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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Contents

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 2040 with 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 Eionet via a web form)
- data projections per sector and gas (uploaded on Eionet as an excel file)
- summary table with projection parameters (uploaded on Eionet as an excel file)
- model fact sheets for models used to produce projections (uploaded on Eionet 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 2020 are included in the projections on greenhouse gas emissions reviewed in section 3. Policies and measures have previously been reported in Sweden's seventh National Communication on Climate Change and fourth Biennial Report to the UNFCCC and in the report submitted under to the EU in March 2019 in accordance to articles 13 and 14 under Regulation (EU) No 525/2013. 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, Sweden is to have no net emissions of greenhouse gases into the atmosphere and should thereafter achieve negative emissions. This means

[1] Govt. Bill 2016/17:146

[2] Govt. Bill 2016/17:146

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 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).

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.[3]

In addition, the Riksdag has decided on energy policy goals linked to certain years based on an energy agreement reached in 2016 between five of the Riksdag political parties.[4] After the agreement was concluded two of the parties have left the agreement. The energy policy goals are:

- In 2020, the share of renewable energy shall be at least 50 percent of the total energy use, the share of renewable energy in the transport sector shall be at least 10 percent and the energy use shall be 20 percent more efficient.
- 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.

2.1.4 Other institutional set-ups to implement the climate targets

A new Climate Board

The government's goal is for Sweden to become the world's first fossil free welfare nation. To achieve this, all policy areas must move in the same direction and the climate issue must be integrated into all relevant policy areas. For that reason, the government has established a climate board within the Government Offices.
The purpose of the Climate Board is to strengthen the government's work to achieve the climate goals and to implement the climate policy action plan. The Climate Board will have regular meetings chaired by the Prime Minister. In addition to the Prime Minister and the Minister for the Environment and Climate, six other ministers are included, whose areas are crucial for climate change. These are: the Minister of Trade and Industry, the Minister of Finance, the Minister of Infrastructure, the Minister of Energy and Digitization, the Minister of Rural Affairs and the Minister of Financial Markets and Housing.

A new Electrification Commission

[3] Government Bill 2017/18:228, bet. 2017/18:NU22, rskr. 2018/19:411

[4] Government Bill 2017/18:228, bet 2017/18:NU22, rskr. 2018/18:411

In the autumn of 2020, the Government set up an Electrification Commission to speed up the work of electrifying the heavy road transport and the transport sector in general. The Commission shall, in consultation with the actors concerned, identify measures that they can take to increase the pace of electrification in the field of transport. The analysis shall include passenger and freight transport within all modes of transport. The Commission will focus in particular on how regional freight transport, state roads, industrial routes and transport projects can be electrified.

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. Almost half of the allowances are allocated for free to installations covered by the system, the rest are auctioned. Free allocation is used in order to avoid risks of carbon leakage in specific industrial sectors such as steel and cement. As a rule, there is no free allocation for emissions from electricity production. Free allocation to sectors not exposed to carbon leakage will cease in 2030. However, free allocation to district heating and district cooling will continue on a low level.

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) and with some new industrial activities. At present, about 760 Swedish installations are included in the system. At the EU level in total, approximately 11 000 installations are covered.

To strengthen EU ETS, the EU has decided on a reform of the system. From 2021 onwards, the annual reduction of the cap will be increased from 1.74 % to 2.2 %. A market stability reserve has been introduced to reduce the surplus of emission allowances on the market. From 2023 onwards, allowances held in the market stability reserve above the number of allowances auctioned the previous year will be cancelled. Finally, the auction share has been set to 57 % and free allocation will be focused on sectors highly at risk of carbon leakage.

Emissions from aviation were included in the system in 2012. Because of extensive protests from some countries outside the EU the EU decided on a temporary exemption for flights outside the EEA.

As the ICAO in September 2016 decided to implement a global measure, the Carbon Offsetting and Reduction Scheme for International Aviation (Corsia), the EU has decided to maintain the geographic scope of the EU ETS limited to intra-EEA flights from 2017 onwards. Corsia is implemented in EU law through a revision of the EU ETS legislation. Sweden is the administering Member State for approximately 90 aircraft operators, however only a few were subject to report their emissions in CORSIA in 2020.

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. Sweden has implemented the necessary adjustments.

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 1.20/kg (2021). 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 biofuels currently are not subject to carbon taxation, if not used within the reduction obligation scheme for motor fuels. With regard to 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.[5] 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 targets[6]. The energy tax on motor fuels used in road vehicles and off-road machinery also internalises external costs from the traffic, such as road wear, noise, etc.[7] .

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 adjusted to take account of the development of gross domestic product (GDP).[8] In July 2019 however, tax rates were lowered by the equivalent of the GDP-adjustment for 2019. The Government further decided in 2020 to put the GDP-adjustment on hold until 2022 to compensate for increased prices due to the reduction obligation scheme, see below.[9]

In January 2021, the energy tax on diesel (environmental class 1) was SEK 2.478 per liter and the carbon tax was 2.262 per liter, while the energy tax on petrol was SEK 4.13 per liter and the carbon tax was 2.61 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

[5] 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).

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

[7] National Institute of Economic Research, 2013

[8] 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).

[9] Government Bill 2020/21:1

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 the 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 sought a prolongation of an exemption which was approved by the European Commission in the autumn 2020. The prolongation of the tax exemption is for one year.[10]

Moreover the European Commission approved in the autumn 2020, under EU state aid rule, a 10-year prolongation of the tax exemption (2021-2030) for non food-based biogas and bio propane used for heating or as motor fuel in Sweden. The objective of the tax exemption is to increase the use of biogas and bio-propane and to reduce the use of fossil fuels and their greenhouse gas emissions, while facilitating the transition towards advanced biofuels.

Carbon dioxide tax and energy tax for heat production
Heat production is subject to energy tax as well as 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 91 % of the carbon tax and 100 % of the energy tax. This represents a sharp increase for CHP's, which prior to 1st August 2019, were subject to only 11 % of the carbon tax and 30 % 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.

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.

Carbon dioxide tax and energy tax for electricity production

[10] https://www.regeringen.se/pressmeddelanden/2020/10/fortsatt-skattebefrielse-for-rena-och-hoginblandade-biodrivmedel/, 27 januari 2021

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 pays 30 % of the general energy tax and, since 2011, is 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. The Government proposed in its budget bill for 2021[11] to totally rescind the reduction of energy tax on heating fuels for industry both covered and not covered by the EU ETS. It is still a proposal and not yet decided.[12] 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 rescinded 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 rescinded 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

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 energy tax paid is still 30 % of the general energy tax rate for heating fuels in these sectors. The Government proposed in its budget bill for 2021[13] to totally rescind the reduction of energy tax

[11] Government Bill 2020/21:1

[12] https://www.regeringen.se/pressmeddelanden/2020/09/slopad-nedsattning-av-energiskatt-for-uppvarmningsbranslen/, 17 Feb 2021

[13] Government Bill 2020/21:1

on heating fuels for agriculture, forestry and aquaculture in two steps. It is still a proposal and not yet decided by the Swedish Riksdag.[14]

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 1 st of January 2020 the reimbursement for carbon tax on diesel for machinery in agricultural , forestry and aquaculture activities was SEK 1.93 per liter.[15]

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 programme for local investments was introduced in 2015, the Climate Leap. In total, SEK 6,6 billion has been granted for investments within the program (as of January 2021). The Swedish Environmental Protection Agency administers 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 of each investment. Examples of investments that can be granted support are charging infrastructure for electric vehicles, biogas plants, infrastructure for biofuel and transitions from fossil oil to biofuel or district heating. In 2019, the combined budget for the program together with the Charge at home-grant (see section 2.2.4) amounted to SEK 1,5 billion. The budget increased to SEK 1,955 billion in 2020 and another SEK 3,5 billion[16] for the period 2022-2026[17]. 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 government proposes that the Swedish Energy Agency become a national center for carbon dioxide capture and storage and funds are also provided to

[14] https://www.regeringen.se/pressmeddelanden/2020/09/slopad-nedsattning-av-energiskatt-for-uppvarmningsbranslen/, 17 Feb 2021

[15] Skatteverket 2021, https://skatteverket.se/foretagochorganisationer/skatter/punktskatter/energiskatter/aterbetalningavskattpaelochbransle.4.109dcbe71721adafd252816.html

[16] The Charge at home-grant is since 2021 no longer included in the budget. The grant has been replaced by a tax deduction for such installations, se chapter 2.2.4.

[17] Government Bill 2020/21:1

set up a system with reverse auctions or fixed storage money for the capture and storage of carbon dioxide from renewable sources (bio-CCS). The possibility of including negative emissions with the help of biochar in the system shall also be analyzed. The grant is estimated to increase by SEK 50 million in 2022 and SEK 200 million in 2023.

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.[18]

Climate change communication

Swedish governmental authorities have long experience of using communication of knowledge as policy instruments for the public and business sectors and for citizens. Some examples:

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.

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. Energy and climate advisers in Sweden's municipalities reply free of charge to questions 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.

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 and scientific research and development. Three important research areas are energy, transport and industry, for which the Government has decided to grant extensive funding.

[18] https://fossilfrittsverige.se/

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 2017[19], which has been 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 bill for 2021 allocates SEK 1.57 billion for operations in 2021. Estimated amounts for 2022 and 2023 are SEK 1.58 billion and SEK 1.48 billion respectively.

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

In order to reduce greenhouse gas emissions from working machineries and strengthen the competitiveness of the Swedish automotive industry, the

[19] Govt. Bill 2016/17:1

Government has decided on targeted support for research, development and market introduction for working machineries in 2021 and 2022.[20]

A government green credit guarantee
The Government proposed in its budget bill for 2021 the introduction of a state green credit guarantee, which is to be based on technology-neutral criteria for major industrial investments that contribute to achieving the goals in the Environmental quality objectives system and the Climate Policy Framework.[21] The Riksdag has authorized the Government to issue credit guarantees in accordance with the proposal.

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

Energy Efficiency Directive 2012/27/EU
The Energy Efficiency Directive came into force in December 2012, replacing the Energy Services Directive and the Cogeneration Directive 2004/8/EC. The Directive establishes 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 1st June 2014[22]. Moreover, changes were made in the Electricity Law (SFS 2014:1064) requiring network operators to adjust tariffs and other practices to promote energy efficiency.
On 30 November 2016, the European Commission presented a package of legislative proposals containing measures in the EU's energy policy, the so-called Clean-energy-for-all package. Putting energy efficiency first is an important goal in the package. The package included a proposal to amend the EED. The European Parliament and Council Directive (EU) 2018/2002 of 11 December 2018 amending Directive 2012/27 / EU on energy efficiency (amending directive) entered into force on 24 December 2018.

[20] Government Bill 2020/21:1

[21] Government Bill 2020/21:1

[22] Govt. Bill 2013/14:174

The amending directive includes a headline target of at least 32.5% improved energy efficiency by 2030. The target can be reviewed and sharpened. The directive requires Member States to achieve cumulative energy savings obligations for the period 2021-2030. The directive also includes revised requirements regarding metering and billing of energy.

Renewable Energy Directive 2009/28/EC

The EU has adopted a binding target requiring an increase in the percentage of renewable energy from 8.5 % of total energy use in 2005 to 20% in 2020. Responsibility for attaining this target has been shared among the Member States. According to this burden sharing, Sweden has to increase its share from just under 44% (2007) to 49% in 2020. This is one percentage point lower than the national target for the same year. With policy instruments already decided upon and planned, according to latest projections, Sweden appears capable of fulfilling its commitment to the EU and meeting the national RES target. In fact, Sweden reached the EU commitment (49%) and the national target (50%) back in 2012. Since then, the use of renewable energy has increased to a level of 54,6% in 2018.

The EU has adopted a revised Renewable Energy Directive that sets a new 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 new Governance Regulation, 2018/1999(EU), member states are to prepare a national energy and climate plan covering the five dimensions of the Energy Union for the period 2021 to 2030. The plans should be submitted during 2019 and include each member state's contribution to the overall renewable energy EU target. The revised directive must be implemented by June 30, 2021.

EU has also set a specific target for the share of renewable energy in the transport sector to increase to 10% in 2020[23]. In 2018 the share of renewable energy in the transport sector in Sweden according to the renewable directive's calculation methodology was already 29,7%.

Production of electricity and district heating

Electricity certificate system

An electricity certificate system aiming to support electricity based on renewable energy was introduced in 2003. In October 2015, the Swedish Parliament approved a new target; as a result, electricity consumers will finance more renewable electricity production within the electricity certificate system – totaling 30 TWh by 2020, compared with the 2002 level. In addition, a new target has been set to increase the production by a further 18 TWh by 2030. The electricity certificate

[23] Renewable Energy Directive 2009/28/EC

system was also prolonged up until 2045[24]. The increase of renewable electricity production through the electricity certificate system is a key element in the Swedish action plan to attain the country's renewables targets for 2020 and 2040.

Since 2012, Sweden and Norway have a common electricity certificate market. In order to implement Sweden's more ambitious goal, Sweden and Norway reached an agreement in modifying the common target from 26.4 TWh to 28.4 TWh by 2020, compared with the 2012 level. The new target for 2030 has also been agreed with Norway[25].

Conceptually, the system works as follows. Electricity suppliers are obliged by law to submit electricity certificates corresponding to a certain share, or quota, of their electricity deliveries. The quota is gradually being increased yearly up to 2020 and 2030. Electricity producers are allocated a certificate from the central government for every megawatt-hour (MWh) of renewable electricity produced. The producers are allowed to sell the certificates in an open market where the price is set by the seller and buyer. The certificates thereby provide extra profit for the producers of renewable electricity (SFS 2011:1200).

The rapid development with regard to the expansion of renewable electricity production has led to the electricity certificate system now fulfills a limited function.

Therefore, the government has decided new electricity generation facilities may not be eligible for the electricity certificate system 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

Different programs have promoted the dissemination of knowledge and information about wind power. One example is the research program "Vindval", which aims to collect and provide scientific knowledge about wind power's impacts on humans and on nature[27].

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 and four areas were added in 2015. The total area of these national interests

[24] Govt. Bill 2016/17:179

[25] Govt. Bill 2016/17:187

[26] Government Bill 2020/21:16

[27] Swedish Environmental Protection Agency, https://www.naturvardsverket.se/vindval

for wind power is roughly 8,000 km^2, 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 need and a national planning basis.[29]

Support for solar power
A subsidy for installations of solar power systems was initiated in 2009. The budget for this support was around SEK 4 billion for the period 2016–2020. All types of actors could obtain financial support for installing grid-connected solar electricity and solar hybrid systems. The investment support contributes to an increased electricity production from solar power systems and to business development of solar energy technology. The support ended 31 December 2020 and has for private individuals been replaced by a tax deduction for green investments. Municipalities and companies will be eligible to continued support in 2021 for the installation of solar cells and energy storage. The subsidy is lowered to 10 percent with the aim to end after 2021, as the Government's assessment is that there is no longer a long-term need for support.

Support for storage of self-produced electricity
During 2016-2020 support was available for private individuals for installation of systems for storage of self-produced electricity. Grants were awarded with a maximum of 60 percent of the eligible costs, however, with a maximum of SEK 50,000.[30] In 2021 the support system was replaced by tax deduction for green investments.

Tax deduction for green investments
With the aim to reduce greenhouse gas emissions private individuals are, since 1 January 2021, eligible to a tax deduction 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 mains-connected solar cell systems the tax deduction is 15 %, for installation of a system for storage of electricity and for installation of at home charging stations for electric vehicles the deduction is 50 %.[31]

[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

[30] Förordning (2016:899) om bidrag till lagring av egenproducerad elenergi

[31] Government Bill 2020/21:1

Tax reduction for micro production of renewable energy
A tax reduction for households and businesses was introduced in 2015 to stimulate investment in the micro-production of renewable electricity. The income tax reduction is SEK 0.60/kWh of renewable electricity fed into the grid in a connection point with a fuse size of up to 100 Amps 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 regulated by the Energy Labelling Directive (2010/30/EU) and applies to all EU member states. Energy labeling makes the product's energy use visible and facilitates for consumers who want to make energy smart choices.

The Ecodesign Directive (2009/125/EC) aims to improve the products' environmental performance during their full life cycle. The requirements act as a floor to prohibit and remove the very worst products on the market, seen from an energy perspective. In principle, these rules can be applied to all energy-related products (except transport) and cover all energy sources. Sweden is particularly active in market surveillance activities, involving laboratory tests of products as well as supervision of distributors. The directive has been 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 EU Member States have decided on requirements for setting minimum energy performance standards, building energy certificates and inspections or advice on boilers and air conditioning systems. The aim of the directive is to reduce greenhouse gas emissions from the EU Member States and secure the energy supply in the medium and long-term.

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 a healthy indoor environment by requiring property owners to learn more about which measures are cost-effective to implement for improving building energy performance.

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/m^2 per year) and average thermal transmittance (W/m^2K).

Support for renovation and energy efficiency of apartment buildings
The Government intends to establish a state subsidy to property owners for renovation and energy efficiency measures that are taken on apartment buildings with rental apartments. The government proposes that the support will be SEK 955 million in 2021, SEK 2.4 billion in 2022 and SEK 1 billion in 2023.[32] 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 programs in building for low energy consumption
Since 2016, the Swedish Energy Agency, in cooperation with other actors, has been responsible for a set of capacity building programs in the area of building for low energy consumption. The programs target different construction stakeholders, such as architects, engineers, technicians, installers, site managers and teachers in building programs at upper secondary schools[34].[35]

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 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).

[32] Government Bill 2020/21:1

[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] Swedish Gymnasieskola

[35] National Board of Housing, Building and Planning and the Swedish Energy Agency 2016, "Underlag till den andra nationella strategin för energieffektiviserande renovering", Report ET 2016:15

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 is a long-term reform which began in 2018 and continues until 2040. It consists of a government scheme that aims to support development of technology and processes to reduce the process-related greenhouse gas emissions in Swedish industry. Financial support, administered by the Swedish Energy Agency, may be provided for research, feasibility studies, pilot and demonstration projects as well as full-scale investments. Projects related to mitigation, as well as to negative emissions, are eligible for funding. The target group for support is industries with process-related emissions, along with universities and research institutes.

One example of a project funded is the initiative "Hydrogen Breakthrough Ironmaking Technology", HYBRIT, which aims at ending the use of coal, traditionally needed for ore-based steel-making, and substitute it with hydrogen. The production of hydrogen is moreover planned to be produced from fossil-free electricity.
The result would be fossil-free steel-making technology, which has potential to cut Swedish emissions by 10 percent.

The scope of the Industrial Leap was amended 2020 when support for measures leading to negative emissions such as BECCS (Bio-Energy with Carbon Capture and Storage) was added.

In 2018, the government budgeted SEK 300 million for the program, while in 2019 the budget was increased to SEK 500 million followed by another increase in June 2020 to SEK 600 million for the period 2020-2022.

In December 2020 the Government decided to further extend the purpose of the grant to also be able to finance research, feasibility studies and investments relating to other greenhouse gas emissions, such as certain combustion emissions and diffuse emissions, linked to process-related emissions and strategically important initiatives in industry that contribute to greenhouse gas emissions reductions. Further, the grant was increased by SEK 150 million in 2021 and is expected to increase by SEK 100 million in 2022.[36]

Energy audits and the Energy Step for large enterprises

The law on energy audits in large enterprises aims at promoting improved energy efficiency (SFS 2014:266)[37]. The law requires large enterprises to conduct energy

[36] Government Bill 2020/21:1

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

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. Enterprises that are subject to the law, and have conducted an energy audit, have had the possibility to apply for support in terms of an in-depth projection of arrangements and additional costs in investment decisions to increase energy efficiency through the Energy Step Program. The program had a budget of totally 125 million SEK during the period 2018–2020.

Grants for small and medium-sized enterprises for energy audits
To stimulate a more efficient use of energy, small and medium-sized enterprises[38] were during 2010 until May 2020 eligible to apply for financial support to conduct an energy audit (SFS 2009:1577). The energy audit should include a survey of current energy use, proposals of measures and an energy plan. The maximum support per entity was 50%, with a maximum of SEK 50,000 since 2015.

Energy and climate coaches for small and medium-sized enterprises
Since 2016 municipalities are eligible to apply for the cost of one half-duty climate and energy coach (SFS 2016:385). The coach provides targeted advisory services to small and medium-sized enterprises[39]. The coaching activities aim to increase energy efficiency and reduce greenhouse gas emissions. By doing this, the enterprises will benefit from reduced costs, strengthened competitiveness and new opportunities for growth[40]. The support was available until June 2020.

The Government decided in December 2020 on an extension of state support through a permanent investment of SEK 120 million from 2021. The support is aimed both at households and small and medium sized enterprises.[41]

Energy efficiency networks for small and medium-sized enterprises
The Swedish Energy Agency has, since 2015, run a network project for small and medium-sized enterprises. The energy efficiency networks are regional enterprise networks where small and medium-sized enterprises get support in decreasing energy use within the enterprise. The networks consist of 8-16 enterprises with an energy use over one gigawatt-hour (GWh). In Sweden, there are currently 40 networks with approximately 300 participating enterprises. A network coordinator appointed by the Swedish Energy Agency leads the networks with support from an energy expert. Sharing experiences and learning from each other within and between the networks are also important success factors. The aim of the network activities is to reduce the energy use of the participating companies by 15 % over a

[38] Businesses using more than 300 MWh of energy annually, farms with at least 100 livestock units and economical organizations are eligible for the support.

[39] Businesses using less than 300 MWh.

[40] Swedish Energy Agency, http://www.energimyndigheten.se/energieffektivisering/program-och-uppdrag/kommunal-energi-och-klimatradgivning

[41] Government Bill 2020/21:1

four-year period. By doing this, the enterprises will benefit from reduced costs, strengthened competitiveness and new opportunities for growth.[42] The Program will end in May 2021.

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 1st 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.

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.

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.

[42] http://www.energimyndigheten.se/nrp/natverk-for-energieffektivisering/

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 2020: SEK 62, 260 or 416), with a yearly indexation. The Swedish Tax Agency is the competent 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 percent in 2021 and increase to 27 percent in 2030.[43]

Aviation in the EU Emissions Trading System
As of 2012, aviation between EEA-countries is included in the EU Emissions Trading System, 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.

Road transport

Emission performance standards for new vehicles
Manufacturers selling vehicles in the EU are subject to EU regulations (Nos 443/2009 and 510/2011) that set emission performance standards for new passenger cars and vans, as part of the Community's integrated approach to reducing CO_2 emissions from light-duty vehicles. Under these regulations, new passenger cars should not emit an average of more than 130 g CO_2/km by 2015 and not more than 95 g CO2/km by 2021. New vans should not emit an average of more than 175 g CO_2/km by 2017 and 147 g CO2/km by 2020. New standards for 2025 and 2030 were adopted by the EU during 2019. Accordingly, CO_2-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. In 2019 the EU also adopted CO_2-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 a number of elements for petrol and diesel specifications and introduces requirements for fuel suppliers to reduce the greenhouse gas

[43] Government Bill 2020/21:1

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. In the national plan for the transport system 2018-2029, SEK 1 billion per year is allocated to the urban environmental agreements. Municipalities are eligible to apply for grants to cover part of the investment costs for public transport infrastructure. The investment 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.

The Government decided in December 2020 on a temporary strengthening of the urban environment agreements with a special focus on cycling. The proposal includes a budget of SEK 550 million during 2022-2023.[44]

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. Investment support may also be provided for vessels in regional public transport as well as for 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.

[44] Government Bill 2020/21:1

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, so that consumers would be largely unaffected by the reform. 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 2018-2020 (SFS 2017:1201)

Year	**2018**	**2019**	**2020**
Diesel	19.3 %	20 %	21 %
Petrol	2.6 %	2.6 %	4.2 %

The Government proposed in its Budget Bill for 2021 that the reduction levels within the reduction obligation scheme be increased gradually until 2030 with indicative levels of 28 per cent for petrol and 66 per cent for diesel 2030 and a control station 2022. For 2021 the level of emission reductions is proposed to be 6 per cent for petrol and 26 per cent for diesel, starting earliest on July 30 2021.[45]

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 m^3 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
- Energy efficiency in the transport sector program
- Demonstration program for electric vehicles
- Vinnova – Innovations for a sustainable society

[45] Government Bill 2020/21:1

- 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.

Sweden is also involved in the EU Refuel project, which aims to develop strategies for introducing cost-effective alternative vehicle fuels. The project is also investigating potential effects on stationary installations using biofuels.

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 qualify for a bonus at purchase, while vehicles with high emissions of carbon dioxide will be taxed at a higher rate for the first three years. The system covers purchases of new light passenger cars, light buses and light trucks. The aim of the system is to increase the proportion of environmentally friendly vehicles and contribute to achieving the goal of a fossil-free vehicle fleet.

Maximum bonus is given to vehicles with zero emissions from the exhaust pipe - SEK 60,000. The bonus then decreases by SEK 714 per gram of carbon dioxide per kilometer emitted. At 70 grams of carbon dioxide per kilometer, the bonus ends. Biogas cars receive a fixed bonus amount of SEK 10,000 regardless of the size of their carbon dioxide emissions. In the emission range of 70-95 grams per kilometer there is neither bonus, nor malus.

All cars are 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 are subject to an increase in vehicle tax (malus) during the first three years. Ethanol and gas-powered vehicles are exempted from the increased tax. The vehicle tax for diesel-powered light vehicles in the bonus–malus-system is adjusted by converting the current fuel factor into a fuel surcharge. When the cars reach three years, the extra tax disappears and all but light diesel vehicles are taxed as in the differentiated vehicle tax system.

The Government proposed in its Budget Bill for 2021, which was adopted by the Riksdag in December 2020, the climate bonus for zero-emission vehicles should be increased from SEK 60,000 to SEK 70,000. In addition, the limit for bonuses should be lowered from 70 to 60 grams of carbon dioxide per kilometer and the maximum bonus amount for vehicles with emissions above zero should amount to around SEK 45,000. In order to strengthen the environmental management and financing of the system, malus should also be raised. This should be done by increasing the amounts included in the increased carbon dioxide amount by SEK 25 per gram of carbon dioxide. For the same reason, the lower limit for when the increased amount of carbon dioxide is taken out should be lowered from 95 to 90

grams and the limit for when the higher level is taken out should be lowered from 140 to 130 grams per kilometer.[46]

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 CO_2-related vehicle tax is SEK 22 per g CO_2/km beyond 111 g CO_2/km in mixed driving. This CO_2 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 CO_2/km beyond the first 111 g CO_2/km. Light trucks, light buses and campers were also brought into the system of CO_2-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 chose 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 CO_2 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.

Lower benefit value on 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 value of the benefit corresponds on average to the market value of the cost of owning the car.
Fuel provided by the employer is taxed separately. The value of the benefit corresponds to 1.2 times the market value of the cost of 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 receive relatively favorable tax treatment through the reduction of their benefit value. Typically, the benefit value is reduced to the (lower)

[46] Government Bill 2020/21:1

level of a similar model without the environmental technology of the green car. This reduction is permanent.

In addition to this reduction, the benefit value of electric cars, plug-in hybrids and cars powered by natural gas (other than liquefied petroleum gas) were provided an extra reduction of 40 %, up to a maximum of SEK 16,000 annually, until the end of 2016. As of 2017, and until the end of 2020, this additional reduction has been lowered to SEK 10,000.

The Government proposes in its budget bill for 2021 adjustments to the car benefit to better reflect the market value, which means that the taxation of most fossil-fueled benefit cars would increase.[47]

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

Since January 2020 regional public transport agencies, public transport companies, municipalities and limited companies[48] are eligible to apply for climate premiums for electric buses, electric and other low-emission heavy-duty vehicles as well as for electric tractors and mobile machinery. The total budget for these premiums is SEK 120 million per year for 2020 and the scheme is set to last until 2023.[49]

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.[50] SEK 500 million is allocated for 2021 and an increase with 550 million is proposed for 2022.[51]

Support for electric fast charging infrastructure

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 candidates can receive 100 percent investment support with a counter-requirement that the charging station must be in operation for five years.[52]

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[47] Government Bill 2020/21:1

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

[49] SFS 2016:836

[50] Government Bill 2020/21:1

[51] Government Bill 2020/21:1

[52] https://www.trafikverket.se/tjanster/ansok-om/ansok-om-bidrag/ansok-om-bidrag-till-snabbladdningsstationer-for-elfordon/, February 2021

Local Climate Investment Program (Climate leap)
The Climate Leap is a comprehensive investment support scheme. Municipalities, companies, organisations 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 deduction for installation of green technology
With the aim to reduce greenhouse gas emissions private individuals are, since 1 January 2021, eligible to a tax deduction 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 deduction is 50 %.[53] (more about the tax deduction for green technology in section 2.2.2)

Conversion premium
To reduce emissions from the existing vehicle fleet the Government proposes in its budget bill for 2021 that a conversion premium for cars from fossil fuels to biofuels or biogas should be introduced in 2022.[54]

Consideration of climate in long-term infrastructure planning
In 2016, Parliament decided on a new national infrastructure plan for 2018-2029, 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.

Compensation for transfer of goods to railway
In 2018, the government launched a temporary support aimed at stimulating the transfer of goods from road to shipping and railway to reduce greenhouse gas emissions from heavy transport. The annual budget of the support was SEK 50 million. 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 for goods by railway in Sweden and has allocated SEK 400 million per year during 2021-2025.[55]

Congestion tax
Congestion tax is levied in the cities of Stockholm and Gothenborg 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

[53] Government Bill 2020/21:1

[54] Government Bill 2020/21:1

[55] Government Bill 2020/21:1

day (in Stockholm for 2021: SEK 15–45, in Gothenburg for 2021: 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.

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 555 SEK per tonne landfilled waste in 2019.[56]

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.

Extended producer responsibility
A set of ordinances mandates extended producer responsibility for producers of eight product groups. Producer responsibility promotes sorting, collection and recycling of certain waste flows[57]. 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).

The municipal waste planning requirement
Since 1991, there has been a requirement that all the municipalities in Sweden must have their own municipal waste plan. A Swedish EPA regulation (NFS 2006:6) sets out the minimum requirements of what each municipality must include in its waste plan, such as a description of the current situation, recycling plants and

[56] https://skatteverket.se/foretagochorganisationer/skatter/punktskatter/avfallsskatt.4.18e1b10334ebe8bc80002886.html

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

landfills, environmental assessment, measures and monitoring. Both the national waste plan[58] and the national prevention program[59] act as guidance for the municipalities in developing their local plans and deciding on prioritized actions.

2.2.6 AGRICULTURE

Common Agricultural Policy

In 2013, the Council of EU Agriculture Ministers formally adopted the four Basic Regulations for a reformed Common Agricultural Policy (CAP), as well as Transition Rules for 2014. Based on certain requirements, farmers can receive support for measures aimed at producing non-profitable services 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 Program 2014—2020

The Swedish Government decided on a new Rural Development Program in June 2014. The program for 2014–2020 includes investment grants for young entrepreneurs, capacity building, cooperation and innovation, support to areas with natural constraints, animal welfare subsidies, ecological farming, and environmental and climate actions. Measures specifically contributing to climate change mitigation include 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 program budget totals SEK 36 billion, of which 59 % is financed by Sweden and the remaining 41 % by the EU.

Rural network

The Rural Network complements the Swedish Rural Development Program, the Ocean and Fishery Program, and the program 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 programs. The Swedish

[58] Swedish Environmental Protection Agency, 2012,From waste management to resource efficiency, Report 6560

[59] Swedish Environmental Protection Agency, 2015, *Tillsammans vinner vi på ett giftfritt och resurseffektivt samhälle Sveriges program för att förebygga avfall 2014–2017,* Report 6654, ISBN 978-91-620-6654-3

Board of Agriculture has been given responsibility by the government to monitor the Rural Network.

'Focus on Nutrients' advisory service
Financed by the Swedish Rural Development Program, the Swedish Board of Agriculture offers an advisory service called 'Focus on Nutrients' together with the Federation of Swedish Farmers and the County Administrative Boards of Sweden. The service started in 2001, with an initial focus on advice for higher nutrient efficiency in order to reduce nutrient leaching. Today, it also provides advice specifically targeting GHG emission reductions and energy efficiency, since reducing GHG emissions has become one of the main objectives of the service.

Support for biogas production
In January 2015, the Government introduced a support scheme 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 methane emissions from manure and the substitution of fossil energy.[60] 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. In the latest support period, 1 October 2019 until 30 September 2020, a total amount of SEK 29,9 million was shared among 65xx biogas plants generating 178 GWh. Support for investments in new biogas plants can also be granted through the Rural Development Program.

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

[60] Swedish Board of Agriculture (2021). https://jordbruksverket.se/stod/fornybar-energi/godselgasstodl

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, guidelines for thinning and measures to limit damage. 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 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 by allowing them to be maintained or continue to increase.

Nature reserves

In Sweden, nature reserves[61] are one of the most common ways of protecting valuable nature in the long term. At present, there are close to 5000 nature reserves in

[61] http://www.naturvardsverket.se/Var-natur/Skyddad-natur/Naturreservat/

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 agreement[62]. 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

Support for re-wetting of wetlands
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 wetlands on peat soils are expected to reduce 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.[63] SEK 350 million is allocated for the support in 2021 and the budget is proposed to increase with SEK 325 million in 2022 and 100 million in 2023.

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 such as nutrient retention and biodiversity. Data of rewetting efforts from the period 1990 to 2019 vary in quality, and

[62] http://www.naturvardsverket.se/Stod-i-miljoarbetet/Vagledningar/Skyddad-natur/Naturvardsavtal

[63] Government Bill 2020/21:1

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.

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 2021: SEK 63, 262 or 418), 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 CO_2 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 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-CO_2 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 CO_2 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 end 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 5000 to collect and report data related to fuel consumption. The system is similar to the monitoring, reporting and verficiation 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 shoreside 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.

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3 Swedish projections of greenhouse gas emissions and removals

Projections of greenhouse gas emissions in Sweden have been produced for the years 2020, 2025, 2030, 2035 and 2040. The projections are based on the policies and measures adopted by the Swedish parliament up to June 2020 which means that it is a projection “with existing measures” (WEM). The base-year for the projections is 2018 in the National inventory submission 2021 and the historical emissions are presented for 1990-2019. All emissions and removals of greenhouse gases use global warming potentials from IPCC Forth Assessment Report (AR4).

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. However, the effects of the Covid-19 pandemic have partly been taken into account in the short term.

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. Two sensitivity projections have been calculated for the energy sector: one with lower emissions, assuming a weaker economic development, and one with higher emissions, assuming lower crude oil prices. One sensitivity projection has also been calculated for the road transportation sector and one for the LULUCF sector.

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 50.9 million tonnes in 2019[64] (excluding The Land Use, Land Use Change and Forestry sector). Total emissions decreased by 20.3 million tonnes, or 29%, between 1990 and 2019. The projections, with existing measures, show that the total emissions of greenhouse gases, (excluding LULUCF) are estimated to be 43.2 million tonnes of carbon dioxide equivalents in 2030. The projected emissions in 2030 are 39% below the 1990 level. After 2030 emissions are projected to continue to decrease, and in 2040 the total emissions of greenhouse gases are expected to be 45% 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—2019 and are expected to do so during the projection period as well.

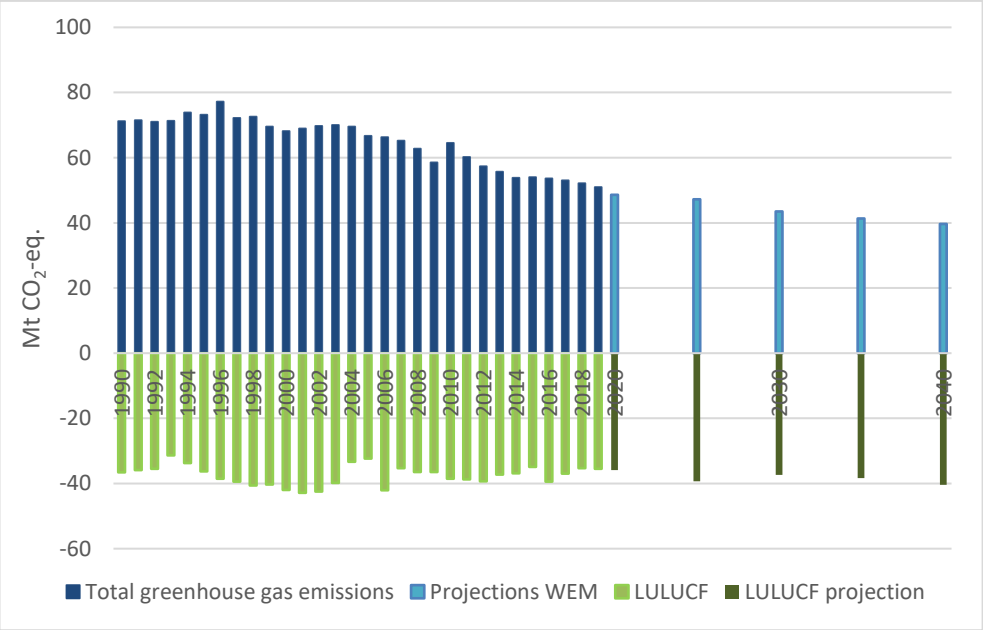

Figure 1 Historical emissions of greenhouse gases and projected emissions of greenhouse gases with existing measures (WEM).

[6464] National Inventory Report Sweden, Submission 2021

Table 1. Historical and projected emissions/removals of greenhouse gases per sector (Mt CO_2-equivalents). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Energy excl. transport	33.1	18.5	18.3	17.4	16.6	16.3	16.2	-50%	-51%
Transport	19.0	16.4	15.6	15.2	13.6	12.0	10.7	-28%	-44%
Industrial processes and product use	7.7	7.9	6.9	7.2	6.1	6.0	6.0	-20%	-22%
Agriculture	7.7	6.9	6.8	6.3	6.1	6.0	5.9	-20%	-22%
Waste	3.7	1.1	1.1	0.9	0.8	0.7	0.6	-79%	-83%
Total emissions	**71.2**	**50.9**	**48.8**	**47.0**	**43.2**	**41.0**	**39.4**	**-39%**	**-45%**
LULUCF	-36.5	-35.5	-35.9	-39.3	-37.4	-38.4	-40.4	2%	11%

Sensitivity calculations have been produced by varying some parameters in the energy sector (incl. transport) and the transport sector respectively (for more information, see section 3.4). Aggregated for all sectors the sensitivity calculations show that the emission level in 2040 may span between 38% and 46% lower than the level in 1990, depending on sensitivity projection. However, this does not include uncertainty in the calculations, which may expand the span between the projections.

3.2 Projections per gas

For the year 2019 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%.[65]
During the projection period, the emissions of all gases decrease, but the share of carbon dioxide emissions is estimated to increase to small extent to about 82% in the year 2030. 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 CO_2-equivalents). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	57.4	40.9	39.0	38.1	35.0	33.1	31.7	-39%	-45%
Methane	7.4	4.2	4.1	3.6	3.4	3.2	3.1	-55%	-58%
Nitrous oxide	5.8	4.7	4.6	4.5	4.4	4.3	4.3	-24%	-26%
Fluorinated greenhouse gases	0.7	1.1	1.0	0.8	0.5	0.4	0.4	-21%	-48%

[65] National Inventory Report Sweden, Submission 2021

Total emissions (excl. LULUCF)	**71.2**	**50.9**	**48.8**	**47.0**	**43.2**	**41.0**	**39.4**	**-39%**	**-45%**

3.3 Projections by sector

In the projections, the emissions from all sectors are decreasing until 2040. The largest reduction is projected for the energy and transport sectors.

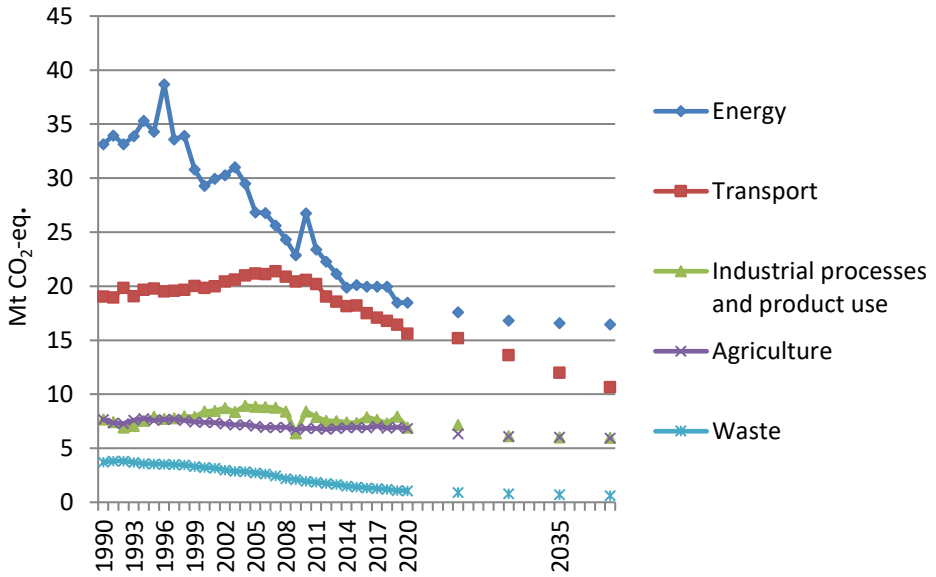

Figure 2. Historical and projected emissions of greenhouse gases by sector.

3.3.1 Energy excluding transport

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

Emissions of greenhouse gases by the energy sector excluding transport amounted to 18.5 million tonnes of carbon dioxide equivalents in 2019.[66] 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 with 50% until 2030, and 51% until 2040, in comparison with 1990.

[66] National Inventory Report Sweden, Submission 2021

Table 3. Historical and projected emissions of greenhouse gases from the energy sector excluding transport (Mt CO_2-equivalents). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	32.5	17.8	17.7	16.7	16.0	15.7	15.6	-51%	-52%
Methane	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-28%	-32%
Nitrous oxide	0.4	0.5	0.4	0.4	0.4	0.4	0.4	-3%	3%
Total emissions	**33.1**	**18.5**	**18.3**	**17.4**	**16.6**	**16.3**	**16.2**	**-50%**	**-51%**

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:

- Within the EU emissions trading scheme, a price of 30 euros was assumed per tonne of carbon dioxide 2030 and 53 euros per tonne 2040 (in 2016 price).
- 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 2040.
- In general, current taxes and other instruments (in place first of July 2020) are assumed to remain unchanged until 2040.
- National Institute of Economic Research estimates of economic development (%/year):

	Reference	
	2015-2035	**2035-2040**
GDP	1.72	1.76
Private consumption	1.87	2.22
Export	2.58	2.59
Import	2.60	2.70

- The effects of the Covid-19 pandemic have partly been taken into account by assuming a lower level of GDP in the beginning of the projection period.

- The trends in fossil fuel prices are given by the European Commission (2016 prices)

	Base year	Reference		
	2018	**2020**	**2030**	**2040**
Crude oil (USD/barrel)	68	42	89	103
Coal (USD/tonnes)	93	53	86	98
Natural gas (USD/Mbtu)	6	4	6	8

- 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 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 slightly during the projection period while the productions 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 also increased use of wind and solar power. The emissions were 6 million tonnes carbon dioxide equivalents in 2019[67] and are projected to stay around the same level until 2040. 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.

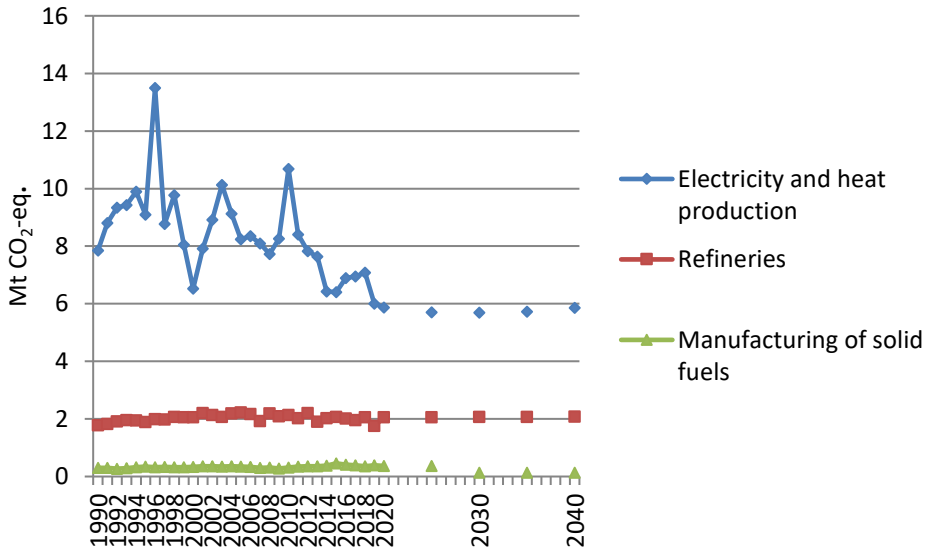

Figure 3. Historical and projected emissions of greenhouse gases from electricity and heat production, refineries and manufacturing of solid fuels.

The net electricity production is assumed to increase during the projection period, mostly due to increased use of renewable energy sources, such as wind and solar power and biomass. Electricity production based on oil and coal is expected to decrease during the period. Electricity use is also expected to increase until 2040, but at a lower rate than the net electricity production, thus resulting in increased net exports of electricity throughout the projection. The assumed increase in electricity production, in combination with lower increase in electricity demand, results in a projected export of about 40 TWh in 2040.

[67] National Inventory Report Sweden, Submission 2021

The total use of *district heating* is expected to remain stable until 2040. District heating production has undergone a shift from being fossil fuel based to being based on biomass and waste during the 1990s and 2000s. In this period there has also been an increase in energy efficiency measures among users and increased competition with other heating solutions. The use of waste as a fuel is projected to continue to increase until 2040.

Table 4. Historical and projected emissions of greenhouse gases from electricity and heat production (CRF 1A1a, Mt CO_2-equivalents). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	7.7	5.7	5.4	5.3	5.3	5.3	5.4	-31%	-29%
Methane	0.02	0.05	0.05	0.05	0.04	0.04	0.04	159%	173%
Nitrous oxide	0.1	0.2	0.2	0.2	0.2	0.2	0.2	59%	68%
Total emissions	**7.8**	**6.0**	**5.7**	**5.5**	**5.5**	**5.6**	**5.7**	**-30%**	**-28%**

Emissions from refineries have increased since 1990 due to increased production, however the emissions in 2019 were lower due to planned maintenance. The production is projected to continue to increase, but the increase is counteracted by the effect of measures performed resulting in higher efficiency. The emissions are expected to continue to increase slightly during the projection period, by 16% until 2030 and by 17% until 2040, compared to the 1990 level. The emissions from refineries are also accounted for in the sector of fugitive emissions.

Table 5. Historical and projected emissions of greenhouse gases from refineries (CRF 1A1b, Mt CO_2-equivalents). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	1.8	1.8	2.1	2.1	2.1	2.1	2.1	16%	17%
Methane	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-5%	-5%
Nitrous oxide	0.001	0.001	0.001	0.001	0.001	0.001	0.001	-24%	-24%
Total emissions	**1.8**	**1.8**	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	**16%**	**17%**

The emissions from manufacturing of solid fuels were around 0.4 million tonnes of carbon dioxide equivalents in 2019. The emissions are estimated to remain stable until 2025 and then decrease due to an assumed shift to fossil free technology.

Table 6. Historical and projected emissions of greenhouse gases from manufacturing of solid fuels (CRF 1A1c, Mt CO_2-equivalents). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	0.3	0.4	0.4	0.4	0.1	0.1	0.1	-54%	-54%
Methane	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	-32%	-32%
Nitrous oxide	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	-32%	-32%
Total emissions	**0.3**	**0.4**	**0.4**	**0.4**	**0.1**	**0.1**	**0.1**	**-54%**	**-54%**

ASSUMPTIONS ON WHICH ESTIMATES FOR ENERGY INDUSTRIES ARE BASED:

- 2 of Sweden's 8 reactors have shut down until 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 no decommission during the projection period.
- Projections of the Swedish sector price for electricity for the years 2030 and 2040. (Annual average, 2016 price level in SEK/kWh)

	2018	2030	2040
Electricity price	0.46	0.33	0.50

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

	2018	2030	2040
Hydropower	62	67	68
Nuclear power production	66	52	52

- For the refinery sector, the emissions are assumed to increase during the projection period, in accordance with the expansion plans of this sector. Counteracting measures for higher efficiency of 5 % in 2040 compared to 2019 are assumed.
- A shift to fossil-free technology is assumed for a part of the manufacturing of solid fuels

3.3.3 Combustion in manufacturing industries

The emissions of greenhouse gases from combustion in manufacturing industries were 7.0 million tonnes of carbon dioxide equivalents in 2019.[68] 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).

[68] National Inventory Report Sweden, Submission 2021

In 2019, the emissions from combustion in manufacturing industries were 35% lower than the 1990 level and are expected to be 51% lower in 2040 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 2019, the iron and steel industry accounted for 22% of the emissions respectively and the mineral industry accounted for 17%.

Emissions are expected to decrease until 2040 because the use of biofuel and electricity is expected to increase more than the use of fossil fuels. The decreasing emissions are mainly explained by decreases in the pulp and paper industry due to a shift from using fossil fuels to biofuels. The decrease after 2030 can also be explained by an assumed shift in technology for a part of the iron and steel industry.

Emissions from working machinery in the industry were 1.4 million tonnes of carbon dioxide equivalents in 2019, which is an increase by 42 % compared to 1990 level. The emissions are projected to remain around the same level as today.

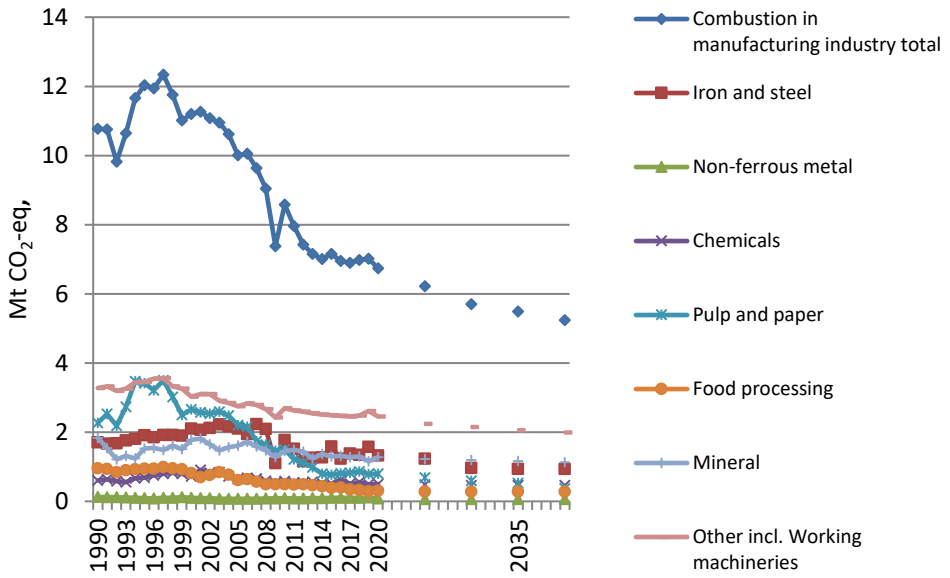

Figure 4. Historical and projected emissions of greenhouse gases from combustion in manufacturing industries.

Table 7. Historical and projected emissions of greenhouse gases from combustion in manufacturing industries (CRF 1A2, Mt CO_2-equivalents). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040

Carbon dioxide	10.6	6.8	6.6	6.0	5.5	5.3	5.1	-48%	-52%
Methane	0.02	0.03	0.03	0.03	0.03	0.03	0.03	13%	16%
Nitrous oxide	0.1	0.1	0.1	0.1	0.1	0.2	0.2	8%	10%
Total emissions	**10.8**	**7.0**	**6.7**	**6.2**	**5.7**	**5.5**	**5.2**	**-47%**	**-51%**

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 2015-2035 and 2035-2040 (National Institute of Economic Research):

Industry	**Annual growth (%) 2015-2035**	**Annual growth (%) 2035-2040**
Pulp and paper industry	2.05	1.33
Chemical industry	1.80	2.05
Iron and steel industry	0.29	0.16
Manufacture of non-metallic mineral products	1.20	1.21
Non-ferrous metalworks	1.07	0.83
Engineering industry	1.33	1.55
Mining	1.17	-0.11

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 2019 from 11.1 to 2.6 million tonnes of carbon dioxide equivalents[69] and are expected to continue to decrease. The emissions in 2019 are 77% lower than in 1990 and are expected to decrease further to 82% and 83% below the 1990 level in 2030 and 2040 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

[69] National Inventory Report Sweden, Submission 2021

heat mainly is based on biomass and waste and district heating is a more efficient way of heating, the emissions still decrease until 2040.

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.

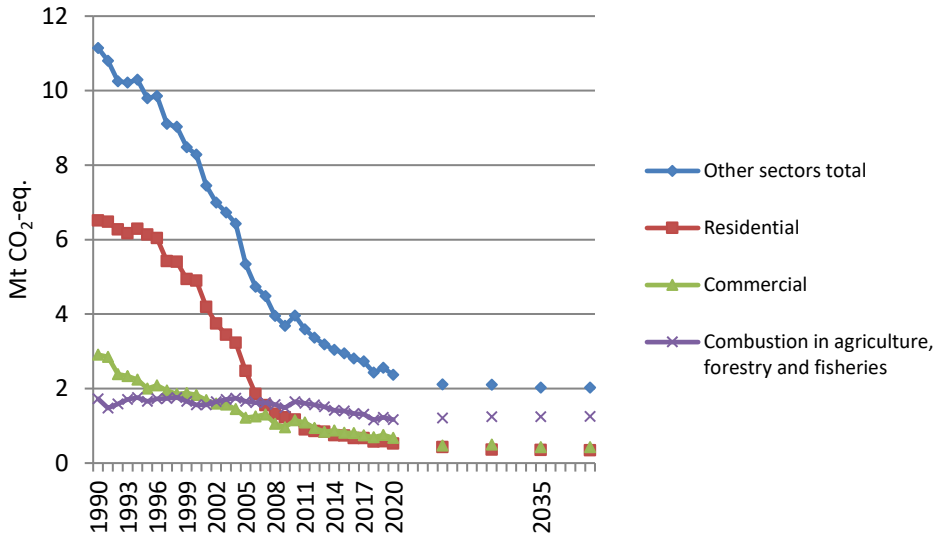

Figure 5. Historical and projected emissions of greenhouse gases from combustion in households, premises, agriculture, forestry and fisheries sectors.

The emissions from stationary 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 slightly after 2025, 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 forestry sector are expected to increase slightly during the projection period after 2020. Emissions from machinery used by fisheries are assumed to stay unchanged during the projection period.

Carbon dioxide emissions account for around 94% of the total emissions from combustion in households, premises and in the agricultural, fishing and forestry sectors in 2019 and are expected to account for 94% of the total emissions in 2040 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 56% between 1990 and 2030 and with 68% between 1990 and 2040. The emission of nitrous oxide decreases with 49% until 2030 and with 56% until 2040 in comparison to 1990.

Table 8. Historical and projected emissions of greenhouse gases from households, premises, agriculture, forestry and fisheries sectors (CRF 1A4, Mt CO_2-equivalents). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	10.9	2.4	2.2	1.9	1.9	1.8	1.8	-83%	-83%
Methane	0.1	0.1	0.1	0.1	0.1	0.04	0.04	-56%	-68%
Nitrous oxide	0.2	0.1	0.1	0.1	0.1	0.1	0.1	-49%	-56%
Total	**11.1**	**2.6**	**2.4**	**2.1**	**2.0**	**1.9**	**1.9**	**-82%**	**-83%**

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. [70]

- Population growth (Statistics Sweden)

	2018	2030	2040
Population	10 230 185	11 094 873	11 529 973

- The number of new apartments in single-dwelling houses and multi-dwelling houses in the projection is assumed to increase by 295 000 from 2019 to 2025 and by 526 000 from 2025 to 2050.
- Heated area of new single dwelling houses and new apartment buildings is assumed to be 150 m^2 and 65 m^2 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.

[70] RCP : Reference Concentration Pathway

3.3.5 Emissions from Other and Fugitive emissions

The emissions from the CRF-sector 'Other' were almost 0.2 million tonnes of carbon dioxide equivalents in 2019.[71] These emissions have been reduced with 79% between 1990 and 2019. The emissions are projected to remain at around the same level as in recent years during the entire projection period.

Table 9. Historical and projected emissions of greenhouse gases from 'Other', (CRF 1A5, Mt CO_2-equivalents). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	0.8	0.2	0.2	0.2	0.2	0.2	0.2	-80%	-80%
Methane	0.001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	-97%	-97%
Nitrous oxide	0.02	0.003	0.002	0.002	0.002	0.002	0.002	-85%	-85%
Total emissions	**0.9**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**-80%**	**-80%**

The fugitive emissions were 0.6 million tonnes of carbon dioxide equivalents in 2019. The emissions are projected to be 122% higher in 2030 and 126% higher in 2040, compared to 1990. The increase is due to an increase in emissions from refineries due to increased production. The emissions from refineries started to increase in 2006 due to new installations with capacity to manufacture hydrogen gas. Emissions are assumed to increase until 2040 due to new installations. 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 10. Historical and projected emissions of greenhouse gases from fugitive emissions (CRF 1B, Mt CO_2-equivalents). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	0.3	0.5	0.9	0.9	1.0	1.0	1.0	165%	170%
Methane	0.1	0.06	0.06	0.06	0.06	0.06	0.06	-35%	-35%
Nitrous oxide	0.001	0.001	0.001	0.001	0.001	0.001	0.001	1%	1%
Total emissions	**0.4**	**0.6**	**0.9**	**0.9**	**1.0**	**1.0**	**1.0**	**122%**	**126%**

3.3.6 Domestic transport

The emissions from domestic transports amounted to 16.4 million tonnes of carbon dioxide equivalents in 2019.[72] Road transportation contributes with the majority of

[71] National Inventory Report Sweden, Submission 2021

[72] National Inventory Report Sweden, Submission 2021

emissions from the sector (approximately 91%), while emissions from navigation, civil aviation and railways are small. The emissions increased from 1990 to around 2005, when they stabilized. The total emissions from transport have decreased since 2010, aside from a small increase from 2014 to 2015. The trend during later years is mainly explained by an increase in energy efficiency and an increased use of bio-fuels. The energy efficiency is due to a shift from petrol-powered cars to diesel-powered cars (diesel motors are more efficient than petrol motors) while cars have also become more energy efficient due to EU-regulations.

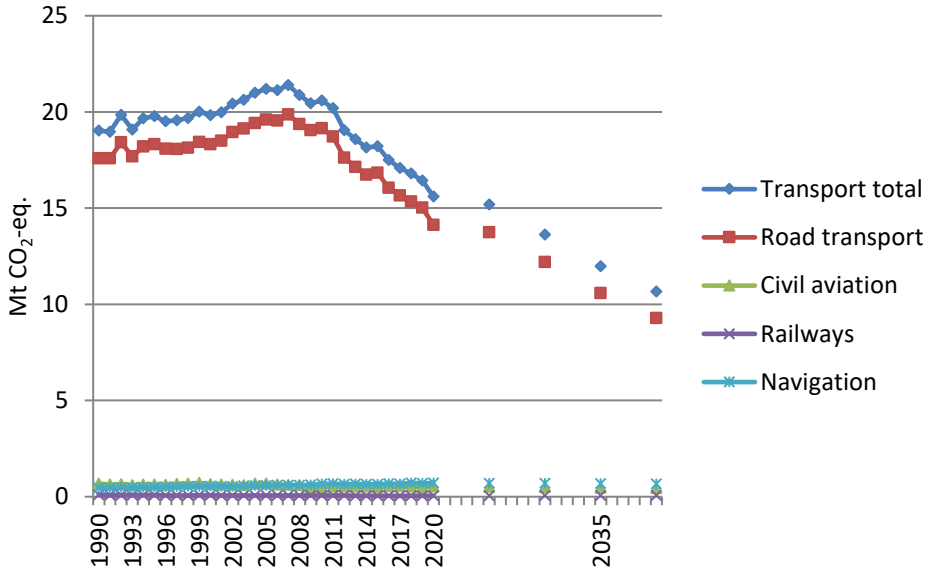

Figure 6. Historical and projected emissions of greenhouse gases from transport sector.

In the projection the emissions will continue to decrease until 2040, especially the emissions from road transport that decrease from 15.0 million tonnes in 2019 to 9.3 million tonnes in 2040. The decrease in emissions is mainly due to large reductions from cars. One reason for this decrease is an ongoing improvement of energy efficiency due to EU regulations that limits the emissions from new cars, heavy duty and light-duty lorries. The energy efficiency is reinforced by a decreasing number of petrol cars. Another reason for the decrease is an increased use of biofuels. It is in particular the obligatory low-blend of biofuels in petrol and diesel by which suppliers must reduce carbon dioxide emissions. Due to an increased use of fossil diesel in heavy-duty vehicles their emissions increase in the period 2020—2025 in the projection. After 2025 the use of fossil diesel decreases and from 2035 onwards, as electric vehicles are more widely used, the emissions from heavy-duty vehicles in the projection remain on a level of around 3 million tonnes. In the projection light duty lorries will be powered by electricity to a higher degree than heavy-duty lorries and the emissions from light duty lorries decrease after 2025.

Emissions from domestic aviation have decreased during the last years, mostly due to higher efficiency as travelling by domestic aviation has increased slightly from

year to year after the financial recession after 2008. In the projection travelling by air is assumed to increase during the entire period from today's level, although a tax on airborne travel inhibits the increase. The price of emissions within the EU ETS is also anticipated to influence domestic air travel by reducing the demand. Emissions from domestic aviation decreases during the entire period as a result of continued efficiency improvements. Use of biofuels for domestic aviation is not included in the projections.

Emissions from domestic navigation have varied between 0.5 and 0.7 million tonnes of carbon dioxide equivalents in the period from 1990 to 2019. The emissions are assumed to be around 0.7 million tonnes between 2020 and 2040.

Emissions from railways have decreased from 0.1 million tonnes of carbon dioxide equivalents in 1990 to 0.05 million tonnes in 2019. Railway traffic is expected to increase during the entire projection period. Although railway traffic is mainly powered by electricity emissions will increase as diesel use is projected to be higher in future years. The diesel use in railway traffic is estimated to increase from 153 GWh in 2018 to 228 GWh in 2040, corresponding to emission of 0.07 million tonnes of carbon dioxide equivalents.

Emissions from other transportation were 0.2 million tonnes in 2019 and are projected to remain at this level until 2040.

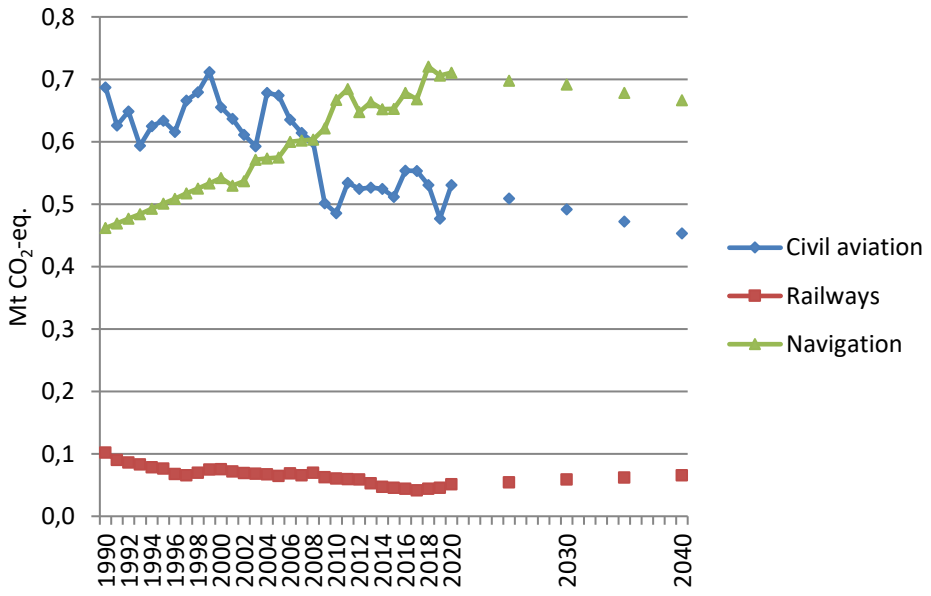

Figure 7. Historical and projected emissions of greenhouse gases from domestic aviation, navigation and railways.

Table 11. Historical and projected emissions of greenhouse gases from different transport modes (CRF 1A3, Mt CO_2-equivalents). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Road transportation	17.6	15.0	14.1	13.7	12.2	10.6	9.3	-31%	-47%
Civil aviation	0.7	0.5	0.5	0.5	0.5	0.5	0.5	-28%	-34%
Navigation	0.5	0.7	0.7	0.7	0.7	0.7	0.7	50%	44%
Railways	0.1	0.05	0.05	0.06	0.06	0.06	0.07	-42%	-35%
Other	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-7%	-7%

Table 12 Historical and projected emissions of greenhouse gases from domestic transport (CRF 1A3, Mt CO_2-equivalents). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	18.7	16.2	15.4	14.9	13.4	11.7	10.4	-29%	-44%
Methane	0.2	0.04	0.04	0.04	0.04	0.04	0.04	-78%	-78%
Nitrous oxide	0.2	0.2	0.2	0.2	0.2	0.2	0.2	34%	24%
Total emissions	**19.0**	**16.4**	**15.6**	**15.2**	**13.6**	**12.0**	**10.7**	**-28%**	**-44%**

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.
- The tax exemption for pure and high-blended biofuels is enforced from 2018-2020, after 2020 no decision on its future has been made meaning the competitiveness for high-blended biofuels and pure biofuels is worsened, meaning less of these fuels (E85, ED95, FAME100 and HVO100) is used.
- EU emission regulations set for cars, heavy-duty vehicles and light duty vehicles respectively.

- **Fuel prices, SEK/litre, including tax and excluding VAT, 2018 year fixed prices**

	2018	2040
Petrol, with low-blend ethanol	12.3	17.7
Diesel, with low blend bio-diesel	12.3	19.4

Since July 1st 2018 there is no exemption from carbon and energy tax on bio-diesel and bio-petrol that is blended with components from non-renewable sources, no matter the level of renewable content. The same tax levels as of today are assumed during the whole period.
The low blending of HVO and ethanol is assumed to increase aligned with the emission reduction obligation until 2020. After 2020 the level of low-blending of HVO in diesel is assumed to be unchanged and the volume of low-blended HVO is thus solely dependent on the diesel usage and the same assumption is made for low-blending of ethanol in petrol.
Renewable fuel (except biogas) that is sold without being blended with non-renewable fuel is fully exempted from tax in 2020, 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 7.9 million tonnes of carbon dioxide equivalents in 2019.[73] 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 2040 to 22% below the 1990 level. The decrease compared to 1990 is due to be caused by a decrease in hydrofluorocarbons (HFCs) but also a decrease in emissions from carbon dioxide are expected after 2030. The emissions of perfluorocarbons (PFCs), started to decrease in 2012 and are expected to stay low until 2040.

The emissions of carbon dioxide were 11% higher in 2019 compared to 1990 level and are expected to decrease until 2040. The decrease is mainly due to a decrease in emissions from the metal industry until 2040 and especially after 2030, due to a shift to fossil-free technology in a part of the iron and steel industry. The emissions of carbon dioxide from the mineral industry are expected to slightly increase until 2040 compared with 1990 due to a projected continuing increase in constructing new buildings. The emissions of greenhouse gases from chemical industry are

[73] National Inventory Report Sweden, Submission 2021

assumed to remain around the same level as in 2019. The emissions from fuel combustion in industry are reported in the energy sector.

In 2019, the total emissions from non-energy products from fuels and solvent use were almost 0.4 million tonnes of carbon dioxide equivalents, which is an increase of 4% 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 36% since 1990 and are estimated to continue to decrease until 2040.

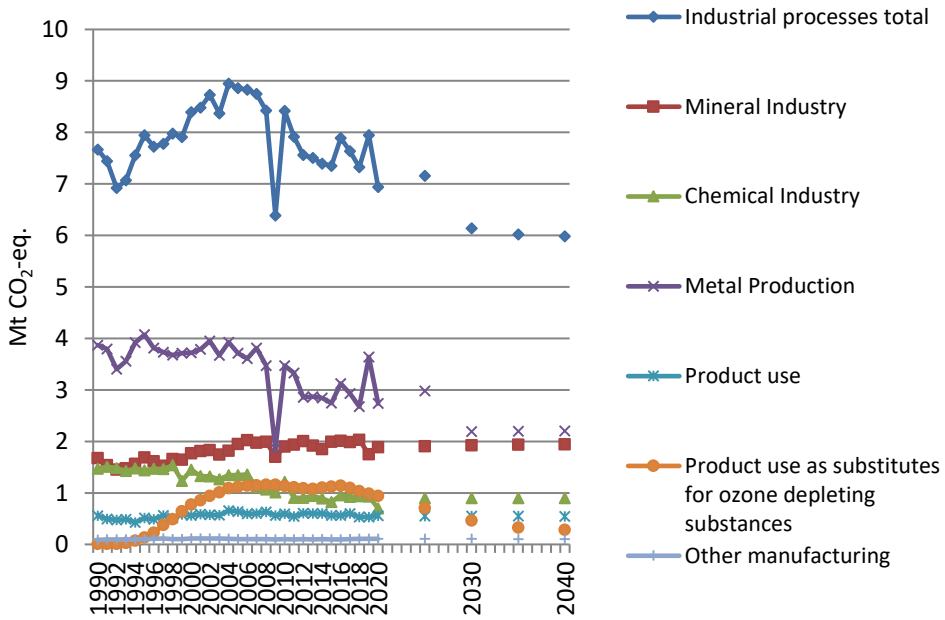

Figure 8 Historical and projected emissions of greenhouse gases from different industries and product use

The major emissions of fluorinated greenhouse gas in 2019 emanated from products used as substitutes for ozone depleting substances. The total greenhouse gas emissions from this type of product use amounted to 1.1 million tonnes calculated as carbon dioxide equivalents in 2019. 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 2040 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 13. Historical and projected emissions of greenhouse gases from industrial processes and product use sector (CRF 2, Mt CO_2-equivalents). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	6.0	6.7	5.7	6.2	5.4	5.4	5.4	-10%	-10%
Methane	0.03	0.01	0.01	0.01	0.01	0.01	0.01	-65%	-66%
Nitrous oxide	1.0	0.2	0.2	0.2	0.2	0.2	0.2	-78%	-79%
HFC	0.006	1.0	0.9	0.7	0.5	0.3	0.3	7011%	4282%
PFC	0.6	0.05	0.04	0.04	0.04	0.04	0.04	-92%	-92%
SF6	0.1	0.03	0.03	0.03	0.03	0.03	0.02	-21%	-48%
Total emissions	**7.7**	**7.9**	**6.9**	**7.2**	**6.1**	**6.0**	**6.0**	**-20%**	**-22%**

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 effects of the Covid-19 pandemic have partly been taken into account by assuming lower emissions in 2020.
- The assumption on projected value added is the same as those for manufacturing industries and construction (CRF 1A2).
- For a part of the iron and steel industry, a shift to a production technology with lower emissions are assumed after 2030.

3.3.8 Agriculture

In 2019, emissions of greenhouse gases from agriculture amounted to 6.9 million tonnes of carbon dioxide equivalents[74]. In comparison with 1990, emissions have decreased by 9% . 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 decline to 6.1 million tonnes of carbon dioxide equivalents in 2030 and then further reduced to 5.9 million tonnes of carbon dioxide equivalents in 2040. Emissions are estimated to decrease as a result of continuous decline in cattle population. The reduced numbers of dairy cows for 2030 and 2040 are due to the assumptions of increased productivity, the

[74] National Inventory Report Sweden, Submission 2021

development of product prices, and continuous adaptation to EU agricultural policy regulations.

Methane emissions from animal digestion are projected to decrease from 3.0 million tonnes of carbon dioxide equivalents in 2019 to 2.5 million tonnes of carbon dioxide equivalents in 2030. Emissions from manure management are projected to decrease from 0.6 million tonnes of carbon dioxide equivalents in 2019 to 0.5 in 2030.

Emissions from agricultural land are also projected to decrease, from 3.3 in 2019 to 3.0 million tonnes of carbon dioxide equivalents in 2030 in this projection. Emissions of carbon dioxide from agriculture are relatively small and are related to liming and urea application. In 2019, the emissions amounted to about 0.1 million tonnes.

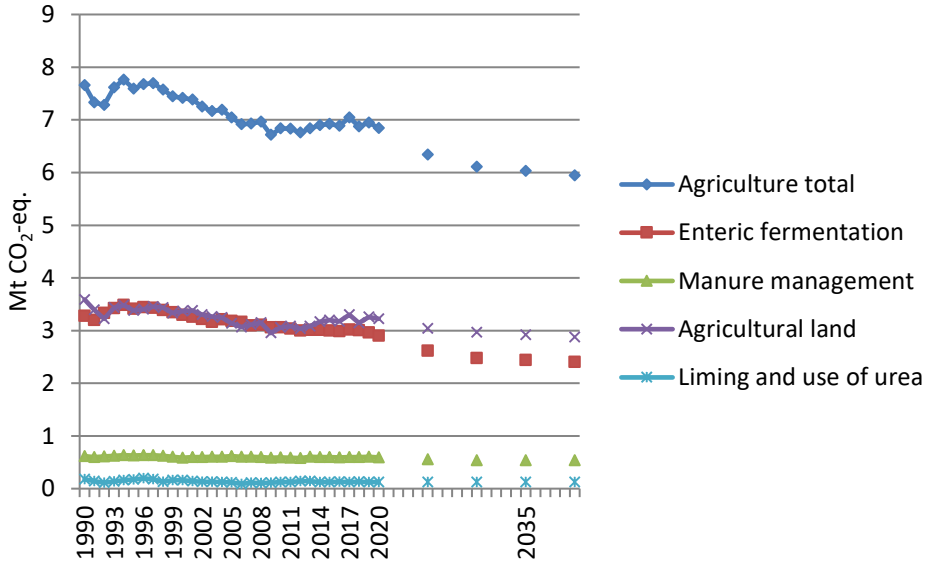

Figure 9. Historical and projected emissions of greenhouse gases from agriculture

Table 14. Historical and projected emissions of greenhouse gases from agriculture per gas (CRF 3, Mt CO_2-equivalents). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Methane	3.5	3.2	3.2	2.9	2.7	2.7	2.6	-23%	-25%
Nitrous oxide	4.0	3.6	3.6	3.3	3.3	3.2	3.2	-17%	-20%
Carbon dioxide	0.2	0.1	0.1	0.1	0.1	0.1	0.1	-29%	-29%
Total agriculture	**7.7**	**6.9**	**6.8**	**6.3**	**6.1**	**6.0**	**5.9**	**-20%**	**-22%**

Table 15. Historical and projected emissions of greenhouse gases from agriculture (CRF 3, Mt CO_2-equivalents). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Enteric fermentation	3.3	3.0	2.9	2.6	2.5	2.4	2.4	-24%	-27%
Manure management	0.6	0.6	0.6	0.6	0.5	0.5	0.5	-12%	-12%
Agricultural land	3.6	3.3	3.2	3.0	3.0	2.9	2.9	-17%	-20%
Liming/Use of urea	0.2	0.1	0.1	0.1	0.1	0.1	0.1	-29%	-29%
Total agriculture	**7.7**	**6.9**	**6.8**	**6.3**	**6.1**	**6.0**	**5.9**	**-20%**	**-22%**

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 2013—2017 in Sweden and price projections from OECD/FAO[75] with an extrapolation to 2040.
- 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: 35% of current buildings are assumed to be in use in 2030 with only maintenance needed, 13% are disposed and 52% can be used if renovations are made.
- The current agricultural policy (CAP) in 2019 is assumed to continue until 2040.

3.3.9 Waste

Total emissions from the waste sector in 2019 amounted to 1.1 million tonnes of carbon dioxide equivalents, which is a reduction of 71% compared with 1990.[76] Methane emissions from landfills are projected to decrease by 92% until 2040 compared with 1990. The main cause for the decrease is the ban on depositing

[75] OECD/FAO. 2018. OECD-FAO Agricultural outlook 2018-2027. OECD Publishing.

[76] National Inventory Report Sweden, Submission 2021

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.

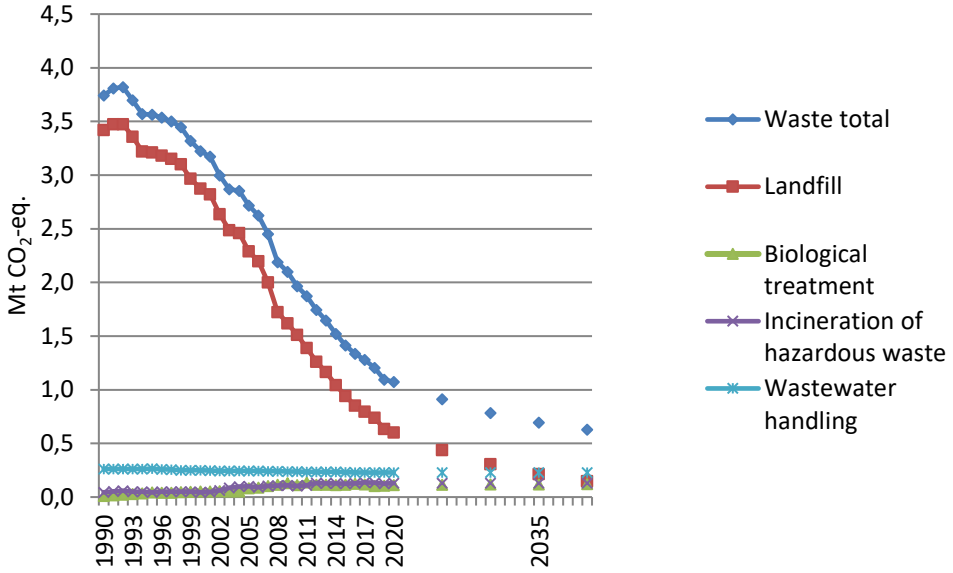

Figure 10. Historical and projected emissions of greenhouse gases from the waste sector.

Table 16. Historical and projected emissions of greenhouse gases from the waste sector (CRF 5, Mt CO_2-equivalents). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Carbon dioxide	0.04	0.1	0.1	0.1	0.1	0.1	0.1	189%	189%
Methane	3.5	0.7	0.7	0.6	0.4	0.3	0.3	-88%	-92%
Nitrous oxide	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0%	0%
Total	**3.7**	**1.1**	**1.1**	**0.9**	**0.8**	**0.7**	**0.6**	**-79%**	**-83%**

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—2019. During the period the annual net removals have varied between 30 and 45 million tonnes of carbon dioxide equivalents. 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 storms on forest land.

The net removals for LULUCF are projected to increase slightly from around 35 million tonnes of carbon dioxide equivalents in year 2019[77] to around 40 million tonnes of carbon dioxide equivalents in 2040. The increase is mainly due to an increase in removals from forest land. The projections for removals of carbon dioxide from forest land is based on the assumption that the current harvest intensity (2015-2019) persist over time and a climate effect which gives a positive effect on the annual gross increment.

The projections are based on a number of assumptions which are characterised by uncertainties. A sensitivity analysis has been performed for the LULUCF projection, simulating forest land using the same settings but without the climate effect which gives a positive effect on the annual gross increment. The net removals for the LULUCF-sector are projected to decrease to around 30 million tonnes of carbon dioxide equivalents in 2040. See also section 3.4.

[77] National Inventory Report Submission 2021

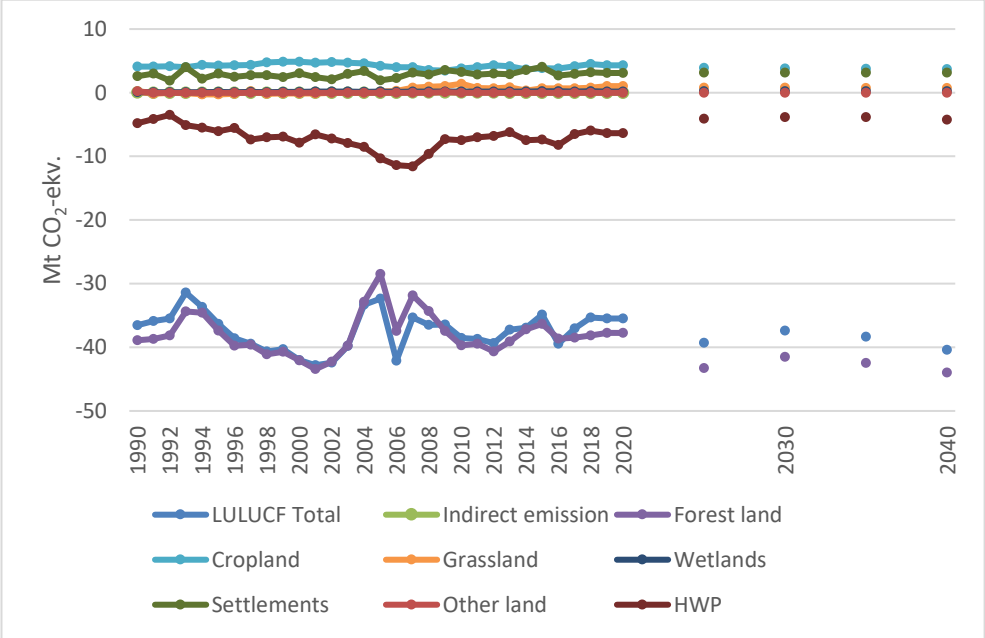

Figure 11 Net emissions (+) and net removals (-) from the LULUCF-sector and its sub-categories in Mt CO_2-equivalents per year.

Net emissions from cropland have varied during the period 1990 to 2019. 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 2-4 million tonnes of carbon dioxide equivalents per year in the period 1990 to 2019. 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 2019 and are projected to stay low for the projection period.

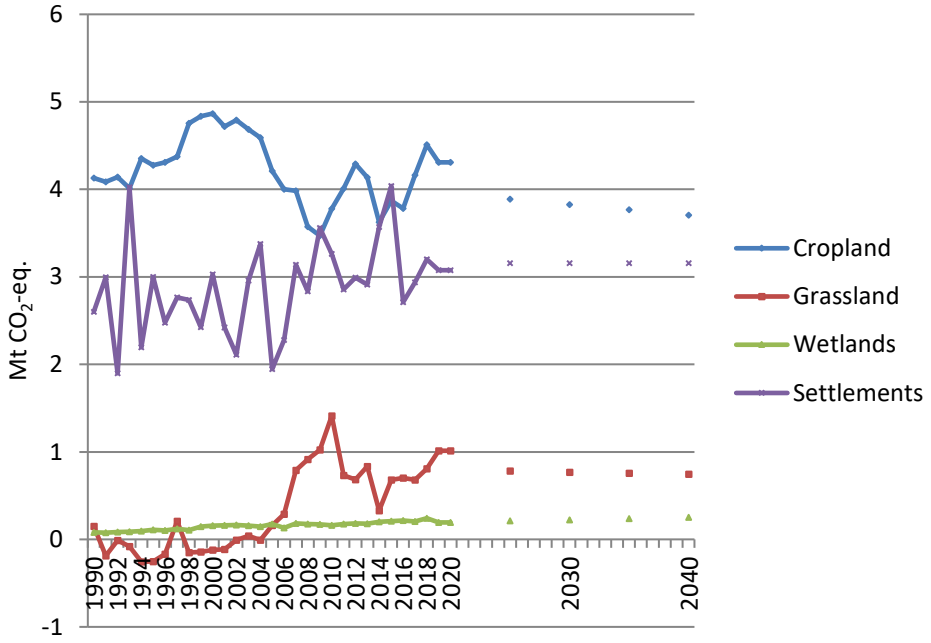

Figure 12. Historical and projected net emission (+) and net removals (-) from the LULUCF categories cropland, grassland, wetland and settlements in Mt CO_2-equivalents per year.

Table 17. Historical and projected net emissions (+) and net removals (-) of greenhouse gases from LULUCF (CRF 4, Mt CO_2-equivalents). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Forest land	-38.9	-37.7	-38.6	-43.2	-41.5	-42.4	-44.0	7%	13%
Cropland	4.1	4.3	3.9	3.9	3.8	3.8	3.7	-7%	-10%
Grassland	0.2	1.0	0.8	0.8	0.8	0.8	0.7	413%	397%
Wetlands	0.1	0.2	0.2	0.2	0.2	0.2	0.3	181%	216%
Settlements	2.6	3.1	3.2	3.2	3.2	3.2	3.2	21%	21%
Other land	0.2	-0.0002	-0.005	-0.005	-0.005	-0.005	-0.005	-102%	-102%
HWP	-4.8	-6.4	-5.3	-4.1	-3.9	-3.8	-4.3	-20%	-11%
Total	**-36.5**	**-35.5**	**-35.9**	**-39.3**	**-37.4**	**-38.4**	**-40.4**	**2%**	**11%**

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 (2015-2019) persist over time. The harvest level was estimated to 84% of the growth available for harvest on productive forest land.

- Other settings are based on the projection in an analysis of the forest development (SKA-15) in terms of management, climate effect and nature conservation.[78]
- 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 National Forest Inventory (NFI) which also forms the base for the annual reporting under the UNFCCC and the Kyoto protocol.
- In the projection 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 848 000 ha is set aside for nature conservation through legal protection and 1 332 000 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 21 349 000 ha. The total simulated area consisted of productive forest land of 23 497 000 ha (including legally or voluntary set-aside areas and forest land used for timber production) and low-production forest land of 4 474 000 ha.
- In the projection a climate effect is included, based on the RCP 4.5 scenario (IPCC 2013) which gives a positive effect on the annual gross increment by 21 % 2070-2100 compared to 1970-2000.

Cropland, Grassland, Wetlands

- The projections for each carbon pool are based on the mean net annual carbon stock change for the period 2010-2019 as reported in the National Inventory Report, submission 2021.
- 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 8 % from 2019 to 2050.

Settlements,

- The projected emissions/removals for each reported carbon pool are assumed to be constant and estimated as a mean for the period 2010-2019 as reported in the National Inventory Report, submission 2021.

Harvested Wood Products (HWP)

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

[78] Claesson, S., Duvemo, K., Lundström, A., & Wikberg, P.E. 2015. Skogliga konsekvensanalyser 2015 – SKA 15. Skogsstyrelsen. Rapport 10/2015.

3.3.11 International transport

The emissions from international aviation and navigation, also known as international bunkers, are 159% higher in 2019 than in 1990.[79] The emissions from international transport are projected to increase during the projection period, mainly due to increased emissions from international aviation.

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. This leads to projected emissions from international navigation at about the same level during the projection period.

The greenhouse gas emissions from international aviation have increased by around 98% between 1990 and 2019 and are expected to increase by 111% until 2030 and by 130% until 2040 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.

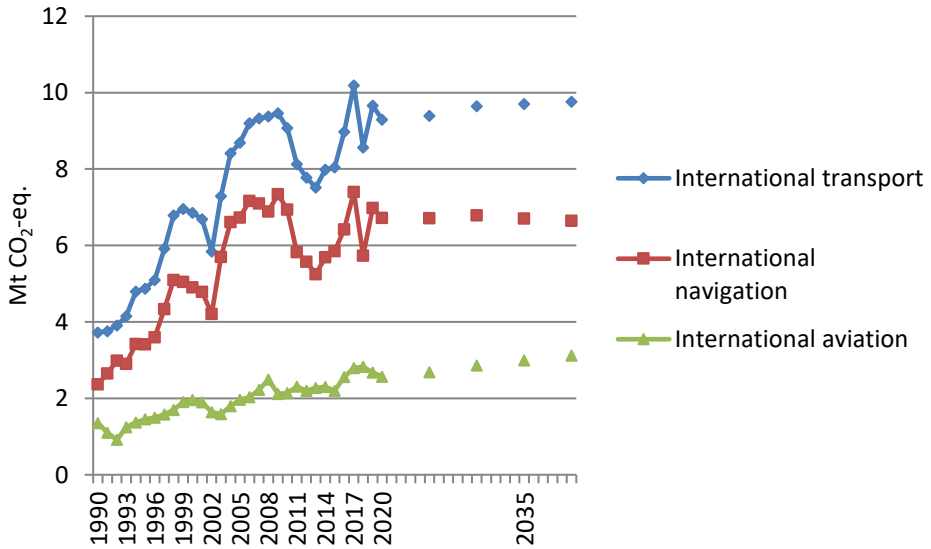

Figure 13. Historical and projected emissions of greenhouse gases from international bunker.

[79] National Inventory Report Sweden, Submission 2021

Table 18. Historical and projected emissions of greenhouse gases from international bunkers (Mt CO_2-equivalents.). As numbers in the table are rounded the percentages might not match

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Navigation	2.4	7.0	6.7	6.7	6.8	6.7	6.6	186%	180%
Aviation	1.4	2.7	2.6	2.7	2.9	3.0	3.1	111%	130%
Total	**3.7**	**9.7**	**9.3**	**9.4**	**9.6**	**9.7**	**9.8**	**159%**	**162%**

3.4 Sensitivity analysis

The sensitivity analysis includes two alternative projections for the energy sector including transport and one alternative projections for the transport sector. The sensitivity alternative also includes one alternative for the LULUCF sector.

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 lower prices on fossil fuels and one with lower economic growth, than in the reference projections. In the projections with lower prices, the prices on fossil fuels are almost 30% lower than in the reference projections. The lower prices on fossil fuels also result in higher economic growth, than in the reference projections. In the projection with lower economic growth, GDP is decreased by almost 30% in 2040 which results in lower emissions. All other assumptions are identical to the ones in the reference projection.

The calculations of the sensitivity projections show that the projection with lower prices on fossil fuels results in higher emissions than in the reference projection until 2040, as expected. The emissions are around 0.7 million tonnes carbon dioxide equivalents higher than in the reference projection in 2030. A lower price of fossil fuels decreases the incitements to replace fossil fuels and improve energy efficiency in industry and increases the need for transportation which gives higher emissions in the transport sector.

The projection with lower economic growth than in the reference projection, results in lower emissions in the energy and transport sectors than in the reference projection. In this case the emissions are around 0.3 million tonnes carbon dioxide equivalents lower in 2030 than in the reference projection. The main reason for the decreased emissions is a lower energy demand due to lower production in the industry sector. A lower economic growth leads to a lower demand for transportation for both goods and people.

Sensitivity calculation for the transport sector

The sensitivity projections above present the effect of two overall key parameters. For the road transportation sector one additional sensitivity projections have been performed separately with lower mileage. All other assumptions are identical to the ones in the reference projections.

The assumption on transport mileage are closely associated with uncertainty and has an effect on the projection results. In the projection the mileage is assumed to be 10% lower in 2040 than in the reference projection. The calculations show that the projections with lower mileage results in emissions that are approximately 0.5 million tonnes carbon dioxide equivalents lower in 2040.

Table 19. Historical and projected total emissions of greenhouse gases from different projections for the road transportation sector (Mt CO_2-equivalents)

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Projections WEM	**71.2**	**50.9**	**48.8**	**47.0**	**43.2**	**41.0**	**39.4**	**-39%**	**-45%**
Energy sector including transport									
Projection "Lower fossil fuel prices"			49.1	48.1	43.9	42.8	42.5	-38%	-40%
Projection "Lower GDP"			48.9	46.9	42.9	40.4	38.6	-40%	-46%
Transport sector									
Projections "Lower mileage"			48.8	46.9	42.9	40.6	38.9	-40%	-45%

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

- Import prices on fossil fuels and exchange rates, 2016 prices

	Base year	Reference and Lower GDP	Lower fossil fuel prices
	2018	**2040**	**2040**
Crude oil (USD/barrel)	68	103	45
Coal (USD/tonnes)	93	98	64
Natural gas (USD/Mbtu)	6	8	5

- National Institute of Economic Research estimates of economic development (%/year):

	Refer-ence		Lower GDP		Lower fossil fuel prices	
	2015-2035	**2035-2040**	**2015-2035**	**2035-2040**	**2015-2035**	**2035-2040**
GDP	1.72	1.76	1.42	1.26	1.77	1.84

Private con-sumption	1.87	2.22	1.43	1.57	2.02	2.26
Export	2.58	2.59	2.12	1.81	2.54	2.72
Import	2.60	2.70	2.14	1.94	2.64	2.75

- Swedish sector price for electricity in projections.
(Annual average, 2016 price level)

SEK/kWh	2018	2030	2040
Reference	0.46	0.33	0.50
Lower fossil fuel prices	0.46	0.29	0.42

3.4.2 Sensitivity calculations for the LULUCF sector

The projections for the LULUCF-sector is based on a number of assumptions which are characterised by uncertainties. The result should be interpreted with that in mind. A sensitivity projection has been calculated for the LULUCF sector. In the reference projections a positive climate effect which gives a positive effect on the annual gross increment by 21 % 2070-2100 compared to 1970-2000 was included for forest management and HWP. In the sensitivity projections no positive climate effect is included. All other assumptions are identical to the ones in the reference projection.

The calculations of the sensitivity projections show that the projection with no climate effect results in a decrease in net removals until 2040 instead of an increase as in the reference projection. The emissions are projected to be around 30 million tonnes in 2040 which is about 11 million tonnes lower compared to the reference projection with climate effect.

Table 20. Historical and projected emissions (+) end removals (-) of greenhouse gases from different projections for the LULUCF sector (CRF 4, Mt CO_2-equivalents).

	1990	2019	2020	2025	2030	2035	2040	1990-2030	1990-2040
Total LULUCF with climate effect	-36.5	-35.5	-35.9	-39.3	-37.4	-38.4	-40.4	2%	11%
Total LULUCF without climate effect	-36.5	-35.5	-32.1	-35.4	-30.3	-30.7	-29.1	-17%	-20%

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

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

Sweden's commitment for the emissions covered by the Effort Sharing Regulation (EU) 2018/842[80] (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). The ESR emissions have decreased since 2005 and are projected to decrease until 2030.

Table 21. Historical and projected emissions of greenhouse covered by the EU ETS and ESD/ESR (Mt CO_2-equivalents, GWP according to IPCC AR4.).

	2019	2020	2025	2030	2035	2040
ESR	31.7	30.2	28.4	26.1	24.0	22.5
ETS incl. aviation	19.2	18.5	18.5	17.1	17.0	16.9
Total	**50.9**	**48.8**	**47.0**	**43.2**	**41.0**	**39.4**

Sweden's commitment according to the Effort Sharing Decision[81]

Sweden's commitment for the emissions covered by the Effort Sharing Decision (ESD) (i.e emissions not included in the EU Emissions Trading Scheme (ETS) is that emissions have to decrease by 17% between 2005 and 2020 (EU ETS scope 2008—12, excl. aviation). This means that the ESD emissions shall decrease linearly from 41.7 Mt in 2013 to 36.1 Mt in 2020.

For the years 2013-2019 Sweden's ESD-emissions were lower than the ESD-targets. The surplus amount of AEAs was over 5 million tonnes per year compared to the Swedish ESD target, see Table 2. The surplus for 2013—2017 were deleted. Sweden has already taken a decision to delete the ESD surplus of 2018 and the Government has proposed to the Parliament that also the surplus for 2019 should be deleted. Compliance for 2018 is planned to be performed in 2021.

Furthermore, Sweden can use credits from international projects activities to meet the target. The annual use is restricted to 3% of 2005 emissions (submission 2012), which equals to 10.9 million tonnes for the whole period 2013-2020. Furthermore, 1% of 2005 emissions can be used in international projects fulfilling certain

[80] Regulation (EU) 842/2018 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

[81] Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020.

requirements. This corresponds to additionally 3.6 million tonnes for the whole period 2013—2020. The maximum possible annual use of international credits amounts thus to maximum 1.8 million tonnes. In addition to this, transfer of emission allowances between Member States may be done up to 5% of the annual emissions allocation for a given year. Furthermore, 5% of the 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.

The target for Sweden[82] is set to 36.1 million tonnes of carbon dioxide equivalents in 2020[83]. The projections indicate an overachievement in relation to the ESD-target. The ESD-emissions are projected to decrease to around 30.2 million tonnes in 2020. The overachievement between the projected trend and the Swedish target in 2020 is estimated to be around 6 million tonnes, without the use of international credits. However, all necessary preparations are made to enable investment in international projects if required to fulfil the ESD target. The projections indicate that Sweden will have a surplus of allowances in 2020. Note that these figures are uncertain and preliminary.

Table 22. Historical and projected emissions (based on IPCC 2006 guidelines) of greenhouse gases that are covered by the Effort Sharing decision (ESD) in relation to ESD target (scope 2013-2020, excl. aviation, GWP according to IPCC AR4). (Mt CO_2-equivalents)

	2013	2014	2015	2016	2017	2018	2019	2020
Historical ESD-emissions [84]	35.3	34.5	33.9	32.6	32.5	31.4	31.7	
Projected ESD-emissions								30.2
ESD target[85]	41.7	41.0	40.4	39.8	37.8	37.2	36.7	36.1
Overachievement in relation to ESD target	6.4	6.5	6.5	7.2	5.4	5.8	5.0	5.9

[82] Decision C(2013)1708 on determining Member States' annual emission allocations for the period from 2013 to 2020 pursuant to Decision No 406/2009/EC.

[83] EU Decision C(2013)1708.

[84] ESD-emissions include emissions that are covered by the Effort Sharing decision and are calculated as total emissions excl. LULUCF minus emissions from domestic aviation minus emissions from EU ETS. ESD-emissions for 2019 are according to Submission 2021. ESD-emissions for 2013-2018 are according to relevant submission used for compliance.

85 According to EU Decision C (2013)1708 on determining Member States' annual emission allocations for the period from 2013 to 2020 pursuant to Decision No 406/2009/EC.

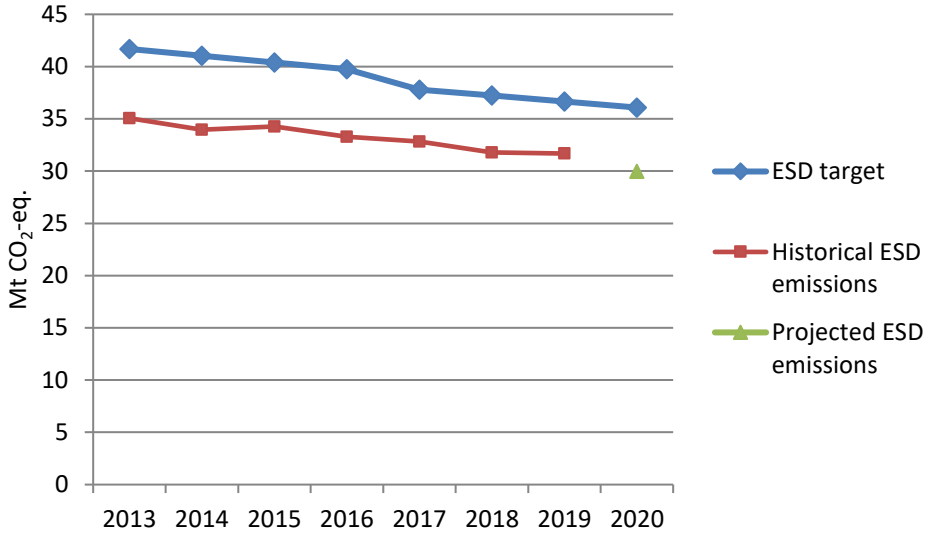

Figure 14. The ESD target (scope 13-20), emissions in 2013-2019 and the historical and projected Swedish ESD emissions (scope 13-20). (National Inventory Report submission 2021)

Target fulfilment in relation to the domestic target

The Swedish target according to the 2009 climate policy resolution of the Swedish parliament is for ESD-emissions (which are not included in the EU ETS) to decrease by 40% or around 20 million tonnes between 1990 and 2020, of which one third can be reduced by emission reductions in other countries.

This was equivalent to a decrease of 33% between 2005 and 2020 when the target was adopted in 2009 (EU ETS scope 2008—12). In the third period of EU ETS, 2013—20, the scope of the EU ETS was extended to include additional sectors. The target was consequently adjusted corresponding to emissions in the transferred sectors. In 2020, the national target will preliminary be 28.6 million tonnes. The projections indicate that the emissions will decrease to around 30.2 million tonnes and there will be a gap to target of around 1.5 million tonnes of carbon dioxide equivalents in 2020. Note that numbers are preliminary until 2022—2023, when a definite calculation can be done based on reviewed inventory data. The gap to target can be closed by emission reductions in other countries.

In June 2017 the Riksdag adopted a climate policy framework including targets until 2045. By 2045, Sweden is to have no net emissions of greenhouse gases into the atmosphere and should thereafter achieve negative emissions. 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. A reduction of 63% means that the target is preliminary set to 17 Mt CO_2-eq. in 2030. The emissions outside EU ETS are projected to decrease

to around 26 Mt CO_2-eq. in 2030, which indicate a gap of around 9 Mt CO_2-eq. In addition, emissions from domestic transport (excl. CO_2 from aviation) are to be reduced by at least 70% by 2030 compared with 2010. The emissions are projected to decrease by 35% 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 CO_2 from the atmosphere through action in the sector.

Projections of reported net emissions and removals from the LULUCF sector by accounting categories as defined in the LULUCF-Regulation[86] indicate total net removals of around 37 million tonnes of carbon dioxide equivalents in 2030.

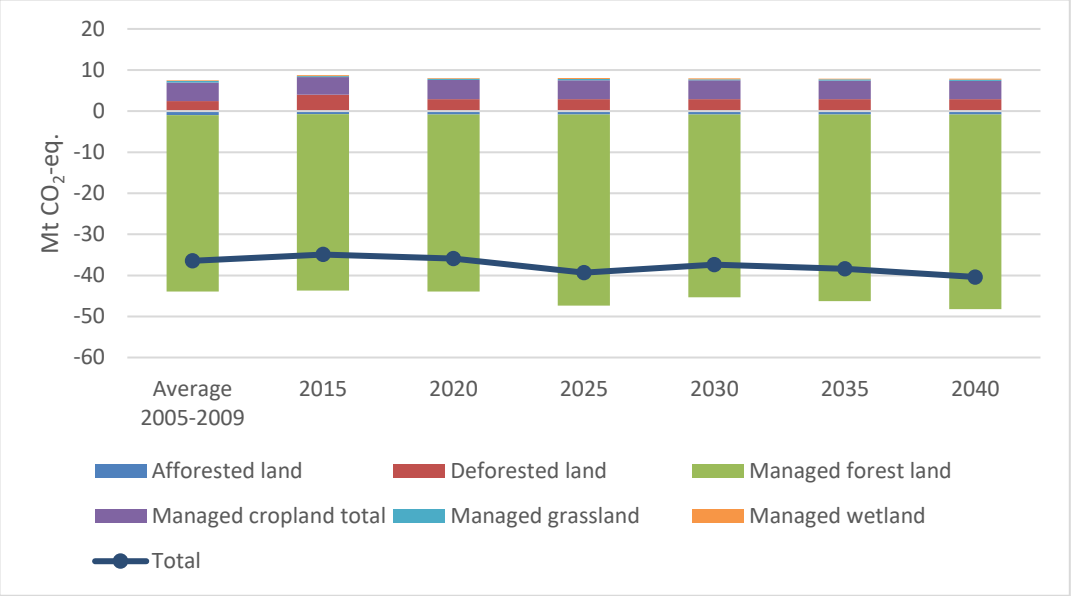

Figure 15.
Historical and projected net emissions and net removals of greenhouse gases from LULUCF sector by accounting categories (Mt CO_2-equivalents).

[86] Regulation (EU) 2018/841

Table 23. Historical and projected net emissions (+) and net removals (-) of greenhouse gases from LULUCF by accounting categories (Mt CO_2-equivalents)

	2015	2019	2020	2025	2030	2035	2040
Afforested land	-0.8	-0.7	-0.9	-0.9	-0.9	-0.9	-0.9
Deforested land	4.0	2.9	2.9	2.9	2.8	2.8	2.7
Managed forest land	-42.9	-43.3	-43.1	-46.5	-44.5	-45.4	-47.4
Managed cropland	4.3	5.1	4.7	4.6	4.6	4.5	4.5
Managed grassland	0.2	0.3	0.3	0.3	0.3	0.3	0.3
Managed wetland	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total	-34.9	-35.6	-35.9	-39.3	-37.4	-38.4	-40.4

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

For the periods from 2021 to 2025 and from 2026 to 2030, 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 periods from 2021 to 2025 and from 2026 to 2030 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 periods from 2021 to 2025 and from 2026 to 2030.

Each Member State shall account for emissions and removals resulting from managed cropland and managed grassland calculated as emissions and removals in the periods from 2021 to 2025 and from 2026 to 2030 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. [87]

[87] For the period 2021-2025 managed wetlands are voluntary to include

The projections of accounted net emissions and removals from the LULUCF sector by accounting categories as defined in the LULUCF-Regulation[88] indicate total net removals of just over 8 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. Net removals for managed forest land 2026-2030 are not possible to estimate until the Forest Reference Level for 2026-2030 is available.

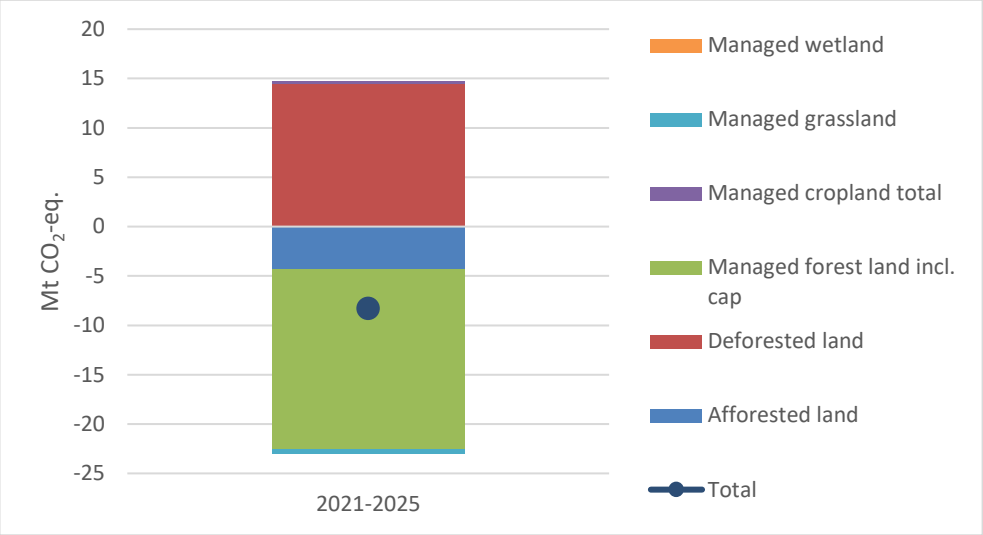

Figure 16. Total accounted cumulative net-emissions and net-removals for 2021-2025.

[88] Regulation (EU) 2018/841

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.

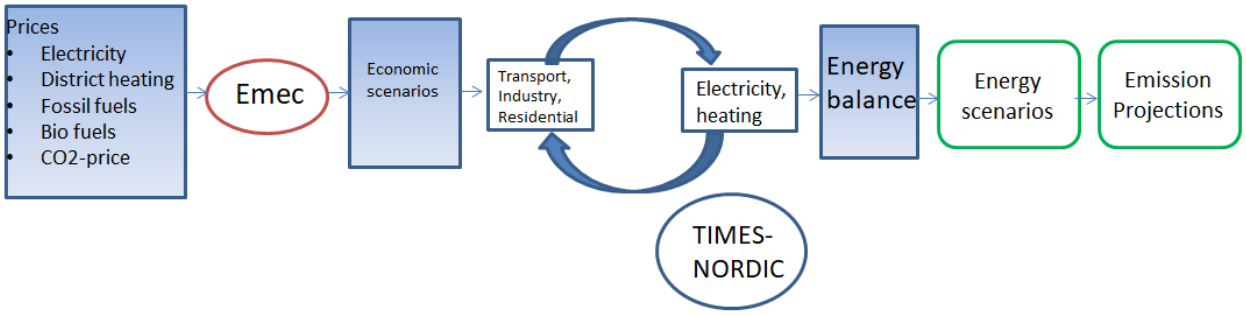

Figure 17 Projection process for emissions from the energy sector.

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 exogenic 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 subsectors: 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 om 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 on forest soil in productive forests. In the projection, net removal in these pools are calculated as the difference between the stocks at different times. The emissions/removals in the soil organic carbon pool and the dead organic matter pool are based on the trend in these pools as reported in the latest submission.

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 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 States 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.

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 Environment 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, SMED[89], see Figure 17.

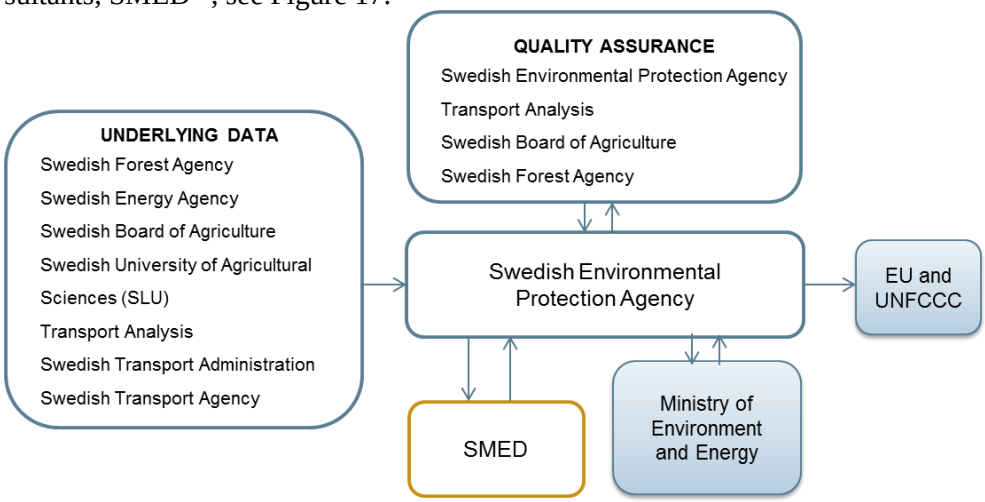

Figure 18. Institutional arrangements for the reporting of projections. SMED is a consortium of consultants.

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.

[89] 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)

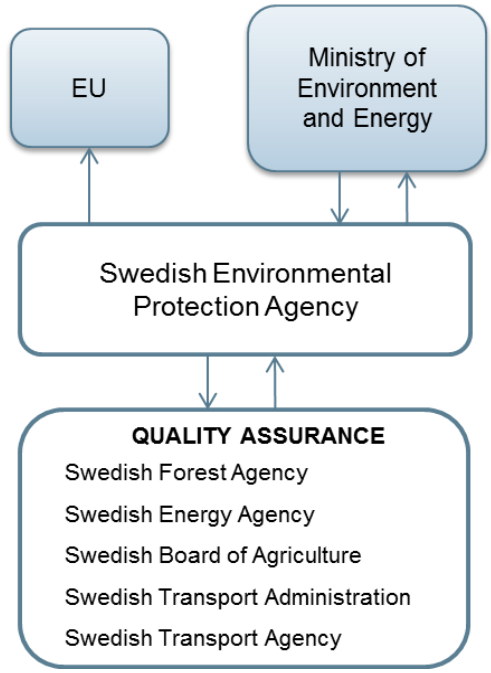

Figure 19 Institutional arrangements for the reporting on policies and measures

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 Reporting[90] (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.

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

[90] http://www.lagboken.se/Views/Pages/GetFile.ashx?portalId=56&cat=24593&docId=2232659&propId=5

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 scenarios 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 scenarios build upon the same assumptions.

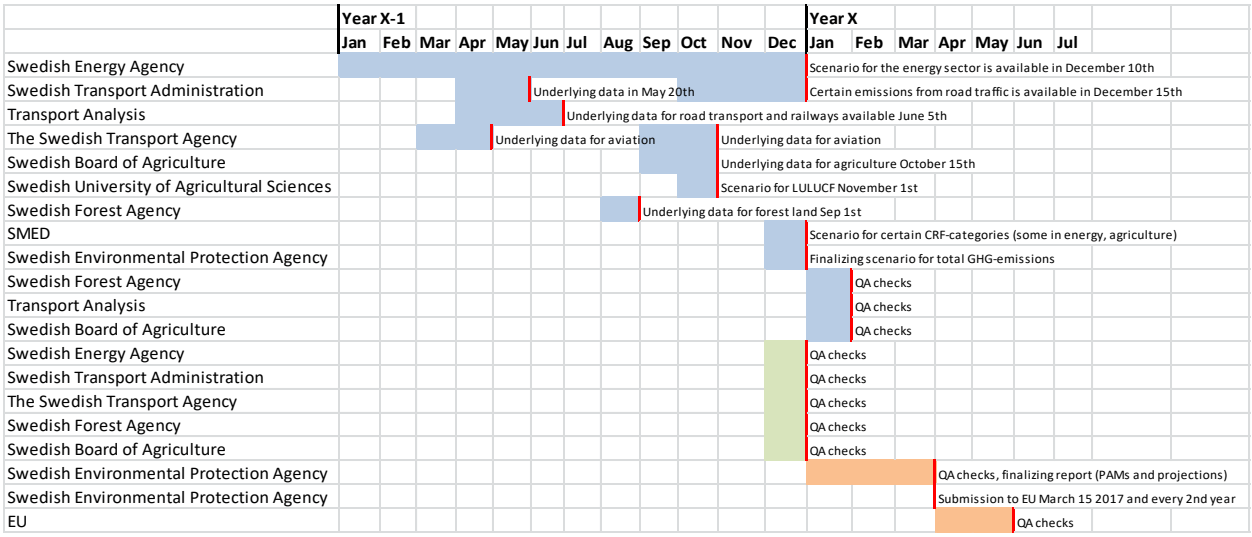

Figure 20 Overview of the process for the reporting of scenarios of greenhouse gases

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 scenarios. 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 Environment 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.

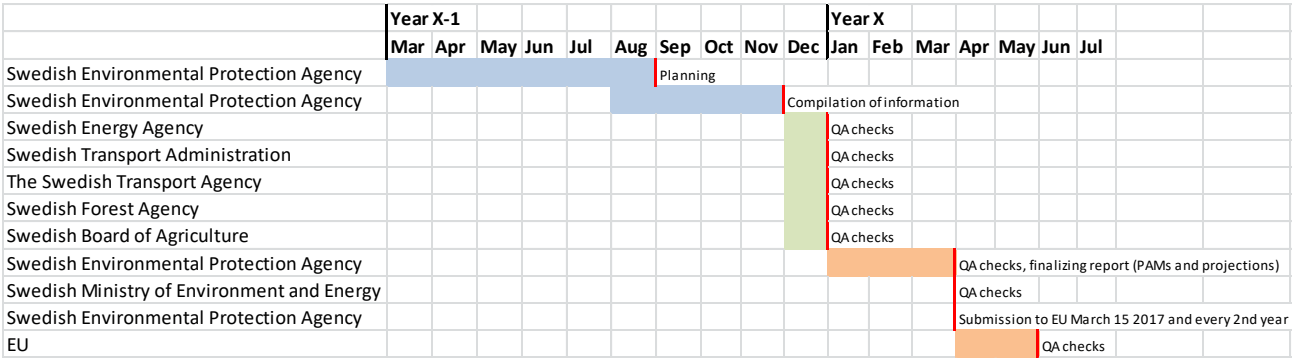

Figure 21 Overview of the process for the reporting of policies and measures

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 scenarios. 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 Swedish Ministry of Environment 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 Environment 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.