

Report for Sweden on climate policies and measures and on projections

In accordance with article 18 under Regulation (EU) No 2018/1999 of the European parliament and of the Council
Decision on the Governance of the Energy Union and
Climate Action

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1 Introduction

This is the report for Sweden on climate policies and measures and on projections in accordance with article 18 under Regulation (EU) No 2018/1999 of the European parliament and of the Council Decision on the Governance of the Energy Union and Climate Action.

Chapter 2 in this report provides information on policies and measures, including information on measures implemented due to relevant Union legislation, how the policies and measures are interlinked and how they contribute to a low carbon development.

Chapter 3 provides information on projections of greenhouse gas emissions and removals until 2050 with, as of 30 June 2022, existing measures. The projections are presented on an aggregate level and per sector together with an analysis.

Chapter 4 provides a description of the status of the low carbon development strategy. For this submission, there are no updates relating to Sweden's low carbon development strategy, which was reported in 2020.

Chapter 5 provides a description of the national system for the reporting of policies and measures and projections.

As part of this report datasheets are also provided, as follows:

- summary table for all existing policies and measures and quantified effects when available (uploaded on Reportnet via a web form)
- data projections per sector and gas (uploaded on Reportnet as an excel file) based on existing measures as of 30 June 2022.
- summary table with projection parameters (uploaded on Reportnet as an excel file)
- model fact sheets for models used to produce projections (uploaded on Reportnet as an excel file)

2 Policies and Measures

This section provides information on key policies and measures implemented or decided in Sweden to reduce greenhouse gas emissions. The policies and measures decided before 1 July 2022 are included in the projections on greenhouse gas emissions and removals reviewed in section 3. Policies and measures have previously been reported in Sweden's eighth National Communication on Climate Change and fifth Biennial Report to the UNFCCC and in the report submitted under to the EU in March 2021 in accordance to article 18 under Regulation (EU) No 2018/1999. Information on national policy instruments to implement the EU common and coordinated policies is presented in each section.

2.1 Swedish Climate Strategy

2.1.1 The Swedish environmental quality objective Reduced Climate Impact

To provide a clear structure for environmental efforts in Sweden, the Riksdag has adopted 16 environmental quality objectives. One of these, Reduced Climate Impact, forms the basis for climate change action in the country. The interpretation of the objective is "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels. Sweden will work internationally for global work to address this goal."¹

2.1.2 Sweden's national climate policy framework

In June 2017, the Riksdag (Swedish Parliament) adopted a proposal on a national climate policy framework for Sweden. The climate policy framework consists of a Climate Act, national climate targets and a climate policy council. The climate policy framework is the most important climate reform in Sweden's history. It creates order and stability in climate policy and sets long-term conditions for the business sector and society. The climate act will impose responsibility on the current Government, and on future governments, to pursue a climate policy that is based on the national climate targets and to provide clear feedback on the progress. Sweden now has long-term climate targets and a council that independently reviews climate policy. The reform is a key component of Sweden's efforts to live up to the Paris Agreement.²

National climate targets

- By 2045 at the latest, Sweden is to have no net emissions of greenhouse gases into the atmosphere and should thereafter achieve net negative

¹ Govt. Bill 2016/17:146

² Govt. Bill 2016/17:146

emissions. This means emissions from activities in Swedish territory are to be at least 85% lower by 2045 compared with 1990. Supplementary measures may count towards achieving zero net emissions, such as increased uptake of carbon dioxide in forests and land, and investments in other countries. International accounting guidelines will be followed for this.

- Emissions in Sweden, outside of the EU ETS and the LULUCF sector, should, by 2030, be at least 63% lower than emissions in 1990, and by 2040 at least 75% lower. No more than 8 and 2 percentage points, respectively, of the emissions reductions may be realized through supplementary measures.
- Emissions from domestic transport are to be reduced by at least 70% by 2030 compared with 2010. Domestic aviation is not included in the goal since this subsector is included in the EU ETS.

Climate Act

- The Climate Act legislates that the Government's climate policy must be based on the national climate targets and specifies how the work should be carried out.
- In its Budget Bill, the Government must submit a climate review to the Riksdag every year. The climate review must contain:
 - A report on emissions development.
 - A report on the key political climate decisions taken during the year.
 - An assessment to identify the need for additional policies and measures, and when and how decisions about such policies and measures can be adopted.
- Every fourth year, the Government must develop a climate policy action plan which provides information on planned policies and measures to achieve emission reductions.

The Climate Act entered into force on 1 January 2018.

Climate Policy Council

The climate policy council provides independent assessments of how the overall policy presented by the Government is compatible with the national climate goals.

The Swedish climate target for 2020

Current climate policy is also set out in two Government Bills, entitled *An Integrated Climate and Energy Policy*, passed by the Riksdag in June 2009 (Govt. Bills 2008/09:162 and 163). The first of these Bills sets a national milestone target for climate, calling for a 40% reduction in emissions by 2020 compared with 1990. If the target in 2020 is met, greenhouse gas emissions from the non-ETS sector would

be around 20 million tonnes of carbon dioxide equivalent lower than in 1990. This target applies to activities not included in the EU Emissions Trading System and does not include the LULUCF sector. In addition, the Bills also set targets for energy efficiency and renewable energy (see 2.1.3). The 2020 target was met.

2.1.3 National energy policy and targets

The Riksdag has decided on an overall goal for energy policy, which is based on the same three pillars as the energy cooperation in the EU and aims to unite security of supply, competitiveness, and ecological sustainability. The energy policy will thus create the conditions for an efficient and sustainable energy use and a cost-effective Swedish energy supply with a low negative impact on health, the environment, and the climate, and facilitate the transition to an ecologically sustainable society.

In addition, the Riksdag has decided on energy policy goals linked to specific years based on an energy agreement reached in 2016 between five of the Riksdag political parties. After the agreement was concluded two of the parties have left the agreement. The energy policy goals are:

- By 2030, Sweden will have 50 percent more efficient energy use compared to 2005.
- By 2040, the goal is 100 percent renewable electricity production. This is a target, not a deadline for banning nuclear power, nor does it mean closing nuclear power plants through political decisions. The goal is currently under review.

2.1.4 Other institutional set-ups to implement the climate targets

The Commission for Electrification

In 2020 the Government set up a Commission for Electrification to speed up the electrification of the transport sector. The Commission for Electrification was an advisory body chaired by the Minister for Infrastructure and was composed of 16 members from business, the public sector and the research community. The Commission for Electrification's mandate was to work on the electrification of all modes of passenger and freight transport. Electrification here refers to electrification with all relevant technologies, including hydrogen technology.

2.2 Policy instruments

2.2.1 CROSS-SECTORAL

EU Emissions Trading System Directive 2003/87/EC

The EU Emissions Trading System (EU ETS) is the EU's most important tool to combat climate change. It was introduced in 2005 and has since been expanded to cover more sectors and greenhouse gases. The rules for the trading system, such as monitoring and reporting of emissions and free allocation and auctioning of

allowances have subsequently been developed and harmonized between the EU Member States.

The amount of emissions allowed within the system is limited by a cap which is decreased every year. 57% of the allowances are allocated to operators through auctioning, the remainder is allocated for free to installations covered by the system. Free allocation is used in order to avoid risks of carbon leakage in specific industrial sectors such as steel and cement. The free allocation is based on benchmarks based on the best installations in each sector. The number of free allowances are being reduced as the total number of allowances are being reduced. In addition, free allocation for sectors included in the Carbon Border Adjustment Mechanism will be phased out between 2026 and 2034. A small number of free allocated allowances are used for district heating and district cooling. As a general rule there is no free allocation for emissions from electricity production.

At the outset, EU ETS covered emissions of carbon dioxide from combustion installations and energy intensive industry (mineral oil refineries, coke ovens, iron and steel industry, pulp and paper industry and mineral industry). The scope was extended in 2013 with new greenhouse gases (nitrous oxide and perfluorocarbons), some new industrial activities, and also by inclusion of commercial aviation within the European Economic Area. At present, about 760 Swedish installations are included in the system. At the EU level in total, approximately 11 000 installations are covered. Emissions from intra-EEA aviation were included in the system in 2012. Sweden is the administering Member State for approximately 90 aircraft operators.

As part of the strengthening of EU climate ambition to 2030, from -40 to -55% net emission reductions compared to 1990, the EU ETS cap will decrease faster. Emissions from EU ETS are to be reduced by 61% to 2030 compared to 2005 emissions.

Energy Taxation Directive 2003/96/EC

Member States are obliged not to go below minimum rates of taxation for heating fuels, motor fuels and electricity. The directive lays down conditions for energy tax relief..

Energy tax and carbon dioxide tax

The Swedish system of energy taxation is based on a combination of a carbon dioxide tax, an energy tax on fuels, and an energy tax on electricity. The key taxes influencing greenhouse gas emissions in Sweden are the carbon dioxide tax and the energy tax on fuels, which are described below in general and more in detail for each sector.

Carbon dioxide tax

A carbon dioxide tax, based on the fossil carbon content in the fuel, was introduced in 1991 and aims at reducing the emissions of carbon dioxide in sectors outside the EU ETS. The tax has been raised in several steps since it was first implemented. In total, the tax has increased from SEK 0.25/kg (1991) carbon dioxide to SEK 1.22/kg (2022). In addition to specific tax increases stipulated in Government bills, a yearly indexation of the tax level is applied.

The tax level is proportionate to the calculated amount of carbon dioxide emissions, based on the fuel's fossil carbon content. This means that pure and high-blended liquid biofuels currently are not subject to carbon taxation, if not used within the reduction obligation scheme for motor fuels. Regarding motor fuels, changes to carbon taxation of biofuels were implemented on 1st July 2018 (see separate section on carbon and energy taxation in the transport sector).

Due to the risk of carbon leakage, a reduced carbon tax is applied for diesel used in agriculture, forestry and aquaculture.

Energy tax

Taxes on energy have been used in Sweden for a long time.³ An energy tax on petrol and diesel was introduced in 1924 and 1937, respectively. Fuels used for heating and electricity became subject to an energy tax in the 1950s.

The aim of the energy tax is mainly fiscal. It does also have the effect to steer energy usage towards Sweden's energy efficiency, renewability and climate targets⁴. The energy tax on motor fuels used in road vehicles and off-road machinery also internalizes external costs from the traffic, such as road wear, noise, etc.⁵.

The energy tax on fuels varies depending on whether it is used as motor fuel or for heating purposes. The tax level on heating fuels also varies between industry, households and the energy conversion sector.

Carbon dioxide tax and energy tax on motor fuels used in road vehicles and off-road machinery

Petrol and diesel are covered by both an energy tax and a carbon tax on fuels used in road vehicles, off-road machinery and private ships and boats. In accordance with the climate policy decision in 2009, the energy tax on diesel has been raised in two stages, in 2011 and 2013, by a total of SEK 0.40 per liter. As of January 2016, the energy tax on diesel was increased by another SEK 0.53 per liter and on petrol by SEK 0.48 per liter. Since 1994, both the energy tax on fuels and electricity and the carbon tax on fuels are adjusted to changes in the consumer price index (CPI), to take account of inflation. Since 2017 the tax rates on petrol and diesel are also

³ Tax on energy is a collective term for excise taxes for fuel and electrical power and is governed by the Act of Excise Duties on Energy (1994:1776).

⁴ The energy efficiency target and the renewable target for 2020 are part of Govt. Bills 2008/09:162 and 163.

⁵ National Institute of Economic Research, 2013

adjusted to take account of the development of gross domestic product (GDP).⁶ In July 2019 however, tax rates were lowered by the equivalent of the GDP-adjustment for 2019. The Government further decided in 2020 and 2021 to put the GDP-adjustment on hold until the end of October 2022 to compensate for increased prices due to the reduction obligation scheme, see below.⁷

In October 2022, the energy tax on diesel (environmental class 1) was SEK 2.1 per liter and the carbon tax was 2.292 per liter, while the energy tax on petrol was SEK 3.78 per liter and the carbon tax was 2.64 per liter. Sweden applied tax reductions for blended sustainable biofuels until July 2018. The energy tax reduction varied between different kinds of biofuels and was between 36 and 100% compared to fossil equivalents in 2017.

As noted in chapter 2.2.4, the Swedish Parliament decided to introduce, from 1st July 2018, an emission reduction obligation scheme. The scheme was accompanied by a number of tax rule changes for petrol and diesel. In particular, low-blended biofuels that are covered by the reduction obligation scheme are subject to carbon tax and energy tax rates that correspond to the rates of their fossil equivalents. At the same time, the carbon tax rates for petrol and diesel were adjusted downwards to take account of the share of low-blended biofuel per liter full blend, as a result of the emission reduction obligation scheme. The energy tax on petrol and diesel was also lowered. High-blended and pure biofuels are not covered by the reduction obligation scheme and such sustainable biofuels are still exempted from both the carbon tax and the energy tax from July 2018. If a given biofuel is classified as petrol or diesel it needs to consist of more than 98 volume percent biomass to be covered by the tax exemption. As the exemption of the carbon and energy tax for these biofuels are not considered compatible with the EU state aid rule, Sweden has an exemption approved by the European Commission lasting until the end of 2026.

Carbon dioxide tax and energy tax for heat production

Heat production is subject to energy tax and in certain cases carbon tax. Biofuels are exempt from energy tax as well as carbon tax.

Fuels used for heat production in combined heat and power plants (CHPs) and in other heating plants within the EU ETS are subject to 100 % of the energy tax. No carbon tax is charged for fuels used for heat production and supplied to manufacturing processes in industries if the industrial activity is part of the EU ETS.

⁶ This is achieved through a flat-rate increase of 2 percent per year. The combined change in the carbon and energy tax rates is, however, added exclusively to the energy tax rate (i.e. the carbon tax rate is only directly affected by the indexation to CPI).

⁷ Government Bill 2020/21:1 and Government Bill 2020/21:196

On 1st August 2019, the energy tax for fuels used to produce heat in CHPs outside the EU ETS was raised from 30% to 100%. These fuels are also subject to 100% carbon tax.

As of 2023⁸ the carbon dioxide tax on fossil fuels used for heat production in heating plants and in combined heat and power plants within the EU ETS has been abolished.

Carbon dioxide tax and energy tax for electricity production

The use of fuels for electricity production is exempt from both energy and carbon taxes. However, the use of electricity is generally subject to the energy tax on electricity.

Carbon dioxide tax and energy tax in the industry sector

The industry sector is subject to some exemptions and reductions in energy and carbon taxes on fuels used in the industrial manufacturing processes, primarily because most of the manufacturing industry is already covered by the EU ETS. One of the main reasons behind the tax reductions is to avoid the application of more than one policy instrument for the same purpose, for cost-efficiency reasons. Moreover, reductions and exemptions are applied to avoid carbon leakage. Manufacturing industries covered by the EU ETS pay 30% of the general energy tax and have, since 2011, been exempted from the carbon tax on heating fuels. Manufacturing industries not covered by the EU ETS also pay 30% of the general energy tax on heating fuels. As of 2023 the carbon dioxide tax on fossil fuels used for heat production in heating plants and in combined heat and power plants within the EU ETS has been abolished.

Fuels used in metallurgical and mineralogical processes and fuels used to produce energy products continued being fully exempted from energy tax. Consequently, the change in fuel tax has a limited impact on companies in steel manufacturing, cement, glass, and refinery industries. Previously, these industries had significant reductions in the carbon tax, but in recent years the tax has been raised. In January 2011, the carbon tax was raised from 21% to 30%, in January 2015 to 60%, and in January 2016 to 80% of the standard rate of carbon tax. The carbon tax reduction was then totally abolished from 1st January 2018.

For so-called mining diesel (diesel that is used in working machinery in manufacturing processes in mining industrial activity), energy taxes and carbon taxes were levied with 11% and 60% respectively of the general levels of taxation until 31 July 2019. This reduction of energy and carbon tax has now been abolished since August 2019, meaning that the full energy and carbon tax rates are applied.

Carbon dioxide tax and energy tax in agriculture, forestry and aquaculture sectors

⁸ Government Bill 2022/23:17

Up until 2014 the agriculture, forestry and aquaculture sectors paid 30% of the general energy and carbon dioxide tax rates for fossil fuel used for heating purposes. Since then, the carbon dioxide tax reduction in the sectors has been reduced in steps. The carbon dioxide tax in these sectors was increased to 60% of the standard rate in January 2015 and to 80% in January 2016, and the carbon dioxide reduction was then totally rescinded on 1st January 2018. The Government proposed in its budget bill for 2021⁹ to totally rescind the reduction of energy tax on heating fuels for agriculture, forestry, and aquaculture in two steps. The proposal was subsequently approved by the parliament and came in effect in June 1st 2021. In its budget bill for 2023¹⁰ the Government proposed that the measure be in effect throughout 2023. It is still a proposal and not yet decided by the Swedish Riksdag.

A special reimbursement for carbon tax on diesel for machinery in agricultural, forestry and aquaculture activities was lowered gradually from SEK 2.10 per liter (2011) to SEK 0.90 per liter in 2015. However, in 2016, the repayment was increased to SEK 1.70 per liter for the period until the end of 2018, when it was again lowered to SEK 1.43 per liter. On 1st July 2019, the reimbursement was raised again to SEK 2.24 per liter and was also subject to a tax reduction on the energy tax by SEK 0.19 per liter. From the 1st of January 2020 the reimbursement for carbon tax on diesel for machinery in agricultural, forestry and aquaculture activities was SEK 1.93 per liter.¹¹ In 2022 and 2023, the tax rates for diesel for machinery in agricultural, forestry and aquaculture activities, have been changed in various steps.

National and international commercial shipping

Fossil fuels for national and international commercial shipping are not targeted with any energy tax or carbon dioxide tax.

Local Climate Investment Program – the Climate Leap

To further stimulate the reduction of greenhouse gas emissions, a program for local investments was introduced in 2015 called the Climate Leap. Since 2015, SEK 12 billion has been granted for investments within the program (as of September 2022). The Swedish Environmental Protection Agency and the County Administrative Boards administer the grants. Investments in all sectors, except those included in the EU ETS, and all types of organizations are eligible to apply for grants. Some investments in sectors included in the EU ETS are also eligible for grants if these result in an increased utilization of waste heat. Applicants compete based on the estimated greenhouse gas reduction per invested SEK. Examples of investments that can be granted support are charging infrastructure for electric vehicles, biogas plants, recycling facilities, infrastructure for biofuel distribution and transitions from fossil to renewable heat sources. In 2021, the combined budget for the

⁹ Government Bill 2020/21:1

¹⁰ Government Bill 2022/23:1

¹¹ Skatteverket 2021, <https://skatteverket.se/foretagochorganisationer/skatter/punktskatter/energiskatter/aterbetalningavskattpaelochbransle.4.109dcbe71721adafd252816.html>

program amounted to SEK 1,955 billion. The budget increased to SEK 2,755 billion in 2022, 3,055 billion in 2023 and another 5 billion for the period 2024–2026. This budget is combined for the Climate Leap and the grant for investment in non-public EV chargers.

A national center for carbon dioxide capture and storage

In order to achieve net zero emissions by 2045, and enable negative emissions thereafter, the Swedish Energy Agency was commissioned to be the national center for carbon dioxide capture and storage (CCS) and funds are also provided to set up a system with reverse auctions for the capture and storage of carbon dioxide from renewable sources (bio-CCS). The possibility of including negative emissions with the help of biochar has also been analyzed. The grant is estimated to increase by SEK 50 million in 2022 and SEK 200 million in 2023. A budget frame of SEK 36 billion is allocated to bio-CCS for the period 2026–2046. The Swedish Energy Agency has been given the task of enabling the export of captured carbon dioxide from Swedish operations to storage sites in other countries.

The environmental code and planning legislation

General legislation in the area of the environment has been collected in the Environmental Code since January 1999. Among other aspects, the Environmental Code contains general rules for consideration to be observed in all activities and measures that are not of negligible significance in individual cases and that can affect the environment. Environmentally hazardous activities, as defined in the 9th chapter, require obtaining a permit. The permit application must include an environmental impact assessment as described in the 6th chapter. In 2018 changes were made in the 6th chapter in order to clarify that direct, indirect and cumulative impacts should be included in the environmental impact assessment. Greenhouse gas emissions form part of the permit assessment procedure and the Code also includes requirements to use the best available technology. However, effective 2005, issuing permits including emissions limit values for carbon dioxide or limiting the use of fossil fuels for installations covered by the EU Emissions Trading Scheme is no longer permitted.

Measures in the area of public planning chiefly impact emission trends in the longer term and may have significance from this point of view. Measures in public planning are principally governed by the Planning and Building Act (PBL)(SFS 2010:900), but many measures are also covered by the Environmental Code. Since May 2011, the PBL introduced new requirements on considering the environmental and climate aspects of planning. The longer-term significance of the development of the built environment for energy and transport needs has been increasingly highlighted, and the PBL also made it mandatory to consider inter-municipal and regional circumstances in planning. To enhance the implementation of the requirements in the PBL, the National Board of Housing, Building and Planning published new guidelines in January 2017 for municipal structure planning, aimed at reducing greenhouse gas emissions.

Since December 2016 large corporations must comply with regulations for sustainability reporting. Sustainability reports must include information needed to understand a company's development, position, earnings and the consequences of their operations that concern the environment.

Fossil Free Sweden

The governmental initiative 'Fossil Free Sweden', launched in 2015, aims to strengthen the dialogue between the state and the business sector, municipalities and civil society. A national coordinator, appointed by the government, is the link between the actors and the government in efforts to remove obstacles and create conditions to speed up the reduction of greenhouse gas emissions. Fossil Free Sweden is open to all actors who support the declaration drawn up for the initiative. The declaration stipulates that actors participating in the initiative share the view that the world must become fossil free. It also stipulates that actors who participate must be able to present concrete measures to reduce emissions. So far, more than 450 actors have signed the declaration and 22 roadmaps from different sectors have been submitted to the government.¹²

Delegation for circular economy

The Government has established a Delegation for the transition to a Circular economy consisting of representatives from the business sector, launched in April 2018. The aim is to strengthen the dialogue between the business sector and the government. In September 2022 the mission was concentrated and focused on contributing to the transition of the business sector to a circular economy, identify obstacles, and make visible and communicate the opportunities of business with a transition to a circular economy¹³.

Climate change communication

The principle of public access to information is a fundamental principle in Sweden's form of government. One of the fundamental laws, the Freedom of the Press Act, contains provisions on the right to access official documents, which is a manifestation of the principle of public access to information.

Swedish governmental authorities have long experience of the principle of public access to information, which is a fundamental principle in Sweden's form of government. One of the fundamental laws, the Freedom of the Press Act, contains provisions on the right to access official documents, which is a manifestation of the principle of public access to information for the public and business sectors and for citizens. Some examples:

¹² <https://fossilfrittverige.se/>

¹³ [Delegationen för cirkulär ekonomi \(delegationcirkularekonomi.se\)](#)

The Swedish Environmental Protection Agency is a driving force and provides support in climate work in Sweden. The website www.naturvardsverket.se is a hub for statistics and facts on emissions and knowledge on effective mitigation activities, widely used by policymakers, media, business, organizations and researchers.

The Swedish Meteorological and Hydrological Institute (SMHI) develops and distributes information about the weather, water and climate change adaptation. The National Knowledge Centre for Climate Change Adaptation, set up at SMHI launched *the Swedish Portal for Climate Change Adaptation*, with facts and guidance on adaptation to a warmer climate. SMHI is the Swedish Focal Point for IPCC and works actively to make information from the IPCC available and relevant for the public, news media and other relevant stakeholders.

The Swedish Energy Agency is responsible for giving both citizens and businesses information and advice on more efficient energy use. On-line energy tests, the websites where you find energy tests of white goods for consumers, are the most visited on the Swedish Energy Agency's web. The Swedish Energy Agency organizes local energy and climate advisers in Sweden's municipalities free of charge to answers about heating, energy costs and efficiency, transport, climate, government grants relating to energy.

The Swedish Forest Agency and *the Swedish Board of Agriculture* focus on e-services and digital information to land- and forest owners, forest officers and farmers on how to reduce the climate impact of forestry, agriculture as well as on climate adaptation.

The Swedish Civil Contingency Agency (MSB) is responsible for supporting society's preparedness for accidents, crises and civil defense. This assignment includes coordinating the various actors' communication and collective information to the public.

The website *Krisinformation.se* is a service for Sweden's collective crisis information to make it easier for the public to find confirmed information from Swedish authorities by collecting it in one place and to reduce the risk of incorrect information being disseminated.

*Panorama*¹⁴ is a digital tool that visualizes Sweden's climate transition. The tool is based on Sweden's official emissions statistics, and it presents an overview of ongoing and potential transitions in various sectors together with indicators showing the progress being made. It is updated regularly with policy instruments, commitments and other initiatives that can make a contribution along the way. The target-based scenario in Panorama is one of several possible ones. The transitions and their potential are based on expert assessments from reports and data from

¹⁴ <https://app.climateview.global/public/board/48023530-bb99-4a82-a00e-c9e7aad71f5d>

government agencies, industry and other stakeholders. Panorama is the result of an interagency collaboration between three government agencies: Climate Policy Council, the Environmental Protection Agency and the Swedish Energy Agency.

Research and development

Public investment in climate-related research and development are aimed at creating better prerequisites for achieving the substantial longer-term emissions reduction required. Swedish climate-related research covers a broad spectrum, from natural sciences to humanities, but with an emphasis on technical research and development. Three important research areas are energy, transport and industry, for which the Government has decided to grant extensive funding.

Energy and climate issues are closely linked, and the solutions to the challenge of climate change are largely energy related. The overall objective of energy research and innovation in Sweden is to contribute to fulfilling the national energy and climate objectives, the long-term energy and climate policy, and energy-related environmental objectives.

In the budget bill for 2017¹⁵, which was approved by the Swedish Parliament, the government proposed an expansion of contributions to energy research and development with funding of SEK 620 million for 2017–2020. This resulted in a level of SEK 1.6 billion in 2020, compared with the earlier level of SEK 1.3 billion. The Government's budget bills for 2021 and 2022 allocated SEK 1.57 billion and 1.43 billion respectively¹⁶. Estimated amounts for 2023 are SEK 1.48 billion.

The Swedish energy research and innovation program is based on Government Bill 2016/17:66 (Research and innovation in the energy sector for sustainable ecology, competition and security of supply). It takes its starting point in five different societal challenges:

- A 100% renewable energy system
- A flexible and robust energy system
- A resource-efficient society
- Innovation for jobs and climate
- Collaboration in the energy system

Following these five societal challenges, energy research and innovation is carried out under nine different thematic areas: the transport system, bioenergy, buildings in the energy system, power systems and electricity generation, industry, a sustainable society, general energy system studies, business development and commercialization, as well as international collaboration.

Alongside the Swedish energy research and innovation program, climate-related research is also being financed by other national research funding programs. In the latest Government research policy bill 2016/17:50 (Collaborating for knowledge–for society's challenges and strengthened competitiveness), climate is listed as one

¹⁵ Govt. Bill 2016/17:1

¹⁶ <https://www.esv.se/statsliggaren/regleringsbrev/?rbid=22914>

of several societal challenges that require special contributions. A national ten-year research program for climate has therefore been established.

To reduce greenhouse gas emissions from working machineries and strengthen the competitiveness of the Swedish automotive industry, the Government has decided on targeted support for research, development, and market introduction for working machineries in 2021 and 2022.¹⁷

State credit guarantees for green investments

On 3 June 2021, the Swedish National Debt Office was given a mandate to issue state credit guarantees for large-scale green industrial investments in Sweden. The guarantees may cover new loans raised by companies with credit institutions for financing investments that contribute to reaching the goals of the Swedish environmental objectives system and climate policy framework.¹⁸ The guarantee framework amounts to SEK 65 billion in 2023. The framework is estimated to SEK 80 billion in 2024.

- To be eligible for a guarantee, a loan must amount to at least SEK 500 million.
- The guarantee covers up to 80 per cent of the loan.
- The maximum maturity of a guarantee is 15 years.

2.2.2 ENERGY – production of electricity and district heating and residential and service sector

Energy Efficiency Directive

The Energy Efficiency Directive 2012/27/EU came into force in December 2012. The Directive established a set of binding measures to help the EU reach its 20% energy efficiency target for 2020. Under the Directive, all EU countries are required to use energy more efficiently at all stages in the energy chain from production to final consumption.

To adapt Swedish regulations to the Directive, the following changes were implemented: i) large enterprises must conduct an energy audit every fourth year; ii) electricity suppliers must invoice customers for the measured consumption of electricity, if the supplier has access to measurements; iii) new requirements are established on the measurement of energy consumption in apartments; and iv) requirements are tightened on authorities to use energy more efficiently. The main part of the new legislation came into force on 1 June 2014¹⁹. Changes were also made in the Electricity Law (SFS 2014:1064) requiring network operators to adjust tariffs and other practices to promote energy efficiency.

¹⁷ Government Bill 2020/21:1

¹⁸ <https://www.riksdagen.se/en/our-operations/guarantee-and-lending/credit-guarantees-for-green-investments/>

¹⁹ Govt. Bill 2013/14:174

In 2016, the European Commission presented the *clean-energy-for-all* package of legislative proposals, where putting energy efficiency first was an important goal. The European Parliament and Council Directive 2018/2002/EU amends Directive 2012/27/EU on energy efficiency and entered into force on 24 December 2018. This directive includes a headline target of at least 32.5% improved energy efficiency by 2030. According to the directive cumulative energy savings obligations for the period 2021-2030 can be substituted with other measures serving the same purpose. In Sweden savings are counted based on the energy and carbon dioxide taxes. The directive also includes revised requirements regarding metering and billing of energy.

In 2021, as part of the “Fit for 55” package, the European Commission proposed amendments to the energy efficiency directive, introducing a higher target for reducing primary (39%) and final (36%) energy consumption by 2030, now binding at EU level, in line with the Climate Target Plan, up from the current target of 32.5% (for both primary and final consumption)²⁰.

Renewable Energy Directive

In the Renewable Energy Directive 2009/28/EC, the EU set a binding target requiring an increase in the percentage of renewable energy to 20% of total energy use during 2005-2020. Responsibility for attaining this target was shared among the Member States. According to this burden sharing, Sweden had to increase its share from just under 44% in 2007 to 49% in 2020. However, Sweden reached the EU commitment (49%) and the national target (50%) in 2012. Since then, the use of renewable energy has increased to a level of 56% in 2019.

The revised Renewable Energy Directive (RED2), 2018/2001(EU), sets a binding renewable energy target for the EU for 2030 of at least 32%, including a review clause by 2023 for an upward revision of the EU level target. As part of the Governance Regulation, 2018/1999(EU), member states have prepared national energy and climate plans covering the five dimensions of the Energy Union for the period 2021 to 2030, which include each member state’s contribution to the overall renewable energy EU target. This is currently being negotiated in trilogue. Furthermore, in May 2022 as part of RePowerEU the Commission proposed further amendments to the directive, including increasing the target to 45% by 2030. This is currently being negotiated in the Council and Parliament, trying to reach their respective positions on the act.

In 2021, as part of “Fit for 55”, the European Commission proposed amendments to the directive (RED3), increasing the current EU-level target to at least 40% by

²⁰ [Commission proposes new Energy Efficiency Directive | European Commission \(europa.eu\)](https://ec.europa.eu/energy/en/press-releases/2021/05/commission-proposes-new-energy-efficiency-directive)

2030, which represents doubling the current renewables share of 19.7% in a decade²¹.

EU has also set a specific target for the share of renewable energy in the transport sector of 10% in 2020²². In 2019, the share of renewable energy in the transport sector in Sweden, according to the renewable directive's calculation methodology, was already 30.3%. RED2 also includes a mandatory subtarget for transport, at least 14% share by 2030 of renewable energy within the final consumption of energy in the transport sector. In RED3 further mandatory subtargets are proposed.

Production of electricity and district heating

Tax on waste incineration

Since 2020, incineration of waste is taxed²³. The tax has gradually been increased and is in 2022 SEK 125 per ton of waste. The tax excludes, for example, hazardous waste and biomass. The tax was abolished 1 January 2023.

Electricity certificate system

An electricity certificate system supporting electricity production based on renewable energy was introduced in 2003. Conceptually, the system works as follows. Electricity producers are allocated a certificate from the central government for every megawatt-hour (MWh) of renewable electricity produced. Electricity suppliers are obliged by law to submit electricity certificates corresponding to a certain share, or quota, of their electricity deliveries. The quota was gradually increased until 2020. The producers sell the certificates in a market where the price is set by the seller and buyer (normally an electricity supplier). The certificates thereby provide an extra revenue for the producers of renewable electricity²⁴.

Since 2012, Sweden and Norway have a common electricity certificate market. The increase of renewable electricity production through the electricity certificate system has been a key element in attaining Sweden's renewables targets. The electricity certificate system was earlier prolonged until 2045²⁵ but the rapid expansion of renewable electricity production has led to the electricity certificates now fulfilling only a limited function. Therefore, new electricity generation facilities are not eligible for electricity certificates after the end of 2021 and the electricity certificate system will be terminated by the end of 2035.²⁶

Initiatives for wind power

Research programs

²¹ [Commission presents Renewable Energy Directive revision | European Commission \(europa.eu\)](#)

²² Renewable Energy Directive 2009/28/EC

²³ Lag (2019:1274) om skatt på avfall som förbränns

²⁴ Lag (2011:1200) om elcertifikat

²⁵ Govt. Bill 2016/17:179

²⁶ Government Bill 2020/21:16, Näringsutskottets betänkande 2020/21:NU6

Different programs have promoted the dissemination of knowledge and information about wind power. An example is the research program *Vindval*, which aims to collect and provide scientific knowledge about wind power's impacts on humans and on nature²⁷.

Designation of areas of national interest for wind power

Since 2004, certain land and water areas in Sweden have been designated as areas of national interest for wind power. There are 313 such areas in Sweden, of which 284 are located onshore and 29 offshore. The most recent update was carried out in 2013 but four areas were added in 2015. The total area of these national interests for wind power is 7,600 km², representing about 1.5% of the country's land area, including Swedish waters.²⁸

A national strategy for sustainable wind power expansion

The Swedish Energy agency and the Swedish Environmental protection agency have jointly developed a national strategy for sustainable wind power expansion, which was presented in January 2021. The strategy, which only covers land-based wind power, contains a regional distribution of a national development needs and a national planning basis.²⁹

Since January 2021 the focus has been on implementing the strategy. A guide has been developed with the aim of aiding the regional analysis work, especially concerning the investigation of co-existence and co-operation with municipalities. A project has been initiated with the purpose of Värmland and Dalarna counties conducting their regional analysis with the aid of the Swedish Energy Agency and the Swedish Environmental Protection Agency. Through this project, a positive side effect is the guide being evaluated.

Local and regional efforts for renewable electricity production

During 2022 most projects within the program Local and regional efforts for renewable electricity production have come to their conclusion. These projects include the development of a national office for local and regional business development surrounding renewable electricity production. The projects also include work on locally added values and connections with the local community concerning renewable electricity production.

Offshore wind power

To promote the development of offshore wind power, the government has assigned the Swedish Energy Agency the role of coordination in finding areas for another 90

²⁷ Swedish Environmental Protection Agency, *Vindval* (naturvardsverket.se)

²⁸ Swedish Energy Agency, <http://www.energimyndigheten.se/fornybart/riksintressen-for-energiandamal/riksintressen-for-vindbruk/>

²⁹ Swedish Energy Agency, 2021. *Nationell strategi för en hållbar vindkraft*. ER 2021:02, ISBN 978-91-89184-88-6

A tax reduction for households and businesses was introduced in 2015 to stimulate investments in micro-production of renewable electricity. The income tax reduction is SEK 0.60 per kWh of renewable electricity fed into the grid in a connection point with a fuse size of up to 100 Amperes but limited to the amount of electricity received from the grid in the same connection point. The tax reduction is capped at SEK 18,000 per year.

Residential and service sector

Ecodesign Directive (2009/125/EC) and Energy Labelling Regulation 2017/1369/EU

Energy labelling is mandatory for the product groups that are covered by delegated acts under the Energy Labelling Regulation (2017/1369/EU) and applies to all EU Member States. Energy labeling makes visible the product's energy efficiency, and other parameters such as performance, water use, noise and thus facilitates for consumers who want to make energy smart choices. Aside from transport the directive applies to all sectors.

The Ecodesign Directive (2009/125/EC) aims to improve the environmental performance of energy related products during their full life cycle. The requirements act as a floor to remove the worst performing products on the market, seen from an energy, functionality, environment performance perspective. Additional parameters are also covered. These rules applies to the product groups covered by implementing acts under the directive and cover all energy sources. The directive is implemented in Sweden through the Ecodesign Act (SFS 2008:112).

Energy Performance of Buildings Directive 2018/844/EC

The Energy Performance of Buildings Directive is a framework within which the EU Member States have decided on measures to help reaching the overall goals to reduce greenhouse gas emissions from the EU Member States and to secure the energy supply in the medium and long-term by improving energy efficiency in new and existing buildings. The framework includes setting minimum energy performance requirements for new buildings and building parts, including requirements to promote improving energy efficiency when renovating existing buildings and building parts, implementing a system for issuing energy performance, certificates for buildings and inspections or advice on boilers and air conditioning systems. The directive has been implemented in Sweden through the Swedish Planning and Building Act (SFS 2010:900) and through the Law on energy performance certificates for buildings (SFS 2006:985). The directive is part of the "Fit for 55" package and is currently under negotiation.

Law on energy performance certificates for buildings

Based on the Energy Performance of Buildings Directive, Sweden has implemented a law on energy performance certificates for buildings (SFS 2006:985).

The law includes an obligation for owners of single-family and multi-dwelling buildings, and of commercial premises, to declare the energy use of buildings and certain parameters regarding the indoor environment. The aim is to promote efficient energy use and at the same time ensure a healthy indoor environment by providing building owners with information based on energy performance and technical status of the certified building. By learning more about possible, cost-effective measures that could be carried out to improve the building's energy performance and indoor environment, building owners can make informed choices and decisions.

Building regulations

Building regulations have been used since the 1960's to set minimum requirements for energy use in new buildings in Sweden. Since 2009, building regulations for new production have included stricter requirements for electrically heated buildings. Stricter requirements for energy use in new buildings with other heating systems took effect in 2012. Regulations include requirements for specific energy use (kWh/m² per year) and average thermal transmittance (W/m²K). Boverket – the Swedish National Board of Housing, Building and Planning is currently reviewing the building regulations (BFS 2011:6).

Support for renovation and energy efficiency of apartment buildings

The Government previously had a subsidy to property owners for renovation and energy efficiency measures that are taken on apartment buildings. On 1 December 2021 the Parliament decided to end this program, yet applications that were submitted by 31 December 2021 were to be accepted and grants were to be allocated to accommodate all support that was decided by 31 December 2022. In the budget bill for 2023 the government proposed to allocate SEK 350 million for this purpose. The support should go to additional costs for energy efficiency measures. The aim of the subsidy is proposed to be to improve the profitability of energy efficiency measures.³³

Training program on how to build for low energy consumption

The Swedish Energy Agency is responsible for a capacity building program in the area of building for low energy use. The program target different construction stakeholders, such as architects, engineers, technicians, installers and site managers.³⁴

Support for market introduction, technology procurement, and networks

Technology procurement is an instrument designed to initiate a market transition and disseminate new, more efficient technology, such as new products, systems and processes. Network-based procurement of technology is an approach that

³³ Boverket (2020) Utvärdering av stödet för renovering och energieffektivisering, rapport 2020:25, <https://www.boverket.se/sv/om-boverket/publicerat-av-boverket/publikationer/2020/utvardering-av-stodet-for-renovering-och-energieffektivisering/>

³⁴ <https://www.energimyndigheten.se/energieffektivisering/jag-arbetar-med-energieffektivisering/byggbranschen/energilyftet/det-har-ar-energilyftet/>

encompasses the entire decision-making process from feasibility study and purchaser group to specification and dissemination of requirements and further development of more energy-efficient technology. It is being used in areas like heating and control, ventilation and lighting. The Swedish Energy Agency coordinates procurement networks for housing (BeBo), commercial and institutional premises (BeLok), small houses (BeSmå), food distribution (ReLivs), and new construction of, and conversion to, energy-efficient buildings (LÅGAN).

2.2.3 INDUSTRIAL EMISSIONS FROM COMBUSTION AND PROCESSES (including emissions of fluorinated greenhouse gases)

Industrial emissions from combustion and processes

Industrial Leap

The Industrial Leap was launched in 2018 by the Swedish Government. It is a long-term support program planned to continue until 2029. The program supports innovative technology and solutions within the Swedish industry that contribute to reducing greenhouse gas emissions. Financial support, administered by the Swedish Energy Agency, can be granted for research, feasibility studies, pilot and demonstration projects as well as for full-scale investments (first-of-a-kind projects). Projects with innovative solutions that contribute to mitigation of hard-to-abate emissions, i.e., emissions that are closely interlinked with current manufacturing processes or to negative emissions, are eligible for funding. Since 2021, the Industrial Leap can also finance research, feasibility studies and investments that are considered as strategically important initiatives. Such initiatives are carried out within the industry but contribute to greenhouse gas emissions reductions in other parts of society. The support program mainly targets the heavy industry, universities and research institutes.

One example of a project funded within the Industrial Leap is the initiative “Hydrogen Breakthrough Ironmaking Technology”, HYBRIT, that aims at transitioning from traditional coal intensive ore-based steelmaking to an innovative hydrogen-based technology. If the project succeeds, it would imply a breakthrough technology for fossil-free steel production given that the hydrogen will be produced from fossil-free electricity. The initiative has potential to cut Swedish emissions by 10 percent by substituting current processes in the companies behind the initiative.

Since 2021, the Industrial Leap is part of the green recovery for a sustainable society after the Covid-19 pandemic and partly financed by EUs Recovery and Resilience Facility, RRF. The RRF is included in NextGenerationEU that will contribute to a more environmentally friendly EU, better prepared for present and future challenges.

In the budget bill for 2023, the Government has budgeted SEK 1,354 million for the program.

Energy audits for large enterprises

The law on energy audits in large enterprises aims at promoting improved energy efficiency (SFS 2014:266)³⁵. The law requires large enterprises to conduct energy audits, including information of total energy use, as well as proposals of cost-efficient measures to improve energy efficiency. An audit must be conducted at least every fourth year.

Energy and climate advice for households, associations and small and medium-sized enterprises

Municipalities are eligible to apply for the cost of climate and energy counselling (SFS 2016:385). The counsellor provides targeted advisory services to households, associations and small and medium-sized enterprises. The counselling activities aim to increase energy efficiency, promote renewable energy and reduce greenhouse gas emissions. The service is provided by the municipalities, free of charge and commercially independent. During the period 2021-2023, 288 out of 290 Swedish municipalities offer this service to citizens and businesses.

In the budget bill for 2023, the Government has allocated SEK 120 million for the municipal energy and climate counselling service.

Regulations governing emissions of fluorinated greenhouse gases

EU Regulation (No 517/2014) on fluorinated greenhouse gases and BREF

The EU Regulation (No 517/2014) on fluorinated greenhouse gases, entered into force on 1 January 2015. The regulation strengthens the previous measures on fluorinated greenhouse gases (hydro fluorocarbons (HFCs), per fluorocarbons (PFCs) and sulphur hexafluoride (SF₆) in former EU Regulation No 842/2006. The regulation aims to cut emissions by two-thirds from current levels by 2030, and includes provisions for the use, reuse and destruction of f-gases. Most importantly, the regulation includes a mechanism for quantified emission reductions of substances containing HFCs, with a gradual decreasing cap for the total emissions of HFCs.

On 5 April 2022, the Commission presented a proposal for a regulation on fluorinated greenhouse gases that would repeal Regulation (EU) No 517/2014. The proposal is now negotiated in Council and Parliament.

The proposal aims to further reduce emissions of fluorinated greenhouse gases (F-gases). It would change the existing quota system, gradually reducing the supply of hydrofluorocarbons (HFC) to the EU market to 2.4% of 2015 levels by 2048. It would also ban F-gases in specific applications and update the rules in respect to implementing best practices, leak checking, record keeping, training, waste treatment and penalties. Finally, the proposal would also align EU legislation with the requirements of the Montreal Protocol to reduce production of HFCs.

The EU adopted a Best Available Techniques reference document (BREF) for the non-ferrous metal industry in June 2016. The specified performance requirements are to be met within four years of the adoption date. These could significantly reduce emissions from aluminum production.

³⁵ The law is part of fulfilling the EU Energy Efficiency Directive, EED (Directive 2012/27/EU)

Swedish Regulation 2016:1128 on fluorinated greenhouse gases

Swedish Regulation 2016:1128 on fluorinated greenhouse gases complements the EU regulation. Provisions in Sweden, for cooling and air conditioning and heat pump equipment include:

- requirements on leak checks in conjunction with installation, reconstruction and other interventions.
- requirements on leakage checks and certified competence, also applying to mobile equipment containing f-gases.
- the results of periodic inspection must be reported to the supervisory authority.
- the supervisory authority must be informed before the installation of equipment containing more than ten kilograms of refrigerants.
- it is prohibited to sell f-gases as refrigerants to recipients other than those laid down in Regulation.
- Upon disposal, importers and those who transfer refrigerants are required to take back any refrigerants that they delivered, free of charge, and to provide containers for this purpose.

Equipment manufactured, imported or brought into Sweden shall be provided with accurate and easy-to-understand operating and maintenance instructions.

2.2.4 TRANSPORT

Aviation

Tax on air travel

A tax on air travel was introduced 1st April 2018. The tax aims to reduce the climate impact of aviation. The tax is regulated in the Swedish act SFS 2017:1200 regarding tax on air travel. It is designed as a tax on commercial flights and is paid for passengers travelling from a Swedish airport. The airline that carries out the flight is liable to tax. Various levels of tax are levied based on the final destination (for 2023: SEK 69, 288 or 461), with a yearly indexation. The Swedish Tax Agency is the designated tax authority.

Reduction obligation for aviation

In its Budget Bill for 2021 the Government proposes to introduce a reduction obligation for aviation to introduce renewable fuel. The level is to be 0.8 % in 2021 and increase to 27% in 2030.³⁶

Aviation in the EU Emissions Trading System

Aviation is included in the EU Emissions Trading System as of 2012 in accordance with EU Regulation No 421/2014 of the European Parliament and of the Council of 16 April 2014 amending Directive 2003/87/EC. As part of the Fit for 55 legislative

³⁶ Government Bill 2020/21:1

package the European Commission is now proposing to revise the ETS aviation rules. This includes a reduced number of free allowances allocated to aircraft operators to reach full auctioning by 2027.

CO₂-differentiated landing and take-off Charge

The CO₂ Emission Charge applies to the two largest airports in Sweden. The objective is to incentivize airlines to continuously improve their CO₂ efficiency. It is designed on bonus malus principles to be revenue neutral. The CO₂ Emission Charge follows the standard landing and take-off (LTO) cycle and is based on certified engine data in the LTO cycle. Airlines also have the possibility of accounting for Sustainable Aviation Fuel (SAF) that has been used and thereby deducting the non-fossil proportion of emissions from the modulation of the charge.

Road transport

Emission performance standards for new vehicles

Manufacturers selling vehicles in the EU are subject to EU regulations (Nos 2019/631) that set emission performance standards for new passenger cars and vans, as part of the Community's integrated approach to reducing CO₂ emissions from light-duty vehicles. Under these regulations, new passenger cars should not emit an average of more than 95 g CO₂/km from 2020. New vans should not emit an average of more than 147 g CO₂/km from 2020. New standards for 2025 and 2030 were adopted by the EU during 2019. Accordingly, CO₂-emissions from new passenger cars and new light commercial vehicles are to be reduced by 37.5 percent and 31 percent respectively by 2030 compared to emission targets in 2020. In 2019 the EU also adopted CO₂-emissions standards for heavy-duty vehicles. Emissions from new heavy-duty vehicles in 2025 are to be 15 percent below the average for 2019, and 30 percent lower compared to 2019 by 2030.

EC Fuel Quality Directive

In 2009, Directive 2009/30/EC was adopted to revise the Fuel Quality Directive (98/70/EC). It amends several elements for petrol and diesel specifications and introduces requirements for fuel suppliers to reduce the greenhouse gas intensity of energy supplied for road transport (low carbon fuel standard) by 6 percent until 2020. Sweden has exceeded the reduction target of 6% for 2020. In addition, the Renewable Energy Directive (2009/28/EC) establishes sustainability criteria that must be met by biofuels if they are to count towards the obligation to reduce greenhouse gas intensity.

Urban environment agreements

Urban environment agreements is a scheme for investments in public transport and cycling infrastructure at the regional and local level in Sweden. The scheme commenced in 2015. The aim of the scheme is to promote sustainable urban environments and the measures should lead to energy-efficient solutions with low greenhouse gas emissions and contribute to achieving the environmental quality goal

Good built environment. Initially, the national plan for the transport system 2018-2029 had SEK 1 billion allocated per year to the urban environmental agreements. In the budget bill for 2023 the Government adjusted this to SEK 775 million during 2023 and 540 million during 2024 and SEK 540 million during 2025. Municipalities are eligible to apply for grants to cover part of the investment costs for public transport, cycling and freight measures. The measures should be coupled with other actions aiming at increasing the long-term sustainability of urban areas and the transport system. These actions can include increased accessibility through public transport, urban planning for housing or increased cycling and walking, lower vehicle speeds, parking policies and pricing. The scheme is administered by the Swedish Transport Administration.

State co-financing for certain regional public transport facilities

Government co-financing for certain regional public transport facilities is an investment support for infrastructure for regional public transport and improved environment and traffic safety on municipal roads and streets. Co-financing amounts to a maximum of 50 percent of the costs.

TARGETED INSTRUMENTS: renewable vehicle fuel

Emission reduction obligation (Fuel change)

In July 2018, a greenhouse gas emission reduction obligation for petrol and diesel in conjunction with fuel tax reforms, called the Fuel Change, was implemented. The emission reduction obligation establishes an obligation on petrol and diesel suppliers to reduce life-cycle carbon dioxide emissions, by gradually increasing blending with sustainable biofuels, see Table 3.1. The Reduction obligation scheme makes an important contribution to the phasing out of fossil fuels in road transport. The obligation replaces the former tax exemption for low-blended biofuels, i.e. biofuels covered by the scheme will be subject to the same tax rate per liter as fossil equivalents. At the same time, both the carbon dioxide and energy tax rates for fuels covered by the Reduction obligation scheme have been reduced. The adjustment of the carbon tax rate was implemented to reflect the reduced greenhouse gas emissions that the blend-in of sustainable biofuels entails. The energy tax rate was reduced to maintain a stable price-level for fuels. High-blended biofuels are not covered by the scheme and are, if sustainable, completely exempt from both carbon dioxide and energy tax. (More information about the tax rates are presented in chapter 2.2.1).

Table 3.1. Level of emission reductions 2018-2022 (SFS 2017:1201)

Year	2018	2019	2020	2021	2022
Diesel	19.3%	20%	21%	26%	30%
Petrol	2.6%	2.6%	4.2%	6%	7.8%

The Government proposed in its Budget Bill for 2023 that the reduction levels within the reduction obligation scheme from 1 January 2024 are reduced to the EU minimal level.³⁷ As there are different interpretations of the EU minimum level, the reduction levels for the coming years are therefore uncertain. The assumed levels of reduction when the projection of greenhouse gas emission in Sweden were produced are described in chapter 3.

Requirements for renewable fuels at filling stations

The availability of renewable fuels has been subject to legislation requiring that filling stations with annual sales of petrol and diesel above a specified level must supply at least one kind of renewable fuel. The law became effective 1 January 2006. This requirement has resulted in an increased number of mainly E85 pumps. As of 1 January 2015, the legal requirements were loosened so that filling stations selling more than 1,500 m³ of petrol or diesel must supply at least one kind of renewable fuel.

Research and demonstration

Swedish agencies are financing several large research projects covering the entire chain from cultivation of raw materials for bio-based motor fuels to the use of new fuels. These include:

- FFI – Strategic vehicle research and innovation
- F3 – Collaboration program for renewable fuels and systems
- SFC – Research on biomass gasification
- Battery funding program
- Vinnova – Innovations for a sustainable society
- Triple F (Fossil Free Freight) focusing on three major challenges: A more transport efficient society; energy efficient and fossil-free vehicles and ships; increased share of renewable fuels.

TARGETED INSTRUMENTS: composition of the vehicle fleet

Bonus malus system for new light vehicles

A bonus malus system for the purchase of new light vehicles, was implemented in July 2018. Vehicles with low emissions of carbon dioxide qualified for a bonus at purchase, while vehicles with high emissions of carbon dioxide was taxed at a higher rate for the first three years. The system covered purchases of new light passenger cars, light buses and light trucks. The aim of the system was to increase the proportion of low-emission vehicles and contribute to achieving the goal of a fossil-free vehicle fleet.

All cars were subject to at least SEK 360 per year in vehicle taxes regardless of emissions. Light petrol or diesel vehicles with high emissions of carbon dioxide were subject to an increase in vehicle tax (malus) during the first three years. Ethanol and gas-powered vehicles were exempted from the increased tax. The vehicle

³⁷ Government Bill 2022/23:1

tax for diesel-powered light vehicles in the bonus–malus-system was adjusted by converting the current fuel factor into a fuel surcharge. When the cars reached three years, the extra tax disappeared and all but light diesel vehicles were taxed as in the differentiated vehicle tax system.

Vehicles with emissions exceeding 75 grams per kilometer were subject to malus. In the range of 75–125 grams per kilometer the increased annual vehicle tax was SEK 107 per gram. For emissions exceeding 125 grams per kilometer the increased annual vehicle tax was SEK 132 per gram.

A subsequent revision of the system, effective 1 June 2022, meant that vehicles with emissions exceeding 75 grams carbon dioxide per kilometer were subject to malus and that emissions exceeding 125 grams per kilometer were taxed at SEK 132 per gram.

With effect from 8 November 2022 the Government discontinued the bonus malus system. This measure was still in effect when the projections of greenhouse gas emissions in Sweden were produced.

Differentiated vehicle tax

Since 2006, Sweden has differentiated the annual vehicle tax with respect to the vehicle's carbon dioxide emissions per kilometer. For older vehicles the tax is dependent on weight. The CO₂-related vehicle tax is SEK 22 per g CO₂/km beyond 111 g CO₂/km in mixed driving. This CO₂ component is multiplied by a factor of 2.37 for diesel cars, since diesel fuel has a lower energy tax than petrol. Cars adapted for alternative fuels such as ethanol and gas, except LPG, are taxed at a lower rate of SEK 11 per g CO₂/km beyond the first 111 g CO₂/km. Light trucks, light buses and campers were also brought into the system of CO₂-differentiated vehicle taxation as of 2011. The taxation of older cars and heavy trucks is mainly based on weight. The main purpose of the differentiation is to make car buyers choose cars with a low climate impact.

The system applies to cars sold before the bonus malus system was introduced on 1 July 2018 and will also apply again for cars “leaving” the bonus malus system three years after purchase. Light diesel vehicles will keep the fuel surcharge from the bonus malus system instead of the fuel factor of 2.37.

Tax exemption for environmentally friendly vehicles

Sweden has offered a tax exemption for environmentally friendly light-duty vehicles (EFVs) for new vehicles in their first five years according to a certain definition (SFS 2006:27). As of 1 January 2013, the definition of EFV is related to the car's curb weight and allows heavier vehicles to emit more CO₂ than lighter vehicles. The tax exemption was removed when the bonus malus system for new light vehicles started on 1 July 2018 but persists for cars sold before that date.

Reduced taxable values for company cars with advanced environmental technology

Company-registered cars represent about 50% of new car registrations in Sweden. Approximately 50% of these cars are cars that are registered in the name of a company and made available to employees for private use. The benefits of private use of a company car are subject to personal income taxes. The taxable value of the benefit corresponds on average to the market value of owning the car.

Fuel provided by the employer is taxed separately. The value of the fuel benefit corresponds to 1.2 times the market value of the fuel. Hence, employees have an incentive to choose more fuel-efficient cars and to limit the private use of company cars.

To increase the incentive to purchase company cars that use environmental technologies, green cars such as electric cars and plug-in hybrids receive relatively favorable tax treatment through a reduction of their taxable value.

In 2021 adjustments were made for taxable values to better reflect the market values, which meant that private use of company cars became slightly more costly than before.

Climate premiums for electric buses, heavy-duty vehicles and working machinery

Since January 2020 regional public transport agencies, public transport companies, municipalities and limited companies³⁸ are eligible to apply for climate premiums for electric buses, electric and renewable-fuelled heavy-duty vehicles as well as for electric tractors and mobile machinery. The budget for these premiums was SEK 170 million for 2021, 1 600 million 2022 and 462 million for 2023.

Support for electric charging infrastructure for heavy vehicles

The Government decided in its Budget Bill for 2021 on a support scheme for regional electrification pilots with charging infrastructure for heavy vehicles. The aim is to enable electrification of heavy road transport in the busiest areas. Tank infrastructure for hydrogen is also included in the support scheme.³⁹ SEK 500 million was allocated for 2021 and the budget for the applications of 2022 was set to SEK 1543 million⁴⁰.

Support for fast charging infrastructure along major routes

In July 2020 the Government decided on a new support for public fast charging infrastructure in connection with major roads in areas where fast charging is missing. The support aims at ensuring basic access to charging infrastructure for fast charging of electric vehicles throughout the country. The Swedish Transport Administration administrates the support totaling SEK 150 million during 2020-2022. The

³⁸ Which by the regional public transport authorities have been given the authority to enter into public transport contracts.

³⁹ Government Bill 2020/21:1

⁴⁰ <https://www.energimyndigheten.se/utlysningar/regionala-energipiloter/>

candidates can receive 100 percent investment support with a counter-requirement that the charging station must be in operation for five years.⁴¹

Local Climate Investment Program (Climate leap)

The Climate Leap is a comprehensive investment support scheme. Municipalities, companies, organizations and others can apply for investment support for measures to reduce climate impact. A large number of these investments relate to the transport sector, such as investments in biogas plants or the installation of charging points for electric vehicles (more about the Climate Leap in section 2.2.1).

Tax reduction for installation of green technology

With the aim to reduce greenhouse gas emissions private individuals are, since 1 January 2021, eligible to a tax reduction for installation of green technology including solar cells, systems for storage of self-produced electricity and at home charging stations. The tax reduction is given on the cost of labor and materials. For installation of at home charging stations for electric vehicles the reduction is 50%⁴² (more about the tax deduction for green technology in section 2.2.2).

Consideration of climate in long-term infrastructure planning

In 2022, the Riksdag decided on a new national infrastructure plan for 2022-2033, to be implemented by The Swedish Transport Administration with other relevant actors. The Swedish Transport Administration is responsible for long-term planning of all modes of transport. Planning is undertaken in dialogue with local and regional planning bodies. Under the Planning and Building Act (SFS 2010:900) there is a clear requirement to take environmental and climate issues into account in planning.

Environmental compensation for rail freight transport

In 2018, the government launched an environmental compensation for freight transport by rail aimed at strengthening the competitive position of rail, thereby contributing to the transfer of goods from road to railway. The budget for 2018–2019 was SEK 563 million in total. In June 2020 the Government decided on another SEK 200 million SEK. Further, in December 2020, the Government decided to prolong and develop the compensation scheme and allocated SEK 400 million per year during 2021-2025.⁴³ The yearly budget was subsequently raised to SEK 550 million. For 2022 specifically, the total funding amounts to SEK 1247 million.

Eco-bonus system to stimulate transfer from road to shipping

In 2018, the government launched a temporary eco-bonus support aimed at stimulating the transfer of goods from road to shipping to reduce

⁴¹ <https://www.trafikverket.se/tjanster/ansok-om/ansok-om-bidrag/ansok-om-bidrag-till-snabbladdningsstationer-for-elfordon/>, February 2021

⁴² Government Bill 2020/21:1

⁴³ Government Bill 2020/21:1

greenhouse gas emissions from heavy transport. The annual budget of the eco-bonus system for heavy transports was SEK 50 million for 2020-2022. The government has prolonged the support scheme until 2024 and intend to broaden its scope, although this is not yet decided, with an annual budget of SEK 100 million (Govt. Bill 2020/21:1; 2021/22:1).

Congestion tax

Congestion tax is levied in the cities of Stockholm and Gothenburg since 2007 and 2013, respectively. The tax is levied during such hours and on such places where there is considered to be congestion. Various levels of tax are levied throughout the day (in Stockholm for 2023: SEK 15–45, in Gothenburg for 2023: SEK 9–22) with a maximum amount per day of SEK 135 in Stockholm and SEK 60 in Gothenburg.

2.2.5 WASTE

Landfill Directive

The Landfill Directive (1999/31/EC) requires landfilling of biodegradable waste to be reduced and for methane to be collected from landfills, preferably with energy recovery. Sweden has, however, introduced more far-reaching national instruments resulting in earlier attained emissions reductions. The national legislation contains a ban on landfilling of organic waste since 2005. However, Sweden has also introduced requirements for the collection of methane from landfills.

Landfill tax

In 2000 a tax of 250 SEK per tonne landfilled waste was imposed on waste disposal to landfill (SFS 1999:673). The landfill tax has been increased gradually and was 573 SEK per tonne landfilled waste in 2022.⁴⁴

Ban on landfilling combustible and organic materials and methane collection

Under the Swedish Ordinance on the Landfill of Waste (SFS 2001:512), a ban on landfilling combustible materials was introduced in 2002 and a similar ban was imposed for organic material in 2005. The ordinance also regulates the collection and disposal of methane gas from landfills. The ordinance is intended to prevent and reduce adverse effects on human health and the environment from landfilling.

Biowaste collection and treatment

The EU's waste framework directive requires that bio-waste shall be sorted out and material recycled by 31 December 2023 at the latest. Bio-waste is: 1. biodegradable garden or park waste, 2. biodegradable food or kitchen waste from households, offices, restaurants, wholesalers, canteens, catering and retail premises, and 3. biodegradable food or kitchen waste from the food industry that is comparable to such waste as referred to in 2.

⁴⁴ <https://skatteverket.se/foretag/skatterochavdrag/punktskatter/avfallsskatt.4.18e1b10334e8bc80002886.html?q=avfallsskatt>

In order to meet the requirements, Sweden has implemented the requirements for all biowaste in the Swedish legislation. Sweden has also required the municipalities to collect food or kitchen waste for which the municipality is responsible by January 1, 2024 at the latest, through on-site collection and material recycling. When recycling materials by digesting food and kitchen waste, the energy is recovered as biogas. Furthermore, digestion or composting means that plant nutrients can also be utilized.

Extended producer responsibility

A set of ordinances mandates extended producer responsibility for producers of ten product groups. Producer responsibility promotes sorting, collection and recycling of certain waste flows⁴⁵. Producer responsibility aims to incentivize producers to develop more resource-efficient products that are easier to recycle and do not contain environmentally hazardous substances. It also aims to reduce the amount of waste. The legislation on extended producer responsibility contains national targets for recycling and has resulted in increased separated collection of waste fractions and increased recycling (apart from pharmaceuticals and radioactive products, where there are no specific targets).

Other waste targets

Within the Swedish environmental objectives system, the Government has decided on seven milestone targets within the waste area. The targets are about More construction and demolition waste materials are recycled and prepared for reuse to 2025, Increase the proportion of municipal waste that is recycled and prepared for reuse to 2025, Increased sorting and biological treatment of food waste to 2023, Reuse of packaging to 2030, Food losses must be reduced and more food must be produced to 2025, and Food waste must be reduced in proportion to the amount of food waste to 2025.

Measures for sustainable use of single-use plastic

The government has decided on a number of regulations that implement the EU-directive (2019/904) on single-use plastics and other measures for sustainable plastic use⁴⁶. Some of the measures are: Prohibition on the release of certain disposable products on the Swedish market, such as cutlery, straws, balloon sticks, tops, stirrers for drinks, mugs that consist of more than 15 percent plastic, plates as well as mugs and food boxes made of expanded polystyrene, A ban on the use confetti outdoor, Requirement that whoever serves food or drink in a disposable cup or disposable lunch box must offer an opportunity to have the food served in a reusable option, and Requirement that producers of the single-use plastic products that litter the most must pay littering fees.

⁴⁵ Extended producer responsibility has been developed for packaging, waste paper, end of life vehicles, tyres, electrical and electronic equipment, batteries, pharmaceuticals and radioactive products.

⁴⁶ [Regeländringar beslutade den 3 november 2021 - Regeringen.se](https://www.regeringen.se/491111/Regeländringar_beslutade_den_3_november_2021_-_Regeringen.se)

delivered to the wider public, such as landscapes, farmland biodiversity and climate change mitigation. Through the CAP's second pillar for rural development, member states have access to a wide range of measures to encourage higher environmental performance, including climate mitigation and adaptation. The policy also requires member states to allocate a minimum share of the second pillar funds to such measures.

Rural Development Programme

The second pillar of the CAP was in Sweden implemented through the Rural Development Programme for the programme period 2014–2020. This period was extended until 2022. It included investment grants for young entrepreneurs, capacity building, cooperation and innovation. Furthermore, it offered support to areas with natural constraints, animal welfare subsidies, ecological farming, and environmental and climate actions. Measures specifically contributing to climate change mitigation included those aimed at: increasing energy efficiency; production and use of renewable energy (including biogas production and establishment of perennial energy crops); conversion from fossil to renewable energy sources; improved manure handling; more efficient use of nitrogen; climate and energy advice; measures to prevent the risk of nitrogen leakage; restoration and establishment of wetlands; promotion of grass ley and catch crop production in intensive cropping areas; conservation of semi-natural pastures; and other separate projects relating to climate and energy. The programme budget for 2014-2022 was 48 billion SEK, of which about 60% was co-financed by Sweden.

New agricultural policy 2023-2027

The programme period 2023-2027 will support the transition to more sustainable production systems and has been adapted to EU laws and commitments in the area of environment and climate. This will address the climate impact from agriculture. The Strategic plan for implementation of the common agricultural policy in Sweden 2023-2027 includes several measures that are expected to contribute to reaching environmental and climate targets in line with measures within CAP during the current period.

The Swedish Rural network

The Rural Network complements the Swedish Rural Development Programme, the Ocean and Fishery Programme, and the programme for local leadership development in the Social fund and Regional fund. The network brings together actors at the local, regional and central levels for exchanging information and experiences. The network is intended to reinforce implementation of these programmes. The Swedish Board of Agriculture has been given responsibility by the government to monitor the Rural Network.

'Focus on Nutrients' advisory service

Since 2001, there is a free advisory service for farmers called "Focus on nutrients" (in Swedish: Greppa Näringen), which is financed by the current rural development

programme. The initial focus was on advice for higher nutrient efficiency in order to reduce nutrient leaching. Today, it also provides advice specifically targeting greenhouse gas emission reductions and energy efficiency.

Support for biogas production from manure

In Sweden there is a support scheme since 2015 for biogas production through anaerobic digestion of manure. The support aims to increase biogas production from manure and thereby gain two-fold environmental and climate benefits through reduced emissions from manure and the substitution of fossil energy.⁵¹ The increased digestion of manure offers several environmental benefits. It reduces both emissions of greenhouse gases and eutrophication of fresh and marine waters, as well as produces biogas for energy. The biogas generated can be used to generate electricity or heat, or as vehicle fuel. The subsidy amounts to a maximum of 0.40 SEK/kWh of biogas produced and the total amount for 2022 has been SEK 72.5 million.

Support can also be granted for investments in biogas facilities, for example through the Climate Leap programme. New from 2022 is that also investments for electricity generation from biogas may receive support through the programme.

Support for biogas production (upgrading)

In the budget for 2022, 450 million Swedish kronor were set aside for upgrading biogas (not only from manure) to biomethane and for the liquefaction of biomethane. This support is suggested to run until 2040 with the aim to reduce the insecurities connected to investments in biogas production. An increased budget has been suggested for the coming years.

2.2.7 LAND USE, LAND USE CHANGE AND FORESTRY (LULUCF)

Forest Policy and the Forest Act

The Swedish Forest Policy (as of 1993) has two overarching, equal objectives: the production objective and the environment objective.

The production objective means that forests and forest lands should be used effectively and responsibly so that they produce sustainable yields. The direction of forest production should be given flexibility in the use of what the forests produce. The environmental objective means that the natural productive capacity of forest land should be preserved, biodiversity and genetic variation in forests should be secured, forests should be managed in a manner that enables naturally occurring plant and animal species to survive in natural conditions and in viable populations,

⁵¹ Swedish Board of Agriculture (2022). <https://jordbruksverket.se/stod/fornybar-energi/godselgasstod>

threatened species and habitats should be protected and cultural heritage assets in forests and their aesthetic and social values should be safeguarded.

Under the Forest Policy, there are no production subsidies, and forest owners have considerable freedom and responsibility to independently conduct long-term sustainable forest management. The regulations in the Forestry Act concerning timber production cover the notification of felling, the lowest age for felling, requirements for reforestation, requirements for environmental protection in guidelines for thinning and measures to limit damage, including regulations to prevent insect damages. No forest management activities are allowed on forestland with lower productivity, so called non-productive forest land. Special regulations apply to certain types of forests, such as subalpine forests and deciduous forests. Examples of regulations concerning nature conservation and cultural heritage include not disturbing important biotopes, buffer zones and arable land, and leaving older trees, high stumps and dead wood in situ. Sustainable forest management influences carbon dioxide removals and emissions in various ways, through the production of renewable raw materials that can replace fossil fuels and materials that generate emissions of greenhouse gases in both Sweden and in countries importing forest products from Sweden, while maintaining or increasing carbon stocks in biomass, soils and harvested wood products.

Regulation on land drainage

The Swedish Environmental Code chapter 11 contains regulations on land drainage, which can be used to reduce emissions from peat soils with large carbon stocks. Land drainage measures are actions taken to remove water from soil or protect against water. In order for the measure to be a land drainage measure according to the Environmental Code, the purpose of the measure is to permanently increase the soil's suitability for a specific purpose, such as cultivation, development, peat cover, road construction, garden plant or golf courses.

In central parts of the southern Swedish highlands and north of the *limes norrlandicus* (the biogeographical boundary of northern Sweden), drainage may only be undertaken with a permit. In the rest of the country, and on sites specially protected under the RAMSAR Convention, such schemes are prohibited. Land drainage has decreased since the beginning of the 1990s and is now occurring only to a very limited extent.

Provisions on nature reserves and habitat protection in the Environmental Code and nature conservation agreements

In Sweden, forests and land are allocated for the conservation of biodiversity, nurture and preserve valuable natural environments, protect, restore or create valuable natural environments and for outdoor recreation. These measures in the form of nature reserves, nature conservation agreements, are also positive for carbon stocks in

forest biomass and soil carbon within the boundaries of the allocated areas by allowing the carbon stocks to increase.

Nature reserves

In Sweden, nature reserves⁵² are one of the most common ways of protecting valuable nature in the long term. At present, there are close to 5,000 nature reserves in Sweden. The seventh chapter of the Environmental Code contains the regulations for the establishment of nature reserves. The work of establishing nature reserves is led by the Swedish Environmental Protection Agency.

Nature conservation agreements

Nature conservation agreement is a civil law agreement⁵³. The property owner and the state or a municipality agree on a certain financial compensation for the property owner, for example, to refrain from logging. The Swedish Forest Agency and the Swedish Environmental Protection Agency cooperate in their implementation.

The Swedish National Forest Program

In 2015 the Government initiated a comprehensive dialogue with stakeholders within the Swedish National Forest Program. In 2018, the Government adopted a strategy for Sweden's National Forest Programme, followed by an action plan with specific measures. The action plan will be updated in dialogue with interested parties. The core of the National Forest Programme is the broad dialogue on the role forests play to ensure a sustainable society and a growing bioeconomy.

The strategy for the National Forest Programme focuses on objectives in five main areas:

- Sustainable forest management with greater climate benefits
- Multiple uses of forest resources for more jobs and sustainable growth throughout the country
- World-class innovation and processed forest products
- Sustainable use and conservation of forests as a profile issue in Sweden's international cooperation
- A knowledge leap to ensure the sustainable use and conservation of forests

Stop the bark beetle project (Stoppa borrharna)

Stop the bark beetle was a collaborative project between 20 authorities, companies and organizations in southern and central Sweden, led by the Forest Agency. The goal was, through cooperation and increased activity in the forest, to limit the attacks and damage of spruce bark beetles as far as possible. The project spread knowledge about the bark beetle to forest owners and limit the damage by collective action. The project included monitoring of infestations and damage, including development of digital support of risk mapping (GIS-tool). The project ended in 2022 to be integrated with ordinary workstreams.

Support for re-wetting of drained wetlands

⁵² <http://www.naturvardsverket.se/Var-natur/Skyddad-natur/Naturresevat/>

⁵³ <http://www.naturvardsverket.se/Stod-i-miljoarbetet/Vagledning/Skyddad-natur/Naturvardsavtal>

The Government decided in December 2020 on a new support scheme for re-wetting previously drained wetlands, which aims at providing climate benefits while also strengthening biodiversity, balance water flows, increase the addition to ground water and reduce eutrophication. The rewetting of peatland is expected to halt the CO₂ emissions caused by the drainage. The initiative is implemented primarily by raising funds within the local nature conservation initiative (LONA). The initiative is based on voluntary participation by landowners.⁵⁴ From 2023 the budget is increased by SEK 200 million annually, 2023-2025.

Rewetting of drained wetlands on organic soils on forest land

Since 1990, the Swedish state has funded the rewetting of more than 3500 ha of drained wetlands on organic soils for purposes other than climate mitigation (such as nutrient retention and biodiversity). Data of rewetting efforts from the period 1990 to 2019 vary in quality, and the total area of forest land (150 ha) is likely underestimated. Rewetting of much larger areas on forest land have been funded and reported, but they have not been registered into the utilized database.

New agricultural policy 2023-2027

For the programme period 2023-2027 support will be given to intercropping and catchcrops via two different eco schemes where the main purpose of the former is to increase carbon storage.

2.2.8 Water-borne navigation and aviation, including international bunkers in Sweden

Tax on air travel

A tax on air travel was introduced 1st April 2018. The tax aims to reduce the climate impact of aviation. The tax is regulated in the Swedish act SFS 2017:1200 regarding tax on air travel. It is designed as a tax on commercial flights and is paid for passengers travelling from a Swedish airport. The airline that carries out the flight is liable to tax. Various levels of tax are levied based on the final destination (for 2023: SEK 69, 288 or 461), with a yearly indexation. The Swedish Tax Agency is the competent tax authority.

ICAO

Within ICAO, Sweden and the EU have been pressing for action to limit greenhouse gas emissions from international aviation, using a unified global measure. ICAO decided in 2016 to develop a market-based mechanism, Carbon Offsetting and Reduction Scheme for International Aviation, CORSIA, to compensate for extra CO₂ emissions from international aviation above 2020-level. The ICAO Council adopted this mechanism in June 2018. The scheme starts with two voluntary phases, 2021-2023 and 2024-2026, with full implementation in 2027. The scheme is planned to last at least until 2035. Due to the Covid-19 pandemic, the ICAO

⁵⁴ Government Bill 2020/21:1

council decided in June 2020 that the baseline for emissions, which originally was based on an average of 2019/2020 emissions was changed to only cover emissions from 2019 for the pilot phase 2021-2023. The upcoming Assembly in 2022 will decide how the baseline will be treated for the later phases. In June 2020, the ICAO Council also decided to initiate the 2022 periodic review of CORSIA. Sweden is among the nations that have voluntarily participated in the scheme from its outset. Sweden is a long-standing member of the Committee on Aviation Environment Protection (CAEP) and relevant subgroups that have been working on the technical parts of the proposal.

CAEP is also working with analyses and policy measures for sustainable aviation fuels, metrics and possible measures for reducing emissions through operative procedures and studies of non-CO₂ effects from particles and nitrogen oxides.

In 2020, a new working group was established in CAEP with the assignment to explore the feasibility of a long-term global aspirational goal for international civil aviation CO₂ emissions reductions (LTAG), including options and roadmaps for their realization. The working group will present its work before the next ICAO Assembly meeting in 2022.

IMO

Sweden has been working actively in the International Maritime Organization (IMO) for many years, pushing for the adoption of ambitious reduction measures.

The Energy Efficiency Design Index (EEDI), which is a standardized way to describe ships' energy efficiency, was made mandatory from 2013 for most (some 85%) newly built vessels. All ships, to which the regulation applies, have to comply with the required EEDI level, which is set relative to a reference line, depending on ship type and size and year of building. The mandatory Ship Energy Efficiency Management Plan (SEEMP) was also introduced in 2013. The SEEMP is to be used in ships' management systems to improve energy efficiency in both existing and new ships. Both the EEDI and SEEMP applies to ships in international traffic with a gross tonnage of more than 400. Since 2019 the IMO data collection system for fuel oil consumption of ships (DCS) mandates all ships in international traffic with a gross tonnage of more than 5,000 to collect and report data related to fuel consumption. The system is similar to the monitoring, reporting and verification system (MRV) of EU that entered into force in 2018.

In 2018 the IMO adopted an initial strategy on the reduction of greenhouse gas emissions from ships, setting out a vision to reduce GHG emissions from international shipping and phase them out, as soon as possible during this century. Ambitions are to reduce CO₂ emissions per transport work, as an average across international shipping, by at least 40% by 2030, pursuing efforts towards 70% by 2050, compared to 2008, and to reduce the total annual GHG emissions by at least 50% by 2050, compared to 2008. IMO is now focusing on developing measures to meet

the ambitions in the initial strategy. A first measure, aiming to complement and strengthen the EEDI and SEEMP was approved in 2020 and, provided formal adoption in 2021, is expected to enter into force in 2022/2023.

Sweden actively promotes the use of batteries and alternative fuels, such as LNG, LBG, methanol and bio methanol, as well as related infrastructure. In 2015, the IMO adopted the IGF Code, which is a regulatory framework for ships using gases or other low-flashpoint fuels. Guidelines for using methanol as marine fuel (MSC.1/Circ.1621) were approved in 2020, and will be included in the IGF code after a test period of 3 to 5 years. Work on guidelines for fuel cells is also under way, which will allow for the use of hydrogen propulsion.

Many Swedish ports have invested in infrastructure allowing ships to use shore-side electricity, considerably reducing their emissions. The Port of Stockholm has introduced attractive incentives for ships using this infrastructure. All these measures form part of a national policy framework for development of alternative fuels and related infrastructure, implementing directive 2014/94/EU.

Part from greenhouse gases, emissions of black carbon from ships is also having considerable impact, not least in the Arctic. Black carbon emissions from shipping are now under review by the IMO, with a particular focus on the potential impacts of future Arctic shipping. Sweden was one of the countries that proposed to raise this issue on IMO's agenda. Sweden now works actively to complete the work on possible reduction measures, including a regulatory framework and voluntary measures to control emissions of BC from international shipping.

3 Swedish projections of greenhouse gas emissions and removals

Projections of greenhouse gas emissions in Sweden have been produced for the years 2025, 2030, 2035, 2040, 2045 and 2050. The projections are based on the policies and measures adopted by the Swedish parliament up until the end of June 2022 which means that it is a projection “with existing measures” (WEM). The base-year for the projections is 2020 in the National inventory report submission 2023⁵⁵ and the historical emissions are presented for 1990-2021. All emissions and removals of greenhouse gases use global warming potentials from IPCC Fifth Assessment Report (AR5).

When producing the projections, model-based calculations and to some extent expert evaluations have been used. The projections are based on a number of assumptions, all of which are characterised by uncertainty. The results should be interpreted with this aspect in mind. The projections can mainly be regarded as a consequential analysis of the assumptions that have been made. The method for estimating the projections is mainly developed for a medium-term or a long-term projection, which means that the projections generally do not take into consideration variations on a short-term basis.

In addition to the projections, sensitivity projections have been calculated for the emissions in the energy sector including transport and the LULUCF sector. In these sensitivity projections one or two parameters has been modified to assess the effect of that parameter.

Policies and measures are continuously developed, and new measures that have been planned since the projections with existing measures were produced, are described in section 2 on policies and measures. However, for this report, there was not enough time for producing a projection with additional measures.

3.1 Aggregate projections

Total greenhouse gas emissions in Sweden, calculated as carbon dioxide equivalents, totalled 47.8 million tonnes in 2021 (excluding The Land Use, Land Use Change and Forestry sector). Total emissions decreased by 23.7 million tonnes, or 33%, between 1990 and 2021. The projections, with existing measures, show that the total emissions of greenhouse gases, (excluding LULUCF) are estimated to be

⁵⁵ National Inventory Report Sweden, submission 2023

30.9 million tonnes of carbon dioxide equivalents in 2030 or 57% below the 1990 level. After 2030 emissions are projected to continue to decrease, and in 2050 the total emissions of greenhouse gases are estimated to be 71% below the 1990 level.

The Land Use, Land Use Change and Forestry sector (LULUCF) contributed to an annual net removal of carbon dioxide in Sweden during the period 1990-2021 and are expected to do so during the projection period as well.

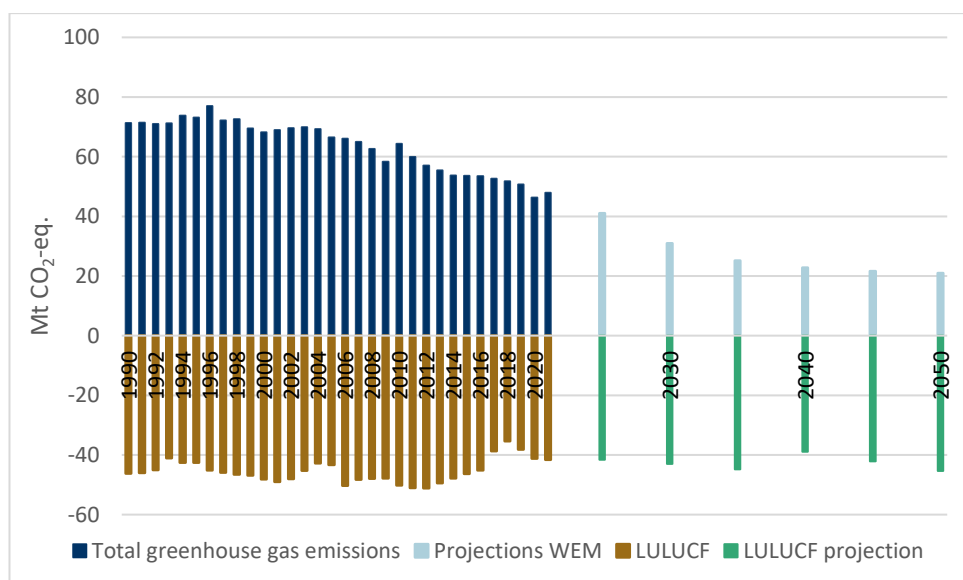


Figure 1 Historical emissions of greenhouse gases and projected emissions of greenhouse gases with existing measures (WEM).

Table 1. Historical and projected emissions/removals of greenhouse gases per sector (Mt CO₂-equivalents).

	1990	2021	2025	2030	2035	2040	2045	2050
Energy excl. transport	32.2	17.7	15.3	12.2	9.3	8.9	8.6	8.5
Transport	20.0	15.4	11.5	6.4	5.0	3.7	2.9	2.5
Industrial processes and product use	7.4	7.0	6.8	5.3	4.1	3.7	3.6	3.6
Agriculture	7.6	6.7	6.5	6.2	6.1	6.0	5.9	5.8
Waste	4.1	1.0	0.9	0.8	0.7	0.6	0.6	0.5
Total emissions	71.5	47.8	41.0	30.9	25.2	22.8	21.6	21.0
LULUCF	-46.3	-41.7	-41.6	-43.0	-44.8	-39.0	-42.2	-45.4

3.2 Projections per gas

For the year 2021 carbon dioxide emissions account for 81% of the greenhouse gas emissions, while methane emissions account for almost 9%, nitrous oxide for just over 8% and fluorinated greenhouse gases for around 2%.

During the projection period, the emissions of all gases decrease, but the share of carbon dioxide emissions is estimated to decrease to about 66% in the year 2050. The other greenhouse gases are estimated to reduce their contribution to total emissions. See Table 2 for the development of the emissions of different greenhouse gases.

Table 2. Historical and projected emissions of greenhouse gases per gas (Mt CO₂-equivalents).

	1990	2021	2025	2030	2035	2040	2045	2050
Carbon dioxide	57.5	38.5	32.2	22.8	17.5	15.4	14.4	13.9
Methane	8.3	4.5	4.4	4.0	3.9	3.8	3.6	3.5
Nitrous oxide	5.0	3.9	3.7	3.6	3.5	3.4	3.3	3.3
Fluorinated greenhouse gases	0.6	0.9	0.7	0.4	0.3	0.3	0.3	0.3
Total emissions (excl. LULUCF)	71.5	47.8	41.0	30.9	25.2	22.8	21.6	21.0

3.3 Projections by sector

In the projections, the emissions from all sectors are decreasing until 2050. The largest reduction is projected for the energy and transport sectors.

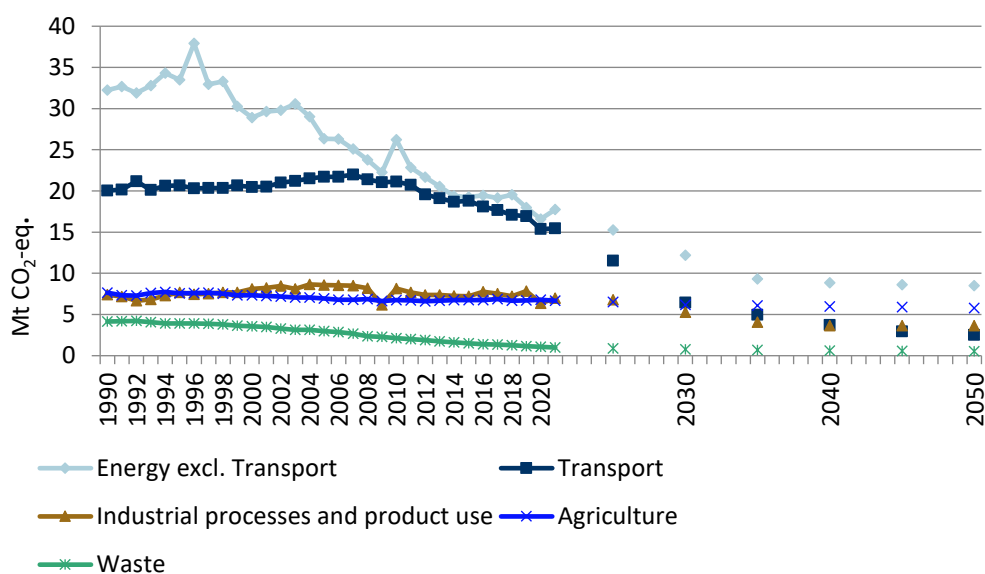


Figure 2. Historical and projected emissions of greenhouse gases by sector.

3.3.1 Energy excluding transport

Emissions from the Energy sector include emissions from electricity and heat production, refineries, manufacture of solid fuels, manufacturing industries, other sectors (including commercial/institutional, residential, agriculture, forestry and fisheries) and fugitive emissions.

Emissions of greenhouse gases by the energy sector excluding transport amounted to 17.7 million tonnes of carbon dioxide equivalents in 2021. Emissions from the energy sector have varied since 1990 depending on temperature and precipitation conditions and the state of the economy, but the trend is decreasing. The total emissions from the energy sector are estimated to decrease by 62% until 2030, and 74% until 2050, in comparison with 1990.

Table 3. Historical and projected emissions of greenhouse gases from the energy sector excluding transport (Mt CO₂-equivalents).

	1990	2021	2025	2030	2035	2040	2045	2050
Carbon dioxide	31.7	17.2	14.7	11.7	8.8	8.4	8.1	8.0
Methane	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Nitrous oxide	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Total emissions	32.2	17.7	15.3	12.2	9.3	8.9	8.6	8.5

The general assumptions on which the projections for the energy sector are based are summarized below. In addition to these, a number of specific assumptions are made for the particular sub-sector concerned.

GENERAL ASSUMPTIONS ON WHICH ESTIMATES FOR THE ENERGY SECTOR ARE BASED:

- In general, current taxes and other instruments (in place First of July 2022) are assumed to remain unchanged until 2050.
- Estimates of economic development, (%/year)
(National Institute of Economic Research)

	Reference	
	2019-2035	2035-2050
GDP	1.76	1.71
Private consumption	1.74	1.67
Export	2.72	2.28
Import	2.64	1.95

- Fossil fuel prices (2020 prices)
(European Commission)

	Base year	Reference		
	2020	2030	2040	2050
Crude oil (Euro/boe)	37	88	93	112
Coal (Euro/tonne)	40	78	83	93
Natural gas (Euro/MWh)	11	41	41	43

- Within the EU emissions trading scheme, a price of 80 euros was assumed per tonne of carbon dioxide 2030, 85 euros per tonne in 2040 and 160 euros per tonne 2050 (in 2020 price).
- In the projections a climate effect is included, based on the RCP 4.5 scenario (IPCC 2013).

3.3.2 Energy industries (Electricity- and heat production, Refineries, Manufacturing of solid fuels)

The emissions from energy industries include emissions from electricity- and heat production, refineries and manufacturing of solid fuels.

The emissions of greenhouse gases from *electricity and heat production* have varied since 1990, mainly due to temperature variations and precipitation. The production of electricity is expected to increase during the projection period while the production of district heating is expected to remain stable. However, the emissions do not increase to the same extent as production, mainly due to biofuels and incineration of waste and an increased use of wind and solar power. The emissions were 5.9 million tonnes carbon dioxide equivalents in 2021 and are projected to decrease by 63% until 2050 compared to 1990 level. In the projections, there is a decrease in production from natural gas, oil and coal while use of waste and biomass increases. The use of biomass increases in combined heat and power plants especially. Furthermore, a shift to fossil-free technology is assumed for the iron and steel industry which leads to a decrease in emissions after 2030 due to a decrease in use of residual gases.

Emissions from *refineries* have increased since 1990 due to increased production. The emissions are projected to decrease slightly until 2050, due to the assumed effect of measures performed resulting in higher efficiency and due to producing more biofuels. The emissions are projected to be 13% higher emissions in 2030 and 8% in 2050, compared to the 1990 level. Emissions from refineries are also accounted for in the sector of fugitive emissions.

The emissions from *manufacturing of solid fuels* were around 0.3 million tonnes of carbon dioxide equivalents in 2021. The emissions are estimated to remain stable until 2025 and then decrease due to an assumed shift to fossil free technology.

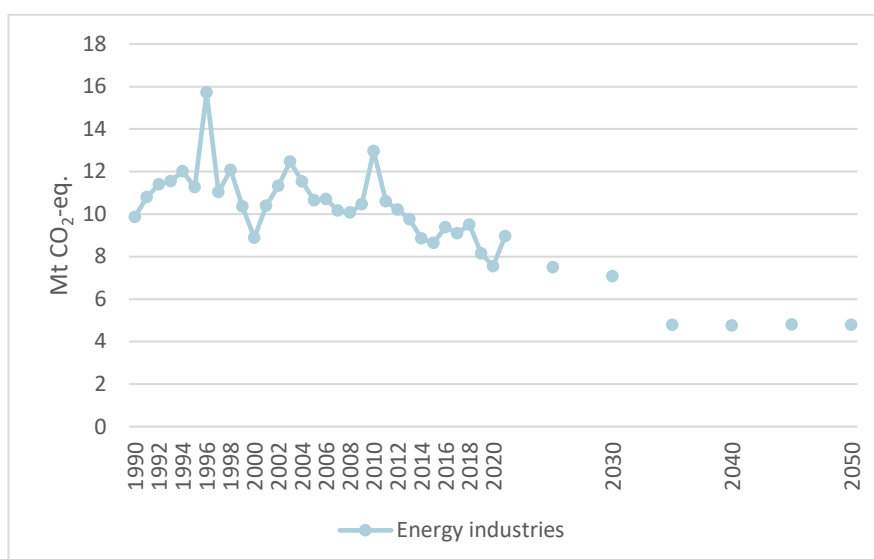


Figure 3. Historical and projected emissions of greenhouse gases from energy industries including emissions from electricity and heat production, refineries and manufacturing of solid fuels.

Table 4. Historical and projected emissions of greenhouse gases from energy industries (CRF 1A1, Mt CO₂-equivalents).

	1990	2021	2025	2030	2035	2040	2045	2050
Carbon dioxide	9.7	8.7	7.3	6.9	4.6	4.6	4.6	4.6
Methane	0.01	0.07	0.05	0.05	0.05	0.05	0.05	0.05
Nitrous oxide	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total emissions	9.9	9.0	7.5	7.1	4.8	4.8	4.8	4.8

ASSUMPTIONS ON WHICH ESTIMATES FOR ENERGY INDUSTRIES ARE BASED:

- 2 of Sweden's 8 reactors were shut down before 2020. This leads to a decrease of the nuclear capacity in Sweden. The remaining nuclear power plants are assumed to have an economic working life of 60 years, which means until 2045. Then the lifetime is lengthened by 20 years for the three youngest reactors.
- Projections of the Swedish sector price for electricity for the years 2030 and 2050. (Annual average, 2020 price level in SEK/kWh)

	2020	2030	2040	2050
Electricity price	0.22	0.43	0.49	0.52

- Electricity production from hydropower (incl. small-scale hydropower) and nuclear power production has been assumed to be, (TWh):

	2020	2030	2040	2050
Hydropower	62	67	67	68
Nuclear power production	47	52	52	52

- Based on the decision in force regarding the Swedish-Norwegian electricity certificate system, it was assumed that the system is operational during the whole projection period and will lead to an increase of 28.4 TWh of new renewable electric power production in 2020 compared to 2012's level. This production goal is considered consistent after year 2020 and the system operational until 2050.
- A shift to fossil-free technology is assumed for the iron and steel industry which leads to a decrease in emissions after 2030 from manufacturing of solid fuels and electricity and heat production.
- For the refinery sector, the emissions are assumed to decrease slightly during the projection period, in accordance with higher efficiency and the increasing production of renewable fuels.

3.3.3 Combustion in manufacturing industries

The emissions of greenhouse gases from combustion in manufacturing industries were 6.3 million tonnes of carbon dioxide equivalents in 2021. It should be noted that combustion in manufacturing industries represents a part of the total industrial emissions. To cover all industry related emissions, emissions from industrial processes should be added to the emissions from combustion (see section 3.3.7).

In 2021, the emissions from combustion in manufacturing industries were 42% lower than the 1990 level and are projected to be 65% lower in 2030 and 76% lower in 2050 compared to the 1990 level. It should be noted that the emission trends have varied between years, which is likely connected to the economic development. Some energy-intensive industries account for a large share of emissions in the sector. In 2021, the iron and steel industry accounted for 21% of the emissions respectively and the mineral industry accounted for 17%.

Emissions are expected to decrease until 2050 because the use of biofuel and electricity is expected to continue to increase while use of fossil fuels are decreasing. The decreasing emissions are mainly explained by a decrease in emissions from the pulp and paper industry due to a shift from using fossil fuels to biofuels. The decrease after 2030 and 2035 can also be explained by an assumed shift in technology for the iron and steel industry.

Emissions from working machinery in the industry were 1.3 million tonnes of carbon dioxide equivalents in 2021, which is an increase by 29% compared to 1990 level. The emissions are projected to decrease by 64% until 2050 compared to 1990 level, mainly due to an increased blending of biofuels due to the emission reduction obligation.

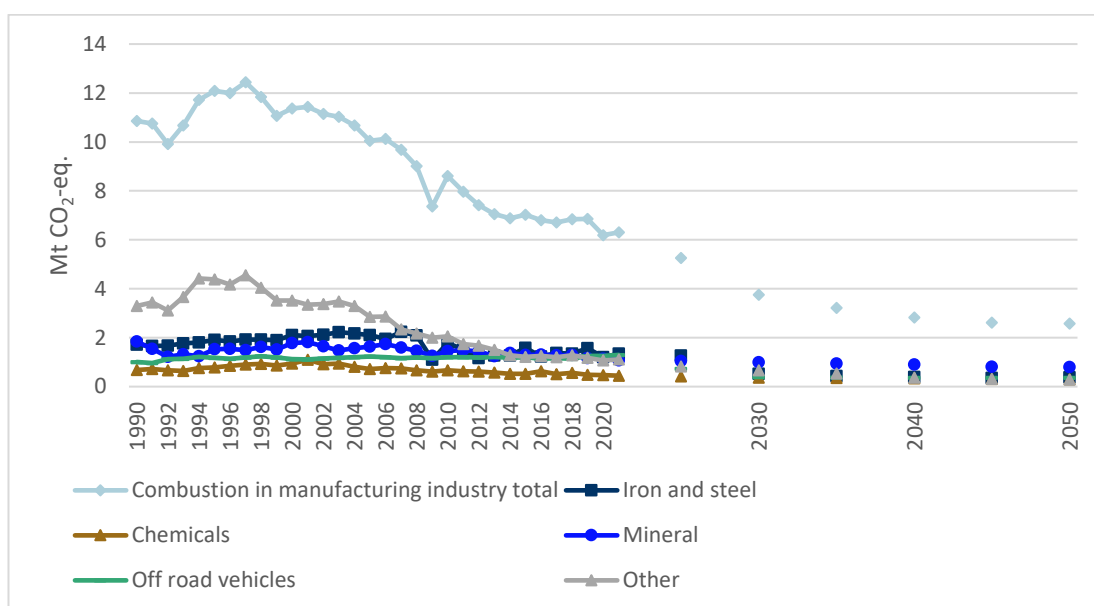


Figure 4. Historical and projected emissions of greenhouse gases from combustion in manufacturing industries.

Table 5. Historical and projected emissions of greenhouse gases from combustion in manufacturing industries (CRF 1A2, Mt CO₂-equivalents).

	1990	2021	2025	2030	2035	2040	2045	2050
Carbon dioxide	10.7	6.2	5.1	3.6	3.1	2.7	2.5	2.4
Methane	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Nitrous oxide	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total emissions	10.9	6.3	5.3	3.8	3.2	2.8	2.6	2.6

ASSUMPTIONS ON WHICH ESTIMATES FOR MANUFACTURING INDUSTRIES ARE BASED:

- The projection for manufacturing industries is based on assumptions on the economic development for the respective industry, the extent of energy efficiency efforts and assumptions on future fuel and energy prices.
- Annual growth in value-added for the periods 2019-2035 and 2035-2050 (National Institute of Economic Research):

Industry	Annual growth (%) 2019-2035	Annual growth (%) 2035-2050
Pulp and paper industry	1.84	2.25
Chemical industry	1.85	2.09
Iron and steel industry	0.53	1.49

Manufacture of non-metallic mineral products	1.35	1.52
Non-ferrous metalworks	1.20	2.40
Engineering industry	1.52	2.57
Mining	1.11	2.18

- A shift to fossil-free technology is assumed for the iron and steel industry which leads to a decrease in emissions after 2030.
- For working machinery, the blending of biofuels is assumed to increase gradually aligned with the emission reduction obligation until 2030, with levels of 28% for petrol and 66% for diesel 2030. After 2030 the level of blending of biofuels in diesel and petrol is assumed to be unchanged. The emission reduction obligation establishes an obligation on petrol and diesel suppliers to reduce life-cycle carbon dioxide emissions, by gradually increasing blending with sustainable biofuels.

3.3.4 Households, premises and combustion in agricultural, forestry and fishing sectors

The emissions from households and premises and from combustion in the agricultural, forestry and fishing sector decreased between 1990 and 2021 from 11.1 to 2.4 million tonnes of carbon dioxide equivalents and are expected to continue to decrease. The emissions in 2021 are 78% lower than in 1990 and are expected to decrease further to 91% and 93% below the 1990 level in 2030 and 2050 respectively. The decrease is mainly due to replacement of individual oil-fuelled boilers for heating and hot water purposes in households and premises, with district heating, electric heating, heat pumps and biomass. There have been strong incentives for this shift and some contributing factors are energy and carbon dioxide taxes and a rise in prices on fossil fuels. The shift to electric and district heating leads to decreased emissions in this sector. On the other hand, emissions are generated during production in energy industries. Since the increased production of electricity and heat mainly is based on biomass and waste and district heating is a more efficient way of heating, the emissions still decrease until 2050.

In addition, the total energy use for heating (temperature-corrected) is expected to decrease in the sector during the projection period. The decrease is due, among other things, to the shift to alternative types of heating. The shift from oil to heat pumps and district heating increases energy efficiency of the sector and the increased use of heat pumps reduces the amount of commercial energy supplied for heating. Moreover, an increase in energy efficiency through measures such as improved insulation and a switch to more energy-efficient windows are expected to reduce the demand for heating. The decrease in energy use is however offset by increased use of household electricity and of increased number of new buildings.

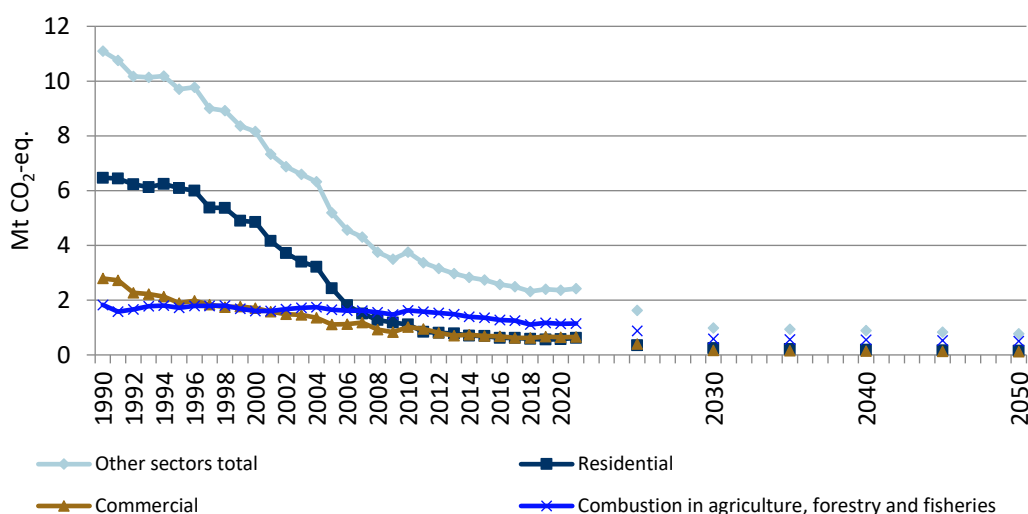


Figure 5. Historical and projected emissions of greenhouse gases from combustion in households, premises, agriculture, forestry and fisheries sectors.

The emissions from combustion in the agricultural, forestry and fishing sectors are expected to decrease during the projection period. The emissions from energy use in the agricultural sector are expected to decrease until 2050, as a consequence of a reduction in the use of diesel fuel for working machines and a reduction in the oil consumption for buildings. The emissions from working machinery in the agriculture and forestry sector are expected to decrease during the projection period due to an increased use of biofuels due to the emissions reduction obligation. Emissions from machinery used by fisheries are assumed to stay unchanged during the projection period.

Carbon dioxide emissions account for around 95% of the total emissions from combustion in households, premises and in the agricultural, fishing and forestry sectors in 2021 and are expected to account for 90% of the total emissions in 2050 as well. The share of methane and nitrous oxide emissions are small, but combustion in homes and commercial premises is the largest source of methane emissions in the energy sector. According to the projections, methane emissions decrease with 60% between 1990 and 2030 and with 75% between 1990 and 2050. The emission of nitrous oxide decreases with 30% until 2030 and with 46% until 2050 in comparison to 1990.

Table 6. Historical and projected emissions of greenhouse gases from households, premises, agriculture, forestry and fisheries sectors (CRF 1A4, Mt CO₂-equivalents).

	1990	2021	2025	2030	2035	2040	2045	2050
Carbon dioxide	10.9	2.3	1.5	0.9	0.8	0.8	0.8	0.7
Methane	0.1	0.07	0.06	0.05	0.05	0.04	0.03	0.03
Nitrous oxide	0.1	0.07	0.06	0.06	0.05	0.05	0.05	0.05
Total	11.1	2.4	1.6	1.0	0.9	0.9	0.8	0.8

ASSUMPTIONS ON WHICH ESTIMATES FOR HOUSEHOLDS, PREMISES AND COMBUSTION IN THE AGRICULTURAL, FORESTRY AND FISHING SECTORS ARE BASED:

- The projections on energy use in households, premises and combustion in the agricultural, forestry and fishing sectors are based on assumptions on future temperature conditions, population trend, stock of housing and commercial premises, energy prices, investment costs, technological development and economic development.
- Future temperature conditions are based on IPCC scenario RCP 4.5.⁵⁶

- Population growth (Statistics Sweden)

	2020	2030	2040	2050
Population	10 379 295	10 917 101	11 365 035	11 835 808

- The number of new apartments in single-dwelling houses and multi-dwelling houses in the projection is assumed to increase by 361 000 from 2022 to 2030 and by 430 000 from 2030 to 2050.
- Heated area of new single dwelling houses and new apartment buildings is assumed to be 164 m² and 61 m² respectively.
- The projections for energy use from working machinery in agricultural sector are based on the projections in the agriculture sector. For working machinery in forestry the projections are based on projections of different processes in forest management. The energy use for households and premises are assumed to be at the same level as today. The energy use for fisheries is assumed to increase until 2025 and then it is assumed to stay the same level until 2050.
- For working machineries, the blending of biofuels is assumed to increase gradually aligned with the emission reduction obligation until 2030, with levels of 28% for petrol and 66% for diesel 2030. After 2030 the level of blending of biofuels in diesel and petrol is assumed to be unchanged. The emission reduction obligation establishes an obligation on petrol and diesel suppliers to reduce life-cycle carbon dioxide emissions, by gradually increasing blending with sustainable biofuels.

3.3.5 Emissions from Fugitive emissions

The emissions from fugitive emissions started to increase in 2006 due to new installations with capacity to manufacture hydrogen gas⁵⁷. The production and emissions from refineries are assumed to increase but are counteracted by the assumed

⁵⁶ RCP: Reference Concentration Pathway

⁵⁷ The emissions in 2021 are low due to part of emissions are included in 1A1b, due to prevailing confidentiality rules.

capture of CO₂ at one installation after 2030. The emissions are projected to be 12% lower in 2030 and 2050 compared to 1990. The emissions from flaring in the iron and steel industry are also expected to remain at the same level during the entire projection period.

Table 7. Historical and projected emissions of greenhouse gases from fugitive emissions (CRF 1B, Mt CO₂-equivalents).

	1990	2021	2025	2030	2035	2040	2045	2050
Carbon dioxide	0.3	0.009	0.8	0.3	0.3	0.3	0.3	0.3
Methane	0.09	0.04	0.05	0.05	0.05	0.05	0.05	0.05
Nitrous oxide	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.001
Total emissions	0.4	0.05	0.9	0.4	0.4	0.4	0.4	0.4

3.3.6 Domestic transport

The emissions from domestic transports amounted to 15.4 million tonnes of carbon dioxide equivalents in 2021. Road transportation contributes with the majority of emissions from the sector (approximately 92%), while emissions from navigation, civil aviation and railways are small. The total emissions from transport have decreased since 2010. The trend is mainly explained by an increase in energy efficiency and an increased use of biofuels. The energy efficiency is due to a shift from petrol-powered cars to diesel-powered cars while cars have also become more energy efficient mainly due to EU-regulations.

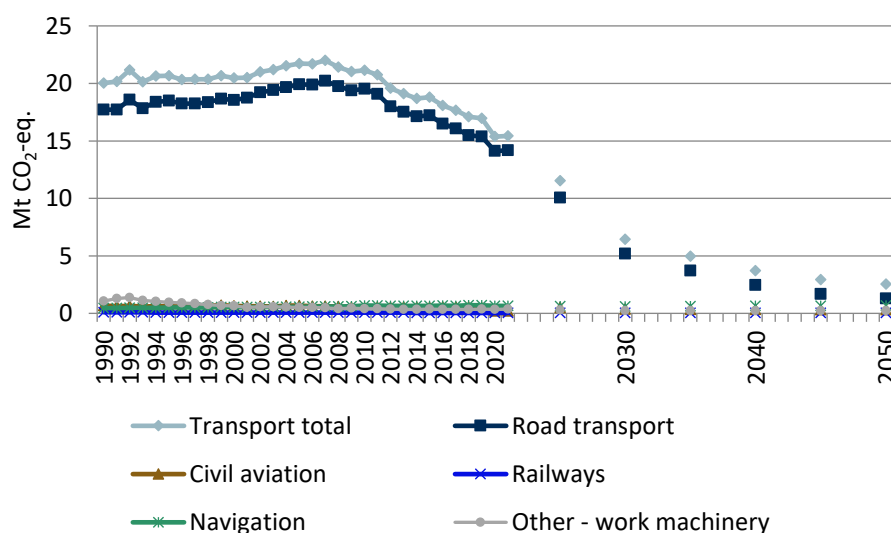


Figure 6. Historical and projected emissions of greenhouse gases from transport sector.

In the projection the emissions will continue to decrease until 2050, especially the emissions from road transport that are projected to decrease from 14.2 million tonnes in 2021 to 1.3 million tonnes in 2050, mainly due to increased use of

biofuels and increased numbers of electric vehicles. The increased use of biofuels is due to the emission reduction obligation. The increase in numbers of electric vehicles and improvement of energy efficiency is due to EU regulations that limits the emissions from new cars, light-duty lorries and heavy-duty vehicles.

Emissions from domestic aviation have decreased during the last years, mostly due to higher efficiency, and were very low in 2020-2021 due to the covid-19 pandemic. The emissions are projected to increase after the pandemic but then decrease during the projection period. Emissions from domestic aviation decreases due to increased use of biofuels due to emissions reductions obligation and continued efficiency improvement. The tax on air travel is also anticipated to influence domestic air travel by reducing the demand.

Emissions from domestic navigation were 0.6 million tonnes of carbon dioxide equivalents in 2021. The emissions are projected to be around 0.7 million tonnes in 2050. The emissions from larger ships are projected to increase slightly due to assumed increased volume of freight transports. The emissions from small boats are projected to decrease due to higher use of biofuels in accordance with the emissions reduction obligation.

Emissions from railways have decreased from 0.1 million tonnes of carbon dioxide equivalents in 1990 to 0.05 million tonnes in 2021. Railway traffic is expected to increase during the entire projection period. However, railway traffic is mainly powered by electricity and emissions are projected to be around 0.04 million tonnes in future years.

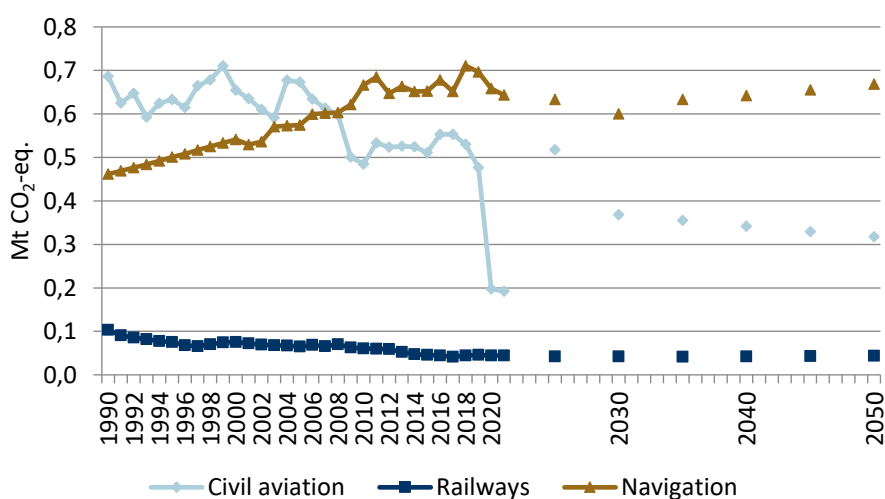


Figure 7. Historical and projected emissions of greenhouse gases from domestic aviation, navigation and railways.

Table 8. Historical and projected emissions of greenhouse gases from different transport modes (CRF 1A3, Mt CO₂-equivalents).

	1990	2021	2025	2030	2035	2040	2045	2050
Road transportation	17.7	14.2	10.1	5.2	3.7	2.5	1.7	1.3
Civil aviation	0.7	0.2	0.5	0.4	0.4	0.3	0.3	0.3
Navigation	0.5	0.7	0.6	0.6	0.6	0.6	0.7	0.7
Railways	0.1	0.05	0.04	0.04	0.04	0.04	0.04	0.04
Other	1.0	0.4	0.3	0.2	0.2	0.2	0.2	0.2

Table 9 Historical and projected emissions of greenhouse gases from domestic transport (CRF 1A3, Mt CO₂-equivalents).

	1990	2021	2025	2030	2035	2040	2045	2050
Carbon dioxide	19.7	15.2	11.3	6.2	4.8	3.6	2.8	2.4
Methane	0.2	0.06	0.06	0.05	0.05	0.05	0.04	0.04
Nitrous oxide	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1
Total emissions	20.0	15.4	11.5	6.4	5.0	3.7	2.9	2.5

3.3.6.1 ASSUMPTIONS ON WHICH ESTIMATES FOR TRANSPORT ARE BASED:

- The transport projections are based on several assumptions regarding number of inhabitants, disposable income of households, GDP, fuel price, exports and imports. Of importance are also assumptions regarding technical development, energy efficiency, mileage and introduction of renewable fuels.
- Traffic volume for cars in the projections is based on the historical relationships between traffic volume trends, GDP and cost of driving.
- Traffic volumes for light-duty lorries and heavy-duty lorries in the projection are based on the respective relationships between the traffic volume trends and GDP.
- EU emission regulations set for cars, heavy-duty vehicles and light duty vehicles respectively. CO₂-emissions from new passenger cars and new light commercial vehicles are to be reduced by 37.5 percent and 31 percent respectively by 2030 compared to average emissions 2021. Emissions from new heavy-duty vehicles in 2025 are to be 15 percent below the average for 2019, and 30 percent lower compared to 2019 by 2030.
- The blending of biofuels is assumed to increase gradually aligned with the emission reduction obligation until 2030, with levels of 28% for petrol and 66% for diesel 2030 for road transport and small boats. The emission reduction obligation establishes an obligation on petrol and diesel suppliers to reduce life-cycle carbon dioxide emissions, by gradually increasing blending with sustainable biofuels. After 2030 the level of blending of

biofuels in diesel and petrol is assumed to be unchanged and the volume of biofuels is thus solely dependent on the fuel usage.

- The blending of biofuels for aviation is assumed to increase gradually aligned with the emission reduction obligation until 2030, with indicative levels of 27% for jet kerosene in 2030.
- Pure and high-blended biofuels is fully exempted from tax in 2022, where after the exemption is removed.

3.3.7 Industrial processes and product use

The sector for industrial processes and product use includes greenhouse gas emissions from the materials used in the industrial processes and the use of solvents and other products, including the use of fluorinated greenhouse gases.

The total emissions from the sector for industrial processes and product use amounted to 7 million tonnes of carbon dioxide equivalents in 2021. Emissions in this sector have varied somewhat since 1990, mainly due to variation in production volumes and economic fluctuations. The greenhouse gas emissions are projected to decrease until 2050 to 51% below the 1990 level. The decrease compared to 1990 is mainly caused by a decrease in carbon dioxide from industrial processes and in emissions of fluorinated greenhouse gases.

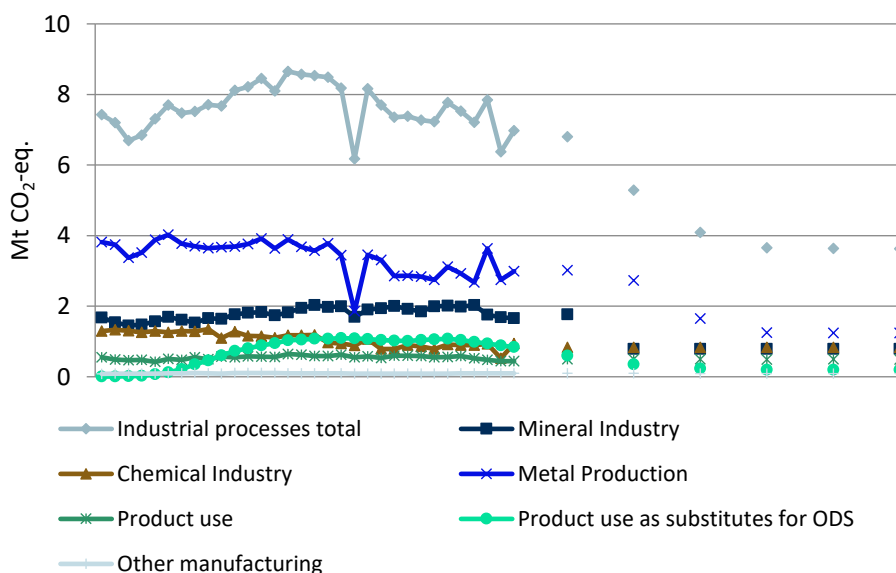


Figure 8 Historical and projected emissions of greenhouse gases from different industries and product use

The emissions of carbon dioxide equivalents from industrial processes were 17% lower in 2021 compared to the level in 1990 and are expected to decrease 57% until 2050. The decrease is mainly due to a decrease in emissions from the metal industry until 2050 and especially after 2030, due to a shift to fossil-free technology in the iron and steel industry. The emissions of carbon dioxide from the mineral industry are expected to decrease until 2050 compared with 1990 due to an assumed capture and storage of CO₂. The emissions of greenhouse gases from chemical industry are assumed to remain around the same level as in 2021. The emissions from fuel combustion in industry are reported in the energy sector.

In 2021, the total emissions from non-energy products from fuels and solvent use were almost 0.3 million tonnes of carbon dioxide equivalents, which is a decrease of 14% compared with 1990. The use of solvents leads to emissions of volatile organic compounds. The carbon in these emissions is assumed to be oxidised to carbon dioxide. Emissions of carbon dioxide from use of solvents have decreased by 32% since 1990 and are estimated to continue to decrease until 2050.

The major emissions of fluorinated greenhouse gases in 2021 emanated from products used as substitutes for ozone depleting substances. The total greenhouse gas emissions from this type of product use amounted to 0.9 million tonnes of carbon dioxide equivalents in 2021. Emissions of fluorinated greenhouse gases are showing an increasing trend between 1990 and 2009 before starting to decrease.

A decrease of emissions of fluorinated greenhouse gases until 2050 is expected due to a ban on their use that came into effect as a consequence of EU regulations. The EU regulation limits the total amount of fluorinated gases sold in the EU. Fluorinated greenhouse gases have also been banned in applications where less harmful alternatives are widely available (e.g. fridges, air conditioning systems as well as foams and aerosols). Furthermore, the regulation requires checks of current equipment to prevent leakages as well as recovery of the gases at the end of the equipment's lifetime.

Table 10. Historical and projected emissions of greenhouse gases from industrial processes and product use sector (CRF 2, Mt CO₂-equivalents).

	1990	2021	2025	2030	2035	2040	2045	2050
Carbon dioxide	5.9	5.9	5.9	4.7	3.6	3.2	3.2	3.2
Methane	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Nitrous oxide	0.8	0.2	0.2	0.2	0.2	0.2	0.2	0.2
HFC	0.006	0.8	0.6	0.4	0.2	0.2	0.2	0.2
PFC	0.5	0.04	0.05	0.05	0.05	0.05	0.05	0.05
SF6	0.1	0.04	0.04	0.05	0.04	0.04	0.04	0.03
Total emissions	7.4	7.0	6.8	5.3	4.1	3.7	3.6	3.6

ASSUMPTIONS ON WHICH ESTIMATES FOR INDUSTRIAL PROCESSES AND PRODUCT USE ARE BASED:

- The projection is based on historical trends as well as economic projections for each industry.
- The assumption on projected value added is the same as those for manufacturing industries and construction (CRF 1A2).
- For the iron and steel industry, a shift to a production technology with lower emissions are assumed for one installation after 2030 and one after 2035.
- For mineral industry carbon capture and storage of CO₂ is assumed after 2030.

3.3.8 Agriculture

In 2021, emissions of greenhouse gases from agriculture amounted to 6.7 million tonnes of carbon dioxide equivalents. In comparison with 1990, emissions have decreased by 13%. The decrease is largely due to an increased efficiency in the production and a reduced number of cattle. This in turn has led to lower methane emissions from the digestion process in ruminant animals and to reduced emissions of methane and nitrous oxide from manure. Emissions of nitrous oxide from agricultural land have also declined as a result of a reduced cereal acreage, reduced use of fertilizers, reduced nitrogen leaching and transition from solid manure to slurry management.

Greenhouse gas emissions are projected to decrease to 6.2 million tonnes carbon dioxide equivalents in 2030 or by 19% compared with 1990 level and then further decrease by 24% in 2050. Emissions are estimated to decrease mainly a result of continuous decline in cattle population. The reduced numbers of dairy cows until 2050 are mainly due to the assumptions of increased productivity and the development of product prices.

Methane emissions from animal digestion are projected to decrease from 3.3 million tonnes of carbon dioxide equivalents in 2021 to 2.9 million tonnes of carbon dioxide equivalents in 2050. Emissions from manure management are projected to decrease from 0.6 million tonnes of carbon dioxide equivalents in 2021 to 0.5 in 2050.

Emissions from agricultural land are also projected to decrease, from 2.7 in 2021 to 2.3 million tonnes of carbon dioxide equivalents in 2050 in this projection. Emissions of carbon dioxide from agriculture are relatively small and are related to liming and urea application. In 2021, the emissions amounted to about 0.1 million tonnes.

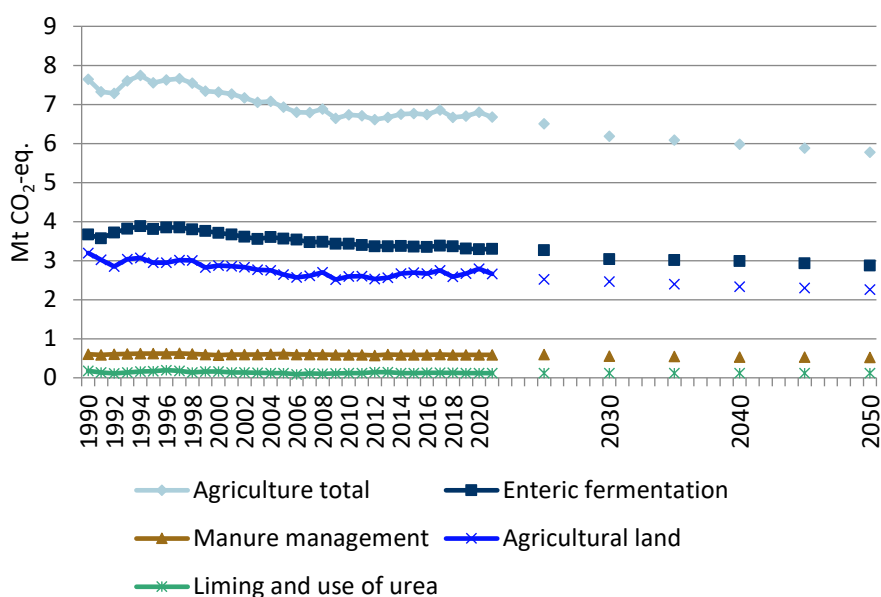


Figure 9. Historical and projected emissions of greenhouse gases from agriculture

Table 11. Historical and projected emissions of greenhouse gases from agriculture per gas (CRF 3, Mt CO₂-equivalents).

	1990	2021	2025	2030	2035	2040	2045	2050
Methane	3.9	3.6	3.6	3.3	3.3	3.3	3.2	3.1
Nitrous oxide	3.5	3.0	2.8	2.7	2.7	2.6	2.6	2.5
Carbon dioxide	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total agriculture	7.6	6.7	6.5	6.2	6.1	6.0	5.9	5.8

Table 12. Historical and projected emissions of greenhouse gases from agriculture (CRF 3, Mt CO₂-equivalents).

	1990	2021	2025	2030	2035	2040	2045	2050
Enteric fermentation	3.7	3.3	3.3	3.0	3.0	3.0	2.9	2.9
Manure management	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.5
Agricultural land	3.2	2.7	2.5	2.5	2.4	2.3	2.3	2.3
Liming/Use of urea	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total agriculture	7.6	6.7	6.5	6.2	6.1	6.0	5.9	5.8

ASSUMPTIONS ON WHICH ESTIMATES FOR THE AGRICULTURAL SECTOR ARE BASED:

- The projections are based on assumptions on prices, productivity and available areas and buildings.

- The prices are based on the average prices for 2021 in Sweden and price projections from OECD/FAO⁵⁸ until 2030, with an extrapolation to 2050.
- Assumed growth in productivity per year:

	Change per year
Harvest	+0.5%
Milk yield	+1%
Swine per sow	+1,5%
Supplies	-0.5%
Labour	-1.5%

- Assumed availability of buildings: 55% of current buildings are assumed to be in use in 2030 with only maintenance needed, 9% are disposed and 36% can be used if renovations are made.
- The current agricultural policy (CAP) in 2023-2027 is assumed to continue until 2050.

3.3.9 Waste

Total emissions from the waste sector in 2021 amounted to 1 million tonnes of carbon dioxide equivalents, which is a reduction of 76% compared with 1990. Methane emissions from landfills are projected to decrease by 98% until 2050 compared with 1990. The main cause for the decrease is the ban on depositing combustible materials in landfills, which was introduced in 2002, and the ban on depositing organic materials in landfills, which was introduced in 2005. Furthermore, a tax on depositing waste in landfills was introduced in 2000.

The emissions of carbon dioxide from waste incineration and nitrous oxide from waste-water handling are low and are expected to remain stable during the entire projection period. However, emissions of nitrous oxide and methane from biological treatment of solid waste have shown an increasing trend and emissions are expected to increase slightly during the period due to increased production of biogas.

⁵⁸ OECD/FAO. 2021. OECD-FAO Agricultural outlook 2021-2030. OECD Publishing.

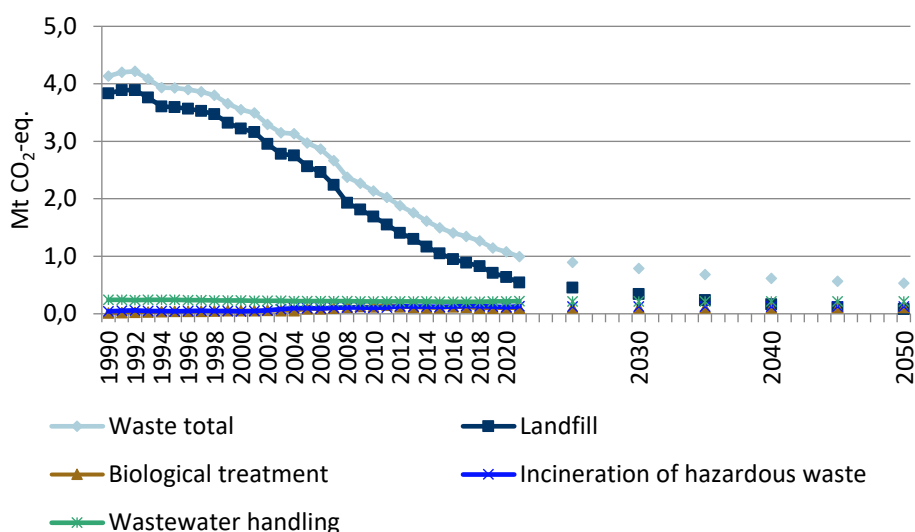


Figure 10. Historical and projected emissions of greenhouse gases from the waste sector.

Table 13. Historical and projected emissions of greenhouse gases from the waste sector (CRF 5, Mt CO₂-equivalents).

	1990	2021	2025	2030	2035	2040	2045	2050
Carbon dioxide	0.04	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Methane	3.9	0.7	0.6	0.5	0.4	0.3	0.2	0.2
Nitrous oxide	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total	4.1	1.0	0.9	0.8	0.7	0.6	0.6	0.5

ASSUMPTIONS ON WHICH ESTIMATES FOR THE WASTE SECTOR ARE BASED:

- The projections are based on the existing policies and measures for reduced landfilling of organic waste, such as the prohibition of landfilling and landfill tax, and have been calculated partly on the basis of estimates of future quantities of landfilled waste, the emergence of alternative treatment capacity and future efficiency in gas recovery at landfills.
- The projections of emissions from biological treatment of solid waste are based on assumed continued increasing production.

3.3.10 Land Use, Land Use Change and Forestry (LULUCF)

The LULUCF-sector contributed to the total greenhouse gas budget with an annual net removal of greenhouse gases in Sweden during the period 1990-2021. During the period the annual net removals have varied between 35 and 50 million tonnes of carbon dioxide equivalents with a decreasing trend in the latest years. The total size and variation of net removal in the LULUCF-sector is mainly affected by the carbon stock change in forest land, and changes in the carbon pool *living biomass* constitute the major part of these changes in net removals followed by carbon stock

changes in mineral soils. Net removals are influenced by inter alia growth, harvests and natural disturbances such as drought, spruce bark beetle, fires and storms on forest land.

The net removals for LULUCF are projected to be around 40 million tonnes of carbon dioxide equivalents per year until 2050 with some variations over time. The projections for removals of carbon dioxide from forest land is based on the assumption that the current harvest intensity (2016-2020) persists over time.

A sensitivity analysis has been performed for the LULUCF projection, simulating the forest using the same settings but different harvest levels and gross increment. The net removals for the LULUCF-sector are calculated to around 20-45 million tonnes of carbon dioxide equivalents per year in the projection period when including all alternatives.

The projections are based on a number of assumptions which are characterised by uncertainties. The reported net removals in *Forest land remaining forest land* shows a decreasing trend in the latest years which has been attributed to a decline in growth. The decreasing growth in turn is explained mainly by changes in climatic conditions accentuated by a severe drought in 2018. In addition, the harvest rate has been slightly higher than normal. The simulation model is based on normal weather conditions and the predicted harvest is based on the average harvest intensity 2016-2020 which was lower than the annual harvest for the last two years. Therefore the predicted net removals are generally higher than the net removals for the last reported years as the harvest intensity is slightly lower than the last years and due to the fact that patterns of natural fluctuations in weather conditions that affect the growth is difficult to predict.

No further sensitivity analysis and simulations were done related to the increased risk of natural disturbances or to random variations in weather conditions. However, the effect of disturbances in line with the severe drought and the large forest fires in 2018 as well as the massive spruce bark beetle attacks the past 5 years may severely affect the net removals in living biomass and also affect other carbon pools accordingly. Measurements within the National Forest Inventory have indicated a decreasing growth, mainly due to unfavourable weather conditions. In the worst case, if the decrease in growth persists, this could lead to a reduction in the net removals of living biomass in the order of 10 million tonnes of carbon dioxide per year in 2020-2050.

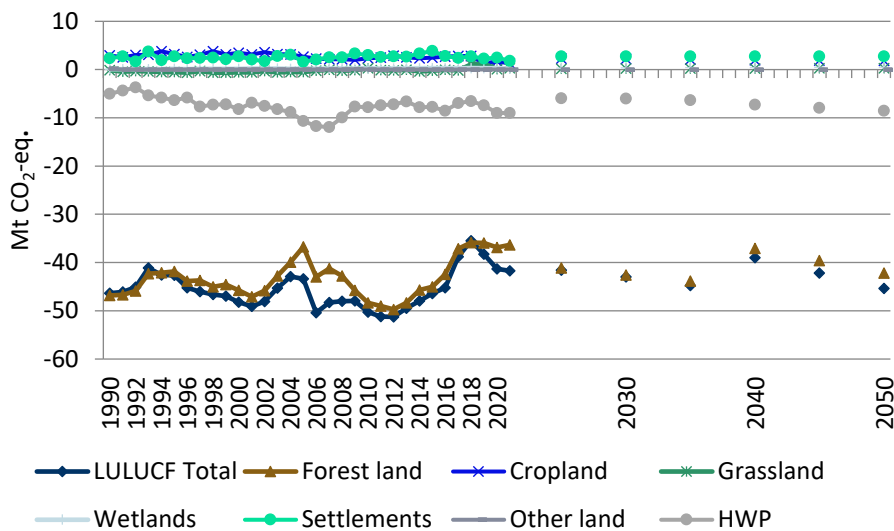


Figure 11 Historical and projected net emissions (+) and net removals (-) from the LULUCF-sector and its subcategories in Mt CO₂-equivalents per year.

Net emissions from cropland have varied during the period 1990 to 2021. The inter-annual variation in net emissions in cropland depends mainly on the variation in net emissions from mineral soils, which depends on climate variability and on the variation in the cultivation of different crops between years. The emissions of carbon dioxide from croplands originate mainly from the cultivation of drained organic soils. Emissions from drained organic soils are the largest sources in croplands. The emissions are projected to decrease slightly based on a projected slight decrease in area and the average net emissions per area for the latest ten years.

Net emissions from settlements were in the range of around 1.5-4 million tonnes of carbon dioxide equivalents per year in the period 1990 to 2021. Emissions are caused by urbanisation, establishments of power lines and forest roads. These emissions are projected to be at the same level for the whole projection period as the average for the latest ten years.

The carbon stock changes in grassland and wetlands were small during the period 1990 to 2021 and are projected to stay low for the projection period.

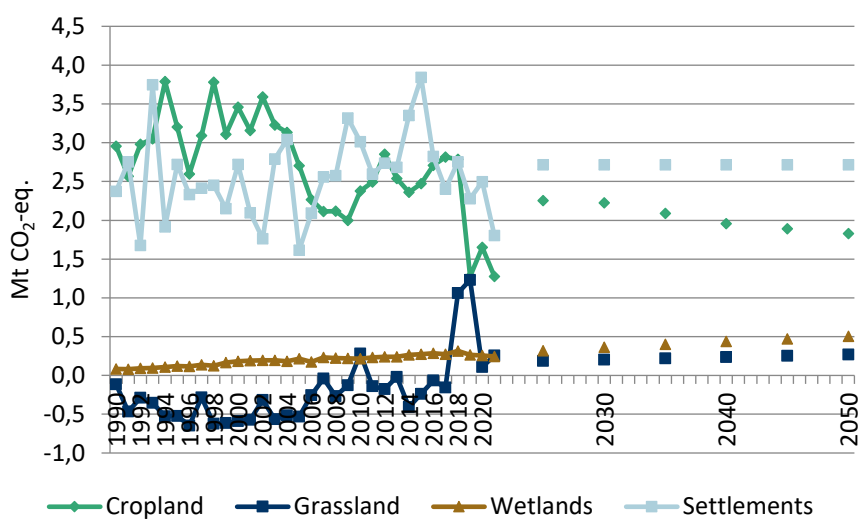


Figure 12. Historical and projected net emission (+) and net removals (-) from the LULUCF categories cropland, grassland, wetland and settlements in Mt CO₂-equivalents per year.

Table 14. Historical and projected net emissions (+) and net removals (-) of greenhouse gases from LULUCF (CRF 4, Mt CO₂-equivalents, AR5).

	1990	2021	2025	2030	2035	2040	2045	2050
Forest land	-46.8	-36.3	-41.1	-42.5	-43.9	-37.1	-39.6	-42.2
Cropland	3.0	1.3	2.3	2.2	2.1	2.0	1.9	1.8
Grassland	-0.1	0.3	0.2	0.2	0.2	0.2	0.3	0.3
Wetlands	0.1	0.2	0.3	0.4	0.4	0.4	0.5	0.5
Settlements	2.4	1.8	2.7	2.7	2.7	2.7	2.7	2.7
Other land	0.2	0.04	0.03	0.03	0.03	0.03	0.03	0.03
HWP	-5.0	-9.0	-6.0	-6.0	-6.4	-7.3	-7.9	-8.5
Total	-46.3	-41.7	-41.6	-43.0	-44.8	-39.0	-42.2	-45.4

3.3.10.1 ASSUMPTIONS ON WHICH ESTIMATES FOR THE LULUCF-SECTOR ARE BASED:

Forest land,

- The reported projection is based on a projection assuming that current harvest intensity (2016-2020) persists over time. The harvest level was estimated at 82% of growth available for harvest, on productive forest land.

- Other settings are based on the projection in an analysis of the forest development (SKA-22) in terms of management, climate effect and nature conservation, which are assumed to continue as today.⁵⁹
- The reported projection is based on a projection in which felling is assumed to not be higher than what is considered as sustainable in the long term.
- The structure of the standing stock at the start of the model simulation is based on the Swedish NFI which also forms the base for the annual reporting under the UNFCCC and the Kyoto protocol. NFI data from the inventories 2016-2020 was used for initial conditions representing 2018.
- In the projection until 2050, current forest management practices are assumed, including environmental measures in forestry and environmental policy aimed at preserving biological diversity. This means that a total of 1 333 000 ha is set aside for nature conservation through legal protection and 3 200 000 ha is voluntary set aside by forest owners. Further 1 468 000 ha is left as retention patches within the forest used for timber production. The total forest land area used for timber production is 20 812 000 ha, including retention patches. The total simulated area consisted of productive forest land of 23 474 000 ha (including legally or voluntary set-aside areas and forest land used for timber production) and low-production forest land of 4 578 000 ha.
- In the reference scenario used for the projection reported here, climate is assumed to be the same as today.

Cropland,

- The projections for each carbon pool are based on the mean net annual carbon stock change for the period 2012-2021 as reported in the National Inventory Report, submission 2023.
- The mean annual carbon stock change per area is multiplied with the projected area. The projection assumes that the area continues to decrease at the same rate as the last 30 years period, i.e. the area was assumed to decrease by 21% from 2021 to 2050.

Grassland,

- The projections for each carbon pool are based on the mean net annual carbon stock change for the period 2012-2021 as reported in the National Inventory Report, submission 2023.
- The mean annual carbon stock change per area is multiplied with the projected area. The projection assumes that the area continues to decrease at the same rate as the last 30 years period,

Wetlands

- The projections of the on-site emissions are based on the average for the period 2012-2021 as reported in the National Inventory Report, submission 2023.

⁵⁹ A. Eriksson, J. Eggers, A. Lundström, J-M Roberge and P-E Wikberg. 2022. Skogliga konsekvensanalyser 2022 - material och metod. Tekniskt underlag. Skogsstyrelsens rapport 2022/08

- For the off-site emissions (i.e. from horticultural use of peat) a trend was extrapolated based on the assumption that the current production of peat for horticultural use continue.

Settlements

- The projected emissions/removals for each reported carbon pool are assumed to be constant and estimated as a mean for the period 2012-2021 as reported in the National Inventory Report, submission 2023.

Harvested Wood Products (HWP)

- The net removals for HWP are estimated based on the projected harvest and the assumption that the available biomass is distributed on the different product groups equally as today.

3.3.11 International transport

The emissions from international aviation and navigation, also known as international bunkers, were 9.1 million tonnes of carbon dioxide equivalents in 2021 and are 144% higher than in 1990. The emissions from international transport are projected to increase during the projection period, mainly due to increased emissions from international navigation.

The increased use of fuel for international navigation is due in part to changes in the passenger traffic between Sweden and the neighbouring countries and in part to goods transport to and from various parts of the world. The projection is based on the assumption that the transport volume will increase, at the same time as the transportation will be more efficient.

The greenhouse gas emissions from international aviation have increased by until 2019 but then decreased in 2020 and 2021 due to the covid-19 pandemic. The emissions are expected to increase by 27% until 2030 and by 105% until 2050 compared to 1990. The increase is explained by the fact that private consumption is expected to increase during the projection period, which leads to an increased number of passengers. The tax on air travel is expected to somewhat restrain the increase of passengers.

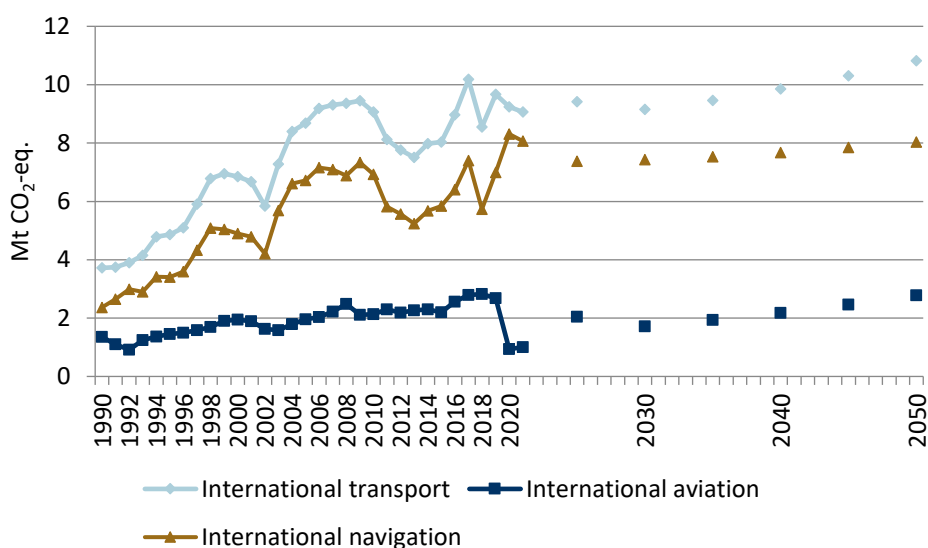


Figure 13. Historical and projected emissions of greenhouse gases from international transport.

Table 15. Historical and projected emissions of greenhouse gases from international transport (Mt CO₂-equivalents.).

	1990	2021	2025	2030	2035	2040	2045	2050
Navigation	2.4	8.1	7.4	7.4	7.5	7.7	7.8	8.0
Aviation	1.4	1.0	2.0	1.7	1.9	2.2	2.5	2.8
Total	3.7	9.1	9.4	9.2	9.5	9.9	10.3	10.8

3.3.11.1 ASSUMPTIONS ON WHICH ESTIMATES FOR THE INTERNATIONAL TRANSPORT-SECTOR ARE BASED:

- The projections for international navigation are based on several assumptions GDP, fuel price, exports and imports. Of importance are also assumptions regarding technical development, energy efficiency, mileage and introduction of renewable fuels.
- The projections for international aviation are based on assumptions on number of passengers based on GDP, energy consumption and energy efficiency.

3.4 Sensitivity analysis

The sensitivity analysis includes two alternative projections for the energy sector including transport and one alternative projections for the LULUCF sector. However, this does not include uncertainty in the calculations, which may expand the span between the projections.

3.4.1 Sensitivity calculations for the energy sector including transport sector

Two sensitivity projections have been calculated for the energy sector including transport; one projection with higher prices on fossil fuels and one with higher economic growth, than in the reference projections. The higher prices on fossil fuels also result in lower economic growth, than in the reference projections. All other assumptions are identical to the ones in the reference projection.

The calculations of the sensitivity projections show that the projection with higher prices on fossil fuels results in lower emissions than in the reference projection until 2050, as expected. The emissions are around 0.2 million tonnes carbon dioxide equivalents lower than in the reference projection in 2030. A higher price of fossil fuels decreases the incitements to replace fossil fuels and improve energy efficiency in industry and decreases the need for transportation.

The projection with higher economic growth than in the reference projection, results in higher emissions in the energy and transport sectors than in the reference projection. In this case the emissions are around 0.8 million tonnes carbon dioxide equivalents higher in 2030 than in the reference projection. The main reason for the increased emissions is a higher energy demand due to higher production in the industry sector. A higher economic growth leads to a higher demand for transportation for both goods and people.

Table 16. Historical and projected total emissions of greenhouse gases from different projections for the energy sector (Mt CO₂-equivalents)

	1990	2021	2025	2030	2035	2040	2045	2050
Projections WEM	71.5	47.8	41.0	30.9	25.2	22.8	21.6	21.0
Energy sector including transport								
Projection "Higher fossil fuel prices"			41.0	30.7	25.0	22.7	21.5	20.8
Projection "Higher GDP"			41.7	31.7	26.6	24.3	22.9	21.9

ASSUMPTIONS ON WHICH ESTIMATES FOR THE SENSITIVE ALTERNATIVES FOR THE ENERGY SECTOR ARE BASED:

- Import prices on fossil fuels and exchange rates, 2020 prices

	Base year	Reference and Higher GDP		Higher fossil fuel prices	
	2020	2030	2050	2030	2050
Crude oil (Euro/boe)	37	88	112	108	131
Coal (Euro/tonne)	40	78	93	95	109

Natural gas (Euro/MWh)	11	41	43	50	50
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- Estimates of economic development (%/year): (National Institute of Economic Research)

	Reference		Higher GDP		Higher fossil fuel prices	
	2019-2035	2035-2050	2019-2035	2035-2050	2019-2035	2035-2050
GDP	1.76	1.71	2.05	2.18	1.75	1.71
Private consumption	1.74	1.67	2.21	2.43	1.73	1.67
Export	2.72	2.28	3.09	2.75	2.74	2.27
Import	2.64	1.95	3.01	2.74	2.67	1.94

3.4.2 Sensitivity calculations for the LULUCF sector

The projections for the LULUCF-sector are based on a number of assumptions which are characterised by uncertainties. The result should be interpreted with that in mind. Sensitivity analysis have been made to reflect sensitivity of the model used for simulations on key parameters. Sensitivity calculations were made for forest land, with a positive climate effect and with higher sustainable harvest levels. All simulations used the same settings related to forest management (except for the harvest levels).

In the reference projections, climate is assumed to be the same as today. As a sensitivity analysis, a simulation assuming a climate effect based on the RCP 4.5 scenario (IPCC 2013) has also been calculated. The climate effect gives a positive effect on the annual gross increment by 18% for the period 2070-2100 compared to the projection based on the current climate. The calculations of the sensitivity projections show that the projections with a positive climate effect result in an increase in net removals for the projection period compared to the projections without the positive climate effect.

In the reference projections, the current harvest intensity (2016-2020) is assumed to persist over time. A simulation was made including higher sustainable harvest levels to reflect the sensitivity of the model. The projections assuming higher sustainable harvest levels result in a decrease in net removals for the projection period. The sensitivity analysis indicates that different assumptions for the simulations have an impact on the result. The net removals for the LULUCF-sector are calculated in the model to be around 20-45 million tonnes of carbon dioxide equivalents in the projection period until 2050, when including all the simulations (see Figure 14 and Table 20).

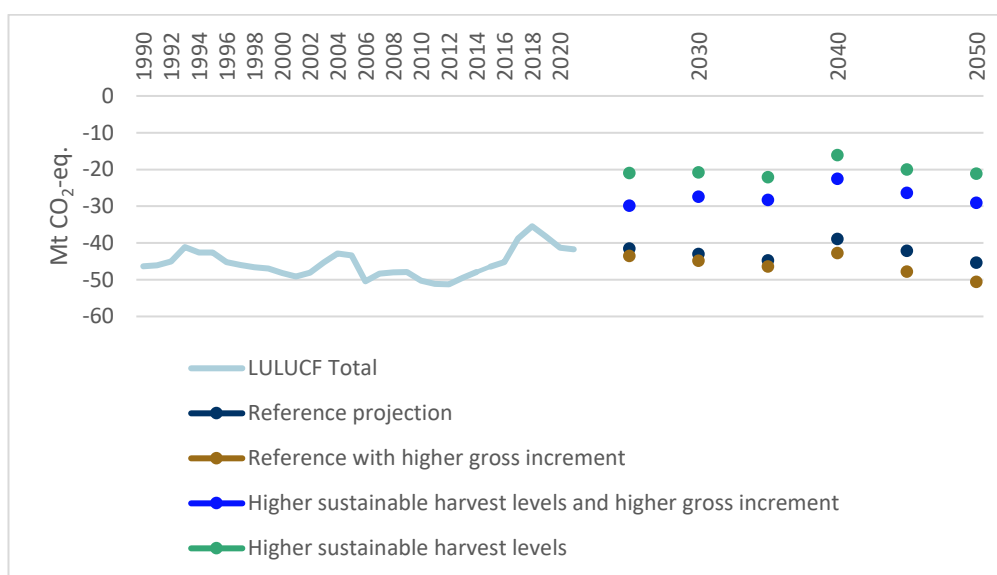


Figure 14 Total net removals (-) from the LULUCF-sector for different simulations in the sensitivity analysis; reference and higher sustainable harvest levels, with and without higher annual gross increment (Mt CO₂-equivalents per year.)

No further sensitivity analysis and simulations were done related to the increased risk of natural disturbances or to random variations in weather conditions. However, the effect of disturbances in line with the severe drought and the large forest fires in 2018 as well as the massive spruce bark beetle attacks the past 5 years may severely affect the net removals in living biomass and also affect other carbon pools accordingly. Measurements within the National Forest Inventory have indicated a decreasing growth, mainly due to unfavourable weather conditions. In the worst case, if the decrease in growth persists, this could lead to a reduction in the net removals of living biomass in the order of 10 million tonnes of carbon dioxide.

Based on previous simulations⁶⁰, the net removals for forest land decreased by approximately 15 million tons per year to 2030 compared to the reference scenario. This was mainly due to a combined effect of the increased natural losses and the fact that that the positive effect on growth of a changed climate does not occur (which was included in the reference scenario in that project). Both of these factors have a negative impact on timber stocks, growth and thus felling potential. The uncertainties for such an assessment are very large but it gives a hint of the vulnerability of forest and the forest sink and the risk of putting too much weight on the forest to deliver climate mitigation in the future.

⁶⁰ "Scenarier för den svenska skogen och skogsmarkens utsläpp och upptag av växthusgaser. Slutredovisning av regeringsuppdrag (beslut N208/01213/SK). SLU ID: SLU ua 2019.2.6-1375"

Table 17. Historical and projected emissions (+) and removals (-) of greenhouse gases from different simulations for the LULUCF sector (CRF 4, Mt CO₂-equivalents per year).

	1990	2021	2025	2030	2035	2040	2045	2050
Reference projections	-46.3	-41.7	-41.6	-43.0	-44.8	-39.0	-42.2	-45.4
Reference projections and higher gross increment	-46.3	-41.7	-43.5	-44.8	-46.5	-42.8	-47.9	-50.6
Higher harvest levels and higher gross increment	-46.3	-41.7	-29.9	-27.4	-28.4	-22.6	-26.4	-29.1
Higher harvest levels	-46.3	-41.7	-21.0	-20.9	-22.1	-16.2	-20.0	-21.2

ASSUMPTIONS ON WHICH ESTIMATES FOR THE SENSITIVE ALTERNATIVES FOR THE LULUCF SECTOR ARE BASED:

- As a sensitivity analysis for forest land, a scenario assuming a climate effect based on the RCP 4.5 scenario (IPCC 2013) has also been calculated. The climate effect gives a positive effect on the annual gross increment by 18% for the period 2070-2100 compared to the scenario based on the current climate. In addition, two other sensitivity analysis were made using the highest sustainable harvest levels. All simulations used the same settings related to forest management (except for the harvest levels).
- In the sensitivity analysis the sustainable harvest level was assumed to 100% of the growth available for harvest on productive forest land, instead of 82% as in the reference projection.

3.5 Projections for emissions covered by EU ETS and for emissions not included in EU ETS

Projections for emissions covered by Effort Sharing Regulation (EU) 2018/842 and EU ETS (Directive 2003/87/EC)

The emissions covered by the Effort Sharing Regulation (ESR) were 29.2 million tonnes of carbon dioxide equivalents in 2021. The ESR-emissions have decreased since 2005 and are projected to decrease until 2030, mainly due to reduced emissions in the transport sector. Emissions covered by the EU ETS were 18.7 million tonnes of carbon dioxide equivalents in 2021 including aviation. The emissions are projected to decrease until 2050 mainly due to an assumed shift to fossil-free technology in the iron and steel industry and assumed CO₂ capture and storage in mineral industry and refineries.

Table 18. Historical and projected emissions of greenhouse covered by the EU ETS and ESR (Mt CO₂-equivalents, GWP according to IPCC AR5).

	2021	2025	2030	2035	2040	2045	2050
ESR	29.2	23.2	16.5	14.5	12.9	11.9	11.3
ETS incl. aviation	18.7	17.8	14.4	10.7	9.9	9.7	9.7
Total	47.8	41.0	30.9	25.2	22.8	21.6	21.0

Sweden’s commitment according to the Effort Sharing Regulation

Sweden’s commitment for the emissions covered by the Effort Sharing Regulation (EU) 2018/842⁶¹. (ESR) (i.e emissions not included in the EU Emissions Trading Scheme (ETS)) is that emissions have to decrease by 40% between 2005 and 2030 (EU ETS scope 2013-20, excl. aviation, GWP according to IPCC AR5). In 2022 a provisional agreement on amendment on ESR was made which would increase the target to 50% reduction until 2030.

The commitment of ESR means that the ESR-emissions shall decrease by 40% from 31.3 Mt in 2021 to 25.9 Mt in 2030. The provisional agreement on amendment on ESR which was made in 2022 would increase the target to 50% reduction until 2030.

Furthermore, Member States can use flexibilities for reaching the targets. Transfer of emission allowances between Member States may be done. In addition to that, annual emissions allocation can be carried over from the next year, and if there is a surplus of allowances this can be transferred to the next year or to other Member States. Furthermore, Member States can also use surplus of net removals from LULUCF and some Member States can also have a limited cancellation of EU ETS allowances.

For 2021, Sweden’s ESR-emissions were lower than the ESR-target. The target was 31.3 million tonnes and the emissions were preliminary 29.2 million tonnes of carbon dioxide equivalents and the surplus amount of AEAs was preliminary around 2 million tonnes compared to the Swedish ESR target. ESR-emissions and surplus will be final calculated for compliance in 2027.

The projections indicate an overachievement in relation to the ESR-target. The ESR-emissions are projected to decrease to around 17 million tonnes in 2030. Note that these figures are uncertain and preliminary.

⁶¹ Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emissions reductions by member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement

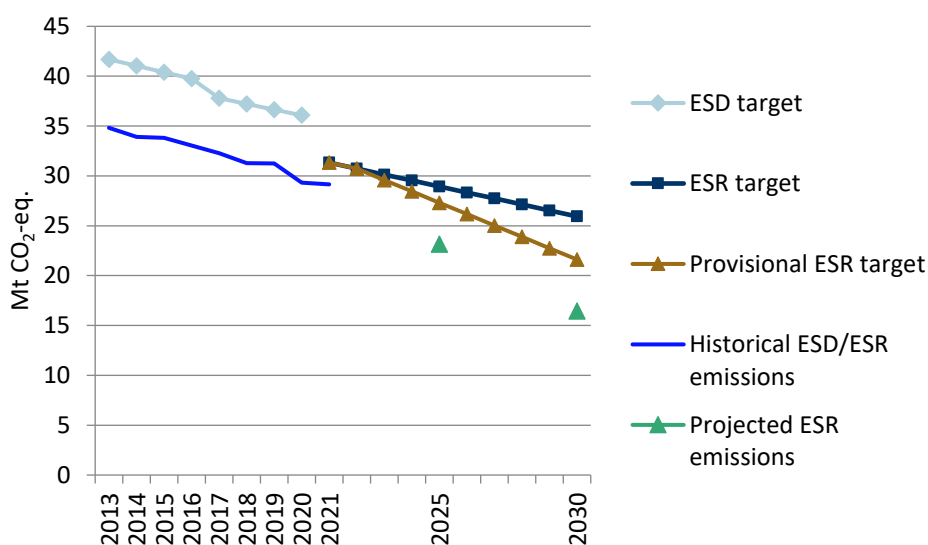


Figure 15. The ESD and ESR target, provisional ESR target and the historical emissions 2013-2021 and projected Swedish ESR emissions. (National Inventory Report submission 2023)

Target fulfilment in relation to the national targets

In June 2017 the Riksdag adopted a climate policy framework including targets until 2045. By 2045, the target for Sweden is to have no net emissions of greenhouse gases into the atmosphere and should thereafter achieve negative emissions. This means emissions from activities in Swedish territory are to be at least 85% lower by 2045 compared with 1990. Supplementary measures may count towards achieving zero net emissions, such as increased uptake of carbon dioxide in forests and land, and investments in other countries. International accounting guidelines will be followed for this. The projections, with existing measures, indicate that the total emissions of greenhouse gases, (excluding LULUCF) are estimated to decrease by 70%.

Emissions outside the EU ETS should be at least 63% lower by 2030 than emissions in 1990 and at least 75% lower by 2040. To achieve these targets, no more than 8 and 2 percentage points, respectively, of the emissions reductions may be realized through supplementary measures. The emissions outside EU ETS are projected to decrease by around 65% until 2030 and by around 72% until 2040. In addition, emissions from domestic transport (excl. CO₂ from aviation) are to be reduced by at least 70% by 2030 compared with 2010. The emissions are projected to decrease by around 71% between 2010 and 2030.

3.6 Projections for LULUCF-sector by accounting categories in the Regulation (EU) 2018/841

The LULUCF-regulation sets a binding commitment for each Member State to ensure that accounted emissions from land use are entirely compensated by an equivalent accounted removal of CO₂ from the atmosphere through action in the sector.

In 2022 a provisional political agreement was made on amendments of the LULUCF-regulation, including revised targets for 2026-2030. The target for 2030 for Sweden would be to increase the total net removal from the LULUCF-sector by 3.955 million tonnes of carbon dioxide equivalents compared to the average of 2016-2018.

Projections of reported net emissions and removals from the LULUCF sector by accounting categories as defined in the LULUCF-Regulation⁶² indicate total net removals of around 41 million tonnes of carbon dioxide equivalents in 2025.

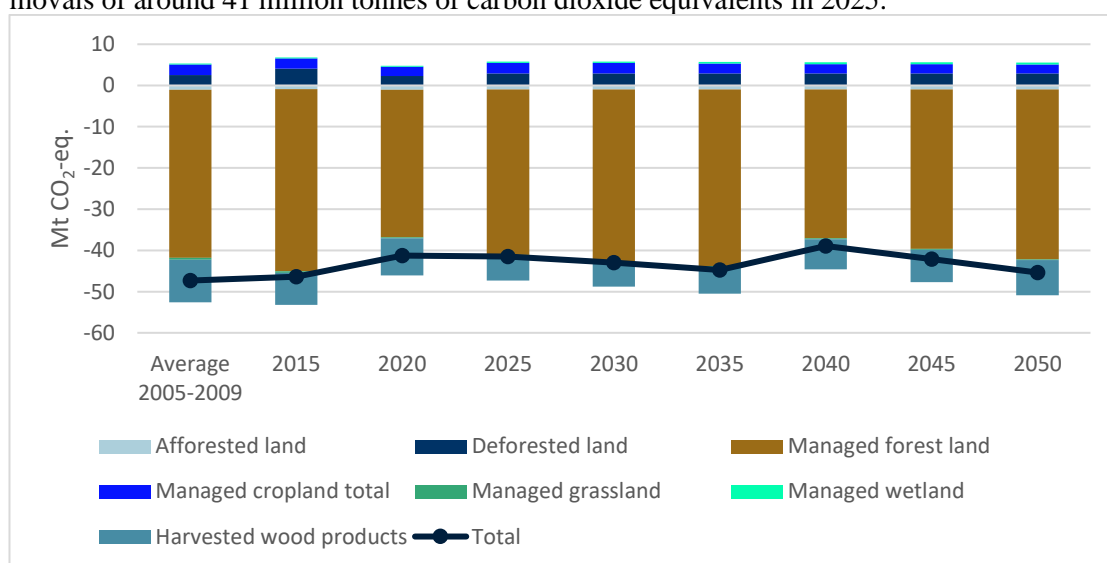


Figure 16. Historical and projected net emissions and net removals of greenhouse gases from LULUCF sector by accounting categories (Mt CO₂-equivalents).

Table 19. Historical and projected net emissions (+) and net removals (-) of greenhouse gases from LULUCF by accounting categories (Mt CO₂-equivalents)

	2015	2020	2025	2030	2040	2050
Afforested land	-0.9	-1.1	-1.0	-1.0	-1.0	-1.0
Deforested land	4.1	2.3	2.9	2.9	2.9	2.9

⁶² Regulation (EU) 2018/841

Managed forest land	-44.1	-35.8	-40.1	-41.6	-36.1	-41.2
Managed cropland	2.5	2.2	2.6	2.6	2.3	2.2
Managed grassland	-0.4	-0.2	-0.3	-0.3	-0.2	-0.2
Managed wetland	0.3	0.3	0.3	0.4	0.4	0.5
Harvested wood products	-7.7	-9.0	-6.0	-6.0	-7.3	-8.5
Total	-46.4	-41.3	-41.5	-43.0	-38.9	-45.3

Accounted changes in net emissions and removals from the LULUCF-sector

For the period from 2021 to 2025, taking into account the flexibilities each Member State shall ensure that accounted changes in emissions do not exceed changes in removals, calculated as the sum of changes in total emissions and total removals on its territory in all of the land accounting categories. Each Member State shall account for changes in emissions and removals resulting from managed forest land, calculated as emissions and removals in the period from 2021 to 2025 minus the value obtained by multiplying by five the forest reference level of the Member State concerned. Where the result of the calculation for managed forest land is negative in relation to the forest reference level, Member States shall only include in its managed forest land accounts total net removals of no more than the equivalent of 3.5% of the emissions in 1990, multiplied by five. Net removals resulting from the carbon pools of dead wood and harvested wood products, except the category of paper shall not be subject to this limitation.

Member States shall account for changes in emissions and removals resulting from afforested land and deforested land, as being the total emissions and total removals for each of the years in the period from 2021 to 2025.

Each Member State shall account for emissions and removals resulting from managed cropland and managed grassland calculated as emissions and removals in the period from 2021 to 2025 minus the value obtained by multiplying by five the Member State's average annual emissions and removals resulting from managed cropland and managed grassland respectively, in its base period from 2005 to 2009.⁶³

The projections of accounted net emissions and removals from the LULUCF sector by accounting categories as defined in the LULUCF-Regulation⁶⁴ indicate total net removals of around 14 million tonnes of carbon dioxide equivalents for 2021-2025. Note that the result is uncertain and preliminary until 2027, when a definite calculation can be done.

⁶³ For the period 2021-2025 managed wetlands are voluntary to include

⁶⁴ Regulation (EU) 2018/841

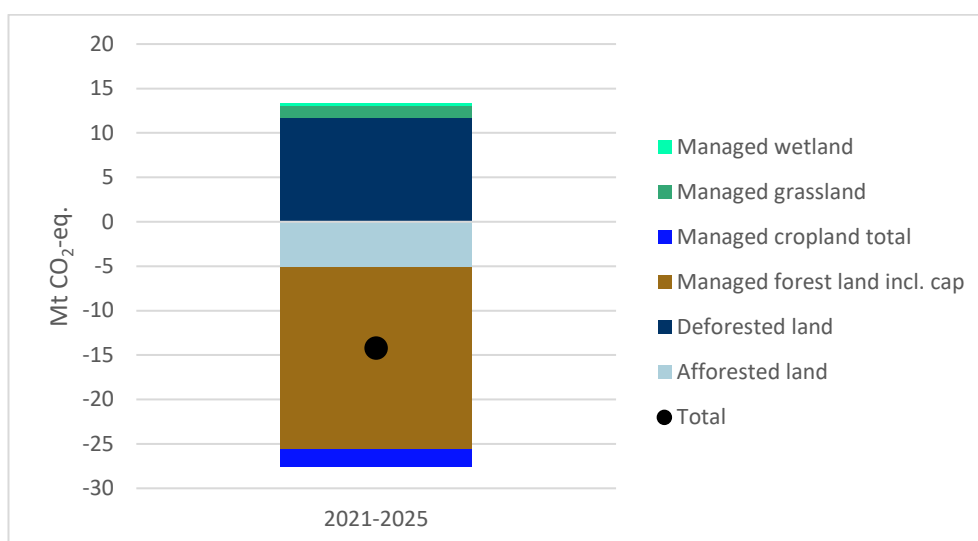


Figure 17. Total accounted cumulative net-emissions and net-removals for 2021-2025.

According to the provisional decision in 2022, the LULUCF regulation is amended leading to different targets for 2026-2030. For Sweden the total net removal in 2030 shall increase by 3.955 million tonnes of carbon dioxide equivalents compared with the average of 2016-2018. The projections for the LULUCF-sector indicate an increase of the total net removal by around 3 million tonnes of carbon dioxide equivalents in the best case in the reference or a decrease by 10-15 million tonnes of carbon dioxide equivalents in the worst case if for example the decrease in growth persists.

3.7 Methodology

Different projection methods are used for different sectors. The methods which have been used to draw up the projections in this report are described in this section.

Energy sector

Projections for greenhouse gases for the energy sector are based on projections for the whole energy system. Projections for carbon dioxide emissions from the energy sector are drawn up by multiplying the total consumption of each fuel by the corresponding emissions factors. The energy projections, together with expert assessments of future emissions factors, have provided the basis for the projections of methane and nitrous oxide from incinerators.

Different models are used for each sub-sector in drawing up projections of trends in the energy system. The Times-Nordic model is used to make projections for electricity and heating production. Demand in the sub-sectors, taxes and other policy instruments, fuel prices and economic and technical development are used as input data for Times-Nordic. Times-Nordic is a dynamic optimization model. Most

of the methods and models used to project development in the energy sector are based on a bottom-up perspective. Model results for different sub-sectors are coordinated so that weighted projections for the whole energy system are finally obtained. The process is described in Figure 15. Expert assessments are an important element in all stages of the process.

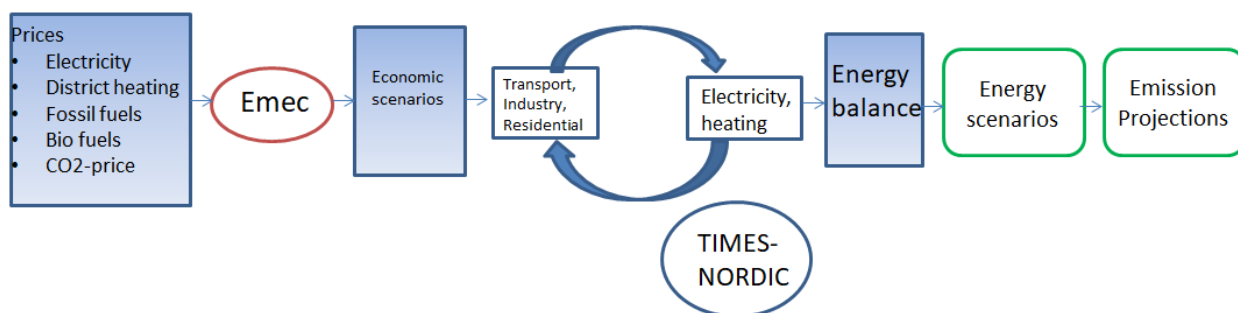


Figure 18 Projection process for emissions from the energy sector.

A starting point in the projection work on the development of the energy system in the short and long-term is assumptions on economic trends, both in Sweden and internationally. The economic variables included in the work on energy projections mainly consist of estimates of the trend in gross domestic product, private and public consumption, disposable income and trends in value-added for industry and commerce. For industry, estimates of economic development at the level of individual branches of industries are included.

Projections on economic development are drawn up using a general equilibrium model, EMEC, by the National Institute of Economic Research. Input data for projections on economic development are harmonized with projections on the development of the energy system by the National Institute of Economic Research and the Swedish Energy Agency. The economic growth generated by the EMEC model is governed firstly by access to production factors such as labor and capital and secondly by technical development, which are given exogenically in the model. The advantage in using this type of model is that it encompasses the whole economy. The model is therefore able to capture repercussions between sectors, for example a change of tax or the introduction of emission caps. The total economic impact is therefore captured in a more complete way than in partial models.

Another important basis for projections on trends in the energy system is the fossil fuel prices received from the EU. A model is used to convert international fossil-fuel prices for crude oil and coal to domestic user prices, paid by the final consumer, as crude oil has to be refined into finished motor fuels and fuels for heating before it can be used on the Swedish market.

Electricity and district-heating production

The projections on fuel use for electricity and district-heating production are based on the Times-Nordic model. The demand for electricity and district heating is exogenous data for the model which, through its optimisation algorithm, works out the most cost-effective fuel mix for the whole energy system, i.e. including energy use in the user sectors. Times-Nordic represents all Nordic countries (excluding Iceland) and permits electricity trade between neighboring countries.

Residential and commercial/institutional sectors

The projections of energy use in the residential and commercial/institutional sectors are drawn up by combining the model results from Times-Nordic and assessments by experts. Times-Nordic also models the competition for different heating systems in buildings. Different variables such as electricity and fuel prices, population development, potential for different heating systems, investment costs of heating systems, levels of efficiency and energy efficiency improvement are assumed. The projections for energy use from working machinery in agricultural sector are based on the projections in the agriculture sector. For working machinery the projections are based on projections from the Swedish Forestry Agency.

Industry sector

The projections on energy use in the industry sector come from an Excel-based model with the energy use in industries linked to economic relations (value added and production value) and energy prices. The energy use is primarily based on assumptions of economic development and energy prices. This result is harmonised through contacts with energy-intensive companies and industry organisations. Account is also taken of the results of the Times-Nordic energy system model.

Transport sector

The projections on carbon dioxide emissions from the transport sector are calculated on the basis of projections of energy use in the transport sector. The calculation of emissions of other greenhouse gases is based on the change in transport activity, number of vehicles in different vehicle types (e.g. fitted with catalytic converter) and emissions factors. The transport sector has been divided into four sub-sectors: road traffic, air traffic, rail traffic and shipping.

The projections for road transport are based on assessments on transport demand and on the development of the vehicle fleet. The demand for transport with passenger cars is expected to be mainly influenced by demography, fuel prices and income in households, while the demand for freight transport is based on assumptions on economic development and trading overseas. The development of the vehicle fleet is based on the result of the HBEFA model. The projections for aviation, navigation and railways are based on assumptions on transport demand and future efficiency.

Industrial processes

Carbon dioxide emissions from industrial processes have been calculated using an Excel-based trend analysis of historical emissions. In addition to official statistics

and economic projections, data and other information from industry organisations and companies have been used to obtain more detailed knowledge on the industries and emissions concerned.

Waste sector

Emissions from landfills in the waste sector are calculated using a model developed by the IPCC that has been partially modified to better represent conditions in Sweden. Results from the model calculations are also compared with results from field measurements. The method is based on figures on quantities of landfilled waste from 1952, the organic content of waste, the gas potentials of different types of waste and emissions factors.

Agricultural sector

Projections of activity data for the agricultural sector are based on results from an economic equilibrium model; the Swedish Agricultural Sector model (SASM), which is based on assumptions on production and future agriculture policy. The projected activity data is used to calculate future emissions in the same way as is done for current emissions within the climate reporting process. Activity data includes figures related to numbers of livestock, manure production, stable period, methods for manure management and annual balances of nitrogen flows to and from agricultural land.

Land Use, Land-Use Change and Forestry sector

The projections for net removals in *Forest land* in the Land Use, Land-Use Change and Forestry sector are mainly estimated using the Heureka Regwise modelling tool. The model simulates the future development of the forests based on assumptions on how they are managed and harvested. The calculations encompass biomass in living trees and dead wood in productive forests. The development of the carbon stock in Living biomass and Dead wood is calculated in 5 year intervals. In the projection, net removals in these pools are calculated as the difference between the stocks at different times and represents the period between the simulated carbon stock.

The soil organic carbon pool (mineral soils) and dead organic matter pool except dead wood (stumps, coarse litter, annual litter and the O-horizon) is based on simulations using the Q-model, which is a process based model based on the continuous quality theory⁶⁵. The Q-model is integrated in the Heureka system and is fed with the annual produced litter (harvest residues, annual litter fall and stumps) provided from the results of the Heureka-simulations.

For *Cropland* and *Grassland*, the average net annual emissions/removals per hectare for each carbon pool for the latest ten reported years are used together with the projected area of these land use categories. The projected emissions/removals for each reported carbon pool for *Wetlands* and *Settlements* are assumed to be constant

⁶⁵ G. Ågren and E. Bosatta. 1996. *Theoretical Ecosystem Ecology*, Cambridge: Cambridge University Press, 1996.

and estimated as the mean over the latest ten years as reported in the latest submission. The net removals for HWP are estimated based on the projected harvest from the Heureka-Regwise-model and the assumption that available biomass is distributed to the different product groups in the same way as in current distribution, i.e. as an average of the five latest years in the latest submission.

4 Low Carbon Development Strategies

Sweden has reported a Low Carbon Development Strategy in January 2020. No changes have been made since then.

5 National system for reporting on policies and measures and projections

Under the MMR (Regulation (EU) 525/2013), Member States were required to report on national systems for policies and measures and projections.

According to Article 39 of Regulation (EU) No 2018/1999 of the European Parliament and the Council on the Governance of the Energy Union and Climate Action and to Article 36 of Commission Implementing Regulation (EU) No 2020/1208 on structure, format, submission processes and review of information reported by Member States pursuant to Regulation (EU) 2018/1999, Member States shall by 15 March 2021 provide a description of their national system for reporting on policies and measures and projections in the format set out in Annex XXIII.

As specified in the implementing regulation, the first report submitted in 2021 shall provide a full description and contain all the information listed in the Table. For subsequent reporting years, only modifications of the national system for policies and measures and projections need to be reported. There are two changes for submission 2023, an updated name for the responsible ministry (see section 5.1) and an additional entity included in the institutional arrangements (see section 5.2.1). In 2023 the Institute of Economic Research was included in the Ordinance on Climate Reporting⁶⁶ (SFS 2014:1434) which describes the roles and responsibilities of the government agencies in the context of climate reporting.

⁶⁶ https://riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/klimatrapporterings-forordning-20141434_sfs-2014-1434

5.1 Name and contact information for the entities with overall responsibility for the National Systems for policies and measures and projections

The Swedish Ministry of Climate and Enterprise is the national entity with the overall responsibility for the national system for reporting on policies and measures and for the projections of anthropogenic greenhouse gas emissions.

5.2 Institutional arrangements in place for preparation of reports on policies and measures and of projections as well as for reporting on them, including an organogram

5.2.1 Institutional arrangements for projections

The Swedish Environmental Protection Agency has the responsibility for the reporting of projections of greenhouse gases, which includes compiling the underlying data, preparing the report and reporting files and for quality assurance. Several governmental agencies are involved in the process as well as a consortium of consultants, SMED⁶⁷, see Figure 17.

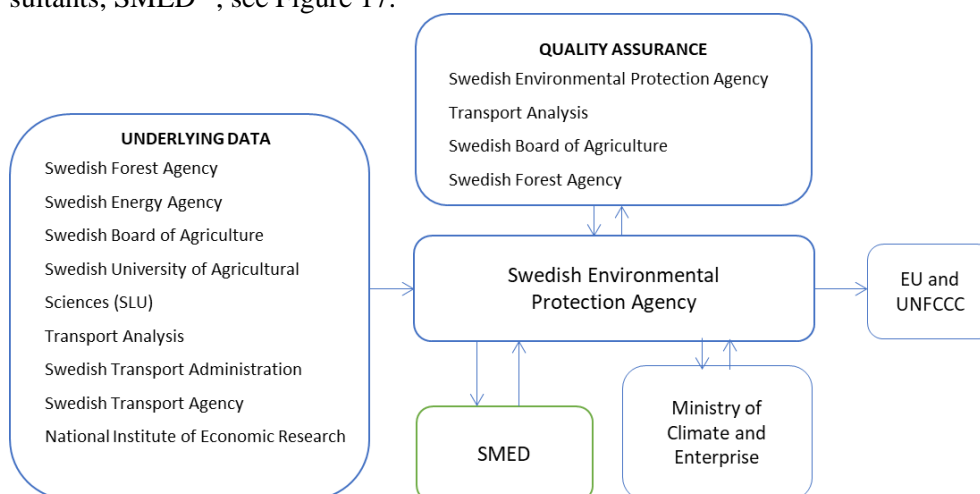


Figure 19. Institutional arrangements for the reporting of projections. SMED is a consortium of consultants.

⁶⁷ Swedish Environmental Emissions Data (SMED), consisting of the Swedish Meteorological and Hydrological Institute (SMHI), Statistics Sweden (SCB), the Swedish University of Agricultural Sciences (SLU) and the Swedish Environmental Research Institute (IVL)

5.2.2 Institutional arrangements for reporting on policies and measures

The Swedish Environmental Protection Agency has the responsibility for the reporting of policies and measures, which includes producing the report and to report. As the governmental agencies have a sectorial responsibility for the implementation and assessment of policies and measures and a thorough know-how of policies and measures, these agencies are also involved in the process of quality assurance, see Figure 18.

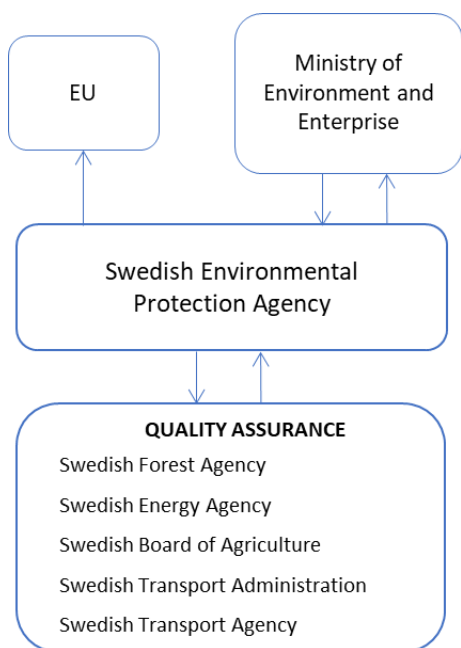


Figure 20 Institutional arrangements for the reporting on policies and measures

5.3 Legal arrangements in place for preparation of reports on policies and measures and of projections

The legal basis for Sweden's national system for reporting on policies and measures and projections is provided by the Ordinance on Climate Reporting⁶⁸ (SFS 2014:1434) which describes the roles and responsibilities of the government agencies in the context of climate reporting. The ordinance requires that sufficient resources are available for timely reporting. The ordinance supports all reporting requirements according to the Governance Regulation.

⁶⁸ <http://www.lagboken.se/Views/Pages/GetFile.ashx?portalId=56&cat=24593&docId=2232659&propId=5>

In addition, formal agreements including the details on content and timetable for providing data have been made between the Swedish Environmental Protection Agency and the relevant government agencies.

5.4 Procedural and administrative arrangements and timescales in place for the preparation of reports on policies and measures and of projections, to ensure the timeliness, transparency, accuracy, consistency, comparability and completeness of the information reported.

5.4.1 Procedural arrangements for projections

The national system is designed to ensure the quality of the reporting on policies and measures and projections, i.e. to ensure its transparency, consistency, comparability, completeness, accuracy and timeliness. The process for reporting applies a plan-do-check-act approach.

Underlying projections on activity data are provided by several government agencies. The projections on emissions are then produced and compiled by the Swedish Environmental Protection Agency.

Projections of emissions and removals of greenhouse gas emissions shall be reported the 15th of March 2021 and every two years after that, according to article 18 in the Regulation (EU) 2018/1999

Planning

Year X is the reporting year. At the end of year X-2 planning begins together with all involved agencies and actors, and which continues during the first quarter of year X-1. The reporting cycle is finalized with a meeting where the process is discussed, quality control and quality assurance activities analyzed and evaluated and areas of improvement are identified. An assessment of models and methodologies for producing of the projections is also performed to identify areas of improvement or if there is a need to change models used. The outcome of the meeting serves as input to the planning of the next reporting cycle.

An overview of the process is given in Figure 19. A close cooperation between involved agencies and actors takes place to ensure that all underlying data will be available on time and that the projections build upon the same assumptions.

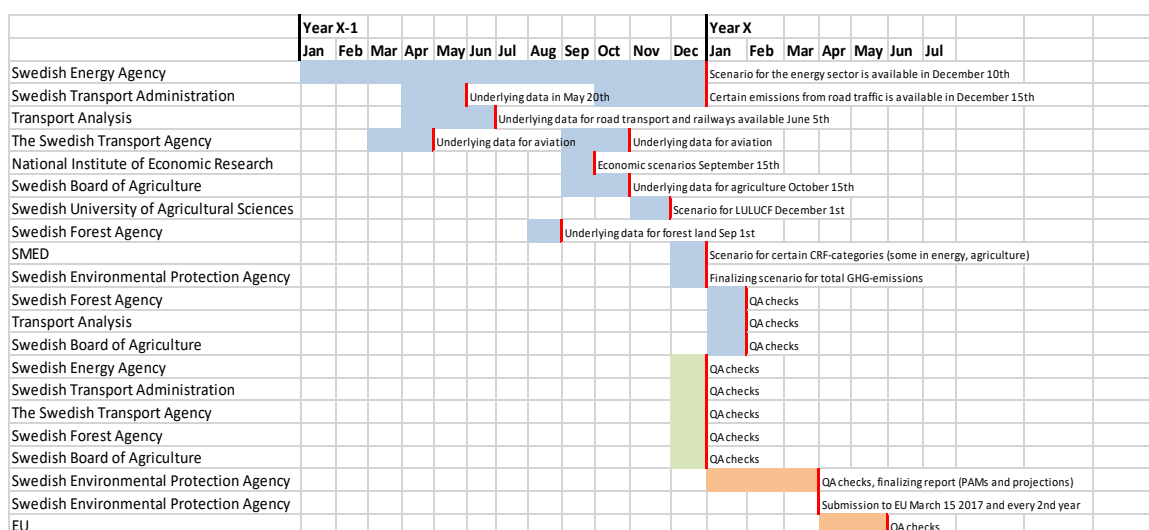


Figure 21 Overview of the process for the reporting of projections of greenhouse gases

Collecting data

During the second half of year X-1 the underlying data are received from the Swedish Energy Agency, the Swedish Transport Agency, the Transport Analysis, the Swedish Transport Administration, the Swedish Board of Agriculture and the Swedish University of Agricultural Sciences and compiled by Swedish Environmental Protection Agency. As the governmental agencies have a sectorial responsibility for the implementation and assessment of policies and measures and a thorough know-how of policies and measures, this ensures that all implemented policies and measures are taken into consideration when producing the projections.

Selecting methodologies and assumptions

The relevant assumptions, methodologies and models for producing the report on policies and measures and projections, are selected when planning the report. The work is based on established methods and models that have been used for many years and assessed to be the most relevant and suitable. The methodologies and models are continuously developed and improved. Assumptions are made based on available data and on expert knowledge. The work is carried out in close cooperation between the Swedish Environmental Protection Agency and other relevant agencies. For projections, sensitivity analyses are performed by applying a range of lower and higher estimates to the key assumptions. These are chosen to reflect the sensitivity of the model when changing some key parameters over a range of values. The result of the sensitivity analyses is described in the textual part of the report.

Quality control and quality assurance

All data are subjected to general quality control activities throughout the production of data. The quality control and quality assurance cover transparency, completeness, consistency, accuracy and comparability. The quality checks also identify potential areas for improvement in future reporting. The findings are discussed

in a final meeting which concludes the reporting cycle and serves as input into the planning of the next.

The quality control and quality assurance activities are performed in two steps. The quality control is performed by the agencies and actors themselves, which provide underlying data to the projections. Then, when the report and reporting files are prepared, the quality assurance activities are performed by the Swedish Environmental Protection Agency, Transport Analysis, the Swedish Board of Agriculture and the Swedish Forest Agency.

The quality control and quality assurance activities are documented. The Swedish Environmental Agency provides a checklist that can be used during the quality procedures and for documentation.

5.4.2 Procedural arrangements for policies and measures

The national system is designed to ensure the quality of the reporting on policies and measures and projections, i.e. to ensure its transparency, consistency, comparability, completeness, accuracy and timeliness. The process for reporting applies a plan-do-check-act approach.

The planning of the compilation of the report on policies and measures starts approximately one year before reporting. The report is compiled and includes quality control activities. After quality assurance activities and, if needed, adjustments of the report, the Swedish Environmental Protection Agency sends the report to the Swedish Ministry of Climate and Enterprise before submitting the report to the EU on the 15th of March 2021 and every two years after that, according to article 18 in the Regulation (EU) 2018/1999, see Figure 20.

	Year X-1												Year X						
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul		
Swedish Environmental Protection Agency	Planning																		
Swedish Environmental Protection Agency						Compilation of information													
Swedish Energy Agency										QA checks									
Swedish Transport Administration										QA checks									
The Swedish Transport Agency										QA checks									
Swedish Forest Agency										QA checks									
Swedish Board of Agriculture										QA checks									
Swedish Environmental Protection Agency														QA checks, finalizing report (PAMs and projections)					
Swedish Ministry of Climate and Enterprise														QA checks					
Swedish Environmental Protection Agency														Submission to EU March 15 2017 and every 2nd year					
EU																QA checks			

Figure 22 Overview of the process for the reporting of policies and measures

Planning

The work on the report on policies and measures is initiated one year before submission through planning activities. The reporting cycle is finalized with a meeting where the process is discussed, quality control and quality assurance activities analyzed and evaluated and areas of improvement are identified. The outcome of the

meeting serves as input to the planning of the next reporting cycle. The information on policies and measures is put together by the Swedish Environmental Protection Agency. Government Agencies, in accordance with the Ordinance, are then performing the quality assurance activities.

Collecting data

The Swedish Environmental Protection Agency collects the information needed for reporting on policies and measures and produces the reports.

Selecting methodologies and assumptions

The relevant assumptions, methodologies and models for producing the report on policies and measures, are selected when planning the report. The work is based on an assessment of the method to be the most relevant and suitable. The work is carried out in close cooperation between the Swedish Environmental Protection Agency and other relevant agencies.

Quality control and quality assurance

All information is subjected to general quality control activities throughout the production of the report. Quality assurance is carried by relevant government agencies, as provided in the Ordinance. The timetables for quality assurance are included in the agreements between the government agencies and the Swedish Environmental Protection Agency. The quality assurance covers transparency, completeness, consistency, accuracy and comparability. The quality control and quality assurance activities identify potential areas for improvement in future reporting. The findings serve as input to the planning of the next reporting cycle.

5.5 Description of the information collection process

5.5.1 Developing projections

During the process of producing the projections the underlying data are received from the Swedish Energy Agency, the Swedish Transport Agency, the Transport Analysis, the Swedish Transport Administration, the Swedish Board of Agriculture and the Swedish University of Agricultural Sciences and compiled by Swedish Environmental Protection Agency. As the governmental agencies have a sectorial responsibility for the implementation and assessment of policies and measures and a thorough know-how of policies and measures, this ensures that all implemented policies and measures are taken into consideration when producing the projections.

5.5.2 Evaluating policies and measures

The Swedish Environmental Protection Agency collects information of policies and measures mainly through scanning Government's bills. Moreover, information on the policies and measures are collected on the implementing government

agencies' websites. As a complement, government agencies identify, in the quality check, if any decision of relevance is missing and provides, if requested, additional information. Information for evaluation of policies and measures is mainly collected from relevant Government agencies and, if relevant, from actors.

5.6 Description of the alignment with the national inventory system

The national system for reporting on policies and measures and projections is based on the national system for the national inventories. The legal arrangements are the same for reporting on policies and measures and projections as for the national inventory. The ordinance supports all reporting requirements according to the Governance Regulation. The institutional and procedural arrangements for reporting on policies and measures and projections are based on the national system for inventories but agencies involved and procedural arrangements and timescales are adjusted to be relevant for reporting on policies and measures and projections.

5.7 Description of the links to arrangements on integrated national energy and climate-reports pursuant to Art. 17 of Regulation (EU) 2018/1999

The information in the report on policies and measures and projections are used in the integrates national energy and climate reports.

5.8 Description of the quality assurance and quality control activities for reporting of policies and measures and projections

5.8.1 Quality control and quality assurance for reporting on projections

All data are subjected to general quality control activities throughout the production of data. The quality control and quality assurance cover transparency, completeness, consistency, accuracy and comparability. The quality checks also identify potential areas for improvement in future reporting. The findings are discussed in a final meeting which concludes the reporting cycle and serves as input into the planning of the next.

The quality control and quality assurance activities are performed in two steps. The quality control is performed by the agencies and actors themselves, which provide underlying data to the projections. Then, when the report and reporting files are prepared, the quality assurance activities are performed by the Swedish Environmental Protection Agency, Transport Analysis, the Swedish Board of Agriculture and the Swedish Forest Agency.

The quality control and quality assurance activities are documented. The Swedish Environmental Agency provides a checklist that can be used during the quality procedures and for documentation.

5.8.2 Quality control and quality assurance for reporting on policies and measures

All information is subjected to general quality control activities throughout the production of the report. Quality assurance is carried by relevant government agencies, as provided in the Ordinance. The timetables for quality assurance are included in the agreements between the government agencies and the Swedish Environmental Protection Agency. The quality assurance covers transparency, completeness, consistency, accuracy and comparability. The quality control and quality assurance activities identify potential areas for improvement in future reporting. The findings serve as input to the planning of the next reporting cycle.

5.9 Description of the process for selecting assumptions, methodologies and models for making projections of anthropogenic greenhouse gas emissions

The relevant assumptions, methodologies and models for producing the report on projections, are selected when planning the report. The work is based on established methods and models that have been used for many years and assessed to be the most relevant and suitable. The methodologies and models are continuously developed and improved. Assumptions are made based on available data and on expert knowledge. The work is carried out in close cooperation between the Swedish Environmental Protection Agency and other relevant agencies. For projections, sensitivity analyses are performed by applying a range of lower and higher estimates to the key assumptions. These are chosen to reflect the sensitivity of the model when changing some key parameters over a range of values.

5.10 Description of procedures for the official consideration and approval of the Member

States national system for policies and measures and projections

The Ministry of Climate and Enterprise is the national entity with the overall responsibility the national system for reporting on policies and measures and for the projections of anthropogenic greenhouse gas emissions.

The Swedish Environmental Protection Agency has the responsibility for the reporting of the national system for reporting on policies and measures and projections.

The Swedish Environmental Protection Agency sends the report to the Swedish Ministry of Climate and Enterprise for official consideration and approval of the Government Offices of Sweden before submitting the report to the EU.

5.11 Information on relevant institutional administrative and procedural arrangements for domestic implementation of the EU's nationally determined contribution, or changes to such arrangements

Sweden has set up a national climate policy framework consisting of a Climate Act, national climate targets and a Climate policy council. The climate act will impose responsibility on the current Government, and on future governments, to pursue a climate policy that is based on the national climate targets and to provide clear feedback on the progress. The national climate targets are in line with, or more ambitious, than the EU's nationally determined contribution, wherefore the institutional set up should be sufficient.

5.12 Description of the stakeholder engagement undertaken in relation to the preparation of policies and measures and projections

In the preparation of reporting on policies and measures several government agencies are involved, as described in section 5.2. In the process of production of projections each government agency contacts relevant actors based on relevance and need for information. Also for evaluation of policies and measures relevant actors are contacted based on need for information.