports) and climate conditions (Figure 2.3).

Methane emissions (CH_4) have decreased by 43 per cent from the 1990 level. This is mainly due to the improvements in the waste sector and reduced emissions from animal husbandry in the agricultural sector. The majority of methane emissions originated from the waste and agricultural sectors in 2020. The production and use of energy also generate methane and nitrous oxide emissions.

Emissions of nitrous oxide (N_2O) have also decreased by 26 per cent since 1990; the greatest decline occurred in 2009, when the implementation of a N_2O abatement technology in nitric acid production significantly reduced emissions. Another reason for the decrease of N_2O emissions is the reduced nitrogen fertilisation of agricultural fields. The majority of nitrous oxide emissions originated from agriculture.

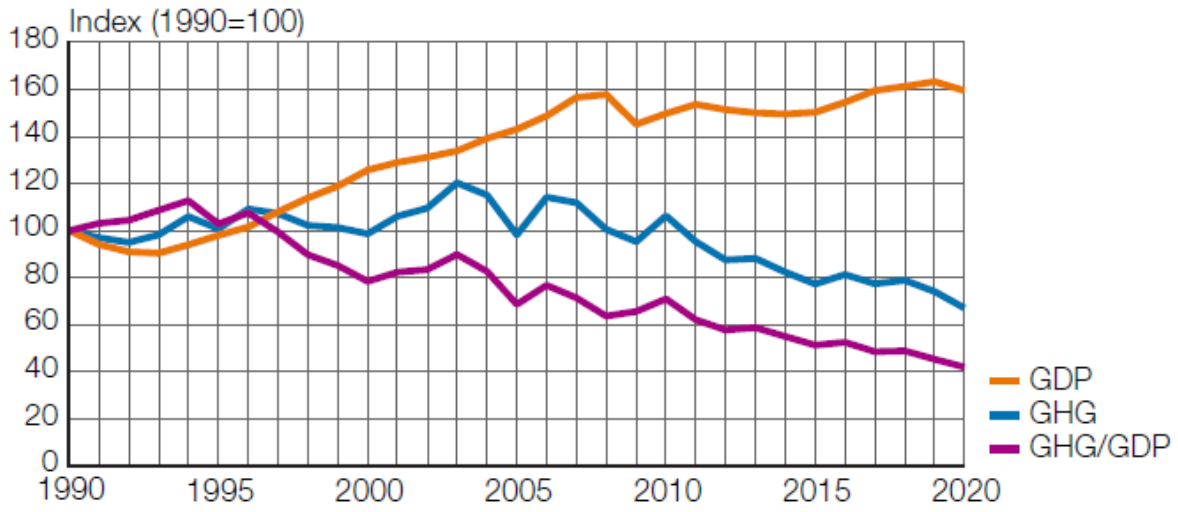
F gas emissions (HFC, PFC, SF_6) increased considerably between 1990 and 2008. A key driver of the trend was the substitution of ozone-depleting substances (ODS) by F gases in many applications. During the 2010s, F gas emissions have started to decline due to decreased leakage rates and the replacement of high-GWP HFC refrigerants with alternative low-GWP non-HFC refrigerants in many applications.

Figure 2.3 Relative development of greenhouse gas emissions by main category relative to the 1990 level (1990=100 per cent)



The overall trend in greenhouse gas emissions relative to Finland's gross domestic product (GDP) has been declining (Figure 2.4), 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 recession, which led to a steeper fall in GDP than in emissions. In 2020, the GHG/GDP ratio was almost 58 per cent below the 1990 level, indicating that the greenhouse gas intensity of the economy has decreased.

Figure 2.4 Greenhouse gas emissions relative to GDP (2010 prices), 1990 to 2020, excluding the LU-LUCF sector



More detailed information on emission trends by sector and gas can be found in CTF Table 1 and in the CRF Reporter Summary tables for 1990 to 2020 on emission trends included in Annex 1 of Finland's Eight National communication and in Finland's latest National Inventory Report (2022).

2.2 Greenhouse gas emissions by sector

2.2.1 Energy

Overview of the sector

The energy sector is the main source of greenhouse gas emissions in Finland. In 2020, the sector contributed 72 per cent to total national emissions, totalling 34.6 million tonnes CO_2 eq. (Figure 2.2). Energy sector emissions can be divided into emissions resulting from fossil fuel combustion and fugitive emissions from fuels. Most of the emissions originate from fuel combustion, which reflects the high energy intensity of the Finnish industry, the extensive consumption of fuels during the long heating period, and the energy consumed for transport in this relatively large and sparsely inhabited country. Fugitive emissions make up only 0.3 per cent of the sector's total emissions. Energy-related emissions vary greatly from year to year (Figure 2.5), mainly following the economic trend, the structure of the energy supply and climatic conditions. Compared with 1990, the emissions in the energy sector in 2020 were about 36 per cent lower. In 2020, emissions in the energy sector were about 12 per cent lower than in the previous year and approximately half the emission level in 2003, the year of the greatest emissions from the energy sector between 1990 and 2020.The energy industries (mainly electricity and district heat production) caused approximately 38 per cent (13.1 million tonnes CO_2 eq.) of the total emissions in the energy sector in 2020. Emissions from the energy industries were 31 per cent lower in 2020 than in 1990. Manufacturing industries and construction produce a great deal of energy for their own use. Their share of energy-related emissions was around 18 per cent in 2020 (6.2 million tonnes CO_2 eq.). These emissions have declined by 53 per cent since 1990. The main reasons for this trend are the increased use of biofuels, i.e. black liquor a by-product of pulp industry, in the forest industry and the outsourcing of power plants from the manufacturing industries to energy industries. Share of biomass as a source of energy has significantly grown in the public electricity and heat production as well as in manufacturing industries and construction between 1990 and 2020 (Figure 2.6). See also Section 2.6 of Finland's Eight National communication for trends in energy sources. Emissions from the residential sector have decreased by 67 per cent and from commercial sectors by 57 per cent compared with 1990 levels. The decrease is mainly due to the substitution of direct oil heating with district heating and electricity. The share of transport of energy-related emissions was more than 30 per cent in 2020. Emissions from transport have decreased by 14 per cent since 1990 and seven per cent since 2019. There was a decline of seven per cent in transport fuels activity data, mainly due to the Covid-19 pandemic, which explained the decrease in emis-

sions. Since 2015, the diesel bioshare has varied annually, causing fluctuations in the annual emissions of road transport.

Figure 2.5 Greenhouse gas emissions in the energy sector, 1990 to 2020

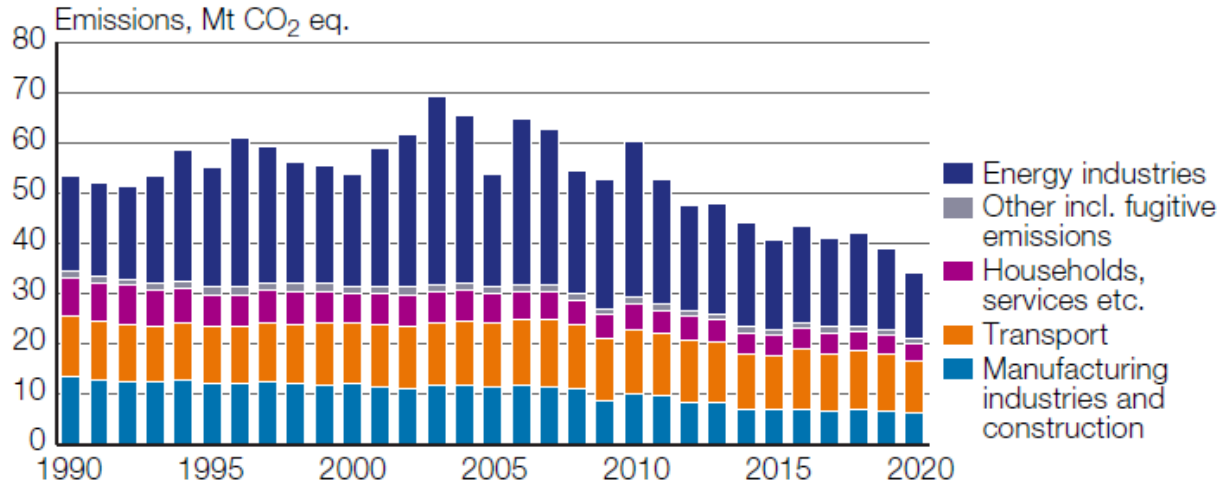
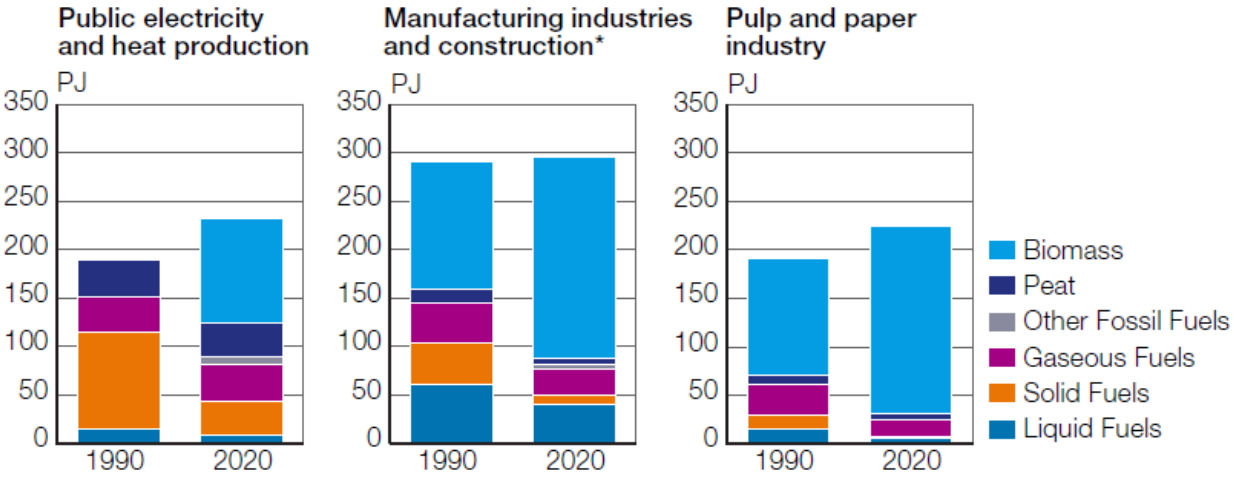


Figure 2.6 Fuel combustion in public electricity and heat production, manufacturing industries and construction, as well as in sub-sector of manufacturing industries, that is pulp and paper industry



* Fuel combustion in the pulp and paper industry is included in the manufacturing industry too.

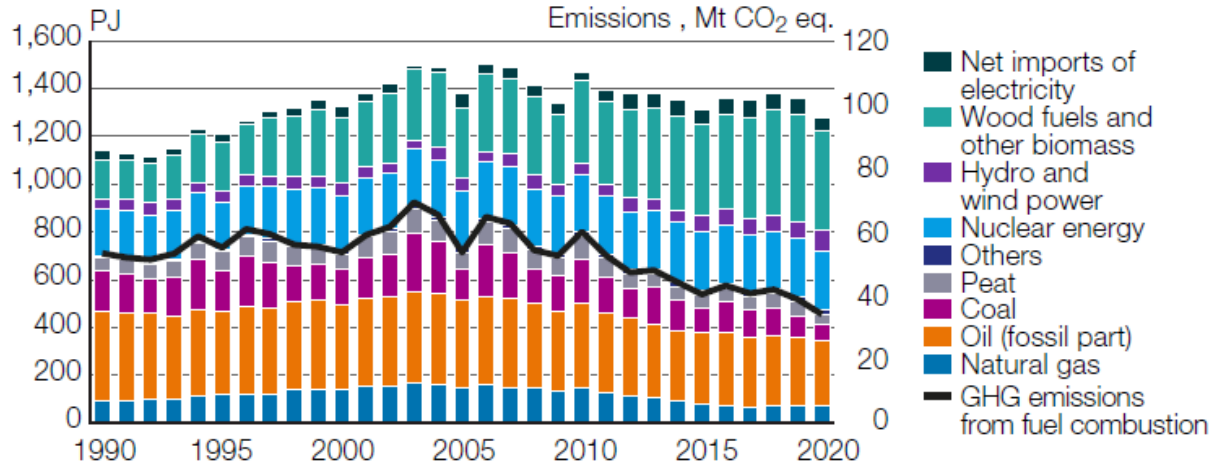
Description and interpretation of energy emission trends

The important drivers in the energy sector's greenhouse emissions trend have been the changes in the amount of imported electricity and in the production of energy with fossil-fuel-based condensing power, as well as growth in the consumption of renewable energy (Figures 2.7 and 2.8). The availability of hydropower in the Nordic electricity market has significantly influenced the electricity supply structure and hence the emissions from fuel combustion during the time series. If the annual precipitation in the Nordic countries is lower than usual, hydropower will be in short supply and Finland's net imports of electricity will decrease. During such years, Finland has generated additional electricity using coal- and peat-fired power plants, resulting in higher CO_2 emissions from corresponding years. During recent years, the share of conventional condensing power in electricity generation has declined as the share of wind power has grown. In addition, the allowance price in EU ETS has risen, which is accelerating the replacement of fossil fuels with renewable energy.

Total energy consumption in 2020 amounted to 1.28 million terajoules (TJ). The trends in the energy sector driving greenhouse gas emissions are described in Section 2.6 of Finland's Eight National communication. In 2020, the energy sector's emissions were about 36 per cent below the 1990 level and half the emission level in 2003, which was the year of the greatest emissions from the energy sector between 1990 and 2020. At the end of the 1990s, total energy consumption increased, but emissions changed very little. The reasons for this were the increased use of wood fuels, nuclear energy, and net imports of electricity, which reduced the condensing power production and thus emissions. Net imports of electricity declined at the beginning of the 2000s, and energy sector emissions were at their peak in 2003. In 1990, the share of renewable energy in total energy consumption was just 18 per cent, since when it has grown steadily. The share of renewable energy sources from the final energy consumption grew to 44.6 per cent in 2020. In addition, the net import of electricity has been at a high level since 2012 (Figures 2.7 and 2.8). The increased use of renewable energy sources compared to the situation in 1990 has increasingly replaced fossil fuels and is the main reason for the decreased emissions despite the growth in energy consumption.

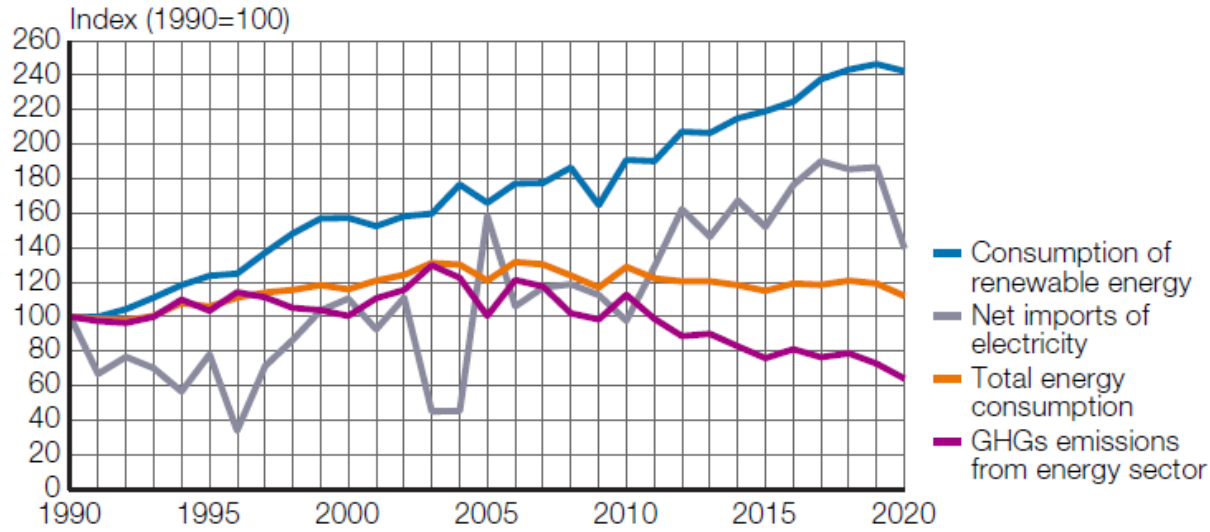
The ban on the use of hard coal for energy production, which will enter into force in 2029, is already decreasing coal consumption. For example, the total consumption of coal, which in addition to hard coal, includes coke and blast furnace and coke oven gas used by manufacturing, decreased by 23 per cent between 2019 and 2020. See Section 2.6 of Finland's Eight National communication for further information on trends in energy.

Figure 2.7 Development of total energy consumption by energy source (PJ) and energy sector greenhouse gas emissions (million tonnes CO_2 eq.), 1990 to 2020[3]



[3]Coal includes hard coal and coke, blast furnace gas, coke oven gas, and until 1994, town gas.

Figure 2.8 Development of the energy sector's emissions, net imports of electricity, and total and renewable energy consumption, 1990 to 2020



2.2.2 Transport

In 2020, the greenhouse gas emissions from transport amounted to 10.4 million tonnes CO_2 equivalent. Compared to 2019, emissions decreased by seven per cent in 2020. A decline of seven per cent in transport fuels activity data, due mainly to the Covid-19 pandemic, explains the decrease in emissions. The share of the transport sector of the total greenhouse gas emissions was approximately 17 per cent (12.1 million tonnes CO_2) in 1990 and 22 per cent (10.4 million tonnes CO_2) in 2020. Road transport is the most important emission source in the transport category (Figure 2.9). Road transport emissions were 9.9 million tonnes (CO_2 eq.) in 2020; this was 95 per cent of the transport emissions and 21 per cent of the total emissions.

CO_2 emissions from transport decreased considerably in the early 1990s due to the economic depression. Since 2008, emissions have fluctuated due to many simultaneous different factors, both societal and legislative. The Covid-19 pandemic since 2020 have decreased kilometrage and thus emissions as well (Figure 2.10). The fuel consumption of cars has been decreasing due to the CO_2 limits set for car manufacturers by the EU. A tax reform for cars in Finland caused a dramatic transition from petrol to diesel cars, which decreased CO_2 emissions in 2009. In the 2010s, the bioshare of diesel oil has varied annually and caused fluctuations in annual emissions. Finland's biofuel legislation allows the distributors to fulfil the bioshare obligation flexibly in advance.

Figure 2.9 Emissions from transport by subcategory (million tonnes CO_2 eq.), 1990 to 2020

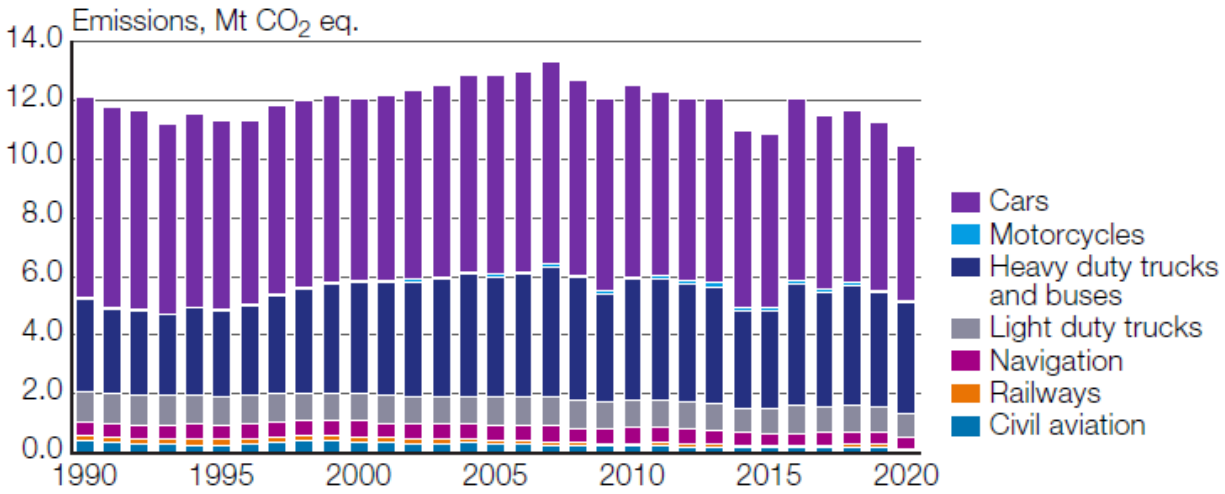
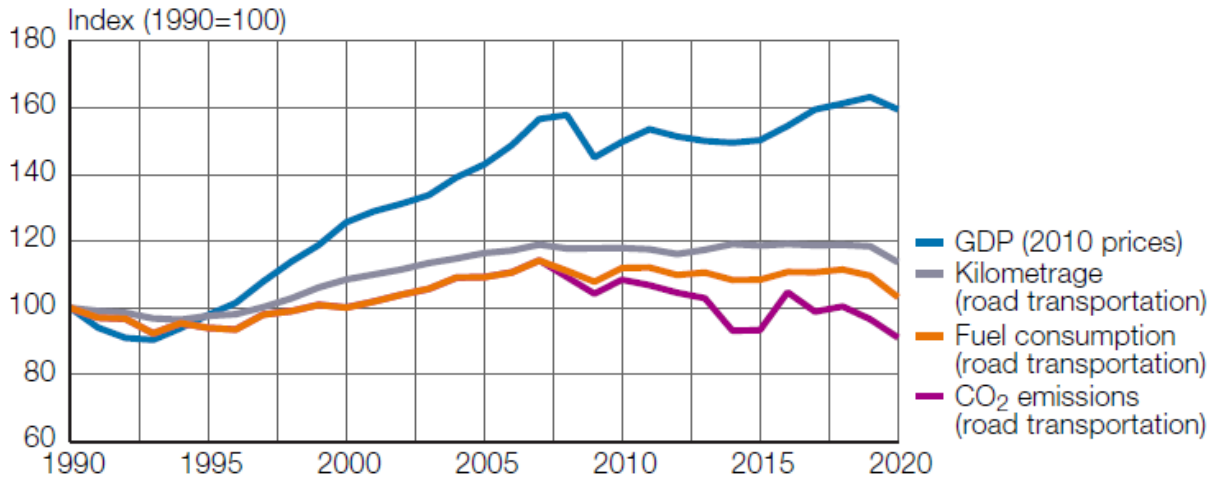


Figure 2.10 Development of GDP and fuel consumption, kilometrage and CO_2 emissions in road transport, 1990 to 2020



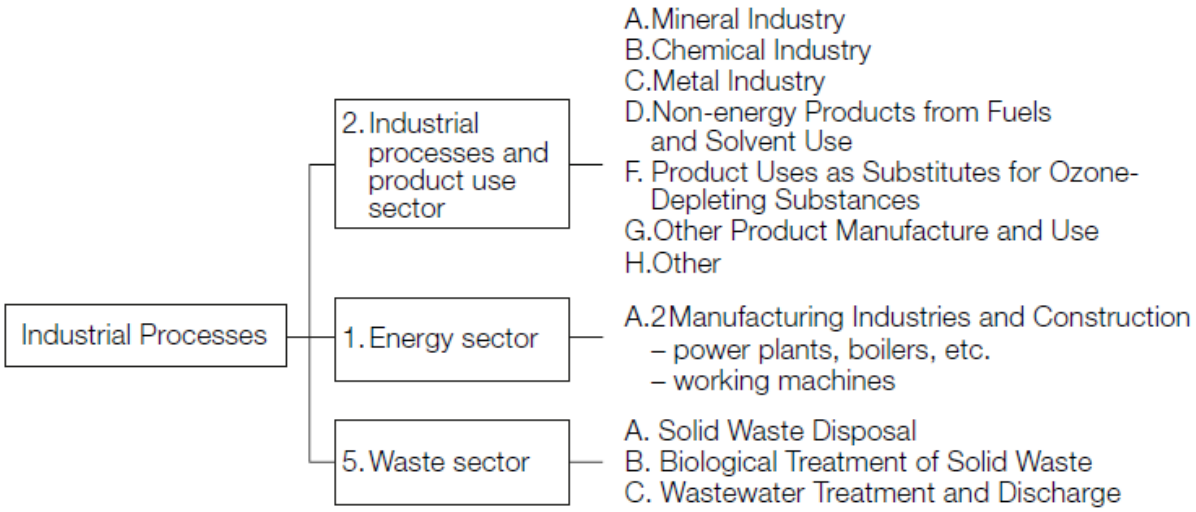
2.2.3 Industrial processes and product use

Greenhouse gas emissions from industrial processes and product use contributed 11 per cent to the total greenhouse gas emissions in Finland in 2020, totalling 5.1 million tonnes CO_2 eq. The most important greenhouse gas emission sources of industrial processes and product use in 2020 were CO_2 eq. emissions from iron and steel, hydrogen and cement production with 3.6, 1.9, and 1.2 per cent shares of total national greenhouse gas emissions respectively. 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 in coke production in the iron and steel industry, in ethylene production (fugitive emissions) and from lubricant use. 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 as aggregated in national totals.

Fluorinated greenhouse gases, or F gases, are reported under industrial processes. They are used to replace ozone-depleting substances (ODS) in refrigeration and cooling devices, as well as in air conditioning devices and aerosols, and they accounted for 2.1 per cent of total national greenhouse gas emissions and 19 per cent of the greenhouse gas emissions of industrial processes and other product use in 2020. The reporting catego-

ries of emissions from the sources of industrial processes in the national greenhouse gas inventory are presented in Figure 2.11.

Figure 2.11 Reporting categories of emissions from industrial process sources in the national greenhouse gas inventory



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, but the implementation of technical abatement measures in nitric acid production in 2008 resulted in a significant reduction in emissions (Figure 2.12). In the period from 1990 to 2020, the largest relative change occurred in F gas emissions, which at first increased rapidly but have now begun to decrease (Figure 2.13) due to decreased leakage rates and the replacement of high-GWP HFC refrigerants with alternative low-GWP non-HFC refrigerants in many applications.

Total emissions of industrial processes and product use were five per cent (0.3 million tonnes CO_2 eq.) smaller in 2020 than in 1990. At the beginning of the time series, some production plants were closed and this caused a rapid decrease in emissions. After this, the production outputs and emissions increased and reached the level of 1990 in 1996. The increase in emissions continued until 2009, when they decreased rapidly due to the economic downturn as the demand for industrial products diminished. The implementation of N_2O abatement technology happened at the same time, which is why the emissions stayed at a lower level, even though production started to increase after the recession in 2010.

Figure 2.12 Greenhouse gas emissions from industrial processes, 1990 to 2020

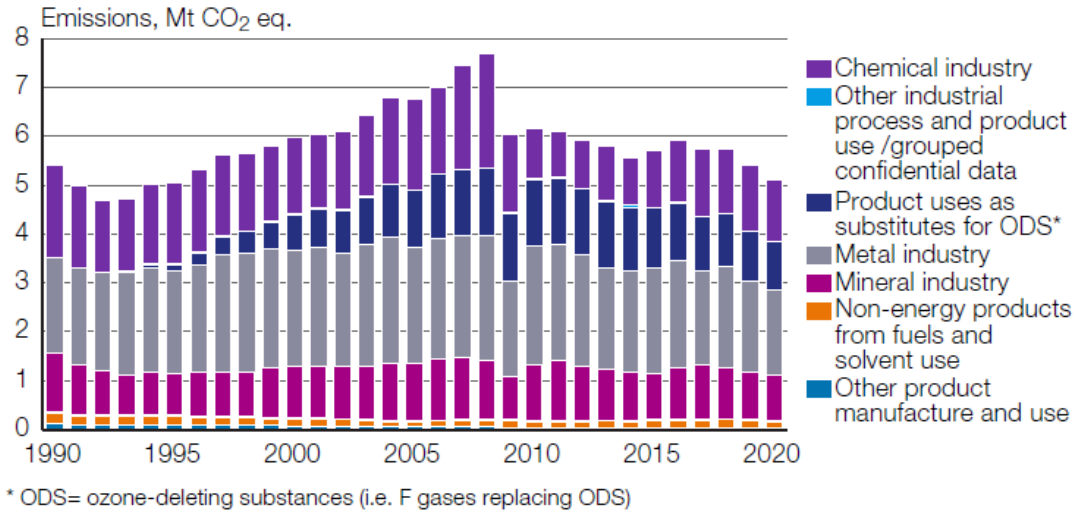
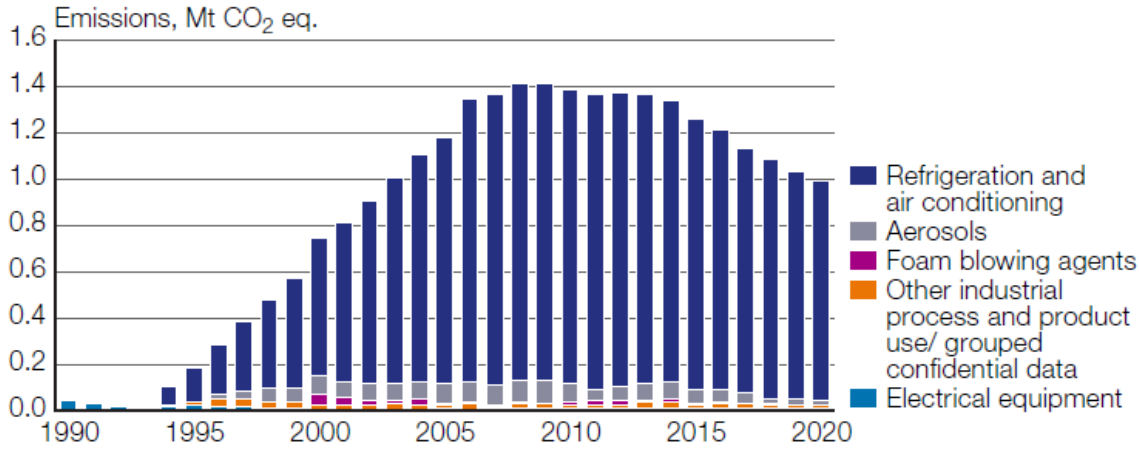


Figure 2.13 F gas emissions, 1990 to 2020



CO_2 emissions were five per cent greater in 2020 than in 1990. The reasons are the increased production of steel and hydrogen and the use of limestone and dolomite. Methane emissions were 74 per cent lower in 2020 than in 1990. Nitrous oxide emissions fluctuated between 1990 and 2020: first, there was a rapid decrease due to the closing of a nitric acid production plan; then a slow increase of emissions. The second rapid 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 1.4 million tonnes CO_2 eq. (85 per cent). F gas emissions in 2020 were 19-fold compared to 1990.

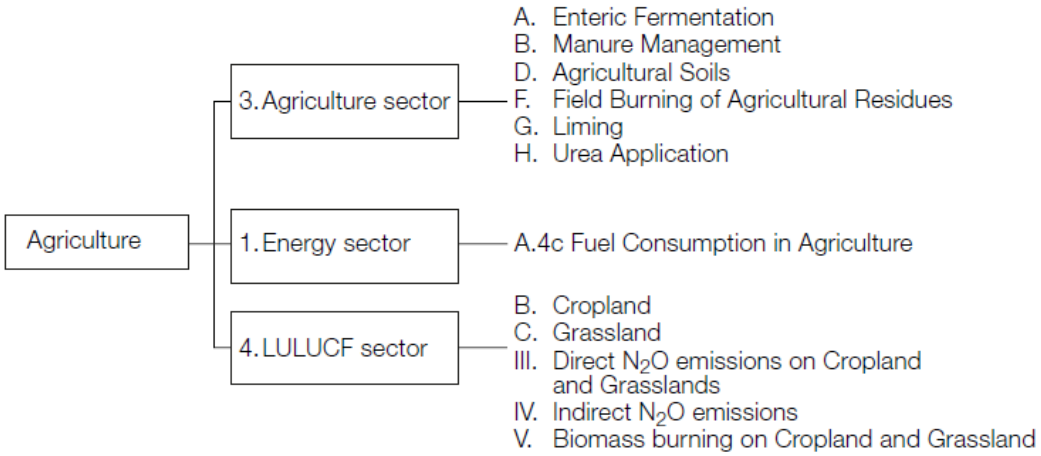
2.2.4 Agriculture

Emissions from the agriculture sector were approximately 6.6 million tonnes CO_2 eq. in 2020. Agricultural emissions reported in the agricultural sector include methane (CH_4) emissions from the enteric fermentation of domestic livestock, manure management and crop residue burning, and nitrous oxide (N_2O) emissions from manure management and direct and indirect N_2O emissions from agricultural soils and crop residue burning. CO_2 emissions from liming and urea fertilisation are also included. Emissions from the agricultural activity are also reported in the energy and LULUCF sectors in the greenhouse gas inventory (Figure 2.14).

The agricultural sector accounted for approximately 14 per cent of Finland's total greenhouse gas emissions in 2020. In 2020, methane emissions from enteric fermentation were 32 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 54 per cent of total agricultural emissions. Liming and the application of urea comprise three per cent of emissions; the share of field burning of agricultural crop residues totals 0.03 per cent.

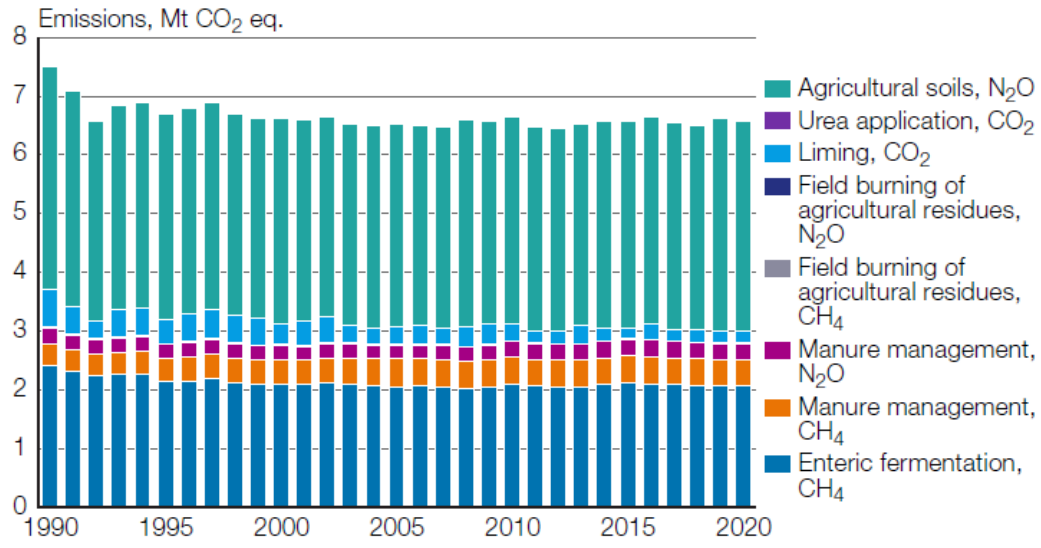
Figure 2.14 Agricultural sources of emissions and their reporting in the CRF categories in the national greenhouse gas inventory



Cattle generate most of the CH_4 emissions from enteric fermentation, 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 decreased by about 13 per cent during the 1990 to 2020 period (Figure 2.15). The most important factor behind the decrease is a reduction in the use of synthetic nitrogen fertilisers of 39 per cent between 1990 and 2020, which significantly reduced greenhouse gas emissions. Total N_2O emissions from agricultural soils were six per cent lower in 2020 than the 1990 level. The area of cultivated organic soils increased during the 1990 to 2020 period, which has also seen increased nitrous oxide emissions from agricultural soils. The decrease in CO_2 emissions from liming due to reduced use of lime is also significant.

Figure 2.15 Greenhouse gas emissions from agriculture, 1990 to 2020*



* Field burning of agricultural residues and urea application are not discernible, because their emissions range from 0.001 to 0.005 million tonnes each.

Since 1995, EU membership has resulted in changes in the economic structure of agriculture in Finland. The number of farms has decreased, average farm size has increased, and livestock numbers have decreased. For example, the number of cattle declined by more than a third between 1995 and 2020. The decline has slowed down over the last ten years. The decrease in cattle numbers over the time series has been counterbalanced by an increase in emission factors for enteric fermentation due to increased animal weights, growth and milk production. Emissions from enteric fermentation were 14 per cent lower in 2020 than in 1990.

Total emissions from manure management increased by 10 per cent between 1990 and 2020. The fluctuation in the emissions from manure management is related to both changes in animal numbers, which depend largely on agricultural policy, and changes in the distribution of the manure management systems. Direct nitrous oxide emissions from manure management first decreased and then increased in the time series. Cattle numbers have decreased, which explains the decreasing trend in manure management. However, nitrogen excretion figures increased over time for many animals, including cattle. The share of cattle slurry with a crust has also increased over time, increasing direct emissions from slurry. Methane emissions from manure management have increased by 21 per cent since 1990. This is due to an increase in the number of animals kept in slurry-based systems.

Some inter-annual variability can be detected in agricultural sector emissions. This is mainly caused by fluctuations in activity data between years due to changes in animal numbers and in the manufacture and import of lime for agriculture. Changes in animal numbers are largely affected by agricultural policy and subsidies, and they particularly affect methane and nitrous oxide emissions from manure management. Emissions from manure management are also affected by the distribution of manure managed in different manure management systems, which varies depending on the animal species. Nitrous oxide emissions from managed soils are affected by the quantity of synthetic fertilisers used annually, animal numbers and crop yields of cultivated crops, for example, which may have a large variation between years.

2.2.5 LULUCF

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 various sources are reported in this sector, including 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 fertilisation of forest land and N_2O emissions resulting from loss of soil organic matter. Emissions and removals are not reported for unmanaged wetlands and other land.

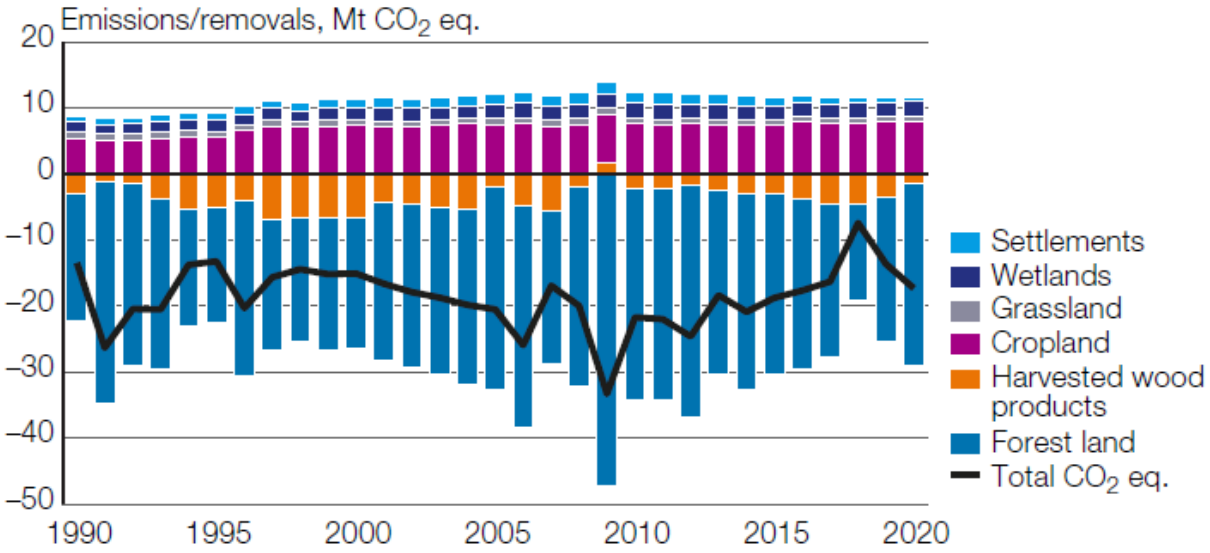
In 2020, the LULUCF sector as a whole acted as a CO_2 sink for –17.3 million tonnes CO_2 eq. This sum of removals and emissions, i.e. carbon stock changes and greenhouse gas emissions, in 2020 was 29 per cent larger than it was in 1990. For forest land, the largest sink was tree biomass, with –27.8 million tonnes CO_2 of net removals in 2020. Mineral soils on forest land were a sink of –5.2 million tonnes of CO_2, whereas organic forest soils were a source of 3.8 million tonnes of CO_2. Other emission sources in the forest land category are methane and nitrogen oxide emission from drained organic forest lands (2.6 million tonnes CO_2 eq.), nitrogen fertilisation (0.04 million tonnes CO_2 eq.) and biomass burning in forest fires and in controlled burning (0.004 million tonnes CO_2 eq. in 2020).

The high fluctuation in net biomass removals in the forest land category during the 1990 to 2020 period is mainly caused by the changes in the international market for forest industry products, which affects the amount of domestic commercial roundwood felling. In 2018, total roundwood removals reached 78 million m^3, the highest in statistical history. Roundwood removals in 2020, 69 million m^3, remained at a high level compared to the historical levels. The other significant factor affecting the trend in forest land sink is the increase in the annual volume increment. Forest growth has increased steadily since 1990 because of factors such as the large proportion of young forest at a strong growth phase and silvicultural measures. The annual growing stock increment was 77.7 million m^3, based on the 8th National Forest Inventory (NFI) (measured 1986 to 1994) and 107.8 million m^3, based on the NFI12 (2014 to 2018). The rapid increase in the increment

in the 1980s and 1990s has levelled out according to the last inventory measurements (see Section 3.1 on the latest results from the national forest inventory).

Although the LULUCF sector has been a significant net carbon sink, it 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 fertilisation of forests. The trend in emissions and removals from the different land-use categories and Harvested Wood Products pool reported in the LULUCF sector is presented in Figure 2.16.

Figure 2.16 Net emissions and removals in the LULUCF sector by land-use category and harvested wood products pool, million tonnes CO_2 eq.



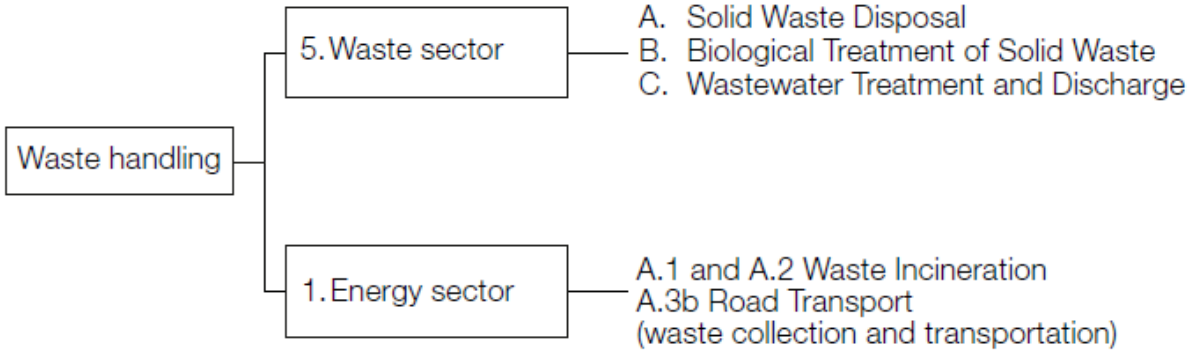
Harvested wood products

The Harvested Wood Products (HWP) pool was a net sink of 1.3 million tonnes of CO_2 in 2020. HWP has been a net sink for the whole reported time series, except in 2009. The annual fluctuations in the time series are generally due to changes in the economic situation and the demand for wood products. Factors behind the HWP carbon stock changes in 2020, such as strikes, the closure of some paper machines and decreased demand for harvested wood products because of the Covid-19 pandemic are described in more detail in Finland's National Inventory Report 2022 to the UNFCCC. HWP is reported as a carbon stock change in production-based HWP stocks originating from wood harvested in Finland divided into two categories: HWP produced and consumed domestically; and HWP produced and exported. HWP comprises 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 purposes other than paper and paperboard started mainly in 2012. The annual change of HWP in domestic solid waste disposal sites (SWDS) is not calculated.

2.2.6 Waste

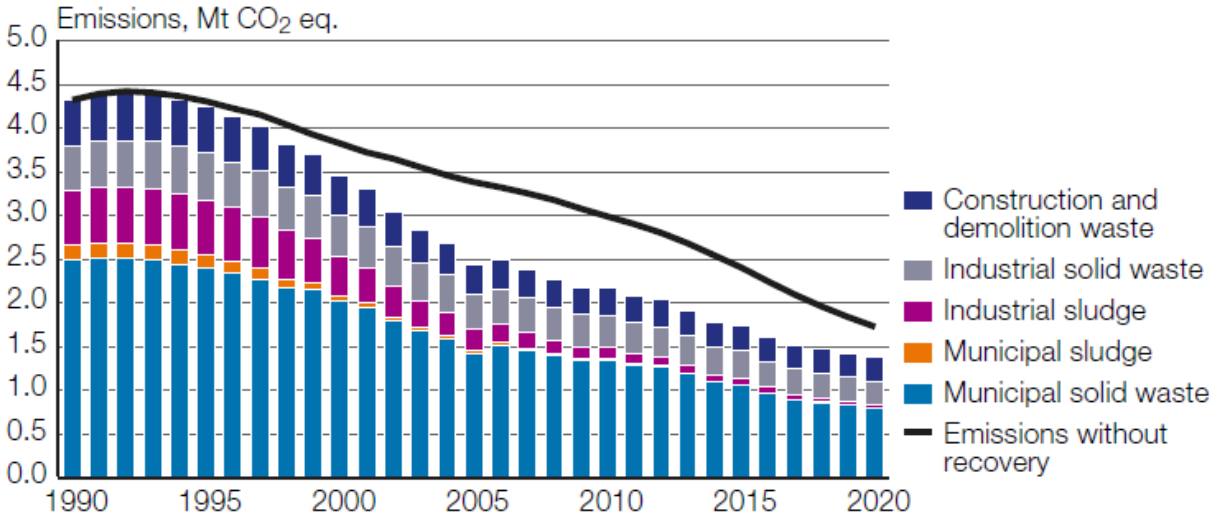
Methane (CH_4) emissions from landfills and CH_4 and N_2O emissions from composting and wastewater treatment are reported under the waste sector (Figure 2.17). Greenhouse gas emissions from the combustion of waste are reported fully in the energy sector, as waste incineration without energy recovery is almost non-existent. Waste sector emissions amounted to 1.7 million tonnes CO_2 eq. in 2020, which accounts for approximately four per cent of Finland's total emissions.

Figure 2.17 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 80 per cent, wastewater treatment about 14 per cent and biological treatment (composting and anaerobic digestion) seven per cent of the sector's total emissions. Compared to 2019, emissions decreased by three per cent in 2020, and since 1990, these emissions have decreased by 63 per cent. A new Waste Act[4] entered into force in 1994, which has led to a reduction in methane emissions from landfill sites (Figure 2.18). The Waste Act has reduced the volume of waste deposited at landfills by promoting recycling and reuse, as well as the energy use of waste materials. The great increase in the amounts of recovered methane at the beginning of 2000 is a result of the regulations of landfill gas recovery (Council of State Decree on Landfills[5]). The amount of recovered methane in recent years has decreased due to the great decrease in the waste amounts to landfills after the ban of organic waste deposits at landfills. The recession of the early 1990s also reduced consumption and waste volumes.

Figure 2.18 Methane emissions from solid waste disposal on land. The figure also shows the amount of methane generated (emission without recovery) at solid waste disposal sites



Emissions from wastewater treatment have also been successfully reduced by 20 per cent compared with 1990. For example, the reduction in emissions has been affected by the increasingly efficient treatment of

[4] 1072/1993

[5] 861/1997

wastewater (also in sparsely populated areas), as well as a lower nitrogen burden released from industrial wastewaters into waterbodies. Emissions from composting have more than doubled since 1990, being six per cent of the waste sector's emissions in 2020. The reason is the 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 for the same reason as the increase in emissions from composting. Yet this emission source is very small, being 0.6 per cent of the waste sector's emissions in 2020.

2.3 National inventory arrangements

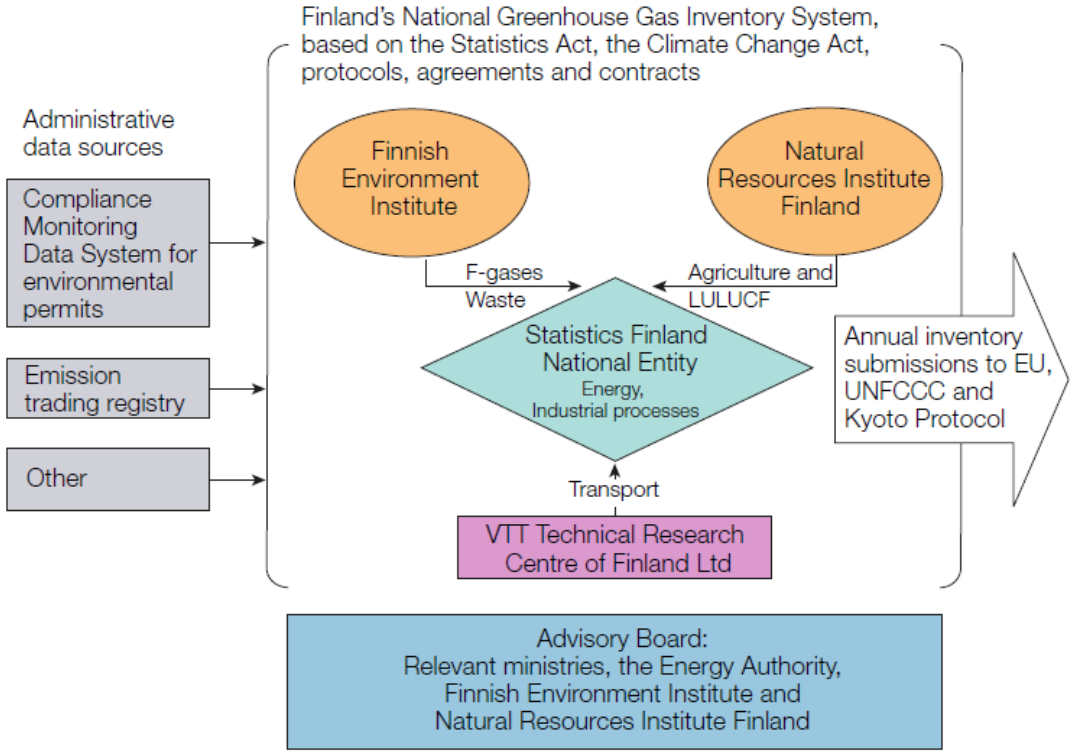
2.3.1 Institutional, legal and procedural arrangements

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[6].

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 emission and removal estimates and related documentation. Statistics Finland also has agreements on cooperation and support for 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 2.19. The contact person for the national entity and its designated representative with overall responsibility for the national inventory at Statistics Finland is Ms Pia Forsell, FI-00022 Statistics Finland, tel. +358-29-551 2937, email pia.forsell@stat.fi.

[6] 609/2015 and 423/2022

Figure 2.19 National system for the greenhouse gas inventory in Finland



Statistics Finland as the national entity for the inventory

In Statistics Finland's activity as the national entity for the greenhouse gas inventory, the Statistics Finland Act[7] and the Statistics Act[8] are applied.

Statistics Finland defines the placement of the inventory functions in its working order. The advisory board of the greenhouse gas inventory established by Statistics Finland ensures collaboration and information exchange in issues related to the reporting of greenhouse gas emissions under the UNFCCC and the Kyoto Protocol. 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 projects related to the development of the inventory and reporting. It also 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 oversees 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 SF6) 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, the regulation on fluorinated gases, the European Pollutant Release and Transfer Register (E-PRTR) and energy statistics regulation. Access to EU ETS data is also

[7] 48/1992 and its amendment 901/2002

[8] 280/2004 and its amendment 361/2013

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 E-PRTR and data collected under the regulation on fluorinated greenhouse gases play 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 comment.

Responsibilities of the expert organisations

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

Table 2.1 Responsibility areas by expert organisation

Area		Organisations
CRF 1.A.	Stationary sources 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 (SYKE)
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 (SYKE)
Indirect CO_2	Non-methane volatile organic compounds, NMVOC	Finnish Environment Institute (SYKE)
KP(LULUCF)	Activities under Article 3, paragraphs 3 and 4 of the Kyoto Protocol (ARD and FM)	Natural Resources Institute Finland (Luke)

Until 2009, Finavia (formerly the Civil Aviation Administration) provided emission data on aviation to the inventory. In 2010, Finavia's status in Finland's inventory system changed. Finavia is no longer performing the calculations. Statistics Finland has taken over 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 for estimating and reporting 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 2.1.

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 inventory's QA/QC and verification process.

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 the data collected in the management of public administration duties in their administrative branch so that they can be used in the emission inventory.

In accordance with the Government resolution, the ministries produce the data 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 also 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 and supervises the monitoring and reporting of the emission data under the European Emissions Trading System (EU ETS) and international emissions trading under the Kyoto Protocol. Statistics Finland and the Energy Authority concluded an agreement in 2006 on collaboration between the national inventory system and registry, including a division of the responsibilities related to reporting. The most recent update to the agreement was made in 2018.

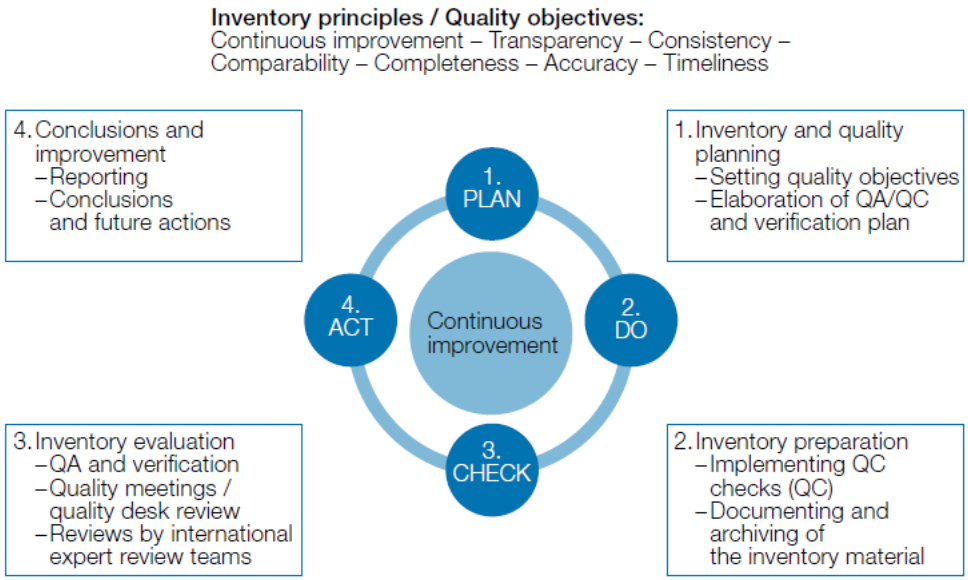
The Energy Authority provides the necessary information on emission reduction units, certified emission reductions, temporary certified emission reductions, long-term certified emission reductions and assigned amount units and removals units for annual inventory submissions in accordance with the guidelines 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 on the website of the Energy Authority.

2.3.2 Annual inventory process

The annual inventory process set out in Figure 2.20 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 of Finland's Eight National communication).

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 and the IPCC 2013 Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol.

Figure 2.20 Inventory and QA/QC process of the inventory



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 are 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 YLVA, 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 conducts a Tier 2 key category analysis annually prior to submitting inventory information to the EC. The Tier 2 methodology uses category-specific uncertainty analyses. The analysis covers all the sources and sinks of the inventory.

The key category analysis functions as a screening exercise. The result is a shortlist (20+) of the subcategories that are the most important in terms of the 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 to 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 to implement methodological improvements in the inventory, including changes in activity data and emission factors, or to include new source or sink categories within the inventory or to correct identified errors, omissions, overlaps, or inconsistencies within the time series.

Greenhouse gas inventory recalculations are based on an annual evaluation of the inventory's preparation and improvement needs, 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 and approved by the inventory unit at Statistics Finland before being implemented.

Any changes made are documented in the CRF 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 of Finland's Eight National communication). The results have been disseminated through articles in scientific journals and presentations at various national workshops and seminars, for example. Some of the research results have also been used by the IPCC in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, the IPCC Emission Factor Database, the '2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands' and '2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories', for example.

2.3.3 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 2.20). 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 (Plan-Do-Check-Act (PDCA) cycle) and aims for 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 its replication where necessary. 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. In addition, a schedule of the coming inventory round is prepared and presented to the expert organisations. The timetable includes deadlines for QC checks of the inventory compilation and draft meeting schedules of the inventory working group and advisory board. The setting of quality objectives is based on the inventory principles. Quality objectives (Table 2.2) are specified statements about the quality level that is aimed at the inventory preparation regarding the inventory principles.

Table 2.2 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 the 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 the emission sources, sinks, gases and geographic areas
6. Accuracy
6.1. Emissions and removals are not systematically over- or underestimated
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

The objectives aim to be appropriate and realistic considering 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 to attain the quality objectives and provide confidence in the Finnish national system's capability of delivering high-quality inventories. The QA/QC plan is written in Finnish and updated annually. It consists of instructions and a QA/QC form. The instructions include descriptions of 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 at each stage of the inventory preparation. Sectoral experts enter into the form the QA/QC and verification procedures performed and their results. Discussions in the bilateral quality meetings or feedback given during the quality desk reviews are based on the information documented in these forms. The QA/QC plan is available in the shared workspace of the inventory and archived according to the inventory unit's archive formation plan. 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 in which significant methodological changes or data revisions have occurred.

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 are 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 which 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 its improvement. At the improvement stage of the QA/QC process, conclusions are drawn 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 being adopted in production (see also Section 3.3.2 of Finland's Eight National communication).

2.3.4 Changes in Finland's GHG inventory arrangements since BR4

Since the submission of Finland' Fourth Biennial Report, no significant changes have been made to the greenhouse gas inventory arrangements and the national system under Article 5, paragraph 1, of the Kyoto Protocol. During 2018-2020 Statistics Finland has updated agreements with the Ministry of Transport and Communication/Transport Agency (Trafi) and the Energy Agency. The updates do not involve any significant changes in the inventory arrangements or system.

3 Quantified economy-wide emission reduction target

3.1 Quantified economy-wide emission reduction target jointly with the European Union

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"). It is therefore a joint pledge with no separate targets for Member States under the Convention. The UK remained part of the joint EU 2020 target with the 27 EU Member States.

Key assumptions and conditions related to the EU's target (for example sectors, base year, coverage of gases) are included in the document FCCC/AWGLCA/2012/MISC.1, the EU 6th National Communications and first Biennial Report under the UNFCCC, and in CTF Tables 2(a–f). EU's Fifth Biennial Report gives more recent information on how the joint target was fulfilled by the EU and its Member States.

3.2 The EU target compliance architecture

The EU has jointly committed to its UNFCCC target and implemented it internally through EU legislation in the 2020 EU Climate and Energy Package. In this package, the EU introduced a clear approach to achieving the 20% reduction in total GHG emissions from 1990 levels, by dividing the effort between the sectors covered by the EU Emissions Trading System (EU ETS) and the sectors under the Effort Sharing Decision (ESD). Binding national targets were set for Member States under the Effort Sharing Decision. The achievement of EU internal compliance under the 2020 Climate and Energy Package including the national targets under the ESD is not subject to the UNFCCC assessment of the EU's joint commitment under the Convention.

The EU and its Member States played their part in the joint commitment as follows. Emissions from categories covered by the EU Emissions Trading System (EU ETS) were to be reduced by 21 per cent by 2020 from their 2005 level, and emissions not covered by the EU ETS were to 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 was an EU-level commitment, and Member State specific caps were not defined for the EU ETS emissions reductions.

The EU Effort Sharing Decision (ESD)[9] established binding annual greenhouse gas emission levels for Member States for the period 2013–2020. The ESD covers the emissions from the non-emissions trading sector (non-ETS) calculated as the total national emissions without LULUCF minus the national emissions in EU Emission trading sector for the Member State in question. The CO_2 emissions from civil aviation are also excluded from the non-ETS emissions. The non-ETS emissions come from sources such as transport, housing, agriculture and waste. The emissions will be cut by approximately 10 per cent from the 2005 level by 2020 within the EU as a whole.

The ESD sets Finland's reduction obligation for the sectors not covered by the EU ETS as 16 per cent of the 2005 emissions. This reduction obligation has been determined in CO_2 equivalent (eq) tonnes after the EU internal review of the 2012 greenhouse gas emission inventory submission in the Commission Decision 2013/163/EU. The decision sets annual emission allocation for each Member State for the year 2013 to 2020. The Commission Implementing Decision 2013/634/EU adjusts these annual emission allocations taking into account the changes in coverage of the EU Emission Trading System from 2013 onwards.

The EU's Effort Sharing Decision defined Finland's reduction obligation for the sources not covered by the EU ETS as 16 per cent of the 2005 emissions. This reduction obligation was determined in CO_2 equivalent (eq.) tonnes in the Commission Decision[10], and adjusted in the Commission Implementing Decision[11] to take

[9] Decision 406/2009/EC

[10] 2013/163/EU

[11] 2013/634/EU

changes in the coverage of the EU Emissions Trading System from 2013 onwards into account. For Finland, these annual adjustments increased the reduction commitment by 2020 by approximately five percentage units. In 2017, the annual emissions allocations of the EU Member States were further adjusted[12] to take into account 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, which increased Finland's annual emission allocations with more than one percentage unit, apply to the ESD commitments for the years 2017 to 2020.

Finland's annual emission allocations under the ESD, including mentioned adjustments, are presented in detail in Table 3.1. The annual emission allocations are also addressed as Finland's target path under the ESD. The target path represents Finland's contribution to the EU's joint target under the UNFCCC. Section 4.1 describes how the EU achieved its joint emission reduction target and Section 4.4 Finland's contribution to the joint target.

Table 3.1 Finland's target path for non-ETS emissions in accordance with the EU Effort Sharing Decision

	2013	2014	2015	2016	2017	2018	2019	2020
Finland's annual emission allocations	31.8	31.3	30.8	30.3	30.2	29.6	29.1	28.5

The Climate and Energy Package 2020 also required 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. It also included requirements for the increase of efficiency in the use of energy.

3.3 Other emission reduction targets

3.3.1 Paris Agreement and the EU's Climate and Energy Package 2030

The Paris Agreement was adopted in December 2015 and entered into force in November 2016. The EU ratified the agreement in October 2016. The Finnish national ratification was completed in November 2016. The EU's joint nationally determined contribution (NDC)[13] under the Paris Agreement is to reduce the greenhouse gas emissions by at least 55 per cent by 2030 from the 1990 level. According to the EU Climate and Energy Package 2030, as in the EU's Climate and Energy Package 2020 before, the emissions reduction obligations are divided between the EU Emissions Trading System (EU level target) and the non-ETS emissions[14] (Member-State level targets). In addition, the LULUCF sector[15] is now part of the Member-State level obligations. According to the EU Climate and Energy Package 2030, 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 by 32 per cent and energy efficiency improved, indicatively, by 32.5 per cent. In the Effort Sharing Regulation, Finland's target for emission reductions in 2030 compared to the 2005 level is 39 per cent.

In 2019, the Commission submitted a communication describing the European Green Deal, which included a target of carbon neutrality by 2050. The target itself is already in the EU's binding legislation, but more detailed laws are still in preparation.

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[12] Decision 2017/1471/EU

[13] EU's First NDC, updated in December 2020 https://unfccc.int/sites/default/files/NDC/2022-06/EU_NDC_Submission_December%202020.pdf

[14] Regulation (EU) 2018/842

[15] Regulation (EU) 2018/841

In 2020, the Commission presented its proposal to tighten the 2030 emissions target so that the new reduction in the EU's total emissions would be at least 55 per cent by 2030 compared to the 1990 level. According to the proposal, the current ETS would be expanded to maritime transport, and a new emissions trading system would be established for ground transport and space heating. Emissions reduction targets for the ETS and effort sharing sectors would be stricter (61 and 40 per cent compared to 2005 respectively), as well as the targets of the share of renewables and energy efficiency (40 and 36 to 39 per cent respectively). The details of the effort sharing between the Member States, including Finland have been negotiated in autumn 2022 as a part of the EU's Fit for 55 Package.

3.3.2 Kyoto Protocol

Finland has also implemented the second commitment period of the Kyoto Protocol to the UNFCCC (2013—2020). The EU, its Member States and Iceland implemented its targets under the Kyoto Protocol jointly. Finland's target and progress towards the achievement of the target for the second commitment period of the Kyoto Protocol has been reported annually in the national inventory report and discussed also in Finland's Eight National Communication.

3.3.3 Additional national targets

In 2019, the Programme of Prime Minister Sanna Marin's Government introduced a carbon neutrality target for 2035, which was included in the reform of the Climate Act in 2022. In addition, new emissions reduction targets for 2030 and 2040 were included in the Climate Act, and the previous emissions reduction target of 80 per cent by 2050 was updated. The new targets are 60 per cent by 2030, 80 per cent by 2040, and at least 90 per cent, aiming for 95 per cent, by 2050 compared to 1990 levels. The scope of the Act was also extended to cover the land-use, land-use change, and forestry (LULUCF) sector, and a target for the strengthening of carbon sinks was added.

4 Progress in achievement of quantified economy-wide emission reduction targets

4.1 Introduction and achievement of quantified economy-wide emission reduction targets

The EU has substantially overachieved its 20 per cent by 2020 reduction target under the Convention, which means that also its Member States and the United Kingdom have fulfilled their emission reduction obligations. The EU joint target under the Convention refers to greenhouse gas emissions of the EU-28 and the emissions are calculated as the sum of the emission of the Member States. As stated in the 2022 EU GHG inventory submission to the UNFCCC, the total GHG emissions, excluding LULUCF and including international aviation, decreased by 34% in the EU-27 + UK compared to the base year 1990 or 1.94 billion tonnes of carbon dioxide equivalent. The achievement of EU internal compliance under the 2020 Climate and Energy Package including the national targets under the ESD is not subject to the UNFCCC assessment of the EU's joint commitment under the Convention.

Finland's emission reduction target for the years 2013-2020 was part of the joint target of the European Union. The historical trend in the EU Member States' total emissions without the LULUCF sector was a key indicator for progress in the achievement of the target. Finland's emission trends 1990 – 2020 are reported in detail in CTF Table 1.

In the following sections, progress in achievement of further, quantified economy-wide emission reduction targets is described through mitigation actions (policies and measures) planned, adopted and implemented for achieving the targets and commitments under the Convention and EU's Climate and Energy Package 2030 as described in the EU legislation entered in force in 2018 and as well as additional national targets set in the Climate Act.

A summary of the progress Finland made towards its emission reduction obligation as a contribution to the EU's joint 2020 target is presented in Section 4.4.

The mitigation actions presented here in Chapter 4 are based on the latest National Climate and Energy Strategy called "Carbon Neutral Finland 2035", the second Medium-term Climate Change Policy Plan and the Climate Plan for the Land Use Sector, all of which were finalized in 2022 (see Chapter 7, Section 7.2 for further details).The focus in the description of the mitigation actions is in the period starting from 2021.

The National Climate and Energy Strategy sets out the key starting points and objectives of the Government Programme goals, including the EU 2030 targets and national carbon neutrality target by 2035. 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.

The mitigation actions are presented separately for the 'With Measures' projection (WM) and the 'With Additional Measures (WAM)' projection (see Section 5.1). Policies and measures that have been implemented by July 2022 are included in the "With Measures" (WM) projection. The "With Additional Measures" (WAM) projection includes in addition policies and measures that are planned but not implemented before 1 August 2022. Finland does not provide a without measures (WOM) projection. A pure "Without Measures Projection" (WOM) is not applicable for Finland's national circumstances: Mitigation policies and measures (such as measures related to energy efficiency improvements and use of renewable energy) have been implemented since the 1970s; any WOM projection created based on previous climate and energy strategies (e.g. 2016, 2013, 2008, or 2005) would therefore be very complicated and require significant effort, particularly in predicting the industrial structure. The technology development outlook in the energy sector would also be quite different without the current emissions trading system and binding renewable energy targets set by the EU. In other words, the

outcome would be a quite arbitrary WOM projection. A more reliable and suitable approach is to compare current projections with WM projections from previous years. This is presented in Finland's eight National Communication (Section 5.4).

Information on domestic institutional arrangements for reporting within national climate policy framework, including arrangements used for domestic compliance, monitoring, reporting, archiving of information and evaluation of the progress towards its economy-wide emission reduction target is given in Finland's eight National Communication (see also Sections 4.5 and 7.1 of this report) for information. Changes in domestic institutional arrangements are described in Section 4.5 of this report.

Emissions/removals in the LULUCF sector are not included in the EU 2020 target under the Convention. They are therefore not included in CTF Table 4 and CTF Table 4(a) is left empty, although CTF Table 4(a)II was filled based on the CRF tables for information only. However, mitigation actions in the LULUCF sector are described in Section 4.2 below and presented in CTF Table 3. Also, projections for the LULUCF sector are presented in Chapter 5 and in CTF Tables 6(a) and 6(c).

4.2 Mitigation actions and their effects

Finnish regulations, policies, and measures are strongly affected by the increasing number of directives, policies, and measures of the EU. This chapter provides information on the most important policies and measures related to the reduction of greenhouse gas emissions. Both existing and planned measures are described. The mitigation actions, or policies and measures, and their effects are presented in detail in CTF Table 3 and described by sector in the sections below.

Finland is continuously seeking to improve the information on the effects of the policies and measures. For some individual measures, Finland has been unable to provide quantified estimates on the impacts on national emissions. These are marked with the notation key NE (not estimated) in the CTF Table 3. There are various reasons why it has not been possible to make the estimates, such as complexity and the overlaps with other measures (for example, the EU ETS), the measure is still in a phase in which the details of implementation are unknown (for example, recently decided agricultural measures such as new types of animal feed additives), the policy or measure targets heterogenous groups and/or many actors with different responses to the measure, or where the quantification of the effect is difficult (for example, measures providing customer advice and information).

For measures targeting F gas emissions and measures in the waste sector, only aggregate impact estimates of the policies and measures are provided to avoid double counting and improve the accuracy of the estimated effects. The impacts of the individual measures are marked with IE (included elsewhere) in the CTF Table 3, and the aggregated estimates are provided for the group of measures. The notation Partly IE, partly included elsewhere, is used in the table for the emissions reduction impact of the investment aid for new energy technology demonstration projects. The emissions reduction has not been estimated separately for this measure because of the wide scope of possible projects being supported. The impact may partly be covered already by the emissions reduction figures for the measures promoting different renewable energy sources. In other words, the total emissions reduction figures for the renewable energy measures are presumably somewhat on the low side. The energy sector policies and measures are split under three headings. Section 4.2.1 presents all energy sector policies and measures except those targeted for the transport sector. Policies and measures in the transport sector are presented in Sections 4.2.2 and 4.2.3.

4.2.1 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, over about half of which are domestic (energy for transport not included). The major trend is a steady increase both absolutely and in relative terms in the use of renewable energy. Direct governmental intervention to guide the choice of energy sources is rare in Finland. However, economic instruments, i.e. taxation and subsidies, are used to

improve energy efficiency and to promote the development of domestic energy sources such as biomass, hydro, wind and solar. For example, new wind power projects established between 2011 and 2017 were eligible for substantial subsidies in the form of a feed-in tariff scheme. The feed-in tariff was also granted to biomass power plants until the end of 2018. The energy market has since undergone and is still undergoing a significant turning point in the investment climate. It is illustrated by the ongoing boom in new wind power projects, which have become profitable without subsidies, for example. In addition to actual energy taxes, the EU ETS acts as sort of tax on carbon, which directs new investments from fossil fuels to renewables. In addition, the recent disruption to the global energy market because of Russia's attack on Ukraine has accelerated the structural changes even further by underlining the need to advance domestic renewables from the energy security angle.

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 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 Emissions Trading System (ETS), energy taxation, 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, i.e. a voluntary scheme for industry and municipalities, have proved 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 CTF Table 3. Energy taxation and tax-related subsidies are described in Section 4.3.

EU Emissions Trading System

The EU ETS continues to be the most important economic policy instrument for reducing emissions in the EU and its Member States. Under the system, emissions are limited under an EU-wide cap, which sets the maximum amount of emissions for all operators obliged to participate in the system. The system is divided into periods for which the emissions reduction target and the representative cap are established. In addition, more significant rule changes usually take place as the period changes.

The EU ETS covers operators from power production, industrial processes and aviation limited to flights within the European Economic Area. The covered GHG gases are CO_2 and N_2O and PFC emissions from certain industries. EU-wide, some 11,000 installations are included in the EU ETS. There are around 600 installations in Finland. Greenhouse gas emissions in the emission trading sector and non-emissions trading sector from 2005 to 2020 are presented in Table 4.1. At the beginning of 2020, the EU ETS was linked with Switzerland's trading system, allowing more flexibility for the use of allowances for both entities.

Table 4.1 Greenhouse gas emissions in the emissions trading (ETS) sector and non-emissions trading sector in Finland in 2005, 2010, 2015 and 2020, 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. Total national emissions (also for 1990) and emissions from domestic aviation are also presented.

	1990	2005	2010	2015	2020
ETS	NA	35.5	41.9	25.4	19.6
of which energy	NA	29.6	37.3	21.5	16.0
industrial processes	NA	3.6	4.0	3.9	3.6
Non-ETS	NA	34.2	33.6	29.5	28.1
CO_2 emissions from domestic civil aviation	NA	0.3	0.2	0.2	0.1
Total	**71.18**	**69.9**	**75.7**	**55.0**	**47.8**

Due to a statistical difference between the greenhouse gas inventory and ETS data, sums may not add up.

Scope of the EU ETS in trading period from 2013 to 2020 has been used.

Over the years, the EU ETS has undergone several reforms such as increasingly harmonised EU-wide rules, more ambitious emissions reduction targets, the introduction of auctioning as the primary allocation method and the establishment of the Market Stability Reserve (MSR), a mechanism that aims to decrease the allowance surplus in the market and improve its resilience to future recessions.

During Phase 4, that is, between 2021 and 2030, 57 per cent of allowances are allocated in auctions, and the rest is granted directly to installations as free allocation. Most Member States, including Finland, auction their allowance shares in joint auctions organised by the European Energy Exchange (EEX). During Phase 3, Finland's appointed auctioneer, the Energy Authority, accounted for a total EUR 1.10 billion of state revenues.

All sectors except electricity production and carbon capture, transport, and storage are entitled to apply for a free allocation. Sectors considered to have the highest risk of carbon leakage will continue to receive full free allocation; sectors considered to be less exposed will get 30 per cent compared to their demand. Starting from 2026, free allocation will gradually phase out for the less exposed sectors, with the exception of district heating.

Phasing out coal

Finland has committed to phasing out coal in the energy sector. Achieving this consists of two measures. One is setting a deadline by law; the other is an additional financial incentive to act sooner.

In 2019, a law[16] prohibiting the use of coal in energy production from 1 May 2029 was enforced. The prohibition was estimated to reduce the use of coal by 3 TWh compared to market-based development without the prohibition. The avoided greenhouse gas emissions equal 0.65 million tonnes of CO_2.

To accelerate the coal phase-out, a special incentive package to support replacement investments was introduced for those energy utilities that undertook to give up the use of coal already by 2025.

[16] 416/2019

The Ministry of Economic Affairs and Employment opened a call for investment subsidies for projects accelerating the replacement of coal in energy production. In 2021, almost EUR 23 million was granted for this purpose in the energy aid mandate. The aid was granted to projects that promoted the production or use of renewable energy, energy saving, or more efficient generation and energy use. Priority was given to projects based on technologies other than combustion. After these projects, the priority was given to combined heat and power production before separate heat production. Novelty and the demonstration potential of the projects was also considered. After these projects are completed by 2025 at the latest, coal will be virtually out of the fuel mix used in the energy sector.

Low-carbon roadmaps

The Government Programmes in 2019 stated that sector-specific roadmaps to low-carbon operation would be prepared in cooperation with the sector's operators. The roadmaps would be used to achieve a better understanding of the scale, costs, and conditions of the required actions.

A total of 13 sectors produced their own roadmaps in coordinated cooperation. In addition, a bioenergy association and one labour organisation published reports to contribute to the roadmap project. A separate Roadmap to fossil-free transport (Government resolution on reducing domestic transport's greenhouse gas emissions) was also adopted in 2021. The sectors had independent control over the drafting and execution of their roadmaps – the guiding principle was that each sector would know their field best. The sectors coordinated the production of their roadmaps internally by engaging with and listening to different operators at different stages of the process. The Ministry of Economic Affairs and Employment (MEAE) supported the sectors by coordinating the whole project, offering guidance, and arranging regular discussions and seminars. Low-carbon road maps were prepared for the following sectors [17]:

- Agriculture
- Bioenergy industry
- Chemical industry
- Commerce
- Construction industry
- Energy industry
- Food industry
- Forest industry
- Hospitality industry
- Logistics and transport
- Property owners and developers
- Sawmill industry
- Technology industries
- Textile industry

Typically, the roadmaps include a comprehensive description of the current situation, an evaluation of emissions-reducing technologies and measures, and an estimate of achievable reductions. The roadmaps also use scenario analysis to assess coming developments. The scenarios include a baseline that depicts the effect of the current operating environment, and nearly all roadmaps included one or two low-carbon scenarios.

The roadmaps show potential for significant reductions in greenhouse gas emissions in different sectors. The results of the roadmap project were used as a direct input for the Government's climate and energy strategy, and many other government plans related to energy and climate policy. Furthermore, the roadmaps will guide the allocation of RDI investments and the preparation of sustainable recovery measures, for example.

[17] https://www.climate2035.fi/

Energy efficiency

The Finnish economy is relatively energy-intensive, which has led to fairly high per capita greenhouse gas emissions. 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 shifted significantly towards less energy-intensive industries, Finland still has a considerable number of energy-intensive industries.

The need for space heating, measured by average heating degree-days, is one of the largest in the world. In addition, the relatively large geographical area and sparse population are factors that increase energy intensity.

In terms of the efficiency of energy use and improving energy efficiency, Finland is among the world's leading countries. Co-generation of heat and electricity, the broad coverage of energy efficiency agreements (the first agreement period started as early as 1997; the third period, 2017 to 2025, is currently ongoing), and the systematic implementation of energy audits since the early 1990s are good examples of successful energy efficiency measures.

Energy Efficiency Directive

The Energy Efficiency Directive (EED) made the energy audits mandatory for big companies. The EED has been implemented mainly with the Energy Efficiency Law[18], which entered into force at the beginning of 2015.

Energy efficiency requirements have designated the public sector as liable for setting an example in promoting energy conservation. Other focus areas include the development of an energy-efficient community structure and enhancement of energy efficiency in the heating of buildings, transport, household use, agriculture, industry, and the entire service sector.

Most energy saving measures are based on EU-wide solutions, regulations and recommendations. Public financing is targeted, inter alia, at research and development activities and enhancement of competences, whereas fiscal solutions emphasise motivating energy savings while ensuring the conditions needed for industry to operate solidly.

For the subsidised energy audit programme, the realised annual CO_2 emissions reductions will decline and are estimated to be 0.37 million tonnes in 2020, and 0.11 million tonnes in 2040. In contrast, the realised annual CO_2 emissions reduction related to mandatory energy audits is estimated to grow, being 0.13 million tonnes in 2020 and 0.31 million tonnes in 2040. The great majority of the emissions reductions, around 95 per cent, is estimated to occur in the emissions trading sector due to the large share of electricity and district heat in energy savings. Buildings' energy use is discussed below in a separate section of this chapter.

Voluntary energy efficiency agreements

Voluntary Energy Efficiency Agreements[19] have played a central role since 1997 in increasing energy efficiency. They cover industries, private services, and municipalities, as well as oil-heated buildings. The agreements have played a central role in implementing both national energy policy and EU energy efficiency obligations. The role of the agreements has been especially important in achieving Finland's binding cumulative energy savings target under EED Article 7. Based on the implemented measures during the agreement period from 2008 to 2016, and the current period from 2017 to 2025, the annual savings in force were about

[18] 1429/2014

[19] https://energiatehokkuussopimukset2017-2025.fi/
(in Finnish), limited content in English https://energiatehokkuussopimukset2017-2025.fi/en/

18.3 TWh of heat and fuels and 5 TWh of electricity at the end of 2020. Energy Efficiency Agreements accounted for well over 60 per cent of the total energy consumption in Finland at the end of 2020.

The estimated annual CO_2 emissions reductions achieved by the Energy Efficiency Agreement was 7.7 million tonnes in 2020, and will be 9.7 million tonnes in 2040. Most of the emissions reductions, well over 95 per cent, are expected to occur in the emissions trading sector due to the large share of electricity and district heat in energy savings. The estimates reported for 2040 are calculated based on assumptions that the current agreement period from 2017 to 2025 will continue.

In 2010, an energy efficiency agreement was also launched in the agricultural sector under the Ministry of Agriculture and Forestry. The agreement was updated in 2016 for the period from 2016 to 2020. The new agreement is under preparation. Farms have received energy advice in the scope of the Farm Energy Programme (2010 to 2015) the Rural Development Programme for Mainland Finland (2016 to 2020) and the CAP transitional period 2021 to 2022. Energy efficiency measures in agriculture are farm re-parcelling to reduce energy use in farm traffic, support fresh grain silos where energy use for drying of grain is avoided, and support investments in unheated cattle buildings and heat recovery from pig slurry. The new CAP 2023 to 2027 period begins in January 2023, and it includes similar measures.

Renewable energy

Finland is one of the world's leading users of renewable energy sources, especially bioenergy. The most important renewable energy sources include bioenergy – wood and wood-based fuels and especially the side-products of the forest industry – hydropower, wind power, ground and air heat pump energy and solar energy. In 2020, the share of renewable energy sources increased to 44.6 per cent of final energy consumption. Finland has agreed statistical transfers with Belgium in the fulfilment of binding renewable energy obligations set by the European Union. When considering statistical transfers, the share of renewable energy sources in 2020 was 43.9 per cent of final energy consumption.

The most significant part of the renewable energy supply comes from biomass, especially from the side-products of the forest industry. The remainder of the renewable energy supply comes mainly from hydro and wind power. The capacity of onshore wind power is rapidly becoming market based. The National Energy and Climate Strategy outlines actions to further increase the share of renewable energy. In 2019, Finland set a target in its integrated energy and climate plan of a 51 per cent share for Finland's national contribution to the European Union's joint target of 32 per cent of renewable energy in 2030.

Policies and measures in the field of renewable energy focus on promoting renewable energy production from various renewable sources (e.g. wind power, wood chips, solar, biogas and bioliquids) and promoting new energy technology demonstration projects.

The sliding feed-in premium system for the production of electricity from renewable energy sources came into force in 2011. The aid scheme concerns government support for electricity production based on wind power, biogas and wood fuels. There is also a separate premium scheme for forest chip use (instead of peat and coal) for CHP plants. The sliding feed-in premium is paid for a maximum of 12 years per plant. The premium level slides according to the average electricity price, average emission allowance price, or tax on peat, depending on the energy source. New plants are not approved for the sliding feed-in premium system. The feed-in premium scheme has been replaced by a technology neutral premium scheme based on tendering.

In May 2018, Parliament approved the amendment to the act on production aid for electricity from renewable energy sources, which laid down provisions for the new premium system. The premium system is based on a competitive tendering process, and investments in different renewable energy sources compete so that the cost-effectiveness target is considered. Tendering for 1.4 TWh of renewable electricity took place in December 2018. No new tendering rounds are being planned.

In total, 2,300 MVA of wind power has been approved for the feed-in tariff scheme, and all the winners of the 1.4 TWh tendering process for the premium system were wind power projects. Currently, onshore wind farms have already been developed and built without public financing. Finland's first offshore wind farm was granted a EUR 20 million investment subsidy in 2014 and was completed in 2017. It has a total capacity of 42 MW. This project aimed to demonstrate wind power technologies suitable for winter conditions in the Baltic Sea area where ice conditions can be very challenging due to pack ice. In 2020, the wind power production in Finland was 7.9 TWh.

The Energy Aid (investment subsidy, annual budget approximately EUR 40 million) is targeted at the commercialisation of new technologies, the non-ETS sector (including plants producing advanced biofuels for transport), and non-ETS electricity and heat production (i.e. small-scale production). The aid can be up to 30 per cent of eligible costs for mature technologies and up to 40 per cent for new technology projects. However, the realised aid levels are typically much lower. Moreover, the objective is that the aid for different technologies will be phased out as the technology develops, the costs are reduced, and the competitiveness improves. Farms can also apply for investment aid for energy production plants such as bioenergy boilers or solar PV from another scheme.

The key aim of energy aid is to promote the development of innovative solutions for replacing the energy system with a low-carbon alternative in the long term. Energy aid can be granted for investment and investigation projects that promote:

1. the production or use of renewable energy, which in turn promotes new technology and its commercial utilisation, involves investments in a new plant, or is a replacement investment that significantly increases the production volumes of renewable energy, or that allows the achievement of another positive energy impact that complies with the goal;
2. energy savings or increase the efficiency of energy generation or use;
3. otherwise replacing the energy system with a low carbon one.

Energy aid is discretionary, and priority is given to projects involving new technology.

Since 2019, a separate investment aid budget and call for large-scale energy technology demonstration projects has also been available. For example, in 2021, EUR 90 million was granted to large-scale energy technology demonstration projects. The investment aid is intended for future energy solutions to meet national and EU targets for 2030. The categories of projects they support are renewable biofuels for transport, other than combustion-based heat production and other large-scale demonstration projects involving new technology. The objective of the scheme is to promote nationally and internationally replicable solutions based on new energy technologies.

Other measures that have been implemented to promote renewable energy include an electricity tax exemption for small-scale production, information measures, and in terms of wind power, the development of land-use planning.

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 emissions reduction impacts of renewables, see Section 5.8.3). Using a marginal emission coefficient of 600 t CO_2/GWh, the promotion of wind power will reduce the emissions in 2020 by 4.8 million tonnes CO_2 and in 2030 by 11.1 million tonnes CO_2 (see Table 4.2). The reduction will occur entirely 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-effective 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 emissions reduction achieved due to the use of forest chips was 5.5 million tonnes CO_2 in 2020 and will be 8.1 million tonnes CO_2 in 2030.

Energy taxation provides an incentive for the use of forest chips and forest industry by-products in CHP production and building-specific heat production. The objective is that most forest-based energy will continue to be produced on market terms from the sidestreams of other wood use. Plenty of wood material is produced in forestry management operations and timber harvesting that is unsuitable as raw material for wood processing. By means of various policy measures, this forest biomass will be channelled to replace fossil fuels in heating, CHP production and transport. The use of wood-based fuels will not be promoted by means of an aid scheme if the use of these fuels is profitable without any aid.

Wind power is promoted by reducing barriers for wind power investment and enabling new demonstration projects for offshore wind power. The historic use of and WM projection for renewable energy in Finland is shown in Figure 4.1 and Table 4.2.

Figure 4.1 Historic development and WM projection for renewable energy, TWh

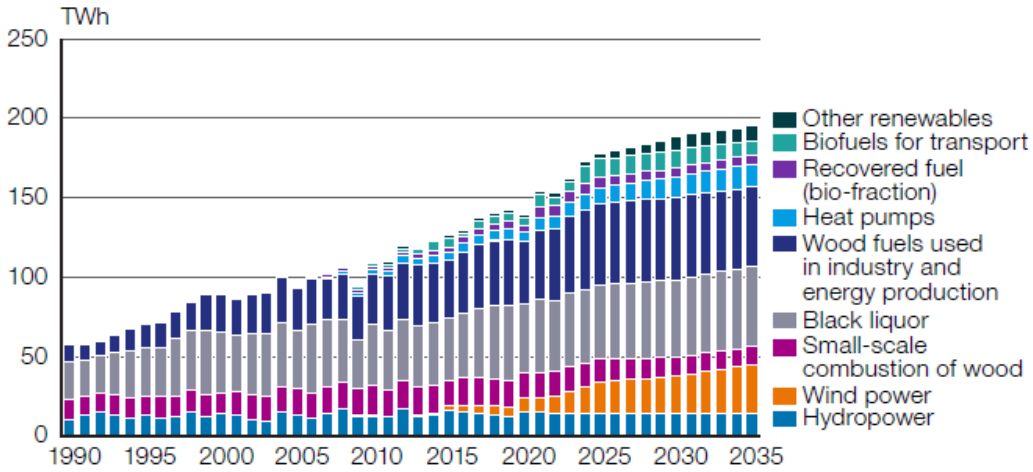


Table 4.2 Historic development and WM projection for renewable energy, TWh

				WM Projection		
	2010	2015	2020	2025	2030	2035
Black liquor	37.7	39.5	43.9	46.5	48.5	50.5
Wood fuels used in industry and energy production	32.3	36.2	39.1	51.1	52.5	49.8
Small-scale combustion of wood	19.2	16.2	15.7	14.1	12.1	11.3
Hydropower	12.7	16.6	15.7	14.3	14.4	14.5
Heat pumps	2.9	4.8	6.6	10.3	12.6	14.5
Wind power	0.3	2.3	7.9	20.0	23.2	30.5
Biofuels for transport	1.6	5.8	4.7	11.6	11.4	8.8
Recovered fuel (bio-fraction)	1.7	3.2	3.8	6.3	5.5	5.7
Other renewables	1.5	1.6	2.2	3.2	8.7	9.3
Total	**109.9**	**126.3**	**139.6**	**177.4**	**188.7**	**195.0**

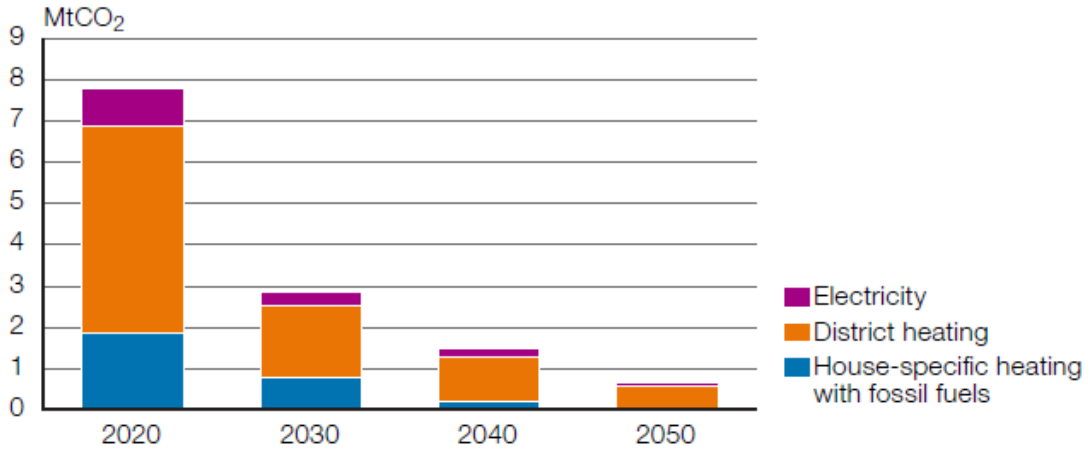
Renewable energy policies and measures for the transport sector are described in Section 4.2.2.

Energy use in residential and other buildings

Policies and measures for buildings and housing aim to improve energy efficiency, making energy use in buildings smarter, 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. Measures are targeted both at new buildings and the existing building stock, including the use and maintenance of the building stock. In addition to policy measures in the building sector, energy use is affected by the EU emissions trading system ETS via changes in the prices of heat and electricity.

Figure 4.2 shows the predicted development of emissions caused by space heating, according to which emissions will decrease sharply by 2050. 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. Most district heating production falls within the sphere of the EU ETS. The total space heating energy used in residential, commercial and public buildings was 70 TWh in 2020 (24 per cent of the total end use of energy in Finland). Slightly less than 28 TWh of the space heating belonged to the non-ETS sector in 2020.

Figure 4.2 Heating and cooling energy use CO_2 emissions (million tonnes CO_2)



Source: Finland's renovation building strategy 2020–2050

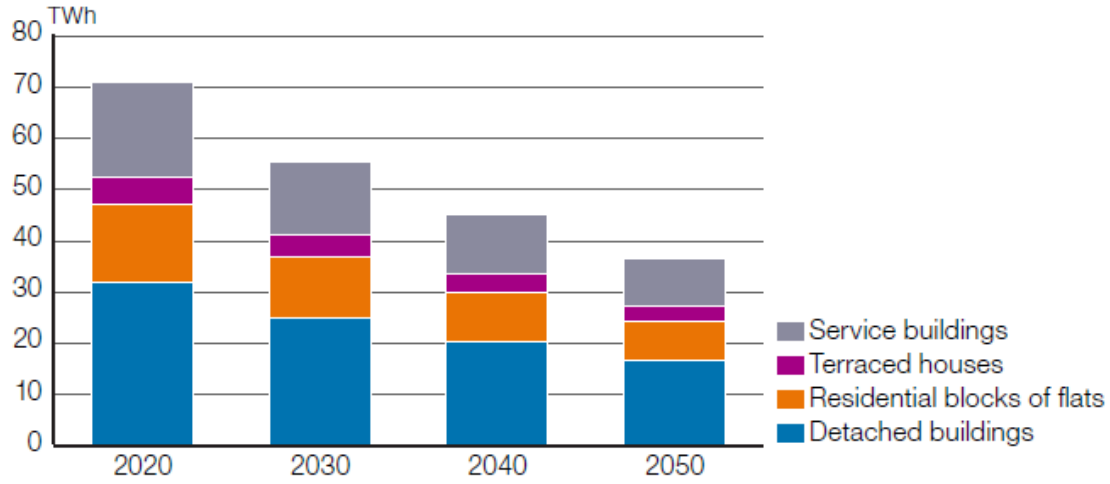
Finland has some specific conditions in the heating and cooling of buildings. The most common heating source in Finland in 2020 was district heating (40 per cent of heat energy use). The second most common heating source in Finland in 2020 was electricity (22 per cent). The share of small-scale combustion of wood in heating energy consumption was 20 per cent. The number of heat pumps is increasing rapidly, especially in detached housing, and the share of heat energy use was nine per cent in 2020. The use of natural gas in building-level heating systems is practically non-existent in Finland, but oil boilers were still quite popular in 2020 (eight per cent). Demand for cooling remains low in Finland, but it is expected to increase due to climate change (Figure 4.3). The Directive on the Energy Performance of Buildings (EPBD) 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
- The Ministry of the Environment Decree on Energy Certification of Buildings
- Act on inspection of air conditioning systems
- Amendments to the Land Use and Building Act, which was expanded to cover energy efficiency requirements and details on how energy efficiency should be calculated.

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 re-

quirements were further tightened (by 20 per cent) in March 2011 due to the implementation of the Directive on the Energy Performance and it is based on the overall energy consumption, which considers, among other things, air conditioning, cooling, lighting and heating, washing water, and heating energy. The regulation favours the utilisation of district heating and renewable energy in defining the overall energy performance of a building. Moreover, 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 on improving the energy performance of buildings undergoing renovation or alteration came into force in June 2013. Due to the implementation of the EPBD, energy regulations were again revised in 2017, and nearly zero-energy regulations for new buildings were given, and new regulations entered into force, on 1 January 2018.

Figure 4.3 Heating and cooling use of buildings by building type, TWh



Source: Finland's renovation building strategy 2020–2050

The Ministry of the Environment is responsible for legislation and guidelines for energy performance certificates, energy performance certificate templates, and other instructions concerning the issuance of certificates. All new buildings need an energy certificate when applying for the building permit. For existing buildings, energy performance certificates are needed when the building (or part of it, for example, an apartment) is sold or rented. The Housing Finance and Development Centre of Finland (ARA) is the administrative authority ensuring the quality of certificates and the qualified experts, and the appropriate preparation and use of the certificates.

The regulation for the energy performance of new buildings entails about 6.2 million tonnes of annual emissions reductions of CO_2 by 2030. Almost all the emissions reduction will take place in the EU ETS sector through the reduced use of electricity and district heat.

Based on the amendment to the decree of the national building code for sewage and freshwater 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 to heat it. The water measurement instruments provide information on the use of water in each apartment and ensure invoicing is done according to 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. Currently, activities exist for giving internet-based informational guidance, e.g. in repair, energy efficiency, and building maintenance issues.

Finland submitted its Long-Term Renovation Strategy (LTRS) to the EU in 2020. It follows the EPBD 2018/844/EU revision and covers the 2020 existing building stock. The main goals of the Finnish strategy are to decrease the energy use of the existing building stock by 51 per cent by 2050 and the related CO_2 emissions by 92 per cent by 2050. The factors affecting the decrease of energy use and emissions are climate change, removals of buildings from the building stock, retrofitting and building maintenance, the change of

heating sources in buildings, and decreasing the emission intensity of electricity and heating production. The improvements of energy performance in renovations and alterations, the phase-out of oil use in heating and related policies, as well as retrofitting subsidies are policy measures supporting the Finnish LTRS.

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 emissions reductions due to improvements in energy performance in renovations and alterations will be 1.03 million tonnes CO_2 annually in 2030. Most of the emissions reductions will take place in the EU ETS sector. However, there are expected non-ETS emissions reductions from oil fuel boiler replacements, especially in detached houses.

Energy subsidies for retrofitting started in Finland as a new policy measure in 2020, and the subsidies have been decided until 2023. The subsidies are aimed at energy efficiency improvements in the housing sector. The estimated annual impact of the energy subsidies for retrofitting is 0.38 million tonnes of CO_2. The new subsidy is a subsidy for renewing the district heating equipment of residential buildings to be suitable for low-temperature district heating. The grant is available in 2022 and 2023. No methods or data to assess the impact of renewing the district heating equipment.

To reduce greenhouse gas emissions from light fuel oil, an obligation to blend bioliquids with light fuel oil used for heating buildings was approved by Parliament in February 2019. According to the Act on the Promotion of the Use of Biofuel Oil, the proportion of biofuel oil in the light fuel oil used for heating and machinery must be at least 3 per cent in 2021 and increasing thereafter by one per cent per year to at least 10 per cent in 2028. However, it is intended to tighten the obligation to distribute biofuel oil, and the proposed changes will be presented by the Government in the autumn of 2022. According to the stricter obligation, the share of biofuel oil should increase annually by 4.6 per cent from 2025 until 2030, from which the share of biofuel oil in heating should be 30 per cent. The effects of promoting the use of bioliquids on greenhouse gas emissions in heating buildings have been calculated in accordance with the stricter obligation – assuming that from 2030, the share of bioliquids in light fuel oil will be 30 per cent.

A commitment to phase out oil heating in the public sector is included in the Medium-Term Climate Change Policy Plan. Two new policy measures for phasing out oil heating started in 2020. The first subsidy system is for phasing out oil heating in detached houses, and the other subsidy system is for buildings owned by municipalities. The annual impact with the grants available in the budget is estimated be 0.22 million tonnes of CO_2. In 2022, the phase-out of fossil gas heating was included in the subsidy systems.

Finland has decided to take measures of advice as an alternative to obligatory inspections of heating and air conditioning systems laid down in articles 14 and 15 of the EPBD. The coordinating advice programme (advice forum) will cover almost all buildings and gather actors in energy efficiency agreements in the building sector. The annual impact is estimated to be 0.015 million tonnes CO_2. This measure is not included in the WM projection, as there is no detailed information on the impact of the measure on the energy balance.

The emission impacts of building-related policy measures have been evaluated using EKOREM and POLIREM calculation models (see Section 5.8.3) and information on the emission coefficients for district heating and electricity. These models calculate 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 emissions reductions with an average emission coefficient in the case of district heating (190 kg CO_2/MWh) and a mean marginal emission coefficient in the case of electricity (600 kg CO2/MWh).

Machinery

There are several existing measures for reducing CO_2 emissions from non-road mobile machinery. Under Act 418/2019, which entered into force in 2019, the biofuel distribution obligation for light fuel oil stands at 3 per cent in 2021 and will rise to 10 per cent by 2028, leading to reduction of CO_2 emissions from non-road mobile machinery as well. According to the government proposal, the distribution obligation of biofuel oil in light fuel oil will be increased to 30 per cent by 2030. It is planned this will enter into force in the autumn of 2022.

The accounting criteria for taxation on heating fuel were revised at the beginning of 2019 to include fuel life cycle emissions in carbon dioxide emissions. At the same time, tax on light fuel oil was raised by about 2 per cent. From the beginning of 2021, tax on light fuel oil was further raised to EUR 2.7 per megawatt-hour, which is an increase of nearly 11 per cent. The tax increases will affect the price of – and therefore demand for – machinery fuels.

In October 2019, the Ministry of the Environment and the Association of Finnish Technical Traders signed a Green Deal on non-road mobile machinery to increase the percentage of low-emission machinery. Through voluntary commitments made under this agreement, those operating in the sector will aim to increase the supply of fully electric and other low-emission non-road mobile machinery and encourage its wider use. In September 2020, the Ministry of the Environment, Senate Properties, and the Cities of Espoo, Helsinki, Turku, and Vantaa signed a voluntary Green Deal to reduce emissions on construction sites. As part of the implementation of the voluntary Green Deals Motiva created in 2021, a training package for non-road mobile machinery with funding and coordination from the Ministry of the Environment. The training package is freely available for operators in the non-road mobile machinery sector.

The conversion of tractors to use biogas is supported as an environmental investment through agricultural investment subsidies. Subsidies are available for modifications to enable biogas use and for the equipment involved, but not for purchasing the tractor itself. Modifications of diesel engines and accessory purchases to convert tractors and other agricultural machinery to use biogas are eligible for a subsidy as environmental improvement measures. The subsidy covers 35 per cent of eligible costs, including costs of the purchase and installation of new equipment.

Municipal climate change solutions programme

The emissions of municipalities in the effort sharing sector decreased by 19 per cent between 2005 and 2020. This quite modest reduction in emissions relative to the carbon neutrality target shows that further action is still needed to promote climate work in municipalities. The municipal climate change solutions programme of the Ministry of the Environment boosts climate work in Finnish municipalities and regions. The aim is to accelerate climate work of municipalities and regions in a way that is fast, cost-effective, and widely accepted. The programme finances municipalities' and regions' own climate projects and national solutions that support their climate work. At the end of 2021, the programme had funded a total of 118 projects to strengthen municipal and regional climate work throughout Finland. Furthermore, 20 new local and regional projects received funding for climate and circular economy projects in 2022. The programme has a wide variety of measures supporting energy efficiency activities and emissions reductions, e.g. in housing and transport.

Consumer energy advice

One main aim of the Action Plan for Energy Services[20] in the Energy Efficiency Agreement scheme and Energy Efficiency Agreement for oil-heated buildings[21] is to enhance their customer energy use. Energy advice actions have been running since the first agreement period starting in 1997. Customer energy advice is also one of the policy measures notified for Energy Efficiency Directive (EED) article 7 implementation in Finland. When calculating energy savings for these behavioural measures based on advice services, only conservative one-year energy savings lifetime has been considered. Annual estimated energy savings are constantly around one terawatt hour per year, and the CO2 emissions reduction is about 0.4 million tonnes per year.

In parallel with customer advice related to voluntary Energy Efficiency Agreements, the Ministry of Economic Affairs and Employment has been building an energy advice infrastructure for consumers since 2010. In 2014, this responsibility was transferred to the Energy Authority. Motiva Oy, a hundred per cent state-

[20] https://energiatehokkuussopimukset2017-2025.fi/wp-content/uploads/2020/02/Company-Accession-Document-Action-Plan-for-Energy-Services.pdf

[21] https://energiatehokkuussopimukset2017-2025.fi/wp-content/uploads/2020/02/Energy-Efficiency-Agreement-2017-2025-on-the-Distribution-of-Liquid-Heating-FuelsH%C3%96YL%C3%84-IV.pdf

owned sustainable development company in Finland, is the national coordination centre for consumer energy advice. In parallel with field activities in projects, coordination activities have been carried out to strengthen internet, telephone and email advisory services and develop advisor training, communications, marketing, and monitoring and evaluation. Energy advisory services enable consumers to rationalise how they use energy, while they also learn about the opportunities offered by renewable energy sources.

Besides, in 2018, the Energy Authority commenced strengthening of regional advice services as part of the Energy Authority's programme on regional energy and climate work. The main goal of the regional energy advice service is to increase awareness of energy efficiency and renewable energy. In addition to consumers, the target groups are municipalities and small and medium-sized enterprises. To avoid double counting, impacts on consumer advice activities are not assessed separately from customer advice services related to voluntary Energy Efficiency Agreements, as these actions overlap and support each other.

Policies and measures in the WAM projection

Additional measures planned for the energy sector are:

- Improving energy efficiency and promoting the use of alternative fuels in machinery.

Machinery

Some of the planned additional measures for reducing emissions from non-road mobile machinery are extensions to current policy actions, and some are entirely new. Voluntary commitments through Green Deals on zero-emission worksites and non-road mobile machinery will be maintained and expanded. Actions that would promote the attainment of the sector's emissions reduction targets are the inclusion of new machinery classes in the non-road mobile machinery Green Deal and introducing new operators to the zero-emission worksite Green Deal. The aim is to further develop and expand the training project initiated in 2021 in line with the sector's trends.

The Government launched an analysis, assessment and research activity project in September 2021 to investigate political steering mechanisms for reducing emissions from non-road mobile machinery. The results of the investigation will be published in 2022, followed by an assessment of the necessary further measures. The Government is exploring the possibility of introducing procurement support for electric and biogas-powered tractors and other non-road mobile machinery. There is also a continuous effort to improve the knowledge base of emissions calculations from non-road mobile machinery.

The impact of the additional machinery measures on greenhouse gas reduction have yet to be assessed. The measures are thus not included in the overall WAM projection.

Summary of policies and measures

A summary of the policies and measures in the energy sector is presented in CTF Table 3.

4.2.2 Transport

Policies and measures in the WM projection

This chapter focuses on measures related to road transport, although the biofuels distribution obligation also slightly reduces emissions from recreational boats. Measures related to maritime and air transport are described in Chapter 4.2.3, as they mainly concern international transport and bunker fuel emissions. In the WM and WAM projections, the maritime and aviation emissions are, nonetheless, reported in accordance with the CRF-classification of the greenhouse gas inventory.

By 2030, Finland will reduce emissions from domestic transport (without domestic aviation) by at least 50 per cent compared to the 2005 level. The aim is to achieve an entirely fossil-free transport sector by 2045. The measures also contribute to achieving the EU's Effort Sharing Decision target.

In line with the Government Programme, the Ministry of Transport and Communications has prepared a Roadmap for fossil-free transport to reduce greenhouse gas emissions from transport[22]. The Government resolution on the reduction of greenhouse gas emissions in domestic transport, i.e. the Roadmap to fossil-free transport, was completed in May 2021. It formed the basis for planning and sizing the emissions reduction measures for transport in the new Medium-Term Climate Change Policy Plan. The Roadmap includes three phases. In the first, a wide range of aids and incentives to promote emissions-free transport will be implemented. For example, these are the inclusion of biogas and electro-fuels in the distribution obligation legislation, various aids related to the procurement and distribution infrastructure of electric and gas vehicles, support for promoting walking, cycling, and public transport services, transport infrastructure maintenance, and digitalisation in logistics. In the second phase, more measures will be added. More information is needed on their effects on emissions before new decisions on measures can be taken. The possible measures include raising the level of obligations in the distribution obligation act, increasing remote work, promoting both combined transport operations in freight transport and digital solutions for transport, and promoting transport services. In the third phase, once the progress of EU-level measures and the impacts of all the measures of phases 1 and 2 are known, the Government will assess and decide on the possible need for additional national measures in the transport sector. Phase three of the Roadmap is conditional.

The WM projection describes the likely evolution of GHG emissions from road transport according to the best information available, and it includes all measures for which there is a decision by August 2022 (a financing decision on measures requiring funding, or which are otherwise likely to occur). In addition, the projection includes assumptions about the effects of remote work, HCT transport, and digitalisation in logistics, although they are not actual measures. The WM projection contains the following themes, under which there are several measures: 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.

Replacing fossil fuels with alternative transport fuels

The main measures under this theme included in the WM projection are the Biofuels distribution obligation and the Inclusion of biogas and electrofuels in distribution obligation.

The amendment to the national Act on promoting the use of biofuels in transport[23] came into force on 1 January 2011. Under the Act, the annual minimum share of biofuels, measured from the total energy content of petrol, diesel and biofuels delivered for consumption, had to be six per cent in 2011 to 2014 and then gradually rise to 20 per cent in 2020. The energy content of second-generation biofuels, i.e. biofuels produced, for example, from waste material, was considered as double its actual energy content when calculating the share of biofuels for the distribution obligation.

The level of ambition was raised with the amendment to the national Act that came into force on 1 April 2019. Under the Act, the annual minimum share of biofuels, measured from the total energy content of petrol, diesel and biofuels delivered for consumption, must be 18 per cent in 2021 and gradually rise to 30 per cent in 2029. There is also a subtarget for advanced biofuels, starting from two per cent in 2021 and rising to 10 per cent in 2030. Advanced biofuels are produced from feedstock listed in Annex IX Part A of the EU's Renewable Energy Directive (RED II, recast)[24]. After this amendment, there will no longer be double counting of second-generation biofuels in the distribution obligation.

The national Act on promoting the use of biofuels in transport was amended in the spring of 2021 to transpose the EU's Renewable energy directive requirements (RED II, recast)[25] for the transport sector to national legislation. The amendment came into force on 30 June 2021. These requirements include limitations to the shares of food- and feed-based biofuels, biofuels produced from used cooking oil and category 1 and category 2 animal fats and biofuels with a high indirect land-use change-risk. Besides the RED II requirements, the

[22] Publications of the Ministry of Transport and Communications 2021:19, http://urn.fi/URN:ISBN:978-952-243-604-7

[23] 446/2007

[24] (EU) 2018/2001

[25] (EU) 2018/2001

amendment included biomethane and renewable liquid and gaseous transport fuels of non-biological origin in the distribution obligation. The annual minimum share of advanced biofuels and biogas produced from the feedstock listed in Part A of Annex IX of the Renewable Energy Directive and renewable liquid and gaseous transport fuels of non-biological origin must be two per cent in 2021 and rise to 10 per cent in 2030. The legislation has been applied to biogas since 2022 and will be applied to renewable liquid and gaseous transport fuels of non-biological origin from 2023. The name of the act changed to the Act on promoting the use of renewable fuels in the transport sector.

The national Act on promoting the use of renewable fuels in the transport sector was recently amended again so that the annual minimum share of biofuels would be temporarily lowered to 12 per cent during 2022. This amendment was made because of rising fuel prices. The amendment came into force on 8 July 2022. It is also planned to temporarily lower the obligation for the following year; the annual minimum share of biofuels would be 13.5 per cent in 2023. It is planned to raise the obligation on the annual minimum share of renewable fuels in transport to 34 per cent in 2030. These amendments to the national Act on promoting the use of renewable fuels in transport have been prepared and are expected to come into force on 1 January 2023.

The measure of biofuel distribution obligation achieved an estimated reduction of 1.2 million tonnes of CO_2 in transport-related greenhouse gas emissions in 2020. It is expected that biofuels will account for 34 per cent (no double counting) of all fuels consumed in transport in 2030. This means that fossil fuels equating to emissions of an estimated 3.1 million tonnes of CO_2 will be replaced by biofuels in 2030.

The WM projection includes new annual distribution obligation percentages for biofuels for 2022 to 2030, which are 12, 13.5, 28, 29, 29, 30, 31, 32, and 34 per cent (from 2030). The share of biofuels (biogas, biodiesel, electro-fuels) in consumption increases, and the share of fossil fuels (natural gas, diesel, gasoline) in consumption decreases. Biogas and electro-fuels must be included in the distribution obligation in accordance with the Act[26] during 2022 to 2050. The bio-share of transport gas will increase by 5 percentage points per year until the share reaches the 99 per cent level. Biogas replaces biodiesel in fulfilling the distribution obligation: biogas consumption increases, and the corresponding amount of energy decreases from the consumption of biodiesel.

The WM projection estimates that the emissions reduction effects of the increased distribution obligation percentage for biofuels and the inclusion of biogas will total around 0.33 million tonnes CO_2 eq. in 2030.

Improving the energy-efficiency of vehicles

The main measures under this theme included in the WM projection are (1) CO_2 emissions performance standards for new passenger cars and new light commercial vehicles, (2) a purchase subsidy for electric passenger cars, (3) a conversion subsidy for passenger cars, (4) a purchase subsidy for electric or gas-powered light commercial vehicles, and (5) a purchase subsidy for electric or gas-powered heavy-duty vehicles. The vehicle taxation as well as for example support for charging and distribution infrastructures are important measures, but the emissions reduction effects of these measures are difficult to separate from that of other measures and therefore has not been assessed separately.

The regulation of the European Parliament and of the Council[27] setting binding CO_2 emissions performance standards for new passenger cars entered into force in 2009. The objective of the regulation was to establish manufacturer-specific emission performance standards for new passenger cars registered in the EU. The amended Regulation setting CO_2 emission performance standards for new passenger cars and new light commercial vehicles[28] (2019) sets new EU fleetwide CO2 emissions targets for 2025 and 2030, for both newly registered passenger cars and light commercial vehicles. These targets are defined as a percentage reduction from the 2021 starting points: for cars, a 15 per cent reduction from 2025 and a 37.5 per cent reduction from 2030 on, and for light commercial vehicles a 15 per cent reduction from 2025 and a 31 per cent reduction from 2030.The WM projection includes the CO_2 emission targets in accordance with the EU's Fit

[26] 446/2007

[27] 2009/443/EU

[28] 2019/631/EU, adopted in 2019 and applied since 1 January 2020

for 55 proposal, i.e. the CO_2 emission declared by the manufacturer for new passenger cars should be 55 per cent less in 2030 and 100 per cent less in 2035 than in 2021. The corresponding reductions are 50 per cent and 100 per cent for new light commercial vehicles. In addition, the EU's Fit for 55 proposal to revise the 2014 directive on the Alternative Fuels Infrastructure (AFIR) for the construction of electric car charging stations and hydrogen refuelling stations is considered.

In Finland, the tax on passenger vehicles consists of several elements differentiated according to vehicle-specific emissions (CO_2 g/km). Initially, at the first registration, a one-time tax ("car tax") is paid. The car tax rate for new passenger cars and light commercial vehicles powered entirely by electricity or hydrogen is 0 for vehicles introduced since October 2021. The highest tax rate (48.9 per cent) using the WLTP method (48.9 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 the CO_2 emissions of each vehicle, as with the registration tax. This basic part of the emissions-based vehicle tax is EUR 0.15 to 1.80 per day, depending on the car's specific CO_2 emissions. Vehicle tax is collected from the period when it is declared that the vehicle will be used in traffic, or from a period of 365 days if it has been declared that the vehicle has been taken out of traffic. However, for zero-emission vehicles, the amount of tax is now also affected by the date of introduction in traffic. If such a vehicle was used in traffic for the first time on or after 1 October 2021, the amount of basic tax levied per day will be the lowest amount of tax in the tax table plus EUR 0.178.

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, 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 emission rate itself. However, the CO_2 rate and vehicle mass have a certain correlation.

In addition, some changes were implemented in the taxation of fringe benefits from the beginning of 2021. The taxable value of the company car benefit for fully electric vehicles has been reduced by EUR 170 per month for 2021 to 2025. Employer-provided charging of electric vehicles is exempted for 2021 to 2025. Employer-subsidised commuter tickets are tax-free up to EUR 3,400 of the taxable value per year, and employer-provided bicycles are tax-free up to EUR 1,200 of taxable value per year. The tax relief for low-emission cars, which applies to company cars with carbon dioxide emissions (WLTP) between 1 and 100 g/km, went into effect from 2022. The amount of the deduction from the taxable value of the company car benefit is EUR 85 per month, which equates to half the rateable value of fully electric cars of 170 EUR/month. All company cars below the emissions limit will receive a discount, regardless of their propulsion power. The emissions reduction effects of vehicle taxation measures are difficult to separate from that of other measures and have therefore not been assessed separately.

Vehicles' energy efficiency is also promoted by different purchase subsidies. The amended Act on periodic support for the purchase of an alternative propulsion vehicle or conversion of a vehicle to alternative propulsion is effective between 1.1.2022 and 1.12.2024[29]. As of 2018, and currently until 31 March 2023, people who are either buying a new electric car or signing a long-term lease agreement for an electric car may receive a EUR 2,000 purchase subsidy from the Finnish government. For the same period, a conversion subsidy can be obtained for converting a petrol- or diesel-fuelled passenger car for use with gas or ethanol. The conversion subsidy amounts to EUR 1,000 if the car is converted for use with gas and to EUR 200 if the car is converted for use with ethanol. Nearly 9,000 electric car purchase subsidies were granted between 2018 and 2021, amounting to roughly 18 million euros. A total of nearly EUR 1.7 million of conversion subsidies was granted between 2018 and 2021 to approximately 5,600 ethanol vehicles and 500 gas vehicles. Electric cars became increasingly popular between 2018 and 2021, and for the first time, more than 10,000 new fully electric cars were registered in Finland in 2021. Many factors are driving this development, and the purchase subsidy has certainly played a role in accelerating demand for low-emission vehicles.

The Government also promotes the use of alternative transport fuels by supporting the construction of public charging point infrastructure for electric cars and for renewable hydrogen and biogas distribution stations

[29] 1289/2021

until 2025[30]. Appropriations for these purposes have been reserved in the central government budget, starting from 2018. In addition, vehicles' energy efficiency is promoted by the support designed for housing companies' charging point infrastructure.

The purchase of a new electric- or gas-powered light commercial vehicle or lorry or electric trailer may also receive financial support from the Transport and Communications Agency Traficom. The amount of aid is between EUR 2,000 and EUR 50,000, depending on the vehicle.

Finland has been active in providing people with more information about the CO_2 emissions and energy efficiency of passenger cars. Examples of this include the Car Calculator[31] published by the Finnish Climate Change Panel, which is designed to support a consumer's car purchase decisions and displays the cumulative full-life cycle greenhouse gas emissions and costs of different propulsion alternatives. Purchase subsidies and scrapping bonuses have been the subject of much communication and have been of great interest to consumers. The Finnish Transport and Communications Agency Traficom has published a Guidance[32] on the creation of an energy label for cars, as well as an information campaign for alternative power sources[33]. Motiva publishes information on sustainable choices along with a Choosing a Car website[34]. In addition, a Green Deal model for car dealerships was concluded in 2018, directing them to present low-emission vehicle alternatives to customers.

The method for measuring emissions from new passenger cars has changed from the NEDC (New European Driving Cycle) method to the WLTP (Worldwide Harmonised Light Vehicle Test Procedure) method. During the 2008 to 2018 period, the average CO_2 emissions (NEDC) of new cars decreased by 28 per cent. The average CO_2 emissions of new cars in 2021 was 103.2 g/km (WLTP). It decreased by 26 per cent between 2019 and 2021. A total of some 98,500 new cars were sold in 2021, of which 31 per cent were electric cars.

The WM projection estimates that the emissions reduction effects of improving the energy efficiency of cars and light commercial vehicles will total around 0.21 million tonnes CO_2 eq. in 2030, and 0.6 million tonnes CO2 eq. in 2035. The estimate includes the impact of new CO_2 emission performance standards for new passenger cars and light commercial vehicles and the AFIR proposal.

In addition to passenger cars and light commercial vehicles, the energy efficiency of heavy-duty vehicles is expected to further improve. The EU Regulation[35] setting CO_2 emissions standards for heavy-duty vehicles entered into force on 14 August 2019. These first EU-wide CO_2 emissions standards for heavy-duty vehicles set targets for reducing the average emissions from new lorries for 2025 and 2030. The targets are expressed as a percentage reduction of emissions compared to the EU average in the reference period (1 July 2019 to 30 June 2020), and from 2025, the target is a 15 per cent reduction. From 2030, the target is a 30 per cent reduction.

A Car Scrapping Premium campaign took place in 2020 and 2021[36]. The State paid a scrapping premium of between EUR 1,000 and 2,000, depending on the power source of the car to be purchased. The premium could also be used for buying an electric bicycle, a seasonal ticket for public transport services, or a mobility service including public transport, in which case the maximum sum was EUR 1,000. A scrapping premium of EUR 2,000 was awarded for purchasing a new flex-fuel car, i.e. a high blend ethanol car, a gas-fuelled vehicle, a full-electric vehicle, or a rechargeable hybrid with maximum emissions of 95 grams per kilometre, and EUR 1,000 for purchasing a car with maximum CO_2 emissions of 120 grams per kilometre. A total of a

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[30] Government Decree on infrastructure support for electric transport, biogas, and renewable hydrogen between 2022 and 2025 (178/2022) https://finlex.fi/fi/laki/alkup/2022/20220178

[31] https://www.ilmastopaneeli.fi/autokalkulaattori/

[32] https://www.traficom.fi/sites/default/files/media/regulation/Ohje_Kulutus%20ja%20p%C3%A4%C3%A4st%C3%B6tietojen%20esitt%C3%A4minen%20 henkil%C3%B6autoja%20myyt%C3%A4essa.pdf

[33] https://www.traficom.fi/fi/ajavaihtoehtoa (only in Finnish)

[34] https://www.motiva.fi/ratkaisut/kestava_liikenne_ja_liikkuminen/valitse_auto_viisaasti (in Finnish)

[35] 2019/1242/EU

[36] 839/2020

little more than 6,500 scrapping premiums was granted, the majority (71 per cent) of which was used for purchasing an electrically assisted bicycle. This new interest in electrically assisted bicycles was a welcome surprise and tangible proof of the popularity of this relatively new mode of transport. The share of new vehicles of the amount of subsidies granted was a little over a quarter, whereas only a few per cent of the subsidies was used for public transport tickets. A total of eight million euros was allocated for the scrapping premiums.

Measures of vehicle fleet renewal create a so-called slow change in the development of road transport: the change accumulates over the years, as the vehicle fleet rebuilds towards zero emissions. With an increasing proportion of energy consumption in road transport being electricity and hydrogen, the emissions impact of fossil fuel substitution measures is reduced. Measures are mutually supportive – the distribution of biofuels will create precise emissions reductions over the next 10 to 20 years, during which the vehicle fleet will be renewed, and the importance of the biofuel distribution obligation as an emissions reduction measure will decrease.

The stricter new CO_2 emission performance standards for new passenger cars and light commercial vehicles and the recharging and refuelling infrastructure to be built with the AFIR proposal will result in the largest GHG emissions reduction in the WM projection under this theme. The emissions reduction effect will increase in time, as the share of zero-emission vehicles in the fleet increases, especially after 2035. The impact of the purchase subsidy for electric passenger cars is the most significant of all purchase subsidies. The effect will peak in 2030 (−19 kt CO_2 eq.), followed by a steady decline.

The WM projection estimates that the emissions reduction effects of the new measures improving the energy efficiency of vehicles described above will total around 0.41 million tonnes CO_2 eq. in 2030.

Improving the energy-efficiency of the transport system

The main measures or phenomena under this theme included in the WM projection are: (1) the investment programme for walking and cycling; (2) urban transport system plans; (3) remote work; and (4) High Capacity Transport (HCT) and digitalisation in logistics.

Finland is a sparsely populated country, which is why cars will be a vital means of transport both now and in the future. Fortunately, especially in urban areas and inter-urban transport, there are also alternatives to cars, such as public transport, shared transport, walking and cycling. Goods transport can also be made more efficient or moved from roads to rail or waterways. The objective of the Roadmap to fossil-free transport[37] is that the vehicle-kilometres of passenger cars will no longer increase in the 2020s. If people's mobility needs continue to increase, the aim is that this growth in urban areas and inter-urban transport will be directed towards sustainable modes of transport. This would represent an increase of about 10 per cent growth in the traffic performance of each sustainable mode of transport in 2030. For individual households in rural areas, car vehicle-kilometres may continue to increase, but as the population concentrates in urban areas, the combined vehicle-kilometres of households throughout the country should remain at the 2019 level.

Improving the energy efficiency of the transport system can be achieved through measures such as promoting walking, cycling and public transport, as well as transport and land-use coordination. Energy efficiency in the transport sector can also be improved by enabling and developing new mobility services and shared mobility. Intelligent transport and the use of information technology (IT) will help improve both traffic safety and fluency, as well as achieving the environmental targets in the transport sector. It will also create significant business opportunities for companies.

A Programme for the Promotion of Walking and Cycling and a Government Resolution to promote walking and cycling were adopted in 2018. The resolution and the programme include ten sets of measures aiming to increase the number of walking and cycling trips by 30 per cent by 2030. At least half of this increase should

[37] Roadmap to fossil-free transport; http://urn.fi/URN:ISBN:978-952-243-604-7

come from replacing car journeys. An entirely new measure in the programme is a joint Investment Programme by the State and municipalities to improve the conditions for walking and cycling within cities' street networks. To launch the investment programme, a total of EUR 7 million has been allocated for 2018 to 2019, EUR 31.5 million for 2020, EUR 22.4 million for 2021, and an estimated EUR 6.5 to 11 million for 2022.

There is an annual state subsidy of EUR 9.75 million for large urban areas (4 areas) and EUR 8.125 million for medium-sized urban areas (10 areas) to support local public transport. In addition, there is separate EUR 20 million climate-based funding for the competent authorities for public transport. The funding will support low-emission public transport and increase the modal share of public transport. The main part of the climate-based funding is allocated to large urban areas and cities. Due to the Covid-19 pandemic, there was additional state funding for the competent authorities to ensure the level of public transport services. The additional state funding was approximately EUR 220 million between 2020 and 2021. In general, public transport is regulated with the requirements of the EU's PSO regulation. The competent public authorities organise public transport in their area if there is no market-oriented transport.

The popularity of public transport, walking, and cycling is also promoted through Mobility Management. Mobility Management is a broad concept, the objective of which is to reduce dependence on private cars. The aim is to offer better information about alternative transport modes and services, and to promote public transport, cycling, walking, carpooling and car sharing. Mobility Management activities at the city or regional level are supported through an annual appropriation of approximately EUR 0.9 million from the Government. Cities, regions and non-profit organisations can apply for this funding every year. Around 30 to 35 projects have been funded annually since 2012.

The aim of the Mobility-as-a-Service (MaaS) concept is to improve the service level of transport by combining public and private transport services. The entity includes both existing services that have already been established, such as public transport and taxis, and new services that are still under development or becoming established, such as shared-use cars or peer rental. With respect to a positive impact, it is essential that MaaS solutions mainly reduce the vehicle-kilometres of cars and enable an increase in the proportion of public transport modes.[38]

Measures related to improving the efficiency of the transport system have been developed in connection with the preparation of the National Transport System Plan (Traffic12)[39]. The Plan is drawn up for a period of 12 years (2021 to 2032) and will be updated each Government term. The National Transport System Plan addresses the overall transport system, and its objectives are associated with sustainability, accessibility, and efficiency. Measures promoting the integration of different mobility services and new services will be specified in more detail as part of the preparation and implementation of the National Transport System Plan. The objective of the plan is that opportunities to choose more sustainable modes of mobility will improve, particularly in urban areas. In urban areas and inter-urban transport, there needs to be a systematic shift from the current car-centric system to a sustainable mobility system. Under a sustainable mobility system, mobility and transport needs are managed by utilising and combining various transport modes and services. Digitalisation and transport-related information are key. Automation can also help achieve transport emissions reduction targets by improving the competitiveness and attractiveness of public transport, for example.

The development of new service models and the revolution of the transport market has been promoted by the introduction of a unified regulatory act (Act on Transport Services[40]). The Act 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

[38] Roadmap to fossil-free transport; Publications of the Ministry of Transport and Communications 2020:19; pages 38–39
[39] The National Transport System Plan for 2021 to 2032; Publications of the Finnish Government 2021:77; http://urn.fi/URN:ISBN:978-952-383-804-8
[40] 320/2017

is encouraged. The Act envisages that essential data on transport services will be made open, laying down provisions for the interoperability of different ticket and payment systems, to facilitate combinations of different transport services. The Act brings together transport market legislation and creates preconditions for the digitalisation of transport. Digitalisation of transport services in large urban areas was promoted through an annual EUR 3.5 million government subsidy between 2018 and 2022. This has especially supported the development of ticketing and payment systems.

Improving the energy efficiency of the transport system is also promoted by coordinating transport and land use in urban areas and in transport system planning, e.g. through land-use, housing and transport agreements (MAL agreements). Agreements are made between the State and municipalities of the biggest city regions. The aim is to build carbon neutral urban regions and increase the proportion of sustainable means of transport.

It is assumed that driving kilometres will decrease when the same mass can be transported with fewer vehicles. It is assumed that the vehicle-kilometre reduction will change linearly between 2022 and 2030 and remain constant after 2030, as enabling HCT[41]transports requires infrastructure investment such as extensions of intersection areas to suit large combinations. HCT transports have therefore presumably yet to achieve the full potential. It is assumed that digitalisation will contribute to the full potential of HCT transport by increasing operational efficiency, transport smoothness, and optimisation. The impact of digitalisation on emissions is estimated to be small in the short term, but the effect will increase in the longer term. However, Finland is a small country, and the volume of transports may be insufficient to introduce digitalisation cost-effectively. HCT transports and digitalisation are expected to support each other and potentially overlap in terms of impacts, and their impact reductions have therefore been assessed together in the WM projection.

The incentivising of various procurers to invest in environmentally friendly vehicles has been promoted since the EC Clean Vehicles Directive[42](CVD) entered into force. The revised Clean Vehicles Directive[43] promotes clean mobility solutions in public procurement tenders, providing a boost to demand and further deployment of low- and zero-emission vehicles. The Directive sets minimum procurement targets for the share of both light-duty vehicles and heavy-duty vehicles like lorries and buses. The Directive strongly promotes electricity, although biofuels, i.e. biogas or renewable diesel, are also accepted, especially at an early stage. Adopted in 2019, the revised Directive is implemented nationally by the Act on environmental and energy efficiency requirements in vehicle and transport services[44], which entered into force in August 2021, and it places obligations on local and central government to ensure a certain proportion of zero and low-emission vehicles in public procurement processes. For example, the Act applies to the procurement of vehicles and transport services in relation to school transport, waste collection, local bus transport, and transport reimbursed by the Social Insurance Institution of Finland.

HCT transport and digitalisation in logistics will result in the largest greenhouse gas emissions reduction in the WM projection under this theme. The WM projection estimates that the emissions reduction effects of improving the transport system's energy efficiency will total around 0.081 million tonnes CO_2 eq. in 2030.

Policies and measures in the WAM projection

CTF Table 3 sets out the main policies and measures included in the WAM projection for the transport sector. The WAM projection includes the measures that had not been decided or financed by August 2022 or were uncertain for other reasons. It contains the following themes, under which there are several measures: (1) replacing fossil fuels with alternative transport fuels (additional measure); (2) improving the energy effi-

[41] High Capacity Transport

[42] 2009/33/EC

[43] 2019/1161/EU

[44] 740/2021

ciency of vehicles (additional measure); and (3) improving the energy efficiency of the transport system (additional measure).

Replacing fossil fuels with alternative transport fuels (additional measure)

In the longer term, renewable or zero-emission fuels and power sources such as electricity, biofuels, and electro-fuels must replace all fossil fuels in transport. The aim is to end the sale of fossil transport fuels for domestic transport in 2045. If fossil fuels continue to be used in transport in 2045, the objective of fossil-free transport cannot be realised.[45] The WAM projection includes annual distribution obligation percentages for biofuels for 2031 to 2045, which are: 35, 36, 37, 38, 40, 46, 52, 58, 64, 70, 76, 82, 88, 94, and 100 per cent from 2045.

Of all the measures in the WAM projection, increasing the biofuel distribution obligation to 100 per cent will result in the largest reduction in greenhouse gas emissions of all the measures considered in the WAM projection. The WAM projection estimates that the emissions reduction effects of replacing fossil fuels with alternative transport fuels (additional measure) will total around 0.089 million tonnes CO_2 eq. in 2031, peaking at approximately 2.8 million tonnes CO_2 eq. in 2045.

Improving the energy efficiency of vehicles (additional measure)

The main measures under this theme included in the WAM projection are new CO_2 emissions standards for heavy-duty vehicles and a new scrapping premium campaign.

In its Work Programme for 2022, the European Commission plans to review the CO_2 emissions standards for heavy-duty vehicles and establish a legislative framework for the harmonised measurement of transport and logistics emissions to support the transition to zero-emission mobility. It is planned to publish the proposal for the review of the CO_2 emissions standards for heavy-duty vehicles at the end of 2022[46]. The reduction in CO_2 emissions of heavy-duty vehicles with the tightening of standards creates significant GHG emissions reductions. The estimated emissions reduction effect will increase until 2035 (0.16 million tonnes CO_2 eq. in 2035), after which the effect will decrease, although the level of uncertainty about this measure is relatively high.

Thus far, three scrappage premium campaigns have been implemented in Finland. Scrappage premium campaigns should occasionally be repeated to enhance functionality. If necessary, the terms of the campaign should be amended so that the criteria for the cars to be supported reflect the changing situation in the car market as much as possible. Petrol and diesel cars will have to be eliminated altogether in the long term, and support for them will no longer be appropriate closer to 2030.[47] The WAM projection assumes that anyone scrapping their car (model year 2010 or older) in 2023 will receive a scrapping premium when purchasing a new low-emission car (gas car, <95 g/km charging hybrid, full electric, or <120 g/km other internal combustion engine car), public transport season ticket or electric-assisted bicycle. The greenhouse gas emissions reduction effect of the scrappage premium campaign is greatest immediately during and after the implementation of the measure (0.015 million tonnes CO_2 eq. in 2023), although the reduction effect at the level of support studied is moderate.

The WAM projection estimates that the emissions reduction effects of improving the energy efficiency of vehicles (additional measure) will total around 0.16 million tonnes CO_2 eq. in 2035 and decrease thereafter.

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[45] Roadmap to fossil-free transport; Publications of the Ministry of Transport and Communications 2020:19; page 49

[46] COM (2021) 645 final, page 4

[47] Roadmap to fossil-free transport; Publications of the Ministry of Transport and Communications 2020:19; page 27

Improving the energy efficiency of the transport system (additional measure)

The main measures under this theme included in the WAM projection are (1) the Mobility-as-a-Service concept (full potential); (2) the combination of urban transport system plans (rest of the potential), increase in the State funding to public transport for large and medium-sized urban areas, and the increase in the state funding for Mobility Management; (3) the Investment Programme for walking and cycling (full potential); and (4) the EU Emissions Trading System for road transport.

In June 2021, the European Commission published a large legislative package that proposed the establishment of a separate emissions trading system for emissions from road transport. The new emissions trading system would operate alongside the existing one. In Finland, the new emissions trading would cover the emissions from fossil fuels used in road transport[48]. The EU Emissions trading for road transport was included in the theme of Improving the energy efficiency of the transport system, as its effect on the calculation model was to reduce vehicle-kilometres. It could also be transposed to the theme of Improving the energy efficiency of vehicles if the impact of emissions trading on the vehicle fleet was modelled. The emissions reduction effect of emissions trading will be greatest in the years immediately following the implementation of the measure. The impact will be reduced in line with other vehicle-kilometre reduction measures, while the share of zero-emission vehicles in the vehicle fleet increases. The uncertainty created by the synergies towards the emissions reduction effect of emissions trading will be lowest until 2035 and will increase thereafter, as with the measures in question. According to an estimate included in the WAM projection, the impact of the new emissions trading for road transport will be greatest in 2026 (approximately −0.25 million tonnes CO_2 eq.) and decrease thereafter.

The aim of the Mobility-as-a-Service concept is to improve the service level of transport by combining public and private transport services. The core purpose of MaaS is to provide user-friendly, reliable, affordable, and competitive door-to-door mobility services to reduce the need for use of a privately owned car and thus reduce passenger car kilometres. The environmental impact of promoting mobility services will depend on how they are implemented. According to an estimate included in the WAM projection, the impact of MaaS will be greatest in 2030 (approximately −0.029 million tonnes CO_2 eq.) and decrease thereafter.

Under the ´Transport system planning and sustainable transport subsidies theme, there are three measures for which emissions reductions must be jointly assessed. These three measures aiming to reduce passenger car kilometres were combined, as all of them were insufficient to calculate the individual impact of the measures. However, the measures have sufficient background data overlaps and similarities to be combined and thought of as mutually supportive measures. In the development of sustainable transport, it is important to pay attention to the fact that the development conditions depend on cooperation between many different parties and operators. For example, sustainable transport can be promoted through MAL[49] agreements or other contractual procedures, as well as urban transport system plans and related funding.

First, for the urban transport system plans, it was estimated[50] that 15 per cent of activities for promoting sustainable transport in urban areas by 2030 had taken place between 2020 and 2022. A similar rough estimate can also be used for the estimated CO_2 reduction related to the measure.

Second, a measure to increase the allocation of existing public transport support for large and medium-sized urban areas beyond 2024 was included in the projection. By increasing the subsidies for public transport, preparations can be made for increasing passenger volumes, especially in large and medium-sized urban areas, where the emissions reduction potential of public transport is greatest. The funding levels for public transport after 2025 to 2032 will be further specified as part of the preparation and implementation of the

[48] Medium-Term Climate Change Policy Plan – Towards a carbon neutral society in 2035; Publications of the Ministry of the Environment 2022, p. 103

[49] Land-use, housing and transport agreements made between the State and municipalities of the biggest city regions.

[50] The Finnish Transport and Communications Agency Traficom's impact assessment (1.7.2022).

Traffic12 plan.[51]

Third, sustainable transport can be supported by Mobility Management. Currently, between EUR 0.6 and EUR 0.9 million per year is spent on central government transfers for mobility management. It is proposed to increase the budget for state transfers to municipalities and non-profit organisations to EUR 2.5 million per year. In addition, the grant should be extended to private employers to manage workplace mobility.[52]

State funding will also be directed through the investment programme for projects that improve the conditions and attractiveness of walking and cycling and thus increase the number of walking and cycling trips and their contribution to modes of transport. Between 2022 and 2024, the State will direct EUR 30 million/year for the investment programme for walking and cycling. At least EUR 10 million/year of funding will be allocated to improving the conditions of walking and cycling infrastructure on highways and traffic nodes. Funding would therefore amount to EUR 40/year, or a total of EUR 120 million in 2022 to 2024, of which EUR 79.5 million would be additional funding. The subsidy levels after 2024 will be decided as part of the implementation of the Traffic12 plan.

The greenhouse gas emissions reduction effect of measures aimed at reducing passenger car kilometres will be greatest in the 2020s and 2030s and will begin to decline as the number of zero-emission vehicles in the vehicle fleet increases. The transport system plans in urban areas and the state funding of public transport have the greatest emissions reduction potential of these three measures. The emissions reduction impact of the Investment Programme for walking and cycling is moderate at a relatively low level of funding. The uncertainty created by the synergies towards the emissions reduction effect of these measures will be low until 2035, after which the uncertainty will increase significantly by all measures. The uncertainty is likely to be increased by different orders of magnitude of the effects of the different measures. The biofuel distribution obligation, which has a relatively high impact on emissions, will have a stronger impact from 2035.

The WAM projection estimates that the emissions reduction effects of improving the transport system's energy efficiency (additional measure) will peak at around 0.31 million tonnes CO_2 eq. in 2026 and decrease thereafter.

Summary of policies and measures
A summary of the policies and measures in the transport sector is presented in CTF Table 3.

4.2.3 International bunkers

Policies and measures in the WM projection

Finland has actively participated in the International Maritime Organization's (IMO) and International Civil Aviation Organisation's (ICAO) work to limit emissions from international transport.

The 2010 ICAO Assembly adopted the existing global aspirational goals for the international aviation sector of 2 per cent annual fuel efficiency improvements and carbon neutral growth from 2020. Finland welcomes that the ICAO Assembly in 2016 adopted a global carbon-offsetting scheme for international aviation, CORSIA. With this decision, aviation became the first industrial sector to have a global market-based measure scheme in place. Finland has fully supported ICAO's work on the development of Annex 16, Volume IV to the Convention on International Civil Aviation containing the Standards and Recommended Practices (SARPs) for the implementation of CORSIA and has confirmed its participation in the CORSIA from its outset.

[51] Roadmap to fossil-free transport; Publications of the Ministry of Transport and Communications 2020:19; page 46.

[52] Roadmap to fossil-free transport; Publications of the Ministry of Transport and Communications 2020:19; page 34.

Finland welcomes that the Initial IMO Strategy on Reduction of Greenhouse Gas Emissions from Ships was adopted in 2018. It envisages a reduction in total greenhouse gas emissions from international shipping and identifies three levels of ambition. First, the carbon intensity of ships should decline through the implementation of further phases of the Energy Efficiency Design Index (EEDI) for new ships. Second, the carbon intensity of international shipping should decline with reductions in CO_2 emissions per transport work, as an average across international shipping, by at least 40 per cent by 2030, pursuing efforts towards 70 per cent by 2050 compared to 2008. Third, greenhouse gas emissions from international shipping should peak as soon as possible, and the total annual emissions should be reduced by at least 50 per cent by 2050 compared to 2008. According to the Roadmap, by 2023, IMO Member States should agree a final strategy on short-, medium-, and long-term measures, taking the results from the IMO Data Collection System into account. In 2021, the IMO agreed to initiate the revision of the Initial 2018 IMO Strategy on Reduction of GHG Emissions from Ships, recognising the need to strengthen the ambition during the revision process. A final draft Revised IMO GHG Strategy will be considered by 2023 with a view to adoption.

The EU MRV Regulation[53] on monitoring, reporting and verification of carbon dioxide emissions from maritime transport entered into force in 2015. The EU regulation applies to ships greater than 5000 gross tonnage, irrespective of their flag, undertaking following voyages in EU and EFTA regions and it requires ships to monitor and report their CO2 emissions, fuel consumption, transport work and average energy efficiency. In 2016, the IMO approved amendments to the Annex VI on Data Collection System (DCS) for the fuel oil consumption of ships of the International Convention for the Prevention of Pollution from Ships (MARPOL). Under the amendments, ships of 5,000 gross tonnage and above are required to collect consumption data for each type of fuel oil they use, as well as other additionally specified data including proxies for transport work. The aggregated data are reported annually to the flag State, which issues a Statement of Compliance to the ship. Flag States are required to subsequently transfer this data to an IMO Ship Fuel Oil Consumption Database. The IMO is required to produce an annual report for the MEPC, summarising the collected data. These measures were implemented in Finland's national legislation[54] in 2021.

In 2021, the IMO adopted amendments to MARPOL Annex VI, which will require ships to reduce their greenhouse gas emissions. These amendments combine technical and operational approaches to improve the energy efficiency of ships, also providing important building blocks for future GHG reduction measures. The new measures will require all ships to calculate their Energy Efficiency Existing Ship Index (EEXI) by following technical means to improve their energy efficiency and establish their annual operational carbon intensity indicator (CII) and CII rating. Carbon intensity links greenhouse gas emissions to the amount of cargo carried over the travelled distance. Ships will be rated for their energy efficiency (A, B, C, D, E – where A is the best). A ship rated D for three consecutive years, or E, is required to submit a corrective action plan to show how the required index (C or above) would be achieved. The new regulations on EEXI and CII will be implemented in Finland's national legislation between 2023 and 2024.

The EU Emissions Trading System (EU ETS) currently applies to aviation and covers all intra-European Economic Area flights. As a member of the European Union, Finland has participated in the EU ETS from its outset. The EU Emissions Trading System has generally been seen as a cost-effective way to reduce emissions from the activities it covers, as it provides a better incentive to reduce emissions and improve energy efficiency than through air passenger taxes, for example. On the other hand, the system enables additional purchases of emissions rights if it will be very expensive or impossible to reduce emissions by means of new technology, for example. The Commission has estimated that the EU ETS has reduced aviation CO_2 emissions by more than 17 million tonnes per year[55].

Based on the Roadmap for fossil-free transport described in Section 4.4.2 the Government made Resolutions on reducing greenhouse gas emissions from aviation, as well as maritime and inland waterway transport.

[53] (EU) 2015/757

[54] 29.6.2021/669

[55] https://ec.europa.eu/clima/eu-action/transport-emissions/reducing-emissions-aviation_en

According to the Government Resolution[56], emissions from domestic and international air traffic departing from Finland will be reduced by 15 per cent from 2018 levels by 2030 and by 50 per cent by 2045. The emissions reduction target concerns emissions within the sector; in addition, aviation delivers emissions savings in other sectors through various market mechanisms. The Resolution includes 23 measures to reduce aviation emissions through renewable fuels, energy efficiency, and pricing. Finland's 5th Action Plan to Reduce CO_2 Emissions from Aviation[57] was submitted to the ICAO in 2021.

The Government Resolution[58] for maritime transport proposes several measures to facilitate the transition to alternative fuels and propulsion technologies and to support energy efficiency improvements in existing vessels and the development of new low-emission vessels in Finland. In addition, the Resolution highlights the importance of actively exerting influence internationally to reduce emissions from maritime transport, as the greatest impact on the international maritime sector can be achieved by global measures. Finland has shared its National Action Plan to address greenhouse gas emissions from ships at the IMO in 2022.

The Black Carbon (BC) emissions also have a large impact on climate change, especially in the polar regions, and Finland is committed to decreasing black carbon emissions. Accordingly, the Finnish Transport and Communications Agency Traficom with the Finnish Meteorological Institute (FMI), and VTT Technical Research Centre of Finland Ltd have been conducting studies to test the candidate measuring methods and collect data on black carbon emissions from shipping. The results of these studies will be introduced at the IMO. In 2021, the IMO adopted a resolution urging Member States and ship operators to voluntarily use distillate or other cleaner alternative fuels or methods of propulsion safe for ships and could contribute to the reduction of black carbon emissions when operating in or near the Arctic and report on measures and best practices to reduce black carbon emissions from shipping. Accordingly, in 2022, Finland and Denmark proposed draft Black Carbon Guidelines to specify the recommendations for the testing, survey, and certification of marine diesel engines, exhaust gas treatment systems, and low-emission fuels to ensure low black carbon emissions from the engine, installed equipment, or fuel used. The IMO guidelines will be developed based on this proposal.

Policies and measures in the WAM projection

As part of the EU's Fit for 55 package, the Commission has proposed a comprehensive set of changes to the existing EU Emissions Trading System (EU ETS), which should result in an overall emissions reduction of 61 per cent in the sectors concerned by 2030 compared to 2005. The increased ambition is to be achieved by strengthening the current provisions and extending the scope of the scheme. Aviation has been included in the EU ETS since 2012, and it applies to flights between airports in the European Economic Area. During aviation's third emissions trading period, which started in 2021, the total number of emissions allowances will be reduced annually with a linear reduction factor of 2.2 per cent. According to the proposal, the free allocation of allowances will be phased out by 2027, and their linear reduction factor will be tightened from 2.2 to 4.2 per cent from 2024. The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) aims to address any annual increase in total CO_2 emissions from international civil aviation above 2020 levels. Under CORSIA, aircraft operators will be required to purchase offsets for the growth in CO_2 emissions covered by the scheme from 2021. Finland welcomes that CORSIA will be integrated into the EU ETS and will be implemented in it.

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[56] Government resolution on reducing greenhouse gas emissions from aviation; Publications of the Ministry of Transport and Communications 2021:22; http://urn.fi/URN:ISBN:978-952-243-616-0

[57] https://www.traficom.fi/sites/default/files/media/publication/Finlands%20Action%20Plan%20to%20Reduce%20CO2%20Emissions%20from%20Aviation%20Revision%202021.pdf

[58] Government Resolution on reducing greenhouse gas emissions from maritime and inland waterway transport; Publications of the Ministry of Transport and Communications 2021:11; http://urn.fi/URN:ISBN:978-952-243-615-3

The proposal concerning maritime transport in the Fit for 55 package notably aims to include emissions from maritime transport in the EU ETS, increase funding available from the modernisation and innovation funds, and revise the market stability reserve to continue ensuring a stable and well-functioning EU ETS.

The ReFuelEU Aviation and FuelEU Maritime proposals aim to ramp up the production and deployment of renewable and low-carbon fuels. The ReFuelEU Aviation proposal includes a blending obligation for fuel suppliers for sustainable aviation fuel (SAF) and a submandate for synthetic aviation fuel. The goal of FuelEU Maritime is to reduce the greenhouse gas intensity of the energy used onboard by ships by up to 75 per cent by 2050, by promoting the use of greener fuels by ships. Despite progress in recent years, the maritime sector still relies almost entirely on fossil fuels and constitutes a significant source of greenhouse gases and other harmful pollutant emissions.

The Fit for 55 package also includes other proposals related to international bunkers – for example, the Alternative Fuels Infrastructure Regulation (AFIR)[59]. According to the proposal, at least 90 per cent of container ships and passenger ships at the busiest seaports will have access to shoreside electricity supply and at most of the inland waterway ports, at least one installation providing shoreside electricity by 2030. At airports, there should be electricity supply for all aircraft stands next to the terminal by 2025 and all remote stands by 2030 (except airports with fewer than 10,000 flights per year).

In line with this momentum on climate change action, the ICAO has sought to explore the feasibility of a long-term global aspirational goal (LTAG) for international aviation. Over the last two years, the ICAO Committee on Aviation Environmental Protection (CAEP) undertook its technical work on the feasibility study of the LTAG. The LTAG report[60] was unanimously approved at the CAEP/12 meeting in February 2022. The High-Level Meeting on LTAG (HLM-LTAG) was held in July 2022 to prepare for the LTAG deliberations at the 41st ICAO Assembly. Finland welcomes that the Assembly finally reached in October 2022 a historic agreement and adopted a LTAG for international aviation of net-zero carbon emissions by 2050 in support of the UNFCCC Paris Agreement's temperature goal.

Summary of policies and measures

A summary of the policies and measures for international bunkers is presented in CTF Table 3.

4.2.4 Industrial processes and product use

The most important greenhouse gas emissions from industrial processes are CO_2 emissions from iron and steel, hydrogen and cement production. The main factors affecting the development of these emissions have until now mainly included changes in industrial production activity. However, one can observe a clear change today, in which the manufacturing industry is actively seeking low-carbon technology alternatives and significantly reduced process emissions. This is typically not the result of a single measure but several measures strengthening the overall feasibility of new technology investments.

In the WM projection, the growth of industrial production increases emissions, while technology changes reduce them. Most of the industrial process emissions reported in this sector are part of the EU ETS, which is also the main measure for reducing process emissions. The steep rise in EU ETS prices with lower electricity tax, new investment grants and increased climate awareness is motivating manufacturing industry to reduce process emissions. The measures are the same as those for reducing energy emissions and a description of them can be found in Section 4.2.1. No additional measures targeting CO_2 emissions from industrial processes are planned.

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[59] https://www.consilium.europa.eu/en/infographics/fit-for-55-afir-alternative-fuelsinfrastructure-regulation/

[60] https://www.icao.int/environmental-protection/LTAG/Pages/LTAGreport.aspx

The policies and measures described in this chapter therefore only address measures related to F gases.

Policies and measures in the WM projection

The amount of emissions from F gases (HFC, PFC, SF6) was two per cent of the total greenhouse gas emissions in 2020. HFC emissions have increased significantly since the early and mid-1990s when they were introduced as substitutes for ozone-depleting substances in many applications. The peak level of HFC emissions occurred at the end of the 2000s but have since started to decline. The share of PFC emissions of total F gas emissions was only 0.2 per cent in 2020. There is a fluctuation in the total annual PFC emission level. In recent years, emissions have decreased from their peak. The peak level of SF6 emissions occurred in the early and mid-1990s. The level of emissions has since decreased, but there is fluctuation in the total annual emissions level due to the use of SF6 in specific applications in which the consumed amount of SF6 varies year-on-year. F gases are not produced in Finland.

The most important regulations affecting the use and emissions of these gases are the F gas regulation[61] and the directive related to HFC emissions from air conditioning systems in motor vehicles.[62] Technical development has also affected the development of emissions. The main features of the F gas regulation in cutting F gas emissions are a phase-down of HFCs that can be placed on the EU market, bans on the use of HFCs in certain applications and obligations related to leak checking and repairs, F gas recovery and technician training.

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 regulatory measures. The main features of the F gas regulation in cutting the emissions will lead to a replacement of HFCs with low GWP alternatives in most applications.

Emissions from electricity distribution equipment have declined from their peak because of voluntary actions by the industries. A steady increase of emissions is assumed in the future, but the peak emissions level in the 1990s will not be reached. Restrictions forced by the EU regulation will have a decreasing effect on emissions from foam blowing and aerosols in the future.

Policies and measures in the WAM projection

The current measures in the WM projection will already cut the emissions strongly. The WAM projection of F gases is based on a few additional measures that will slightly accelerate the decrease of emissions. These additional measures include the revision of the F gas Regulation, improved control of F gas banks and recovery of F gases, and promotion of alternative non-HFC technologies.

It is estimated that the emissions reduction achieved by these additional measures will be 0.2 million tonnes CO2 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 CTF Table 3.

[61] 2014/517/EC

[62] 2006/40/EC

4.2.5 Agriculture

Policies and measures in the 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 to have profitable domestic production and make agriculture sustainable and multifunctional. The objectives of sustainable and multifunctional agriculture include taking greenhouse gas emissions, the possible need for adaptation measures, and other environmental and socioeconomic aspects into account. These objectives can be reached through the Common Agricultural Policy (CAP) of the EU, as well as through national measures. According to conclusions of the European Council, agricultural production should continue in all areas of the Community.

The starting point of agriculture emissions projection is that domestic food production will be secured and maintained at the current level, and mitigation policies will be implemented where the most cost-effective reduction potential exists. Some of the effective climate policy measures may conflict with other agricultural policy objectives and measures such as securing the availability of food, animal welfare, and the biodiversity of rural areas. If Finnish food 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.

There are measures in the CAP aim to reduce greenhouse gas emissions. Agri-environment-climate measures are part of the Rural Development Programme for Mainland Finland from 2014 to 2020 and the CAP transitional period from 2021 to 2022. 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. Their objectives are to decrease nutrient loading from agriculture in surface waters and groundwaters 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 ammonia emissions, as well as to adapt to climate change.

In the Rural Development Programme for 2014 to 2020 and for the CAP transitional period between 2021 and 2022, there are several measures for climate change mitigation and adaptation: an environment payment for the incorporation of slurry into the soil; recycling of nutrients and organic matter; control of runoff waters; environmental management of grassland; and plant cover on arable land in the winter. Agricultural investment support 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, an investment system for biogas plants. As part of the programme, advisory services will be provided regarding cross-compliance conditions, greening payments, climate change mitigation and adaptation, biodiversity, the protection of water and soil, environment payments, the maintenance of agricultural land, organic production, and issues related to environmental efficiency, including more efficient energy use and renewable energies. The new CAP period from 2023 to 2027 begins in January 2023, and it includes similar, partly improved, climate and agri-environment measures. There will also be a new element: an eco-scheme. The eco-scheme's measures differ from the climate and agri-environment commitments and are more demanding than climate and environmental legislation.

The Rural Development Programmes for Mainland Finland have been the main instruments for implementing climate change mitigation and adaptation measures in the agricultural sector. Rural Development Programmes are evaluated as defined in the Parliament and Council regulation.[63] At programme level, Finland has defined evaluation and implementation plans to evaluate climate change issues[64].

As it is neither possible nor appropriate to implement all climate change mitigation or adaptation measures in agriculture through the EU's Common Agriculture Policy, national measures are also required.

The new Climate Plan for the Land Use Sector[65] complements the climate measures targeted at agricultural peatlands. Alternative measures include raising the groundwater level on peaty arable land to prevent peat decomposition, the promotion of perennial grasslands without tilling and converting agricultural land into managed wetlands (when the area would no longer be used for agricultural production). These measures targeted at agricultural soils also reduce CO_2 emissions in the land use, land-use change and forestry (LULUCF) sector.

In the most recent Medium-Term Climate Change Policy Plan, measures targeting agriculture are partly the same as mentioned in the CAP. However, the plan also includes other national measures that are currently implemented or adopted in Finland. Enteric methane emissions from ruminants can be reduced by changing feeding practices for dairy cows. Using rapeseed cake in the feeding of dairy cows can reduce methane emissions by approximately 10 per cent per litre of milk if the cows are fed predominantly with roughage, i.e. grass[66]. However, as more than 40 per cent of the feed of dairy cows is concentrated feed, rapeseed cake would mostly replace the currently widely used rapeseed meal, and the actual reduction in methane emissions would probably be three to five per cent per cow.

Of the feed additives that reduce enteric methane production, research has advanced furthest regarding 3-NOP (3-nitrooxypropanol), which has recently been approved in the EU as a feed additive for dairy cows and cows for reproduction. In the best-case scenario, this additive may reduce methane emissions from dairy cows by up to 25 per cent, but would entail additional costs for farmers at the same time.

The food consumption measures highlighted in the Medium-Term Climate Change Policy Plan include reducing food waste and eating according to nutritional recommendations. The national target of halving food waste in Finland by 2030 is also in line with Sustainable Development Goal 12.3, "By 2030, halve per capita food waste". The total food waste in the Finnish food chain is estimated to be around 400 to 500 million kilogrammes a year. Food waste occurs at every stage of the food chain, and in terms of volume, it is divided as follows: primary production 12 per cent; industry 20 per cent; trade 18 per cent; food services 20 per cent; and households 30 per cent. The Natural Resources Institute Finland has developed a National Food Waste Road Map[67]. Measures for reducing food waste have been categorised in thematic areas: regulation and policy instruments; education and information guidance; changes in sustainability practices; technological solutions and new business models; research-driven solutions; and cooperation between operators. Emissions impacts of reducing food waste arise when the amount of food waste decreases, and correspondingly, the demand, production and imports of food decrease. As a result, the climate impact of food production will diminish in both the agricultural and land use, land-use change and forestry sectors. EU Member States are also obligated to measure the amount of food waste and report on it in accordance with the Commission's Delegated Decision (EU) 2019/1597.

In addition to the measures referred to above, many other factors may contribute to a reduction in the greenhouse gas emissions from agriculture in 2035. However, the magnitude remains difficult to estimate. For ex-

[63] 1305/2013/EU (rural development regulation)

[64] https://jukuri.luke.fi/handle/10024/544713

[65] https://urn.fi/URN:ISBN:978-952-366-388-6

[66] Maanavilja L. et al. (2021)

[67] Riipi, I. et al. (2021)

ample, gender-selected semen is a relatively new technology. The goal is to reduce the number of male dairy calves and increase the share of faster-growing dairy–beef crossbreed calves among dairy cattle. More research is needed on the use and effects of gender-selected semen, but the method is already rapidly gaining popularity.

Prime Minister Sanna Marin's Government Programme also sets the following implemented measures for reducing emissions in the agricultural sector: improving real estate composition of fields; increasing organic production; the Catch the Carbon programme and recycling of nutrients; and promoting biogas production.

The Ministry of Agriculture and Forestry of Finland has drawn up a development programme for the real estate composition of fields, including the preparation and implementation of the associated measures to improve the competitiveness of agricultural production, while taking the impact on the environment, waters, climate and biodiversity into account. The real estate composition of fields can be markedly improved by parcel or land arrangements. The composition could also be affected by measures in the upcoming Common Agricultural Policy plan and matters associated with ownership, renting systems, and taxation of fields.

One of the methods mentioned in the Government Programme for achieving a climate and environmentally friendly food system is to increase the share of domestic organic products in food production, food processing, domestic consumption, and exports. Organic production is based on good soil management. The cultivation methods used promote the sequestration of organic matter and carbon in soil, which is a precondition for the fertility of fields. At the same time, these methods promote nutrient recycling, reduce dependence on fossil energy and increase farms' nutrient self-sufficiency. The new national organic farming programme, Luomu 2.0[68], was published in the spring of 2021. A more detailed implementation plan and its performance indicators are currently being prepared in cooperation with stakeholders in the organic farming sector.

The Catch the Carbon Research and Innovation Programme is a new kind of climate programme for the agricultural, forestry, and land-use sectors. Catch the Carbon began in 2020 and is implemented under the Government Programme. More than 100 research, development and innovation projects have been funded as part of the programme. These projects create new knowledge on climate-sustainable solutions for agriculture and forestry, engage stakeholders and actors, reduce greenhouse gas emissions, and enhance carbon sinks and reservoirs. There is a special emphasis on communication, interaction and competence to build better and strong implementation of climate-smart agriculture and forestry practices.

The Making Use of Agricultural Nutrients Project[69] was a three-year pilot programme carried out between 2016 and 2018. It was part of the government key project for the circular economy, introduced in the Government Programme. It conveyed information on the funding possibilities related to the recycling of nutrients and essential research knowledge to practical operators. It identified the bottlenecks in nutrient recycling and facilitated their elimination. It also promoted the networking and new experiments of nutrient recycling operators. The project has also been continued in Prime Minister Sanna Marin's Government Programme 2019. In addition to the Making Use of the Agricultural Nutrients Project, there has been investment aid for biogas and advanced biomass processing technologies, i.e. investment aid for nutrient recycling. The aid is intended for larger-scale activities, and it is granted for investments in machinery, equipment, and buildings for processing manure or biogas plant rejects into highly processed fertiliser or other nutrient products that are easily movable and storable. The pilot project and investment aid together support the entire biogas and nutrient cycling chain from the ideation and product development level to production-scale operations. Efforts have also been made to develop statistics for and monitor nutrient recycling, as nutrient recycling is a new challenge for the industry and needs statistical and monitoring mechanisms.

[68] http://urn.fi/URN:ISBN:978-952-366-196-7
[69] https://mmm.fi/ravinteetkiertoon

Ammonia is to some extent involved in greenhouse gas emissions because part of the ammonium nitrogen landing on the ground is transformed into nitrous oxide. International treaties and EU legislation oblige Finland to reduce its ammonia emissions into the air. Approximately 90 per cent of Finland's ammonia emissions originate from agricultural sources. The most effective measures for reducing ammonia emissions from agriculture involve manure, its storage, and its application. Ammonia emissions can also be reduced by measures involving the feeding of domestic animals, but these measures are more difficult to regulate, and impact is more difficult to assess, than measures related to the management of manure[70].

Policies and measures in the WAM projection

In December 2021, the Finnish government set an ambitious emissions reduction target of 29 per cent for Finnish agriculture (including agricultural emissions in the effort sharing sector and land use, land-use change and forestry sector) by 2035. This means emissions from agriculture should decrease by 4.6 Mt CO_2 equivalent by 2035. The potential measures to achieve this target are specified in the Carbon Euro Programme[71]. Many of these measures are also mentioned in the WM projection, but the scale and parameters vary. Controlled subsurface drainage, the promotion of paludiculture, the reduction and replacement of one-year cereal cultivation with grassland, the removal of poorly productive arable land from agricultural production and the afforestation of low-yield arable land are considered the most effective means to reduce emissions from agriculture in organic soils. For mineral soils, carbon sequestration and afforestation have been identified as potential measures for emissions reduction in Finland's conditions. The above-mentioned measures reduce emissions in the agricultural sector, as well as in the land use, land-use change, and forestry sector. Other measures that could help to achieve the 29 per cent emissions reduction target in agriculture are more precise nitrogen fertilisation, the use of additives in feeds for bovines, as well as a decrease in the number of bovines and utilising renewable energy in agriculture.

These measures are partly the same as those identified in the CAP strategic plan for 2023 to 2027, in the Climate Plan for the Land Use Sector, and in the Medium-Term Climate Change Policy Plan.

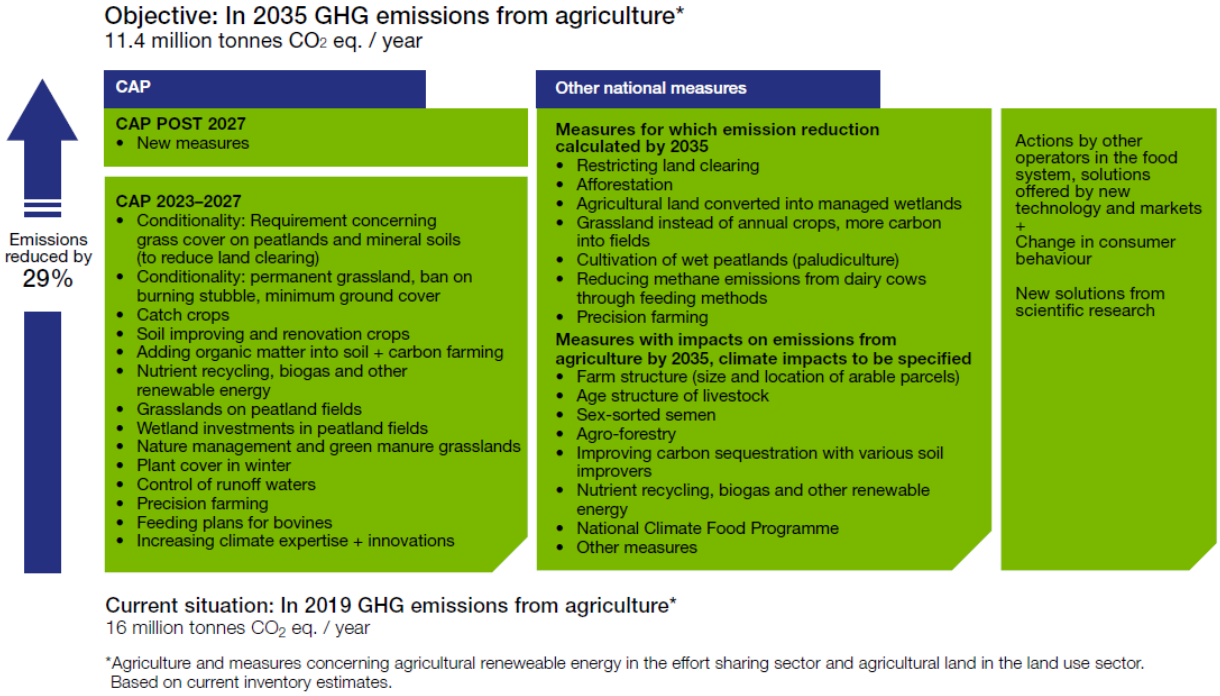
In addition to the mitigation measures mentioned above, it is important to ensure the adequate adaptation of agriculture to climate change. In the agricultural sector, adaptation measures are often also good for mitigation. There is more about adaptation in agriculture in Finland's Eight National Communication, Chapter 6.

Achieving the challenging 29 per cent emissions reduction target is unlikely to be possible with public guidance and incentives alone. Hence, private emissions compensation payments, food industry climate and responsibility programmes, and farm-level solutions and goals, including yield targets, will be needed.

Figure 4.4 specifies the potential measures to achieve the 29 per cent emissions reduction target. The measures are carried out either through the Common Agricultural Policy (CAP) or other national measures.

[70] http://urn.fi/URN:ISBN:978-952-366-192-9
[71] https://mmm.fi/documents/1410837/1516663/HERO_selvitys_2022.pdf/fd751aad-a2f2-a31a-396a-872d034f823b/HERO_selvitys_2022.pdf?t=1650519685134

Figure 4.4 Potential measures to reach the 29 per cent emission reduction target for Finnish agriculture by 2035



In line with the Government Programme, the Ministry of Agriculture and Forestry is currently preparing a Climate Food Programme that aims to support society's transition to a climate-resilient food system. The programme includes measures to enhance sustainable food production and food services. There is a particular emphasis on scaling up the plant protein sector. A climate-resilient food system takes all the dimensions of sustainability into account: social; economic; cultural; and ecological. The programme also supports the objective of the Finnish Government to achieve carbon neutrality in 2035.[72] The emissions reduction impact of the Climate Food Programme has not been estimated.

Finland's national nutrition recommendations are based on the Nordic Nutrition Recommendations, which are currently being updated. The new Nordic recommendation will be launched by the end of 2022, and it will seek to clarify the link between nutrition and sustainable development. There is a potential to reduce the climate impact of diets by changing diet content and taking care of carbon sequestration[73]. A climate-friendly diet may be achieved in multiple ways, but in all cases, it requires a reduction in meat consumption. The emissions reduction impact of the new nutrition recommendations has not been estimated.

A shift towards more plant-based consumer diet will change agricultural production and land-use in a direction with lower emissions, but the greatest emissions reductions will realize after 2035. This is due to dynamics and time lags in milk and beef production and implied land-use change.

Despite the national dietary change, the reduction of greenhouse gas emissions may be slow, if exports of dairy products increase due to strong global demand and prices. Then structural development and productivity will progress, and the change in production and land use will remain small.

Whether consumers reduce their consumption of meat and dairy products as assumed in the scenario depends on the development of consumers' taste and eating habits. When implemented, a more plant-based diet will significantly reduce emissions from livestock production and, together with land use measures, it will also give the opportunity to reduce emissions from cropland, which are currently around 75 per cent of total agricultural emissions.

[72] https://mmm.fi/en/climatefriendlyfoodprogramme

[73] http://urn.fi/URN:ISBN:978-952-287-773-4

In the Medium-Term Climate Change Policy Plan[74] in 2022, additional measures to cut emissions from the agriculture sector that are not yet included in the projections scenario are related to the age structure of cattle and agroforestry. As the life expectancy of cows increases, fewer new heifers will be needed. This will contribute to reducing methane emissions in agriculture.

Currently, however, no policy measures influence the age structure of cattle. By means of agroforestry, it may be possible to improve the fertility of fields, reduce erosion and nutrient leaching, increase biodiversity, and sequester carbon to both soil and vegetation. There is currently very little agroforestry production in Finland. Hence, no concrete policy measures for agroforestry are in practice. Suitable operating models for agroforestry in northern conditions are currently being identified. Therefore, the emission reduction estimate is pending.

Summary of policies and measures

A summary of the policies and measures in the agriculture sector is presented in CTF Table 3.

4.2.6 Land use, land-use change and forestry

Policies and measures in the WM projection

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

- Maintaining 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 overall LULUCF sector is a net sink in Finland because the emissions for which it accounts are smaller than the removals. This net sink from the LULUCF sector can vary greatly from one year to the next: the highest sink was 33.8 million tonnes CO2 eq. in 2009, and the lowest was 10.3 million tonnes CO2 eq. in 2018. According to the National Forest Inventory, the annual increment of growing stock has been increasing since the 1970s, reaching its current level of 103,5 million cubic metres. The high fluctuation in net biomass removals in the forest land category have been caused mainly by the changes in the international market for forest industry products, which affect the amount of domestic commercial roundwood felling.

The Climate Plan for the Land Use Sector, published in 2022, specifies how climate emissions from the land use, land-use change and forestry sector can be reduced, and carbon sinks and reservoirs strengthened. The Plan brings together ongoing measures such as the updated ownership policies of the State Forests (Metsähallitus), the ash fertilisation of peatland forests (part of the Fixed-term Act on the Financing of Sustainable Forestry since 2020), and the Act on Fixed-Term Support for Afforestation, and outlines additional measures categorised in four themes: resource-efficient land use and land-use change; climate-resilient use of peatlands; other measures to promote carbon sequestration and carbon storage; and crosscutting measures (see Tables 4.3 and 4.4). In addition to the ongoing measures presented above, the new measures focus on, e.g. actions in the peatland fields and forests, development of carbon markets, the swift and timely forest regeneration, increasing the amount of dead wood for climate and biodiversity perspectives, promoting training and expertise and communication. The most effective measures have been identified in halting deforestation and promoting actions in the peatlands. The Catch the Carbon programme has been advancing climate measures in the LULUCF sector since its launch in 2020[75].

[74] http://urn.fi/URN:ISBN:978-952-361-262-4

[75] In line with the Government Decree 5/2021.

Table 4.3 Measures identified in the Climate Plan for the Land Use Sector

Resource efficient land use, land use change	Climate-resilient use of peatlands	Other measures to promote carbon sequestration and carbon storage	Enabling environment – cross-cutting measures
To prevent forest conversion to other land uses: • Preventing the conversion of forests into fields • Developing the structure of arable land • Preventing the clearing of forests for settlements • Land use change fee for all land uses	Climate-resilient use of peatland fields: • Raising the groundwater level in peatland fields to prevent the decomposition of peat • Managed wetland on peatland field • Perennial grasslands without tilling • Wetting of low-yield, thick-peat fields and cut-over peatlands to establish managed wetlands • Preparing a roadmap for the use of peatland fields	Climate actions in state owned forests (Metsähallitus)	Competence, training and guidance
		Promoting markets and incentives related to carbon sequestration and storage and the reduction of emissions	Communication and interaction
			EU and international cooperation
		Promoting carbon sequestration and storage in fields	Development and adoptation of technologies
		Promoting the fertilisation of mineral soil forests	HERO programme
		Promoting rapid and efficient forest renewal	Sectoral low-carbon roadmaps
To promote afforestation: • Act on fixed-term support for afforestation • Afforestation of low-yield fields suitable for afforestation			Local and regional cooperation
		Increasing carbon stocks of decaying wood in commercial forests due to biodiversity and climate considerations by leaving retention trees in place	Development of the greenhouse gas inventory and monitoring system
			Catch the Carbon Research and Innovation Programme
	Climate-resilient management and use of peatland forests: • Comprehensive planning of peatland forest management • Promoting ash fertilisation of peatland forests	Climate-resilient continued use of cut-over peatlands	Piloting and implementation (Catch the Carbon development projects)
		Promoting carbon stocks in long-lived wood products and structures	
	Catchment area planning		

Table 4.4 Preliminary climate impacts in 2030 and 2035 of the measures presented in the Climate Plan for the Land Use Sector (million tonnes of carbon dioxide equivalent)

Measure	Area	Climate impact in 2030, million tonnes CO_2 eq.	Climate impact in 2035, million tonnes CO_2 eq.
Owner policy of Metsähallitus		0.4	0.7–0.9
Preventing the conversion of forests into fields	about 1,700–1,900 ha per year		0.5
Act on fixed-term support for afforestation	3,000 ha per year, of which 40% in peat production areas	0.09	0.11
Afforestation of low-yield fields	9,000 ha in 2024–2028	0.09	0.10
Raising the groundwater level in peaty agricultural lands (grasslands) –30 cm	2030: 20,000 ha	0.135	0.219
	2035: 32,500 ha		
Paludiculture, groundwater level –30 cm	2030: 5,000 ha	0.047	0.094
	2035: 10,000 ha		
Paludiculture, groundwater level –5 – –10 cm	2030: 2,500 ha	0.047	0.094
	2035: 5,000 ha		
Managed wetlands	2030: 4,000 ha	0.072	0.136
	2035: 7,500 ha		
Perennial grasslands without tilling	2030: 40,000 ha	0.081	0.081
	2035: 40,000 ha		
Wetting of low-yield, thick-peat fields to establish wetlands	2030: 10,000 ha	0.181	0.181
	2035: 10,000 ha		
Comprehensive planning of peatland forest management (avoidance of remedial ditching)	–	–	–
Comprehensive planning of peatland forest management (continuous cover forestry in mires)	6,000 ha per year	0.21	0.21
Ash fertilisation of peatland forests	26,000 ha per year	0.18	0.40
Promotion of forest fertilization on mineral soils	25,000 ha per year	0.46	0.28
Increasing the carbon stocks of decaying wood in commercial forests due to biodiversity and climate considerations by leaving retention trees in place	–	–	–
Total		**1.99**	**3.11–3.31**

Source: Natural Resources Institute Finland 2022

Finland's forest policy aims for sustainable forest management, and the policy measures include legislation, the National Forest Strategy 2025 (NFS), financial support, and extensive public forestry organisations. More information on them is provided in Finland's Seventh National Communication, Section 4.3. The National Forest Strategy 2025 was adopted by the Government in 2015. It is implemented by ten key projects that were updated in 2019.

According to the NFS, forest growth and health will be maintained and enhanced through active forest management. Climate change mitigation and adaptation in forests are supported by diversifying 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 both the growth and resistance of growing stock to damage, while safeguarding the ecosystem services of forests and producing wood biomass sustainably. The strong legislative and structural basis already in place in Finland can be used to reach multiple climate and forest related objectives of current policies: this includes legislation to prevent forest pests and diseases; ensure forest regeneration and protect habitats and species biodiversity; a long-term programme of forest tree improvement to ensure good-quality seeds to different climatic conditions; ongoing projects to further develop research-based silvicultural measures; and extensive extension services for forest owners in forest management and silviculture. Several updates have been made over the years to this legislative and structural basis, such as amendments to the Forest Act[76] and the Forest Damages Prevention Act[77] to take climate change adaptation into account by allowing more diverse forest management and adjusting timber removal practices to earlier occurrence of pests due to the warming climate. Measures related to the adaptation to climate change are described in more detail in Finland's Eight National Communication. The relevance and functioning of both the Forest Act and the Forest Damages Prevention Act were reviewed recently.

Forests will be a key part of the Finnish bioeconomy, and the NFS therefore aims to increase the use of wood to replace fossil resources with renewable biomass. 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.[78] Global economic development will greatly influence the achievements of the NFS goals.

The national measures are set out in the NFS[79]. The measures, consistent with the National Energy and Climate Strategy for 2030, aim to secure the climate advantages provided by forests and ensure the availability of renewable raw materials. The strategy is implemented by ten strategic projects updated in 2019. The completely new projects added to the National Forest Strategy apply to climate sustainable forestry, international forest policy, and EU policies, as well as new products made from wood. More projects than before also include the diversification of forest management methods, the safeguarding of biodiversity, water protection and the diversification of business. Projects to be considered crosscutting include the improvement of the availability and usability of forest, nature and environmental data and the facilitation of their integration with other data sources. The crosscutting projects also include an aim to build common understanding and cooperation between various actors with pluralistic communication and interaction.

Regarding agricultural soils, measures affecting CO_2 emissions and removals from croplands and grasslands are presented in Table 4.3.

Policies and measures in the WAM projection

The Climate Plan for the Land Use Sector was adopted in 2022. There are no additional measures targeted especially at the LULUCF sector. However, some agricultural measures also affect the emissions in the LULUCF sector.

Information on the 29 per cent emissions reduction targets set for agriculture and measures to achieve this target can be found in paragraph 4.4.5. "Policies and measures in the WAM projection".

Measures identified in the Medium-Term Climate Change Policy Plan related to reducing emissions from

[76] 1093/1996 (amendment 1085/2013)

[77] 1087/2013 (amendment 1168/2021)

[78] 2001/77/EC and 2009/28/EC

[79] http://mmm.fi/en/nfs

organic soils from the agricultural sector also affect emissions from the LULUCF sector (see Section 4.4.5).

Summary of policies and measures

A summary of the policies and measures in the LULUCF sector is presented in CTF Table 3.

4.2.7 Waste management and waste tax

Policies and measures in the WM projection

A Waste Tax Act (1126/2010) entered into force at the beginning of 2011. The purpose of the Waste Tax Act is to collect tax from those waste fractions which could be technically and environmentally recovered, but which are disposed of in landfill sites. The tax list of waste is based on Commission Decision 2000/532/EC on the Waste List. The industrial landfills are also under taxation. The waste tax has been EUR 70 per tonne since 2016.

The National Waste Plan for 2027 was approved by the Government in March 2022. The National Waste Plan includes both a plan to reduce the volume and harmfulness of waste and a waste management plan. The vision of the plan is e.g. to reduce the generation of waste and increase recycling, while reducing greenhouse gas emissions. The Waste Plan proposes measures to achieve the vision and objectives.

The general reform of waste legislation has been conducted in 2021. For example, the following legislation has been amended: the Waste Act[80]; the Decree on Waste[81]; the Government Decree on Landfills[82]; and the Government Decree on Packaging and Packaging Waste[83]. For example, the reform 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. It applies to all forms of waste production and waste management. Enforcement of the amended Waste Act[84] and the Decree on Waste[85] will increase recycling and recovery. Landfilling has been reduced, and greenhouse gas emissions of the waste sector have diminished. The Decree on Packaging and Packaging Waste[86] is also intended to increase recycling.

The restrictions on the landfilling of biodegradable municipal solid and other organic wastes have been made stricter. The Decree on Landfills[87] restricts the amount of biodegradable and other organic waste to less than 10 per cent of total organic carbon or loss on ignition. These restrictions increased the incineration of waste and decreased landfilling. A Biowaste-strategy was prepared in 2004. The objective of the strategy was to ensure that the amount of biodegradable municipal waste placed in landfills would be reduced in accordance with the schedule and numerical targets given in the directive on the landfill of waste[88]. Those targets were achieved and the landfilling of organic waste was heavily restricted in Finland from 2016.

The estimated total emissions reduction of waste management measures is roughly 4 million tonnes of CO_2 eq. per year.

[80] 646/2011

[81] 978/2021

[82] 331/2013

[83] 1029/2021

[84] 646/2011

[85] 978/2021

[86] 1029/2021

[87] 331/2013

[88] 1999/31/EC

Policies and measures in the WAM projection

The Waste Tax Act is currently being amended, and if the amendment is adopted, the amount of the waste tax will be EUR 80 per tonne from the beginning of 2023. In addition, small changes to the tax list of waste have been proposed in the same context. The changes are likely to have a minor impact on greenhouse gas emissions, but it is challenging to assess them. The impact of planned waste sector measures is therefore not included in the overall WAM projection.

Summary of policies and measures

A summary of the policies and measures in the waste sector is presented in CTF Table 3.

4.2.8 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 the cutting of emissions in the urban structure are associated with sustainable urban development: the urban structure and effective functioning of urban subregions; the coordination of land use and transport; the creation of 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 to 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.

The preconditions for increasing wind power production include the coordination of wind power construction with land use in the surrounding areas, giving sufficient consideration for negative impacts and ensuring local acceptability. To promote planning, the Land-Use and Building Act[89] contains specific provisions on local master plans that directly apply to wind power construction. 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 (2017) for the installation and construction of solar panels and solar collectors harmonises and streamlines the permit procedure so that permit consideration will only be required for solar panels or collectors that have significant impacts on the townscape or the environment.

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

Nearly all the regions in Finland and many individual municipalities have prepared their own climate strategies. However, it is difficult to provide quantitative emissions reduction potentials for the policies and measures concerning land-use planning and the urban structure. For example, the urban form influences emissions mainly in the energy sector through its effects on transport and the heating of buildings. Emissions from daily mobility especially may be many times higher in car-oriented zones than in 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 with 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 thus depend not only on the urban structure but on complex processes that include lifestyle changes, as well as economic conditions and development.

The land-use planning measures are included in the energy and transport measures in CTF Table 3.

[89] 132/1999

4.3 Energy taxation and related measures

4.3.1 Energy taxation

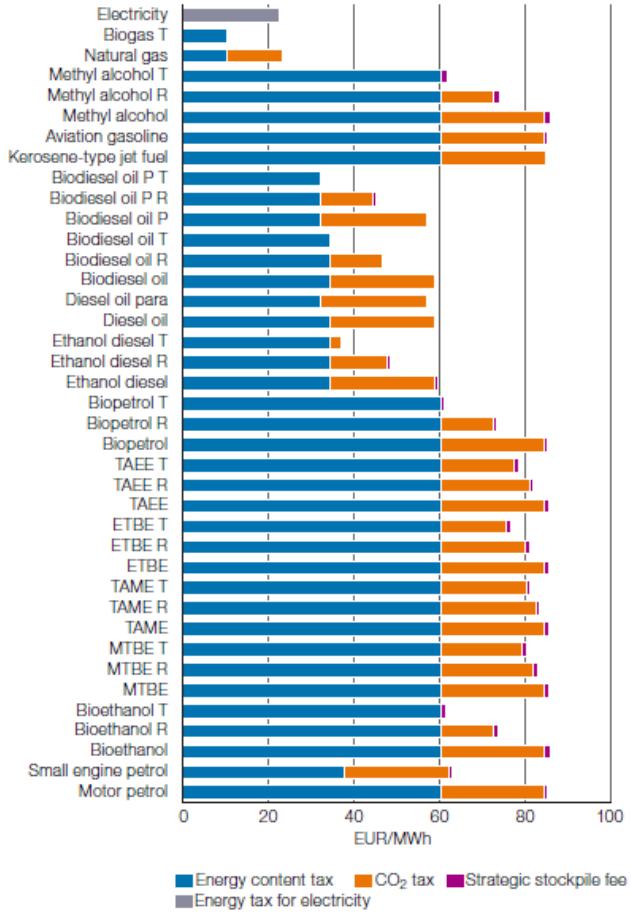
Energy taxation is a key instrument of the Government's climate and energy policy. Energy taxes are levied on electricity, coal, natural gas, peat, tall oil and liquid fuels.[90] The energy taxation of fuels is based on the energy content, life cycle carbon dioxide emissions and local emissions of fuels. The energy content component is levied on both fossil fuels and biofuels, based on their volumetric energy content. The CO_2 component is based on the lifetime CO_2 emissions of the fuel in question, and biofuels are therefore 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. In connection with the excise duties on electricity, coal, natural gas and liquid fuels, the Government also collects a strategic stockpile fee, which is transferred to the National Emergency Supply Agency.

The energy tax rates of fuels used in transport are presented in Figure 4.5. The basis for calculating the carbon dioxide tax on petrol and diesel oil, as well as the corresponding biofuels, is the price of carbon dioxide, or EUR 77 per tonne, and the carbon dioxide emission coefficient specific to each fossil product.[91] The energy content tax on petrol and corresponding biofuels is EUR 0.01681 per MJ, except for small engine petrol, which has a tax reduction of EUR 0.20 per litre. The energy content tax on fossil and bio-based diesel is approximately EUR 0.0072 per MJ lower than on petrol. By imposing a lower tax on diesel, an effort has been made to reduce the costs of HGV transport and consequently the export industry, as well as bus and coach transport. Furthermore, until the end of 2022, a reduction of EUR 0.02 per litre for paraffinic fossil diesel oil and biodiesel is granted on the energy content tax, as the fuels have lower local emissions than conventional fossil fuels. Fuels for commercial aviation and shipping are exempt. Gas oil used in rail transport is taxed at a lower rate; the rate on light fuel oil and electricity used in rail transport is exempt.

[90] 1260/1996 and 1472/1994

[91] As the carbon dioxide tax also factors in the fuel's life cycle carbon dioxide emissions, the price per tonne of carbon dioxide used in the calculation of the CO_2 tax (EUR 77) should be increased by approximately 20 per cent to be comparable to the price of carbon dioxide tonnes calculated based on emissions from combustion alone..

Figure 4.5 Energy tax rates of fuels used in transport in 2022



As the energy content tax on diesel is lower than the environmental criteria of the tax require, and there are no other environmental or other grounds for favouring diesel cars, diesel-powered cars are subject to the tax on driving power as part of annual vehicle tax. It complements fuel taxation and harmonises the cost differences for motorists, arising from the different tax treatment of petrol and diesel based on the average annual transport performance. In addition to diesel cars, the tax on driving power is levied on cars fuelled by other driving powers such as electricity or gas, whose taxation is based on less stringent criteria than the taxation on petrol. Tax on driving power for passenger cars is set as cents per day for each partial or complete 100 kilograms of total vehicle mass. The tax level is 5.5 cents for diesel, 1.5 for electricity, 0.5 for electricity and petrol, 4.9 for electricity and diesel, and 3.1 for methane.[92]

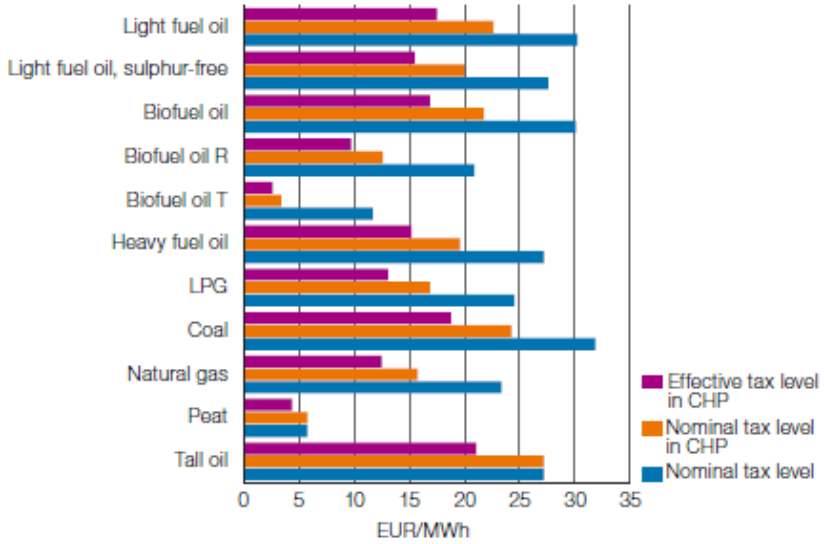
Energy tax rates for fuels used for heating, as well as in power plants and mobile machinery, which are later referred to as heating fuels, are presented in Figure 4.6. The value used in the calculation of the carbon dioxide tax is EUR 53 per tonne of carbon dioxide, and the energy content tax is EUR 10.33 per MWh. As the taxation of peat and tall oil is not based on the environmentally related tax model, they are subject to a separate energy tax rather than the energy content and carbon dioxide taxes. In addition, peat is only subject to tax for the part exceeding 10,000 MWh per plant.[93]Tall oil used for heating is subject to excise duty equivalent to that on heavy fuel oil. The purpose of the tax is to encourage the further processing of tall oil as a chemical industry raw material rather than using it for energy. Gaseous and solid biofuels in heating use are

[92] 1281/2003

[93] The limit for tax-free use of peat for energy will be 10,000 MWh per plant for the period between 2022 and 2026, and 8,000 MWh per plant for the period between 2027 and 2029. From 2030, peat will be subject to a tax in heat production when used in a power plant or heating plant whose peat use exceeds 5,000 MWh.

exempt. For professional agriculture, the energy content tax component included in the price of light fuel oil, heavy fuel oil, and biofuel oil is refunded.[94]

Figure 4.6 Energy tax rates for fuels used for heating, as well as in power plants and mobile machinery in 2022



The fuels used to produce electricity are exempt from tax in both separate condensing power plant production and CHP. Electricity consumption is subject to tax, and taxes are levied on all electricity, regardless of the production method.[95]The tax exemption for fuels used to produce electricity is based on the EU Energy Taxation Directive and motivated by the need to coordinate the functioning of the electricity market and taxation, especially in the import and export of electricity. The excise duty on electricity is differentiated into two categories. Category I tax is generally levied on business activities such as services, forestry, and construction, as well as on electricity used in the public sector and households. Category I electricity tax is EUR 22.4 per MWh. The lower Category II tax covers electricity consumption in industry, mining, data centres, and greenhouses, as well as electricity supplied to certain heat pumps, electric boilers, and recirculating water pumps. While other areas of agriculture also fall into tax Category II, this reduction takes the form of an energy tax refund for agriculture. Category II electricity tax is EUR 0.5 per MWh.

Energy-intensive industry (including mining and greenhouses) is eligible for a tax refund insofar as the amount of excise duties included in the price of taxable energy products used or purchased by it, other than electricity, transport, and machinery fuels, exceeds 1.7 per cent of the company's value added. In this respect, the company is eligible for an 85 per cent refund of the excise duties it has paid. However, a contribution of EUR 50,000 is deducted from the refund. Under the currently valid act, the tax refund for energy-intensive enterprises will be phased out gradually by 2025.

Taxation is included in the mitigation measures for the energy and transport sector in CTF Table 3. In the WM and WAM projections, the taxation structure and levels remain constant as they are in 2022 as there is no plans of changes at the present.

[94] 603/2006 https://finlex.fi/fi/laki/ajantasa/2006/20060603

[95] However, exemptions apply to small-scale electricity production for one's own use. If electricity generated in a micro or small power plant is transmitted through the electricity grid for consumption, however, the tax exemption is not transferred with the electricity, and the network operator transmitting the electricity for consumption is liable to pay Category I or II energy tax on it.

4.3.2 Government expenditure on energy and climate policy

The Finnish government supports the transformation to a greener economy with a variety of different subsidies. The total Government expenditures on energy and climate policy have increased significantly in recent years, with the budget for 2022 being EUR 2,554 million. This expenditure covers a wide range of sectors, and the largest outlays are in subsidies given to energy and agriculture.

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 the public economy's other expenditure needs.

One of the main ways in which the Government supports the transition to greener energy production is a direct subsidy for projects that aim to cut emissions at the firm or municipality level ("Energy Subsidy"). The current total level of this subsidy is EUR 230 million for 2022 (including RRF[96] funding), which is substantially higher than just a few years ago, when it was around EUR 50 million.

In addition, there have been separate fixed-term aid schemes for renewable energy and additional budget authorities for different large demonstration projects. As renewable energy has become more profitable, direct subsidies for renewable production have decreased. These energy-related measures include the Government's key projects related to energy (in total, EUR 100 million between 2016 and 2018), energy projects replacing coal (in total, EUR 90 million between 2020 and 2021), and current Recovery and Resilience Facility (RRF) energy projects (around EUR 500 million between 2022 and 2023) and large demonstration projects. Initially, a total of EUR 200 million was earmarked for large demonstration projects in the period from 2019 to 2022. The Ministerial Working Group on Preparedness decided to increase the budget authority for the energy aid item for the period from 2022 to 2023 by a total of EUR 150 million. At the same time, an additional budget authority was decided for hydrogen projects (EUR 150 million) and battery ecosystem projects (EUR 50 million). The development is partly based on the policies of the previous climate and energy strategy on shifting the focus of renewable energy subsidies from production subsidy type aid schemes to supporting new technologies. In addition, the number of projects has increased significantly and national targets have become stricter.

On top of these subsidies, the Government also actively provides support for R&D projects and rail projects and funding for private sector projects that aim to cut emissions. While this support is divided over several smaller measures, they amount to a total of several hundred million euros annually.

Table 4.5 shows a compilation of funding related to the energy and climate policy from 2018 to 2022 under the General Government Fiscal Plan.

[96] EU's Recovery and Resilience Facility

Table 4.5 Funding under the current General Government Fiscal Plan in accordance with the Government report on the National Energy and Climate Strategy for 2030

Appropriation	2018	2019	2020	2021	2022
	EUR million				
Ministry of Economic Affairs and Employment					
Energy aid	58	47	61	101	231
Investment and operating subsidies for renewable energy and new energy technologies	354	215	337	294	135
Subsidies for green R&D and innovation	120	121	130	143	176
Other measures	189	146	155	180	190
Ministry of Agriculture and Forestry					
Agri-environment payment measures	218	218	185	236	263
Other measures	313	313	398	353	413
Ministry of Transport and Communications					
Investment in rail infrastructure	0	0	8	26	123
Other measures	150	127	521	267	281
Ministry of the Environment					
Investment subsidies for lower emission heating systems	65	70	306	261	323
Other measures	85	86	116	105	105
Ministry for Foreign Affairs					
Development aid for environmental, water and energy related projects	144	159	199	266	283
Other measures	65	70	236	186	184
Total appropriations	**1,761**	**1,573**	**2,651**	**2,418**	**2,706**

4.4 Estimates of emission reductions and removals and the use of units from the market-based mechanisms and land use, land-use change and forestry

Finland's total national greenhouse gas emission without the LULUCF sector are presented in the CTF Table 4. The emissions in 2020 (47.8 million tonnes CO_2 eq.), the most recent inventory year in the latest inventory submission to the UNFCCC, are 33 per cent lower than in the base year 1990.

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"). It is therefore a joint pledge with no separate targets for Member States under the Convention. As stated in the 2022 EU GHG inventory submission to the UNFCCC, the total GHG emissions, excluding LULUCF and including international aviation, decreased by 34% in the EU-27 + UK compared to the base year 1990 or 1.94 billion tonnes of carbon dioxide equivalent. The EU has substantially overachieved its 20 per cent by 2020 reduction target under the Convention, which means that also its Member States and the United Kingdom have fulfilled their emission reduction obligations.

Finland's contribution to the the joint EU 2020 target ("Cancun Pledge"), was to reduce its non-ETS emissions so that the emissions were below the target path (the target is presented in more detail in Section 3.1 and Table 3.1). The progress made in achieving this target is illustrated in the Table 4.6.

Table 4.6 Finland's target path for non-ETS emissions in accordance with the EU Effort Sharing Decision and corresponding emissions for 2013 to 2020

	2013	2014	2015	2016	2017	2018	2019	2020	sum (2013–2020)
Finland's annual emission allocations	31.8	31.3	30.8	30.3	30.2	29.6	29.1	28.5	241.559
Non-ETS emissions[1]	31.6	30.1	29.9	31.4	30.1	29.9	29.6	28.1	240.727
Distance from the target[2]	–0.2	–1.1	–0.9	1.0	–0.1	0.3	0.6	–0.4	–0.832

1 Due to the annual implementation of the EU ESD, the emissions used for assessing compliance are not updated after the compliance assessment. The emissions may therefore differ from the most recent inventory data.

2 Distance from the target is expressed as a negative number when actual emissions are below annual emission allocations.

Finland has not reported on use of market mechanisms in Table 4 or 4(b) as the targets for the years 2013 - 2020 have been met with domestic policies and measures.

Information on the use of flexible mechanisms under the EU ETS (EU-wide measure, see Chapter 3) is reported in the EU's Fifth Biennial Report under the UNFCCC.

The emissions from the LULUCF sector are not included in the EU joint target, or Finland's contribution to the emission reduction under this target under the UNFCCC, and therefore not given in the CTF Tables 4 and 4(a)I but are presented in CTF Table 1. In Finland, the LULUCF sector was a net sink throughout the 1990 to 2020 reporting period, because greenhouse gas removals in the sector exceeded emissions., In 2020, the LULUCF sector as a whole acted as a CO_2 sink for –17.3 million tonnes CO_2 eq. The net removals were –17.3 million tonnes CO_2 eq. in 2020, which was 29 per cent larger than it was in 1990.

4.5 Information on changes in domestic institutional arrangements

Finland has not made major changes in the domestic institutional, legal, administrative and procedural arrangements for domestic compliance, monitoring, reporting and archiving of information and evaluation of the progress towards Finland's emissions reductions obligations and targets since the submission of Finland's Fourth Biennial Report. The present domestic institutional arrangements are described in detail in Chapter 4 of the Finland's 8th National communication.

The new Climate Act (423/2022) entered into force on 1 July 2022, giving a framework for long-term and cost-effective planning and monitoring of climate policy in Finland. The previous Climate Change Act, the first in Finland, was adopted in 2015. The Act sets out several plans that aim to reduce greenhouse gas emissions and adapt to climate change in Finland. It also obliges the central government authorities to monitor the trends in emissions and achievement of climate targets and report on them to Parliament. Pursuant to the new Climate Act (423/2022), a new Sámi Climate Council will be set up. The council is an independent expert body that will identify key issues in terms of promoting Sámi culture in the preparation of national climate policy plans. The council will consist of Sámi people with traditional knowledge and representatives from key disciplines. A government decree regarding the council is currently being prepared in the Ministry of the Environment. The council is to be set up in 2023.

The climate change policy planning system includes a national energy and climate strategy, a medium-term climate change policy plan as well as a long-term climate change policy plan and a national adaptation plan for climate change. Most recent national energy and climate strategy, medium-term climate change policy plan and the climate plan for the land use sector were submitted to Parliament in 2022. In addition, Finland

submitted its Long-Term Strategy (LTS) to the UN and EU in 2020. Information on these plans and strategies is given in Section 7.2 and in Finland's Eight National Communication, Chapter 4.

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 national inventory arrangements and system and changes made to them since the previous biennial report are described in Chapter 2 of this report.

5 Projections

5.1 Overview of WM and WAM projections

The projections presented in this chapter are based on data produced for the National Energy and Climate Strategy, the Medium-term Climate Change Policy Plan and the Climate Plan for the Land Use Sector. All three Government Reports were submitted to Parliament in 2022. For the reports, comprehensive modelling and assessments were conducted by experts from various research fields in an extensive project "Carbon neutral Finland 2035 – measures and impacts of the climate and energy policies" (HIISI project) financed by the Government's analysis, assessment and research activities. The analysis and results of the HIISI project have been complemented by other studies and updated with recent information and data.

The projections' starting point is 2020 (the most recent inventory year available in the annual greenhouse gas emission inventory submission to the UNFCCC in 2022). Policies and measures that have been implemented by July 2022 are included in the "With Measures" (WM) projection. The "With Additional Measures" (WAM) projection includes in addition policies and measures that are planned but not implemented before 1 August 2022. The policies and measures included in the WM and WAM projections, including estimated impacts on greenhouse gas emissions, are presented in more detail in Chapter 4.

A pure "Without Measures Projection" (WOM) is not applicable for Finland's national circumstances and has therefore not been provided: mitigation policies and measures (such as measures related to energy efficiency improvements and use of renewable energy) have been implemented since the 1970s; any WOM projection created based on previous climate and energy strategies (e.g. 2016, 2013, 2008, or 2005) would therefore be very complicated and require significant effort, particularly in predicting the industrial structure. The technology development outlook in the energy sector would also be quite different without the current emissions trading system and binding renewable energy targets set by the EU. In other words, the outcome would be a quite arbitrary WOM projection. A more reliable and suitable approach is to compare current projections with WM projections from previous years. This is done in Section 5.4.

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 implemented new policy measures affecting future emissions compared to the Seventh National Communication are the group of measures promoting emissions-free and energy-efficient road transport, ban on energy use of hard coal, measures phasing out oil heating, and several new measures in agriculture, LULUCF and machinery.

The "With Additional Measures" projection (WAM) includes only a few measures additional to the WM projection, as the National Energy and Climate Strategy, the Medium-term Climate Change Policy Plan and the Climate Plan for the Land Use Sector have recently been approved, and most new measures are therefore adopted or implemented and included in the WM projection. The WAM projection includes the estimated impact of planned future measures regarding F-gases and in the agriculture and transport sectors. These WAM measures are described in Chapter 4.

Statistics Finland's population forecast is used in the projections. The forecast, published in 2019, estimates that the population will increase only slightly from the current 5.53 million (2020) to 5.57 million in 2030. Based on the current development, Finland's population will start decreasing in 2031. In 2050, the population will be some 100,000 lower than today. The average size of households will decrease slightly, while the number of households is expected to grow from 2.7 million to almost 2.9 million during the period. In this population forecast, the population is smaller and flattens out and starts to shrink, contrary to the forecast used in the projections for the Seventh National Communication, which anticipated continuous growth.

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 the "What kind of expertise will Finland need in 2040?" report of Pellervo Economic Research PTT and Merit Economics[97], which has been complemented and updated in the HIISI project with industry-

[97] Millaista osaamista Suomi tarvitsee 2040? What kind of expertise will Finland need in 2040? (in Finnish). PTT Reports 269. https://www.ptt.fi/julkaisut-ja-hankkeet/kaikki-julkaisut/millaista-osaamista-suomi-tarvitsee-vuonna-2040.html

specific low-carbon strategies and recent energy and climate policies and measures. The macro-economic projections are described in the report "Macroeconomic scenarios: Carbon neutral Finland 2035 – measures and impacts of climate and energy policies"[98].

The Covid-19 pandemic and its assumed effects on the economy have been considered in the modelling. In contrast, 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 (see Section 3.1). Thus, the estimates of carbon removals in the LULUCF sector will be re-evaluated in future.

According to the Ministry of Finance's forecast used in the modelling of the projections, economic growth would recover during 2021, but remain modest at first thereafter. During the 2020s, the world economy was expected to recover from the pandemic, which would also begin to impact Finland. It was assumed employment would recover during 2021, but towards the end of the decade, the shrinking working-age population would result in no new growth through labour input. Economic growth therefore 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, but per capita GDP growth will remain at 1.2 per cent. The conditions for economic growth will improve in the 2030s, so GDP growth may also be higher.

Regarding the forest industry, the growth assumptions are based on several sources, of which one of the most essential is the expertise of Pöyry Management Consulting, published in the "Suomen metsäteollisuus 2015–2035" report (Finland's forest industry 2015 to 2035)[99]. As some of the information is starting to be somewhat outdated, it has been updated and complemented by other sources that consist of two low-carbon roadmaps published in 2020 by the Finnish Forest Industries Federation and the Finnish Sawmills association and the expertise of Natural Resources Institute Finland (Luke). Pöyry bases its assessment on regional and global demand projections of pulp, paper, and wood products, the competitiveness of production facilities in Finland, and investment plans published by the forest industry. The Finnish Forest Industries' roadmap mainly follows the Pöyry report, but some production volumes have been updated in accordance with the association's more recent views. The Finnish Sawmills roadmap focuses only on the sawmill industry, whereas the experts from Natural Resources Institute Finland (Luke) provide valuable insights into recent changes in paper production capacities, capacity-derived production volumes, and how they will develop in the future. Compared to the figures used in the projections of the Seventh National Communication, the estimated production of printing and writing paper is 1.2 million tonnes lower in 2035, a total of only 2.1 million tonnes. The volume of sawmill products is also expected to be smaller than the previous estimate, whereas the production of other papers is expected to be 0.9 million tonnes higher than previously estimated, i.e. 6.1 million tonnes in 2035. The total volume of paperboard and corrugated cardboard is expected to be some 0.4 million tonnes lower in 2035 and that of market pulp 1.0 million tonnes higher than in the Seventh National Communication. The most remarkable difference between the new and previous projections is a new category, so-called new products, which consists of biomass-based biofuels, chemicals, bioplastics, and textiles, and which has the projected total volume in 2035 of 2 million tonnes.

Table 5.1 shows a summary of the main assumptions of the WM projection for 2020 to 2035. The numerical values for key variables and assumptions are presented in CTF Table 5.

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[98] Macroeconomic scenarios: Carbon neutral Finland 2035 – measures and impacts of climate and energy policies, Publications of the Government's analysis, assessment and research activities 2021:65. http://urn.fi/URN:ISBN:978-952-383-295-4

[99] Suomen metsäteollisuus 2015 – 2035 (Finland's forest industry 2015 to 2035) Final Report X304203, 19 January 2016, Pöyry Management Consulting, https://docplayer.fi/22653047-Suomen-metsateollisuus-2015-2035-19-tammikuuta-2016-loppuraportti-x304203.html

Table 5.1 Assumptions of the WM projection

Parameter	Trend 2020 to 2035
GDP growth	1.6 per cent annually
Structure of economy	Increasing share of services
Structure of industry	Less capital and energy intensive
Population growth	Increasing by 0.6 per cent in 10 years until to 2030, slowly decreasing after 2030
Population structure	Ageing
Technology development	Gradual introduction of improved and more energy efficient technology, increased electrification

5.2 "With Measures" projection

5.2.1 Total effects

Total emissions in the WM projection for 1990 to 2035 are shown in Figure 5.1 (total emissions without the LULUCF sector) and Table 5.2 (without and with the LULUCF sector).

Compared with the 1990 base year, the total greenhouse gas emissions without LULUCF are projected to be 58 per cent lower in 2030, and 65 per cent lower in 2035. The corresponding figures for CO_2 emissions are 62 and 69 per cent. CH_4 emissions are expected to continue to decline steadily, being 57 per cent lower in 2030 and 60 per cent lower in 2035 than in 1990. N2O emissions are projected to decrease slightly, being 32 per cent lower in 2030 and 34 per cent lower in 2035 than in 1990. The amount of emissions from F-gases is small and expected to decrease in the coming years.

Figure 5.1 Greenhouse gas emissions without LULUCF, with indirect CO_2, by gas according to the latest greenhouse gas emission inventory (1990 to 2020) and the WM projection (up to 2035), million tonnes CO_2 eq.

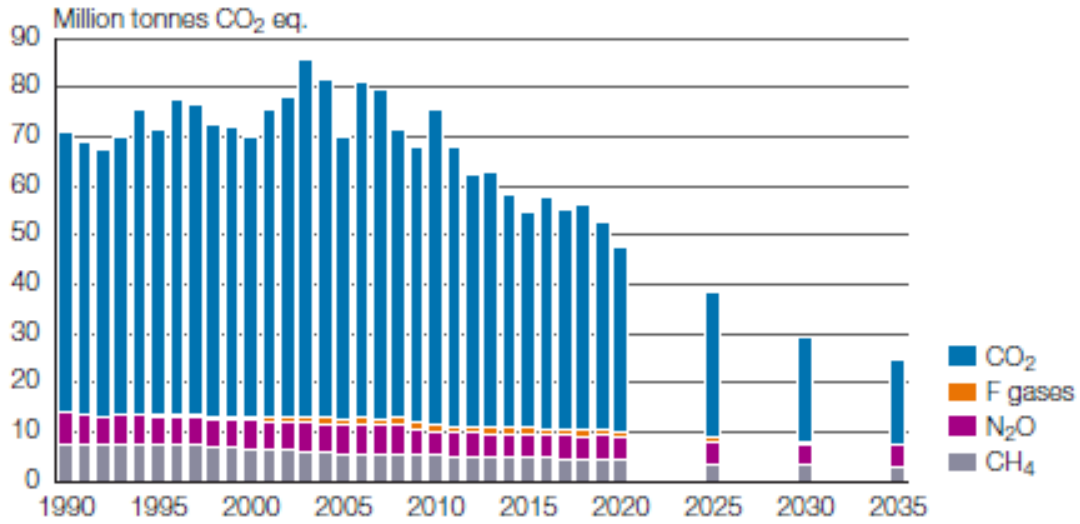


Table 5.2. Greenhouse gas emissions according to the most recent inventory data (1990 to 2020) and the WM projection (2025 to 2035)

	GHG emissions and removals (kilotonnes CO_2 eq.)									
	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
Sector										
1. Energy	53,442	55,275	53,710	53,743	60,230	40,602	34,290	25,368	18,051	14,984
2. Industrial processes and product use	5,398	5,064	5,988	6,765	6,159	5,704	5,124	5,763	4,649	3,471
3. Agriculture	7,507	6,698	6,615	6,529	6,651	6,574	6,566	5,938	5,682	5,477
4. Land use, land-use change and forestry	–13,441	–13,193	–15,048	–20,494	–21,711	–18,762	–17,303	–22,947	–20,890	–22,633
5. Waste	4,669	4,596	3,817	2,812	2,562	2,092	1,736	1,383	1,152	984
6. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Indirect CO_2 emissions	166	133	108	88	70	55	66	41	31	26
Gas										
CO_2 emissions without net CO_2 from LULUCF[1]	57,081	58,249	57,118	57,135	64,151	44,154	37,662	29,589	21,582	17,476
CO_2 emissions with net CO_2 from LULUCF[1]	39,976	41,468	38,574	33,308	39,361	22,576	17,571	3,868	–2,095	–7,975
CH_4 emissions without CH_4 from LULUCF	7,687	7,426	6,566	5,583	5,350	4,857	4,402	3,647	3,305	3,056
CH_4 emissions with CH_4 from LULUCF	9,219	8,876	7,912	6,788	6,325	5,653	5,168	4,443	4,151	3,942
N_2O emissions without N_2O from LULUCF	6,362	5,903	5,809	6,035	4,784	4,753	4,722	4,539	4,327	4,189
N_2O emissions with N_2O from LULUCF	8,494	8,040	7,959	8,164	6,888	6,773	6,744	6,517	6,268	6,122
HFCs	0	150	715	1,158	1,363	1,239	976	689	321	189
PFCs	0	2	3	4	3	1	2	1	1	1
Unspecified mix of HFCs and PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
SF_6	52	37	26	22	22	22	19	27	29	31
NF_3	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (without LULUCF)	71,016	71,632	70,130	69,849	75,602	54,971	47,716	38,452	29,534	24,916
Total (with LULUCF)	57,575	58,439	55,082	49,356	53,892	36,209	30,413	15,505	8,644	2,283
Total (without LULUCF, with indirect)	**71,182**	**71,766**	**70,238**	**69,938**	**75,672**	**55,026**	**47,782**	**38,493**	**29,565**	**24,942**
Total (with LULUCF, with indirect)	**57,741**	**58,573**	**55,190**	**49,444**	**53,962**	**36,264**	**30,479**	**15,546**	**8,675**	**2,309**

NO = not occurring

1) including indirect CO_2 emissions

The split of greenhouse gas emissions between the EU ETS sector and the non-ETS sector is illustrated in Figure 5.2. and Table 5.3. The historical ETS emissions correspond to the EU ETS scope in the emissions trading period from 2013 to 2020. The emissions in the EU ETS sector reached their peak in the mid-2000s and have declined since. In 2020, emissions in the EU ETS sector accounted for 41 per cent of the total greenhouse gas emissions, whereas the non-ETS sector accounted for 59 per cent. The ETS emissions are expected to decrease further in the future.

The emissions from the non-ETS sector have decreased steadily since 2005, and the decrease is expected to continue. In the WM projection, the emissions from the non-ETS sector in 2030 are 42 per cent, and in 2035, 49 per cent below the 2005 level when using the 2013–2020 scope for the EU ETS. Approximately 2.4 million tonnes CO_2 eq. non-ETS emissions in 2005 originate from sources that have since been moved to the ETS sector.

Figure 5.2 The split of greenhouse gas emissions between the EU ETS sector and the non-ETS sector (2005 to 2020) based on the latest greenhouse gas inventory and the WM projection (until 2035). The development of the total emissions without the LULUCF sector is also presented.

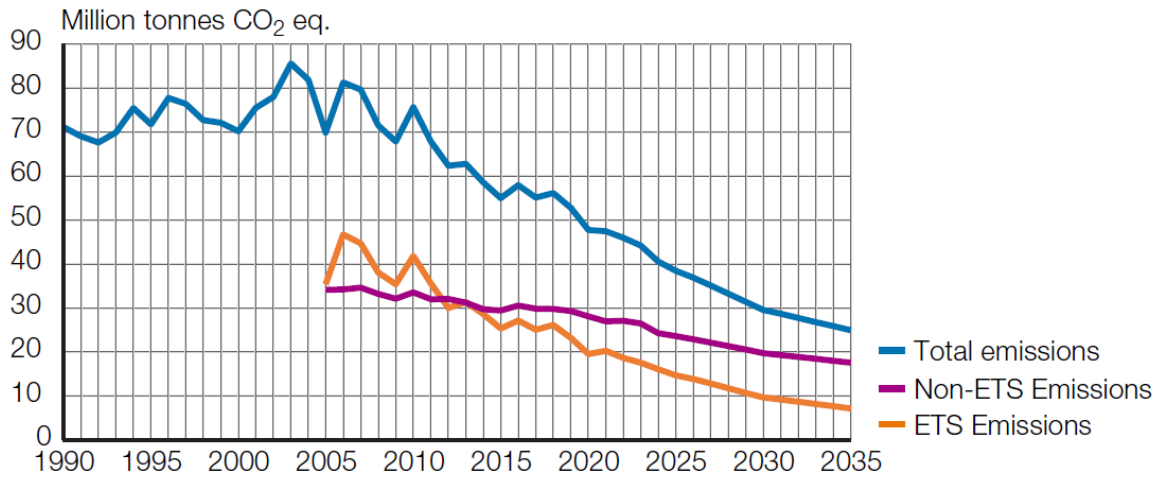


Table 5.3 Historical (2005 to 2020) and projected (2025 to 2035) greenhouse gas emissions in the Non-ETS and ETS sector and civil aviation based on the latest greenhouse gas inventory and the WM projection respectively

	Historical			WM Projection		
	2005	2010	2020	2025	2030	2035
	million tonnes CO_2 eq.					
Non-ETS	34.2	33.6	28.1	23.6	19.7	17.6
ETS	35.5	41.9	19.6	14.7	9.7	7.2
Civil aviation, CO_2	0.3	0.2	0.1	0.2	0.2	0.2
Total emissions[1]	**69.9**	**75.7**	**47.8**	**38.5**	**29.5**	**25.0**

1) For the non-ETS and ETS split, the 2013 scope of EU ETS has been used

The development of total emissions regarding the number of inhabitants, primary energy use, and economic development is presented in Table 5.4. All indicators show a steady downward trend that continues in the WM projection. Today, the emissions are decoupled from both the GDP growth and energy use development and decline steadily.

Table 5.4 Greenhouse gas emission intensity based on the latest greenhouse gas inventory for 2010 to 2020 and the WM projection for 2025 to 2035

	Historical			WM projection		
	2010	2015	2020	2025	2030	2035
Emissions per capita, tonnes CO_2 eq./capita	14.08	9.56	8.70	6.92	5.31	4.49
Emissions per GDP, kg CO_2 eq./EUR	0.35	0.22	0.21	0.15	0.11	0.08
Emissions per primary energy, tonnes CO_2 eq./MWh	0.19	0.14	0.13	0.10	0.08	0.07

5.2.2 Sectoral emissions

Energy

The energy sector is strongly affected by policy measures to reduce the emissions, enhance energy efficiency and increase the share of renewable energy sources. Both the supply and demand sides have faced significant changes in the last decade: part of the changes results from policy measures; part from technological development and the development of the energy and fuel markets. The transition is only half completed, and the emissions will decline further in the energy sector. As many of the changes involve or concern investments like power plants, the effects are robust and enduring.

The supply and demand situation in the Nordic-Baltic regional electricity market to which Finland belongs was a very important factor affecting the Finnish power supply's greenhouse gas emissions in the past. However, 85 per cent of the Finnish electricity production is emissions-free today and the positive development is expected to continue further, resulting in lower and less varying total greenhouse gas emissions for Finland.

In the WM projection, the most significant future changes in electricity and heat production are the start-up in 2022 of a new 1,600 MW nuclear power plant unit and the increase in the use of renewable energy sources and waste heat. Use of coal for energy will be banned from May 2029, and the use of peat will rapidly decrease in the 2020s due to high prices of emission allowances. All these changes reduce emissions.

Factors affecting the future energy demand are primarily energy efficiency measures, as well as the economic development and structural and technology changes within the industry. According to the WM projection, energy used to heat residential and service sector buildings will decrease, even though the volume of buildings is expected to increase continuously. The emissions from space heating are decreasing even faster than energy demand due to the increased use of renewable energy. District heat production from heat-only plants is expected to slightly increase its share at the expense of combined heat and power production, which has been struggling with feasibility. Low electricity prices in the 2010s and rising prices of emission allowances and fuel prices in the 2020s have challenged combustion-based heat and power production.

District heating, power generation, and industrial energy use are strongly affected by the EU ETS price, which makes the use of fossil fuel increasingly infeasible and with energy taxation, efficiently cuts emissions in these sectors. This trend will lead to increased electricity demand replacing some fossil fuel consumption, which is also reflected in the low-carbon roadmaps prepared by all major industries and sectors. In power generation, the emphasis is shifting from fossil fuels (especially coal and natural gas) and peat to renewables. In district heating and industry, fossil fuels are increasingly being replaced with renewables and waste heat recovery. In specific industrial sectors, electrolysis-based hydrogen production is also expected to take off, although the exact timing is difficult to predict. Carbon Capture in its various forms (such as CCS, CCSU, BECCS) could reduce emissions even further, but its timing is even more difficult to estimate, and it has therefore been omitted from the WM projection. Electrification is also true of other sectors like transport, due to which (with Finland's biofuel and other policies) the refining volumes of fossil oil are also decreasing.

The historical and projected emissions from the energy sector (excluding transport) in the WM projection are presented in Table 5.5. 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, belongs to the EU Emissions Trading System.

Table 5.5 Historical (1990 to 2020) and projected (2025 to 2035) 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	2035
	million tonnes CO_2 eq.									
Total emissions	**41.3**	**44.0**	**41.6**	**40.9**	**47.6**	**29.7**	**23.8**	**17.3**	**11.5**	**9.6**
CO_2	40.8	43.2	40.9	40.0	46.7	29.0	23.2	16.6	10.9	9.0
CH_4	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.2	0.2
N_2O	0.4	0.4	0.5	0.5	0.6	0.5	0.4	0.4	0.4	0.3

Historically, emissions from space heating on site, as well as district heating, have varied according to heating demand (cold or warm winters). Likewise, emissions from condensing power have varied strongly, depending on the hydro situation in the Nordic-Baltic electricity market. In the projections, future years are assumed to be standard years (i.e. the long-term average plus the impact of climate change) with respect to heating demand and hydro levels. Consequently, the energy sector emissions are smoother in the future years (i.e. they have less interannual variability) of the WM projection than in the historical years.

The importance of CH_4 and N_2O emissions within the energy sector is 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 low.

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 decrease from the recent 1.5 to 2 million tonnes CO_2 eq. to 0.6 million tonnes CO_2 eq. in 2030. The emissions from machinery are expected to decrease from their current level, i.e. 2.4 million tonnes CO_2 eq. to 1.6 million tonnes by 2030. The reasons for this favourable development are more efficient equipment (including some electric machinery) and a more efficient use of the equipment. The emissions from non-ETS industrial energy use remain at around the current level of 0.6 million tonnes CO_2 eq. in the WM projection at first and slightly decrease later, despite an increase in activity. The energy-related emissions from agriculture and forestry are 1.3-1.4 million tonnes CO_2 today, 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 0.8 million tonnes CO_2 eq.

Transport

The WM projection describes the likely evolution of GHG emissions from transport according to the best information available, and it includes, with a few exceptions, all measures for which there is a decision by August 2022 (a financing decision on measures requiring funding, or which are otherwise likely to occur). The WM projection contains the following themes, under which there are several measures: 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 effect of following recently implemented measures are not included in the WM projection because of difficulties in estimating the effects of the measures:

- Temporary reductions of taxable values of the company car benefit for battery electric vehicles and employer-provided charging for electric vehicles (long-term effects difficult to estimate)

- Changes to taxable values of employer-provided commuter tickets and bicycles (no assessment available).

A phenomenon with emissions reduction potential is the increase of remote work. Remote work is a new phenomenon created by the Covid-19 pandemic, which was unforeseeable in the NC7, but which is now included in the WM projection. During the pandemic in 2020, the number of remote workers more than doubled from pre-Covid numbers. This is assumed to be the maximum in the current regional and employment structure. The increase in remote work facilitates work and leisure coordination and mainly reduces emissions from transport as well, as it may reduce vehicle kilometres and the annual CO_2 emissions from passenger car traffic, with the reduction being approximately 61 kt CO_2 eq. in 2030 according to the WM projection.

According to the WM projection, GHG emissions from road transport will decrease significantly in the long term. Temporary changes in the biofuel distribution obligation in road transport will bring a short-term increase in emissions in 2022 and 2023. However, the tightening of the distribution obligation after a temporary reduction will create the most significant emissions reductions in the near future, while in the long term, the emissions reduction effect of vehicle fleet renewal will be highlighted. In particular, the EU Regulation[100] setting stricter CO_2 emission standards for cars and light commercial vehicles will contribute to a significant reduction in the WM projection, where domestic transport emissions will decrease by 49.4 per cent compared to 2005 emissions, i.e. close to the target of 50 per cent emissions reduction. The reduction in emissions takes place mainly in road transport. Compared to the current situation, emissions from water transport will also decrease slightly. Emissions from rail transport will remain the same. Greenhouse gas emissions from the transport sector are expected to decrease by 1.7 million tonnes from 2005 to 2020 and by 4.8 million tonnes from 2005 to 2030 (Table 5.6).

Table 5.6 Historical (1990 to 2020) and projected (2025 to 2035) 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	2035
	million tonnes CO_2 eq.									
Total emissions	**12.1**	**11.3**	**12.1**	**12.9**	**12.7**	**10.9**	**10.4**	**8.1**	**6.6**	**5.4**
CO_2	11.8	11.1	11.9	12.7	12.6	10.8	10.3	8.0	6.5	5.3
CH_4	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N_2O	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

International bunkers

According to the most recent greenhouse gas emission inventory, the fuel consumption for international aviation was 11,873 TJ and for international marine transport 12,718 TJ in 2020. The Covid-19 pandemic has especially affected international aviation, as the corresponding fuel consumption prior to the pandemic in 2019 was 35,166 TJ for aviation bunkers and 13,563 TJ for marine bunkers.

According to the latest EUROCONTROL most-likely base scenario[101], the annual flight growth rate for Finland between 2019 and 2050 will be an average of 1.6 per cent. This scenario was prepared before the start

[100] 2019/631/EU, adopted in 2019 and applied since 1 January 2020

[101] EUROCONTROL Aviation Outlook 2050. Main Report April 2022; https://www.eurocontrol.int/sites/default/files/2022-04/eurocontrol-aviation-outlook-2050-main-report.pdf

of Russia's invasion of Ukraine, and it therefore does not take into account the current geopolitical situation, which greatly affects Finnish air transport. The annual growth rate by 2030 is estimated to be two per cent for international marine transport. Based on these assumptions and 2020 emissions, the total greenhouse gas emissions from bunker fuels are projected to be 2.2 million tonnes CO_2 eq. in 2030 (1.0 million tonnes CO_2 eq. from aviation bunkers and 1.2 million tonnes CO_2 eq. from marine bunkers). As the Covid-19 pandemic has impacted international transport and air transport especially strongly, the 2019 emissions can also be considered departure data. Using the emissions in 2019 as the basis, the total greenhouse gas emissions from bunker fuels are projected to be 4.4 million tonnes CO_2 eq. in 2030 (3.1 million tonnes CO_2 eq. from aviation bunkers and 1.3 million tonnes CO_2 eq. from marine bunkers). The most likely growth may be something between these two projections, although there are many uncertainties in the current geopolitical and market situation. The average of the above figures is therefore selected in Table 5.7.

These projected emissions of marine and aviation bunkers do not as such consider the impact of the measures presented in Section 4.2.3, which aim to improve energy efficiency and increase the use of alternative fuels.

Table 5.7 Historical (1990 to 2020) and projected (2025 to 2035) greenhouse gas emissions from international bunkers based on the latest greenhouse gas inventory and the WM projection, respectively

	Historical							WM Projection		
	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
	million tonnes CO_2 eq.									
Total emissions	**2.9**	**1.9**	**3.1**	**2.9**	**2.3**	**2.9**	**1.9**	**3.0**	**3.3**	**3.6**
Aviation	1.0	0.9	1.1	1.3	1.7	2.0	0.9	1.9	2.0	2.2
Navigation	1.9	1.0	2.1	1.6	0.7	0.9	1.0	1.1	1.3	1.4

Industrial processes and other product use

The most important greenhouse gas emission sources in this sector are iron and steel, hydrogen, and cement production. The main factors affecting the development of emissions include changes in industrial production volumes and technology. In the WM projection, the growth of the industrial production volumes increases these emissions. Most of the emissions other than F-gases in this sector are part of the EU ETS, which is also the main measure for reducing process emissions. Other measures driving low-carbon technology investments in the manufacturing industry are increased funds for new technology investments and the reduction of the electricity tax.

In the WM projection, it is assumed that the industrial use of fossil fuels decreases thanks to the above measures. In carbon steel production, Finland's largest steel mill has disclosed plans to replace the existing two blast furnaces with electric arc furnaces and the use of carbon-free direct reduced iron (or sponge iron), which is produced in and imported from Sweden. However, the exact timing of this shift is still a significant uncertainty, but the assumption in the WM projection for the first blast furnace is by 2030 and for the second one by 2035. In the chemical industry, the share of fossil fuels will probably decrease due to the largest plastic producer's plans to replace the existing chemical cracking furnace with an electric cracking process. In the WM projection, the replacement will be implemented by 2030. The low-carbon roadmaps prepared by different industries also include additional but more high-level measures that are not yet finally decided but are expected to decrease industrial emissions further in the future.

The WM projection for F-gases includes the impacts of the EU regulation on F-gases[102] and the EC directive related to emissions from air-conditioning systems in motor vehicles[103]. Emissions from refrigeration and air-conditioning equipment are expected to decline because of the regulatory measures.

The main features of the F-gas regulation in cutting F-gas emissions are a phase down of HFCs that can be placed on the EU market, bans on the use of HFCs in certain applications and obligations related to leak checking and repairs, F-gas recovery and technician training.

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

Emissions from solvent and other product use are expected to remain at their present level in the WM projection. Historical and projected greenhouse gas emissions from industrial processes and other product use are presented by gas in Table 5.8.

Table 5.8 Historical (1990 to 2020) and projected (2025 to 2035) 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	2035
	million tonnes CO_2 eq.									
Total emissions	**5.4**	**5.1**	**6.0**	**6.8**	**6.2**	**5.7**	**5.1**	**5.8**	**4.6**	**3.5**
CO_2	3.7	3.4	3.9	4.0	4.6	4.2	3.9	4.8	4.0	2.9
CH_4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N_2O	1.7	1.5	1.4	1.6	0.2	0.3	0.2	0.3	0.3	0.3
F gases	0.1	0.2	0.7	1.2	1.4	1.3	1.0	0.7	0.4	0.2

Agriculture

In recent years, changes in the emissions from agriculture have been small. The projections were updated in 2022. In the WM projection, the total emissions from the agricultural sector are expected to decrease[104]. Emissions from the agricultural sector will decrease by around 0.9 million tonnes of CO_2 eq. by 2030 and 1.1 million tonnes of CO_2 eq. by 2035 (compared to the 2020 level) (Table 5.9).

The decline in livestock numbers and increase in use of feed additives will reduce methane emissions from cattle's digestion. In addition, the decrease in cattle and pig numbers will reduce emissions from manure processing and manure application. However, there is uncertainty about the future price and scale of adoption of feed additives and thus the emissions reduction from cattle.

Measures identified to reduce N_2O emissions from organic soils will also affect the CO_2 emissions from the LULUCF sector. The increasing grass area in crop rotations and continuous use of catch crops will increase

[102] 2014/517/EU

[103] 2006/40/EC

[104] Miettinen et al. (2022)

the emissions of plant residues but reduce nitrogen mineralisation emissions from mineral soils, leaving the net effect in the agricultural sector small per hectare but positive for the climate. Energy-related emissions related to agriculture are reported in the energy sector and are not included in Table 5.9.

Table 5.9 Historical (1990 to 2020) and projected (2025 to 2035) 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	2035
	million tonnes CO_2 eq.									
Total emissions	**7.5**	**6.7**	**6.6**	**6.5**	**6.7**	**6.6**	**6.6**	**5.9**	**5.7**	**5.5**
CO_2	0.6	0.4	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2
CH_4	2.8	2.5	2.5	2.5	2.6	2.6	2.5	2.1	2.0	1.9
N_2O	4.1	3.7	3.7	3.7	3.8	3.8	3.8	3.6	3.5	3.3

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 5.10).

Table 5.10 Historical (1990 to 2020) and projected (2025 to 2035) 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	2035
	million tonnes CO_2 eq.									
Total emissions and removals	**–13.4**	**–13.2**	**–15.0**	**–20.5**	**–21.7**	**–18.8**	**–17.3**	**–22.9**	**–20.9**	**–22.6**
CO_2	–17.1	–16.8	–18.5	–23.8	–24.8	–21.6	–20.1	–25.7	–23.7	–25.5
CH_4	1.5	1.5	1.3	1.2	1.0	0.8	0.8	0.8	0.8	0.9
N_2O	2.1	2.1	2.2	2.1	2.1	2.0	2.0	2.0	1.9	1.9

The measures mentioned in the Climate Plan for the Land Use Sector aim to reach the annual net climate impact of at least three million tonnes of carbon dioxide equivalent by 2035 (Table 5.11). The measures target agricultural land, forest, and land-use changes. In 2035, the net sink of the land-use sector is estimated to be −22.6 million tonnes of carbon dioxide equivalent. The net sink is expected to increase by a total of 5.3 million tonnes of carbon dioxide equivalent by 2035 compared to the 2020 level, exceeding the minimum target set for the Plan.

In the WM projection for the agricultural sector, measures targeted at organic soils are also expected to decrease emissions in the LULUCF sector by around one million tonnes of CO_2 eq. by 2030, 1.3 million tonnes of CO_2 eq. by 2035, and around 1.6 million tonnes of CO_2 eq. by 2040 (compared to the 2020 level). This is due to a reduction in land clearing and conversion of land from cropland and grassland to afforested land and wetlands. In addition, grassland cultivation with increased water levels and paludiculture are expected to decrease emissions from organic soils.

The projections for the agricultural sector and the LULUCF sector include to some extent different measures for cropland and grassland, different implementation areas, and different assumptions about the cultivation history, i.e. different parameters. The LULUCF projection also includes a few measures targeted at organic soils that are not included in the WM projection for agriculture. The LULUCF sector projection therefore produces higher emissions reductions for cropland and grassland than using the measures and parameters of the agriculture WM projection.

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[105]. The vision of the Strategy is "Sustainable forest management is a source of growing welfare". The strategy is implemented by ten key projects. NFS projects were updated in 2019. 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. Current forest legislation and ongoing measures for climate- and forest-related objectives are briefly described in Section 7.2.5.

Forests will be a key part of the Finnish bioeconomy, and the NFS therefore aims to increase the use of wood to replace fossil resources with renewable biomass. In the WM projection, the harvesting increases by up to 80 million cubic metres (including the use of wood for bioenergy) in 2026 to 2035, the estimated carbon sink of forests (including trees and soil) will be approximately at the level of −22.6 million tonnes of CO_2 eq. per annum by 2035. The decreasing trend in emissions from wetlands is due to the decreasing energy use of peat, resulting in a smaller area being needed for peat extraction.

[105] Ministry of Agriculture and Forestry 2019

Table 5.11 Preliminary climate impacts in 2030 and 2035 of the measures presented in Climate Plan for the Land Use Sector (million tonnes of carbon dioxide equivalent)

Measure	Area	Climate impact in 2030, million tonnes CO_2 eq.	Climate impact in 2035, million tonnes CO_2 eq.
Owner policy of Metsähallitus		0.4	0.7–0.9
Preventing the conversion of forests into fields	about 1,700–1,900 ha per year		0.5
Act on fixed-term support for afforestation	3,000 ha per year, of which 40% in peat production areas	0.09	0.11
Afforestation of low-yield fields	9,000 ha in 2024–2028	0.09	0.10
Raising the groundwater level in peaty agricultural lands (grasslands) –30 cm	2030: 20,000 ha	0.135	0.219
	2035: 32,500 ha		
Paludiculture, groundwater level –30 cm	2030: 5,000 ha	0.047	0.094
	2035: 10,000 ha		
Paludiculture, groundwater level –5 – –10 cm	2030: 2,500 ha	0.047	0.094
	2035: 5,000 ha		
Managed wetlands	2030: 4,000 ha	0.072	0.136
	2035: 7,500 ha		
Perennial grasslands without tilling	2030: 40,000 ha	0.081	0.081
	2035: 40,000 ha		
Wetting of low-yield, thick-peat fields to establish wetlands	2030: 10,000 ha	0.181	0.181
	2035: 10,000 ha		
Comprehensive planning of peatland forest management (avoidance of remedial ditching)	–	–	–
Comprehensive planning of peatland forest management (continuous cover forestry in mires)	6,000 ha per year	0.21	0.21
Ash fertilisation of peatland forests	26,000 ha per year	0.18	0.40
Promotion of forest fertilization on mineral soils	25,000 ha per year	0.46	0.28
Increasing the carbon stocks of decaying wood in commercial forests due to biodiversity and climate considerations by leaving retention trees in place	–	–	–
Total		**1.99**	**3.11–3.31**

Source: Natural Resources Institute Finland 2022

Waste

Greenhouse gas emission projections for the waste sector include CH_4 from landfills and anaerobic digestion and CH_4 and N_2O emissions from composting and wastewater treatment. Emission figures for the waste sector do not include emissions from waste incineration, which are reported in the energy sector.

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 0.24 million tonnes. Several new

waste incineration plants have since been constructed, and the incinerated amount was already more than 1.7 million tonnes in 2019. Currently, waste co-incineration is included in the emissions trading sector, whereas waste incineration plants are in the effort-sharing sector.

Greenhouse gas emissions from the waste sector will decrease in the WM projection (Table 5.12). The main reason for this reduction is the implementation of the Landfill Directive[106] and national legislation[107] and strategies aimed at reducing the amount of waste generated and minimising the amount of waste disposed at landfills. Over a longer period, the amount of greenhouse gases from landfills will decline because of the restrictions on organic waste landfilling.

Table 5.12 Historical (1990 to 2020) and projected (2025 to 2035) greenhouse gas emissions from the waste sector based on the latest greenhouse gas inventory and the WM projection respectively (waste incineration not included)

	Historical							WM Projection		
	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
	million tonnes CO_2 eq.									
Total emissions	**4.7**	**4.6**	**3.8**	**2.8**	**2.6**	**2.1**	**1.7**	**1.4**	**1.2**	**1.0**
CH_4	4.6	4.5	3.7	2.7	2.4	2.0	1.6	1.3	1.0	0.9
N_2O	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Indirect CO_2 emissions

The WM projection for indirect CO_2 assumes that their share of the total national emissions without LULUCF will remain at the present level, 0.1 per cent of total national emissions without the LULUCF sector.

5.3 'With Additional Measures' projection

The WAM projection presented in this chapter includes measures already decided at a governmental level and described in Chapter 4. There are planned measures for the transport sector, machinery, F-gases, agriculture, and the waste sector.

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 or the emissions remains unknown or has not been assessed have not been included in the WAM projection. Such measures are:

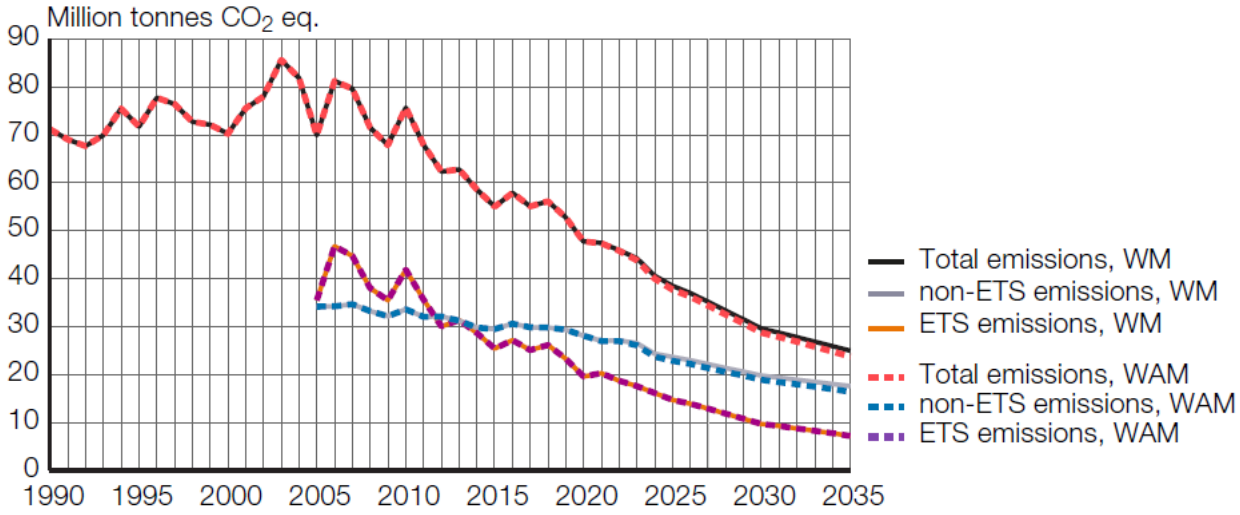
- Improving energy efficiency and promoting the use of alternative fuels in machinery (no assessment available yet)
- Amendment of the waste tax legislation (only minor impact on emissions, difficult to estimate, no assessment available)
- Influencing the age structure of cattle (measures not yet defined)
- Promoting agroforestry (measures not yet defined).

The effect of the policies and measures included in the WAM projection on the total greenhouse gas emissions is illustrated in Figure 5.3. Solid lines portray the WM projection, and dashed lines the WAM projection. The effect of the additional measures is aimed at the 2020s except for the transport sector, where the additional measures increasingly diminish emissions in the 2030s.

[106] Landfill Directive 99/31/EC

[107] Government decree on Landfills (331/2013)

Figure 5.3 Greenhouse gas emissions in EU ETS and non-ETS sectors in the WAM projection (dashed lines) compared to the WM projection (solid lines) in 2021 to 2035 and historical emissions for 1990 to 2020 based on the most recent inventory



The total greenhouse gas emissions (without the LULUCF sector) in 2030 are 29.6 million tonnes CO_2 eq. in the WM projection and 28.7 million tonnes CO_2 eq. in the WAM projection. The additional emissions reduction measures in the WAM projection will only affect transport, industrial processes and agriculture in the non-ETS sector (Table 5.13). The emissions in the ETS sector remain the same as in the WM projection.

Table 5.13 Historical (2005 to 2020) and projected (2025 to 2035) greenhouse gas emissions in the Non-ETS and ETS sectors and civil aviation based on the latest greenhouse gas inventory and the WAM projection, respectively

	Historical			WAM Projection		
	2005	2010	2020	2025	2030	2035
	million tonnes CO_2 eq.					
Non-ETS	34.2	33.6	28.1	22.8	18.9	16.4
ETS	35.5	41.9	19.6	14.7	9.7	7.2
Civil aviation, CO_2	0.3	0.2	0.1	0.2	0.2	0.2
Total emissions	**69.9**	**75.7**	**47.8**	**37.7**	**28.7**	**23.8**

Table 5.14 presents a summary of the WAM projection emissions and the difference between them and the emissions levels in the WM projection.

Table 5.14 Greenhouse gas emissions on a gas-by-gas basis for the WAM projection and the difference between them and the WM projection between 2025 and 2035, million tonnes CO_2 eq. (the greenhouse gas emissions in 2010 and 2020 are based on the most recent inventory and shown for comparison.)

	Historical		WAM Projection		
	2010	2020	2025	2030	2035
	million tonnes CO_2 eq.				
CO_2	64.2	37.7	29.1	21.1	16.6
CH_4	5.4	4.4	3.6	3.2	3.0
N_2O	4.8	4.7	4.4	4.2	4.1
F-gases	1.4	1.0	0.6	0.2	0.1
Total	**75.7**	**47.8**	**37.7**	**28.7**	**23.7**
Difference to WM			–0.8	–0.8	–1.2

When the different emission sectors are examined, the sectoral WAM projections do not differ from the WM projections in the following cases:

- the energy sector, excluding transport
- international bunkers
- industrial processes and product uses other than F-gases
- the LULUCF sector
- waste management.

The WAM projections differ from the WM projections for transport, F-gases, and agriculture, and marginally, for indirect CO_2 emissions. Of the sectors with separate WAM projections, transport has the largest absolute difference between WM and WAM emissions, whereas F-gases have the largest relative difference.

The WAM projection includes those transport measures that had not been finally decided or financed by August 2022 or were uncertain for other reasons. It contains the following themes, under which there are several measures: 1) replacing fossil fuels with alternative transport fuels (additional measures); 2) improving the energy efficiency of vehicles (additional measures); and 3) improving the energy efficiency of the transport system (additional measures).

Transport sector emissions decrease somewhat faster in the WAM projection than in the WM projection in the 2020s. From 2030, the difference in emissions increases significantly faster along with the heavily increasing share of biofuels in the WAM projection. In the long term, fossil fuel substitution will have the greatest emissions reduction effect, bringing GHG emissions from road transport close to zero in 2045. The impact of the renewal of the vehicle fleet in the WAM projection remains the smallest of these categories and the most uncertain of all. It is estimated that the emissions reductions in transport achieved by these additional measures, including the effect of increased remote work, will be 0.5 million CO2 eq. in 2030 compared to the WM projection.

The current F-gas measures in the WM projection will already cut the emissions strongly. The WAM projection of F-gases is based on a few additional measures that will slightly accelerate the decrease of emissions. These additional measures include the revision of the F-gas Regulation, improved control of F-gas banks and recovery of F-gases, and promotion of alternative non-HFC technologies. It is estimated that the emissions reduction achieved by these additional measures will be 0.2 million tonnes CO_2 eq. in 2030.

The WAM projection of agriculture[108] was updated in 2022 and assumes gradual changes in consumers' diet until 2035, which in turn will affect agricultural production and the use of arable land. In the agricultural sector, the estimated additional total emissions reduction is 0.2 million tonnes of CO_2 eq. by 2030 and 0.2 million tonnes of CO_2 eq. by 2035. However, the WAM projection involves major uncertainties. For example, the change in food consumption may differ for different population groups. Large changes in consumers' diet cannot be achieved by economic policy instruments alone.

The Government of Finland has set an emissions reduction target of 29 per cent for Finnish agriculture by 2035 (emissions should decrease by 4.6 million tonnes CO_2 eq. by 2035 compared to 2019). It is likely that agriculture will not fully achieve this emissions reductions target with the actions of the WAM scenario alone. The existing actions should be intensified, and new actions should be developed.

For cropland and grassland, the WAM measures also have effects on emissions from the LULUCF sector. The WAM scenario, with fewer livestock, less organic matter spread on fields in manure, and fewer grasslands, implies a lower carbon input into soils and slightly higher LULUCF emissions from soils compared with the WM scenario. However, the difference is small, 0.1 to 0.2 million tonnes of CO_2 eq. and less than the achieved emissions reductions of the agricultural sector in the WAM scenario, especially after 2035. Measures identified to reduce N_2O emissions from organic soils will also affect emissions from the LULUCF sector (see Table 5.10).

For the LULUCF sector, the WAM projection does not differ from the WM projection. Hence, the above-mentioned impacts of the additional measures included in the WAM projection for the agricultural sector are not included in the WAM projection for the LULUCF sector.

The assumptions for indirect CO_2 emissions are the same in the WAM and WM projections, i.e. emissions equal 0.1 per cent of total national emissions without the LULUCF sector. The absolute amount of indirect CO_2 emissions is therefore marginally smaller in the WAM projection than in the WM projection.

5.4 Assessment of aggregate effect of policies and measures

The aggregated estimates for the greenhouse gas reduction impacts of individual WM policies and measures presented in Chapter 4 are 25 and 52 million tonnes CO_2 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 CO_2 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. The total effect of the current policies and measures calculated bottom-up is shown in Table 5.15.

[108] Miettinen et al. (2022)

Table 5.15 The total i.e. aggregate effect of the policies and measures (PaMs) calculated based on the estimated impact of PaMs (see Tables 4.2, 4.5, 4.7, 4.8 and 4.12) for 2020, 2025, 2030 and 2035 (million tonnes CO_2 eq). The total emissions in 2020 based on the most recent inventory are also given for comparison

	Total emissions in 2020*	Total effects of PaMs			
		2020	2025	2030	2035
WM measures	47.8	24.9	44.2	52.0	55.0
WAM measures[1]		0.0	0.2	0.8	0.9

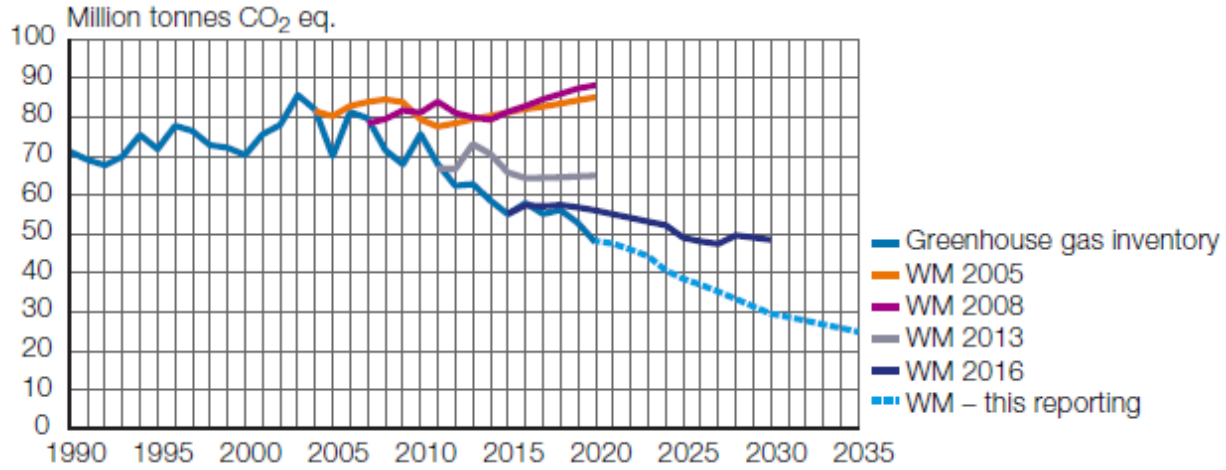
* Without LULUCF

1 In addition to the total effect of PaMs included in the WM projection

The estimated total effect of policies and measures contains noticeable uncertainties. The mitigation impact has not been estimated for all policies and measures. Furthermore, the impact estimates of individual policies and measures are not always 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 in the case of the simultaneous increase of biofuel content and energy efficiency in machinery, the transport sector, and heating, for example. Altogether, the total emissions reduction is probably larger than the reported total effect.

A top-down assessment of the overall effect of mitigation policies and measures is possible by comparing the greenhouse gas emissions of this reporting with WM projections from earlier reporting rounds. Figure 5.4 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.

Figure 5.4 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 of this reporting



The main difference between the projections shown in Figure 5.4 is that most measures from previous WAM projections have been implemented since the previous reporting and are therefore included in the following WM projections. The biofuel quota obligation in road transport is one of the measures with the greatest impact. Another significant difference since the WM projections of 2013 and earlier years is the result of domestic conventional condensing power capacity being shut down almost entirely. Furthermore, combined heat and power plants are struggling with their feasibility and are being shut down ahead of time due to mar-

ket circumstances and the prohibition of coal energy use. The electrification of society and the introduction of new emissions-free technology in all sectors are accelerating earlier and faster than previously expected. The projections have been updated accordingly to reflect the most recent development. The use of fossil fuels and greenhouse gas emissions are therefore significantly lower than anticipated in the previous National Communications.

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.

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 CO_2 eq. in 2020. By 2030 the gap would presumably increase to at least 60 million tonnes CO_2 eq. if the old projections would have 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 52 million tonnes CO_2 eq. emissions reduction in 2030, which added to the emissions of the WAM projection would result in an emission level of at least 81 million tonnes CO_2 eq. in 2030 for a WOM projection.

5.5 Economic impacts

Most of the effects of the WM projection on the economy stem from the need to invest in new carbon-free and energy-efficient technologies in the energy sectors, industry, and the transport sector. These very large investments will probably dominate economic activity for most of the next two decades and entail current account deficits, but once completed, they will facilitate a structural shift of the economy towards an energy- and material-efficient low-carbon economy, in which many of the current industries will become newly competitive and create export growth.

Economic growth and changes in the structure of the economy also 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 limits. However, in the short and medium term, factors affecting labour input growth also matter because changes in labour input directly affect the economy's potential output. In Finland, the ageing population is the single most significant factor in terms of its effect on labour input and thus the 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 above new investments will result in both increased costs and changes to economic consumption and production structures. At the microeconomic level, the WM projection assumes that businesses make mostly profitable investments. Nevertheless, less profitable investments are also necessary to meet the strict emission targets. Such investments usually require subsidies or investment aid from the Government, which contributes to households being susceptible to a decline in their purchasing power due to the additional costs of cutting emissions. The costs typically include different direct and indirect taxes and other policies. For example, if the government implements a costly investment aid scheme to reduce emissions, it is likely that part of the funding will need to come from income tax increases. Indirect taxes can mean higher costs of fossil fuels, and other policies may even force households to make new investments such as purchasing electric vehicles if new gasoline cars are no longer available in the future. In absolute terms, the impact is most significant on households that consume the most energy and energy-intensive commodities and services, i.e. middle- and high-income households. However, in relative terms, the impact may be even more significant for lower-income households, because energy is a necessity in modern societies.

Yet at the macroeconomic level, the new structures are expected to lead to improved economic efficiency, including labour productivity and new business opportunities especially adding value to exports. Structural changes in the economy will also have impacts on employment. The total employment rate is expected to

grow slightly thanks to new investments, but as is often the case, some sectors will benefit more than others. It is expected that industrial and construction sectors will receive most of the benefits, whereas agriculture and services especially will add fewer jobs.

Information on the minimisation of adverse effects of policies and measures in other countries are presented in Finland's Eight National Communication in Section 4.9 as well as in previous national inventory reports.

5.6 Sensitivity analysis of the projections

Energy use and hence greenhouse gas emissions are sensitive to the assumptions made for economic growth. Two sensitivity analyses have therefore been carried out for the WM projection, varying the economic growth of industry and service branches. No sensitivity analysis of the transport sector was made, but lower economic growth could generally have both a reducing and an increasing impact on energy use and greenhouse gas emissions for transport. On the one hand, the need for transport is likely to be lower; on the other, the renewal of the transport fleet will be slower. The situation is similar for buildings in which lower economic growth results in slower growth of the building volume, but also in less investment in energy efficiency. In the sensitivity analyses, energy uses in the transport sector and buildings remain unchanged.

The manufacturing industry uses about 45 per cent of both the country's final energy and electricity. The forest industry has a significant impact on the energy sector, including renewable energy production, energy consumption, and electricity generation. Iron and steel production is another energy-intensive branch, the development of which significantly influences the projections. The energy balance projections for these branches are based on product-group-specific volume estimates. Both branches develop generally positively in the WM projection, even though some product groups already decrease (e.g. paper manufacturing) in the base case WM. In the sensitivity analysis, the annual growth of the product volumes in the forest and metal industries varies by 1 percentage point in both directions from 2020 compared to the WM projection.

In addition to the branches and sectors mentioned above, the annual growth rate of the other industry and service branches was varied by plus and minus 1 percentage point from the WM assumptions. No dynamic effects were considered.

The results of the sensitivity analyses are presented in Table 5.16 below. The overall effect of a lower economic growth (WM −) results in a steadily decreasing final energy consumption in contrast with higher economic growth (WM +), which steadily increases the energy use in the period from 2021 to 2030. In turn, in the base case WM projection, the final energy consumption is almost flat.

In 2030, the final energy consumption would be only 284 TWh in the low growth case, but 307 TWh in the high growth case compared to 295 TWh in the base case WM. The corresponding figures for primary energy consumption are 364 TWh (WM −), 391 TWh (WM +), and 377 TWh (base case WM). The relative impact of economic growth is therefore somewhat higher on final energy consumption than on primary energy. The greenhouse gas emissions in 2030 differ in both cases in total by about 0.9 to 1.0 million tonnes of CO_2 eq. from the emissions in the base case WM projection.

Most of the emission increase and reduction respectively would take place in the ETS sector, with only 0.2 to 0.4 million tonnes of CO_2 eq. reduction in the non-ETS sector.

Table 5.16 Main results for the sensitivity analysis on how the economic growth rate affects the overall energy balance and greenhouse gas emission

	Unit	2020	2030			2035		
			WM	WM +	WM –	WM	WM +	WM –
GHG emissions								
Total excluding LULUCF	million tonnes CO_2 eq.	47.8	29.6	30.6	28.7	24.9	26.1	23.9
Total ETS	million tonnes CO_2 eq.	19.6	9.7	10.5	9.0	7.2	8.1	6.4
Total non-ETS	million tonnes CO_2 eq.	28.1	19.7	19.9	19.5	17.6	17.9	17.4
Primary energy consumption	TWh	354.7	376.6	390.6	363.8	371.4	393.1	352.4
Gross final energy consumption	TWh	285.0	294.9	307.2	283.7	292.0	311.0	275.3

WM +, projection with higher economic growth than the WM projection
WM –, projection with lower economic growth than the WM projection

Source for historical data: Energy Statistics and Finnish Energy

5.7 Methodology

5.7.1 Approach and responsibilities

The reported WM–and WAM-projections are integrated energy and climate projections that were originally modelled for the preparation of three Government Reports, namely the National Energy and Climate Strategy, the Medium-term Climate Change Policy Plan, and the Climate Change Plan for the Land Use Sector. The modelling and assessments were conducted by experts from various research fields in the "Carbon neutral Finland 2035 – measures and impacts of the climate and energy policies" project (HIISI project)[109] financed by the Government's analysis, assessment, and research activities. The analysis and results of the HIISI project were complemented in 2022 by the current information and updates of sectoral projections.

Finland uses a sectoral approach with detailed sector-specific modelling that is coordinated and manually interlinked across sectors. The preparation of the reported WM and WAM projections was coordinated by the Ministry of Economic Affairs and Employment. 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 of fuel and carbon dioxide emissions in the energy production sectors as a whole. The Ministry of the Environment was responsible for the projection regarding space heating, the analysis of the regional and urban structure, and emission projections and calculations for F-gases, waste and machinery. The duty of the Ministry of Transport and Communications included projections for fuel and electricity use, as well as emissions from the transport sector and international bunkers. 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. The Ministry of Finance was responsible for forecasting short-term economic development and taxation.

The sectoral projections, assessments of policies and measures, and other calculations, modelling, and analysis were made by expert organisations, research institutes, and consultants selected for the purpose by the ministries. The following authorities and expert organisations contributed to the reporting in 2022: the Energy Authority; the Finnish Environment Institute; VTT Technical Research Centre of Finland Ltd; Motiva Ltd; Natural Resources Institute Finland; the Finnish Institute for Health and Welfare; Pellervo Economic

[109] Koljonen, T. et al. 2021, https://urn.fi/URN:ISBN:978-952-383-257-2

Research PTT; the Finnish Transport and Communications Agency; Sitowise Group Oyj; and Statistics Finland.

The main models and methods used in the work are briefly described in Section 5.8.3 of Finland's Eight National Communication.

5.7.2 Assumptions underlying calculations

A summary of key variables and assumptions is presented in Table 5.17. Specific sectoral and category-specific data are given in CTF Table 5. A detailed description of assumptions and key variables can also be found in Finland's Eight National Communication, Section 5.8.

Finland's population will increase only slightly from the current 5.53 to 5.57 million in 2030. In 2031, the population will start to decrease. The population's age structure will change significantly over the next couple of decades as the share of older age groups increases. The number of households is expected to grow from the current 2.7 million to almost 2.9 million by 2050. However, at the same time, the average size of households will decrease. The number, structure, and location of households will have an impact on energy demand.

Table 5.17 Key variables and assumptions used in the projections analysis for 1990 to 2035

	Unit	Historical							Projected		
		1990	1995	2000	2005	2010	2015	2020	2025	2030	2035
Population	Million inhabitants	5.00	5.12	5.18	5.26	5.38	5.49	5.53	5.56	5.57	5.56
Gross Domestic Product	Million EUR, 2020 prices	146,000	143,000	183,000	208,000	218,000	219,000	232,000	257,000	276,000	297,000
Coal wholesale price	EUR/GJ LHV, 2020 prices for history, 2022 prices for the future	NA*	3	4	5	5	8	10	3	3	3
Crude oil wholesale price	EUR/GJ LHV, 2020 prices for history, 2022 prices for the future	NA*	4	7	9	9	8	9	12	14	15
Natural gas wholesale price	EUR/GJ LHV, 2020 prices for history, 2022 prices for the future	NA*	4	5	6	9	13	13	6	6	7
Emission allowance price	EUR/t nominal prices	NO	NO	NO	23	14	7	25	25	30	35
Tax components: **											
Electricity, tax category I	cent/kWh, 2020 prices for history, 2022 prices for the future	NA*	NA*	NA*	NA*	0.98	2.33	2.24	2.24	2.24	2.24
Electricity, tax category II	cent/kWh, 2020 prices for history, 2022 prices for the future	NA*	NA*	NA*	NA*	0.28	0.72	0.69	0.05	0.05	0.05
Calculation basis of excise duty rates for heating, power plant and machinery fuels (coal, natural gas)											
Energy content component	EUR/MWh LHV, 2020 prices for history, 2022 prices for the future	NA*	NA*	NA*	NA*	NA*	6.92	7.63	10.33	10.33	10.33
Carbon dioxide component***	EUR/t lifetime CO_2 emissions, 2020 prices for history, 2022 prices for the future	NA*	NA*	NA*	NA*	NA*	NA*	53.00	53.00	53.00	53.00
Calculation basis of excise duty rates for liquid transport fuels											
Energy content component	EUR/MWh LHV, 2020 prices	NA*	NA*	NA*	NA*	NA*	59.90	58.72	60.52	60.52	60.52
Carbon dioxide component***	EUR/t lifetime CO_2 emissions	NA*	NA*	NA*	NA*	NA*	60.32	62.00	77.00	77.00	77.00

* No data available or regarding taxes, the taxation structure was significantly different from the present and thus not comparable
** The values in the table represent base case rates. Several reductions and exemptions exist (more information in Section 4.5)
***For combustion only, the value would be 20% higher.

In addition, please note that the historical data on population and gross domestic production represents the data used in the projections and may slightly differ from the latest statistics

Sources: AFRY, Statistics Finland

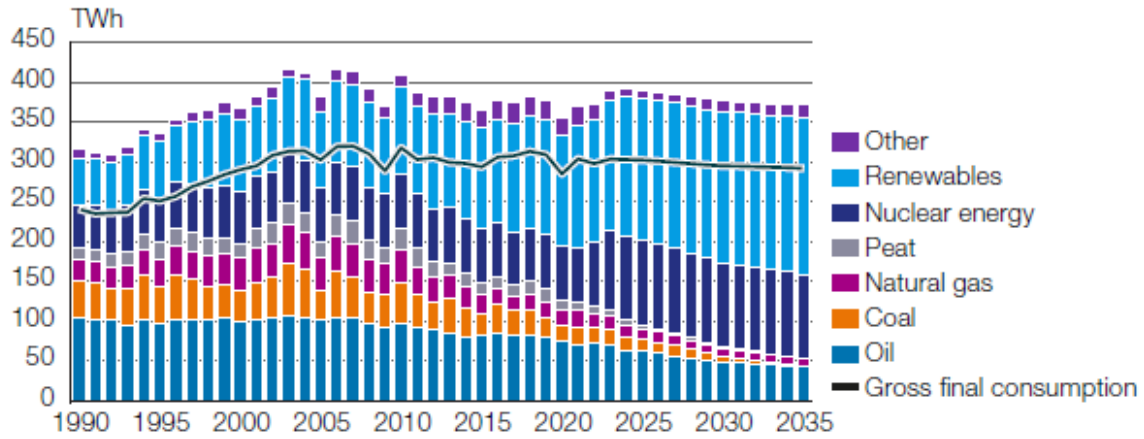
The impact of the Covid-19 pandemic was also considered when projecting the economic development and to the extent possible in the sector projections. Economic growth will recover during 2021, but it will remain modest at first thereafter. During the 2020s, the world economy is expected to recover, which will also begin to have an impact in Finland. The average annual GDP growth rate in the 2020s is 1.5 per cent in the projections. The activities that will sustain most growth in production in the 2020s are expected to be machinery and equipment manufacturing, the forest industry, and the financial and insurance business.

The fuel taxation structure was recently overhauled to make energy content and carbon dioxide the main components. They are applied to two categories shown in the table above and described in more detail in Section 4.5. The electricity tax is divided into two categories, of which the lower (category II) is applied to industry and heat pumps in district heat production, and the higher mostly to consumers, for example. As the table illustrates, the ongoing trend is that electricity for industry is taxed less and combustion fuels more. The 2025 figures in the table correspond to taxation in 2022. After 2025, the taxation structure and levels remain constant in the projections, as no changes are currently planned.

Assumed fossil fuel prices in the world market and the assumed prices of emissions allowances in the EU's emissions trading system correspond to the recommended harmonised values provided by the EU Commission for greenhouse gas emission projections before the current energy crisis in Europe.
The primary energy by source, energy sources for district heat and combined heat and power production, electricity supply, electricity consumption in the forest industry and energy sources in the transport sector are presented in Tables 5.18 to 5.22.

Gross final energy consumption is levelled off in the projections because of increased energy efficiency in all sectors. The decreasing energy sector emissions are the result of policy measures that replace fossil fuels with renewables and electricity. Despite the flat final consumption projection, the primary energy consumption significantly varies in the projections. The main reason for this is the substantial changes in domestic nuclear power production (increase in early 2020s and 2030s), which replaces electricity imports. Expressed in primary energy, the value of nuclear power is three times that of imported electricity, despite the same amount of electricity fed to consumption. The development of the primary energy supply and gross final energy consumption in the WM projection is shown in Figure 5.5 and Table 5.17.

Figure 5.5 Historical development (1990 to 2020) and WM projection (until 2035) of the primary energy supply by energy source and gross final energy consumption (solid line), TWh



Source for historical data: Energy Statistics

Table 5.18 Primary energy by energy source and gross final energy in 2010, 2015, 2020 and in the WM projection for 2025, 2030 and 2035, TWh

	Historical			WM Projection		
	2010	2015	2020	2025	2030	2035
Oil	97.2	81.6	74.3	61.7	48.2	42.1
Coal	51.8	28.3	19.5	14.8	7.2	1.5
Natural gas	41.3	22.9	20.7	13.8	10.0	8.8
Peat	27.2	16.1	12.0	4.9	1.6	0.4
Nuclear energy	66.3	67.7	67.7	106.2	106.2	106.2
Renewables	109.9	126.3	139.6	178.4	189.8	196.6
Other	14.6	21.4	20.9	9.6	13.6	15.8
Gross final consumption	317.7	293.9	285.0	302.4	294.9	292.0

Source for historical data: Energy Statistics

The trend of replacing fossil fuels and peat with renewables and electricity is also clear in the district heating sector, as the table 5.19 below illustrates. The share of waste heat recovery especially is expected to grow rapidly in the coming years, being three times the 2020 level after 2025. Most of the increase is attributed to heat pumps, as almost all the waste heat streams that can be directly utilised are already harnessed. The table also presents the fact that the total district heat consumption, and therefore the energy sources, is in decline due to buildings' improving energy efficiency.

Table 5.19 Energy sources for district heat (heat-only boilers and CHP-heat) and CHP-electricity in 2010, 2015, 2020 and in the WM projection for 2025, 2030 and 2035, TWh

	Historical			WM Projection		
	2010	2015	2020	2025	2030	2035
Fuel oils	3.5	1.5	0.8	0.6	0.3	0.3
Coal	14.2	11.7	6.9	0.6	0.0	0.0
Natural gas	25.7	11.9	9.1	3.6	1.5	0.9
Peat	13.3	9.3	7.7	2.0	0.4	0.2
Wood-based fuels	19.5	24.1	27.9	24.4	23.4	19.6
Other renewables (mainly biogas and renewable part of waste)	1.0	2.3	3.0	2.7	2.8	2.7
Other fossil fuels (mainly non-renewable part of waste)	1.0	1.9	2.5	2.3	2.1	2.1
Other sources (mainly waste heat and electric boilers, includes both electricity and heat of heat pumps)	1.2	2.6	4.5	9.4	10.4	11.1

Source for historical data: Energy Statistics

In electricity supply, the share of wind power especially will probably grow even more rapidly than in the past (Table 5.20). At the same time, the share of wood-based fuels is expected to grow to some extent, and that of fossil fuels to decrease. The need for electricity imports depends on many factors, but the annual net import should generally remain substantially lower than in the past, despite the continuously growing electricity demand that results from decarbonisation and electrification.

Table 5.20 Electricity supply in 2010, 2015, 2020 and in the WM projection for 2020, 2030 and 2035, TWh

	Historical			WM Projection		
	2010	2015	2020	2025	2030	2035
Hydro	12.7	16.6	15.7	14.3	14.4	14.5
Wind and solar	0.3	2.3	8.2	20.6	25.6	33.9
Wood-based biomass	10.0	10.1	10.3	13.6	13.6	13.7
Other renewables (mainly renewable part of waste)	0.4	0.6	0.6	0.7	0.5	0.6
Nuclear	21.9	22.3	22.4	35.0	35.0	35.0
Oil	0.4	0.2	0.2	0.1	0.0	0.0
Coal	13.6	4.8	2.3	1.3	0.3	0.0
Natural gas	11.0	5.1	3.9	2.9	2.3	2.2
Peat	5.9	2.9	2.0	0.8	0.2	0.0
Others (mainly fossil part of waste)	0.4	0.3	0.9	0.6	0.5	0.5
Imports	10.5	16.3	15.0	1.7	6.1	7.9

Source for historical data: Energy Statistics

The forest industry is both a significant energy consumer and an electricity and heat producer. Pulp mills especially produce large amounts of electricity and heat from black liquor, which is the main by-product from the kraft process, which digests pulpwood into paper pulp. In addition, biomass by-products from the forest industry, such as bark and sawdust from the mechanical forest industry, are utilised as fuels in both the forest industry and the energy sector. For example, these by-products equated to approximately 24 TWh and black liquor to 46 TWh in 2021. At the same time, the total use of wood-based fuels was approximately 110 TWh.

Conventionally, all black liquor has been combusted in specially designed boilers for heat and electricity. In the WM projection, it is expected that some black liquor will be converted into biofuels for transport in the future. Large amounts of black liquor should be available, as the market trends seem to decrease print, special, and soft paper production but increase the production of pulp and new products (such as textiles, chemicals, and bioplastics) that generate black liquor as a by-product. The table 5.21 below shows historical and projected electricity consumption in the forest industry. The product volumes are included in the table listing LULUCF parameters (Table 5.26a).

Table 5.21 Electricity consumption in the forest industry in 2010, 2015 2020 (historical) and 2025, 2030 and 2035 (WM projection)

	Historical			WM Projection		
	2010	2015	2020	2025	2030	2035
Electricity consumption, TWh						
Pulp and paper	20.6	17.5	15.6	16.5	16.4	16.4
Mechanical forest industry	1.6	1.3	1.4	1.3	1.4	1.3

Source for historical data: Statistics Finland

In the transport sector, greenhouse gas emissions are influenced by a decline in specific energy consumption and especially by replacing fossil fuels with alternative transport fuels (Tables 5.22 and 5.23). The WM projection's annual distribution obligation percentages for biofuels for 2022 to 2030 are 12, 13.5, 28, 29, 29, 30, 31, 32, and 34 per cent (from 2030 onwards). The share of biofuels in consumption increases, and respectively, the share of fossil fuels in consumption decreases. Biogas and electric fuels are included in the distribution obligation between 2022 and 2050. In the WM projection, the bio-share of transport gas will increase by 5 per

cent units per year until the share reaches the 99 per cent level. Biogas replaces biodiesel in fulfilling the distribution obligation: biogas consumption increases, and the corresponding amount of energy decreases from the consumption of biodiesel. In the WAM projection, the share increases to 100 per cent in 2045.

Table 5.22 Energy sources in transport in 2010, 2015, 2020 and in the WM projection for 2025, 2030 and 2035, TWh

	Historical			WM Projection		
	2010	2015	2020	2025	2030	2035
Gasoline, fossil	17.8	15.8	13.6	12.9	11.1	8.5
Diesel, fossil	27.1	23.4	24.5	15.6	11.9	10.1
Biofuels	1.5	5.8	4.7	11.6	11.6	9.0
Aviation fuels, fossil	1.6	1.2	1.0	1.1	1.1	1.1
Light fuel oil	1.7	1.6	1.3	1.3	1.1	1.0
Heavy fuel oil, gas, hydrogen	0.5	0.1	0.2	0.8	1.2	2.0
Electricity	0.7	0.7	0.8	2.1	4.6	7.9

Source for historical data: Energy Statistics

Table 5.23 Main assumptions for the transport sector

	Unit	Historical			WM Projection		
		2010	2015	2020	2025	2030	2035
Number of vehicles – in total	**pieces**	**3,340,794**	**3,461,862**	**3,461,451**	**3,566,784**	**3,656,316**	**3,706,248**
Passenger cars	pieces	2,486,283	2,612,922	2,748,448	2,797,311	2,891,542	2,938,448
Vans	pieces	289,824	307,706	338,389	331,924	327,795	329,174
Buses	pieces	11,610	12,455	9,955	11,573	12,615	13,409
Trucks	pieces	94,334	95,250	94,691	99,247	104,451	110,180
Motorcycles, mopeds, 4-wheels	pieces	458,743	433,529	269,968	326,729	319,913	315,037
Passenger cars by operating forces							
Petrol and Diesel	%	100	100	97	85	68	48
Battery Electric and Plug-in Hybrid	%	0	0	2	14	30	48
CNG Gas and Flexible Fuel Vehicles	%	0	0	1	1	1	1
Hydrogen	%	0	0	0	0	0	3
Vehicle kilometres – in total	**Million kilometers**	**54,860**	**56,365**	**49,668**	**53,060**	**57,639**	**64,333**
Passenger cars	Million kilometers	46,245	47,355	39,092	42,166	46,597	53,138
Others	Million kilometers	8,615	9,010	10,576	10,894	11,042	11,195

The main assumptions for the F-gases are listed in Table 5.24. Significantly more than 90 per cent of the emissions of F-gases originate from refrigeration and air-conditioning equipment. The single most significant emission source is commercial refrigeration. The sector is comprised of refrigeration in food retail stores and

professional kitchens. The most significant factor affecting the emissions of F-gases is the replacement of HFC refrigerants with natural refrigerants (carbon dioxide and hydrocarbons). By 2035, it is assumed that all the remaining HFC refrigerants will have been replaced by natural refrigerants in existing commercial refrigeration equipment. The replacement is assumed to be slightly faster in the WAM scenario.

Table 5.24 Main assumptions for F gases

	Historical			Projection		
	2010	2015	2020	2025	2030	2035
	%					
WM projection						
Share of centralized refrigeration systems with CO_2 or hydrocarbons annually in use						
in food retail stores	3	8	15	36	83	100
in professional kitchens	NO	NO	10	25	65	100
WAM projection						
Share of centralized refrigeration systems with CO_2 or hydrocarbons annually in use						
in food retail stores	3	8	15	36	89	100
in professional kitchens	NO	NO	10	25	75	100

Source: Finnish Environment Institute

For agriculture, the development of livestock numbers has been estimated using the Dremfia agricultural sector model14, which considers the prices of agricultural inputs and outputs and agricultural policy.

Farm sizes and productivity are increasing in dairy cattle farming, which will see a large-scale shift from single dairy robot units to units of two or more robots between the 2020s and 2030s. Total milk production will fall by 3 per cent from the 2020 level by 2035, but the number of dairy cows will be reduced by approximately 15 per cent. Fewer cows will be needed to produce the same amount of milk because the average milk yield of dairy cows will increase in the future.

The development in the dairy sector is reflected in the lower numbers of calves and heifers. Instead, the number of suckler cows will increase by about 1,500 cows by 2035. The slow reduction in the real price of beef and the expected constant agricultural subsidy for cattle do not give economic opportunities for greater suckler cow production growth.

Production of pork and poultry meat, and hence also animal numbers, depends on domestic demand. Pork consumption is decreasing, but the annual consumption of poultry meat is expected to reach 150 million kilograms and remain at this level. It has been assumed that the number of sheep will remain the same.

In the Dremfia model, total fertilisation and synthetic nitrogen fertilisation, which complements nitrogen from manure, are determined according to nitrogen yield response and nitrogen and plant product prices. The amount of manure decreases as the numbers of farmed animals decrease. Hence, the amount of nitrogen input from the application of manure will decrease by 8 per cent between 2020 and 2035. The nitrogen requirement of crops is complemented by synthetic nitrogen fertilisation, the amount of which will increase by 2 per cent between 2020 and 2035. Rising synthetic nitrogen fertiliser prices caused by rising fossil energy prices will reduce the growth of synthetic fertiliser application.

The increasing grassland area and use of catch crops will increase the nitrogen emission of crop residues returned to soils. The area of agricultural land will decrease by 2035 as more agricultural land will be converted to other land uses than new agricultural land is cleared. Reduction is proportionately strongest on cultivated organic soils, the area of which will decrease by 3 per cent between 2020 and 2035.

Table 5.25 Main assumptions for the agricultural sector

	Unit	Historical			WM Projection		
		2010	2015	2020	2025	2030	2035
Livestock							
Dairy cattle	1,000 heads	289	285	260	238	231	219
Non-dairy cattle	1,000 heads	636	630	587	566	537	525
Sheep	1,000 heads	126	155	140	140	140	140
Pig	1,000 heads	1,340	1,239	1,104	1,010	984	967
Poultry	1,000 heads	9,587	12,927	13,577	14,072	13,896	13,829
Nitrogen input from application of synthetic fertilizers	kt nitrogen	157	143	139	148	143	142
Nitrogen input from application of manure	kt nitrogen	73	74	71	69	67	65
Nitrogen in crop residues returned to soils	kt nitrogen	87	99	91	84	89	92
Area of cultivated organic soils	1,000 hectares	317	327	338	341	336	328

The main assumptions for the LULUCF sector are presented in Table 5.26a, with additional information in Table 5.26b. Assumptions are based on three scenario studies: the HIISI scenario; the updated HIISI for agriculture; and the scenario for the Climate Plan for the Land Use Sector. The HIISI scenario for the LULUCF sector was compiled in 2021. It was updated with the Climate Plan for the Land Use Sector in 2022. At the same time, the HIISI scenario for agriculture was updated. The LULUCF projection in this NC8 is a compilation of these three scenarios. The whole LULUCF projection was not updated in 2022, because a new scenario study will start at the beginning of 2023.

Table 5.26a Main assumptions for the LULUCF sector

Table 5.26a
Main assumptions for the LULUCF sector

	Unit	Historical			WM Projection		
		2010	2015	2020	2025	2030	2035
4.A Forest land							
Forest harvest removals for energy use	1,000 m^3	7,734	9,186	10,308	9,300	10,800	10,800
Forest harvest removals for non- energy use	1,000 m^3	51,957	58,849	58,546	61,800	67,800	67,800
Forest increment	1,000 m^3	106,400	105,640	105,640	106,800	108,600	108,600
Forest land remaining forest land	1,000 ha	21,781	21,754	21,754	21,723	21,692	21,676
Land converted to forest land	1,000 ha	162	130	95	118	156	161
4.B Cropland							
Cropland	1,000 ha	2,474	2,490	2,502	2,489	2,475	2,465
4.C Crassland							
Grassland	1,000 ha	238	238	243	245	243	241
4.D Wetlands							
Peat extraction sites	1,000 ha	108	112	111	99	67	47
Other wetlands	1,000 ha	6,336	6,325	6,322	6,306	6,305	6,310
4.E Settlements							
Lands converted to settlements	1,000 ha	232	252	227	212	190	175
4.G Harvested wood products							
Production of sawn wood	1,000 m^3	9,473	10,640	10,916	11,580	12,260	12,350
Production of wood panels	1,000 m^3	1,347	1,314	1,206	1,291	1,286	1,288
Production of paper and paperboard	1,000 tonnes	10,508	10,247	10,120	7,713	7,919	8,217
Export of pulp	1,000 tonnes	2,159	3,136	4,333	5,222	5,744	6,139

m^3 = cubic meters, ha = hectares

Table 5.26b Main assumptions for the LULUCF sector

Table 5.26b
Main assumptions for the LULUCF sector

	Assumption	Source
Forest		
Roundwood demand	Based on production volumes of different branches of forest industry and roundwood import	HIISI scenarios
Energy wood demand		HIISI scenarios
Wood prices	Average of 2008 to 2017	Forest Statistics
Costs of silviculture	Average of 2007 to 2026	Forest Statistics
Climate	Increase in temperature and CO_2 concentration has increased increment of trees	HIISI scenarios
Avoidance of remedial drainage	1,000 hectares less annually on drained most fertile and poorest peatland forests	Climate Plan for the Land Use Sector
Comprehensive peatland forest management, thinning from above	6,000 hectares annually on most fertile drained peatland forests	Climate Plan for the Land Use Sector
Ash fertilisation on peatland forests	50,000 hectares per year	Climate Plan for the Land Use Sector
Forest fertilisation on mineral soils	67,000 hectares per year	Climate Plan for the Land Use Sector
Increased volume of dead wood in commercially utilised forests	Increase of up to 7 cubic meters per hectare	Climate Plan for the Land Use Sector
Immediate regeneration after regeneration felling	No delays	Climate Plan for the Land Use Sector
Agricultural lands	years 2025, 2030, 2035	
Raising the groundwater level in peaty agricultural lands (grasslands) –30 cm	7,500, 20,000, 32,500 hectares	Climate Plan for the Land Use Sector, Updated HIISI AGRI
Paludiculture, groundwater level –30 cm	2,000, 5,000, 10,000 hectares	Climate Plan for the Land Use Sector, Updated HIISI AGRI
Perennial grasslands without tilling	40,000, 40,000, 40,000	Climate Plan for the Land Use Sector, Updated HIISI AGRI
Land-use change		
Afforestation of arable lands and peat production areas 2021 to 2023	3,000–4,000 hectares per year	Climate Plan for the Land Use Sector
Afforestation of low-yield fields 2024 to 2028	9,000 hectares per year	Climate Plan for the Land Use Sector
Deforestation, from forest to arable land	Decrease of 900 hectares per year on organic soils and 800 hectares per year on mineral soils	Climate Plan for the Land Use Sector
Wetting of poorly productive, thick-peaty fields to establish wetlands	4,000, 10,000, 10,000 hectares	Climate Plan for the Land Use Sector
Managed wetlands, peaty arable land to wetland (no longer in agricultural use)	1,500, 4,000, 7,500 hectares	Climate Plan for the Land Use Sector, Updated HIISI AGRI
Paludiculture, groundwater level –5 – –10 cm, peaty arable land to wetland	1,000, 2,500, 5,000 hectares	Climate Plan for the Land Use Sector

The main assumptions for waste sector are listed in Table 5.27. 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 (2,444 TJ) and in REF burning plants 313,000 tonnes (6,260 TJ). Several new waste incineration plants have been constructed in recent years and in 2020 the incinerated amount outside the emissions trading sector was already more than 18,400 TJ15. The WM projection estimates from 2023 onwards the incinerated amount outside the emissions trading sector to be 20,200 to 20,400 TJ. Since 2017, there has been a comprehensive landfill ban on biodegradable waste and biodegradable waste could only go to landfills in waste batches (e.g. rejects) with a very low biodegradable fraction. In the WM projection, it is assumed that 15 thousand tonnes of municipal waste would go to landfills per year from 2021. The share of methane recovery from landfills WM-projection is assumed to be 25 per cent of the total methane generation for years 2025, 2030 and 2035. No new recovery plants are assumed to be built and no changes are assumed to the technical level of the plants' operation in the current situation.

Table 5.27 Main assumptions for the waste sector

	Unit	Historical			WM Projection		
		2010	2015	2020	2025	2030	2035
Municipal solid waste (MSW) going to landfills	tonnes	1,093,000	316,000	15,000	15,000	15,000	15,000
Share of CH_4 recovery in CH_4 generation (excluding industrial wastes) from landfills	%	33	33	24	25	25	25

For the projections, the split of emissions in those included in the EU Emissions Trading System (EU ETS) and those outside the EU ETS is based on a data set of greenhouse gas emissions covering 2005 to 2020 and provided by Statistics Finland. The relative shares of EU ETS and non-ETS emissions to be used in the projections are set for the individual branches and greenhouse gases and are listed in Table 5.28. The individual shares are assumed to remain constant for each branch over time in the projections.

Table 5.28 Projected EU ETS and non-ETS shares of GHG emissions. The split is based on GHG inventory data for the years 2018 to 2020

Table 5.28
Projected EU ETS and non-ETS shares of GHG emissions
The split is based on GHG inventory data for the years 2018 to 2020

	EU ETS	Non-ETS
	%	%
CO_2 emissions		
Energy sector		
Energy industries excl. small plants	100	0
Energy industries, small plants	0	100
Waste incineration plants	0	100
Food industries and manufacture of beverages	60	40
Manufacture of wood and of products of wood	9	89
Manufacture of paper and paper products	92	8
Petroleum refining	96	4
Chemical industry excl. petroleum refining	80	20
Manufacture of non-metallic mineral products	89	11
Manufacture of basic metals, iron and steel production	100	0
Manufacture of basic metals, non-ferrous metal production	0	100
Other manufacturing industry	7	93
Civil aviation	99	1
Transport sector excl. civil aviation	0	100
Machinery	0	100
Building specific heating	0	100
Agriculture	0	100
Fishing	0	100
Other energy sector emissions	0	100
Fugitive emissions	90	10
Industrial processes		
Mineral industry	89	11
Chemical industry, hydrogen production	100	0
Chemical industry, production of phosphoric acid and other chemicals	0	100
Metal industry, iron and steel production	100	0
Other		
CO_2 captured	100	0
Liming	0	100
Other product and solvent use	0	100
Indirect CO_2 emissions	0	100
N_2O emissions		
Fuel combustion incl. transport and machinery	0	100
Nitric acid production	100	0
Manure management	0	100
Agricultural soils	0	100
Waste disposal and treatment	0	100
Other emissions	0	100
CH_4 emissions		
Fuel combustion incl. transport and machinery	0	100
Fugitive emissions	0	100
Enteric fermentation	0	100
Manure management	0	100
Waste disposal and treatment	0	100
F gas emissions		
F gas use	0	100

Assumptions and data sources for the different sectors are presented in more detail in the background reports that were prepared for the National Climate and Energy Strategy[110].

5.7.3 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. These are described in detail in Finland's Eight National Communication, Section 5.8.3. The same projections are reported in this report as are in the Eight National Communication and the same models and methodologies are used.

[110] Koljonen, T. et al., 2021, 2022 https://publications.vtt.fi/pdf/technology/2022/T402.pdf https://urn.fiURN:ISBN:978-952-383-257-2

6 Provision of financial, technological and capacity-building support to developing country Parties

This section aims to give an overview of the financial, technological and capacity-building support to developing country Parties provided by Finland. Financial support provided with exact figures is reported in the CTF Tables 7 for 2019 and 2020. The provision of technology development and transfer support and capacity-building support is summarised in CTF Tables 8 and 9.

6.1 Tracking climate finance

Finland uses the "Rio markers" developed for the OECD Development Assistance Committee's Creditor Reporting System (OECD DAC CRS) to track adaptation and mitigation-related finance based on the data provided in the CRS. As the markers give qualitative rather than quantitative information, there is a need for follow-up work to obtain quantitative results. Depending on whether adaptation or mitigation is the principal or a significant objective, the share usually varies between 10 and 100 per cent. Based on the project document or other relevant documentation from the implementing organisations (e.g. budget information or agreed strategies), the desk officer responsible for the respective intervention gives a value for the markers. For the MDBs, Finland uses a similar approach to that of the OECD when calculating imputed multilateral contributions. To avoid double-counting, an important element of this phase is to ensure that the total sum of all Rio markers does not exceed 100 per cent. The shares of adaptation or mitigation of the core support for multilateral organisations are based on data provided by the organisation on exact thematic budget allocations.

6.2 Climate finance in 2019 and 2020

The overall aim of Finland's development policy is to reduce poverty and inequality in the context of sustainable development. With its development policy, Finland supports the realisation of human rights, the rules-based multilateral system and the Sustainable Development Goals (SDGs) adopted by the UN. Finland's international cooperation and actions are grounded in the UNFCCC, Kyoto Protocol and the Paris Agreement on Climate Change and the goals of the 2030 Agenda for Sustainable Development. The cross-cutting objectives that Finland promotes through its development policy include gender equality, non-discrimination, climate resilience and low emission development, as well as protection of the environment, with an emphasis on safeguarding biodiversity. The integration of climate change has been one of the cross-cutting objectives of Finland's development policy and development cooperation since 2012. Overall, Finland's development cooperation aims to strengthen developing countries' own capacities and resilience.

Finland takes a long-term perspective on development cooperation. The Government Report on Development Policy across Parliamentary Terms confirms Finland's commitment to long-term development policy. A parliamentary monitoring group representing all parliamentary parties participated in the preparation of the report, which was adopted by the Government in 2021 and approved by Parliament in 2022. The report confirms Finland's aim to provide long-term support for climate change mitigation and adaptation, development that is low in emissions and climate-resilient, and biodiversity protection.

Finland's development cooperation focuses on a limited number of priorities building on its values and strength. "Climate change, biodiversity and sustainable management and use of natural resources" is one of them. It emphasises the strengthening of adaptation alongside the mitigation of climate change, food security, water and energy, meteorology and disaster risk prevention, forests and safeguarding biodiversity.

Finland's contribution to international climate finance is channelled as part of financing allocated for development cooperation. Financing is continued in a way that takes Finland's international obligations into account, and that targets resources equally to both mitigation of and adaptation to climate change. In 2019,

Finland's development aid disbursements were EUR 1,010 million[111], which was 0.41 per cent of gross national income (GNI). The Official Development Assistance (ODA) figures for 2020, which is the final year in this report, amounted to EUR 1,121 million[112] (0.47% of GNI).

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 (as grants) 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 147 million in 2019 and EUR 131 million in 2020 Annex 2 of NC8 and CTF Tables 7. Total climate finance allocations are projected to increase, even though there was a slight decrease in 2020 compared to the record figure of 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.
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 to strenghten national capacity building in developing countries (see also Section 8.4). Most Finnish climate finance is provided through multilateral channels (CTF tables 7).

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 are slowing down the achievement of sustainable development goals. The priority for Finland's climate finance is to support the least developed countries and small island developing states, as they are particularly vulnerable to the impacts of climate change. This approach is taken into account when any new funding opportunities are considered. For example, Finland is a long-term funder of the Least Developed Countries Fund (LDCF), which helps least developed countries build resilience and reduce vulnerability to climate change. In 2020, Finland contributed EUR seven million to the LDCF (CTF Table 7a). In addition, in late 2020, Finland joined CREWS[113] (the Climate Risk and Early Warning Systems Initiative) as a funder. This is a mechanism that funds Least Developed Countries (LDC) and Small Island Developing States (SIDS) for risk informed early warning services to better equip them to forecast and respond to climate risks.

Finland's development cooperation is based on the development needs defined by the partner countries and their own development plans. The objective is to strengthen developing countries' own carrying capacity. Accordingly, Finland's resources are especially directed at bringing about system-level changes that strengthen the opportunities and ability of the partner country and its society and communities to respond better and more sustainably to the country's own economy and wellbeing.

Similarly, in climate finance, Finland's support is based on developing country ownership and national plans, which, however, must be in line with internationally agreed development goals and values such as the Paris Agreement and Sustainable Development Goals. Most Finnish climate finance is channelled through multilateral funds and organisations. In 2019, the top receivers of Finland's climate finance were the Finland-IFC Blended Finance Climate Program, the Green Climate Fund and the Asian Development Bank (CTF Table 7a). Many of these support climate-resilient and low emissions pathways, e.g. development and implementa-

[111] 1 USD = EUR 0.8933 (2019)

[112] 1 USD = EUR 0.8775 (2020)

[113] https://www.crews-initiative.org/en

tion of NDCs and NAPs in developing countries. One example is the GCF and its Readiness and Preparatory Support programme, which finances the formulation and implementation of NDCs and NAPs.

6.3 Multilateral assistance

UN agencies, development finance institutions and multilateral climate funds play an important role in the mitigation of and adaptation to climate change. Finland defends the multilateral system and international law, recognises the significant results obtained through multilateral cooperation, and thus sees this system as one of the most important climate action. A large part of Finland's international climate finance is therefore channelled through multilateral organisations and funds. The strengths of multilateral cooperation are its wider coordination of climate finance and larger common funding base, which also has great potential for effectiveness. Finland works with other likeminded countries from its various constituencies to influence the full Paris-alignment of the strategies and operations of the multilateral development banks and funds.

As a party to international climate agreements, Finland supports the official financing mechanisms under which developed countries finance climate action in developing countries in accordance with the objectives of the climate agreements. Of the official financing mechanisms for international climate agreements, Finland financed the Global Environment Facility (GEF), the Least Developed Countries Fund (LDCF) and the Green Climate Fund (GCF) in 2019 and 2020.

Finland supports other multilateral climate funds with their own specific purposes. These include the Climate Risks and Early Warning Systems initiative, which supports the development of early warning systems and meteorological capacities in the Least Developed Countries and Small Island Developing States and the Partnership for Market Implementation managed by the World Bank, which supports the readiness and implementation of carbon pricing in developing countries. During the reporting period, Finland has contributed EUR five million to each of these funds. In addition, Finland invested EUR 46 million in a bilateral climate fund established with the International Finance Corporation (IFC) in 2019. This was part of a EUR 114 million investment in the Fund between 2017 and 2019. The Finland-IFC climate fund invests in large climate mitigation projects especially in least developed, low-income and lower-middle-income countries globally. Finland also invested EUR 20 million in the Asian Development Bank's Ventures Investment Fund in 2020. The Fund focuses on combating climate change and improving adaptation to climate change by investing capital in start-up and growth companies in Southeast and South Asia that aim to develop and scale up new climate solutions technology.

Finland contributes to a holistic view of climate change and biodiversity in terms of both challenges and solutions (for example, an ecosystem-based approach or nature-based solutions). Finland's biodiversity funding is primarily channelled through the Global Environment Facility (GEF), which is the funding mechanism for the UN Convention on Biological Diversity and has targets for climate change mitigation.

6.4 Bilateral, regional and other channels

The bilateral cooperation in long-term partner countries is based on country programmes that are prepared in collaboration with partners and that build on national development plans. The main sectors for climate-related cooperation, especially with public sector counterparts, include energy, forestry, natural resource management, water and sanitation and meteorology.

The forest projects implemented in Tanzania aim principally to increase forest-based livelihoods and employment but also provide significant climate benefits (mitigation and/or adaptation). Likewise, the projects focusing on water, sanitation and hygiene (WASH) in Nepal, Kenya and Ethiopia also include measures for climate change adaptation. In the energy sector, the regional energy and environment partnerships in the Mekong and in Southern and Eastern Africa support energy access through renewable sources, providing also significant mitigation benefits.

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 forecast 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 (see also Sections 6.3.5 and 6.4).

The national Development Finance Institution of Finland, Finnfund, plays a key role in financing private-sector climate mitigation and adaptation projects in all developing countries and especially in the least developed and lower-middle-income countries. Finnfund makes new investments worth approximately EUR 200 to 250 million per year, with the aim of allocating at least 50 per cent of its new investments to climate projects annually. The Government of Finland granted Finnfund new equity worth EUR 70 million during 2019 and 2020 and a EUR 105 million loan earmarked for climate investments in 2019.

Finnish NGOs and their local counterpart organisations also play an important role in supporting local communities in their endeavours to adapt to climate change, as well as in protecting the environment.

6.5 Private finance

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.

Finland has used investment-based and loan-based climate finance since 2016 to complement traditional grant-based climate finance. According to the current Government of Finland policies, 75 per cent of the investment- and loan-based ODA finance must be allocated to climate action. Besides concrete climate mitigation and adaptation targets, one of the objectives of this investment finance is to leverage large amounts of other financing, especially private sector financing, for climate projects. Most of the investments made by the Government of Finland have been targeted at the special climate-focused funds and activities of the international financial organisations (IFIs). They produce and share data on the overall leveraged amount of financing for climate funds and projects, but despite constant requests, not all of them separately report to donors the amount of leveraged private financing of the total leveraged amount of financing. Finland continues to advocate more accurate and transparent data on leveraged private sector financing figures from IFIs.

6.6 Technology development and transfer

Finland has specific programmes and financial arrangements for transferring environmentally sound technology to developing countries thus enhancing access to it (examples in Annex 2 of the NC8, CTF 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. The differences between these types of technologies are not always clear, and some activities have characteristics of both.

Many climate funds which Finland supports provide funding for technology transfer among other project types. These could be installation of renewable energy equipment in new areas or grey technology for adaptation, such as flood walls. However, it is rarely reported separately in their project portfolios.

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 coopera-

tion and concessional credit arrangements (see Table 7.1 for an example and Sections 8.3.5 and 8.4 for more details).

Table 7.1
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:
Upgrading the rainfall, storm and lightning detection capabilities of the national hydrometeorological service, Vietnam

Purpose: To strengthen the capacity of Vietnam's hydrometeorological service

Recipient Countries	Sector	Total Funding	Years in operation
Vietnam	Meteorology	Grant approximately EUR 12.4m	2017 to 2020 (*disbursements for the interest subsidy ongoing)

Description:
The goal of the project was to strengthen the capability of Vietnam to mitigate the adverse impacts of climate change and weather, thus providing safer living conditions, decreased economic losses, and improved overall preparedness for civil crisis management. In this project, a world-class meteorological monitoring infrastructure was established in Vietnam, specifically targeting the remote monitoring capabilities of rainfall and tropical storms. The project consisted of an upgrade of the current weather radar observation network adding five new weather radars and upgrading three existing weather radars, and also establishing a lightning detection network. In addition to modern observation infrastructure, the project included the installation and commissioning of the meteorological data visualization and automated forecast production system, SmartMet, from Finnish Meteorological Institute (FMI).

Factors which led to the project/programme's success:
High-quality products and extensive technical assistance and capacity-building by the Vaisala corporation throughout the project phases, plus extensive capacity-building by the Finnish Meteorological Institute (FMI). Counterpart funding from the partner / host country for infrastructural works including for example establishment of data communication for equipment and road access to installation sites.
Continued support and capacity-building by the FMI through the ongoing Institutional Cooperation Instrument (ICI) project (2019- ongoing).

Technology transferred:
Weather radars, lightning detection system, weather radar and lightning central site servers and application software, meteorological data visualization and automated forecast production system (SmartMet).

6.7 Capacity building

Finland supports capacity building through its climate finance to developing countries 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 as a response to existing and emerging capacity-building needs in our partner countries. Finland also supports several multilateral climate funds (such as GCF, GEF, LDCF, CREWS and the World Bank's Partnership for Market Implementation), which include a strong capacity-building component in their activities. This can be in the form of capacity building for developing country stakeholders for developing mitigation and/or adaptation projects to apply for funding or capacity development in a specific climate change theme.

For example, 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). During the reporting period, capacity support programmes for hydro-meteorological institutions were ongoing in Africa and Asia. The

main instrument for channelling funds for hydrometeorological cooperation is the Institutional Cooperation Instrument (ICI). Other channels for funding capacity building include Higher Education Institutions Institutional Cooperation Instrument (HEI-ICI) and the Academy Programme for Development Research (DEVELOP). Detailed information about these funding instruments and the capacity building projects is provided in Chapter 8.4 of Finland's Eight National Communication and in CTF Table 9.

Since 2004, Finland has funded an international course on environmental law and diplomacy. The support is also expected to continue in the coming years. This "Course on Multilateral Environmental Agreements" is organised annually by the University of Eastern Finland in cooperation with the UNEP and partners in developing countries. The course transfers 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. Due to the Covid-19 pandemic, it was impossible to organise the course in 2020, and the course was held in virtual format in 2021.

7 Other reporting matters

7.1 Introduction

In this chapter of the biennial report, Parties are encouraged to report, to the extent possible, on the domestic arrangements established for the process of the self-assessment of compliance with emission reductions in comparison with emission reduction commitments or the level of emission reduction that is required by science. Parties are also encouraged to report, to the extent possible, on the progress made in the establishment of national rules for taking local action against domestic non-compliance with emission reduction targets.

Finland's Eight National Communication describes the domestic climate change policy-making process, including legislative and administrative arrangements as well as monitoring and assessment of compliance with Finland's emissions reduction commitments (Chapters 2 to 6, especially Chapter 4 in Finland's NC8). Information on changes in domestic institutional arrangements is presented in the Section 4.5.

Finland has not established specific national rules for taking action against domestic non-compliance with emission reduction because such rules are established in the EU legislation (see the 4th Biennial Report of the European Union, Section 4.2.2 for the period of 2013–2020). The legislation concerning the EU ETS, including compliance in the ETS sector, is harmonized across the EU.
Interaction between research and policy making, regional and municipal action and initiatives are addressed in the Eight National Communication. This information is not repeated here.

Parties are also encouraged to provide any other information in this chapter it considers relevant to the achievement of the Convention. In Finland, the mitigation and adaptation objectives and actions are largely defined in national, governmental, regional and/or sectoral strategies, programmes and plans. Section 7.2 gives information on the aims and contents of the most relevant strategies, programmes and plans relevant for climate change mitigation.

7.2 Strategies, plans and programmes

Effective climate change policies require global collaboration and actions. Finland's climate policy is therefore based on international agreements: the UNFCCC; the Kyoto Protocol; and the Paris Agreement. This chapter describes the Finnish climate policy framework, the policy-making process and domestic and regional programmes, legislative arrangements and procedures for climate policy implementation under 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.

Finland's Eight National Communication gives a comprehensive description of Finland's adaptation and mitigation objectives and actions and related national, governmental, regional and/or sectoral strategies, programmes and plans. Mitigation policies and actions are also guided by the EU initiatives, programmes and the EU regulations. Information on the most relevant strategies, programmes and plans for climate change mitigation is given here below.

7.2.1 National energy and climate strategies

The Government Programme of Prime Minister Marin sets ambitious energy and climate targets, of which the most ambitious is Finland's national objective to be a carbon neutral society by 2035. National and EU-level legislation sets other energy and climate targets and commitments for 2030 and 2050 as well. In addition to the EU, certain international goals come from the UNFCCC, Paris Agreement and Kyoto Protocol, for example. The Government regularly prepares strategies and plans for achieving these energy and climate targets.

In 2020, Finland submitted its Long-Term Strategy to the EU and UN in accordance with the Implementing Regulation Act 2018/1999. The strategy includes Finland's latest national target, which is to achieve carbon neutrality by 2035.

The latest energy and climate strategy, called "Carbon Neutral Finland 2035 – National Climate and Energy Strategy"[114], sets out the key starting points and objectives of the Government Programme goals, including the EU 2030 targets and national carbon neutrality target by 2035. It then assesses the adequacy of current measures for meeting the targets (the base scenario) and additional measures by which its targets can be attained (the policy scenario). The strategy also refers to the latest Medium-Term Climate Change Policy Plan, which specifies the key measures for achieving the binding emissions reduction targets in the effort sharing sector by 2030, and to the Climate Change Plan for the Land-Use Sector.

With minor exceptions, Finland is phasing out the use of coal in the energy sector. The share of transport biofuels will be increased to 34 per cent (of the fuel energy content), and an obligation to blend light fuel oil used in machinery and heating with 30 per cent of bioliquids will be introduced. Finland will continue to subsidise electric and gas vehicles and promote the use of biogas in transport. The minimum aim in the strategy was to have 750,000 electric and 130,00 gas-powered vehicles on the roads in 2030. The electricity market will be developed at the regional and European levels. The flexibility of electricity demand and supply and in general, system-level energy efficiency, will be improved. A continuously strong focus will be kept on the national Energy aid scheme, which funds energy projects based on new energy technologies.

With the additional measures outlined in the strategy, the share of renewable energy in primary consumption is expected to increase to approximately 50 per cent, and the self-sufficiency in energy to more than 50 per cent by 2030. Most of this is attributed to biomass and wind power, including offshore wind. The national carbon neutrality target by 2035 appears possible to achieve, but much depends on individual companies' timing in investing in reducing process-related emissions, as well as the kind of carbon sink levels the LU-LUCF sector will be able to sustain. Due to the high carbon prices in the EU's ETS, the target of halving the use of energy peat set out in the Government Programme by 2030 will be achieved well in advance. The greatest non-ETS sector reductions in emissions will be achieved in the transport sector, which is also the foundation of the latest Medium-Term Climate Change Policy Plan prepared in 2022.

The relevant ministries are responsible for implementing the measures set out in the National Climate and Energy Strategy and for their monitoring and evaluation. In some cases, this responsibility has been delegated to specialised government entities such as Motiva Oy, an entirely state-owned sustainable development company in Finland that promotes the efficient and sustainable use of energy and materials.

[114] http://urn.fi/URN:ISBN:978-952-327-843-1

An example of sectoral climate policy progress reports are the summaries on the impact of energy efficiency agreements published on the internet[115] by Motiva Oy.

As a member of the European Union, Finland has reporting obligations to the EU concerning policies and measures and projections. The requirements are set by the EU Monitoring Mechanism Regulation[116]. 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), state owned sustainable development company Motiva Oy, and Natural Resources Institute Finland (Luke).

In the Government's annual report to Parliament, mitigation measures and emissions development are evaluated at a general level. Other energy and climate reporting activities include an annual report to 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.[117]

A new EU regulation on the Governance of the Energy Union and Climate Change Actions requires that every EU Member State prepares an integrated National Energy and Climate Plan by the end of 2019 and an update of it by June 2023. Finland has submitted its plan to the Commission in December 2019.

7.2.2 Long-Term Strategy (LTS)

In 2020, Finland submitted its Long-Term Strategy (LTS) to the UN and EU. It replaces the former Energy and Climate Roadmap 2050, published in 2014. The preparation of an LTS is stipulated in Article 4, Paragraph 19 of the Paris Agreement under the UNFCCC and in Regulation (EU) 2018/1999 of the European Parliament and of the Council on the Governance of the Energy Union and Climate Action, also known as the "Governance Regulation". It was the first strategy to take Finland's carbon neutrality target into account before the latest National Climate and Energy Strategy in 2022.

Finland's Long-Term Strategy lays out scenarios and impact assessments concerning the national carbon neutrality target set for 2035 and developments in greenhouse gas emissions and removals by 2050. The strategy explores the following three scenarios. Alongside the reference scenario depicting the development achievable with current policy measures at that time, known as the "With Existing Measures" (WEM) scenario, the strategy presents two alternative low-emission scenarios, known as the "Continuous Growth" and "Savings" scenarios. The Continuous Growth and Savings scenarios describe alternative pathways for achieving the emissions reduction target at that time set by Finland (or by the European Union, if stricter) for 2050. The Long-Term Strategy does not consider the transition to a low-emission society from the perspective of regional or social justice; instead, its underlying calculations are based on the premise that emissions reduction costs will be minimised across the country. Nor does the Long-Term Strategy identify the sectors to which emissions reductions should be allocated; nor do the impact assessments derived from the scenarios include any quantitative analysis of the concrete measures or political decisions that would be required to achieve the carbon neutrality target or the 2050 targets considered here.

With existing measures (WEM), carbon neutrality will not be achieved until 2050 – and even then, only with land-use net sinks at about 30 Mt CO2 eq. per year. Conversely, the Continuous Growth and Savings scenarios will achieve carbon neutrality in 2035, but this will require substantial emissions reductions over the 2030 to 2035 period, while also keeping the size of forest carbon sinks at a reasonable level. The measures decided by the Government and their impact on emissions are described in the latest National Climate and Energy Strategy, prepared in 2022.

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[115] https://energiatehokkuussopimukset2017-2025.fi/tulokset/sopimusten-tuloksetyhteensa/(Energy Efficiency Agreements 2017 to 2025, Results; platform only in Finnish)

[116] 2013/525/EU

[117] 609/2015 and 423/2022

Going forward, Finland will prepare a new complementary national Long-Term Strategy in accordance with the requirements set out in the Climate Change Act. The new strategy will be submitted to Parliament by the end of 2025 at the latest.

7.2.3 Medium-term Climate Change Policy Plan

The Climate Change Act[118] 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 will include an action plan that contains measures for the reduction of anthropogenic greenhouse gas emissions and the 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 the relevant ministries are involved in the work. The Annual Climate report, which is submitted to Parliament every year, contains information on the implementation of the policy measures contained in the Medium-Term Climate Change Policy Plan.

The second Medium-Term Climate Change Policy Plan was finalised during 2022. Alongside the National Climate and Energy Strategy and the Climate Plan for the Land-Use Sector, this plan implements the climate policy objectives of the Government Programme. It specifies and complements the emissions reduction measures outlined in the National Climate and Energy Strategy and the Climate Plan for the Land-Use Sector. It also examines links between different sectors and crosscutting themes such as the role of consumption and regional climate action. The plan takes the energy policy measures included in the strategy and the measures included in the Climate Plan for the Land-Use Sector into account, because they will have an impact on the development of the total emissions.

The Medium-Term Climate Policy plan was updated to meet the increasingly stringent EU obligations for 2030 and the Government's target to achieve carbon neutrality by 2035. The plan sets a target for reducing greenhouse gas (GHG) emissions 50 per cent in the effort sharing sector by 2030 compared to the 2005 level. It also 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 55 per cent compared with 1990 levels and is in line with Finland's long-term climate goal. As the existing measures are insufficient to achieve the 2030 EU target and the national target to be climate neutral by 2035, the plan identifies a range of additional measures. The greatest emissions reduction potential is identified in the transport sector. The plan also includes measures to reduce emissions in the agriculture, waste, and machinery sectors, as well as emissions from building-specific heating and F gas emissions.

A wide range of citizens and stakeholder groups was heard during the preparation of the Medium-Term Climate Change Policy Plan. The plan is based on the principle that carbon neutrality should be achieved as cost-effectively and fairly as possible.

7.2.4 Climate Plan for the Land Use Sector

The Climate Plan for the Land Use Sector (LULUCF)[119] was prepared from 2021 to 2022 for the first time, and it will be one of the key elements of the planning system under the revised Climate Change Act. In line with the UN Framework Convention on Climate Change and the Paris Climate Change Agreement, the land use sector comprises land use, land-use change, and forestry (LULUCF).

The preparation of the Plan was coordinated by a working group, which included members from the Ministry of Agriculture and Forestry and other relevant ministries, as well as two experts from the Finnish Climate Change Panel. The key principle in the preparation was to reach the climate targets as cost-effectively, fairly and justly as possible. The Plan was preceded by an analysis of the most effective climate measures in the

[118] 609/2015 and 423/2022

[119] http://urn.fi/URN:ISBN:978-952-366-388-6

LULUCF sector and complemented by an environmental impact assessment, as well as an analysis of the cost-effectiveness of the proposed measures. The Plan was prepared in a participatory manner.

The purpose of the Plan 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. The annual net impact, i.e. decrease in the emissions and increase in the removals, for which the additional climate measures in the land-use sector aim is at least three million tonnes of carbon dioxide equivalent by 2035.

Some measures were implemented already during the preparation of the Plan. Such measures include new ownership policy guidelines for the State Forest Enterprise (Metsähallitus) for 2020 to 2024, the act on fixed-term support for afforestation, and the act on fixed-term support for fertilisation of forests with wood ash. The Plan also includes measures targeting land-use changes, carbon dioxide emissions from agricultural land, the management of peatland forests, the promotion of carbon markets, as well as long-lived wood products and construction, and several crosscutting measures. The annual climate change report will contain information on the implementation of the policy measures included in the Climate Plan for the Land Use Sector. Links to the Medium-Term Climate Change Policy Plan and Climate and Energy Strategy were considered in the preparation process.

7.2.5 National forest legislation and programmes

National forest legislation and programmes are discussed in Finland's Eight National Communication in detail.

The sustainable management of forests in Finland is based on legislation, high-level scientific knowledge, and good practices. Maintaining the forest carbon sink is part of sustainable forest management.

The means for steering the use of forests include legislation, Finland's National Forest Strategy 2025, financing, and public forestry extension organisations. Forest legislation is the most important forest policy means for ensuring sustainable forestry. The key acts include the Forest Act[120] and the Act on the Financing of Sustainable Forestry.[121] There is also legislation dealing with the prevention of forest damage and the trade in forest reproductive material, timber measurement, jointly owned forests, and organisations in the forestry sector.

The Forest Act sets requirements for the regeneration and conservation of certain key habitats. The Forest Act is complemented by guidelines for good forest management and silviculture, which have been compiled and promoted by public forestry extension organisations.

The Government Report on Forest Policy 2050 adopted in 2014outlines 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 people and society. Based on the Forest Policy 2050, Finland's National Forest Strategy (NFS)[122], adopted by the Government in February 2015 and updated in 2019, specifies the main objectives for forest-based business and activities until 2025. The NFS describes the priorities and measures for the development of forest-based business and activities, on which the Government will focus as part of the sector's joint development. A new NFS until 2035 is currently being prepared (2022).

According to the current 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 both the growth and the resistance of growing stock to damage, while safeguarding the ecosystem services of forests and producing

[120] 1093/1996 (amendment 1085/2013)

[121] 1093/1996

[122] https://mmm.fi/en/nfs

wood biomass sustainably. Forests as a carbon sink have been a significant means of mitigating climate change in Finland.

The NFS is also implemented through Regional Forest Programmes, in which the special regional characteristics are duly considered. Regarding the contribution 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. 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.

The new Helmi programme is a key tool for halting biodiversity loss in Finland. The programme (2021 to 2030) is a joint programme of the Ministry of the Environment and the Ministry of Agriculture and Forestry, implemented together by the administrative branches of both ministries and municipal authorities and organisations.

The main objective of the Helmi programme is to take a comprehensive view of habitats and the necessary restoration and management measures in collaboration between numerous stakeholders. Restoration and management actions are targeted to specific areas and sites to maximise their impact on biodiversity.

7.2.6 Sectoral and regional programmes and plans

Sectoral policies and measures, including sectoral strategies, plans and programmes are described in more detail in Finland's Eight National Communication, Section 4.4. Some examples of sectoral and/or regional strategies, plans and programmes are given here below:

Low-carbon roadmaps

The Government Programmes in 2019 stated that sector-specific roadmaps to low-carbon operation would be prepared in cooperation with the sector's operators. The roadmaps would be used to achieve a better understanding of the scale, costs, and conditions of the required actions. A total of 13 sectors produced their own roadmaps in coordinated cooperation. In addition, a bioenergy association and one labour organisation published reports to contribute to the roadmap project. The results of the roadmap project was used as a direct input for the Government's climate and energy strategy, and many other government plans related to energy and climate policy. Furthermore, the roadmaps will guide the allocation of RDI investments and the preparation of sustainable recovery measures, for example. Low-carbon road maps were prepared for the following sectors[123]:

- Agriculture
- Bioenergy industry
- Chemical industry
- Commerce
- Construction industry
- Energy industry
- Food industry
- Forest industry
- Hospitality industry

[123] https://www.climate2035.fi/

- Logistics and transport
- Property owners and developers
- Sawmill industry
- Technology industries
- Textile industry

Municipal climate change solutions programme

The municipal climate change solutions programme of the Ministry of the Environment boosts climate work in Finnish municipalities and regions. The aim is to accelerate climate work of municipalities and regions in a way that is fast, cost-effective, and widely accepted. The programme finances municipalities' and regions' own climate projects and national solutions that support their climate work. At the end of 2021, the programme had funded a total of 118 projects to strengthen municipal and regional climate work throughout Finland. Furthermore, 20 new local and regional projects received funding for climate and circular economy projects in 2022. The programme has a wide variety of measures supporting energy efficiency activities and emissions reductions, e.g. in housing and transport.

Roadmap for fossil-free transport

The Government resolution on the reduction of greenhouse gas emissions in domestic transport, i.e. the Roadmap to fossil-free transport[124], was completed in May 2021. It formed the basis for planning and sizing the emissions reduction measures for transport in the new Medium-Term Climate Change Policy Plan. The Roadmap includes three phases. In the first, a wide range of aids and incentives to promote emissions-free transport will be implemented. For example, these are the inclusion of biogas and electro-fuels in the distribution obligation legislation, various aids related to the procurement and distribution infrastructure of electric and gas vehicles, support for promoting walking, cycling, and public transport services, transport infrastructure maintenance, and digitalisation in logistics. In the second phase, more measures will be added. More information is needed on their effects on emissions before new decisions on measures can be taken. The possible measures include raising the level of obligations in the distribution obligation act, increasing remote work, promoting both combined transport operations in freight transport and digital solutions for transport, and promoting transport services. In the third phase, once the progress of EU-level measures and the impacts of all the measures of phases 1 and 2 are known, the Government will assess and decide on the possible need for additional national measures in the transport sector. Phase three of the Roadmap is conditional.

Programme for the Promotion of Walking and Cycling

A Programme for the Promotion of Walking and Cycling and a Government Resolution to promote walking and cycling were adopted in 2018. The resolution and the programme include ten sets of measures aiming to increase the number of walking and cycling trips by 30 per cent by 2030. At least half of this increase should come from replacing car journeys. An entirely new measure in the programme is a joint Investment Programme by the State and municipalities to improve the conditions for walking and cycling within cities' street networks.

National Transport System Plan

Measures related to improving the efficiency of the transport system have been developed in connection with the preparation of the National Transport System Plan (Traffic12)[125]. The Plan is drawn up for a period of 12

[124] Roadmap to fossil-free transport; Publications of the Ministry of Transport and Communications 2020:19

[125] The National Transport System Plan for 2021 to 2032; Publications of the Finnish Government 2021:77; http://urn.fi/URN:ISBN:978-952-383-804-8

years (2021 to 2032) and will be updated each Government term. The National Transport System Plan addresses the overall transport system, and its objectives are associated with sustainability, accessibility, and efficiency. Measures promoting the integration of different mobility services and new services will be specified in more detail as part of the preparation and implementation of the National Transport System Plan. The objective of the plan is that opportunities to choose more sustainable modes of mobility will improve, particularly in urban areas. In urban areas and inter-urban transport, there needs to be a systematic shift from the current car-centric system to a sustainable mobility system. Under a sustainable mobility system, mobility and transport needs are managed by utilising and combining various transport modes and services. Digitalisation and transport-related information are key. Automation can also help achieve transport emissions reduction targets by improving the competitiveness and attractiveness of public transport, for example.

Catch the Carbon Research and Innovation Programme

The Catch the Carbon Research and Innovation Programme is a new kind of climate programme for the agricultural, forestry, and land-use sectors. Catch the Carbon began in 2020 and is implemented under the Government Programme. More than 100 research, development and innovation projects have been funded as part of the programme. These projects create new knowledge on climate-sustainable solutions for agriculture and forestry, engage stakeholders and actors, reduce greenhouse gas emissions, and enhance carbon sinks and reservoirs. There is a special emphasis on communication, interaction and competence to build better and strong implementation of climate-smart agriculture and forestry practices.

Carbon Euro Programme

In December 2021, the Finnish government set an ambitious emissions reduction target of 29 per cent for Finnish agriculture (including agricultural emissions in the effort sharing sector and land use, land-use change and forestry sector) by 2035. This means emissions from agriculture should decrease by 4.6 million tonnes CO_2 equivalent by 2035. The potential measures to achieve this target are specified in the Carbon Euro Programme[126]. The programme has not yet been implemented.

Climate Food Programme

The ministry of Agriculture and Forestry is currently preparing a Climate Food Programme[127] that aims to support society's transition to a climate-resilient food system. The programme includes measures to enhance sustainable food production and food services. There is a particular emphasis on scaling up the plant protein sector. A climate-resilient food system takes all the dimensions of sustainability into account: social; economic; cultural; and ecological. The programme also supports the objective of the Finnish Government to achieve carbon neutrality in 2035.

[126] https://mmm.fi/documents/1410837/1516663/HERO_selvitys_2022.pdf/fd751aad-a2f2-a31a-396a-872d034f823b/HERO_selvitys_2022.pdf?t=1650519685134

[127] https://mmm.fi/en/climatefriendlyfoodprogramme

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ANNEX 1 Recommendations in FCCC/ttr.4/FIN

Recommendations in FCCC/TTR.4/FIN	Finland's response in BR5	Where in BR5
The ERT recommends that Finland further explain its classification of mitigation actions as planned or implemented (e.g. using a custom footnote in CTF table 3).	Division of mitigation actions between implemented and planned actions is described in text and a custom footnote has been added to CTF Table 3.	Section 5.1 and CTF Table 3
The ERT recommends that Finland include in its next BR information on missing estimates of mitigation impacts in CTF table 3 or adequately explain in the textual part	Information on reasons why it has not been possible to provide quantified mitigation effects for all measures in the CTF Table 3 is given in text and the use of notation key of NE (not estimated) in CTF Table 3 for those cases is explained in text.	Beginning of Section 4.2.
The ERT recommends that Finland improve the transparency of its reporting by ensuring that the emission projections for fuel sold to ships and aircraft engaged in international transport are reported consistently with the most up-to-date estimates of historical GHG emission estimates.	Estimation method using the historical GHG emission estimates of the latest inventory submission to the UNFCCC is described in detail in text.	Section 5.2.2
The ERT recommends that Finland increase the transparency of its reporting on financial support provided to non-Annex I Parties by providing clear information on the total amount of financial support provided to developing Parties in CTF tables 7and 7(a). If support to Annex I Parties is included in the totals of CTF tables 7 and 7(a), the Party should clarify this by, for example, using a footnote to the CTF tables and explaining the issue in the textual part of the BR.	We note that both the NC and BR guidelines talk about in addition to support to non-Annex I countries also about support to developing countries. We prepare the reports based on our ODA data and in 2019 and 2020 there were disbursements in addition to non-Annex I countries to Ukraine, which is an ODA eligible country. Ukraine is also one of the EIT countries which we are about to support under the Convention as an Annex I country. Disbursements to Ukraine are marked in the respective tables as footnotes.	CTF Tables 7 and 7a

ANNEX 2 Custom footnotes for the CTF Tables of Finland's BR5

Due to some technical problems, some of the custom footnotes in the CTF tables are difficult to find and read. The custom footnotes, as included in the CTF tables, are listed here as auxiliary information:

Table 2(f)

(1) NF_3 not covered in the joint commitment under the UNFCCC by the European Union and its Member States (by 2020 target) (see the BR4 by the European Union)
(2) Market-based mechanisms under the Convention: Finland has fulfilled with domestic policies and measures its obligation under the EU Effort Sharing Decision (ESD) as its contribution to the joint target by the European Union.
(3) EU's joint target, Finland's contribution and commitments under the joint target are described in Chapter 3 of the BR5.

Table 3

(1) For Table 3 in general: Implemented actions refer to actions that have been implemented by 31 July 2022 and planned actions to those that have not been implemented before 1 August 2022.
(2) For Table 3 in general: Some refinements were made to the English translations of information on mitigation actions used in the NC8 and in the textual part of the BR5 so in some cases they differ from English wording on mitigation actions presented here in the CTF Table 3.
(3) For Table 3 in general, NE=not estimated, IE=included elsewhere. Use of NE is explained in Section 4.2 of the textual part of the BR5.
(4) The measure increases the emissions of the WM projection in relation to the previous WM projection, where biogas was not included in the distribution obligation but provided additional emission reductions. In the new WM projection, biogas/high-blend ethanol fuel reduces the amount of other biofuel in the distribution obligation and therefore increases emissions compared to the previous projection.
(5) The measure increases the emissions of the WM projection in relation to the previous WM projection, where biogas was not included in the distribution obligation but provided additional emission reductions. In the new WM projection, biogas/high-blend ethanol fuel reduces the amount of other biofuel in the distribution obligation and therefore increases emissions compared to the previous projection.
(6) In CTF Table 3, mitigation actions under Transport include also actions related to international bunker fuels. In the NC8 (text and tables) and in the textual part of the BR5, mitigation actions are separated into two groups, Transport and International bunker fuels.

Table 4

(1) Including indirect CO_2 emissions

Table 5

(1) The values in the table represent base case rates. Several reductions and exemptions exist.
(2) The values in the table represent base case rates. Several reductions and exemptions exist.
(3) For combustion only, the value would be 20% higher.
(4) For combustion only, the value would be 20% higher.
(5) The historical data on population and gross domestic production represents the data used in the projections and may slightly differ from the latest statistics.
(6) For all cells marked with * the following applies: No data available or in case of taxes, the taxation structure was significantly different from the present and thus not comparable.
(7) The energy content component is the tax component allocated to the energy content of the fuel in question based on the lower heating value. This component applies to heating, power plant and machinery fuels (coal, natural gas)
(8) The carbon dioxide component is the tax component allocated to the amount of CO_2 emissions that a given amount of the fuel in question produces. This component applies to heating, power plant and machinery fuels (coal, natural gas).
(9) The energy content component is the tax component allocated to the energy content of the fuel in question based on the lower heating value. This component applies to liquid transport fuels.
(10) The carbon dioxide component is the tax component allocated to the amount of CO_2 emissions that a given amount of the fuel in question produces. This component applies to liquid transport fuels.

Table 6(a)

(1) Including indirect CO_2 emissions
(2) Including indirect CO_2 emissions
(3) Including indirect CO_2 emissions

(4) Including indirect CO_2 emissions
(5) For all rows, values in the column "2020" are greenhouse gas emissions and removals, not projection/scenario estimates, because the most recent annual greenhouse gas inventory submission in 2022 already covered the inventory year 2020.
(6) IE = included elsewhere. For values for transport please see Section 5.2.2 in the textual part of Finland's BR5.
(7) Indirect CO_2 emissions are not counted twice. The totals are automatically calculated based on sums per gas.
(8) Historical greenhouse gas emissions (1990-2020) and projected emissions based on the WM projection (2030) from international bunkers are not included in this table but presented in the textual part of the BR5. Projection estimates for the WAM projection do not differ from the WM projection estimates.

Table 6(c)

(1) For all rows, values in the column "2020" are greenhouse gas emissions and removals, not projection/scenario estimates, because the most recent annual greenhouse gas inventory submission in 2022 already covered the inventory year 2020.
(2) For transport, data for greenhouse gas emissions are given in Section 5.2.2 of the textual part of the BR. The WAM emission estimate for 2030 is 6116 kt
(3) Including indirect CO_2 emissions
(4) including indirect CO_2 emissions
(5) Including indirect CO_2 emissions
(6) Including indirect CO_2 emissions
(7) Indirect CO2 emissions are not counted twice. The totals are automatically calculated based on sums per gas.
(8) Historical greenhouse gas emissions (1990-2020) and projected emissions (2030) from international bunkers are not included in this table but presented in the textual part of the BR5. Projection estimates for the WAM projection do not differ from the WM projection estimates.

Table 7(a) 2019 and 2020

(1) Domestic currency is EUR. 1 USD = EUR 0.8933 (2019), 1 USD = EUR 0.8775 (2020)
(2) Other multilateral climate change funds (2019): Includes disbursement of 0.5 million EUR/ 0.5 million EUR climate specific, NEFCO, recipient country Ukraine
(3) Other multilateral climate change funds (2020): Includes disbursement of 0.5 million EUR / 0.5 million EUR climate specific, NEFCO, recipient country Ukraine
(4) European Bank for Reconstruction and Development (2020): Includes disbursement of 1 million EUR / 0.9 million EUR climate specific, ERBD, partly recipient country Ukraine

Table 7(b) 2019 and 2020

(1) Domestic currency is EUR. 1 USD = EUR 0.8933 (2019), 1 USD = EUR 0.8775 (2020)
(2) Domestic currency is EUR. 1 USD = EUR 0.8933 (2019), 1 USD = EUR 0.8775 (2020)

Table 9

Complete list of projects in Chapter 8.4 of Finland's NC8. Please note that the Chapter 8.4. lists projects from 2017 to 2021.