



Ministry of the
Environment Finland

Annual Climate Report 2022

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Government**

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Ministry of the Environment

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ISBN pdf: 978-952-361-390-4

ISSN pdf: 2490-1024

Layout: PunaMusta Oy

Helsinki 2023 Finland

Annual Climate Report 2022

Publications of the Ministry of the Environment 2022:15		Subject	Environmental protection
Publisher	Ministry of the Environment		
Editor(s)	Riikka Siljander, Magnus Cederlöf, Kai Skoglund		
Language	English	Pages	121

Abstract

Under the Climate Change Act, the Government submits an Annual Climate Report to the Parliament each year. The report monitors the general development of greenhouse gas emission trends, the sufficiency of the planned measures to achieve the set emission reduction targets for the coming 15 years as well as progress made in implementing the National Adaptation Plan.

The total emissions in 2021 remained approximately on the same level as in the previous year. There was an increase in emissions from the emissions trading sector but the emissions from this sector have declined substantially during earlier years. The emissions from the effort sharing sector decreased compared to the previous year. The emissions from this sector have decreased more slowly than the emissions from the emissions trading sector. Based on the verified emission figures from 2020, Finland fulfills the emission reduction obligation for the period 2013-2020.

According to the proxy estimates, in 2021, the land use sector turned from a carbon sink into an emissions source for the first time. As a result, Finland's net emissions increased and exceeded the 2005 level. The transformation of the sink into an emissions source is assumed to be a result of slower tree growth and high amount of felling.

Based on scenarios used in this Annual Climate Report, it can be assessed that the measures taken in the emissions trading sector and the effort sharing sector are sufficient to achieve the emission reduction targets. However, a substantial amount of uncertainty is related to the achievement of the targets. The scenarios do not take into account energy price hikes or the development of emissions and sinks in the land use sector.

Keywords climate policy, emissions, reporting, Annual Climate Report, climate change, environmental protection

ISBN PDF	978-952-361-390-4	ISSN PDF	2490-1024
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URN address <https://urn.fi/URN:ISBN:978-952-361-390-4>

Ilmastovuosikertomus 2022

Ympäristöministeriön julkaisuja 2022:15		Teema	Ympäristönsuojelu
Julkaisija	Ympäristöministeriö		
Toimittaja/t	Riikka Siljander, Magnus Cederlöf, Kai Skoglund	Sivumäärä	121
Kieli	englanti		
Tiivistelmä	<p>Ilmastolain mukaan valtioneuvosto antaa ilmastovuosikertomuksen eduskunnalle vuosittain. Ilmastovuosikertomuksessa tarkastellaan yleistä kasvihuonekaasujen päästökehitystä, suunniteltujen toimien riittävyttä seuraavan 15 vuoden ajalle asetettujen tavoitteiden saavuttamisen osalta ja arvioidaan sopeutumissuunnitelman toimeenpanotilannetta.</p> <p>Vuonna 2021 kokonaispäästöt ilman maankäyttösektoria pysyivät lähes edellisen vuoden tasolla. Päästökauppasektorin päästöt kasvoivat edellisvuodesta, mutta päästöt ovat kuitenkin pienentyneet merkittävästi aiempina vuosina. Taakanjakosektorin päästöt vähenivät edellisvuoteen verrattuna. Sektorin päästöt ovat kuitenkin vähentyneet hitaammin kuin päästökaupan päästöt. Vuoden 2020 tarkastettujen päästötietojen perusteella Suomi saavuttaa kaudelle 2013–2020 asetetun taakanjakosektorin velvoitteen.</p> <p>Pikaennakkotietojen mukaan maankäyttösektori muuttui vuonna 2021 ensimmäistä kertaa nielusta päästölähteeksi. Tästä syystä Suomen nettopäästöt kääntyivät kasvuun, ja ne ylittävät nyt vuoden 2005 tason. Nielun muuttumisen päästölähteeksi arvioidaan johtuvan hidastuneesta puuston kasvusta sekä korkeista hakkuumääristä.</p> <p>Tässä ilmastovuosikertomuksessa käytettyjen skenaarioiden pohjalta voidaan arvioida, että päästökaupan ja taakanjakosektorin toimet ovat riittäviä päästövähennystavoitteiden saavuttamiseksi. Tavoitteiden saavuttamiseen liittyy kuitenkin huomattavaa epävarmuutta, eikä käytetyissä skenaarioissa ole otettu huomioon energian hinnannousua tai maankäyttösektorin päästö- ja nielukehitystä.</p>		
Asiasanat	ilmastopoliittika, päästöt, raportointi, ilmastovuosikertomus, ilmastonmuutos, ympäristönsuojelu		
ISBN PDF	978-952-361-390-4	ISSN PDF	2490-1024
Julkaisun osoite	https://urn.fi/URN:ISBN:978-952-361-390-4		

Klimatårsberättelse 2022

Miljöministeriets publikationer 2022:15		Tema	Miljövård
Utgivare	Miljöministeriet		
Redigerare	Riikka Siljander, Magnus Cederlöf, Kai Skoglund		
Språk	Engelska	Sidantal	121
Referat	<p>Enligt klimatlagen avläter statsrådet årligen en klimatårsberättelse till riksdagen. I klimatårsberättelsen redogörs för utsläppsutvecklingen av växthusgaser, analyseras hur långt de planerade åtgärderna kommer att räcka för de följande 15 åren för att uppnå de uppställda målen samt görs en bedömning av hur verkställandet av planen för klimatanpassning framskrider.</p> <p>År 2021 höll sig de totala utsläppen utan markanvändningssektorn på i stort sett samma nivå som året innan. Utsläppen från utsläppshandelssektorn växte jämfört med föregående år men sektorns utsläpp har ändå minskat betydligt under tidigare år. Utsläppen från börd fördelningsssektorn minskade jämfört med året innan; utsläppen från sektorn har dock minskat långsammare än utsläppshandels utsläpp. Enligt de granskade utsläppsuppgifterna för år 2020 uppfyller Finland förpliknelsen som gäller börd fördelningsssektorn för perioden 2013-2020.</p> <p>Enligt snabbestimatet förvandlades markanvändningssektorn år 2021 för första gången från att ha varit en sänka till en utsläppskälla. Av denna anledning steg Finlands nettoutsläpp och översteg den nivå nettoutsläppen låg på år 2005. Det faktum att sänkan förvandlades till en utsläppskälla bedöms bero på långsammare skogstillväxt samt höga avverkningsnivåer. Enligt de scenarier som tillämpats i denna klimatårsberättelse kan man göra bedömningen att åtgärderna inom utsläppshandeln och börd fördelningsssektorn är tillräckliga för att uppnå utsläppsmålen. Måluppnåelsen är dock förenad med betydande osäkerhet, de använda scenarierna beaktar inte heller de stegrande energipriserna eller utvecklingen av sänkan och utsläppen inom markanvändningssektorn.</p>		
Nyckelord	klimatpolitik, utsläpp, rapportering, klimatårsberättelse, klimatförändring, miljövård		
ISBN PDF	978-952-361-390-4	ISSN PDF	2490-1024
URN-adress	https://urn.fi/URN:ISBN:978-952-361-390-4		

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ANNUAL CLIMATE REPORT 2022 — EXECUTIVE SUMMARY

The preparation of the Annual Climate Report is provided for in the Climate Act (423/2022). The Finnish Government submits an Annual Climate Report to Parliament each year to report on the trends in emissions, realisation of the Medium-Term Climate Plan and the Climate Plan for the Land Use Sector and progress towards the targets set for emission reductions. The Annual Climate Report has been issued since 2019. In connection with the parliamentary deliberations of the previous Annual Climate Reports, requests have been made for the development of the report. Based on policies outlined by Parliament, the scope of the Annual Climate Report has been diversified with a view to providing the most comprehensive situation report possible of development trends in climate change policy. In addition, in connection with the reform of the Climate Act, the content requirements of the annual report have been specified and expanded to reflect the scope of the new act.

In addition to the assessment of the achievement of the climate targets and the sectoral reviews, this Annual Climate Report also provides an assessment of the progress of cross-cutting activities. It also presents a comprehensive review of the climate change adaptation situation.

Emission trends in 2021

Finland's total emissions excluding the land use/LULUCF sector, that is aggregate emissions from the emissions trading and effort sharing sectors, amounted to 47.8 Mt CO₂-eq in 2020 and, based on proxy estimates, to 47.7 Mt CO₂-eq in 2021. In 2021, emissions decreased by 0.1 Mt CO₂-eq from the year before. Since 2005, total emissions without the land use sector have declined by an average 2% a year. Over the period from 2005 to 2021, total emissions decreased by 22.2 Mt CO₂-eq, or 32%. The land use sector has been a significant net sink in Finland. According to a proxy estimate, the carbon sink in the land use sector turned into net emissions for the first time in 2021, amounting to 2.1 Mt CO₂-eq.

In 2021, emissions from Finnish installations included in emissions trading totalled 20.3 Mt CO₂-eq. Emissions increased by 0.7 Mt CO₂-eq, or 4%, from the year before. The growth in emissions was caused by higher consumption of coal than in the previous year. The growth in the consumption of coal was influenced by, among other things, colder weather

and the high market price of natural gas. Since 2005, emissions have decreased by an average of about 3% per year.

Greenhouse gas emissions have decreased more slowly in the effort sharing sector than in the emissions trading sector. Emissions in the effort sharing sector amounted to 28.1 Mt CO₂-eq in 2020 and, based on proxy estimates, 27.2 Mt CO₂-eq in 2021. In 2020, emissions were 1.2 Mt CO₂-eq lower than in the previous year. According to proxy estimates, emissions continued to fall by 0.9 Mt CO₂-eq in 2021. Relative to 2005 levels, net emissions from the effort sharing sector have decreased by 7.1 Mt CO₂-eq, equating to 21% and an average of approximately 1% annually.

Achieving the emission reduction targets

Finland's obligation under EU law has been to reduce the effort sharing sector's emissions from 2005 levels by 16% by 2020 and by 39% by 2030. In addition, according to the Government Programme, Finland aims to be carbon neutral by 2035 and carbon negative shortly thereafter. Furthermore, on the basis of the new Climate Act, total emissions must be reduced by 60% by 2030.

According to the verified emission data for 2020, Finland is on track to meet its emissions reduction obligation for the effort sharing sector for the entire 2013–2020 period without the need to make use of international emission units. Based on inventory data, Finland should have 0.8 Mt CO₂-eq in surplus units calculated cumulatively for the entire 2013–2020 period.

According to the proxy estimate, the emission level in the effort sharing sector in 2021, 27.2 Mt CO₂-eq, will be 1.6 Mt below the emission allocation in 2021 under the current Effort Sharing Regulation. According to the present reform proposal of the Commission's Effort Sharing Regulation, the Finnish effort sharing sector will have an emission reduction obligation of 50% in 2030, which corresponds to approximately 17.2 Mt CO₂-eq in 2030. In order to meet this obligation, a new Medium-term Climate Change Policy Plan (KAISU) was drawn up and submitted to Parliament in June 2022.

Another key factor for the carbon neutrality target is the expected amount of carbon sinks in 2035, which determines the magnitude of the required emission reductions. In the planning of climate policy, the sink level for 2035 has been assumed to amount to 21 Mt CO₂-eq, which has also been used in this context as the assumption in assessing the achievement of the carbon neutrality target. According to the policy scenario of the Carbon Neutral Finland 2035 project, we will fall approximately 4 Mt CO₂-eq short of that emission level. However, the above-mentioned policy scenario does not include all measures of the Medium-term Climate Change Policy Plan or low-carbon investments in the Raahe steelworks. As a result of their combined effect, the emission level could be reduced to around 21 Mt CO₂-eq in 2035, achieving the carbon neutrality target.

Sectoral trends

According to Statistics Finland's proxy estimate, greenhouse gas emissions from domestic transport, excluding air transport, totalled around 9.9 Mt CO₂-eq in 2021. This was slightly over 20% of total emissions and almost 37% of the emissions in the effort sharing sector. In 2021, road transport work decreased (0.5%) and the proportion of renewable fuels in transport rose significantly from approximately 11% to about 18%.

According to the 2016 Climate and Energy Strategy, the target for the transport sector is to halve emissions from 2005 levels by 2030. The Government Programme has the same objective. The roadmap for fossil-free transport includes the measures needed to halve emissions. Similar measures are also included in the Medium-term Climate Change Policy Plan.

Emissions from agriculture counted towards the effort sharing sector have remained more or less the same over the last few years. Proxy estimates put the emissions at 6.4 Mt CO₂-eq in 2021. The emissions fell by one per cent from the previous year. The aim of the measures of the Medium-term Climate Change Policy Plan is to reverse emissions in the agricultural sector. The necessary emission reduction measures have been defined, inter alia, in the context of the preparation of the National Strategic Plan for the EU's Common Agricultural Policy (CAP) for the funding period 2021–2027. Implementation of the plan will start in 2023. In addition, national measures are being prepared, and the carbon footprint of food consumed is intended to be reduced by improving the overall sustainability of the food system.

Emissions from building-specific heating have seen a downward trend in recent years due to a decline in oil heating and the improved energy efficiency of buildings. Emissions from building-specific heating are mainly caused by oil heating. Emissions from building-specific heating amounted to 2.1 Mt CO₂-eq in 2020, a decrease of 0.1 Mt CO₂-eq from the year before. Newly introduced support will be used to promote discontinuation of oil use in residential properties. In addition, support will be allocated to municipalities and parishes to accelerate the phasing out of oil heating.

Greenhouse gas emissions from non-road mobile machinery have declined slowly. In 2021, they were 2.4 Mt CO₂-eq, remaining on par with the previous year. Emissions are expected to decrease moving forward, as the proportion of biofuel in light fuel oil increases in keeping with the biofuel distribution obligation. Furthermore, tax on light fuel oil was raised at the beginning of 2021, while electrification is also expected to make gradual progress starting from small non-road mobile machinery. Changes in the way non-road mobile machinery is used can also affect its emissions.

The 2021 proxy estimate puts greenhouse gas emissions from waste treatment at 1.8 Mt CO₂-eq. Emissions from waste treatment have been declining steadily since the 1990s. Since 2005, emissions have decreased by as much as 41%. The main reason for this is the stricter energy legislation, which has reduced the landfilling of municipal waste and increased energy recovery from waste. Landfill gas recovery has also reduced emissions. Methane produced by landfills is the most significant source of emissions in waste treatment. On the other hand, increased energy use of waste has increased emissions from waste incineration.

According to the proxy estimate, the emissions of industrial gases, or F-gases, were 0.9 Mt CO₂-eq in 2021, a decrease of 6% from 2020. Emissions from the use of refrigeration and air-conditioning equipment in trade decreased the most. Refrigeration and air-conditioning equipment account for over 90% of F-gas emissions. Emissions are being reduced by the ever-increasing use of carbon dioxide as a refrigerant.

Cross-cutting measures

In total, 138 of Finland's 309 municipalities have set themselves a municipal or regional climate target. Some 4.5 million people, which is approximately 80% of the population of Finland, live in these municipalities. Two thirds of Finns live in municipalities that aim to reduce emissions by 80% in 2007–2030 (especially the municipalities of the Towards Carbon Neutral Municipalities (Hinku) network) or to become carbon neutral by 2035. The Finnish Government decided during its budget session in September 2021 that legislation would be amended to include the obligation to draw up climate change plans at the local, sub-regional or regional level. This is to be clarified in that the Climate Act would impose an obligation on municipalities to draw up a climate plan alone or together with other municipalities. A government proposal on this is intended to be introduced in autumn 2022.

The National Public Procurement Strategy aims to support Finland's 2035 carbon neutrality target. Approximately 22% of emissions from public procurements and investments are attributable to the state, 71% to procurements and investments made by municipalities and joint municipal authorities and 7% to procurements and investments made by other public organisations. The administrative branch of the Ministry of Defence was the largest source of greenhouse gas emissions in central government procurement, followed by the administrative branches of the Ministry of Transport and Communications and the Ministry of the Interior.

The most significant emission reductions resulting from the circular economy take place in production, as the use of virgin natural resources and energy required in production processes decrease. Furthermore, circular economy operating models will reduce the

consumption footprint. The strategic programme to promote a circular economy was completed in January 2021, and the Finnish Government adopted a resolution based on it in April 2021. The Strategic Programme for Circular Economy set out a vision and objectives for the circular economy, defined the necessary measures and monitoring indicators and proposed the resources required to promote the circular economy.

Adaptation

In keeping with the Climate Act, the national adaptation plan is being updated under the leadership of the Ministry of Agriculture and Forestry. The plan will guide adaptation until 2030, defining the vision and objectives for adaptation to be pursued between 2023 and 2030. Targets to be implemented by the measures set out in the plan are defined under the objectives.

The adaptation plan under preparation includes a risk and vulnerability assessment. Adaptation needs are examined both by administrative branch and across branches, as well as from a regional perspective. The aim is also to develop a monitoring system to assess the progress and effectiveness of the measures.

The new adaptation plan will be prepared on the basis of the experience gained from the implementation of the current plan, taking into account the obligations set by both the national Climate Act and the EU. The adaptation plan is part of the climate policy planning system in accordance with the Finnish Climate Act. The European Climate Law also requires Member States to have comprehensive national adaptation plans.

1 Introduction

The preparation of the Annual Climate Report is provided for in the Climate Act (423/2022). In accordance with the policies of the Government Programme, the revised Climate Act entered into force on 1 July 2022. With regard to the Annual Climate Report, the act was reformed to reflect the scope of reporting already applied in previous annual reports.

The Climate Act specifies the parts of the planning system for national climate change policy as well as its schedules and responsibilities. Under the Climate Act, the planning system comprises four parts: a long-term plan, the Medium-Term Climate Change Policy Plan, the Climate Plan for the Land Use Sector and the adaptation plan. With the Annual Climate Report, the Government reports annually to Parliament information on the development of emissions and sinks, assessments of the adequacy of the climate change plans and the achievement of the targets set for the next 15 years. The reporting covers both the Medium-Term Climate Change Policy Plan and the Climate Plan for the Land Use Sector. Actions under the adaptation plan must also be reported on an annual basis. The main content of the annual report must be adequately communicated to the public.

The Annual Climate Report has been issued since 2019. In connection with the parliamentary deliberations of the previous Annual Climate Reports, requests have been made for the development of the report. These requests have been taken into account in the preparation of subsequent Annual Climate Reports. The feedback received has been taken into account in the scope of reporting and in the development of communications, in particular. The development needs of the Annual Climate Report were also taken into account in connection with the reform of the Climate Act, in which context the content requirements of the report were specified and expanded to reflect the scope of the new act. In its discussion paper (YmVM 10/2020 vp) on the Annual Climate Report 2021, the Environment Committee stated that the report had been improved in accordance with the previous guidelines presented by Parliament. In the future, the scope of the annual report can be maintained unchanged and a separate communication summary published. Parliament believes that it would be justified if future annual reports examined, for example, the links between climate and economic policy and, in particular, the importance of various investments in terms of emissions development. As in previous years, the annual report contains reviews of measures that transcend sector boundaries, such as municipal climate policy and the circular economy.

2 Emissions reduction targets

2.1 Government Programme

According to the Programme of Prime Minister Sanna Marin's Government, Finland aims to be carbon neutral by 2035 and carbon negative shortly thereafter. This means that, in 2035, emissions should stand at or below the level of sinks, which should subsequently exceed emissions. According to the Government Programme, emissions reduction measures will be carried out in a way that is fair from a social and regional perspective and that involves all sectors of society. New targets have been taken into account in the preparation of the Medium-term Climate Change Policy Plan and the Climate and Energy Strategy. The key climate objectives of the Government Programme have been included in the revised Climate Act.

In keeping with the Government Programme, electricity and heat production must be made nearly emissions-free by the end of the 2030s while also taking into account security of supply aspects. Further objectives include reducing emissions from the land use sector and strengthening carbon sinks in the long and short term. The carbon neutrality target specified in the Government Programme is more ambitious than the corresponding targets currently in place at the EU level.

2.2 Climate Act

The revised Climate Act entered into force on 1 July 2022. The revised act sets out the target for carbon neutrality for 2035 and emission reduction targets for 2030 and 2040, as well as an updated target for 2050. The emission reduction targets are 60% from the 1990 levels by 2030, 80% by 2040 and 90% (while still aiming at 95%) by 2050. The act also includes a target for increasing sinks to meet the carbon neutrality target and even further by 2035. In terms of scale, the reform is substantial and specifies the act's scope of application and targets. Regardless, the revised act remains fundamentally a framework act, laying down provisions on the planning system for climate change policy.

During the consultation round, the obligation for municipalities to promote the objectives of the act and the regulation of appeals contained in the draft Climate Act were criticised. For this reason, these were not included in the government proposal presented to Parliament on the reform of the Climate Act but were moved to continued drafting. The Government is due to submit an additional proposal for the Climate Act to Parliament

in autumn 2022, adding the obligation for municipalities to prepare climate plans individually or jointly. At the same time, the appeal procedure of the Climate Act will also be regulated.

2.3 EU climate objectives

By a decision of the European Council of December 2020, the European Union committed to reducing net greenhouse gas emissions by at least 55% from 1990 levels by 2030. Net emissions also include carbon sinks. Increasing the target from 40% to 55% aims to ensure that climate neutrality can be achieved in the longer term. Both the new 2030 target and the objective of a climate-neutral European Union by 2050 are included in the European Climate Law, which entered into force in July 2021.

In July 2021, the Commission presented sector-specific legislative proposals necessary to achieve the 2030 target, which are still under negotiation between the Commission, the Council and Parliament. Under the current emission reduction commitments in force, emissions are to be reduced by 43% in the emissions trading sector and by 30% in the effort sharing sector from 2005 levels by 2030. The new legislative proposals would raise the emission reduction target for the emissions trading sector to 61% by 2030 and the effort sharing sector EU-level target to 40%.

The Commission also adopted a proposal to update legislation on the land use, land use change and forestry sector (LULUCF). The objective of the current regulation is to ensure that the calculated greenhouse gas removals in the land use sector in accordance with the calculation rules are at least at the level of its calculated emissions. This 'no-debit' rule applies both to the EU as a whole and to individual Member States. The Commission estimates that these obligations will result in a net carbon sink at EU level of 225 Mt CO₂-eq in 2030. In the new proposal, the Commission proposed only minor amendments to the current regulation for the period 2021–2025. The main changes proposed by the Commission for the period 2026–2030 are: Net sink target at EU level –310 Mt CO₂-eq for 2030, transition to a greenhouse gas inventory-based accounting system and transition to binding annual sink targets for each Member State. In addition, the Commission proposed the creation of a new AFOLU (agriculture, forestry and land use) sector from 2031 onwards. The sector would cover non-CO₂ emissions from agriculture as well as land use categories under the current LULUCF Regulation.

2.4 The international policy framework and the Paris Agreement

The Paris Agreement on climate change was adopted in 2015 and entered into force in November 2016. By the end of 2021, the Paris Agreement had been ratified by 191 parties and covered 97% of global greenhouse gas emissions. The Paris Agreement applies to the post-2020 period and is in effect until further notice. In November 2021, the 26th Conference of the Parties (COP26) in Glasgow agreed on further modalities for Article 6 on market mechanisms and on consistent and transparent reporting of climate action and emissions, thereby finalising the rules for the implementation and application of the agreement.

The central aim of the Paris Agreement is to keep the rise in global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C. A further objective is to strengthen the ability of the parties to adapt to climate change, to foster their climate resilience and to direct financial flows towards low-carbon development. For the temperature goal to be achieved, global greenhouse gas emissions need to be brought downwards as soon as possible and quickly reduced thereafter so as to achieve a balance between anthropogenic greenhouse gas emissions and sinks in the second half of this century.

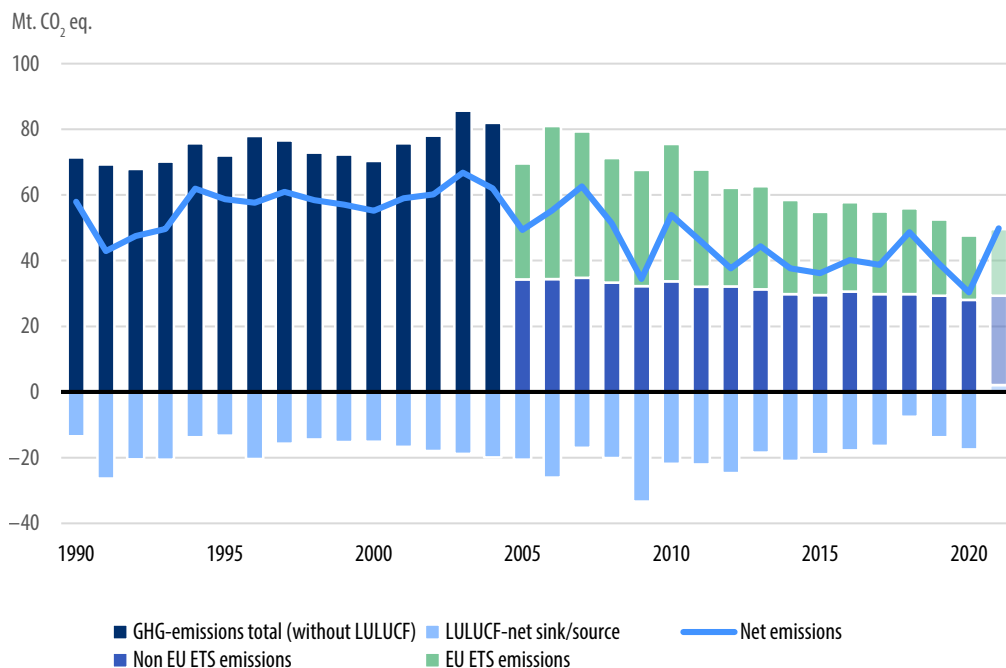
The key elements of the Paris Agreement include the parties' obligation to formulate their nationally determined contributions (NDCs) used to declare their emission reduction and adaptation targets and report their planned climate action. The NDCs must be increased at least every five years and must correspond to the party's highest possible level of ambition. On the basis of the national emission reduction targets announced by the latest Conference of the Parties in November 2021, it seems that temperature rise will exceed 2°C. According to the latest report of the Intergovernmental Panel on Climate Change (IPCC), published in April 2022, emission reduction measures should already be stepped up in the next decade in order to meet the international targets for limiting global warming. The collective progress of the countries towards the objectives of the Paris Agreement is reviewed in global stocktakes every five years. The first stocktake will be organised in 2023.

3 Greenhouse gas emissions 2005–2021

3.1 Total emissions

Finland's total emissions excluding the land use/LULUCF sector, that is aggregate emissions from the emissions trading and effort sharing sectors, amounted to 47.8 Mt CO₂-eq in 2020 and, based on proxy estimates, to 47.7 Mt CO₂-eq in 2021. In 2021, emissions decreased by 0.1 Mt CO₂-eq from the year before. Since 2005, total emissions without the land use sector have declined by an average 2% a year. Over the last five years, the pace of the decrease has stood at an average 4% per year. Over the period from 2005 to 2021, total emissions decreased by 22.2 Mt CO₂-eq, or 32%. The land use sector has been a significant net sink in Finland. According to the proxy estimate, the carbon sink in the land use sector turned into net emissions for the first time in 2021 at 2.1 Mt CO₂-eq (Figure 1).

Figure 1. Development of total emissions 1990–2021. The negative values represent the net sink of the land use sector. From 2005 onwards, total emissions have been divided between the effort sharing and emissions trading sectors. The 2021 data are proxy estimates.



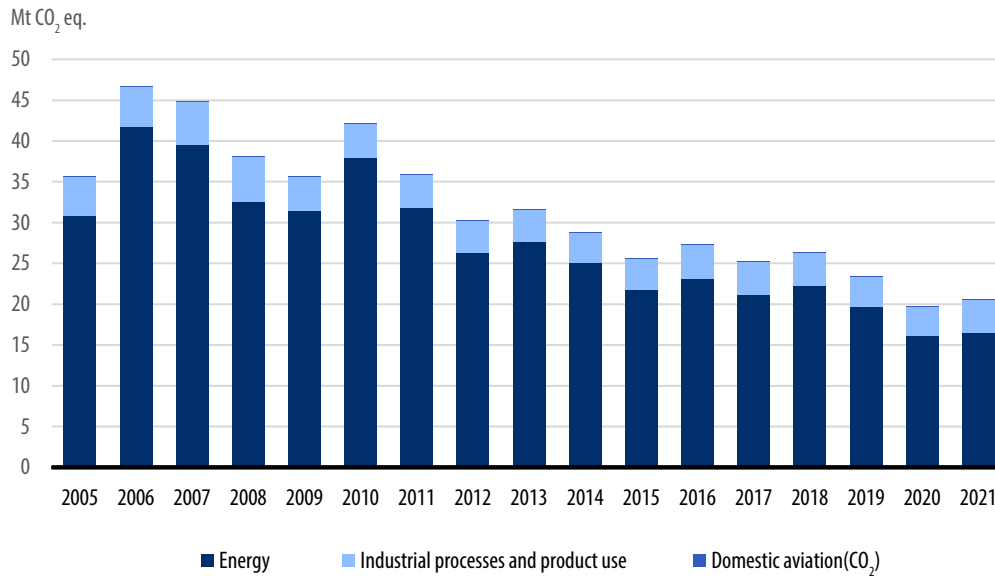
Trends in net emissions play an essential role in terms of climate change mitigation. Net emissions refer to total emissions minus the land use sector's net sink. Achieving the carbon neutrality target in accordance with the Climate Act requires net emissions be zero or less by 2035. In addition, the aim of the Climate Act is for emissions to decrease and for removals to increase further after 2035, at which point net emissions should be negative. In 2020, net emissions amounted to 30.3 Mt CO₂-eq, reverting to more or less the same level as in 2014–2017. In 2021, net emissions were 49.8 Mt CO₂-eq. The growth of net emissions was affected by the change in the net carbon sinks of the land use sector to a net source of emissions. Over the period from 2005 to 2020, net emissions decreased by 24 Mt CO₂-eq, equating to 49%. In 2021, however, net emissions began to rise, exceeding the 2005 level by 1.7%.

Emission trends need to be analysed taking account of cross-sectoral links, which means that a specific trend in one sector may impact on emissions in another. A typical example is electrification of various functions of society. There is a significant electrification trend under way in the transport sector, for example, due to the transition from combustion to electric engines in vehicles. While an electric engine does not generate direct emissions, it increases electricity consumption and may therefore also push up emissions from electricity production. At the same time, the emissions generated move from the effort sharing to the emissions trading sector. Similarly, connections also exist between the emissions trading, effort sharing and land use sectors. Achieving carbon neutrality requires action in all sectors and ensuring that progress made in one sector is not cancelled out by increasing emissions or shrinking sinks in another.

3.2 Emissions trading sector

The EU emissions trading system (ETS) covers major industrial and energy production plants as well as air transport within Europe. In 2021, emissions from Finnish installations included in emissions trading totalled 20.3 Mt CO₂-eq (Figure 2) and amounted to 43% of Finland's total emissions. Emissions increased by 0.7 Mt CO₂-eq, or 4%, from the year before. The growth in emissions was due to higher consumption of coal, which was influenced by, among other things, colder weather than in the year before and the high market price of natural gas. Since 2005, emissions have decreased by an average of about 3% per year, and overall, emissions from the emissions trading sector have decreased by 15.0 Mt CO₂-eq, or 42.5%. In 2020, energy-based emissions accounted for about 81% of total emissions in the emissions trading sector, while the figure for industrial processes and product use stood at about 19%. The proportion of process emissions has shown a slight increase in recent years (Figure 2). According to the 2021 proxy estimate, CO₂ emissions from domestic air transport according to the greenhouse gas inventory have decreased by 31% since 2005.

Figure 2. Greenhouse gas emissions in the emissions trading sector and inventory-based CO₂ emissions from domestic air transport 2005–2021. Emissions are calculated on the basis of the current coverage of the emissions trading system. The coverage of emissions trading and its calculation method for air transport differ from the inventory calculation method. The 2021 data are proxy estimates.



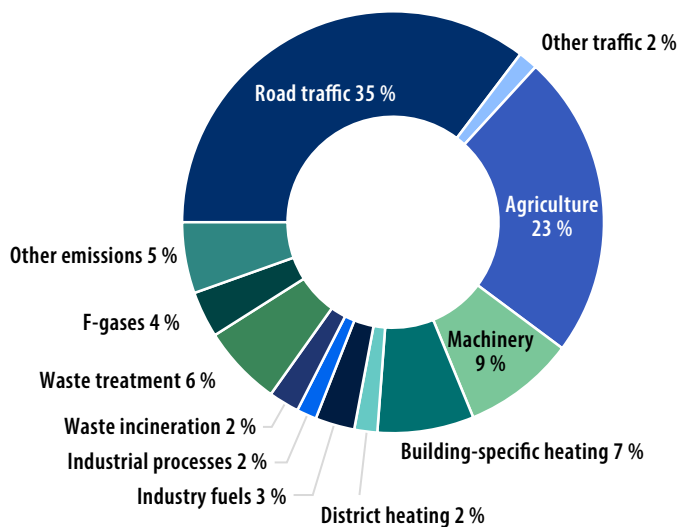
Emission trends in the emissions trading sector are influenced by the declining use of fossil energy sources as well as factors such as demand for electricity, weather-dependent consumption of heating energy, and the Nordic hydropower situation, which has a bearing on electricity prices and, consequently, its imports and the need for separate electricity production. Another crucial factor is the price of an EU emissions trading system (ETS) emission allowance.

3.3 Effort sharing sector

The effort sharing sector covers all of the greenhouse gas emissions not included in the ETS or the land use sector that are reported in the national emissions inventory. CO₂ emissions from domestic air transport based on the greenhouse gas inventory are not included in the effort sharing sector. The primary sources of emissions in the effort sharing sector include transport, agriculture, building-specific heating, non-road mobile machinery, waste treatment and F-gases. The effort sharing sector further covers emissions from fuel use in small-scale industries and the defence forces, other unspecified fuel uses and non-CO₂ emissions from energy use in the emissions trading sector. Waste

incineration is also mostly included in the effort sharing sector. Figure 3 shows the breakdown of emissions in the effort sharing sector in 2020.

Figure 3. Breakdown of greenhouse gas emissions by source in the effort sharing sector in 2020.



Greenhouse gas emissions have decreased more slowly in the effort sharing sector than in the emissions trading sector. Emissions in the effort sharing sector amounted to 28.1 Mt CO₂-eq in 2020 and, based on proxy estimates, 27.2 Mt CO₂-eq in 2021. In 2020, emissions were 1.2 Mt CO₂-eq lower than in the previous year. According to proxy estimates, emissions fell by 0.9 Mt CO₂-eq from 2020 to 2021, decreasing especially in the transport sector.

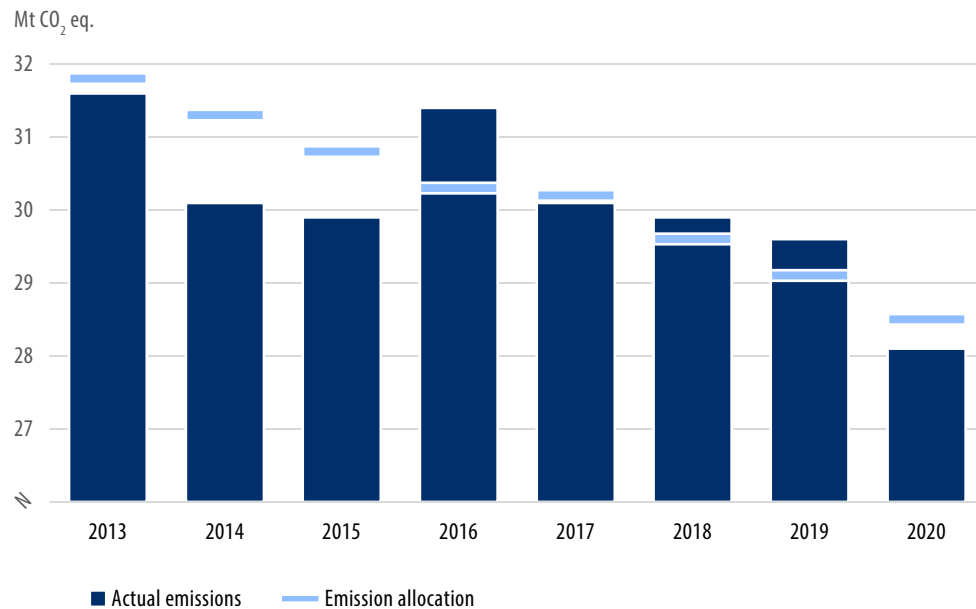
The total emissions of the effort sharing sector in 2021 stood at about 21% below 2005 levels. Emissions have decreased in all sectors except agriculture. Emissions from transport (excluding domestic air transport) have decreased by about 2.7 Mt CO₂-eq. Likewise, current emissions from waste treatment and from industries covered by the effort sharing sector are clearly below 2005 levels (Table 1).

Table 1. Emissions in the effort sharing sector in 2005, 2020 and 2021 and the change from 2005 (Mt CO₂-eq). (Inventory data for building-specific heating in 2021 will be completed in December 2022.) The 2021 data are proxy estimates.

Sector	2005	2020	2021	Change 05-21 (Mt)	Change 05-21 (%)
Transport	12.6	10.4	9.9	-2.7	-21%
Agriculture	6.4	6.4	6.4	0.05	0.7%
Building-specific heating	4.0	2.1
Non-road mobile machinery	2.6	2.4	2.4	-0.2	-9%
Waste treatment	3.1	1.9	1.8	-1.3	-41%
F-gases	1.2	1.0	0.9	-0.2	-21%
Industry	1.7	1.5	1.4	-0.3	-16%
Other emissions	2.7	2.4
Total	34.3	28.1	27.2	-7.1	-21%

Finland fulfilled its effort-sharing sector obligation for 2013–2020

Finland's obligation under EU law was to reduce the effort sharing sector's emissions by 16% of 2005 levels by 2020. Its fulfilment is specifically assessed by means of annual emission allocations set for each year within the 2013–2020 period. Emissions in the Finnish effort sharing sector in 2013–2015, 2017 and 2020 fell below the emission allocations for these years. Conversely, emission allocations were exceeded in 2016, 2018 and 2019 (Figure 4).

Figure 4. Greenhouse gas emissions and emission allocations in the effort sharing sector in 2013–2020.

When assessing whether the emissions reduction obligation for the effort sharing sector is being met, it is relevant to compare the combined emissions in 2013–2020 with the sum total of all annual emission allocations set for these years, as units can be transferred between years. Finland used the surplus units from 2013–2015 to offset the excess emissions in 2016. Exceeded allocations in 2018 and 2019 were also offset by surplus units accumulated in previous years.

According to the verified emissions data for 2020, Finland achieved the effort sharing sector reduction obligation for the entire period 2013–2020 through national measures. The fulfilment of the obligation was confirmed after an EU review of inventory data. Based on the inventory data, Finland has 0.8 Mt CO₂-eq in surplus units calculated cumulatively for the entire 2013–2020 period (Table 2). These units cannot be transferred to the coming period 2021–2030.

Table 2. Finland's emission allocations for the 2013–2020 period, actual emissions in 2013–2020 and the difference between allocations and emissions (Mt CO₂-eq AR4 coefficients). The difference between emissions and allocations is expressed as a negative value where actual emissions fall below the allocation and as a positive figure where emissions exceed the allocation.

	2013	2014	2015	2016	2017	2018	2019	2020
Emission allocation	31,8	31,3	30,8	30,3	30,2	29,6	29,1	28,5
Actual emissions	31,6	30,1	29,9	31,4	30,1	29,9	29,6	28,1
Difference between emissions and allocations	-0,2	-1,1	-0,9	1,0	-0,1	0,3	0,6	-0,4
Cumulative difference	-0,2	-1,3	-2,2	-1,2	-1,3	-1,0	-0,4	-0,8

Finland will likely meet its commitments under the Kyoto Protocol in 2013–2020

In addition to the European Union's own emission reduction targets, EU Member States and Iceland share a common obligation of a 20% reduction from 1990 levels for the second commitment period under the Kyoto Protocol from 2013 to 2020. The European Union has divided its commitments into an EU-level obligation in the emissions trading sector and specific obligations for each Member State, covering non-ETS emissions and the impact on the commitment of LULUCF activities under Kyoto Protocol Article 3, paragraphs 3 and 4. Accordingly, Finland was required to limit its emissions in the effort sharing sector to 240.5 Mt CO₂-eq over the 2013–2020 period.

According to inventory data, the cumulative emissions in the effort sharing sector for the entire commitment period were 238.2 Mt CO₂-eq. LULUCF measures (afforestation and reforestation, deforestation, forest management) are taken into account under the Kyoto Protocol commitment using different accounting rules. On the basis of the inventory data, Finland will meet its commitments under the Kyoto Protocol but will have to use for this purpose not only the units left over from the assigned amount, but also surplus emission units carried over from the previous commitment period of the Kyoto Protocol or units acquired from project mechanisms due to the additional effort (5.9 Mt CO₂-eq) resulting from the LULUCF measures. Finland has sufficient emission units at its disposal to fulfil both commitments (Table 3). The fulfilment of the commitments will be ensured after international inspections and the 'true-up' period from 2022 to 2024.

Table 3. Implementation of the commitment under the second commitment period of the Kyoto Protocol 2013–2020. For more information on the Kyoto calculation, see Appendix 1.

	Commitment period 2013–2020 Mt CO ₂ -eq
Finland's assigned amount	240,5
Non-ETS emissions in accordance with the inventory	238,2
Difference between actual emissions and the assigned amount	–2,3
Actions under Article 3.3 (sum of emissions and removals of afforestation, reforestation and deforestation)	25,9
Actions under Article 3.4 (forestry)	–20,0
Combined effect of Articles 3.3 and 3.4 on Finland's commitment	5,9
Sum of underspent assigned amount and the combined effect of Articles 3.3 and 3.4	3,5
Assigned amount units carried over from the previous period	–14,0
Units procured from project mechanisms	–12,9

3.4 Land use sector

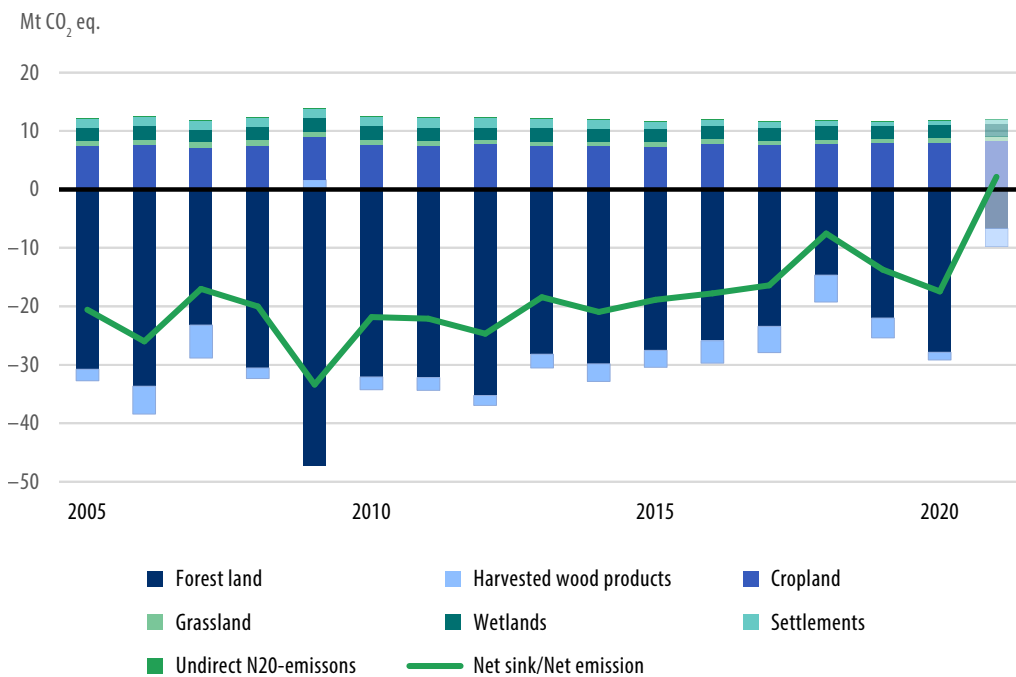
The LULUCF sector comprises six land use categories — forest land, cropland, grassland, wetlands, settlements and other land — and harvested wood products. The land use sector's net sink is derived by adding up the emissions and removals of all land use categories (Figure 5). Forest land is the sector's most important net sink, as its removals exceed its emissions. Harvested wood products have also mostly served as a carbon sink.

According to proxy estimates, the carbon sink in the land use sector turned into a net emission source for the first time in 2021. Emissions in the sector exceeded removals, i.e. the amount of carbon fixed in various stocks during the year, by 2.1 Mt CO₂-eq. The land use sector used to be a significant net sink in Finland, as its emissions were lower than removals. The transformation of the sector from a net sink to a net source of emissions was especially due to a slowdown in tree growth and high harvesting levels. The new growth estimate is based on the 13th National Forest Inventory and still preliminary. According to the Natural Resources Institute Finland, the harvesting level increased to 76.3 million m³ in 2021 (see Appendix 2 Figure 43). The level grew by 10% on an annual basis and was the

second highest ever recorded. The 2021 forest removals included a total of 65.7 million m³ for forest industry needs or export, 10.3 million m³ for use as energy wood and 0.3 million m³ for use as household wood by forest owners.

In 2020, the net sink of the land use sector was -17.4 Mt CO₂-eq, which covered 48% of the combined emissions of the emissions trading and effort sharing sectors. Finland's average net sink between 2005 and 2020 was -19.8 Mt CO₂-eq. The result of the 2021 proxy estimate cannot yet be compared with the results of previous years, as the methods for calculating forest sinks are not equivalent. A comparison will be possible in the time series to be published in December 2022.

Figure 5. Emissions and removals and Net Sink or Net emission of the land use categories in the land use sector in 2005–2020. The 2021 data are proxy estimates that include estimates for forest land, cropland and wood products, while the data for other land use categories correspond to the figures of the previous year.



4 Achieving of targets

4.1 Climate Act targets for 2030 and 2035

The 60% emission reduction target for 2030 set in the National Climate Act requires total emissions to be no more than 28.5 Mt CO₂-eq in 2030. A key factor for the carbon neutrality target is the expected amount of carbon sinks in 2035, which determines the magnitude of the required emission reductions. In this review of the carbon neutrality target, the level of net sinks in the land use sector is assumed to be –21 Mt CO₂-eq (see Section 4.3). In this case, total emissions may not exceed 21 Mt CO₂-eq in 2035, so they must be approximately 70% lower than in 1990. Total emissions here refer to the combined emissions of the emissions trading and effort sharing sectors.

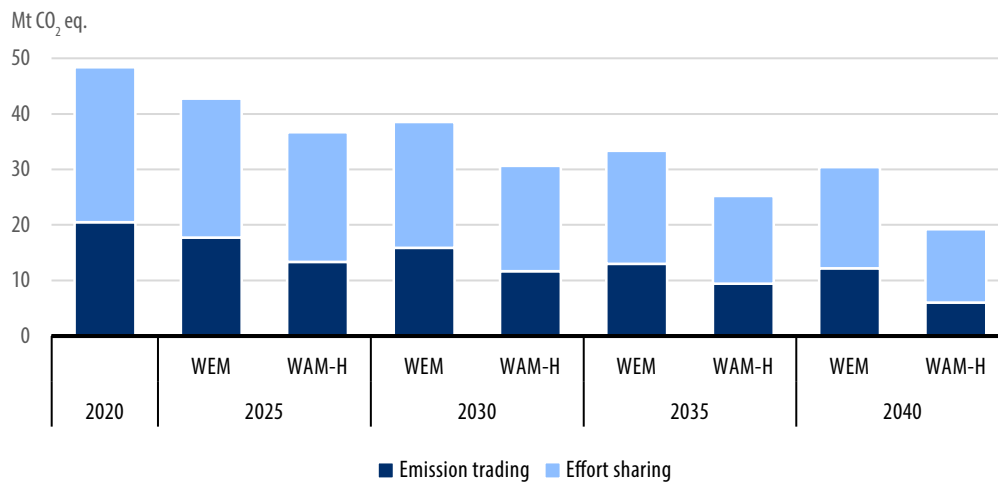
This Annual Climate Report examines the achievement of the Climate Act's 2030 and 2035 emission and carbon neutrality targets on the basis of scenarios prepared in the further study of the Carbon Neutral Finland 2035 – measures and impacts of climate and energy policies (HII SI) project. The baseline scenario produced in the project describes the development in the current operating environment, taking into account the development of technologies, sectors, markets and infrastructure, as well as the impact of the policy measures implemented before 31 December 2019. The policy scenario takes into account the policy measures decided after 1 January 2020, including the emission reduction measures outlined in the Medium-term Climate Change Policy Plan and the Climate and Energy Strategy (sector-specific emission reduction measures are discussed in more detail in Sections 5.1–5.8). The HII SI project's scenarios for the effort sharing sector differ slightly from the Medium-term Climate Change Policy Plan scenarios used in this annual report for the effort sharing sector analyses in Section 4.2 and Chapter 5.

According to the baseline scenario of the HII SI project, Finland's greenhouse gas emissions will be about 39 Mt CO₂-eq in 2030 and 33 Mt CO₂-eq in 2035. In the policy scenario, Finland's greenhouse gas emissions will decrease more rapidly than in the baseline scenario, to about 31 Mt CO₂-eq in 2030 and 25 Mt CO₂-eq in 2035 (Figure 6). In the policy scenario, emissions will fall from the 2021 proxy estimate by approximately 17 Mt CO₂-eq by 2030 and by 22 Mt CO₂-eq by 2035. The emission reductions will be almost evenly distributed between the emissions trading and effort sharing sectors, although emissions in the emissions trading sector will decrease more in percentage terms.

In the emissions trading sector, emissions will decrease in the existing measure and policy scenarios, especially in the production of electricity and heat, where the efficient

economic guiding factor is emissions trading and the price of allowances determined by it. By contrast, industrial emissions from the emissions trading sector are falling slowly. In the effort sharing sector, the largest emission reductions are achieved in the transport sector, but significant relative reductions are also achieved especially in building-specific heating and in F-gas emissions. Emission trends by sector in the effort sharing sector up to 2030 and 2035 are described in more detail in Sections 5.1–5.7.

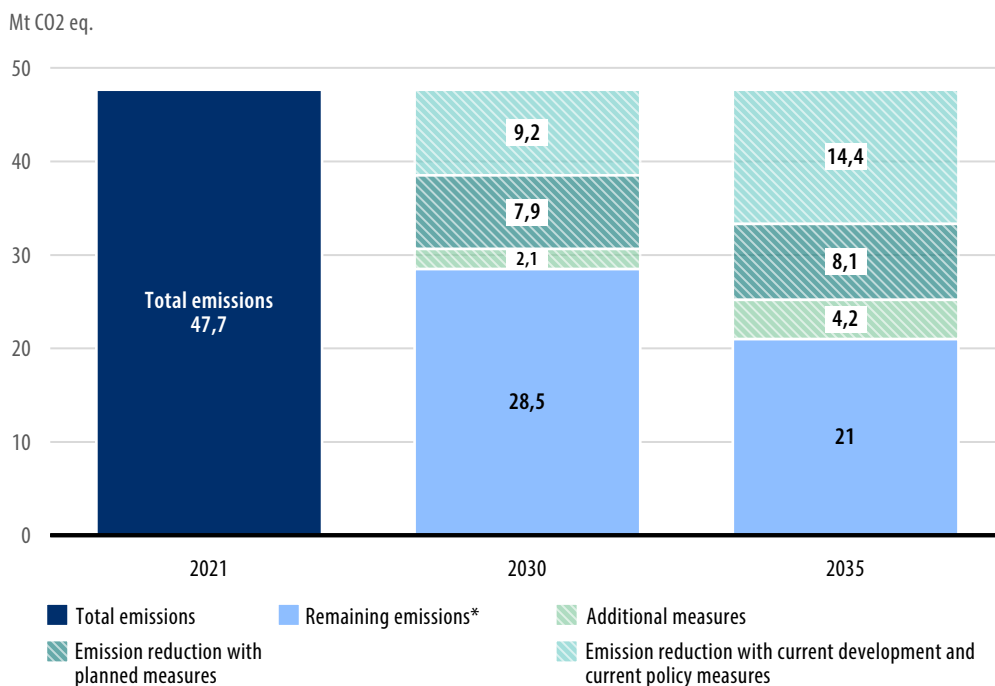
Figure 6. Emissions development in the baseline scenario (WEM) and policy scenario (WAM-H). The scenarios were prepared in the further study for the Carbon Neutral Finland 2035 – measures and impacts of climate and energy policies (HISI) project.



The difference between the HISI project's policy scenario and the targets is 2 Mt CO₂-eq in 2030 and 4 Mt CO₂-eq in 2035 (Figure 7). However, the scenarios did not take into account all planned policy measures and investments, which partly explains the difference between the targets and the level of emissions to be achieved in the scenario. With regard to the effort sharing sector, the estimates of the HISI project and the Medium-term Climate Change Policy Plan on the development of emissions in the effort sharing sector differ in that, in the Plan, emissions will fall to a slightly lower level, especially in 2030. Without flexibility, the difference in 2030 will be close to one million tonnes. The differences are due to a different analytical approach and the fact that not all policy measures included in the Medium-term Climate Change Policy Plan were included in the HISI project's analysis. In the emissions trading sector, companies' investment decisions and their implementation are of great importance for the development of emissions. For example, the HISI project's policy scenario assumes that the blast furnaces of SSAB's Raahe steelworks will only be removed after 2035. In January 2022, SSAB published a statement stating that it would move to fossil-free steel production in Raahe as early as in

2030. If this is achieved, emissions will decrease by 3–4 Mt CO₂-eq more than projected in the scenario by 2035, which would significantly reduce the emissions gap to the carbon neutrality target.

Figure 7. Emission reductions achieved by 2030 and 2035 with existing and planned measures compared with 2021 levels. The planned activities refer here to the measures of the Medium-term Climate Change Policy Plan and the Climate and Energy Strategy included in the policy scenario (WAM-H) of the HISSI project's further study. The additional measures refer to measures needed in addition to these, at least some of which can be covered by already planned policy measures and investment decisions. The 2021 emission data are proxy estimates. *The emission level required to achieve the carbon neutrality target depends on the sink level in 2035. Here, a land use sector net sink of 21 Mt CO₂-eq is assumed.



All estimates of future emission trends involve uncertainty, which becomes greater the further into the future the estimates extend to. In the light of current information, it can be estimated that the measures decided on to reduce emissions in the emissions trading and effort sharing sectors will be sufficient if the above-mentioned SSAB investment is realised. There are also uncertainties with regard to investments and the implementation of policy measures in other scenarios and the emission reductions they will produce. In addition, the updating of EU legislation is still ongoing, which is why there is uncertainty about its impact, for example in terms of flexibility and the expansion of emissions

trading. It is therefore important to review the adequacy of the measures regularly and, if necessary, to decide on new measures. The scenarios used in this assessment of the carbon neutrality target will be updated in the coming years. At that time, account can be taken of, for example, the development of energy prices, which was unusual during the spring of 2022, especially as a result of the war in Ukraine. The strong increase in the price of fossil fuels will affect emissions development in many sectors in a way that has not been taken into account in the current scenarios. Uncertainties beyond the development of total emissions are related to the development of emissions and sinks in the land use sector and whether the assumed sink level is realised there.

4.2 Effort sharing sector 2030 target

At EU level, binding obligations have been set for all Member States in the effort sharing sector, which consist of an obligation to reduce emissions by a certain percentage in the target year and annual emission allocations. In addition, the effort sharing legislation stipulates flexibilities that Member States can use to achieve the objectives. During the period 2021–2030, Member States will be able to make use of time flexibilities to offset emissions between individual years. When necessary, emission units can also be purchased from other Member States to cover the emission reduction obligation. In addition, a limited number of allowances can be transferred from the emissions trading sector to cover effort sharing sector emissions through the one-off flexibility mechanism and, under certain conditions, very limited amounts of any surplus units from the land use sector can be used to meet the effort sharing sector's obligation. On the other hand, if the land use sector is calculated to become a source of emissions, the calculated emissions of the land use sector may need to be compensated by additional emission reductions in the effort sharing sector.

According to the current Effort Sharing Regulation, Finland's emission reduction obligation in the effort sharing sector for 2030 is 39% from the 2005 levels. In July 2021, the EU Commission published a proposal to reform the Effort Sharing Regulation, proposing a 50% reduction as a new obligation for Finland. This Annual Climate Report reviews the adequacy of the response to the 2030 obligation as proposed by the Commission in 2021.

In addition to the 2030 obligation, Finland is also bound by annual emission allocations. According to the Commission's 2021 proposal, the 2021–2022 allocations would remain in line with the current Effort Sharing Regulation Implementing Decision (2020/2126). On the other hand, the allocations for the years 2023–2030 would become stricter than they are today. Achieving the obligations of the effort sharing sector is reviewed every 5 years (2021–2025 and 2026–2030). The inspections will be carried out in 2027 and 2032. Finland's

emission allocation for 2021 was approximately 28.8 Mt CO₂-eq. According to the 2021 proxy estimate, emissions in the effort sharing sector amounted to 27.2 Mt CO₂-eq and the emission allocation was approximately 1.7 Mt CO₂-eq in surplus.

The latest Medium-term Climate Change Policy Plan was completed in spring 2022. It outlines the actions to be taken in order to achieve the 50% emission reduction obligation set out in the Commission's proposal. The plan estimated that, with current developments and existing measures, emissions in the effort sharing sector would fall to 22.8 Mt CO₂-eq by 2030, while emissions corresponding to the 50% reduction obligation would be 17.2 Mt CO₂-eq. The plan was therefore drawn up on the premise of the 5.6 Mt CO₂-eq emissions gap in 2030, for which the plan proposes additional measures.

The starting point of the Medium-term Climate Change Policy Plan is that Finland will use a one-off flexibility and the flexibility for the land use sector to achieve the 2030 target for the effort sharing sector (LULUCF flexibility). Further reductions in greenhouse gas emissions corresponding to the flexibilities need to be achieved in the emissions trading and land use sectors. According to the relevant government resolution, emission allowances in the emissions trading sector will be cancelled to the maximum amount specified in the EU Effort Sharing Decision, which is equivalent to 0.7 Mt CO₂-eq per year, which is a total of 7 Mt CO₂-eq over the 2021–2030 period. The maximum amount of LULUCF flexibility available for Finland is 0.45 Mt CO₂-eq per year. According to estimates, the LULUCF calculation rules for 2021–2025 do not allow in practice for the creation of a surplus and flexibility for the effort sharing sector. The possibility of using flexibility for the period 2026–2030 will depend on the EU LULUCF Regulation under negotiation and its rules, as well as on the need to frontload the measures of the Climate Plan for the Land Use Sector. During the preparation of the Medium-term Climate Change Policy Plan, it was established that the additional measures decided in the Climate Plan for the Land Use Sector will be implemented in such a way that this flexibility is available. Combined, the one-off flexibility and LULUCF flexibility can cover up to 1.1 Mt CO₂-eq of the effort sharing sector's emission reductions in 2030.

The Medium-term Climate Change Policy Plan estimated that the measures (including flexibilities) set out in the Plan will achieve about 5.7 Mt CO₂-eq of additional emission reductions in 2030 compared to the baseline scenario, fulfilling the 2030 emission reduction obligation. The Medium-term Climate Change Policy Plan includes emission reduction measures from all sectors covered by the plan. In addition, the plan includes measures that cross sector boundaries and relate to municipalities' climate work, consumers and public procurement. Sector-specific measures and emission trends are described in more detail in Chapter 5. Cross-sectoral measures are presented in Chapter 6.

4.3 Land use sector target

According to the current EU LULUCF Regulation, Member States must ensure that the land use sector does not produce any calculated emissions. Different calculation rules apply for different land use categories. The calculated sink or emission of forests is obtained by comparing the actual removals during the commitment period with the specified reference level (Finland's reference level is defined as $-29.4 \text{ Mt CO}_2\text{-eq}$ including the sink of wood products). Emissions from cropland and grassland are calculated by comparing them with emissions in the period 2005–2009. Emissions from deforestation and afforestation are calculated in full. The target is reviewed every five years (2021–2025 and 2026–2030). If, after compliance with the calculation rules, the LULUCF sector is a calculated emission, the Member State must compensate for the resulting emissions either by additional effort in the effort sharing sector or by purchasing LULUCF units from another Member State. As part of the reform of the EU LULUCF Regulation, the Commission proposed a net sink target of $-17.8 \text{ Mt CO}_2\text{-eq}$ in 2030 for Finland. The proposal maintains the targets for the period 2021–2025 unchanged.

According to the 2021 proxy estimate, the forest land sink was $-6.7 \text{ Mt CO}_2\text{-eq}$ and the net removal of the carbon pool of harvested wood products was $-3.1 \text{ t CO}_2\text{-eq}$ calculated based on greenhouse gas inventory classifications. The annual forest reference level defined for Finland in the EU LULUCF Regulation is $-29.4 \text{ Mt CO}_2\text{-eq}$. According to the proxy estimate, the sink of forest land is clearly smaller than the reference level set for Finland. The land use classification according to the inventory differs from the LULUCF Regulation's accounting categories but serves as a rough benchmark. The approximations based on proxy estimates are rough estimates, and data concerning the monitoring of the land use sector target will be updated and revised in the future.

The Climate Plan for the Land Use Sector (MISU) prepared in accordance with the Government Programme will play a key role in climate policy and its implementation in the coming years. The Climate Plan for the Land Use Sector was presented to Parliament as a government report in July 2022. The objective agreed for the plan is a net sink target of $-3 \text{ Mt CO}_2\text{-eq}$ by 2035 for the land use sector, which would mean a net sink level of approximately $-21 \text{ Mt CO}_2\text{-eq}$ in 2035. The Climate Plan for the Land Use Sector will be part of the climate policy planning system in accordance with the new Climate Act. The plan has similarities with the Medium-term Climate Change Policy Plan for the agricultural sector, in particular, and with the Climate and Energy Strategy for the energy sector and especially the use of biomass.

The plan includes the actions already launched under the climate action package for the Hiilestä kiinni – Catch the carbon programme for the land use sector, launched in 2020, as well as the additional measures expected to be necessary to achieve the target. Measures

related to agriculture, forestry, land use change and wetlands aim to reduce emissions from the land use sector, strengthen carbon sinks and pools in the short and long term and promote adaptation to climate change. For its part, the Climate Plan for the Land Use Sector will also implement the target set by the Government in December 2021 to reduce greenhouse gas emissions from agriculture by 29% by 2035.

The Natural Resources Institute Finland estimates that the measures of the Climate Plan for the Land Use Sector will generate a net sink increase of -4.7 Mt CO_2 in 2035 compared to the HII SI baseline scenario, resulting in a net sink of $-22.7 \text{ Mt CO}_2\text{-eq}$ in the land use sector. In 2030, the estimated net sink effect of the additional measures will be $-4.2 \text{ Mt CO}_2\text{-eq}$ compared to the baseline scenario. Of the total net sink effect in 2035, forest land accounts for 68% and cropland for 32%. The starting point for the policy scenario of the Climate Plan for the Land Use Sector is the HII SI baseline scenario, where the net sink of the land use sector is $-18 \text{ Mt CO}_2\text{-eq}$ in 2035.

The scenarios used in the Climate Plan for the Land Use Sector do not take into account the changed forest growth estimate or the impact of the Russian invasion of Ukraine. As a result, there are considerable uncertainties about the implementation of the scenarios at the level described above. The results of the proxy estimate of the greenhouse gas inventory for May 2022 were calculated for the land use sector using a different method from the previous years, so the proxy estimate of the forest land sink of 2021 cannot be directly compared to the previous years' sinks. The causes of the decrease in tree growth are not yet fully known. There are likely to be several reasons; changes in the age distribution of forest stands, harvesting levels well above the long-term average of the last decade and the possible allocation of final felling to younger forests, as well as possibly weather factors for a single year. During the autumn of 2022, the Natural Resources Institute Finland will study the factors behind the decline in forest growth. The decline in growth can affect the sink for more than a few years, and it is not easy to turn growth positive again, or it may not happen quickly, especially as the Russian war in Ukraine and the resulting sanctions may create a significant additional need for the use of domestic forest biomass. It is therefore quite possible that the level of CO_2 removals from sinks will be lower in the coming years than estimated in the HII SI baseline scenario. In addition, in the policy scenario of the Climate Plan for the Land Use Sector, the increase in forest growth is to a large extent based on a very significant increase in forest fertilisation areas. Especially in the next few years, fertilisers for forestry use may be less easily available.

5 Emissions reduction measures by sector

5.1 Transport

Greenhouse gas emissions from domestic transport, with the exception of domestic air transport, are counted towards the effort sharing sector. Transport is the largest source of emissions in the effort sharing sector in Finland, which is why transport emission reduction measures will play a key role in achieving the 2030 target for the effort sharing sector. In particular, the following three factors have an essential impact on the trends in greenhouse gas emissions from transport: trends in transport work (kilometres travelled), energy efficiency of means of transport and the types of propulsion (sources of energy) used in transport. All of these three factors are addressed in the Medium-term Climate Change Policy Plan by measures and targets.

According to the Climate and Energy Strategy for 2030 prepared in 2016, Finland aims to halve transport emissions from 2005 levels by 2030. The Programme of Prime Minister Sanna Marin's Government has the same objective. In May 2021, the Finnish Government adopted a resolution on reducing greenhouse gas emissions from domestic transport (Roadmap for fossil-free transport). The resolution outlined the measures to be taken to achieve the objective.

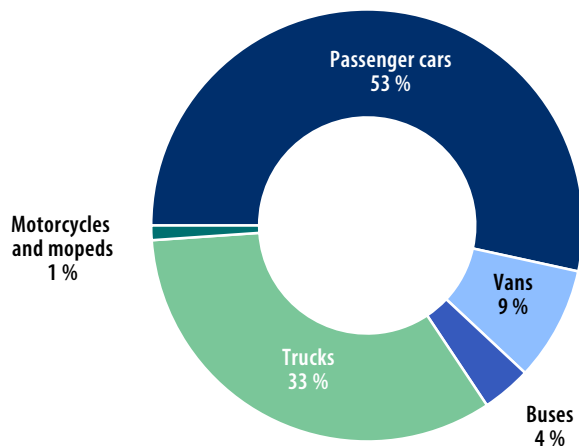
Emissions from transport have decreased in recent years. According to Statistics Finland's proxy estimate, greenhouse gas emissions from domestic transport, excluding air transport, totalled around 9.9 Mt CO₂-eq in 2021. This was slightly over 20% of total emissions and approximately 37% of the emissions in the effort sharing sector. In 2020, domestic transport emissions without air transport were 10.4 Mt CO₂-eq.

Emissions from transport decreased by about 6% from 2019 to 2020 and by a further 4% in 2021. In 2020, the reduction in emissions was particularly affected by the COVID-19 pandemic and the resulting reduced transport work. In 2021, road transport work also decreased (0.5%) and the proportion of renewable fuels in transport increased significantly from 11% to approximately 18%.

In 2021, about 95% of greenhouse gas emissions from domestic transport were generated by road transport, of which about 53% was from passenger cars and slightly more than 33% from lorries (Figure 8). Rail transport accounted for about 1% of domestic transport emissions and domestic water transport for about 3%. Domestic air transport accounted

for less than 1% of emissions in 2021. However, air transport emissions are not counted towards the effort sharing sector.

Figure 8. Breakdown of greenhouse gas emissions from road transport in 2021. The 2021 emission data are proxy estimates.

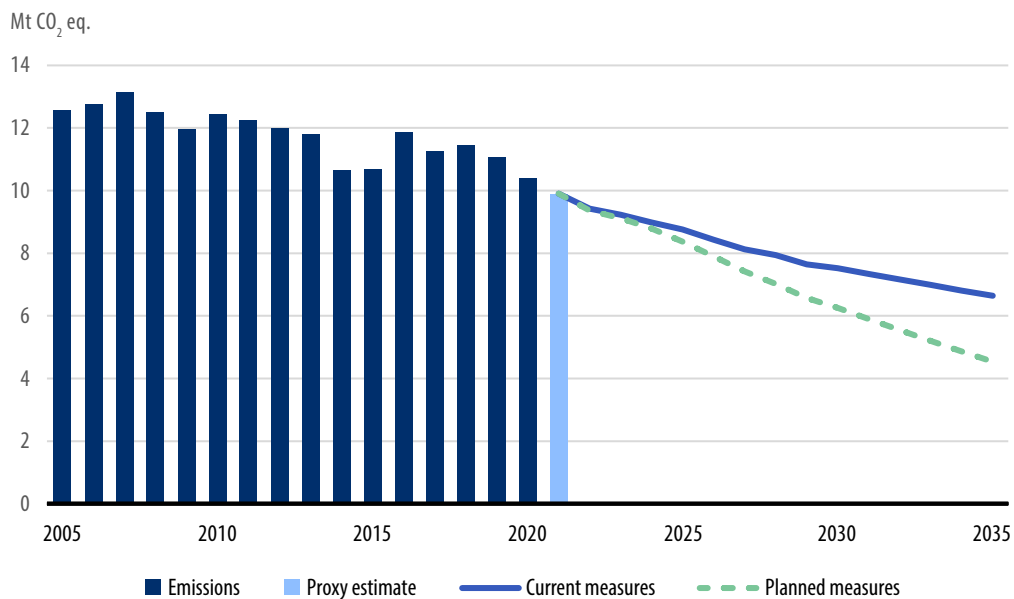


Transport emissions showed an almost linear growth up until 2007, at which point the trend took a downward turn from 2008 to 2021, with the exception of some isolated years (see Figure 9). The reduction in emissions has been due in particular to the increased proportion of biofuels in road transport fuels, but also to the improved energy efficiency of new cars and the slowdown in the growth of transport work.

Variation between individual years is to a great extent explained by fluctuations in the amount of biofuels sold for transport, but factors such as trends in vehicle sales also have some bearing. In 2020 and 2021, the reduction in transport emissions was sufficient in relation to the targets, but this was partly due to the decline in transport work caused by the COVID-19 pandemic. The temporary reduction of the obligation to distribute renewable fuel agreed in 2022 will increase transport emissions in 2022–2023. According to VTT's estimate, a 7.5 percent annual reduction in the distribution obligation in 2022–2023 will cause an increase in emissions of about 1.7 Mt in traffic compared to a situation where the obligation levels would have remained the same. This increase in emissions is very large on the scale of Finland (burden sharing sector). In order to catch up with the growth of cumulative emissions in the 2020s, it is necessary to tighten the distribution obligation beyond the original obligation path in the years 2024–2030. The government's motion (174/2022 vp) on easing the obligation for 2023 and new strictures has been issued in the fall of 2022. According to the government's motion, the distribution

obligation would increase to 34% in 2030 in accordance with the guidelines of the medium-term climate plan.

Figure 9. Domestic transport emissions (excluding domestic air transport) 2005–2021, as well as estimates in keeping with the baseline scenario and the target trajectory of the roadmap for fossil-free transport (planned measures) for 2022–2035. The 2021 data are proxy estimates.



Extensive strategies of the government term have progressed to implementation

Implementation of the new measures set out in the roadmap for fossil-free transport has begun. According to the updated baseline projection for greenhouse gas emissions in transport, the measures of the roadmap for fossil-free transport should reduce emissions by approximately 1.25 Mt CO₂-eq by 2030 compared to the baseline scenario.

A large part of the roadmap's support and incentive measures entered into force at the beginning of 2022. These include updated support programmes to promote public distribution infrastructure and private charging infrastructure, as well as updated subsidies for vehicle purchase and conversion. In addition to the procurement of battery electric cars and gas-powered lorries, Finland will also, for the first time, support the purchase of electric and gas-powered vans and electric lorries.

However, following the budget negotiations of autumn 2021 and the decisions of the Ministerial Working Group on Preparedness, the funding allocated for 2022–2023 is not fully at the level indicated in the resolution. In particular, there are shortcomings in the

funding for walking, cycling and public transport. Deductions were also proposed for distribution infrastructure and purchase subsidies by the Ministerial Working Group on Sustainable Growth on 22 June 2022 due to the need to update Finland's Recovery and Resilience Plan. The realisation of the projected emission reduction effect requires that the funding of the roadmap activities be at the level set out in the resolution.

During 2021, further studies were carried out in accordance with the second phase of the roadmap for emission reduction measures on whose impact further information was needed for possible decision-making. The further studies assessed the impact of telecommuting, transport services and combined transport on reducing emissions. The emission reduction impacts of the proposals of the EU's Fit for 55 package of July 2021 and the impact of a possible increase in the distribution obligation were also assessed as part of the overall package.

The third phase of the roadmap will be introduced if the actions of the first two phases, together with other EU actions, for example, are insufficient to halve transport emissions. In practice, the third phase would involve, for example, the introduction in Finland of a national emissions trading scheme or a transport tax model based on kilometres travelled and road categories. In spring 2022, the Ministerial Working Group on Climate and Energy Policy outlined that preparations for national emissions trading in transport would continue in the event that emissions trading at EU level did not take place for some reason.

In 2021, resolutions were also made to reduce greenhouse gas emissions from air, maritime and inland waterway transport. The resolutions set out national measures and priorities for international influencing. Most of the studies and activities outlined in the resolutions have started. In the case of air transport, a report on a national air tax has been completed. Progress in implementing the policy decisions is being monitored by the Ministry of Transport and Communications, the Ministerial Working Group on Climate and Energy Policy and, in the case of maritime transport, the Steering Group on Maritime Policy on a regular basis.

In addition to the roadmap for fossil-free transport, the Government decided in spring 2021 on a National Transport System Plan for 2021–2032. The plan is based on the Act on the Transport System and Highways (503/2005) and was prepared at parliamentary level. According to the plan's objectives and strategic guidelines, opportunities to choose more sustainable modes of mobility will improve, particularly in urban areas. Its other objectives are related to accessibility and efficiency. In keeping with the plan, the conditions for sustainable transport will be improved by means such as shifting the focus of the maintenance and development of the transport infrastructure network to the rail network, improving the infrastructure for walking and cycling and park-and-ride facilities,

developing public transport and travel chains, as well as enhancing efficient utilisation of information in the transport system.

Progress on implementing the first Medium-term Climate Change Policy Plan

The measures to reduce emissions from domestic transport in the first Medium-term Climate Change Policy Plan have mainly been implemented or are in the process of being implemented. The measures yet to be implemented are especially geared towards halting the growth in the mileage of passenger cars and speeding up the vehicle replacement rate.

The target set in the first Medium-term Climate Change Policy Plan is to halt the growth in passenger car transport in urban areas. It seems that this target will mostly be achieved despite the fact that some of the plan's measures relating to financial guidance are yet to be implemented. Since 2015, passenger car mileages on the street network have decreased with the exception of the 2020 pandemic year. In 2021, passenger car mileages on the street network fell while mileages on the roads grew. The combined mileage of passenger cars decreased by 0.8% from 2020. The total mileage of all vehicles fell by around half a per cent in 2021 compared to 2020, which was due not only to the fall in the mileage of passenger cars, but especially to the record low mileage of buses and coaches. By contrast, the mileages of lorries and vans started to grow in a reversal from the exceptional year of 2020.

According to the proxy estimate, biofuels accounted for 18% of transport fuels in 2021. In 2020, the corresponding percentage was 11%. A legal amendment entered into force in June 2021, extending the Distribution Obligations Act to include not only biofuels but also biogas (from the beginning of 2022) and non-biological renewable liquid and gaseous transport fuels (RFNBO fuels, including electrofuels from the beginning of 2023).

The vehicle stock ages, alternative propulsion becomes more common

The goal has been set for much faster renewal of the Finnish vehicle stock than at present. The average CO₂ emissions from new vehicles registered for the first time measured using the NEDC method were 103.4 g/km in 2020 and 85.8 g/km in 2021. The decrease between 2020 and 2021 was approximately 12%. A particular explanatory factor behind this decrease was the increasing proportion of electric cars of first registrations of new passenger cars. In the summer of 2021, the European Commission proposed tightening the limit values for car manufacturers to 0 g/km by 2035, which would mean the end of the production of cars and vans with combustion engines by 2035. Therefore, the decline in the specific emissions of new cars and the electrification of transport are likely to continue. Negotiations on the proposal are ongoing.

The target of speeding up the vehicle replacement rate has not been achieved. In 2021, the average age of the car stock increased again slightly to 12.6 years (including vintage cars), while in 2020 the corresponding figure was 12.5 years. The number of new passenger cars sold amounted to about 114,000–120,000 cars per year between 2016 and 2019, and significantly fewer in the pandemic years: only 96,000 in 2020 and 98,000 in 2021. In order to lower the average age, the sales of new cars would have to be about 120,000 to 130,000 per year.

Slightly more than 45,000 used cars were imported into Finland in 2021. This is close to the record number of 2019. Imports of used cars have been growing since 2014, with the exception of the pandemic year 2020. Imported used cars are, on average, often large diesel cars with higher emissions, but some are alternative propulsion vehicles. In 2021, more than 36% of imported used vehicles used alternative propulsion (electricity, natural gas, flex-fuel), outnumbering imported diesel vehicles for the first time.

Between 1 December 2020 and 31 December 2021, a scrapping premium campaign ran for the renewal of the vehicle stock, with an earmarked allocation of EUR 8 million. The campaign was very popular and the budget was already spent in spring 2021. During the campaign, a person scrapping their old car could apply for a scrapping premium from the Finnish Transport and Communications Agency, not only for the purchase of a new car (EUR 1,000–2,000), but also for a public transport ticket or an electric bicycle (up to EUR 1,000). The majority (71%) of the scrapping premiums granted were used for the purchase of an electric bicycle. New cars accounted for around a quarter (26%) of the premiums, while only a few per cent (3%) of the premiums was spent on public transport tickets. In 2022, the Finnish Transport and Communications Agency is carrying out a follow-up study on the effectiveness of the scrapping premium campaign, including permanently making more environmentally friendly mobility choices.

The number of electric cars has risen sharply in recent years and, at the end of 2021, the number of electric cars in transport use neared 100,000: there were about 22,900 battery electric vehicles and nearly 77,000 plug-in hybrids on the roads — about 99,900 electric vehicles in total. The roadmap for fossil-free transport set a target of 700,000 electric passenger cars in 2030 and the Medium-term Climate Change Policy Plan set a target of 750,000, but it already seems that the targets might even be exceeded. The popularity of electric cars is also reflected in the use of purchase subsidies, as the initial allocation for 2022 for electric cars was already exhausted in April 2022.

In the case of gas-powered vehicles, the roadmap for fossil-free transport set a target of at least 130,000 gas-powered passenger cars and vans in Finland by 2030. At the end of 2021, there were approximately 14,400 gas-powered vehicles on the roads. The achievement

of the target for gas-powered vehicles seems uncertain due to the decisions of several vehicle manufacturers to discontinue the development of gas-powered cars.

At the end of 2021, approximately 4.3% of the passenger cars used for transport in Finland used alternative propulsion. In addition to electric and gas-powered vehicles, the vehicle stock included around 4,500 ethanol-powered cars and two hydrogen vehicles.

Transport system measures implemented on a broad front

Implementation of the transport system measures included in the first Medium-term Climate Change Policy Plan has continued on a broad front. However, the COVID-19 pandemic had a negative impact on sustainable mobility patterns in both 2020 and 2021. During the pandemic, the number of public transport passengers has decreased significantly. The recovery in passenger demand has been slow: for example, in urban areas, it is likely to take several years to reach pre-pandemic passenger levels.

Preparation of land use, housing and transport (LHT) plans also continued. In accordance with the Government Programme, agreements were drawn up with Lahti, Jyväskylä and Kuopio for the first time in 2021. Agreements had already been signed with the city regions of Helsinki, Tampere, Turku and Oulu in 2020. With the expansion, 55% of the population of Finland is covered by LHT agreements. In keeping with the Government Programme, the time span for the agreements was extended to 12 years while intensifying their pursuit of climate change mitigation through community structure integrity and sustainable modes of mobility. The purpose of the LHT agreements is to coordinate the measures to develop community structures and the transport system so as to create the preconditions for a sufficient and diverse offering of plots and housing production, more compact urban structures and a functional, safe and sustainable transport system.

Continuous multi-actor cooperation is required to develop station areas and improve their service level. As transport nodes, rail transport stations play a key role in enabling low-carbon daily life and travel chains. Services at stations can increase the attraction of public transport and make residents' daily lives smoother. The level of station services varies significantly in different parts of Finland, so station areas have in recent years been subject to extensive development pressures and several concrete projects to develop them have been launched by cities and the central government. Promoting sustainable transport and developing station areas have also featured prominently in the LHT agreements and in the National Transport System Plan for 2021–2032.

The national programme for the promotion of walking and cycling is currently being implemented. The programme sets the target for walking and cycling at increasing the number of journeys by 30% by 2030. Information on developments will be available

when the national passenger transport survey is completed by the beginning of 2023. The COVID-19 pandemic has also reduced the number of commuting trips on foot and by bike. The investment programme for walking and cycling improves walking and cycling conditions on municipal street networks. The amounts reserved for discretionary government grants to local governments stood at EUR 32.9 million in 2020 and almost EUR 30 million in 2021. The funding allocated for 2022 is EUR 6.5 million. The investment programme for walking and cycling has also assisted the development of bicycle parking at nodes and bus stops, for example. Bicycle parking has been implemented in connection with the road and rail network, typically as joint projects of the Finnish Transport Infrastructure Agency with municipalities. Developing the accessibility of stations and stops for persons with disabilities is also part of promoting walking and cycling.

The Government Programme outlines an annual subsidy of EUR 20 million for climate measures in public transport. The climate-based central government subsidy is intended for use by large and medium-sized cities and other competent public transport authorities. In addition, part of the financing of passenger rail transport procurement is covered by climate-based public transport aid. The funding was granted taking into account, for example, the mileages of clean equipment and propulsion, as well as projects promoting the growth and monitoring of the modal share. Funding surplus will be carried over to 2022, in which year significant deployments of, for example, electric bus transport are planned in urban areas.

Rail transport is also carried out by means of purchase agreements. For 2021, the Ministry of Transport and Communications and VR Group concluded an agreement on purchased transport, which ensured the service level and continuity of purchased transport during the pandemic with the help of EUR 22 million granted by Parliament. In 2021, regional train transport, night train transport, rail bus transport and individual Intercity and Pendolino train services were acquired.

Table 4. Transport sector – key policy measures in place

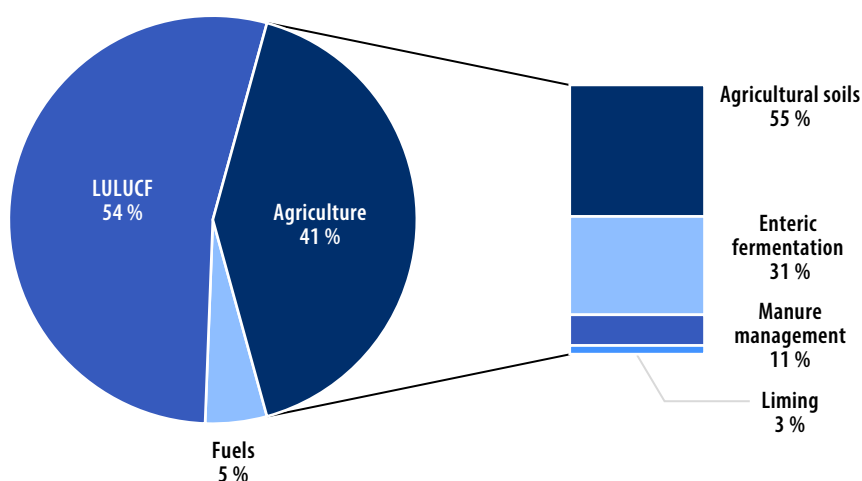
Policy measure	Implementation status
Biofuel distribution obligation	The obligation to distribute biofuels under the current act (446/2007) will increase to 30% in 2030. The new Medium-term Climate Change Policy Plan outlines that the distribution obligation will increase to 34%. The Ministerial Working Group on Preparedness has decided to temporarily reduce the level of obligation by 7.5 percentage points in 2022 and 2023 due to higher fuel prices and cost pressures in the transport sector. A legislative proposal on the topic was presented to Parliament in May 2022. The temporary reduction will be bridged by additional increases in the level of obligation between 2024 and 2030.
Transport taxation	Changes to taxation of transport-related employee benefits were decided as part of the budget negotiations held in autumn 2020 and spring 2021. The changes encourage the purchase of low-emission company cars and the provision of bicycles and commuting tickets as employee benefits. In autumn 2021, it was decided to exempt battery electric vehicles from automobile tax.
Roadmap for fossil-free transport	The government resolution was adopted in May 2021. Implementation is under way.
Digitalisation of public transport services	In 2021, state grants amounting to EUR 4.9 million were granted to eight different projects.
Support for public transport climate measures	The Finnish Transport and Communications Agency granted EUR 15.5 of support in 2021. Approximately EUR 9.6 million of the climate-based support was committed to seven city regions in LHT agreements, and the Finnish Transport and Communications Agency also granted EUR 5.9 million in discretionary support for climate action in public transport.
Support for the construction of distribution infrastructure	Public distribution infrastructure support programmes: VNA 498/2018 (support scheme 2018–2021), VNA 178/2022 (support scheme 2022–2025). Private charging infrastructure support programme based on a budget entry.
Support for the purchase of electric and gas-powered vehicles and conversion support	Act on Fixed-Term Subsidies for Purchasing and Converting Vehicles to Use Alternative Fuels or Propulsion Systems (1289/2021) An amendment to extend the application period for support for the purchase of vans and lorries is in preparation.
Scrapping premium	Acts 839/2020 and 163/2021 (scrapping premium campaign 2020–2021)
Green Deal for the automotive sector	Agreement 2018
Public procurement	Act on Environmental and Energy Efficiency Requirements for Vehicle and Transport Service Procurements (740/2021)
Agreements concerning land use, housing and transport (LHT)	Helsinki, Tampere, Turku and Oulu (valid 2020–2031) city regions Jyväskylä, Lahti and Kuopio (2021–2031) city regions
Rail-related purchases	The Ministry of Transport and Communications and VR Group signed an agreement on purchased transport for 2022–2030 in January 2022.

5.2 Agriculture

Agricultural emissions have remained stable

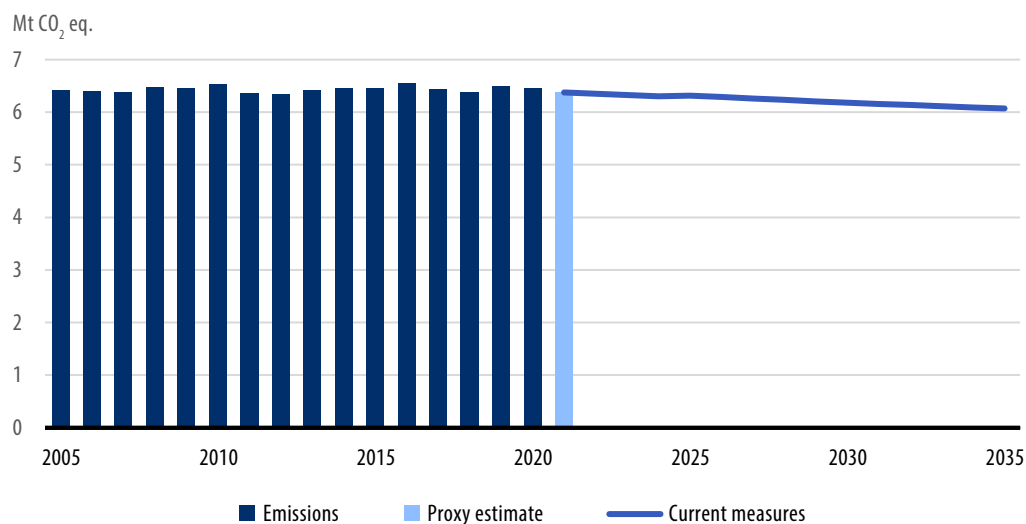
Greenhouse gas emissions from agriculture are reported in several reporting sectors. The effort sharing sector covers methane and nitrous oxide emissions from agriculture, mostly from livestock, manure and soil, as well as carbon dioxide emissions from liming. Small amounts of emissions are also generated by urea fertilisation and field burning of agricultural residues. CO₂ emissions from croplands and grasslands are reported in the land use sector (LULUCF). Furthermore, emissions from the use of fuels in agricultural machinery, building-specific heating and grain dryers are reported in the effort sharing sector (Figure 10).

Figure 10. Distribution of greenhouse gas emissions from agriculture to the effort sharing sector (agriculture and fuels) and to the land use sector (LULUCF) in 2021, based on proxy estimates.



Emissions from agriculture counted towards the effort sharing sector, excluding energy use emissions, have remained relatively stable over the last few years. In 2020, emissions from agriculture remained at the previous year's level of about 6.4 Mt CO₂-eq (Figure 11). According to the proxy estimate, emissions remained at the same level in 2021. Soil N₂O emissions fell from the previous year due a poor harvest, which reduced the amount of nitrogen entering the soil with the mowing residue of plants. The reduction in the use of fertilisers also reduced soil N₂O emissions. On the other hand, the total area of agricultural areas on peatlands, that is croplands and grasslands, increased by about 2,300 hectares, which increased the N₂O emissions from peat soil. The combined N₂O emissions from mineral and peat soils were lower than in the previous year. The existing measures are expected to lead to a slight downward trend in agricultural emissions.

Figure 11. Emissions from agriculture 2005–2021 and an estimate of the emissions trend achieved from 2022 to 2035 with existing measures. The 2021 data are proxy estimates.



Reported emissions in the land use sector have also remained more or less the same since 2005. About three-quarters of total agricultural emissions are related to soil when nitrous oxide emissions from the agricultural sector are included in addition to carbon dioxide emissions from the land use sector. In turn, around three-quarters of these emissions are related to organic soils. Because studies show that the most effective emission reduction measures in agriculture are related to organic soils, emission reduction measures in the Medium-term Climate Change Policy Plan are mainly aimed at these soils. These measures reduce emissions from both the effort sharing and land use sectors.

With regard to agriculture, it is worth noting that it is not only a source of greenhouse gas emissions, but also one of the few sectors capable of absorbing carbon from the atmosphere and sequestering it in soil. This is made possible by favourable farming practices, such as winter plant cover, perennial grasslands and light tillage.

A number of actions are under way to reduce emissions in the agricultural sector

In accordance with the Climate Act, planning related to agricultural production must ensure that climate change mitigation measures are planned and implemented in such a way that they do not endanger domestic food production or global food security.

In March 2022, the Ministerial Working Group on Preparedness decided on measures to ensure the security of agricultural supply. As part of this security of supply package, the ministerial working group outlined measures to be implemented between 2022 and 2026

to accelerate the rapid transition from fossil fuels to renewable energy sources. Further investment support was proposed for investments and changes in alternative energy sources and other security of supply, as well as advanced biogas digestate treatment technologies. In order to improve nutrient and energy self-sufficiency, additional funding is proposed for the nutrient recycling pilot programme and investment support is proposed for advanced nutrient recovery technologies and related investments in machinery, equipment, buildings and plants. Furthermore, funding for the cultivation of wetlands was also proposed.

In late 2021, the Finnish Government set a target for reducing greenhouse gas emissions from agriculture. The aim is to reduce the combined emissions of the agricultural effort sharing and land use sectors by 29% from the 2019 level by 2035. In April 2022, the HERO programme for climate action and farm economy was completed. The programme grouped agricultural climate and environmental measures into a single set of measures, which further defines the emission reduction pathway to 2035. The measures taken by the agricultural sector under the Medium-term Climate Change Policy Plan will contribute to achieving the targeted 29% reduction in emissions. In addition to this, however, there is also a need for other measures to reduce emissions.

The reform of the EU's Common Agricultural Policy (CAP) for the next financing period is currently under way, with the aim of allocating 40% of the total EU funding for CAP measures to EU-level climate measures. It is the responsibility of the Member States to ensure that 30% of rural development funding is earmarked for environmental and climate measures at national level. The main tasks of Finland's CAP Strategic Plan are to secure active food production, agricultural climate and environmental wisdom, and to strengthen the vitality of the regenerating countryside.

The Medium-term Climate Change Policy Plan also outlines the promotion of biogas production in the agricultural sector. The emission reduction effect is divided between agriculture, transport, non-road mobile machinery and building-specific heating. In 2021, a total of 905 GWh of biogas was produced in Finland, 27 GWh of it on farms. The total production of biogas increased by 3% from the previous year, while the production at on-farm plants increased by 50%.

A national biogas programme was completed in January 2020. The most significant challenges in the development of the biogas sector are still related to the poor profitability of operations. According to the working group, profitability could be improved by lowering investment costs, improving the selling price of finished products and making the sourcing of agricultural raw materials more efficient. High investment costs slow things down, especially for small plants. In spring 2022, it was estimated that the end of natural gas imports from Russia would strengthen the position of biogas in Finland.

The Finnish Government has also raised the issues of manure treatment and nutrient recycling as part of the overall sustainability of agricultural production. There are various incentive schemes in place for research, experimentation, guidance and investment in improving manure treatment and nutrient recycling. The Ministry of Agriculture and Forestry is allocating a maximum of EUR 5.1 million to a pilot programme to finance innovative solutions for nutrient recycling. The call for applications for funding from the national pilot programme for 2020–2022 was opened in the summer of 2020. The pilot programme is a continuation of a programme launched in 2016–2018.

The Rural Development Programme for Mainland Finland 2014–2020, which was extended to 2021 and 2022, includes measures that, in addition to impacts on waterways, also contribute to increasing and preserving soil carbon storage. The emissions reduction effect is felt both in the land use sector and in the agricultural sector. The measures include the recycling of nutrients and organic substances, placement of slurry on fields, winter plant cover of fields and environmental grasslands.

A number of research and development projects related to increasing soil carbon and conserving carbon pools are currently under way. The research and innovation programme, information programme and development projects of the Hiilestä kiinni – Catch the carbon package launched by the Ministry of Agriculture and Forestry promote carbon-capturing, carbon-storing and emissions-reducing farming methods, techniques, products and services in agriculture.

More sustainable eating habits are being sought through a wide range of means

As measures related to food consumption, the Medium-term Climate Change Policy Plan highlights the reduction of food waste and eating in accordance with dietary recommendations. The Nordic Nutrition Recommendations are currently being updated and are to be published in 2023. Among other things, the new recommendations are intended to clarify the links between nutrition and sustainable development. The Finnish Dietary Guidelines are based on the Nordic Nutrition Recommendations, so the work on the revision of the national guidelines will begin after the adoption of the Nordic recommendations. The Natural Resources Institute Finland (Luke) has coordinated the development of a national food waste monitoring system in Finland. The food system as a whole has developed a common roadmap, which sets out key ways to reduce food waste and loss at all stages of the food chain: primary production, industry, shops, food services and households. The roadmap was published in January 2021.

The Government Programme set the objective of halving food waste by 2030. Changing food waste and dietary habits does not directly reduce the emissions in the agricultural

sector and the land use sector reported in Finland; in order to reduce emissions, these must also generate changes in domestic food production.

A national Climate Food Programme in keeping with the Government Programme has been prepared under the leadership of the Ministry of Agriculture and Forestry. The programme aims to reduce the climate footprint of consumed food, increase understanding of food production and support the transition of society towards a climate-resilient food system. A climate-resilient food system takes into account all aspects of sustainability: social, economic, cultural and ecological. The aim of the Climate Food Programme is to increase the proportion of fish, mushrooms and plant products in people's diet, control the consumption of meat and dairy products, ensure that the products consumed are more sustainably produced, reduce food waste, increase the use of seasonal ingredients and produce added value from the side streams of the food system.

The Government Programme states that public procurement and public food services play an important role in improving the sustainability of the food system. The goal for public food procurement and food services is to increase the proportion of vegetarian food, which is also the goal in the official nutrition and food recommendations. The food recommendations for comprehensive school, secondary school and higher education students recommend offering vegetarian meals to all as a daily self-serve option available to all or to add a weekly vegetarian food day to the menu. They also recommend putting more fish and vegetables on the menu. Many municipalities are already implementing these recommendations and are thinking more broadly about increasing the offering of vegetarian and fish dishes on the menu in order to achieve their own climate targets.

The National Public Procurement Strategy has also set a target for the procurement of food and food services that promote an ecologically sustainable food system. The Ministry of Agriculture and Forestry has implemented this by, for example, updating the guide to responsible food procurement and organising training and events to support responsible food procurement in food services. In addition, a guide for the procurement of responsible food services, which aims to promote the organisation and procurement of overall sustainable food services in accordance with sustainability objectives, was completed.

Furthermore, an EAFRD-funded project led by the Natural Resources Institute Finland aims to harmonise and develop the methodology for the life-cycle assessment of food and the food system in order to obtain more reliable and comparable calculation results, for example for carbon footprint calculations. In addition, the Ministry of Agriculture and Forestry is funding a project implemented by the Natural Resources Institute Finland to create a tool for the restaurant industry for calculating the climate impact at all levels: restaurant, menu, recipe, meal and portion.

Table 5. Agriculture – key policy measures in place

Policy measure	Implementation status
Perennial cultivation of organic soil without soil preparation	Rural Development Programme for Mainland Finland, 2014–2020 and transitional period 2021–2022
Afforestation of organic soil Wetland afforestation of organic soil	Act on Temporary Subsidy for Afforestation 1114/2020
Raising the groundwater level by means of controlled drainage	Rural Development Programme for Mainland Finland, 2014–2020 and transitional period 2021–2022
Increasing and preserving soil carbon storage, including the “4 per mille” initiative	Implementation is under way.
Promoting biogas production	Rural Development Programme for Mainland Finland, 2014–2020 and transitional period 2021–2022. A national biogas programme was completed in 2020. Implementation of the measures proposed by the working group is under way. The Ministry of Agriculture and Forestry’s pilot programme for innovative solutions for nutrient recycling for 2020–2022 is under way. Investment aid to support biogas plants and new manure treatment technologies in 2020–2021, totalling MEUR 7.5. The preparation of a subsidy for the production of a biogas based on nutrient cycles is still in progress. As part of the Government’s COVID-19 recovery package, the support percentages for biogas investments in agricultural investment aid and rural business financing were raised to 50% for a fixed term.
Food consumption, food waste and dietary recommendations	The Nordic Nutrition Recommendations are currently being updated and are to be published in 2023. A national food waste monitoring system was published in 2021. The national Climate Food Programme will be completed in 2022.
Reform of the EU’s Common Agricultural Policy	Activities related to climate change mitigation and adaptation have been reviewed in the context of the preparation of the national CAP Strategic Plan. Finland’s CAP Strategic Plan was approved by the Government in December 2021. The draft plan outlines the funding and priorities for agriculture and rural development for the years 2023–2027. Negotiations are under way with the Commission to finalise the plan. At the same time, the content of the national measures is being prepared. The implementation of Finland’s CAP Strategic will start in 2023.

5.3 Building-specific heating

Emissions from building-specific heating have seen a downward trend in recent years, but there is annual variation due to, for example, the need for heating. The falling trend in emissions from building-specific heating is due to a decline in oil heating and an improvement in the energy efficiency of buildings. Emissions from building-specific heating are mainly caused by oil heating. In 2020, the emissions from building-specific heating amounted to 2.1 Mt CO₂-eq. Residential buildings accounted for 48% of the emissions from building-specific heating in 2020, commercial and service buildings for 36% and agriculture for 18% (Figure 12). Emissions from building-specific heating have decreased by 55% from 2005 levels (Figure 13).

Figure 12. Distribution of emissions from building-specific heating in 2020.

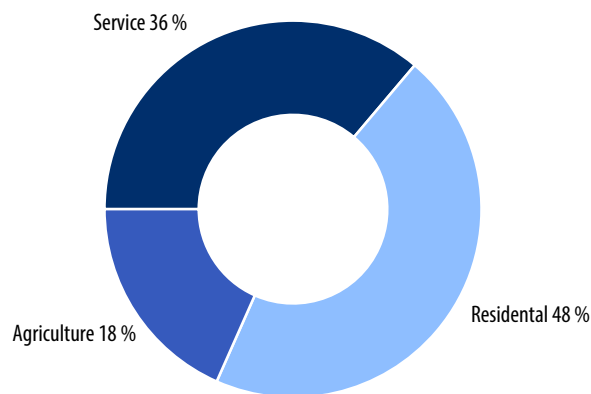
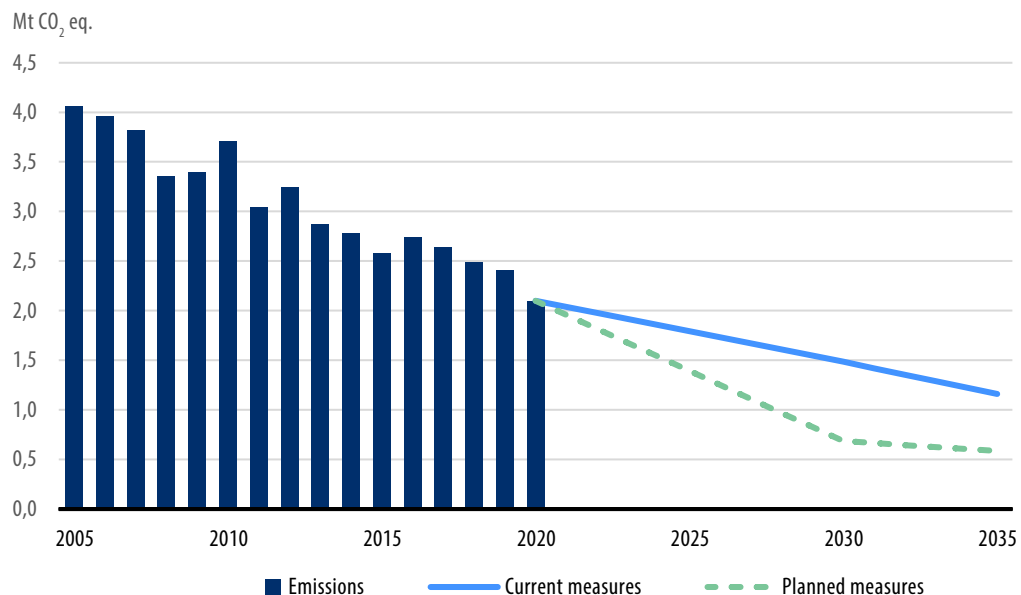


Figure 13. Figure 13. Greenhouse gas emissions from building-specific heating 2005–2020 and estimates of the emissions trend achieved from 2021 to 2035 with existing measures and the measures of the Medium-term Climate Change Policy Plan.



In accordance with the Programme of Prime Minister Sanna Marin's Government, the use of fossil oil in heating will be discontinued by the beginning of the 2030s. Oil heating of central and local government buildings is planned to be phased out by 2024. Oil-heated properties will be encouraged to switch to other forms of heating during the 2020s through a separate action plan.

The oil sector has signed the HÖYLÄ IV Energy Efficiency Agreement for the distribution of heating fuels with the Finnish Government, with the aim of improving the energy efficiency of oil-heated buildings and promoting renewable energy sources in oil heating. The agreement covers the period 2017–2025.

In the existing measure scenario, emissions are expected to fall further as a result of the renewal of the building stock, renovation construction and changes in heating systems. A significant emission-reducing effect comes from the obligation to distribute biofuel oil and the replacement of fossil oil heating with other forms of heating.

The greenhouse gas emissions from oil heating of residential buildings were 0.8 Mt CO₂-eq in 2019. About 80–90% of this came from detached and semi-detached houses. Approximately 40% of the total emissions from detached and semi-detached houses are caused by oil heating. According to the Finnish Dwellings Study 2019, 133,000 houses in Finland used an oil boiler in 2019. According to the study, the average oil-heated detached house consumed about 2,220 litres of oil per year. Only approximately 5% of all oil products in the energy sector are used in households.

According to the latest data from the Finnish Gas Association, in 2019 approximately 4,800 residential buildings were heated with natural gas, which included about 4,000 detached houses and about 750 terraced houses and blocks of flats. The total number of gas stove users in both the domestic and tertiary sectors was around 25,400. Households using natural gas heating, up to about 13,000, are few compared to the total number of households (2.8 million). In the service sector, there are approximately 1,200 buildings heated with natural gas.

Newly introduced support will be used to promote discontinuation of oil use in residential properties. Support for detached houses may be granted to cover the costs of removing the oil heating system of a detached house occupied on a year-round basis and to converting it to other heating systems. EUR 4,000 of support is being granted per oil heating system for the removal of an oil heating system from a detached house and its conversion into a district heating, geothermal or air-to-water heating system, or EUR 2,500 per oil heating system for the removal of the system in a detached house and its conversion into another heating system. In accordance with the decision of the Ministerial

Working Group on Preparedness of 7 April 2022, the system of support for detached houses will also be extended to phasing out natural gas heating.

The support for giving up oil heating has activated the replacement of oil heating systems considerably. As of beginning of August 2022, a total of 24,073 owners of detached houses had applied for oil heating replacement support and more than 13,700 had received a positive decision. Approximately EUR 54 million in aid has been committed to the decisions. The estimated impact on annual emissions of the change in heating mode by those who have received a positive decision so far is about 0.08 Mt CO₂-eq. The tax credit for domestic help is an alternative for owners of a detached house who are planning to replace the house's heating system.

Emissions from residential buildings will also be reduced through energy grants for energy efficiency improvement projects. The estimated impact on annual emissions is about 0.16 Mt CO₂-eq. The impact covers emissions from all residential buildings, not just oil-heated properties. As a result, some of the emission reduction effects will be allocated to the emissions trading sector. In the second draft supplementary budget for 2022, the Finnish Government proposed that an additional budget authority of EUR 20 million be allocated to energy support and that a maximum of EUR 10 million be granted for the replacement of residential heat exchangers suitable for low-temperature district heating.

Phasing out oil heating and switching to other forms of heating in municipally owned buildings has been expedited by grants since October 2020. In Finland, there are approximately 9,300 oil-heated buildings owned by municipalities and municipal enterprises, about 4,300 of them occupied and about 5,000 vacant. Even vacant buildings often need to be heated. The grant represents 30% of the approved and actual costs of the investment as approved and implemented in the decision. The grant will be increased by 5 percentage points if the municipality has joined a voluntary energy-efficiency agreement. In the 2020 budget, an amount of EUR 14.895 million has been set aside for the subsidy, with the targeted annual emission reduction of about 15 kt CO₂-eq.

The second supplementary budget for 2022 includes an appropriation of EUR 9.86 million for phasing out fossil oil and gas heating in the buildings of municipalities, parishes and associations. The grant represents 30% of the investment for municipalities and 20% for parishes and associations of the actual costs approved for support in the grant decision. The grant for a municipality will be increased by 5 percentage points if the municipality has joined a voluntary energy-efficiency agreement.

Table 6. Heating of buildings – key policy measures in place

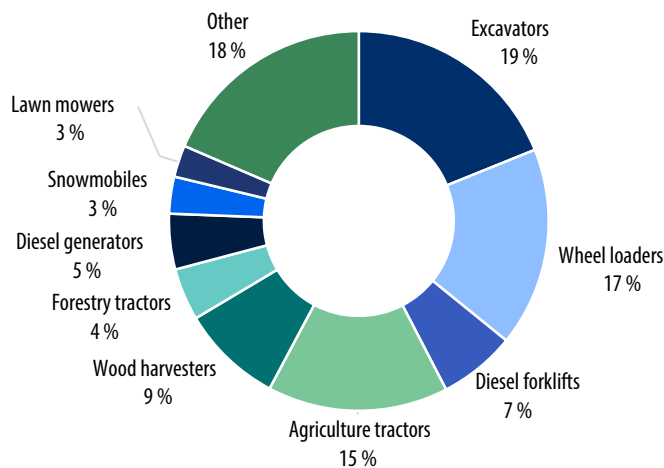
Policy measure	Implementation status
Support for giving up oil- and gas heating in residential buildings	Launched in September 2020, this subsidy scheme applies to detached houses. In April 2022, the system of support was extended to phasing out natural gas heating. The support is being granted by the Pirkanmaa Centre for Economic Development, Transport and the Environment (ELY Centre). A total of EUR 131.86 million has been allocated to the support in the budgets for the period 2020–2022. Changes in Finland’s recovery and resilience plan may change the situation.
Support for phasing out fossil oil and gas heating is being supported in buildings owned by municipalities, parishes and associations	The transition from fossil oil and gas heating to other forms of heating in buildings owned by municipalities has been supported by means of government grants since October 2020. An appropriation of EUR 14.9 million has been reserved for the support. The second supplementary budget for 2022 includes an appropriation of EUR 9.86 million for phasing out fossil oil and gas heating in buildings owned by municipalities, parishes and associations. The grants are available through the Housing Finance and Development Centre of Finland (ARA).
Energy support for residential buildings to improve energy efficiency and reduce emissions	The funding system started in 2020 and an allocation of approximately EUR 148 million is available in 2020–2022. The grants are available through the Housing Finance and Development Centre of Finland (ARA).
Tax credit for domestic help when giving up oil heating	In 2022, changes of heating method will be supported by raising the maximum tax credit for domestic help from EUR 2,250 to EUR 3,500 and the compensation rate from 40% to 60%. The tax credit is only available for the share of work. The change is valid for a fixed term from 2022 to 2027.
Distribution obligation of light fuel oil	Under the act (418/2019) in force as of 2019, the distribution obligation for light fuel oil stands at 3% in 2021 and will rise to 10% by 2028. A government proposal to increase the proportion of biofuel in the distribution obligation for light fuel oil is in preparation and will be submitted to Parliament in autumn 2022.

5.4 Machinery

Greenhouse gas emissions from non-road mobile machinery amounted to 2.4 Mt CO₂-eq in 2020, which is approximately 5% of Finland's total emissions and 9% of emissions in the effort sharing sector. Emissions from non-road mobile machinery have remained more or less stable in recent years (Figure 15). The proxy estimate puts the emissions in 2021 at 2.4 Mt CO₂-eq. Emissions from non-road mobile machinery were generated in manufacturing (48%), the service sector (13%), agriculture and forestry (32%) and households (7%).

Non-road mobile machinery includes equipment for a wide variety of applications, ranging from heavy excavators, road graders and agricultural and forestry machinery to forklifts, quad bikes and lawn mowers. Emissions from non-road mobile machinery vary from year to year depending on, for example, the economic trends in manufacturing and construction. Figure 14 shows the distribution of greenhouse gas emissions from non-road mobile machinery in the most important categories of non-road mobile machinery in 2020, and Figure 40 in Appendix 2 shows the corresponding development of emissions 2005–2020.

Figure 14. Breakdown of greenhouse gas emissions from non-road mobile machinery in 2021.

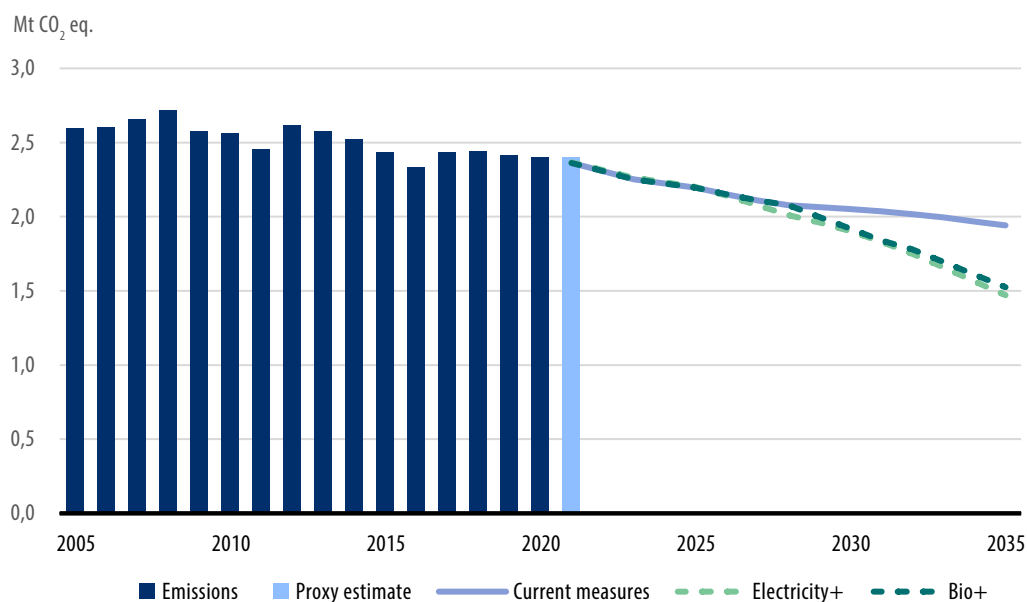


Non-road mobile machinery is still powered almost exclusively by internal combustion engines. Slightly over 90% of the emissions from non-road mobile machinery is caused by diesel engines. The remaining just under 10% is mainly caused by light petrol-powered machinery. The age of non-road mobile machinery varies significantly in Finland and there is a considerable amount of old stock in use, although machinery with a high utilisation rate is significantly newer than machinery with a low utilisation rate.

The most significant part of the environmental impact of non-road mobile machinery arises during operation. The environmental load during operation is particularly influenced by the characteristics of the stock, but the way it is driven or used and the planning of work phases also matter. The most significant environmental impacts during use are CO₂ emissions and exhaust emissions that are harmful to health. The exhaust emissions of non-road mobile machinery are usually considerably higher than those of a passenger car. In addition, the use of non-road mobile machinery causes noise. Exhaust emissions and noise, which are harmful to health, are more relevant in areas with a high population density.

According to the baseline projection, greenhouse gas emissions from the non-road mobile machinery sector will be about 20% lower in the target year 2035. Figure 15 shows the actual emission development of non-road mobile machinery and the development according to the baseline scenario and additional operating scenarios until 2035.

Figure 15. Emissions from non-road mobile machinery 2005–2021 and estimates of emissions trends according to the scenarios. Electricity+ is a rapid electrification scenario, and in Bio+ the proportion of bio-mix will increase to 30% between 2029 and 2030. The 2021 data are proxy estimates.



Several measures are currently being used to reduce CO₂ emissions from non-road mobile machinery.

Under the Act on the Promotion of the Use of Biofuel Oil (418/2019), the distribution obligation for light fuel oil stands at 3% in 2021 and will rise to 10% by 2028. The

Medium-term Climate Change Policy Plan adopted in June 2022 outlines an increase of the distribution obligation for the bio-share of light fuel oil to 30% by 2030. This has been estimated to reduce emissions for non-road mobile machinery by 0.2 Mt CO₂-eq in 2030 compared to the baseline scenario.

In non-road mobile machinery, substituting oil with other energy sources is considerably more difficult than in the case of building-specific heating and, for example, there is currently very limited availability of electric non-road mobile machinery. More benefits can be seen in the allocation of biofuel oil for use in non-road mobile machinery than in the allocation of biofuel oil for heating, as there are many non-oil heating systems available. Possibilities for the use of biogas in non-road mobile machinery are also being investigated. During its budget session in September 2021, the Finnish Government outlined that promoting biogas in the effort sharing sector aims to achieve emission reductions of 0.1 Mt CO₂-eq by 2030. Part of this (0.04 Mt CO₂-eq) is also targeted at non-road mobile machinery.

The accounting criteria for taxation on heating fuel were revised at the beginning of 2019 to include fuel life-cycle emissions in CO₂ emissions. At the same time, tax on light fuel oil was raised by about 2%. At the beginning of 2021, the tax was further increased by EUR 2.7 per megawatt-hour (MWh), or almost 11%. The tax increases will affect the price of — and, consequently, demand for — machinery fuels. For non-road mobile machinery, the emission reduction in 2030 has been estimated at 0.02 Mt CO₂-eq compared to the baseline scenario.

In October 2019, the Ministry of the Environment and the Association of Finnish Technical Traders signed a Green Deal on non-road mobile machinery in order to increase the percentage of low-emission machinery through public procurement. Through voluntary commitments made under this agreement, those operating in the sector aim to increase the supply of all-electric and other low-emission machinery and encourage its wider use. The aim of the agreement is to make construction sites of the cities and Senate Properties fossil-free by the end of 2025, meaning that they will not use fossil fuels. In addition, by 2030, at least 50% of construction machinery and site transport operations will be powered by electricity, biogas or hydrogen. The objectives of the agreement are currently being promoted, for example by developing procurement criteria, experimenting with new operating models and promoting market dialogue.

The aim is to promote the achievement of emission reduction targets in the non-road mobile machinery sector, in particular by including new categories of machinery in the Green Deal in the non-road mobile machinery sector and by merging new operators into the Green Deal in zero-emission construction sites. The training package included in the Green Deal is a process in which the content of the training created in 2021 will be

developed taking into account also the experience gained from the use of the training package.

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 purchasing the tractor itself. The subsidy covers 35% of eligible costs, including the costs of purchase and installation of new equipment. In addition, the Medium-term Climate Change Policy Plan adopted in June 2022 outlines that the possibility of introducing aid for the purchase of electric and biogas-powered tractors and other non-road mobile machinery will be explored.

At EU level, efforts are being made to influence the development of the Stage Regulation (2016/1628) to include CO₂ emissions. In addition, the introduction of an EU-wide emissions trading scheme for road transport and heating of buildings as proposed by the Commission would also have a partial impact on emissions from non-road mobile machinery in households and the service sector. For non-road mobile machinery, the emission reducing impact in 2030 has been estimated at 0.01 Mt CO₂-eq compared to the baseline scenario.

The emission calculation for the non-road mobile machinery sector is based on the TYKO model of VTT Technical Research Centre of Finland. Steps have been taken to improve the knowledge base on non-road mobile machinery emissions by developing the quality of the baseline data used in the TYKO model. Development of the model will continue as part of the overall development of the LIPASTO system. The model's current challenges include its limited ability to take account of the effects of different measures on emissions. Emission estimates do not take changes to machinery power sources or applications sufficiently into account, and trends cannot be linked to financial steering mechanisms, for example.

A VN-TEAS project launched in September 2021 examines cost-effective emission reduction measures for non-road mobile machinery (TYKO2). The aim of the project is to explore different ways of significantly reducing greenhouse gas and local emissions from non-road mobile machinery. The project analyses technologies, machinery stock, the market, alternative system solutions to reduce emissions and the future outlook of different technologies. Instruments to accelerate the reduction of CO₂ emissions, in particular the role of the distribution obligation, are also being examined. The study will be completed in autumn 2022, after which the necessary follow-up will be assessed.

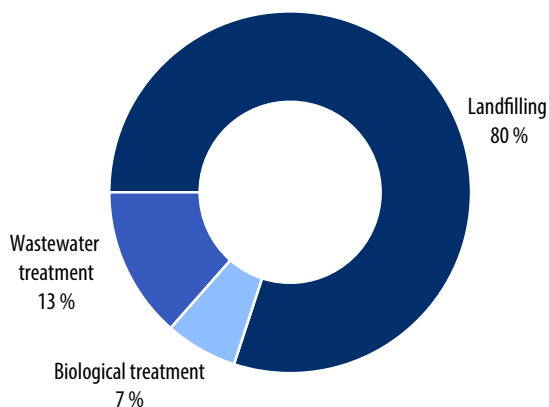
Table 7. Non-road mobile machinery – key policy measures in place

Policy measure	Implementation status
Distribution obligation of light fuel oil	Under the Act on the Promotion of the Use of Biofuel Oil (418/2019), the distribution obligation for light fuel oil stands at 3% in 2021 and will rise to 10% by 2028. A government proposal to increase the proportion of biofuel in the distribution obligation for light fuel oil is in preparation and will be submitted to Parliament in autumn 2022.
Taxation of light fuel oil	At the beginning of 2021, the tax was increased by EUR 2.7 per megawatt-hour (MWh), or almost 11%.
Emission-free construction sites, Green Deals in the non-road mobile machinery sector and the machinery training package	In October 2019, the Ministry of the Environment and the Association of Finnish Technical Traders signed a Green Deal for the non-road mobile machinery sector. 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 at construction sites. The Ministry of the Environment has worked with Motiva and the Association of Finnish Technical Traders to design a training programme on the energy-efficient use of non-road mobile machinery. The training package will be developed during 2022 and 2023.
Conversion of tractors to run on biogas and purchase subsidies for non-road mobile machinery	Conversion of tractors to use biogas is supported as an environmental investment through agricultural investment subsidies. As a new measure after the completion of the results of the TYKO 2 project, the possibility of introducing aid for the purchase of electric and biogas-powered tractors and other non-road mobile machinery will be explored.
Actions at EU level	Efforts are being made to influence the development of the EU Stage Regulation (2016/1628) to include CO ₂ emissions.
Development of the knowledge base – emission calculations and review of instruments	Development of the TYKO calculation model will continue as part of the overall development of the LIPASTO system, which has been in progress since 2021. A VN-TEAS project launched in September 2021 explores different ways of significantly reducing greenhouse gas and local emissions from non-road mobile machinery. The study will be completed in autumn 2022, after which the necessary follow-up will be assessed.

5.5 Waste management

Greenhouse gas emissions from waste treatment amounted to 1.9 Mt CO₂-eq in 2020 and, based on a proxy estimate, 1.8 Mt CO₂-eq in 2021 (Kuva 17). This accounts for about 7% of emissions in the Finnish effort sharing sector. Emissions from waste treatment have been declining steadily since the 1990s. Since 2005, emissions have decreased by as much as 41%. Methane produced by landfills is the most significant source of emissions in waste treatment. Other sources include biological waste treatment (composting and anaerobic digestion) and wastewater treatment (Kuva 16).

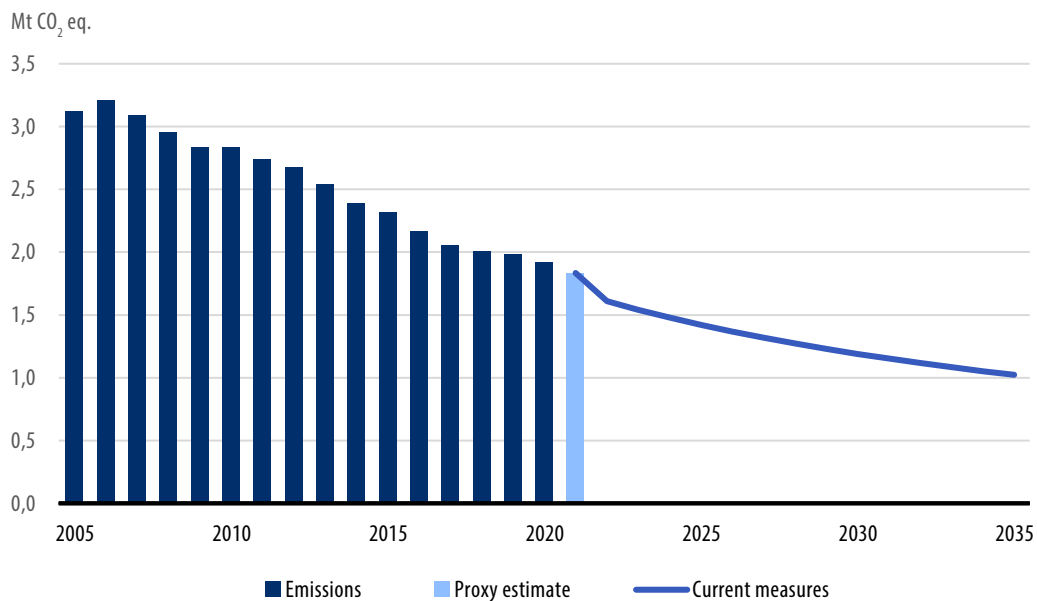
Figure 16. Breakdown of greenhouse gas emissions from waste treatment in 2021.



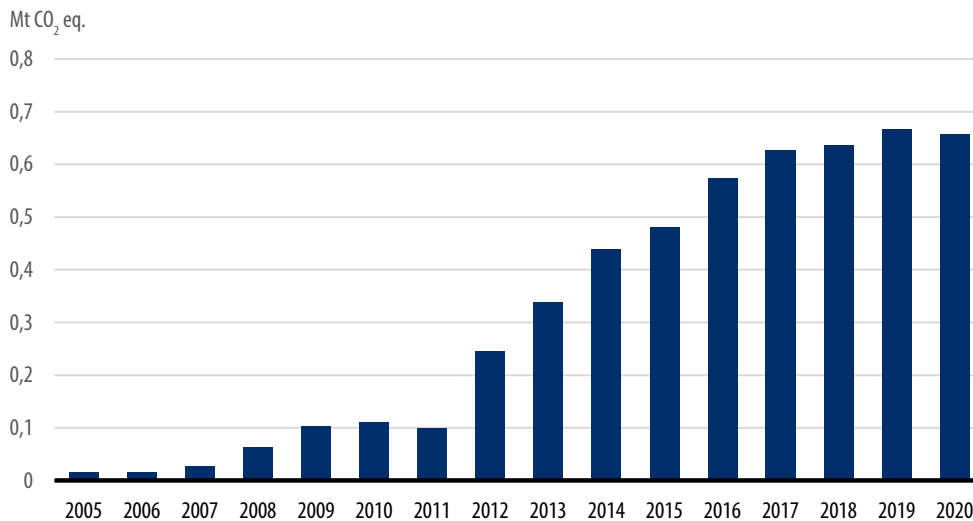
Since 2005, greatest reductions have been achieved in methane emissions from landfills, as landfilling of organic waste has declined to the point that practically no municipal waste is being landfilled any longer. The disposal of municipal waste by landfilling has been almost completely replaced by recycling and energy recovery from waste. Landfill gas recovery has also reduced emissions. The decreasing emissions trend is expected to continue in the near future, as the Government Decree on Landfills that restricts landfilling organic waste, in force since 2016, will further reduce greenhouse gas emissions from landfills, and gas generation in old landfills will continue to decrease as a result. However, the reductions in emissions introduced by the Government Decree on Landfills have already been factored into the baseline scenario, and no actual new emissions reduction measures have been outlined. Methane emissions from anaerobic digestion have slightly increased as the method has become more prevalent, whereas greenhouse gas emissions from composting have correspondingly decreased as a result of its declining prevalence. The emissions trend of wastewater treatment has been relatively stable and the emissions are expected to remain more or less unchanged. According to the baseline scenario,

emissions from waste treatment will decrease by 40% from 2019 to 2030. In 2035, emissions will be nearly half as low as today (Figure 17).

Figure 17. The emissions trend in waste treatment 2005–2021 and the baseline scenario estimate of the emissions trend achieved over 2022–2035 with existing measures. The 2021 data are proxy estimates. The figure does not include greenhouse gas emissions from waste incineration.



Emissions caused by energy recovery from waste (waste incineration) are reported as energy-based emissions, so they are not included in the data on emissions from waste treatment presented above. Emissions from municipal waste incineration plants are mainly counted towards the effort sharing sector, whereas co-incineration plants fall within the emissions trading sector. The effort sharing sector's emissions from waste incineration have risen very significantly since 2005 (Figure 188) due to increased energy recovery from municipal waste. About 58% of municipal waste generated in 2020 was recovered for energy, while only about 17% of municipal waste was incinerated in 2008. Waste incineration emissions are expected to grow slightly in the next few years but stabilise thereafter.

Figure 18. Emissions trend of waste incineration in the effort sharing sector 2005–2020.

The Government Programme outlines that the Government will investigate the conditions for using a waste incineration tax to promote a circular economy. A study conducted during 2020 explored the possibilities offered by a tax on waste incineration and voluntary agreements on waste incineration — the Ministry of the Environment’s Green Deal — in terms of promoting a circular economy and reducing climate impact. With the tax levels analysed in the study, energy-based and weight-based waste incineration taxes will not lead to any significant recycling and climate effects. Correspondingly, the effects of a Green Deal purely focusing on waste incineration may remain fairly modest, but the study suggests that a wider Green Deal covering the entire waste value chain could be more effective and lead to emission reductions as well. Preliminary negotiations on the Green Deal on waste incineration started in autumn 2021 and were continued in spring 2022. If the agreement is implemented, it will reduce emissions from the waste sector and waste incineration, but assessment of the concrete emission reductions is challenging as of yet.

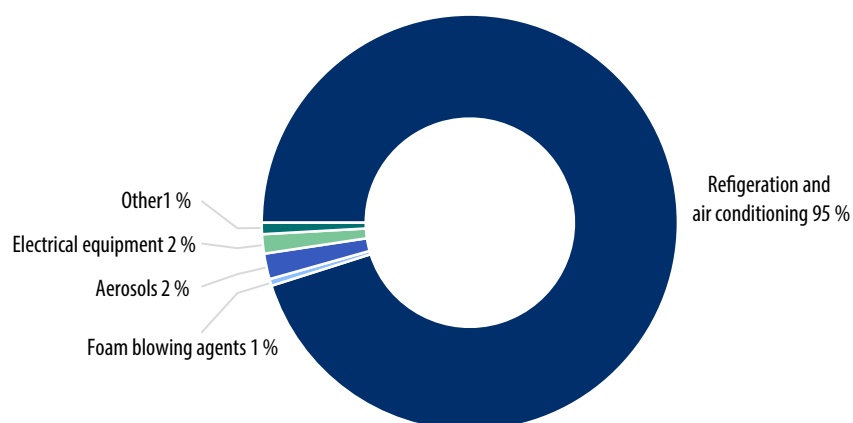
The waste legislation was mostly reformed in 2021. The key objectives of the reform are to reduce the amount of waste and increase reuse and recycling. Separate collection obligations became stricter and, as a result, more municipal waste is being recycled instead of incinerated. The National Waste Plan, updated in early 2022, aims increasingly to prevent the generation of waste and, together with the legislative changes, to increase the recycling rate. These policy measures will indirectly reduce greenhouse gas emissions from the waste sector in the longer term, but their emission reduction potential is difficult to assess.

Table 8. Waste sector – key policy measures

Policy measure	Implementation status
A voluntary Green Deal to reduce greenhouse gas emissions that takes into account the incineration of municipal waste	Preliminary negotiations on the Green Deal on waste incineration started in autumn 2021.

5.6 F-gases

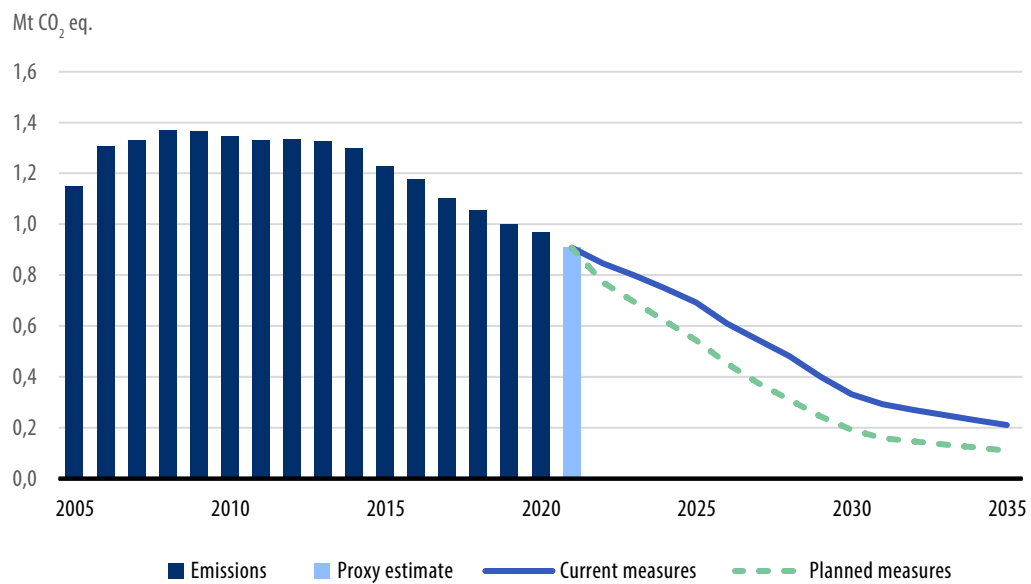
Emissions from the use of fluorinated greenhouse gases (F-gases) increased from the 1990s up until 2008, after which the growth reversed, and in recent years emissions have been falling (Figure 20). F-gases are mainly used in refrigeration and air-conditioning equipment, heat pumps, electrical switchgear, fire-fighting and foam blowing, and as aerosols and solvents (Figure 19). The most significant reason for the increase in F-gas emissions since the 1990s is the replacement of ozone-depleting compounds with F-gases in refrigeration and air-conditioning equipment and other applications.

Figure 19. Breakdown of F-gas emissions in 2021. Source: Statistics Finland.

F-gas emissions decreased by a good 3% in 2020 from the previous year, amounting to 1.0 Mt CO₂-eq. According to the proxy estimate, the emissions amounted to 0.9 Mt CO₂-eq

in 2021. The emissions have declined by almost 30% from the 2008 peak, but they still remain almost 20 times higher than in 1990.

Figure 20. F-gas emissions 2005–2021 and estimates of the emission trends achieved from 2022 to 2035 with existing and planned measures. The 2021 data are proxy estimate.



In large refrigeration plants in the trade sector, refrigerants with high Global Warming Potential (GWP) have already been replaced with CO₂ in new equipment. In vehicle air-conditioning systems, hydrofluorocarbon (HFC) refrigerants were already set aside a few years ago in favour of a low-GWP refrigerant in the air-conditioning systems of new passenger cars and small vans.

The regulation of F-gases has increased at the EU level as a result of the F-gas Regulation (517/2014), for example, which aims to gradually reduce the quantity of F-gases placed on the market. With existing measures, F-gas emissions are expected to decrease by about 65% by 2030 and by about 80% by 2035 relative to current levels.

Table 9. F-gases – key policy measures in place

Policy measure	Implementation status
Reform of the EU's F-gas Regulation	<p>The regulation under review implements the global Montreal Protocol commitments on HFCs to reduce HFC production and consumption after 2030, and adapts the F-gas legislation to the EU's tightened climate targets.</p> <p>The reform of the F-Gas Regulation started in spring 2022.</p>
Better management and more efficient recovery of F-gas stocks in appliances and products	<p>Estimates of the amounts of F-gases and ozone-depleting substances in existing equipment and various products will be updated. The evaluation started in 2021 and will be completed in 2022. Based on the evaluation report, the drafting of guidelines will be started, after which training will be organised and implementation will be monitored.</p> <p>The awareness of consumers and companies about the importance of F-gas recovery and its proper organisation will be promoted, for example through information, guidance and training provided by the authorities and the industry. After the completion of the report in 2022, the drafting of guidelines will be started and after that training and monitoring of implementation will be started as a separate project.</p>
Avoidance of equipment containing F-gases in public procurements	<p>The guiding principle is the criteria established for public procurement for alternatives to HFCs.</p> <p>Communications and deployment are in progress. The uptake of natural refrigerants will be promoted by updating procurement criteria, as technologies are rapidly evolving, and by promoting voluntary commitments.</p>
Promotion of the uptake of alternative technologies through training and information	<p>The introduction of competence requirements for persons handling natural refrigerants will be explored to ensure a safe transition to alternatives to F-gases. The Finnish Environment Institute (SYKE) has improved information and guidance on the alternatives.</p>

5.7 Other emissions

Non-ETS energy emissions are addressed by means of energy taxation, energy subsidies, energy efficiency measures and the obligation to distribute light fuel oil, as described above in the Annual Climate Report.

A voluntary energy auditing programme has been developed for SMEs. Voluntary energy audits are comprehensive on-site surveys of energy consumption, identifying opportunities to save energy. The audits are conducted and reported according to separate instructions. The Ministry of Economic Affairs and Employment subsidises voluntary energy auditing by local authorities and SMEs. Carrying out an energy audit in accordance with relevant models and instructions is a precondition for energy aid. Motiva Ltd is responsible for all practical tasks relating to subsidised audits, such as instructions, monitoring, development, quality control, auditor training and advisory services. The emissions reduction effect of subsidised energy audits is estimated at 0.37 Mt CO₂ in 2021. In 2040, the emissions reduction effect is estimated to only amount to 0.11 Mt CO₂. The majority of emission reductions are created in the emissions trading sector, as most energy savings come from declining consumption of electricity and district heat.

The electricity tax for industry was reduced to the minimum level allowed by the EU at the beginning of 2021. In addition, an act on lowering taxes on electricity used by heat pumps producing district heating or cooling will enter into force in 2022. These measures have an incentive effect to electrify processes and production currently using fossil fuels also in non-ETS industry and in district heating production. However, the overall impact in the effort sharing sector is limited, as the majority of industry and district heat production is covered by emissions trading.

Policy measures targeting non-ETS energy-based emissions and the status of their implementation are grouped together with the emissions trading sector measures in Table 10 in Section 5.8.

5.8 Emissions trading sector

In 2021, emissions from Finnish installations included in emissions trading totalled 20.3 Mt CO₂-eq. Since 2005, emissions have decreased by an average of about 3% per year. In the emissions trading sector, greenhouse gas emissions are primarily reduced by means of price controls created by the emissions trading system. The emissions trading system functions at the EU level and cannot be regulated at the national level. Emission trends in the Finnish emissions trading sector are described in more detail in Section 3.2.

The emissions trading system covers large industrial installations, power installations with a total thermal output exceeding 20 MW and smaller installations within the same district heating network, as well as air transport within the European Economic Area. All installations located in Finland that fall within the emissions trading system are required to obtain a greenhouse gas emissions permit from the Energy Authority. The emissions trading system applies to over 500 installations in Finland. The permit involves requirements to monitor and report emissions and an obligation to surrender each year to the Energy Authority allowances that are equal to the installation's emissions during the preceding calendar year. Each emission allowance gives the holder the right to emit one tonne of CO₂. While the price of emission allowances was still at a maximum of EUR 30 per tonne in 2020, the price started to rise in 2021 and reached almost EUR 100 at the beginning of February 2022 (see Appendix 2, Figure 25). Following the Russian invasion of Ukraine, the price of an allowance fell significantly at first, but has since then typically fluctuated between 70 and 80 EUR/tCO₂. The average price in early 2022 was 82 EUR/tCO₂.

Alongside emissions trading, Finland also has in place some national policy instruments that can influence emission trends in ETS installations located in Finland, at least to some extent. These include energy taxation, energy and other subsidies, energy efficiency measures and measures to end the use of coal for energy. As the majority of electricity and district heat production falls within the emissions trading system, emissions from the emissions trading sector will also decrease when the consumption of electricity or district heat declines, for example as a result of energy efficiency measures.

Installations falling within the scope of the emissions trading system are also covered by the energy tax system and subject to the same tax rates and rules as non-ETS entities. Peat is subject to lower energy taxes than other fossil fuels. A 'floor price mechanism' for energy peat entered into force at the beginning of 2022. It increases peat taxation if the price of emission allowances falls below 21.20 EUR/tCO₂. This is to ensure that the price of energy peat remains high enough in all circumstances to encourage a shift towards lower-carbon energy sources. At the beginning of 2021, taxation of industry and other electricity in tax category II was reduced to the minimum level set by the EU to encourage industry to electrify its processes and activities in order to reduce its greenhouse gas emissions.

Separate electrification aid for energy-intensive industries may also be granted for the period from 2021 to 2025. The sectors eligible and the criteria for granting the aid are in line with the guidelines on State aid on greenhouse gas emission allowance trading (2020/C 317/04), in which the Commission defined the conditions under which increases in electricity prices resulting from emissions trading can be compensated at national level. It has been agreed nationally that beneficiaries must use at least 50% of the aid received for development measures to increase the proportion of renewable energy or promote the reduction of greenhouse gas emissions, energy efficiency or electrification.

The condition for the use of the aid is a national addition to the conditions set out in the State aid guidelines for emissions trading. The total amount of aid granted is estimated to amount to EUR 344 million. A precise emission reduction impact assessment has not been prepared, but it has been noted that the aid will accelerate the reductions sought by low-carbon roadmaps. At the same time, the level of excise duty reimbursement for fossil fuels used by energy-intensive companies will be gradually reduced over the period 2021–2024 before being completely abolished. Total fuel use in energy-intensive industries corresponds to just under 3 Mt CO₂ emissions per year, but no precise impact assessment has been made of the reduction in use.

In addition, an act on lowering taxes on electricity used by heat pumps and electric boilers producing district heating or cooling to the above-mentioned EU minimum level will enter into force in 2022. The change also includes heat pumps outside the district heating sector with a total output of at least 0.5 MW, circulators at geothermal heating plants and some of the data centres. Specific emission reduction estimates have not been made.

The Energy Authority manages and guides energy efficiency measures within the administrative branch of the Ministry of Economic Affairs and Employment, the most measures important being energy efficiency agreements, energy audits, regional energy advisory services and preparation of eco-design and energy labelling matters for specific product groups.

Energy efficiency agreements are a means jointly chosen by the central government and the participating sectors to meet the international energy efficiency obligations imposed on Finland. The purpose of these agreements is to guide companies and organisations in improving their energy efficiency. The agreements cover more than 600 companies and their more than 7,000 sites as well as nearly 120 municipalities and joint municipal authorities. According to Motiva's estimate, the annual emission reductions achieved through energy efficiency agreements amounted to approximately 7.7 Mt CO₂ in 2021. Assuming that the current agreement period for 2017–2025 will continue, annual emission reductions are estimated to stand at 9.5 Mt CO₂ in 2030 and 9.7 Mt CO₂ in 2040. About 95% of emission reductions are estimated to be generated in the emissions trading sector due to the large proportion of electricity and district heating in all energy savings.

The Energy Efficiency Act obliges large enterprises to carry out an energy audit every four years. Energy audits are used to produce knowledge of the existing energy consumption profile of a company's units, identifying energy savings opportunities. In 2021, the annual emissions reduction effect of the mandatory energy audits launched at the end of 2015 amounted to approximately 0.13 Mt CO₂, which is estimated to increase to 0.31 Mt CO₂ by 2040. Since the majority of emission reductions come from declining consumption of

electricity and district heat, about 95% of emissions reduced by mandatory energy audits are generated in the emissions trading sector.

The Ministry of Economic Affairs and Employment and Business Finland, the Finnish funding agency for innovation, may allocate discretionary aid to innovative energy projects. Two types of aid are available: energy aid for investment projects and studies (granted by the Ministry of Economic Affairs and Employment/Business Finland) and investment aid for projects to replace use of coal for energy (granted by the Ministry of Economic Affairs and Employment).

Energy aid is available for projects to promote renewable energy production or use, energy savings or energy efficiency, or conversion into a low-carbon energy system by other means. Investment aid for new energy technologies and large demonstration projects may be granted to projects pursuing future energy solutions with a budget of more than EUR 5 million. The objective of the investment aid is to help achieve the national and EU-level targets set for future energy solutions by 2030. In 2021, more than 900 decisions were made to issue energy grants amounting to a total of about EUR 157 million. The total amounts awarded to renewable energy projects and energy efficiency projects stood at about EUR 80 million and EUR 77 million, respectively. The majority of the total amount of aid, about EUR 90 million, was allocated to large demonstration projects. Nearly EUR 23 million was granted to projects replacing the energy use of coal. As a general rule, energy aid will not be granted to projects falling within the scope of the Emissions Trading Act. However, aid may be granted to investment projects related to activities falling within the act's scope of application insofar as the project involves new technologies or the investment only results in modest financial benefits in emissions trading.

In addition, the Sustainable Growth Programme for Finland, which is Finland's plan for the use of the EU Recovery and Resilience Facility (RRF) funding, is in force. In the programme, Finland has allocated half of the total funding of EUR 1.8 billion to the green transition. Originally the programme has earmarked EUR 192 million for R&D activities supporting the green transition and EUR 75 million for research and innovation infrastructure investments supporting sustainable growth and digitalisation. Originally EUR 645 million of funding has been earmarked for energy system projects and industrial low-carbon and circular economy projects. However, the final total funding will not be decided until 2023, when the final approval of the EU's recovery and resilience instrument is decided and support decisions can be made. The funding will be used in particular for demonstrating new solutions.

The Act on the Prohibition of Energy Use of Coal adopted in 2019 basically applies to energy production installations operating within the emissions trading system. The

prohibition will enter into force on 1 May 2029. In order to speed up decarbonisation, in March 2020 the Finnish Government issued a decree on investment aid for projects accelerating the replacement of coal in energy production in 2020–2025. The aid is intended to promote the voluntary phase-out of coal use by the end of 2025. A total of EUR 90 million was allocated to the aid programme in the General Government Fiscal Plan for 2020–2021. Seven projects were granted support in 2020 and 2021 with a total sum of about EUR 30.5 million. The unused mandate of just under EUR 60 million will be allocated in full to other energy support projects related to, for example, photovoltaics and energy efficiency, waste heat and other heat pump systems, biogas production, small-scale renewable energy production and large investment grants for demonstration projects in new energy technologies.

Table 10. Emissions trading sector – key policy measures in place

Policy measure	Implementation status
Act on Discontinuing the Use of Coal in Energy Production	The act entered into force in April 2019. Energy use of coal will be banned from May 2029 onwards.
Investment support for projects to replace coal as an energy source, 2020 and 2021	The Finnish Government issued the decree in March 2020. A total of EUR 90 million was allocated to the scheme, of which approximately EUR 30.5 million was granted to seven projects in 2020 and 2021.
Tax increase of heating fuels (including the reduction of tax benefit for combined production)	The act entered into force in December 2020. The amendment entered into force at the beginning of 2021.
Floor price mechanism for energy peat	The act entered into force at the end of 2021. If the price of emission allowances falls below 21.20 EUR/t, the taxation of energy peat is increased. The mechanism is operational from the beginning of 2022.
Reduction of electricity tax category II to the EU minimum and application of category II to electricity used by industry	The act entered into force at the end of 2020. The amendment entered into force at the beginning of 2021.
Abolishment of the energy tax return of energy intensive companies	The act entered into force at the end of 2020. The partial refund of the energy content tax on fossil fuels will be phased out over the period 2021–2024.

Policy measure	Implementation status
Moving heat pumps producing district heating or cooling, other heat pumps of sufficient size and some of the data centres to electricity tax category II.	The draft law is to be adopted by the EU Commission and will most likely enter into force in 2022.
Energy efficiency agreements	Agreement period 2017–2025 is under way. The agreement activities involve more than 600 companies and their more than 7,000 sites as well as nearly 120 municipalities and joint municipal authorities.
Sustainable Growth Programme for Finland	Several calls for funding applications, the first of which were opened in 2021. Supports, for example, green transition RDI projects and low-carbon and circular economy projects.
Energy aid	A form of aid available until further notice. Supports the green transition in the energy sector, such as increasing the use of renewable energy.

5.9 Land use sector

So far, climate action in the land use sector has not been guided by central government plans in the same way as action in the effort sharing or emissions trading sectors. Recent developments in the land use sector have led to a debate on new measures to reduce soil emissions in the sector and to strengthen carbon sinks, thereby increasing the growth of carbon pools. The Climate Plan for the Land Use Sector, submitted to Parliament in July 2022, aims to meet this need.

As regards the carbon balance of the land use sector, annual changes have typically been large compared to other sectors. Fluctuations have occurred especially in the sink of forest lands as a result of fluctuations in commercial felling. Commercial felling depends on the global demand for forest products. Emissions from other land use categories in the sector have remained more or less at the same level. Based on the statistics, the sink level of forest land primarily follows the actual felling (Appendix 2, Figure 43).

Forest policy is guided mainly by the National Forest Strategy extending to 2025, which sets a target of 80 million m³ of roundwood removal and 8 million m³ of logging residue

and stumps. Forest harvesting levels have been determined primarily on the basis of the demand for forest products on the global market, but Finland has also made long-term efforts to increase the use of forest biomass, taking into account the sustainability of wood production. Forest management can increase both carbon sinks and carbon pools in forests. Forest management measures have not directly targeted the maintenance of forest carbon sinks, but forest carbon pools have also increased as a knock-on effect. Work is under way to update the National Forestry Strategy, which will enable the objectives of forest policy to be examined in relation to climate and energy policy. The timeframe of the new strategy extends to 2035.

Forestry practices are governed, for example, by the Forest Act and the Best Practices for Sustainable Forest Management in Finland. When the Forest Act was amended in 2014, the age and diameter limits of forest stands concerning final felling were abolished. According to state forest inventories, the average regeneration age of trees has decreased. In northern Finland, thinnings have been more extensive than before. This may be partly due to heavy snow and storm damage. In addition, the growth of pine forests in northern Finland in particular has slowed down.

The Best Practices for Sustainable Forest Management in Finland have played an important role, especially in the activities of organisations providing forestry advisory services, and through them in the activities of forest owners. Currently, the best practices offer a wide range of tools for implementing different types of forestry, starting from the objectives of the forest owner. The climate resilience of forests has been taken into account in the best practices for a long time but, as part of the climate action package for the land use sector coordinated by the Ministry of Agriculture and Forestry, Tapio Ltd has launched a project aimed at making climate sustainability an integral part of the best practices. The new best practices will be published in 2022.

The new Climate Act requires a Climate Plan for the Land Use Sector to be drafted at least every other parliamentary term. The Climate Plan for the Land Use Sector will become part of the plan system of the Climate Act, and structural and substantive requirements will be set for the plan. The implementation of the plan will be monitored in the Annual Climate Report.

The funding required to launch the activities of the first plan will be implemented to a significant extent through Government decree 5/2021. The plan includes a lot of measures to mitigate climate change in the land use sector and brings climate action into agricultural and forestry practices. Particularly in the case of peatland fields, there are measures in the plan that, if implemented, would be completely novel in the sector.

The Climate Plan for the Land Use Sector includes a wide range of measures to reduce emissions from the land use sector or strengthen its sink. Some of the measures have also been assessed in terms of their emission reduction impact. A number of measures concern the reduction of emissions from peatlands. Measures are also proposed to reduce deforestation and ensure the growth of forests. The package also includes measures to strengthen the knowledge base.

The Climate Plan for the Land Use Sector includes an entry on the preparation of a land use change fee. The fee would be applied to both construction and clearing land for cultivation and would be aimed at curbing deforestation. The aim is to prepare a draft proposal on the basis of official work in April 2023.

The measures of the Climate Plan for the Land Use Sector targeted at peatland forests are largely based on the report of the working group on the new forestry incentive scheme (METKA). The measures proposed in the Climate Plan for the Land Use Sector aim to increase continuous farming/uneven-aged forestry in luxuriant hardwood-spruce swamps. Efforts will also be made to reduce ditch cleaning and supplementary ditching. Support for the management of the Finnish forest in the current Temporary Act on the Financing of Sustainable Forestry (KEMERA) would be replaced by support for the management plan for peatland forests and support for water protection measures and the creation of skid trails in peatland forests. Another aim of METKA is to promote and increase the comprehensive and multi-purpose management planning of peatland forests.

In particular, the land use sector differs in nature from other sectors in terms of the long response time to the climate impacts of many activities, i.e. the time it takes for the impacts to be verified at all, or the time it takes for the activities to produce climate benefits. The activities of the Hiilestä kiinni – Catch the carbon package have already been included in the Climate Plan for the Land Use Sector with funding for the period 2020–2023. These measures can therefore be considered as already being implemented. The Climate Plan for the Land Use Sector has no defined, separate baseline scenario, instead using the HII SI project's baseline scenario for the land use sector.

Measures launched in the Hiilestä kiinni – Catch the carbon package:

- new ownership policy guidelines issued in 2020 to Metsähallitus, the state-owned enterprise governing the use of state-owned land, which put more emphasis on carbon sequestration and strengthening diversity;
- new aid scheme to promote afforestation of non-productive land;
- expansion of support for wood ash fertilisation (KEMERA) to strengthen carbon sequestration in peatland forests;

- the Hiilestä kiinni – Catch the carbon research and innovation programme, which produces research data to support the reduction of carbon emissions from land use and the maintenance and increase of carbon sinks and carbon pools;
- a land use sector information programme prepared in 2020, which includes proposals for measures to acquire data sets on the land use sector, develop their use and promote their efficient utilisation, including information products and services and modelling;
- a development project package launched in 2020, which has funded a total of almost 100 projects through open calls for projects, competitive tendering and the state's internal service procurement. Through the project package, the needs defined in the information programme for the land use sector are also being implemented. The projects refine soil information as required by carbon market measures and climate policy needs, and develop emission factors, among other things.

As part of the package of measures, in the first call for proposals for the Hiilestä kiinni – Catch the carbon research and innovation programme, a total of EUR 10.7 million was allocated to ten research and innovation projects. In a call for applications in late 2021, the aim was to provide a total of EUR 5 million of funding to five new projects of the research and innovation programme on the themes of “change in the air”, “a push in land use”, “wisdom in the soil”, and “anticipation and instruments for land use”.

In addition, two open calls for projects have been organised in connection with the project package, for the implementation of the Hiilestä kiinni – Catch the carbon development projects and the land use sector information programme. The aim of the land use sector information programme is to produce information to support climate action and to promote its use. In the first round of applications, a total of approximately EUR 10 million was allocated to projects that support the themes of promoting climate-resilient forestry, promoting climate-resilient agriculture, land use change and wetlands, adapting agriculture and forestry to climate change, and implementing the information programme for the land use sector. In a call for applications in late 2021, projects were sought for a total of approximately EUR 8 million in funding around the themes of regional and local climate work, carbon market experiments and the implementation of the information programme for the land use sector. The projects were launched in spring 2022.

The package of measures has been coordinated with other measures and projects in the Government Programme, such as the Climate Food Programme, a set of measures concerning the nutrient cycle, the field structure development programme and the flood protection and field water management measures. The climate action package also

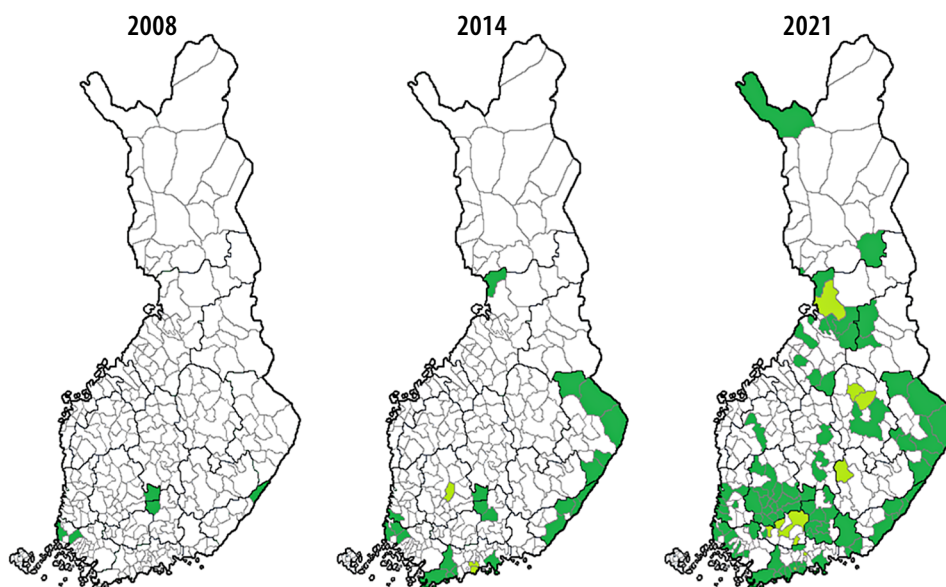
implements the objectives of the National Forestry Strategy 2025. In addition, the EU's Common Agricultural Policy (CAP) measures will be used to implement the measures of the package.

6 Cross-cutting measures

6.1 Climate work in municipalities and regions

Local authorities play a key role in Finland's efforts to achieve carbon neutrality by 2035. They can actively influence the amount of their greenhouse gas emissions. They also have many ways to promote and accelerate emission reductions among municipal residents, companies, communities and other stakeholders. Within their own municipality, local authorities are responsible for town planning, land use, transport planning, ownership steering of municipality-owned energy companies, heating choices for many buildings and public procurement, for example. In total, 138 of Finland's 309 municipalities have set themselves a municipal or regional climate target. Some 4.5 million people, which is approximately 80% of the population of Finland, live in these municipalities. Almost two thirds of Finns live in municipalities that seek to reduce emissions by 80% in the period 2007–2030 (especially the municipalities of the Towards Carbon Neutral Municipalities (Hinku) network) or become carbon neutral by 2035 (Figure 21).

Figure 21. Municipalities with a target of reducing emissions by at least 80% by 2030 (dark green) or after 2030 (light green). The figure shows the situation in 2008, 2014 and 2021.



According to the new online emissions data service launched by the Finnish Environment Institute in February 2020, the effort sharing sector's total emissions in the whole of Finland — including those of municipalities — decreased by 19% from 2005 to 2020, but there are significant differences between municipalities. Although Finland has many municipalities that are at the leading edge of climate action, many others have not yet taken part in active climate work. Municipalities have very different starting points. The larger the municipality's population, the more likely it is that the municipality has set a climate target and is already doing climate work. According to the 2021 Climate Report of the Association of Finnish Local and Regional Authorities, the biggest challenge in terms of achieving municipal climate targets is the lack of financial and human resources across the board.

In recent years, municipalities and regions have been able to apply for grants for their climate action from various sources. A monthly updated list of suitable calls for funding applications for the promotion and acceleration of local and regional climate action is available on the websites of Motiva and the Finnish Environment Institute. Support has been provided for sector-specific climate action, such as giving up oil heating, different energy solutions and the promotion of walking and cycling. In addition, municipalities have been able to apply for grants for various climate work development projects and small-scale experiments, for example through the Ministry of the Environment's Municipal Climate Change Solutions Programme and the Sustainable City Programme. For the largest urban areas, climate work is also supported by the agreement procedure on land use, housing and transport (LHT).

The Municipal Climate Change Solutions Programme of the Ministry of the Environment funds municipalities' and regions' own climate projects and solutions supporting their climate work at national level. The total budget for the programme for the period 2018–2022 is EUR 9 million, which has already funded 118 projects to strengthen the climate work of municipalities all over Finland. Twenty new local and regional projects received funding from the 2022 appropriation (EUR 1 million).

At the regional level, the programme has funded the national climate work development project of the Centres for Economic Development, Transport and the Environment, the most important output of which is a roadmap tool that promotes and strengthens the internal and external climate work of the centres. In addition, the programme funds have launched projects in most regions that support all municipalities, but especially the smallest ones, in implementing climate work.

The Energy Efficiency Agreement for Municipal Sector (KETS) is an agreement between the Ministry of Economic Affairs and Employment, the Energy Authority and the Association of Finnish Local and Regional Authorities on more efficient use of energy in the municipal

sector. The current agreement period is from 2017 to 2025. Energy efficiency agreement activities are a key part of Finland's energy policy and an important means of meeting both the EU's and international energy efficiency and emission reduction targets to which Finland is committed. A total of 124 municipalities and joint municipal authorities, which cover more than three-quarters of Finland's population, are bound by the agreements.

Regional energy advisory services (2018–2025) funded by the Energy Authority are an important way to promote achievement of energy and climate targets. The advisory services provide objective information on energy, enabling the implementation of the objectives of energy efficiency and emission reductions.

The Finnish Government decided during its budget session in September 2021 that legislation would be amended to include the obligation to draw up climate change plans at the local, sub-regional or regional level. This is to be clarified in that the Climate Act would impose an obligation on municipalities to draw up a climate plan alone or together with other municipalities. The new obligation of municipalities to draw up a climate plan would cause permanent resource needs for municipalities, and for them, municipalities should receive funding in the form of state grants. The government is preparing for the change in the role of municipalities by allocating 2,831,000 euros of additional funding during the framework period. The Government proposal to amend the Climate Act is to be submitted in autumn 2022, and the municipalities' obligation to prepare a climate plan would enter into force from the beginning of 2023.

6.2 Carbon footprint of consumption

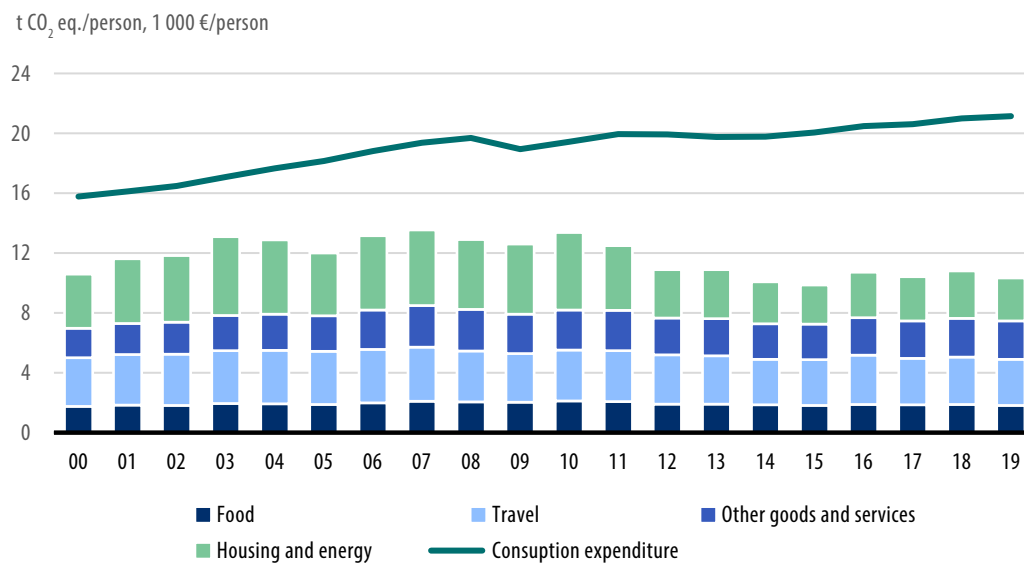
The latest analysis of the development of the carbon footprint of households was carried out by the Finnish Environment Institute in spring 2021 and covered the period 2000–2019. According to the Finnish Environment Institute, household consumption is of great importance to Finland's emissions; it accounted for about 66% of Finland's consumption-based greenhouse gas emissions in 2015. The average household carbon footprint has barely shrunk in recent years. Estimates of consumption-based emissions differ from Finland's official, production-based emissions (produced or generated within the territory of Finland) reported in the greenhouse gas emission inventory, in that the former include inventory-based emissions as well as overseas emissions from production chains of imported goods, excluding emissions from production chains of exported goods.

According to the Finnish Environment Institute, changes in the consumption structure and the emission intensity of consumer goods helped to reduce the total carbon footprint of Finnish households by –6.1 Mt CO₂-eq in the period 2000–2019. The impact has been greater than the impact of the increase in consumption expenditure. Change in footprint

over the 2000–2019 period can be divided into the following three factors: change in consumption expenditure (which alone would have increased emissions by 31%), change in consumption patterns (–7%) and change in emission intensity of products and services (–34%). The analysis was carried out using emission intensities by product group.

The average annual per capita carbon footprint of household consumption expenditure varied between 9.9 tonnes and 14.2 tonnes CO₂-eq, peaking in 2003 and 2007 (Figure 22). In 2019, the average carbon footprint was 10.0 t CO₂-eq. According to the Finnish Environment Institute’s research, consumption correlates most with income level. Based on 2016 data, the Finnish Climate Change Panel estimates that the carbon footprint in the highest income decile is almost triple that in the lowest.

Figure 22. Average consumption expenditure (at 2015 prices) and carbon footprint of Finnish households 2000–2019. The data are based on updated calculations from the ENVIMAT model of the Finnish Environment Institute.



The sustainable level of consumption-based emissions is estimated at about 2.5 tonnes CO₂-eq per capita in 2030 if global warming is to be limited to 1.5°C. The Finnish Climate Change Panel estimates that the household carbon footprint should have declined by about 70% when the 2016 carbon footprint is compared with the 2030 climate targets.

To support the reduction of the carbon footprint of households, carbon footprint calculators have been developed to determine emissions from personal consumption. Examples of such calculators are Sitra’s Lifestyle Test and the Finnish Environment

Institute's Climate Diet Calculator. The calculators have proven to be popular. Sitra's Lifestyle Test calculator has been used more than one million times so far. The average carbon footprint produced by the calculator is 6.9 t CO₂-eq, which is less than the average Finnish carbon footprint estimated by the Finnish Environment Institute.

Projects are under way to strengthen the knowledge base, such as the consumption project of the Finnish Climate Change Panel and the Policy instruments for sustainable consumption (KULO) project. The Finnish Climate Change Panel's project examines the importance of consumers' choices for emission reductions in Finland by 2035. The project assesses what additional steps consumers could take to reduce their carbon footprint and the emission reduction potential of those steps. The project focuses in particular on additional activities that cannot be directly influenced by social policy instruments. The KULO project identifies and evaluates effective combinations of policy instruments that could effectively reduce climate emissions from private consumption by 2035. The aim of the project is to produce at least two combinations of instruments with emission reduction targets of 50% and 70% of the baseline year. In addition, the Finnish Environment Institute will update the data on greenhouse gas emissions of households, public consumption and investments in connection with the project. The KULO project is scheduled to be completed by the end of February 2023.

6.3 Public procurement

The climate impact of public procurement is not monitored on an annual basis. In 2015, the carbon footprint of public procurement in Finland was 8.3 Mt CO₂-eq and the carbon footprint of investments made by public organisations was 2.7 Mt CO₂-eq. Consumption-based emissions, which include imports and exports, have been taken into account in the calculation.

In 2015, approximately 22% of emissions from public procurement and investments were attributable to the central government, 71% to procurements and investments made by local government and joint municipal authorities, and 7% to procurement and investments made by other public organisations. The administrative branch of the Ministry of Defence was the largest source of greenhouse gas emissions in central government procurement, followed by the administrative branches of the Ministry of Transport and Communications and the Ministry of the Interior.

Low-carbon public procurement is promoted in the national Procurement Finland strategy, which aims to ensure that procurement supports Finland's carbon neutrality goal. In the municipal sector, for example, some municipalities have set emission targets for procurement in either climate or procurement strategies and, especially in the HINKU

network of pioneering municipalities in climate change mitigation, procurement is one of the targets for development. The Competence Centre for Sustainable and Innovative Public Procurement (KEINO) is a key developer and coach of low-carbon procurement know-how and operating models.

Procurement of vehicles and transport services powered by electricity or natural gas

The Act on Environmental and Energy Efficiency Requirements for Vehicle and Transport Service Procurements entered into force in August 2021. The act requires a certain proportion of vehicles purchased by local and central government to have low or zero emissions. The minimum procurement requirements have been divided into three vehicle categories and the obligations have been divided into two procurement periods: from 2 August 2021 to 2025 and from 2026 to 2030. The requirements apply when the procuring entity buys, rents or leases a vehicle, pays for one in instalments or purchases certain transport services. Municipalities belonging to different regions have different minimum proportions.

The act set the objective that 38.5% of car and van procurements should be environmentally friendly. During the first procurement period, vehicles are considered as environmentally friendly passenger cars and light commercial vehicles if they have maximum emissions of 50 CO₂ g/km (plug-in hybrids or a battery electric vehicles), and during the second procurement period the maximum is 0 CO₂ g/km (battery electric vehicles). In lorry purchases, 9% must be environmentally friendly during the first procurement period and 15% during the second. A clean lorry refers to a vehicle that is powered by an alternative fuel, such as biofuel, electricity, natural gas or hydrogen. As for buses, 41% of new bus procurements in local transport in the first procurement period and 59% in the second must be environmentally friendly. An environmentally friendly bus is defined as a vehicle running on an alternative fuel, such as electricity, hydrogen, natural gas or biofuel.

Environmental impacts can be reduced through public procurement guidance

The Programme of Sanna Marin's Government highlights the importance of sustainable procurement and environmental responsibility and aims to increase its mandatory nature. In order to implement the objectives of the Government Programme, the Carbon and environmental footprint in procurement – legislation and measuring (HILMI) project of the Finnish Government's analysis, assessment and research activities examined how legislation and the operating models of public procurement should be developed in order to take the carbon and environmental footprint into account in public procurement in a cost-effective manner.

The project produced an assessment of the need to develop legislation and of the impact and effectiveness of possible legislative changes. The Ministry of Economic Affairs and Employment is currently preparing an amendment to the Act on Public Procurement and Concession Contracts. The assessment group also recommended supporting the sustainability of procurement with more permanent, well-resourced administrative and organisational structures. In addition, the organisation of cost-effective monitoring of the achievement of the objectives and criteria set for procurement was recommended as part of the existing systems and information production.

KEINO Competence Centre emphasises low-carbon procurement

One key promoter of low-carbon procurement is the Competence Centre for Sustainable and Innovative Public Procurement (KEINO), which has, among other things, implemented a low-carbon procurement development programme, developed criteria for emission-free construction sites with municipalities as part of the Green Deal (see more in Section 5.4), and published a guide to low-carbon procurement.

KEINO's low-carbon procurement development programme supported procuring entities to meet their low-carbon targets for procurement. Six organisations were selected for the development programme: the City of Kouvola (wooden school contract procurement), Metsähallitus (forest contracting), Suomen Erillisverkot Oy (server procurement), the City of Tampere (street contract procurement), the City of Tornio (school transport procurement) and the City of Vaasa (winter maintenance of pedestrian and bicycle routes). The development programme identified the most effective procurement categories for each organisation's climate objectives and prepared their implementation plans. With the support of experts, the programme promoted the implementation of topical procurements and enabled new solutions. Building on the lessons of the development programme, a playbook was compiled for those working in public procurement to help refine strategy, tactics and practical work to achieve low-carbon targets.

6.4 Circular economy

The circular economy provides solutions and operating models that can reduce greenhouse gas emissions and mitigate other environmental impacts of consumption and production. The circular economy is generally understood as an operating model that minimises the amount of natural resources taken into the economy by changing production patterns to circular ones, increasing resource efficiency, and adopting new business models and consumption patterns. Such circular economy operating models can reduce emissions from both consumption and production.

Emissions from consumption can be reduced most effectively by reducing material consumption in general and by extending the useful life of goods by repairing, maintaining and reusing; by buying and selling second-hand goods. Emissions from consumption can also be reduced by reducing the need to produce new goods by increasing the number of times goods are used, for example by switching from buying products to using services and to the renting and sharing of goods. Many of these circular economy measures are already in place, but significant emission reductions can be achieved only when these operating models become mainstream. This development can be accelerated by promoting digitalisation.

Product design plays a key role in reducing production-based emissions, as good design can reduce as much as 80% of a product's life-cycle emissions. In a circular economy operating model, products are designed such that they are resource-efficient and durable and can be repaired, reused, remanufactured and safely recycled. Remanufacturing uses parts of old products in the manufacture of new products, which saves materials and especially energy. At the end of a product's life cycle, its materials are recycled within the economy as long as possible, retaining or even adding to its value. The utilisation of various side streams of production and more efficient recovery of valuable materials is also important for reducing emissions. The most significant emission reductions are achieved in production by reducing the use of primary raw materials and developing energy-efficient production processes.

Promoting a circular economy at EU level in 2021

In 2021, the European Commission continued the implementation of the new EU Circular Economy Action Plan – For a cleaner and more competitive Europe, published the previous year. The action plan aims at a green transition towards sustainable and circular economy production and consumption in Europe. It contains 35 legislative and non-legislative initiatives, which the Commission continued to prepare during 2021. Some of the initiatives affecting product policy and originally planned for publication in 2021, such as the Sustainable Products Initiative, the extension of eco-design regulation, the reform of the Construction Products Regulation and the publication of the EU strategy for sustainable textiles, were postponed to 2022.

One key initiative to reduce waste and greenhouse gas emissions that went forward in 2021 was the Commission's proposal to amend Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment. The purpose of the Commission's proposal is to promote the introduction of a common charger suitable for all devices, for example to reduce the production of electrical and electronic equipment and the resulting waste and greenhouse gas emissions. According to the Commission's impact assessment, the total

amount of materials used in chargers is projected to decrease by 2,606 tonnes per year on the EU market as a result of the introduction of the common charger. The volume of electronic waste is projected to decrease by 980 tonnes per year.

Circular Economy Programme measures support climate objectives

The strategic programme to promote a circular economy was completed in January 2021, and the Finnish Government adopted a resolution based on it in April 2021. The programme set out a vision and objectives for the circular economy, defined the necessary measures and monitoring indicators and proposed the resources required to promote the circular economy.

The programme aims to reduce the consumption of non-renewable natural resources and enable the sustainable use of renewable natural resources such that the total consumption of primary raw materials in 2035 will not exceed 2015 levels. Natural resources used to manufacture export products are not included in this objective. At the same time, the aim is to double resource productivity and the circular material use rate. The implementation of the programme is coordinated by the Ministry of the Environment and the Ministry of Economic Affairs and Employment in cooperation with other ministries and stakeholders. The Circular Economy Cooperation Group accelerates the implementation of the objectives and measures of the programme and supports ministries in strategic guidelines and in the assessment of the Circular Economy Programme.

The implementation of the Circular Economy Programme has included the start of preparation of a low-carbon circular economy agreement. In cooperation with research institutes, the planning and preparation of national scenario work has been launched with the aim of creating research-based scenarios on the possibilities of the circular economy to promote the objective of carbon neutrality and green transition in cooperation with sectors and local governments. The aim is for the organisations involved in the scenario process to make their own customised commitments, in which they set targets and identify key measures to be implemented. One key measure is the circular economy expertise network of the Finnish Environment Institute and Motiva, which brings together those involved in the circular economy, and disseminates information and good operating models.

Funding for the circular economy has been targeted in the Sustainable Growth Programme for Finland, which is allocating EUR 110 million to investments promoting the re-use and recycling of certain materials. Similarly, the Carbon neutral Finland priority area of the EU regional structural policy programme Innovation and Skills in Finland 2021–2027 aims to promote the transition to a circular economy with EUR 100 million.

6.5 Bioeconomy

Finland's first Bioeconomy Strategy was published in 2014, and a new strategy updated under the leadership of the Ministry of Economic Affairs and Employment was completed in April 2021. The strategy aims to double the value added of bioeconomy in an ecologically, socially and economically sustainable manner and to make Finland climate neutral by 2035.

The Bioeconomy Strategy aims to move Finland towards a carbon-neutral society with high overall sustainability in a socially and regionally fair way. The Bioeconomy Strategy's approach of overall sustainability is based on cross-sectoral cooperation and the systemic transformation it enables. Closer cooperation is a prerequisite for building a common approach based on knowledge of the overall resources available on a sustainable basis and the sharing of access between sectors. In the best-case scenario, this will lead to integrated use and recycling of raw materials through the identification of new opportunities, allowing sectors to use resources in parallel and on a continuous basis and to make efficient use of them. It also helps to create new opportunities for innovation. Sustainability is assessed based on scientific data. Demonstrating the sustainability of the Finnish bioeconomy is one of the key issues for the future success of the bioeconomy.

The measures of the Bioeconomy Strategy are divided into four sub-areas: (1) higher added value from bioeconomy, (2) a strong competence and technology base, (3) a competitive operating environment, and (4) the usability and sustainability of bioresources and other ecosystem services. The strategy also includes sector-specific measures.

In order to increase the added value of bioeconomy, a research and development programme for the green transition of bioeconomy will be drawn up and implemented, and the establishment of new, innovative pilot and demonstration facilities for bio-based products and the first of industrial-scale installations in Finland will be promoted. Regions will also be encouraged to draw up bioeconomy action plans. The measures are financed by the Sustainable Growth Programme for Finland, among other sources.

7 Climate change adaptation

Climate change has various impacts

Climate change has already raised the average temperature in Finland, and the warming is expected to continue in the future. During the thirty-year period from 1991 to 2020, the average temperature in Finland was approximately 2.9°C, which is approximately 0.6°C warmer than during the 1981–2010 period. The average temperature has already increased by around 1.3°C compared to the 1961–1990 period and, compared to the middle of the 19th century, the average temperature in Finland has risen by more than 2°C. The biggest change has been in December, the smallest in June and October. The shortening of winters has also led to a decrease in snow cover in the south. Permanent snow cover, that is the longest period of continuous snow cover in winter, has shortened in the southern and central parts of the country by 1–2 weeks compared to the previous corresponding period. Compared with the 1961–1990 period, the change is even greater: the length of permanent snow cover on the southern and western coasts has decreased by more than a month. With regard to temperature, the climate change scenarios were updated on the basis of international climate models published in 2021, and the results are similar to the previous ones. The main difference is that summers are expected to warm up more in Finland than previously estimated. The average annual temperature in Finland is expected to rise by 2–6°C by the end of the century. Warming will continue to be stronger in winter than in summer.

A slight increase in annual precipitation has also been observed in the long term. The increase has been strongest in the winter months from December to February and has been concentrated in the north of the country. In August, precipitation has decreased on average. However, the variation in annual precipitation in Finland is considerable compared to, for example, temperature variations, and the changes are not as noticeable as those in temperature. According to meteorological observations, the average wind speed has been slightly decreasing in recent decades.

As the climate changes, overall precipitation is forecast to increase, although in Southern Finland the change may be very small in summer. Changes in the average wind speed are expected to be small. There is a great deal of uncertainty surrounding the assessment of future changes in storminess. The total number and intensity of severe low-pressure storms in the North Atlantic is expected to decline. On the other hand, climate simulations show that strong thunderstorms will increase by 5–40% by the end of the century in northern Europe. This increases the risk of strong gusts associated with summer

thunderstorms. The reduction of ground frost increases the risks to forests even if the changes in wind conditions remain minor.

In addition to changing temperatures and weather conditions, the effects of climate change affect, for example, the Baltic Sea, biodiversity, natural resource sectors, the built environment, critical infrastructure, human health, industry and national defence. The consequences will be seen throughout the country, but regional impacts depend on the characteristics of the regions, such as location and the structure of the economy and population. The economic impacts of climate change are described in more detail in Section 8.1. The cross-border impacts of climate change can also take the form of increased population movements. Despite the fact that only a small proportion of population movements extend all the way to Finland, uncontrolled population movements cause social changes. They can lead to wide-ranging economic and political problems, which may also require an active contribution from Finland to resolve and which require the integration of climate change policy with foreign and security policy.

Progress in adaptation at national level

Finland's National Climate Change Adaptation Plan 2022 was adopted as a government resolution in 2014. Its overall objective was to achieve better adaptability in Finnish society by 2022. This was specified by three sub-objectives: (1) integration of adaptation into the planning and activities of sectors and operators; (2) development of the necessary methods for assessing and managing climate risks; and (3) development of innovative new solutions through research and development, communication, education and training as well as better public awareness of adaptation to climate change. The VN TEAS KOKOSOPU project produced an overall assessment of the state of implementation of Finland's adaptation policy in 2021–2022.

Since 2019, several legislative reform projects have been launched and plans have been drawn up to formulate adaptation targets for various sectors. The majority of the objectives are of a general nature. They state the need to adapt or prepare for climate change but do not set quantitative targets, such as limiting the amount of flood damage or the extent of forest fires or reducing the morbidity caused by heat waves.

The aim of the new Climate Act is to bring adaptation more strongly alongside mitigation as part of the climate change policy planning system and to clarify substantive requirements. In addition, adaptation is one of the objectives of the new Nature Conservation Act (HE 76/2022).

The current Rescue Act reform project aims to reform the act to better correspond to its operating environment, where climate change has been identified as a key megatrend.

The effects of climate change on overall security have also been taken into account in the Government resolution on the objectives of security of supply (1048/2018), which supplements the Act on the Measures Necessary to Secure Security of Supply (1390/1992).

The water sector is undergoing a national reform of the water supply system, which pays attention to ensuring the smooth operation of water services and better management of risks. In addition, the programme to enhance water protection (2019–2023) has set several cross-sectoral objectives that serve adaptation to and preparation for climate change. In contrast, the Programme of Measures of Finland's Marine Strategy (2022–2027) does not include objectives related to climate change, although it is taken into account as a 'precondition' for achieving other necessary developments.

The need for adaptation has not yet been identified in legislation in all areas that may be affected by climate change. For example, the aim of the ongoing work on the reform of the Mining Act is to improve the level of environmental protection, but the adaptation to climate change has not been taken into account in the reform process of the act so far.

According to a joint Nordic report published in spring 2022, the Nordic countries have recognised and taken into account cross-border climate risks quite well in international comparison. In Finland, awareness of cross-border climate risks is in some respects ahead of other Nordic countries, but little concrete action has been taken to manage the risks.

In international activities, Finland's new Action Plan for Climate Smart Foreign Policy aims to extend climate change as a cross-cutting theme to the entire work of the Ministry for Foreign Affairs in line with the Agenda 2030 goals of sustainable development (Ministry for Foreign Affairs 2019). This means promoting climate change mitigation and adaptation as part of security and trade policy, in addition to development policy. The level and predictability of international adaptation funding has become a major theme globally. This is particularly important to the least developed countries. Finland has joined the Champions Group on Adaptation Finance, which aims to improve the quality, quantity and availability of adaptation funding, particularly for the least developed countries and small developing island states, both through its own funding and through global climate finance.

Differences in adaptation progress between regions

At the regional level, the Centres for Economic Development, Transport and the Environment play a key role in adapting to climate change, producing and managing relevant information, and translating national plans into practical action. The centres' Climate Roadmap project, which identified the adaptation interfaces of the centres' statutory tasks, has been continued by developing the adaptation skills of the centres'

personnel. Adaptation training, both open and focused on specific sectors, has been organised for experts. In total, about 100 participants from all areas of responsibility — industrial and commercial activity, transport and the environment — have been trained. The publication of all the results of the project has continued in the electronic Ikkuna tool, which is used in developing the impact of the climate work of the Centres for Economic Development, Transport and the Environment.

Based on an analysis focused on the adaptation work and strategic plans of the regional councils, the adaptation work and the plans for it are at fairly different stages in different regions. In some regions, adaptation or preparedness has already been mentioned in a climate strategy or programme completed at the beginning of the 2010s or in the regional development plan. As a rule, however, the work is on a general level without concrete measures; the needs for adaptation are still unstructured and there is a lack of proper plans or systematic objectives. Only a few regions have considered how climate change is affecting the development of the region and how it should be adapted to or its opportunities exploited. Lapland has already done this, however, and Kymenlaakso approved its first regional adaptation plan in June 2022. So far, the main emphasis in the climate work of regions has been on mitigation. Regional adaptation needs and set or planned targets are examined by region in the report 'Adapting to climate change in Finland – regional dimensions and policy instruments' of the Finnish Climate Change Panel published in 2021.

However, the situation is improving rapidly and adaptation targets have begun to be formulated according to regional specificities, for example as part of fresh climate roadmaps. Newer climate strategies in Kainuu, for example, laudably consider the impact of the success of mitigation and adaptation on the region's development and its visions. Themes of adaptation are also addressed in regional plans 2022–2025. According to the Act on Regional Development and the Implementation of the European Union's Regional and Structural Policy (756/2021), climate change mitigation and adaptation are part of regional development and the tasks of regional councils.

Sectoral legislation enables the setting of regional climate targets, for example in the Land Use and Building Act (which is to be separated into acts for construction and town planning), but so far few concrete targets have been set.

The next National Adaptation Plan will be completed in 2022

Adaptation to climate change has been systematically promoted in Finland for over 15 years. Finland was the first EU country to publish a national climate change adaptation strategy in 2005. In keeping with the Climate Act, the national adaptation plan is being updated under the leadership of the Ministry of Agriculture and Forestry. A preparatory

group of representatives from nine ministries was appointed to prepare the plan and started work in autumn 2021. In addition to the Ministry of Agriculture and Forestry, the preparatory group includes representatives from the Ministry of the Interior, the Ministry of the Environment, the Ministry of Economic Affairs and Employment, the Ministry of Transport and Communications, the Ministry of Social Affairs and Health, the Ministry of Defence, the Ministry for Foreign Affairs and the Ministry of Finance.

The plan will guide adaptation until 2030, defining the vision and objectives for adaptation to be pursued between 2023 and 2030. Targets to be implemented by the measures set out in the plan are defined under the objectives. The plan also includes a risk and vulnerability assessment. Adaptation needs are examined both by administrative branch and across branches, as well as from a regional perspective. The aim is also to develop a monitoring system to assess the progress and effectiveness of the measures.

The new national adaptation plan will be prepared on the basis of the experience gained from the implementation of the current plan, taking into account the obligations set by both the national Climate Act and the EU. The national adaptation plan is part of the climate policy planning system in accordance with the Finnish Climate Act, and the European Climate Law requires Member States to have comprehensive national adaptation plans. The plan will be presented to Parliament as a government report.

Adaptation work has been examined in several research projects

The Finnish Climate Change Panel's project 'Adapting to climate change in Finland – regional dimensions and policy instruments' examined the situation of regions' adaptation work and strategies in spring 2021. The project produces synthesis data for the preparation of the National Climate Change Adaptation Plan and the Climate Act. The focus of the work was especially on regional risk assessments in the current and future climate, adaptation instruments and the costs and benefits of adaptation.

The VN TEAS KUITTI project produced a national overall cost estimate of the economic risks associated with the effects of climate change. The estimate is based on the effects of climate change on agriculture, forestry, river and coastal floods, as well as disruptions in electricity supply, all of which also have an impact on the economy. For more detail on the economic impacts of climate change, see Section 8.1.

The VN TEAS KOKOSOPU project produced an assessment of the successes and challenges of Finland's adaptation policy and the current adaptation plan. KOKOSOPU builds its analysis by combining high-quality research and policy assessments from different fields and creates a synthesis that helps Finland to maintain its position at the leading edge of adaptation policy development.

The Academy of Finland's programme Climate Change and Health (CLIHE) 2020–2023 produces new information on the health risks caused by climate change and the social consequences of the health impacts, while the CLIMINI project examines the adaptation issues of Finland's Arctic location and reindeer husbandry, which is important for indigenous peoples.

Cross-border impacts were studied in the project Nordic Perspectives on Transboundary Climate Risk – Current Knowledge and Pathways for Action funded by the Nordic Council of Ministers. The project assessed cross-border impacts through seven impact categories: trade, finance (e.g. foreign investment, remittances), people (travel and migration), psychological (e.g. inaction if risks are considered to affect only other countries), geopolitical, biophysical (through shared ecosystems and other natural resources) and infrastructure.

EU-funded research and innovation project activities are also under way to support adaptation. The EU's Mission on Adaptation to Climate Change, launched by the Commission in September 2021, plans to allocate EUR 100 million to large-scale demonstration projects to demonstrate how climate change phenomena, such as floods, can be prepared for in local conditions. It is still necessary to promote the opportunities of Finnish operators to participate in international research and development in order to make use of the information, services and business models produced by these in national efforts to prepare for and adapt to a changing climate.

8 Climate policy and the economy

8.1 Economic impact of climate policy

Climate change has a negative impact on the ability of the global economy to produce economic wellbeing. For example, an increase in extreme weather phenomena linked to climate change may cause increasing losses to the economy, disrupt production and affect the health of the population.

The costs of climate change to the global economy have been estimated based on a combined climate and economic model. According to the projections, an increase in the global average temperature of 2–4°C would mean a loss of 0.5–40% of the world's gross domestic product (GDP) by 2100, depending on the more detailed temperature scenario, the model used and the underlying assumptions, compared with a situation where the global average temperature would not rise from its current level. The projections involve significant uncertainties and data gaps. The main costs and uncertainties are related to the risk of catastrophic climate developments (such as climate tipping points).

Despite significant uncertainties and modelling constraints, there is a broad consensus among modellers that the increase in the economic costs of climate change is non-linear in relation to the increase in temperature. In other words, the higher the average global temperature rises, the faster the economic costs increase. This non-linearity, coupled with a lack of knowledge about catastrophic climate risks, provides a clear economic motive to take forward-looking and decisive climate action.

Finland is vulnerable to the indirect effects of climate change

The effects of climate change will affect different regions, sectors of the economy and income groups in different ways. As a country with a cool climate and a developed society, Finland is unlikely to be one of the countries most vulnerable to the direct impacts of climate change. Some direct impacts on the economy may even be positive for Finland in the coming decades.

However, as a small open economy, Finland is vulnerable to indirect consequences of climate change coming through the global economy. They may be significantly greater than the direct impacts of climate change on Finland. The Finnish economy may be indirectly affected by, for example, damage to international value chains, higher production prices in trading partner countries due to production losses, or changes

in migration between countries. The effects through the global economy are also a key reason why Finland should participate in climate action and promote raising the international level of climate action.

A project commissioned by the Government to examine the total costs of inaction related to climate change estimated that the impact of climate change on Finland's GDP would be relatively small. The impact was estimated to range from 0% to –0.3% of GDP between 2040 and 2070, compared to a scenario without increasing climate change adaptation measures from current levels. Adaptation measures would, however, lead to cumulative savings of EUR 8 billion by 2070. The project was not able to take into account all potentially significant channels of direct impacts of climate change.

Achieving of the targets requires a structural reform of the economy

Achieving ambitious climate targets requires a comprehensive and rapid reform of the structures of the Finnish economy into a low-emission economy. The pace of reform must also be accelerated in order to achieve the tightening climate targets.

In the long term, accelerating the reform of economic structures will bring both costs and benefits to the economy. The size of their net impact on the economy depends crucially on policy choices to accelerate the transition and on future technological developments. The uncertainties surrounding these factors make it very difficult to assess the long-term net impact of the transition on the economy.

However, it is generally estimated that the net costs of inaction will exceed the net costs of climate policy. Several modelled scenarios also suggest that it would be possible to achieve the green transition in a way that does not have a significant negative impact on the standard of living in the long term. For example, European and Finnish modelling efforts suggest that the macroeconomic impact of the green transition would be slightly negative, or even slightly positive in the best-case scenario, by 2030, 2035 and 2050 compared with a situation where no further climate action would be taken.

A common feature of these scenarios, which provide a favourable long-term macroeconomic outlook, is the belief that the challenge of climate change can be essentially addressed by technological developments. The idea is that tightening climate targets, new investments and government emissions control will trigger timely action, innovations and investments which, in the long run, will renew the economy and improve its productivity. There will be a wave of investment and regeneration, which will bring not only the (necessary) protection of the climate but also economic and other benefits in the long term.

However, the potential economic costs of the green transition may be significant if the economic challenges of the transition are not systematically addressed. This is due to the fact that the scale and speed of the necessary structural adjustment will challenge the adaptability of businesses and households in the short term. The productive capital in the economy causing emissions urgently needs to be replaced by low-emission capital, the costs of which in the private sector may be reflected, for example, in investment costs linked to capital stock reform, depreciation of assets, plant closures and the need to train workers for new tasks. For example, in the case of public finances, the effects may take the form of indebtedness when the public sector invests in research and infrastructure and finances income transfers that mitigate the negative impacts on vulnerable households due to the acceleration of the green transition.

In addition to the costs, the green transition also brings new growth opportunities for the benefit of the technological frontrunners. Investments in low-carbon business and new low-carbon products and solutions will create new markets. New products and solutions can also catalyse innovation in the wider economy, improving business performance and boosting productivity growth. New low-emission products and solutions developed in Finland can also replace higher-emission products on the international market. Through this so-called carbon handprint effect, Finland can have more influence on global emissions than its size would suggest and at the same time promote (sustainable) economic growth.

However, the net cumulative impact of climate policy on the economy during the transition is very likely to remain negative; climate policy does not finance itself. This is due to the fact that during the transition, the economy will have to run down production methods with high emissions that would have been profitable for a long time to come if not for tightened emission controls.

Striving for cost-efficient climate policy

The costs and benefits of the green transition are essentially the result of policy measures to manage the transition of the economy to a low-emission economy and the way the economy responds to these measures. By choosing policies that guide households and businesses to take cost-effective climate action, political decision-makers are best placed to ensure that the cost of the emissions reduction path towards climate targets is kept to a minimum.

For climate policy to be cost-effective, policy measures must be selected and implemented in the order of cost-effectiveness, i.e. in an order where actions with the highest possible emission reduction impact (= effectiveness) at the lowest possible cost (= efficiency) are selected first. In other words, a cost-effective climate policy is not about

choosing the cheapest measures for public finances or the national economy, but about choosing the measures that will bring about changes in the economy that enable the political goals to be achieved in the most resource-efficient way.

Comprehensive and consistent application of the principle of cost-effectiveness in the design of practical climate policies is often challenging due to an inadequate knowledge base. However, research data on the costs and emission reduction potential of many climate actions have been accumulated and are constantly being produced. The available data also show that the differences between the most expensive and the cheapest measures per tonne of emissions reduced can be tenfold or even a hundredfold.

The key challenge for policy makers is to find policies that will guide households and businesses to make decisions that reduce emissions cost-effectively. Climate policy should primarily use technology-neutral instruments that set a price on emissions. Emissions trading and taxes are among the instruments that put a price on emissions. They also have the advantage of generating revenues for other policy instruments, such as climate finance or other public sector needs.

In addition to emissions taxes or emissions trading, subsidies for the development and introduction of low-emission technologies can be introduced. By carefully targeting projects with wider societal benefits, they can reduce climate policy costs by accelerating the development of low-emission technologies. In principle, bans and regulation of emissions are expensive means of reducing emissions, but they may be needed in situations where the damage from emissions is significant and more effective instruments are not available.

Although cost-effectiveness is not a policy objective in itself but a guiding principle, the implementation of a cost-effective climate policy can be considered as characterised by justice from an intergenerational perspective. This is due to the fact that, following a cost-effective green transition, the economy as a whole will be passed on to future generations in a better state than in ineffective implementation scenarios.

However, the costs and benefits of cost-effective emission reductions may be unevenly distributed between households and businesses, and this distribution of impacts in society may not correspond to the values of society. Alongside climate policy, there is a need for income distribution policies that contribute to a fair distribution of economic impacts in society.

Climate policy requires substantial investment

The effects of climate policy on the national economy are largely due to the additional costs of the measures required to reduce emissions, which increase with the emission reduction target. These impacts arise primarily from increased investment in energy technology, but also from increased investment in energy efficiency and production processes, as well as from the electrification of transport, among other things.

Investment in modernising the productive fabric of the economy, such as the electrification of various activities, can lead to significant efficiency gains. Electrification is a key driver in the development of emissions: emission reductions in different sectors can be achieved by switching from fossil energy sources to zero-emission electricity. In the medium to long term, it is estimated that hydrogen, in particular, will be the way forward for the most difficult sectors to carbon-neutralise.

Electricity production is well on the way to becoming almost zero-emission as a result of the investments underway. New technologies are also replacing fossil fuels in production, which increases the energy and material efficiency of production. This structural change is reflected in the development of the national economy.

Estimates of the investment needs in the foreseeable future are different and vary considerably depending on the assumptions used. In any case, it seems likely that the total investment requirement for the period 2020–2050 would be at least EUR 100 billion. On an annual basis, this would mean an average investment requirement of just over EUR 3 billion. However, the most comprehensive estimates use a significantly higher level of investment. Almost zero emissions for energy production alone would require investments of at least EUR 20 billion in the period 2020–2050. In addition, the transition to a hydrogen economy will require substantial investment. A significant need for investment also applies to the building stock, which has been the subject of a long-term renovation construction strategy.

8.2 Carbon handprint

A company's carbon handprint indicates the extent to which the company's products and services help other operators to reduce their carbon footprint with alternative low-carbon solutions or by making the client's process more low-carbon. Instead of the company's own emission reductions, the handprint only includes emissions avoided as a result of using the company's products and services. The handprint can also be examined at the industry level. In this case, emissions avoided by means of the products and services of

companies in the entire sector are added together. The larger the handprint, the greater the impact achieved to mitigate global warming.

VTT Technical Research Centre of Finland and LUT University updated their carbon handprint calculation guide in 2021. In addition to the company's carbon handprint, the new calculation guide also covers the environmental handprint. The previous calculation guide was specifically targeted at calculating the carbon handprint of products and services, but the new guide can also be applied to a project or an organisation. The new calculation guide is still based on a life-cycle assessment, but it now also includes the environmental impact assessment of solutions.

Although the handprint can be calculated using life-cycle assessment, a particular challenge in the methodology is assessing the products or processes to be replaced in each specific case and the corresponding carbon footprint data. Due to the choices and knowledge gaps involved, corporate or sectoral handprints may differ considerably in different assessments; neither are the handprints reported by different sectors always comparable. Despite methodological difficulties, it is fair to say that, as a general rule, companies operating at the vanguard of low-carbon technological development have a higher handprint potential and probably also a significant export potential in a world pursuing a low-carbon future.

In connection with the sector-specific low-carbon roadmaps, the forest industry, chemical industry and technology industry have assessed their carbon handprint impacts. The energy-intensive industries prepared low-carbon roadmaps during 2019–2020 with the aim of achieving significant emission reductions by 2035. The industries' estimates of their own carbon handprints are high compared to Finland's current greenhouse gas emissions.

In the case of low-carbon roadmaps, the single-minded work continues, and several industries have implemented roadmaps at the enterprise level. Some have already updated their roadmap or carried out further studies in connection with it, where applicable. Some are planning an update or a broader perspective, extending the scope of the review to include broader biodiversity and natural resource issues. In particular, the rise in energy prices has made it more profitable to implement measures highlighted in the roadmaps.

9 Social impacts of climate policy

9.1 Justice of climate action

Achieving the emission reduction targets requires extensive and rapid societal changes that will affect the daily lives of individuals and communities as well as businesses. It has been considered important that the transition to a carbon-neutral society be just. Disregarding justice considerations could lead to confrontation if some people experienced more of the negative impacts of climate action than others or if their income levels fell due to climate action. Experience of justice affects the acceptance of climate action and, ultimately, the success of climate change mitigation and adaptation.

One of the objectives of the national Climate Act and its climate policy planning system is to ensure the justice of climate action. The objective seeks to ensure that the climate policy process is fair and transparent and that the transition to a low-carbon society does not impose a disproportionate burden on, for example, a population group or an industry. The new EU Climate Law also emphasises that the transition to a more sustainable society must be just. However, there is no well-established definition of justice in legislation or international agreements.

The Finnish Climate Change Panel has approached the justice of climate policy through a three-pronged approach. This includes (1) justice in distribution, that is the distribution of the benefits and disadvantages of sustainable transition in society, (2) recognising fairness, that is the consideration of different world views, lifestyles and positions of power, and (3) the fairness of procedures, that is the ability of people to participate in decision-making, to influence plans and their implementation. The cross-cutting themes of the three-pronged approach are global justice and equality of human rights.

The Justice in Climate Change Policy project of the Finnish Climate Change Panel specifies the dimensions of a just transition and develops a review framework to support the development, implementation and evaluation of Finland's climate policy. The impact of climate policy is also examined from the perspective of the implementation of citizens' fundamental rights. The project focuses on energy, transport, food and regional issues, in particular. Issues of justice in relation to the status of the Sámi as an indigenous people will be addressed separately. The project will be completed by the end of 2022.

9.2 Legitimacy of climate action

Legitimacy can be roughly defined as acceptance or a lack of rejection or opposition. Legitimacy has also been defined in studies, for example through general, local and market-based legitimacy. For some policy measures such as taxation, passive public acceptance is sufficient, while others require more active acceptance in the form of stronger support and more direct action. One measure that requires active acceptance is the abandonment of private cars.

Legitimacy is influenced by project and process-specific factors, factors related to the individual and societal factors. Project-specific acceptance involves, for example, people's attitudes to a particular technology or project. Process-specific factors include communicating about the project and involving people. Individual factors affecting acceptance are related to individual characteristics, such as socio-demographic background, worldview and place attachment. Societal factors include the prevailing technical and economic structures, the political context and confidence in institutions.

Inclusion is considered in the new Climate Act and climate policy plans. During the planning phase of the Medium-Term Climate Change Policy Plan in 2021, different groups of people were involved, for example, through an online citizens' survey, a citizens' panel and consultations with young people, Sámi and special groups. The Climate Act strives to increase opportunities for influencing climate policy, for example through the consultation procedures of the planning system and the Sámi Climate Council. In addition to opportunities for participation, the formation of legitimacy is influenced by how the opinions in the consultation procedures and the Climate Council are communicated to the public and how divergent positions are reacted to in climate policy plans or otherwise.

Consultations for the Medium-term Climate Change Policy Plan showed that climate action is generally welcomed. In a citizens' survey, clearer food labelling and the promotion of pedestrian and bicycle traffic were considered as the most acceptable climate policy measures. By contrast, significant increases in the price of fuels, electricity, heat and heating oil were the least supported measures. Tax reforms related to climate action were considered the most challenging in terms of fairness and legitimacy. On the other hand, various subsidies, incentives and information sharing were seen as very meaningful and effective means. Significant tax reforms, bans and restrictions increase concerns about the correct targeting of the measures and their justice and legitimacy for different groups of people, as different regions and their inhabitants may have very different resources to adapt to regulation without adequate support.

The 2035 Legitimacy project examines the legitimacy and societal impacts of the carbon neutrality target. The aim of the project is to improve the legitimacy of climate action

from the point of view of ordinary citizens. The justice and legitimacy of climate policy are addressed in general terms and its impact on employment and income distribution from the perspective of individuals, households and businesses. The project also examines the legal possibilities and obstacles for ordinary citizens to participate in climate policy. A report on the project will be completed during 2023.

9.3 Equality

Equality means that all people are equal. Equality is regulated, for example, in the Constitution and the Non-discrimination Act. According to section 6(1) of the Constitution of Finland, everyone is equal before the law. Section 6(2) stipulates that no one shall, without an acceptable reason, be treated differently from other persons on the ground of sex, age, origin, language, religion, conviction, opinion, health, disability or other reason that concerns his or her person. According to section 6(3) of the Constitution, children shall be treated equally and as individuals and they shall be allowed to influence matters pertaining to themselves to a degree corresponding to their level of development. Finland is committed to non-discrimination and equality as part of international human rights obligations. The implementation of equality in climate policy can be promoted, for example, by avoiding actions that would increase inequality between different population groups.

Climate action targets different generations and genders in different ways

Climate change will particularly affect the lives of children, young people and future generations. Ambitious climate action promotes intergenerational justice. Young people are also particularly affected by the mental health effects of climate change. According to the 2018 Youth Barometer, 67% of young people felt very or fairly unsafe or uncertain because of climate change. Some climate action requires the introduction of new technologies and digital platforms. This requires the flexibility to learn new ways of working. Learning new ways of working can be challenging for older age groups, which puts them in an unequal position.

The equality impact of climate action has been assessed in the preparation of the Medium-term Climate Change Policy Plan and in a gender impact assessment carried out for the Climate and Energy Strategy. The gender impact assessment found that climate action targets women and men in different ways. Policy measures aimed at reducing emissions target male-dominated sectors in particular, include technical solutions that are of interest to men and affect men's consumption habits. However, the overall impact on employment in male-dominated sectors is positive even if some jobs related to fossil fuels will disappear. Impacts focused particularly on women included the negative impact

on service sector employment. Attitudes towards climate action differ between the sexes; women are more prepared than men to make and support climate-friendly decisions. According to Sitra, women also suffer more than men from climate anxiety.

Effects on the Sámi under review

Many aspects of Sámi culture and livelihoods are directly linked to climate and nature. The effects of climate change are evident in the Arctic faster and more strongly than in the rest of the country. According to the project SAAMI – Adaptation of Saami people to the climate change, the Sámi Homeland has warmed by 2–3°C from the pre-industrial period, and observations related to climate change in the Sámi Homeland have been accelerating since 1990. The change in the living environment caused by climate change may complicate the practice of Sámi culture, traditional trades and use of language, which may have a negative impact on the wellbeing of Sámi people.

The new Climate Act requires that the rights of the Sámi be taken into account in climate policy. According to section 2(3) of the Climate Act, the act and the planning system aim to ensure that the Sámi people are able to maintain and develop their own language and culture. Section 21 of the act provides for a Sámi Climate Council, which is appointed for a fixed term by the Government. The purpose of the Sámi Climate Council is to provide a knowledge base for the promotion of the rights of the Sámi people. In addition, pursuant to section 14(1), the authorities must consult the Sámi Parliament when preparing their plans.

9.4 Income distribution

It is recognised that climate policy may have potential effects on income distribution, which are reflected in the legitimacy of policy measures and, in broader terms, in social sustainability. If, for example, taxes linked to climate policy had a greater impact on people on low incomes or fuel taxes on people living in the countryside, these policies could lead to inequality. Efforts should be made to identify and prevent negative income distribution effects already during the planning phase of climate action. Economic measures should also be communicated well in advance so that people can react and adapt to them.

Climate policy affects income distribution through income generation (wages and salaries, capital income, direct payments, long-term growth potential) and consumption (emission tax, energy content of different products). Households are also affected by factors such as their position in income brackets, consumption patterns (e.g. proportion of transport in consumption), socio-economic status (e.g. occupation), stage in life and place of residence.

Different policy measures target households and businesses in different ways: taxes on transport and heating fuels focus in particular on household consumption and the services they use, while the effects of removing the electricity tax and the energy tax cutting measures focus on business and energy production, but also indirectly on households. Compensation means are also allocated differently between income categories depending on their formulation and targeting. Possible effects on income distribution can be balanced, for example, by shifting the focus of taxation and offsetting adverse effects in other taxation. Examples of such compensation include offsetting an increase in a consumption tax by lowering income taxes with focus on low-income and middle-income households.

In connection with the preparation of the roadmap for fossil-free transport, it was noted that low-income households consume significantly less fuel than high-income households. However, the percentage of disposable income spent on fuel purchases by the households with the lowest income is significantly higher than in middle-income and high-income households. For example, an increase in fuel taxation would be targeted the most at high-income households, but the greatest impact in relation to income might hit the lowest income bracket. Nevertheless, impact assessment has shown that, since emissions from low-income households are lower than those from middle-income and high-income households everywhere in Finland, the disadvantages caused by higher fuel prices could be compensated to low-income households with a small proportion of the total revenue. The promotion of walking and cycling was found to be conducive to accessibility, especially for those without access to cars. Cheaper public transport fares were considered to prevent transport poverty.

The economic impact assessment carried out in the context of the HII SI project compares the WEM (with existing measures) scenario with the WAM-H scenario, which includes additional measures in addition to the existing climate and energy policy measures in energy production and industry, transport and heating of buildings. In the WAM scenario, the price-increasing effects of the measures are mainly visible for households in the consumption of residential and transport services, but also indirectly in the prices of other products and services, depending on how energy-intensive and emissions-intensive their production is.

Appendices

Appendix 1. Statistics and scenarios used

Inventory data

The emissions data presented for 2005–2021 in the Annual Climate Report are in accordance with Finland’s official greenhouse gas inventory and were calculated according to IPCC Guidelines. The greenhouse gas inventory has shifted to using the coefficients set out in the IPCC’s fifth assessment report (AR5). The coefficients used in this annual report are those set out in AR5, with the exception of the description of the monitoring of the 2020 targets, which used the coefficients set out in AR4. The descriptions of the methods used in reporting emissions data are included in the emissions data releases by Statistics Finland. The statistical methods are constantly being developed, and emissions data can also be changed retroactively based on new developments. These changes are usually very small.

The 2021 data are proxy estimates. A proxy estimate is calculated at a rougher level than the actual inventory calculation. The proxy estimate is therefore not final, and emissions data will be specified when all the data used in the calculation is completed. The figures used in monitoring the obligation imposed by the Effort Sharing Decision are fixed in conjunction with annual EU inspections and are not updated retroactively. The data presented for 2013–2020 in the figures and table in Section 3.3 of this report are based on emissions data fixed in conjunction with EU inspections. The emissions data in the most recent release and inventory submission by Statistics Finland for these years deviate from the data presented in this report.

Scenarios used

The estimates presented in the annual report on the meeting of the emission reduction targets are partly based on scenario calculations. The emission scenarios were prepared by compiling sector-specific estimates of emission trends in the next few years. A scenario is a calculated estimate of how emissions will develop if the assumptions that formed the basis for the calculation come true. Scenario calculation is subject to continuous updating and development, and the aim is to complement and specify the knowledge base for the scenarios. Scenario calculation typically utilises mathematical models that are used to create the necessary projected emission trends. The baseline scenario of the development of total emissions used in this Annual Climate Report includes the measures implemented

by the end of 2019. The scenario is based on calculations made in the Carbon Neutral Finland 2035 – measures and impacts of climate and energy policies (HIISI) project's further study at the beginning of 2022. In addition, the annual report uses sector-specific scenarios prepared in the preparation of the Medium-term Climate Change Policy Plan.

Land use sector

Emissions and sinks in the land use sector vary considerably from year to year. In addition, the knowledge base and impact of the measures in the land use sector involve greater uncertainties than in other sectors. The retrospective revisions to the land use sector are usually larger than in other sectors. The estimates for the most recent years will typically become more accurate when further data on details such as the increment of growing stock and surface areas in different land use categories become available from the National Forest Inventory according to its inventory cycles. In particular, the proxy estimate for the land use sector's net sink may differ considerably from the result subsequently calculated from revised baseline data. The 2021 inventory data are based on the latest forest inventory (VMI 13).

GWP factors

A new reporting period for greenhouse gas emissions and removals is starting. The greenhouse gas inventory data will now be used to monitor the implementation of the EU 2030 Climate and Energy Framework's emission reduction targets for the period 2021–2030. The greenhouse gas inventory data will be produced in accordance with the EU's new Regulation on the Governance of the Energy Union and Climate Change Action Model Regulation, and reporting will be carried out using the GWP (100) factors set out in IPCC AR5. GWP factors are used to align the global warming potential of different greenhouse gases into carbon dioxide equivalents (CO₂-eq).

The GWP factors of the fourth assessment report (AR4) are methane 25, nitrous oxide 298 and F-gases 12–22,800, depending on the gas, while the factors in the fifth assessment report (AR5) are methane 28, nitrous oxide 265 and F-gases 4–23,500. The change in the GWP factors will not have a major impact on the total inventory emissions (excluding the LULUCF sector), the difference being –20,000 tonnes CO₂-eq in 2021. The switch to AR5 coefficients increased emissions in the waste sector by 170,000 tonnes CO₂-eq and reduced emissions in the land use sector by 130,000 tonnes CO₂-eq and in the agricultural sector by 120,000 tonnes CO₂-eq. In other sectors, the changes were smaller.

Commitment under the Kyoto Protocol

Net removals above the corrected forest reference level (approximately 65 Mt CO₂-eq) of the Article 3.4 measure may be counted towards the fulfilment of the obligation up to the cap. The cap is 0.035 x total emissions in baseline year 1990 (excluding the LULUCF sector) x 8 (commitment period years). The cap was fixed during the audit of the first reporting of the commitment period. In order to meet its commitments under the Kyoto Protocol, Finland will have to use excess assigned amount units (AAUs) from the previous commitment period of the Kyoto Protocol or units acquired from the project mechanisms in the second period (CERs and ERUs). The final data on the emissions and removals contributing to the fulfilment of the commitment under the second commitment period of the Kyoto Protocol will be verified following a review by an international review team coordinated by the UNFCCC Secretariat. Subsequently, the Kyoto Protocol will receive a true-up period report, in which the Parties to the Kyoto Protocol report on the implementation of their commitments on the basis of emissions register data. Following the review of the true-up period, the fulfilment of the obligation is confirmed. This is expected happen in late 2023 or in 2024.

Appendix 2. Sector-specific indicators

Figure 23. Emissions from industrial processes 2005–2021. The 2021 data are proxy estimates. Source: Statistics Finland.

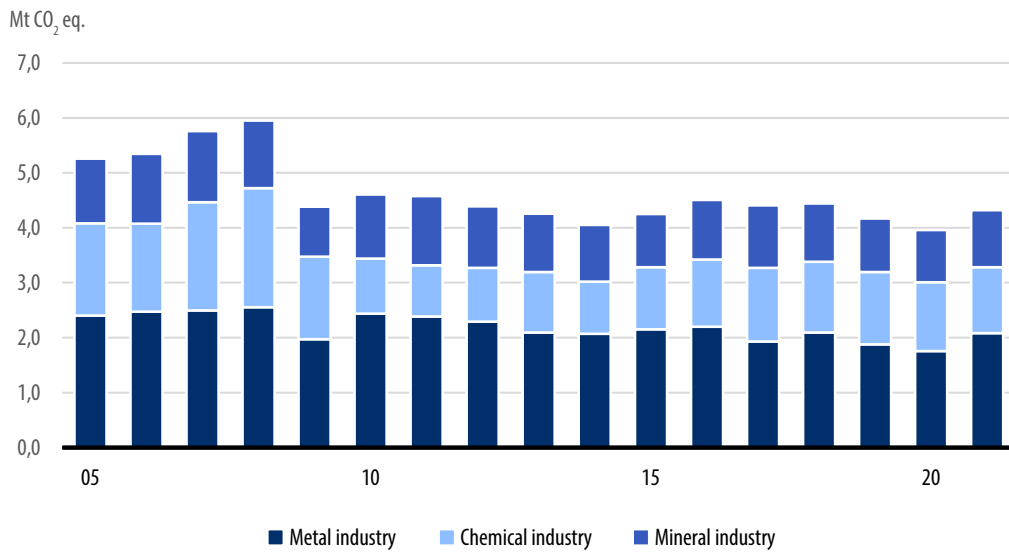


Figure 24. Total energy consumption by energy source 2005–2021. The 2021 data are proxy estimates. Source: Statistics Finland.

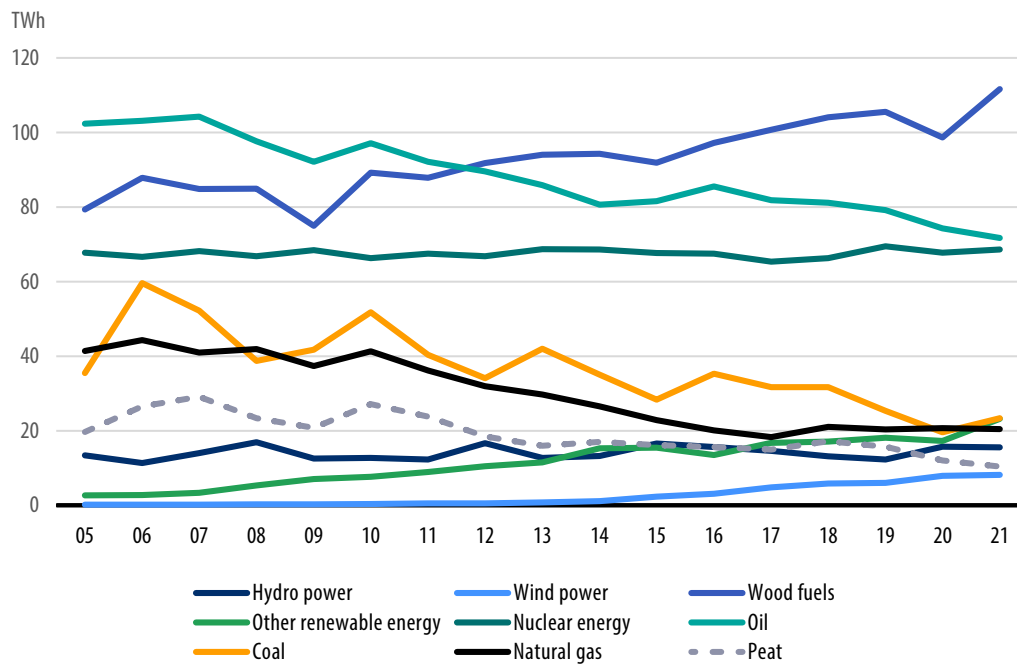


Figure 25. The price of an EU ETS emission allowance from April 2008 to August 2022. Source: Ember.



Figure 26. Energy consumption in road transport by energy source 2005–2020. Source: Statistics Finland.

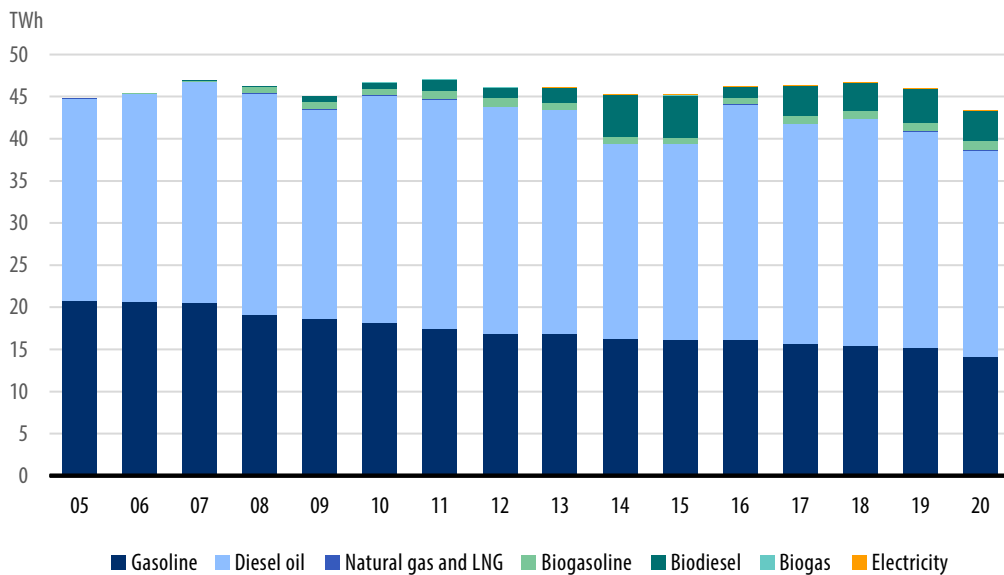


Figure 27. Road transport performance (million km) 2000–2021. The statistical method for calculating street transport performance changed in 2016. Source: Statistics Finland.

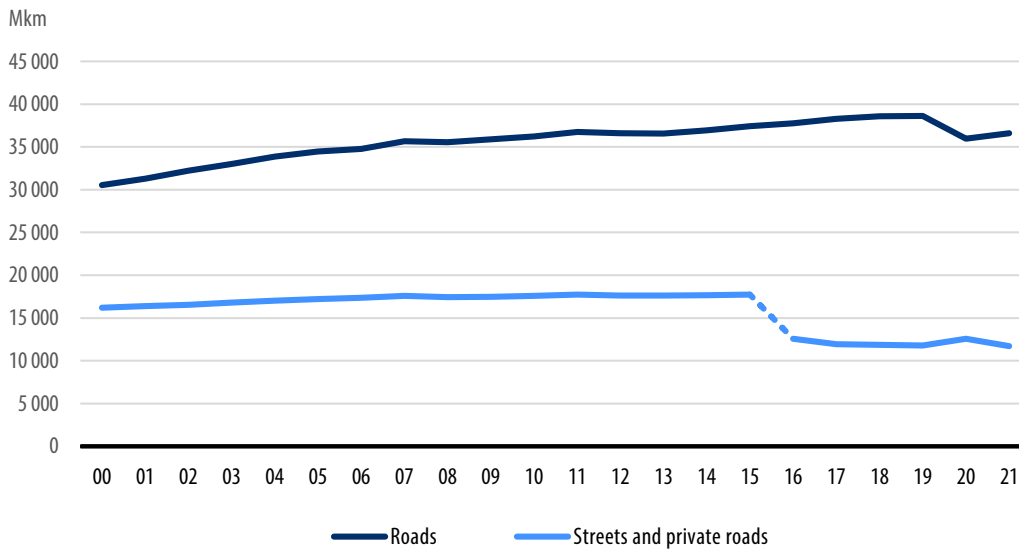


Figure 28. Share of biofuels in transport fuels (%). Double counting is taken into account in the targets for 2008–2020. The 2030 target, on the other hand, does not include double counting and does not take into account the raising of the target to 34% and the temporary decrease in the distribution obligation for 2022 and 2023.. The 2021 data are preliminary and only contain the physical share of biofuels. Source: Eurostat and Statistics Finland.

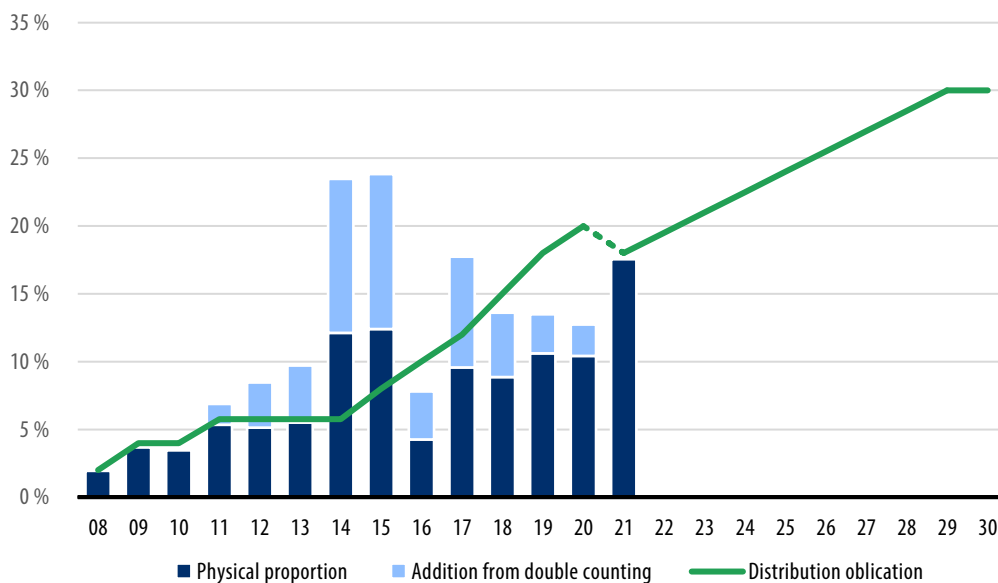


Figure 29. First registrations of passenger cars 2005–2021 and imported used passenger cars 2014–2021. Source: Traficom.

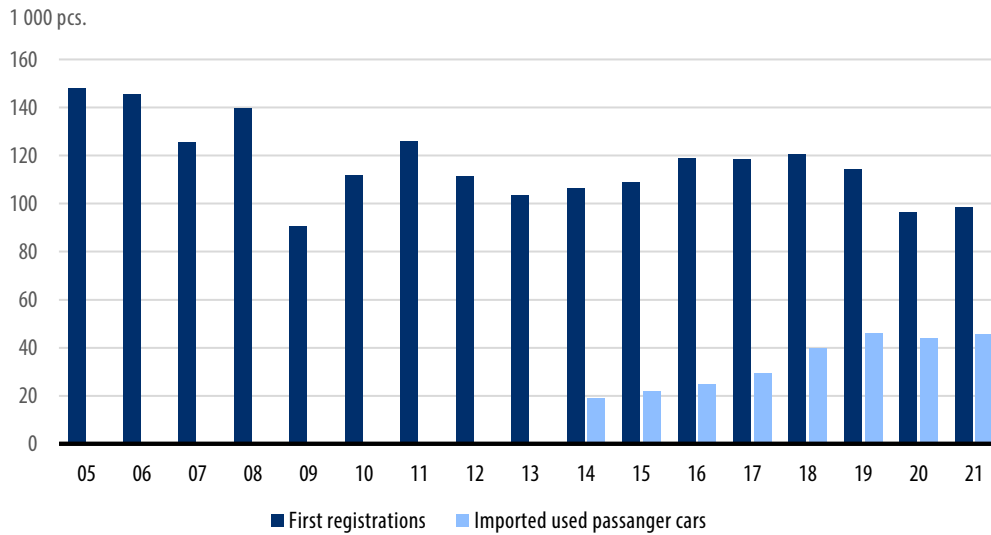


Figure 30. CO₂ emissions (g/km) from passenger cars registered for the first time. Source: Statistics Finland

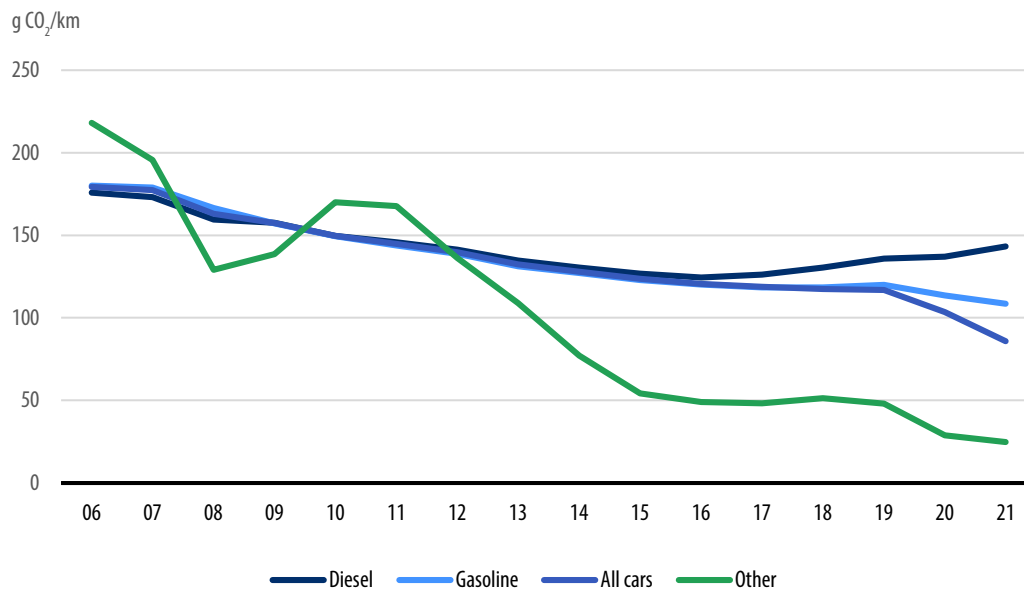


Figure 31. Number of electric cars, natural gas vehicles and ethanol-powered vehicles in Finland in 2010–2021. Source: Statistics Finland.

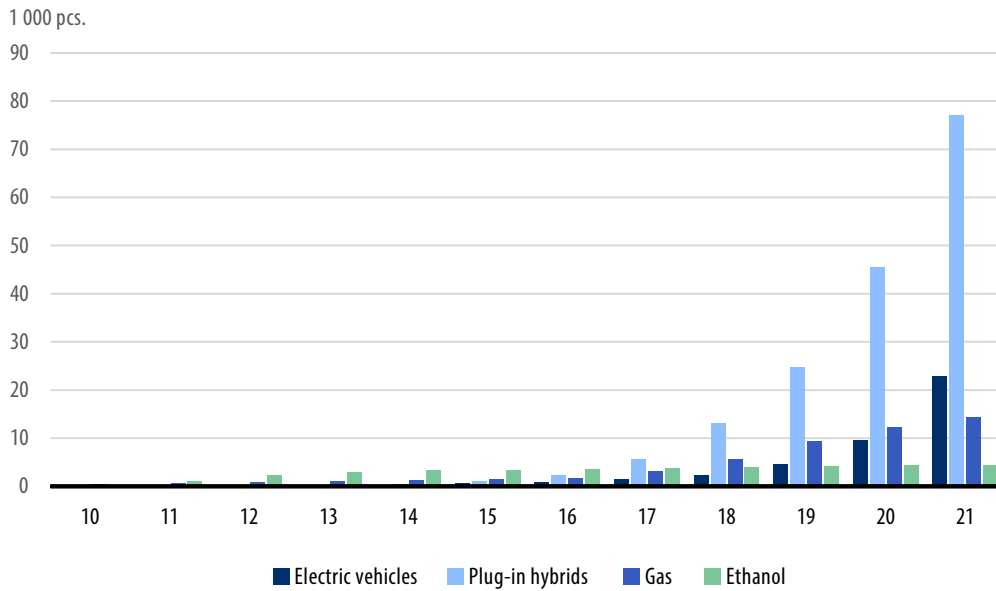


Figure 32. Average age of passenger cars in transport use 1990–2021. Source: The Finnish Transport and Communications Agency and the Finnish Information Centre of Automobile Sector.

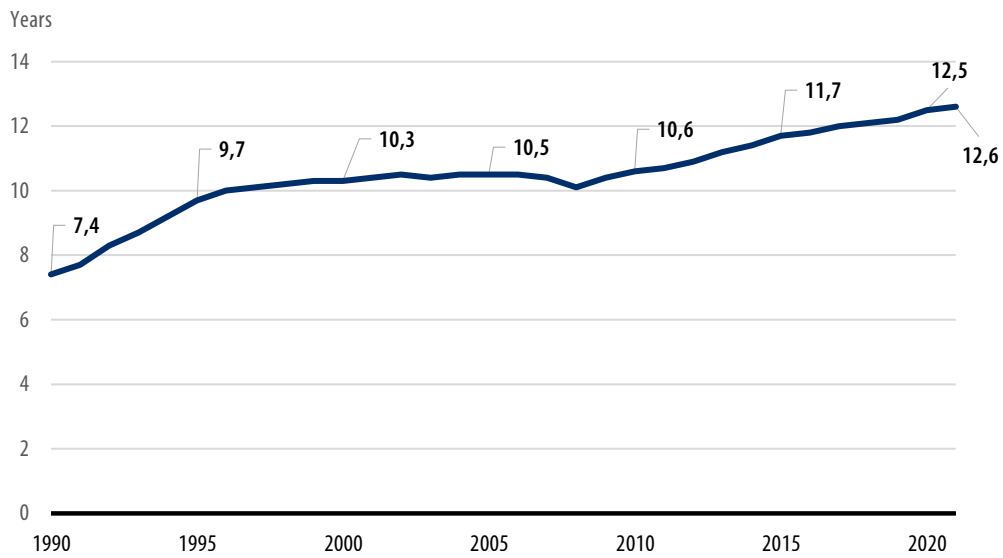


Figure 33. Use of conversion and procurement subsidies in 2018–2021. Source: Finnish Transport and Communications Agency.

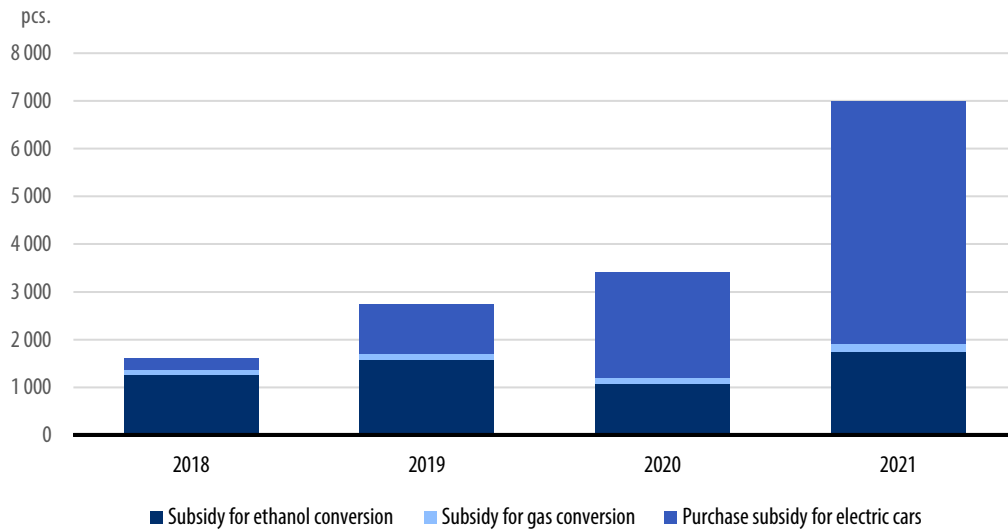
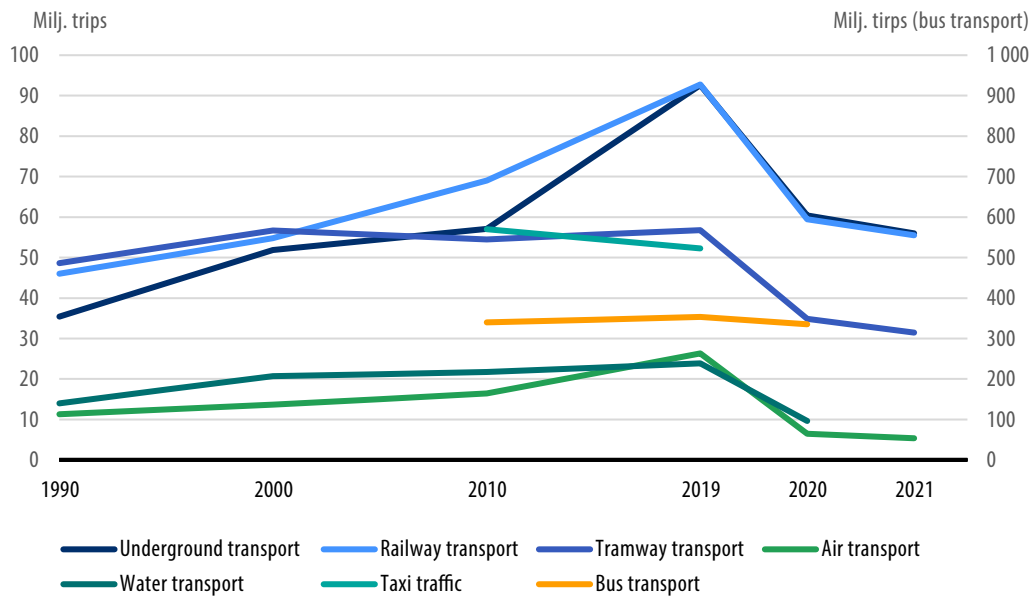


Figure 34. Passengers by mode of transport. Source: Statistics Finland.



Agriculture

Figure 35. Greenhouse gas emissions from agriculture reported in the effort sharing sector 2005–2021. The 2021 data are proxy estimates. Source: Statistics Finland.

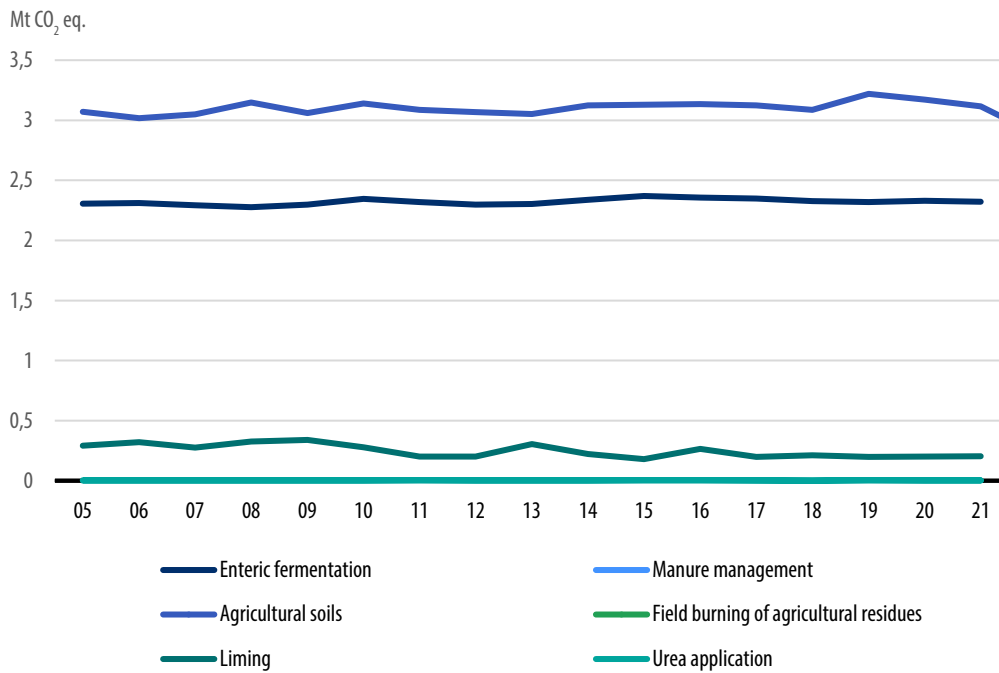


Figure 36. Numbers of animals on farms 2005–2021. Source: Natural Resources Institute Finland.

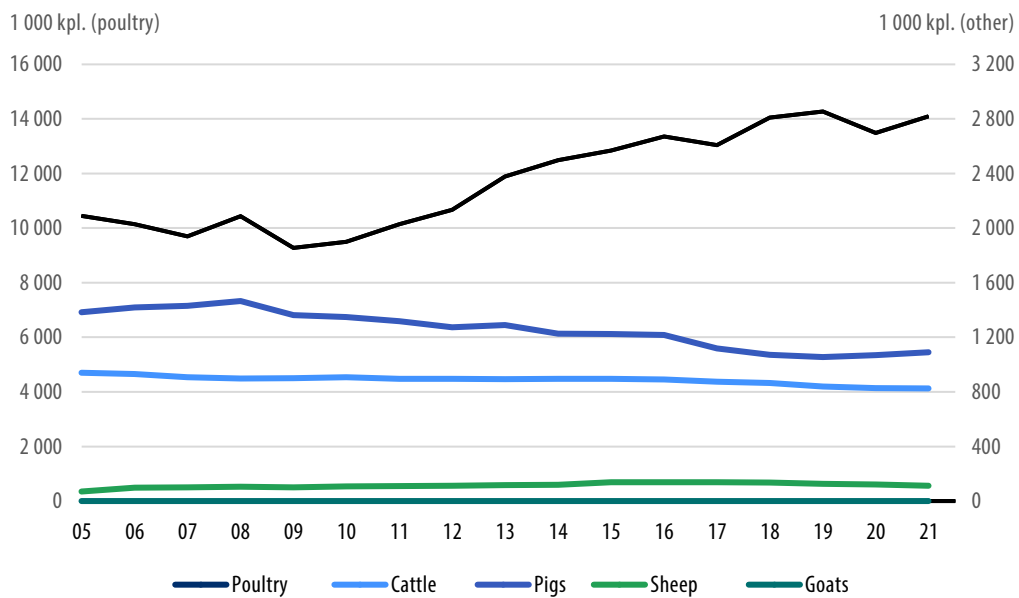
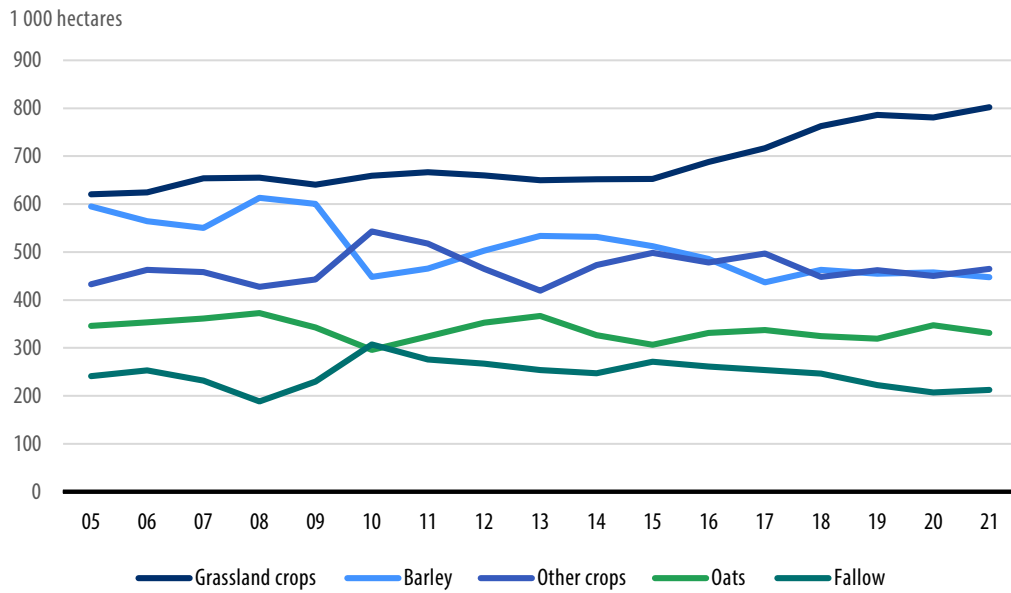
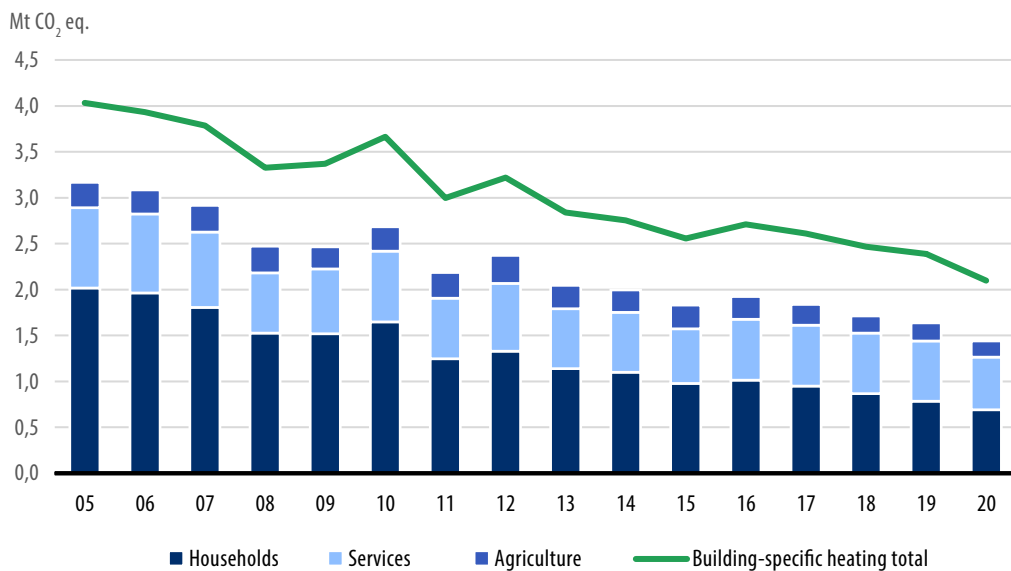


Figure 37. Use of agricultural area 2005–2021. Source: Natural Resources Institute Finland.



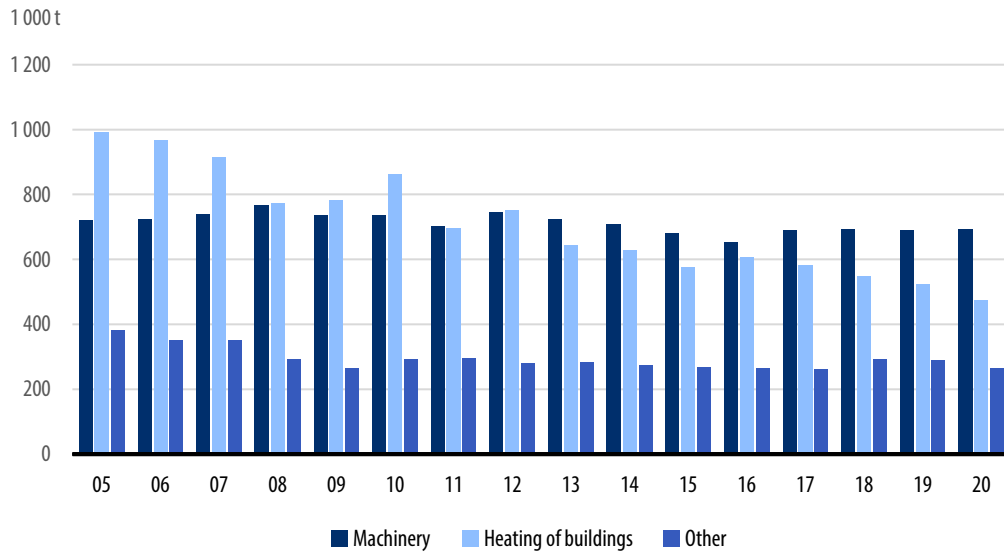
Building-specific heating

Figure 38. Figure 38. Emissions from light fuel oil by sector in building-specific heating and total emissions from building-specific heating 2005–2020. Agriculture includes grain dryers. Source: Statistics Finland



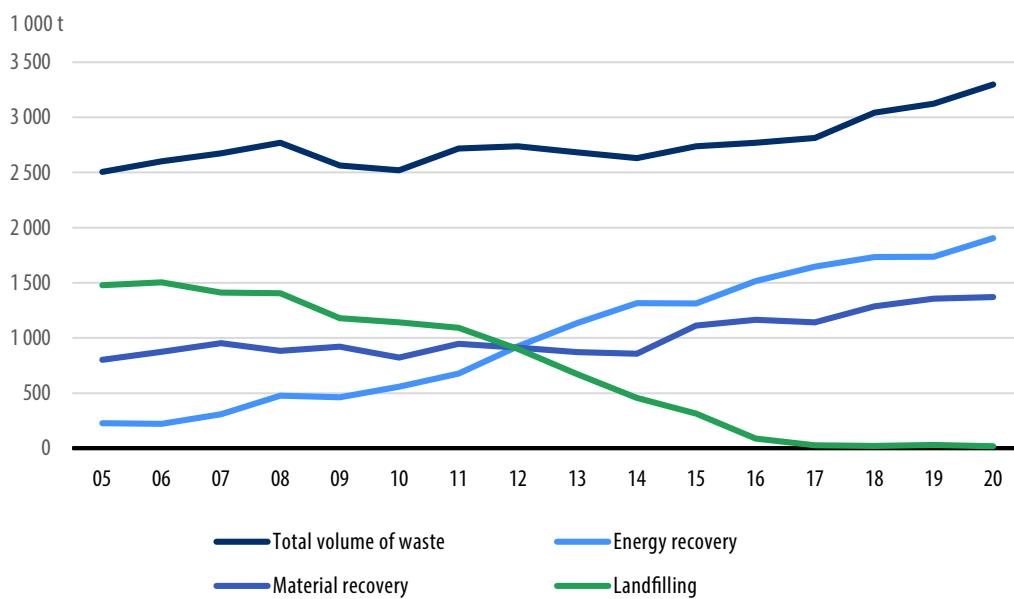
Use of light fuel oil

Figure 39. Consumption of light fuel oil in the effort sharing sector, broken down into machinery, heating of buildings and other use 2005–2012. Other use includes oil use in industry for purposes other than machinery and oil use in rail transport, water transport and fishing vessels. Source: Statistics Finland.



Waste management

Figure 40. Amount of municipal waste in Finland by treatment method 2005–2020. Source: Statistics Finland, Finnish Environment Institute.



F-gases

Figure 41. Emissions of F-gases by emission source 2005–2021. The 2021 data are proxy estimates. Source: Finnish Environment Institute.

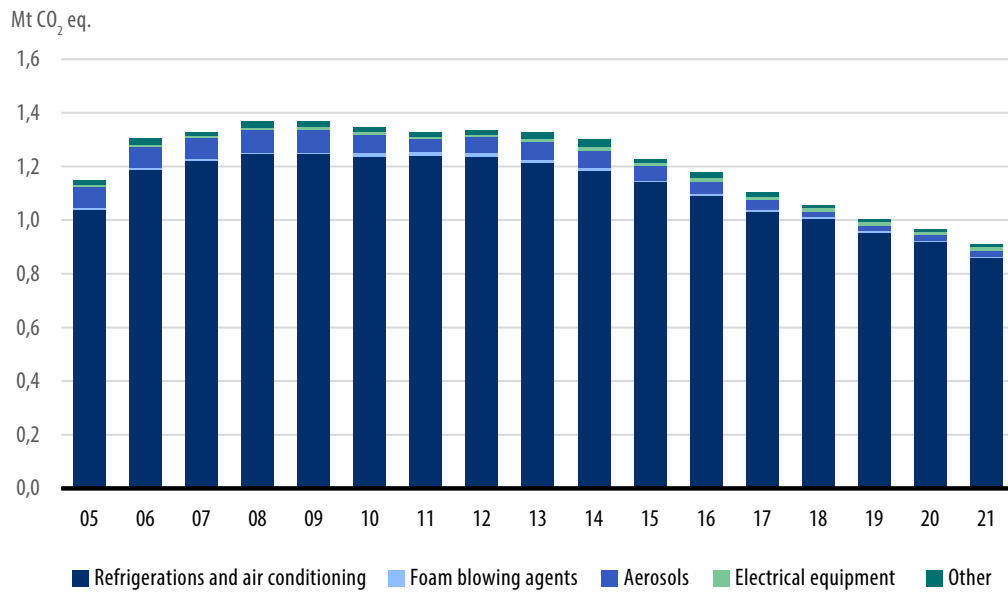
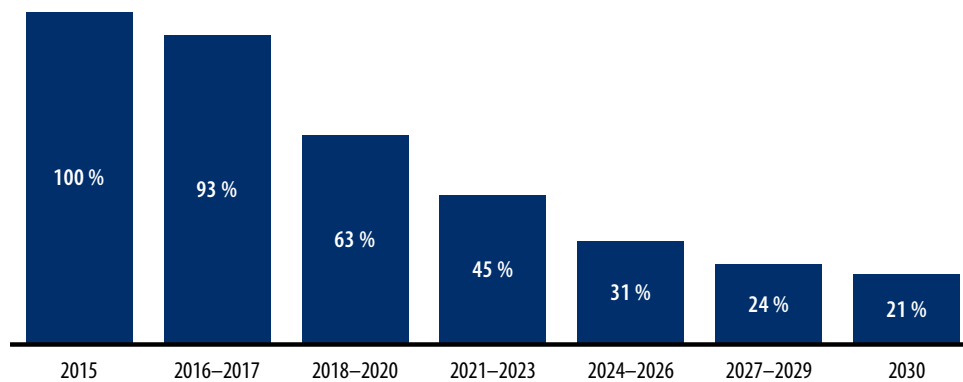
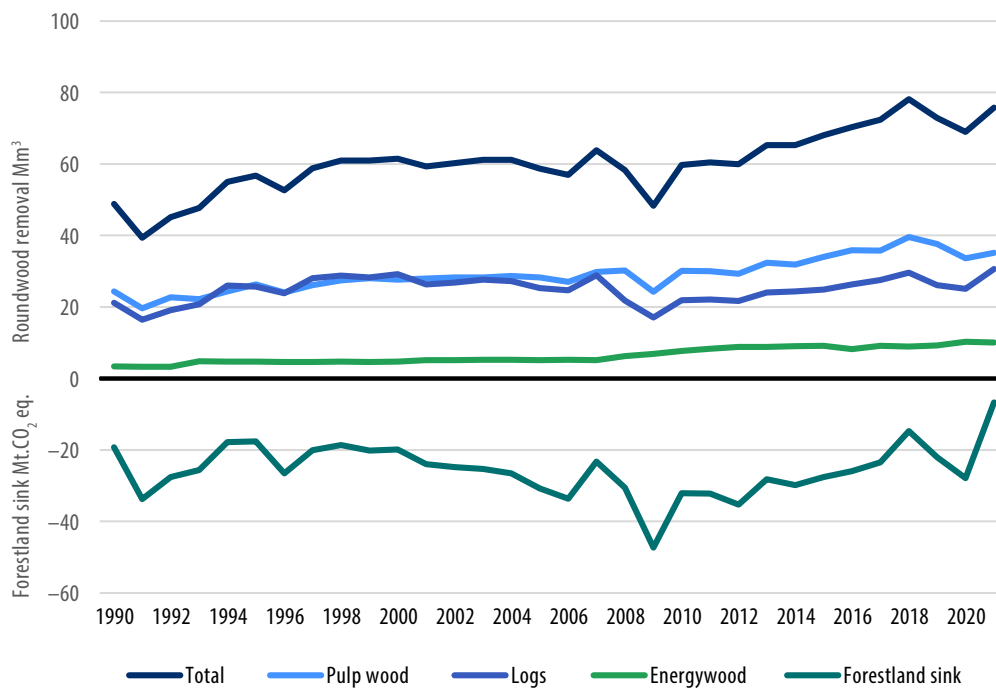


Figure 42. The quota of HFCs placed on the market within the EU 2015–2030 as a percentage of the 2009–2012 level.



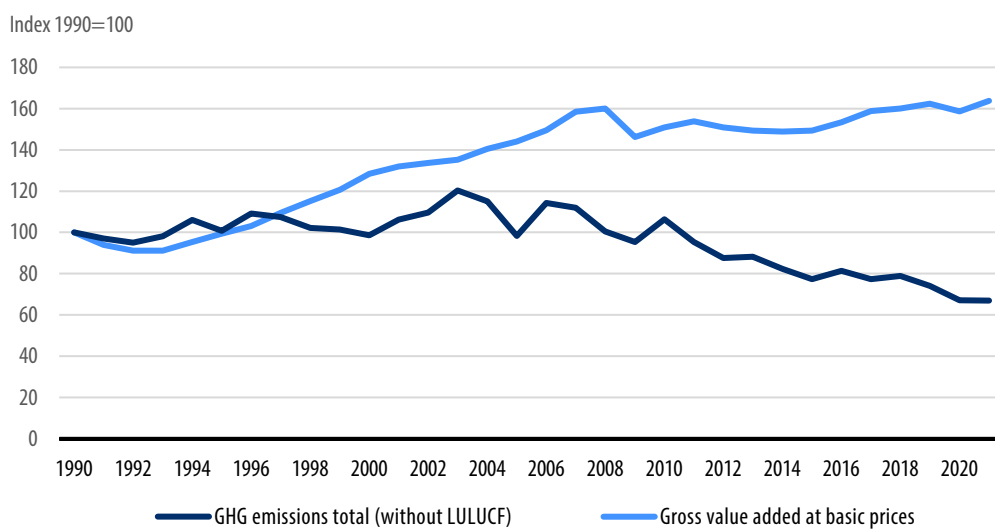
Roundwood removal

Figure 43. Roundwood removal and forest land sink in Finland 1990–2021. Source: Natural Resources Institute Finland.



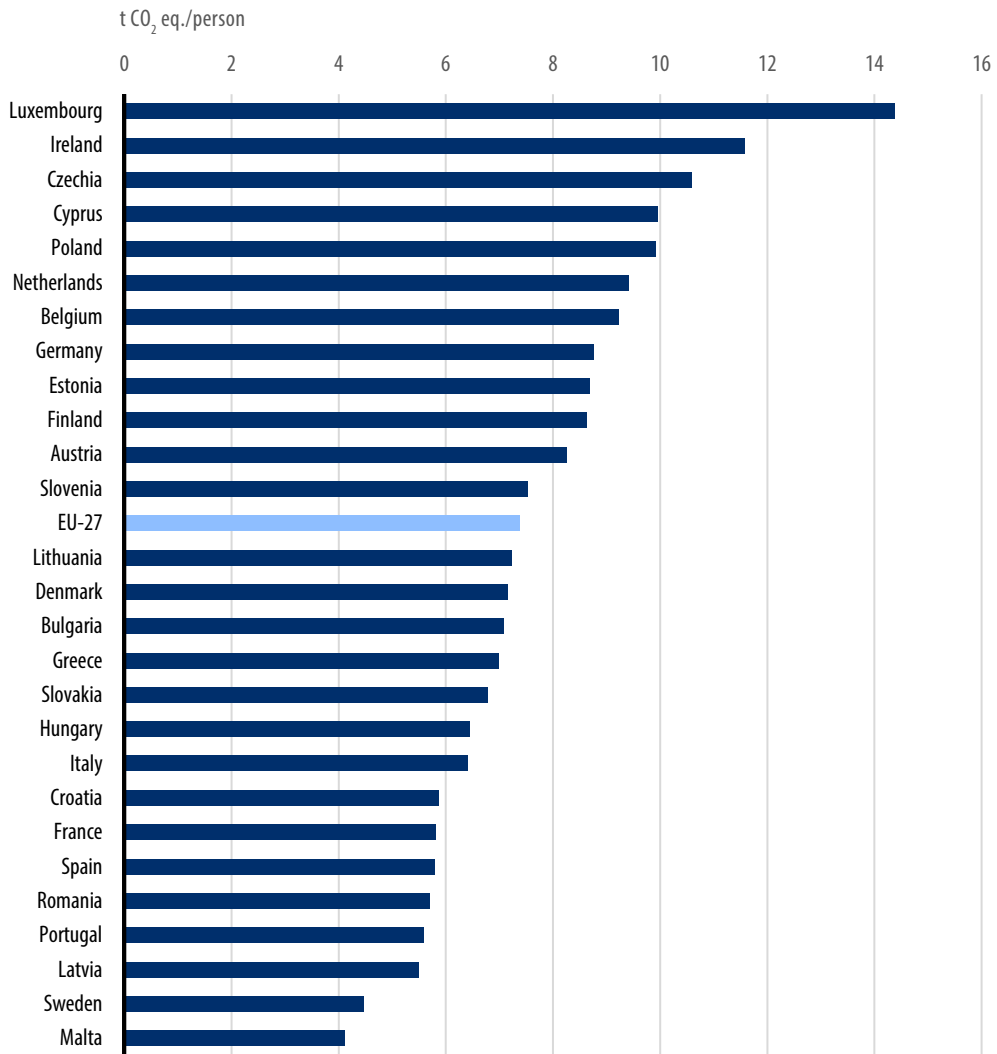
National economy

Figure 44. Development of the national economy (Gross value added at basic prices, at reference year 2010 prices) and greenhouse gas emissions in Finland 1990–2021. Source: Statistics Finland.



Emissions in the EU

Figure 45. EU and EU-27 GHG emissions per capita in 2020. Source: EEA/UNFCCC.



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Ministry of the
Environment Finland

ISBN: 978-952-361-390-4 PDF
ISSN: 2490-1024 PDF

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