Sweden's fourth Biennial Report under the UNFCCC

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ISBN 978-91-620-6905-6
ISSN 0282-7298

Preface

Climate change is upon us and it already now poses unprecedented threats to ecosystems and the lives of many across the globe. Failure to act will further aggravate the state of our planet and bring even higher costs to society. Risks for conflict, poverty and inequality will also increase. We should not leave that burden to future generations. Climate change is the defining issue of our time and we should respond to it appropriately.

It is evident that the way we organise our society and make use of natural resources is having a global long-term impact on the ecosystem of our planet. The old model of achieving wealth through excessive use of natural resources and excessive pollution has proved to be outdated. Coherent and accelerated implementation of the 2030 Agenda for sustainable development, Addis Ababa Action Agenda on financing for development and the Paris Agreement to combat climate change will strengthen national efforts and maximize co-benefits.

Ambition in addressing climate change should be continuously enhanced, based on and guided by the best science available. To limit the temperature increase to no more than 1.5°C as agreed in the Paris Agreement, we need to achieve far-reaching, rapid and unprecedented transformation of all aspects of society. Global carbon dioxide emissions should be halved by 2030. All governments should step up and take further actions towards that goal.

Climate change is a top priority for the Swedish government, and we are ready to show climate leadership. The Swedish government sees a lot of opportunities in the transition towards a low carbon and climate resilient society and is aiming to be the world's first fossil-free welfare country. This ambition requires mobilising the whole of society, not least municipalities, cities, the business sector and civil society.

The policy instruments introduced in Sweden have had a significant effect and emissions have fallen by around 26 percent between 1990 and 2017. Of particular significance are investments from earlier decades in developing carbon-free production of electricity and district heating as well as the energy and carbon taxes.

As a government, we see it as our responsibility to introduce the necessary legislation and provide long-term and predictable policy instruments for the relevant stakeholders. With broad support from Parliament, the government

adopted a climate policy framework with a climate act for Sweden in June 2017. This framework is the most important climate reform in Sweden's history and sets out Sweden's contribution to the implementation of the Paris Agreement. The framework contains new ambitious climate goals, a climate act and a new climate policy council. By 2045 at the latest, Sweden is to have zero net emissions of greenhouse gases into the atmosphere and should thereafter achieve negative emissions. The transport sector should reduce its emissions by 70 percent between 2010 and 2030, and specific targets are set for the sectors that are outside the EU's emission trading system. Sweden's climate targets are to be integrated in national policies and processes, including budget processes.

During the last four year period , the Swedish government has more than doubled the environment and climate budget and introduced a number of new policy measures. One example is the Industrial Leap, a long-term long-term support scheme to reduce industry's emissions, which has among others funded a pilot plant for fossil-free steel production. Another example is the obligation to reduce carbon emissions from petrol and diesel by gradually increasing blending with sustainable biofuels. A third example is the phasing out of carbon tax exemptions for diesel in mining working machinery and industry production outside EU ETS. Further measures are nevertheless required and will be taken to reach our long term objectives.

Sweden is thus undertaking action to achieve emission reductions that far exceed Sweden's required emission reductions under current EU legislation.

We encourage other countries to do the same.

Sweden stands ready to offer support in relation to policy, financing and technology to accelerate climate action globally. A climate perspective is to be integrated into all Swedish development cooperation. Sweden provides approximately SEK 6 billion annually to support climate action in developing countries. Sweden is one of the largest per capita donors in the world to the Green Climate Fund (GCF) and the Global Environment Facility (GEF) – as well as to other key multilateral climate funds, such as the Adaptation Fund.

In this fourth biennial report, a comprehensive summary of Sweden's efforts to combat climate change is provided. Emissions and removals of greenhouse gases are reported for each sector and adopted and planned policy measures and their impact on emissions are described. The report

contains projections for emissions up to 2045, with focus on 2020. According to these projections, emissions will continue to decrease, and the national target for 2020 is within reach with national measures alone. The biennial report also describes Sweden's contributions to climate finance.

The material on which the biennial report is based has been obtained through extensive input from approximately ten government agencies, led by the Swedish Environmental Protection Agency. The report has been elaborated in accordance with the UNFCCC biennial reporting guidelines for developed country Parties contained in Decision 2/CP.17 as adopted by the Conference of the Parties at its seventeenth session[1].

Stockholm, December 2019

Isabella Lövin

[1] Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action under the Convention, Document: FCCC/CP/2011/9/Add.1

Content

1. Information on GHG emissions and removals and trends, GHG inventory including information on national system

The information in this chapter is a summary of the 2019 inventory of emissions and removals of greenhouse gases for the years 1990 to 2017, submitted under the UN Framework Convention on Climate Change and the Kyoto Protocol (National Inventory Report Sweden 2019). The chapter also includes information on the national system for GHG inventory and policies, measures and projections.

1.1. Total emissions and removals of greenhouse gases

In 2017, greenhouse gas emissions (excluding LULUCF) in Sweden totalled 52.7 million tonnes of carbon dioxide equivalents (Mt CO_2-eq.), see Figure 1.1. Total emissions have decreased by 18.6 Mt, or 26 %, between 1990 and 2017. Emission levels have varied between a low of 52.7 Mt CO_2-eq. in 2017 and a high of 76.9 Mt CO_2-eq. in 1996. Annual variations are largely due to fluctuations in temperature, precipitation and to the economic situation. The net sink attributable to the land use, land-use change and forestry (LULUCF) sector has varied over the period. In 2017 it amounted to nearly 44 Mt CO_2-eq., which corresponds to 83 % of total greenhouse gas emissions.

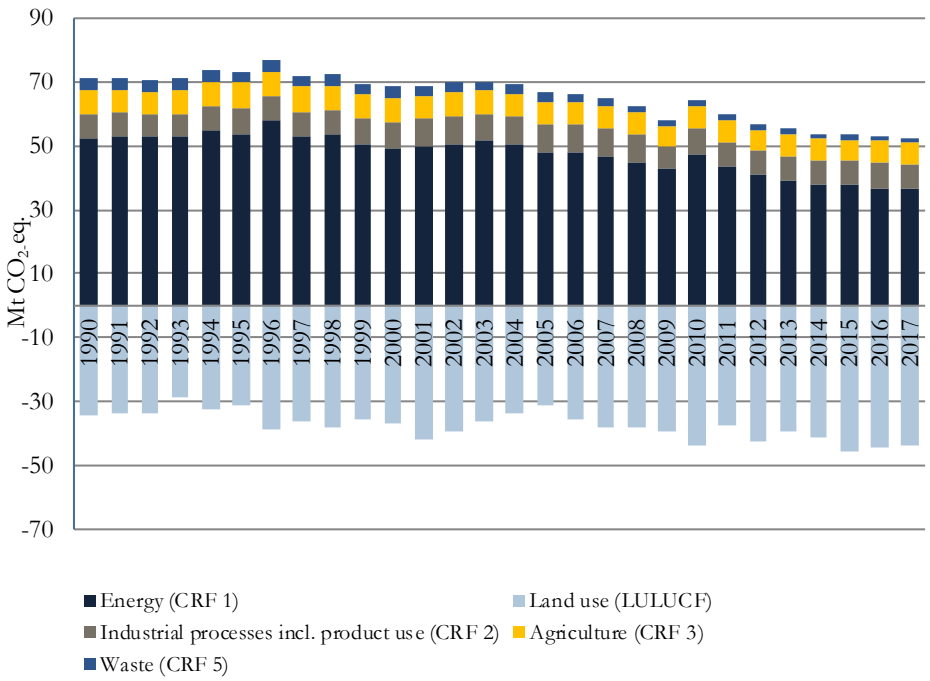


Figure 1.1 **Total greenhouse gas emissions from different sectors.**

In 2017, emissions (excl. LULUCF) of carbon dioxide (CO_2) amounted to 42 Mt CO_2 in total, which is equivalent to 80 % of total greenhouse gas emissions, calculated as CO_2-eq. Emissions of methane (CH_4) accounted for 4.5 Mt of CO_2-eq. (about 9 % of total emissions), emissions of nitrous oxide (N_2O) 4.9 Mt (9 %), fluorinated greenhouse gases (HFCs, PFCs and SF6) 1.1

Mt (2 %), see Figure 1.2. The shares of the different greenhouse gases have remained stable over the period 1990 to 2017.

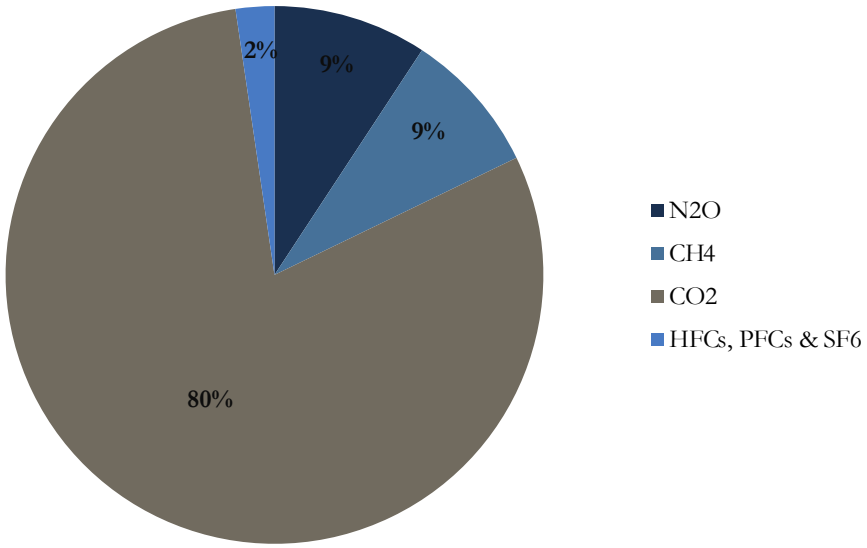


Figure 1.2 **Greenhouse gas emissions in 2017 (excl. LULUCF) by gas, in carbon dioxide equivalent.**

The largest sources of emissions in 2017 were the energy sector (70 %), agriculture (14 %) and industrial processes and product use (14 %), as shown in Figure 1.3.

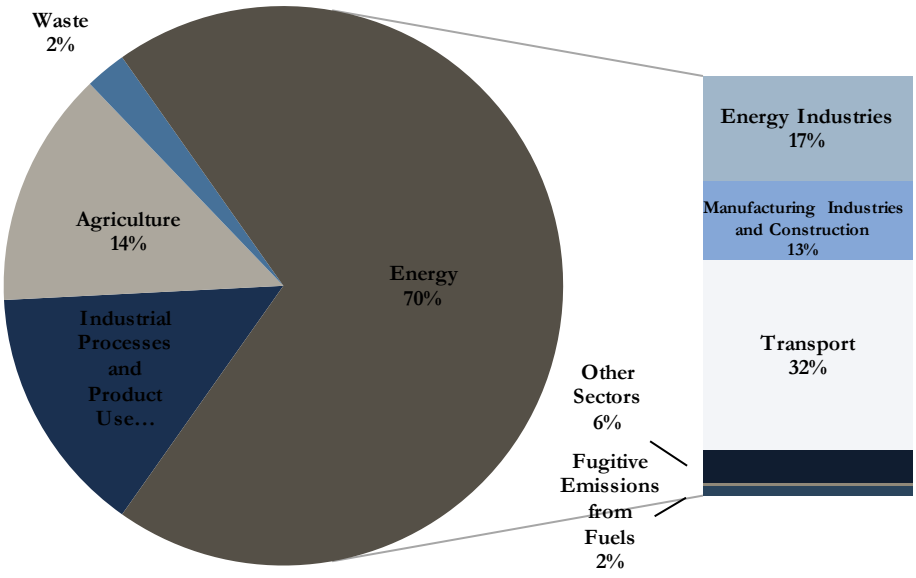
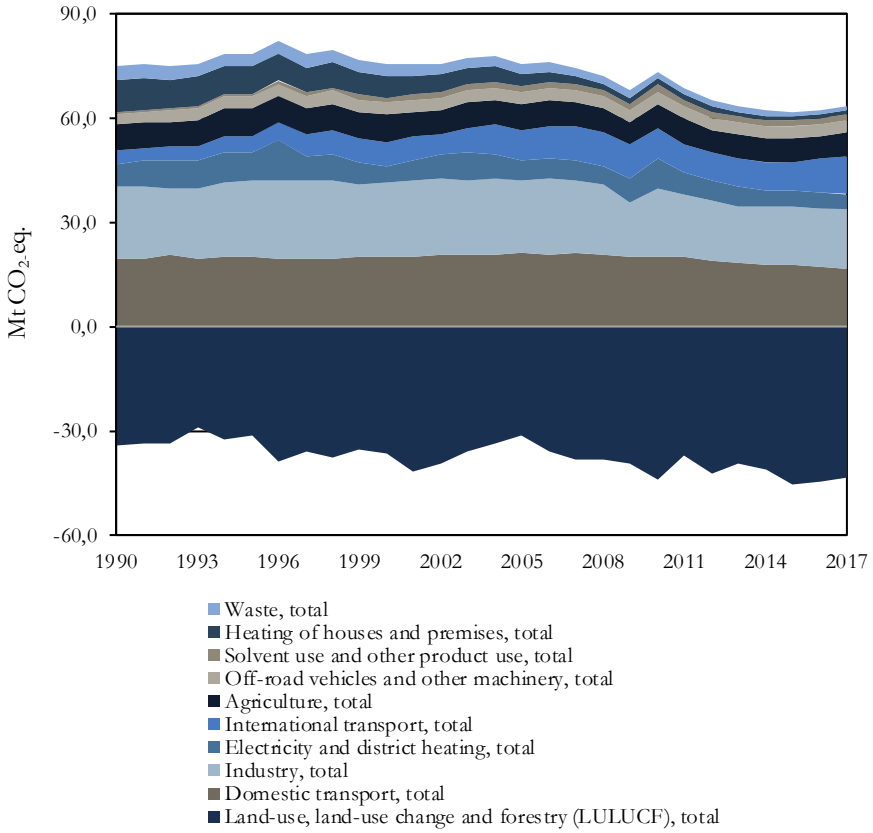


Figure 1.3 **Greenhouse gas emissions in 2017 (excl. LULUCF), by sector.**

In recent years there has been a downward trend in emissions. The largest reductions in absolute terms are due to a transition from oil-fuelled heating of homes and commercial and institutional premises to electricity, e.g. heat pumps and district heating. Increased use of biofuels in district heating generation and industry has also contributed to the reductions together with reductions in landfilling of waste. Fluctuations in production levels of manufacturing industries following changes in the economic development of specific industries have also had significant impacts on the national trend.

BOX 1. 1 The Swedish national sectorial breakdown

The Swedish greenhouse gas inventories are published using a national sectorial breakdown for the purpose of tracking progress with national targets and tracking the effect of implemented policies and measures. The sectorial breakdown is designed to allocate emissions and removals in line with the design of national policies and measures. The aggregation of all industrial emissions in one main sector that is sub-divided by type of industry is the largest difference between the national sectorial breakdown and the IPCC sectors in the Common Reporting Format.



Emissions from domestic transport respond to about one third of Sweden's total emissions (excluding LULUCF and international transport). The other main emission sources in Sweden are agriculture as well as electricity and district heating according to this breakdown.

Emissions from domestic transport, a sector dominated by road transport, increased after 1990 and reached a peak in 2007. Since then, emissions have been declining as a result of a transition to sustainable biofuels and more efficient vehicles.

Emissions from industry respond to 33 % of Sweden's total emissions and have decreased by 17 % since 1990, while changes in the economic development of different industries have resulted in annual variations. The emissions reductions are mainly related to decreased use of oil due to shifts towards biofuels, mainly in the pulp and paper industry. New processes in the chemical industry have also contributed to the decreasing trend. Shifting production levels in response to changing economic conditions in certain industries significantly impacts the trend as well. In the last few years, emissions have been increasing again due to the economic recovery.

Greenhouse gas emissions from agriculture have been declining slowly and are now about 6 percent lower than in 1990. The decrease is mainly due to a reduced amount of

animals (especially dairy cows and pigs) and partly to a reduced use of mineral fertilizers.

Electricity and district heating show a trend of decreasing emissions despite the increased demand for district heating. The decrease in emissions is due to a shift towards combustion of more waste and biofuels, and less fossil fuels. Combustion of industry-derived gases is allocated to the industry.

More information about the national breakdown including how different CRF-categories are allocated is available at:
Description of trends (in Swedish): http://www.naturvardsverket.se/klimatutslapp
Detailed data and reference to CRF-categories (in English): http://www.scb.se/mi0107-en.

1.1.1. Energy industries

The total emissions from energy industries were approximately 9.2 Mt CO_2-eq. in 2017, an 8 % decrease compared with 1990. Production of electricity and district heating account for the larger part of the emissions with 74 % (6.8 Mt) in 2017. Emissions from refineries and the manufacture of solid fuels totalled 2.0 Mt in 2017.

Energy industries are dominated by electricity and heat production, where emissions fluctuate between the years due to the influence of weather conditions, see Figure 1.4. The fluctuations seen for emission from coke production and refineries are primarily related to changes in production levels in response to the economic development of these industries. Emissions from Sweden's electricity and heat production mainly originate from combined heat and power plants that are, to a large extent, fuelled by waste and renewable resources with low emission factors, and industry-derived gases from steel production. The use of coal, oil and gas is decreasing. Demand for district heating has increased by over 50 % since 1990, although the emissions have remained at a level similar to 1990.

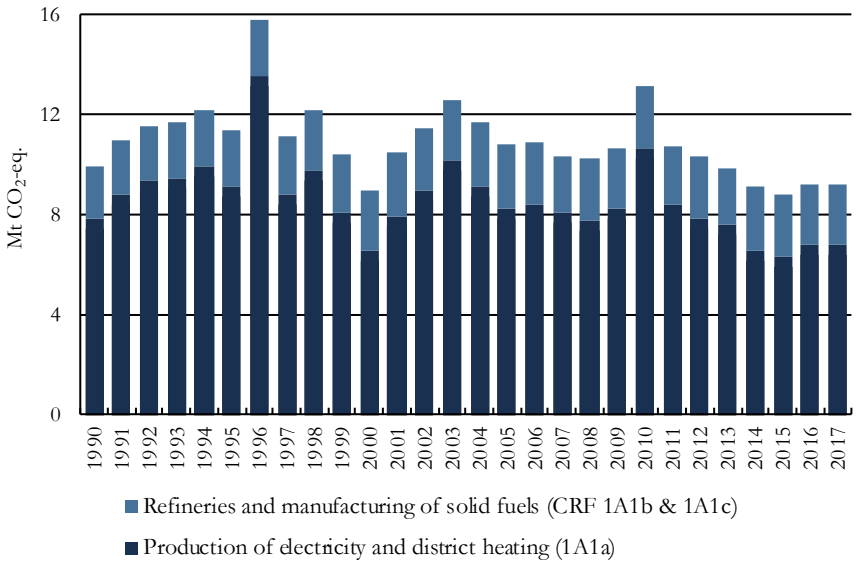


Figure 1.4 **Greenhouse gas emissions from the energy industries (CRF 1A1).**

1.1.2. Residential and commercial/institutional

Greenhouse gas emissions from fuel combustion in the residential, commercial and institutional sectors were 74 % lower in 2017 compared to 1990 due to a strong decrease in combustion of fossil fuels for heating, see Figure 1.5. The emissions were approximately 2.9 Mt of CO_2-eq. in 2017. Emissions are primarily due to stationary combustion in homes, non-residential premises or within agriculture, forestry and fisheries. Emissions also come from mobile machinery, off-road vehicles and fishing boats. Oil-fired furnaces have been replaced by district heating, and electricity, including the increased use of heat pumps. Since emissions from stationary combustion for heating purposes have decreased significantly, the main emissions within the sector now come from non-road mobile machinery.

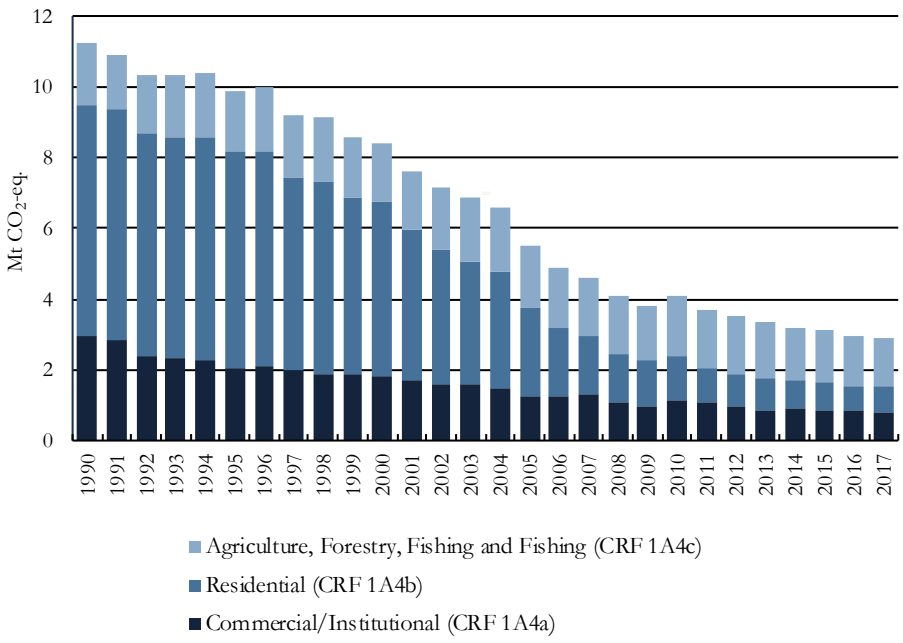


Figure 1.5 **Greenhouse gas emissions from combustion in the commercial and institutional, residential, and agriculture, forestry and fisheries sectors.**

1.1.3. Industrial combustion

To cover all industry-related emissions it is necessary to include process emissions and emissions from combustion and fugitive emissions. These are to be reported under separate CRF (Common Reporting Format) categories according to UNFCCC guidelines.

The mining, iron and steel industries, as well as the pulp and paper industry, are examples of historically important industries for Sweden. Emissions from combustion in manufacturing industries and construction were 6.9 Mt CO_2-eq. in 2017, see Figure 1.6. Emissions in 2017 were 36 % lower than in 1990 and 2 % lower when compared to emission levels in 2016. The lower emissions in 2009 and higher emissions in 2010 were caused by the impact of the financial crisis on production levels and their subsequent recovery. The decreasing trend is primarily related to a lower use of oil as oil has been replaced by electricity or biomass.

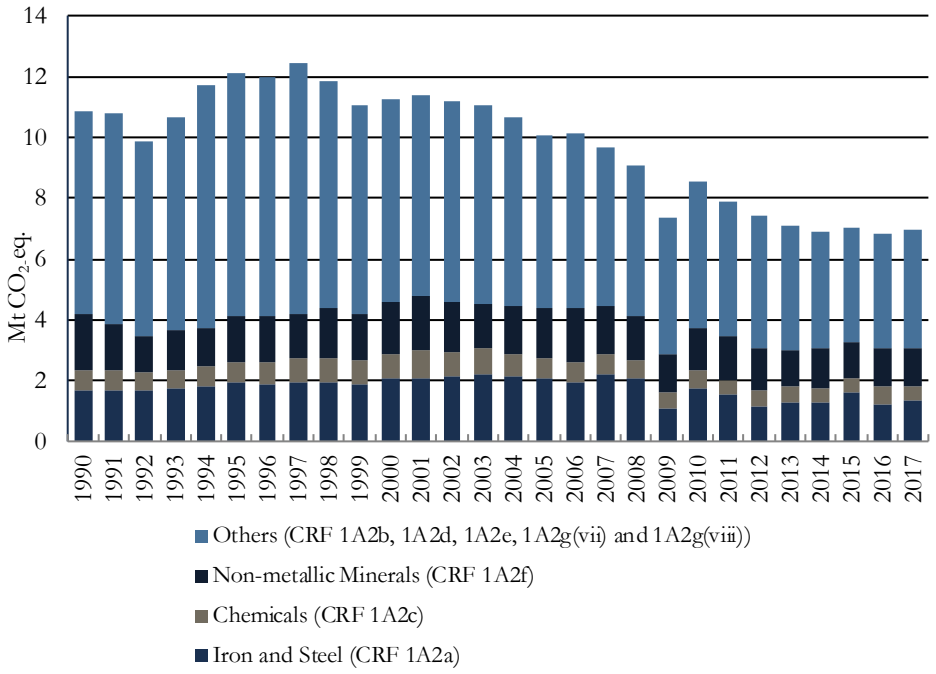


Figure 1.6 **Greenhouse gas emissions from industrial combustion.**

1.1.4. Fugitive emissions

Fugitive emissions come from sources like processing, storing and using fuels, gas flaring, and the transmission and distribution of gas. Emissions were around 0.9 Mt CO_2-eq. in 2017, see Figure 1.7, and have increased by 126 % compared with 1990. The increase of fugitive emissions from oil, observed in the time series from 2006, is related to the establishment of hydrogen production facilities at two oil refineries.

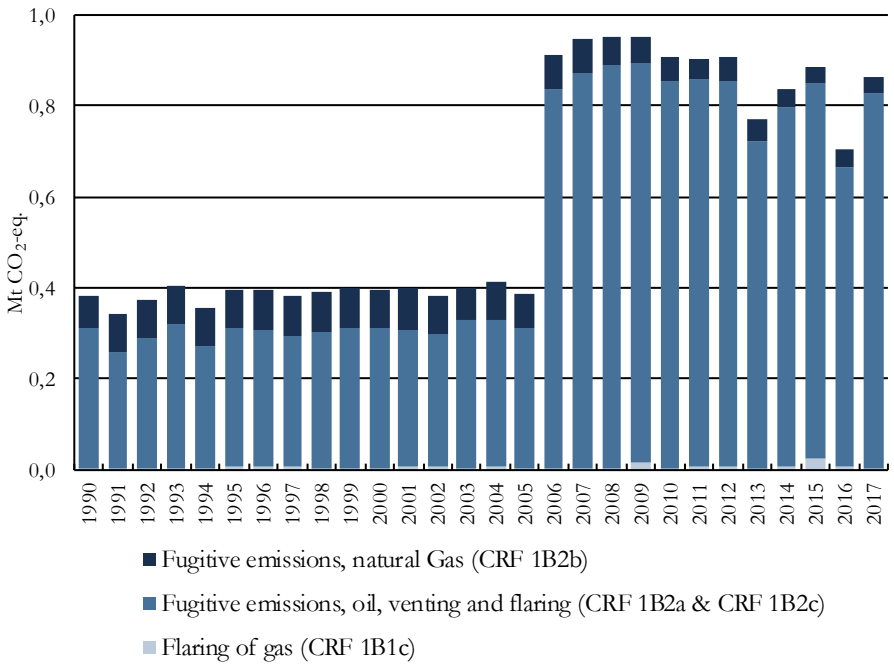


Figure 1.7 **Fugitive emissions.**

1.1.5. Industrial processes and product use

Emissions from the industrial processes and product use sector represented 14 % of total national emissions in 2017. The main sources of emissions in this sector are the production of iron and steel as well as the cement and lime industries. Greenhouse gas emissions from industrial processes and product use were at the same level in 2017 as in 1990, about 7.6 Mt CO_2-eq. see Figure 1.8.

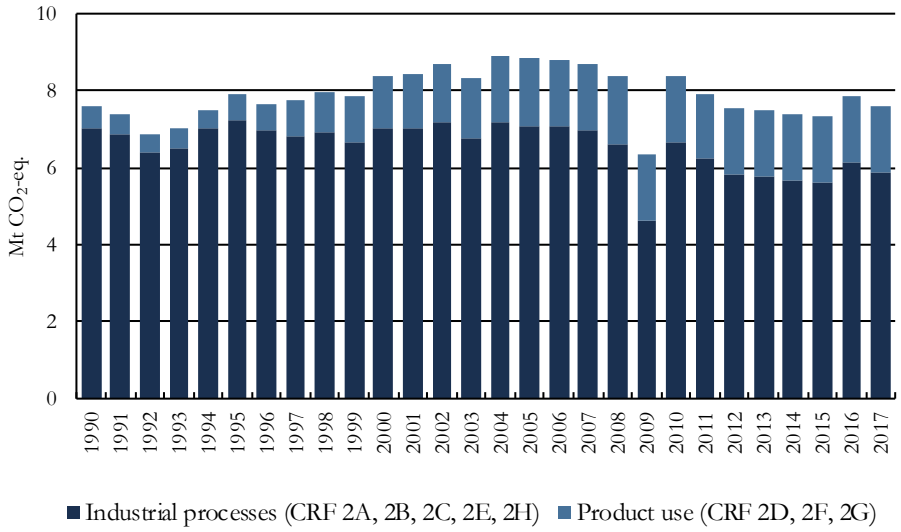


Figure 1.8 **Emissions from the industrial processes and product use.**

Greenhouse gas emissions from industrial processes and product use show an overall decreasing trend since 1995, except for 2009 and 2010. Emissions from product use were significantly higher in 2017 compared to 1990 but are relatively unchanged since 2004. The trend of emissions from product use is mainly influenced by products used as substitutes for ozone depleting substances. Emissions of such greenhouse gases have increased substantially, by 1.1 Mt CO_2-eq., since 1990. The use of HFCs as refrigerants in refrigerators, freezers and air-conditioning equipment has contributed to the larger share in later years.

1.1.6. Transport

In 2017, emissions of greenhouse gases from domestic transport totalled 16.6 Mt CO_2-eq., equivalent to a third of the national total. Most of the transport-related greenhouse gas emissions in Sweden come from road traffic, mainly from passenger cars and heavy-duty vehicles, as seen Figure 1.9. The switch from petrol-powered to diesel-powered cars has led to a more energy-efficient car fleet, which since the mid-2000s has been bolstered by a general improvement in fuel efficiency for new cars. Nevertheless, the emission reductions have been diminished by an increased trend in the amount of traffic.

The emissions from heavy-duty vehicles follow the fluctuations of economic activity. These emissions increased between 1996 and 2008. The decrease in

emissions from heavy-duty vehicles that started in 2010 has slowed down since 2013.

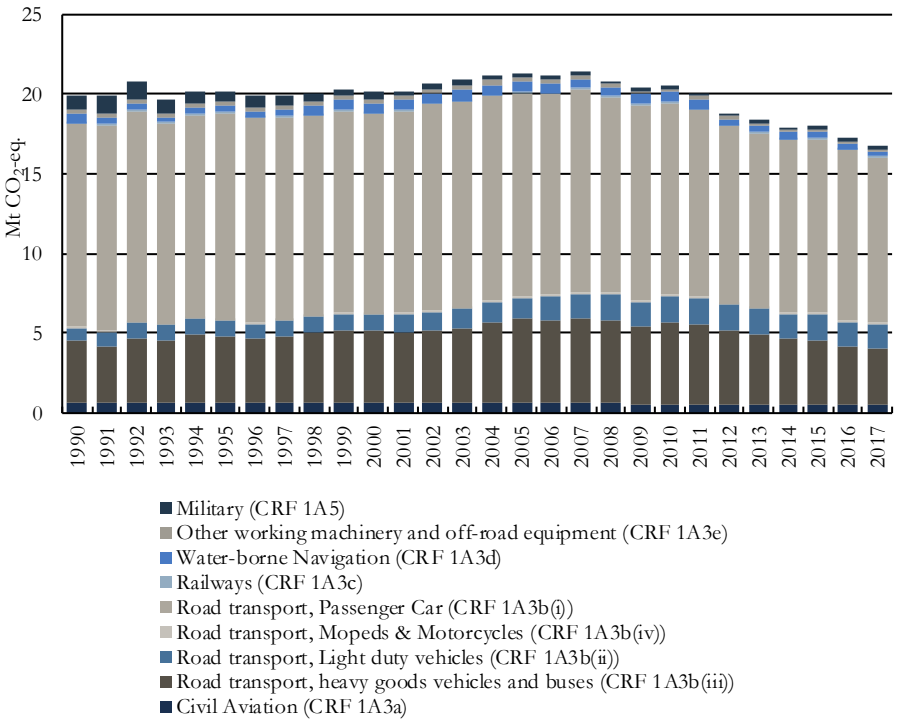


Figure 1.9 **Greenhouse gas emissions from domestic transport.**

In addition to emissions from road transport, emissions from transport include emissions from domestic civil aviation, railways, national navigation, non-road mobile machinery as well as domestic military operations. In 2017, the greenhouse gas emissions from road transport were 15.5 Mt CO_2-eq., 0.6 Mt CO_2-eq. from domestic aviation, 0.3 Mt CO_2-eq. from domestic navigation, 0.04 Mt CO_2-eq. from railways, and 0.2 Mt CO_2-eq. from non-road mobile machinery. Emissions from domestic military operations totalled 0.2 Mt CO_2-eq. in 2017.

1.1.7. Waste

Emissions from the waste sector have decreased by about 67 % in 2017 compared to emission levels in 1990. From 2016 to 2017, emissions have been reduced by nearly 5 % due to continued emission reductions from landfill. Emissions from the waste sector are dominated by methane gas from waste landfill. Methane emissions account for 76 % of emissions, while nitrous oxide emissions from wastewater treatment and biological treatment

of solid waste account for 19 % and carbon dioxide emissions from waste incineration account for the rest., see Figure 1.10.

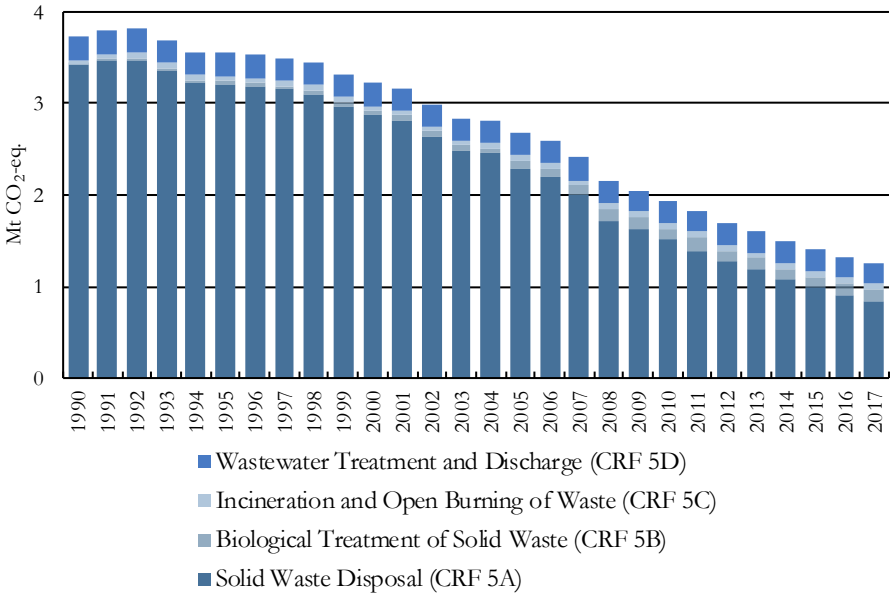


Figure 1.10 **Greenhouse gas emissions from the waste sector, per subsector.**

The most important mitigation measures are the expansion of the methane recovery from landfills, the reduction of landfill disposal of organic material, the increased levels of recovery of materials, and waste incineration with energy recovery. The main reasons for the decrease in the quantities of waste sent to landfill are the bans on landfill disposal of combustible and organic material, introduced in 2002 and 2005 respectively. Producer responsibility, municipal waste plans and the waste tax have also contributed to the reduction of the amount of waste deposited in landfills. Emissions from the incineration of waste for electricity and heat production are allocated to the energy sector and not to the waste sector. In 2017, emissions from the waste sector were 1.3 Mt CO_2-eq., which corresponds to 2.4 % of total greenhouse gas emissions.

1.1.8. Agriculture

In 2017, the aggregated greenhouse gas emissions from the agriculture sector were about 7.2 Mt CO_2-eq., which corresponds to approximately 14 % of the total greenhouse gas emissions in Sweden. About half of the emissions in the sector in 2017, summarized as carbon dioxide equivalents, were nitrous

oxide and the other half methane. Emissions from the agriculture sector have decreased by almost 0.5 Mt CO_2-eq. (equivalent to a 6 % decrease) between 1990 and 2017, see Figure. 1.11.

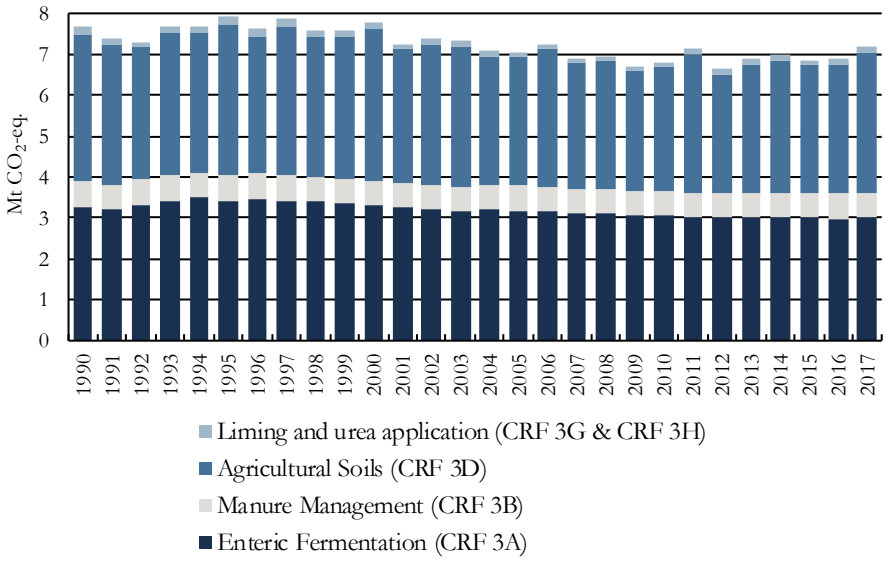


Figure 1.11 **Greenhouse gas emissions from agriculture.**

The decrease since 1990 is due to several factors, such as a reduction in the number of animals (especially dairy cows and swine), reduced volumes of manure, improved manure management practices, decreased use of N-mineral fertilizers as well as reduced area of cropland. Between 2016 and 2017, emissions from the sector increased by 4.6 %, mainly due to increased use of N-mineral fertilizer, elevated emission of N_2O from organic soils and increased emissions from cattle digestion due to increased numbers of non-dairy-cows.

1.1.9. Land use, Land use change and Forestry (LULUCF)

The sector Land use, Land use change and Forestry (LULUCF) has generated annual net removals in Sweden during the whole period 1990—2017. In 2017 total net removal from the sector was estimated to about 44 Mt CO_2-eq. During the period total net removals have varied between around 34 to 44 Mt of CO_2-eq. Between 2016 and 2017 the total net removals decreased by almost 1 Mt CO_2-eq., see Figure 1.12.

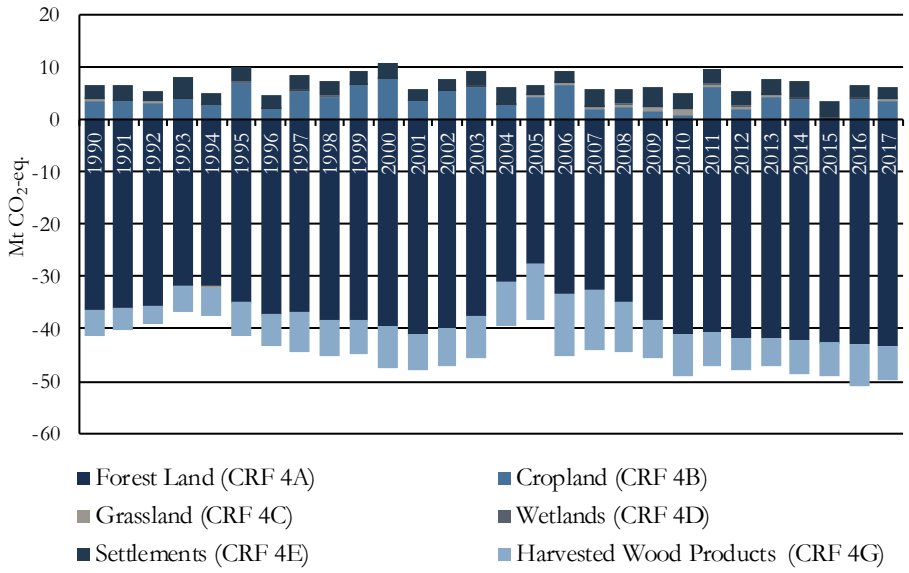


Figure 1.12 **Greenhouse gas emissions and removals from land use.**

The largest net removals occured in forest land and amounted to about 43 Mt CO_2-eq. in 2017, followed by harvested wood products with removals of about 7 Mt CO_2-eq. The total size and variation of net removals 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 in this sector are heavily influenced by harvests and natural disturbances such as storms on forest land. The net removal in the carbon pool living biomass in 2017 was about 37 Mt CO_2-eq. The lowest net removal for living biomass was in 2005 after the storm Gudrun. The HWP pool stock change depends on the estimated difference between the inflow of carbon in terms of new products and the modelled outflow of discarded products. At present, the estimated pool therefore covariates with the Living biomass net removals in the category forest land. The largest net removals in the pool/category HWP, occurred after the big storm in 2005 resulting in increased felling (salvage logging) the year after the storm. The net removal in the pool HWP was about 7 Mt CO_2-eq. in 2017. The largest net emissions in this sector come from cropland and settlements. Net emissions from cropland has been about 4 Mt of CO_2-eq. as a mean value since 1990 until 2017. The inter-annual variation in net emissions in cropland is connected to the variation in mineral soils. The annual variations depend on what is grown and how large areas of crops that are grown between years together with the climatic conditions (air temperature and

precipitations). The emissions of carbon dioxide in croplands originate from the cultivation of organic soils. Emissions from drained organic soils are the largest source in this land use category and in 2017 the net emissions amounted to 3 Mt CO_2-eq. Total net emissions from settlements were as a mean about 3 Mt CO_2-eq. during the period 1990 until 2017. Emissions are mainly caused by urbanization and establishments of power lines and forest roads.

1.1.10. International transport

Greenhouse gas emissions from international shipping and aviation, also called emissions from international bunkering, are considerably larger than those from domestic shipping and aviation. In 2017, they amounted to 10.6 Mt CO_2-eq., which is an increase of 13 % since 2016, see Figure 1.13.

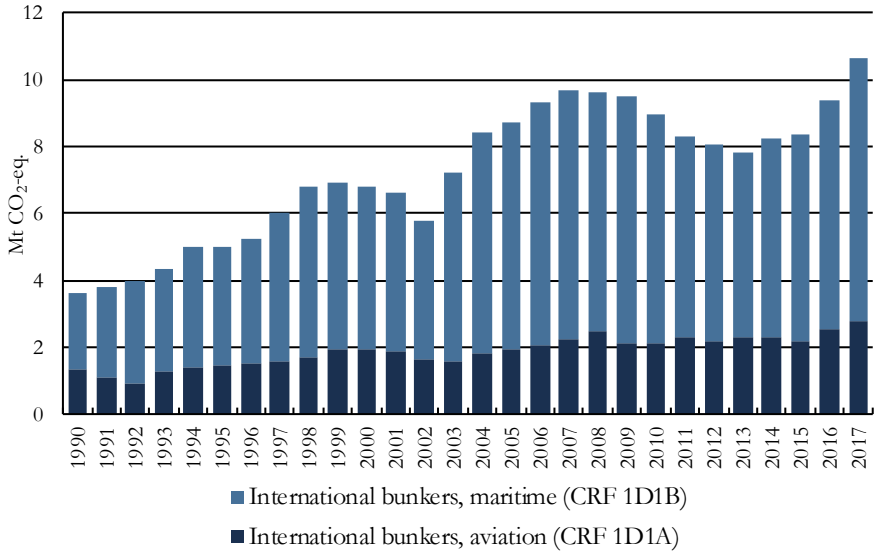


Figure 1.13 **Greenhouse gas emissions from international bunkers.**

Emissions from international shipping reached a total of 7.8 Mt of CO_2-eq. in 2017. This is an increase of 15 % compared with 2016 and 246 % higher than in 1990. The increase may be a result of the production by Swedish refineries of low-sulphur marine fuels (fuel oil Nos. 2–5), which meet strict environmental standards. As a result, more shipping companies choose to refuel in Sweden. Another explanation may be the globalisation of trade and production systems, which has led to goods being transported over greater distances. Fluctuations in bunker volumes between years are also dependent on fuel prices in Sweden compared with the price at ports in other countries.

Greenhouse gas emissions from international aviation bunkers were 2.8 Mt of CO_2-eq. in 2017. This is an increase of 9 % compared to 2016 and 106 % higher than in 1990. Emissions from international bunkering of aviation have varied over time. The trend points to a rise in these emissions, owing to growth in travel abroad.

The Swedish Armed Forces bunker very small quantities of fuel in Sweden for operations abroad.

1.2. The national system for the GHG inventory and for policies and measures and projections

In accordance with the Kyoto Protocol, as well as the associated Decision 24/CP19, as well as EU Monitoring Mechanism Regulation (EU/No/525/2013), Sweden has established a national system for preparing its greenhouse gas (GHG) inventory (see section 1.3). The Swedish national system for policies and measures and projections aims to ensure that the policies, and measures and projections are reported in compliance with specified requirements to the Secretariat of the Convention (UNFCCC), the Kyoto Protocol and the European Commission.

The Swedish national system for preparation of its GHG inventory came into force on the 1:st of January 2006, and a national system **for** policies and measures and projections was set up in 2015. In relation to legal arrangements, the information is the same for the two systems.

On the 29th of December 2014, the Ordinance on Climate Reporting (SFS 2014:1434) came into force in Sweden. The ordinance describes the roles and responsibilities of government agencies in the context of climate reporting and concerns both the GHG inventory and the reporting of policies, measures and projections. This led to several changes in Swedish reporting, such as enlarging the national system, adding other agencies, as well as adding responsibilities for agencies already involved. The ordinance requires that sufficient capacity be available for timely reporting.

1.3. The national system for preparing the Swedish GHG inventory

The Swedish national system for preparing its GHG inventory was established in 2006 in accordance with 19/CMP.1, 20/CP.7 and decision 280/2004/EC. In 2013, EU decision No 280/2004/EC was replaced by the Monitoring Mechanism Regulation 525/2013/EC. The Monitoring Mechanism Regulation has the same demands for national systems as the Monitoring Mechanism decision. The aim is to ensure that climate reporting to the secretariat of the Convention (UNFCCC), the Kyoto Protocol, and the European Commission complies with specified requirements. The national system for GHG inventory preparation is described in detail every year in Sweden's annual National Inventory Report, submitted to the UNFCCC Secretariat. The Kyoto protocol reporting of LULUCF uses the same institutional arrangements, national system and corresponding QA/QC procedures as for the UNFCCC reporting.

1.3.1. Legal arrangements

The legal basis for Sweden's national system is provided by the Ordinance on Climate Reporting (2014:1434), which describes the roles and responsibilities of the relevant government agencies in this area. The Ordinance ensures that sufficient capacity is available for reporting. In addition to the Ordinance on Climate Reporting, formal agreements between the Swedish EPA and the concerned agencies have been signed, detailing the requirements regarding content and timeframes for submissions from each agency.

Sweden also has legislation which indirectly supports climate reporting efforts by providing a basis for estimating greenhouse gas emissions and removals. The Official Statistics Act (SFS 2001:99) impose an obligation to submit annual data. Environmental reports are submitted under the Environmental Code (SFS 1998:808). In addition, government agencies in Sweden must comply with the Information and Secrecy Act (SFS 2009:400).

1.3.2. Institutional arrangements

Preparing the annual inventory and other reports is done in collaboration between the Ministry of the Environment, the Swedish EPA and other government agencies and consultants. Depending on the role of these agencies in the climate-reporting process, this responsibility may range from supplying data and producing emission factors/calorific values to

performing calculations for estimating emissions or conducting a national peer review. Figure 1.14 illustrates the institutional arrangements for the yearly inventory report, as well as for other reporting, to the European Commission and the UNFCCC.

The Ministry of the Environment is responsible for the national system and for ensuring that Sweden meets international reporting requirements in the area of climate change. The Swedish EPA is responsible for coordinating the national system for climate reporting, for maintaining the necessary reporting system and for producing data and drafts for the required reporting and submitting the material to the government.

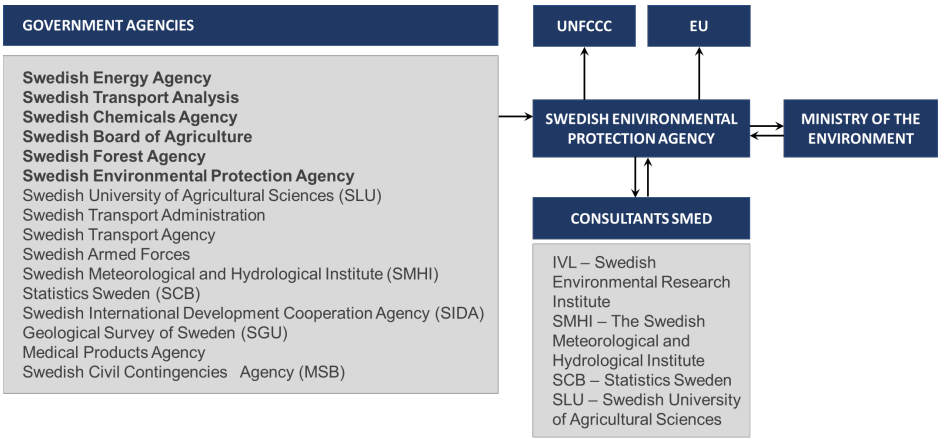


Figure 1.14 **The Swedish national system for preparing its GHG inventory. Agencies marked in bold participates in a yearly national peer review.**

Under contract to the Swedish EPA, the consortium SMED[2] processes data and documentation received from the various government agencies, as well as their own data, to calculate Swedish greenhouse gas emissions and removals.

1.3.3. Contact details of organisation responsible

The Swedish Ministry of the Environment is the national entity with overall responsibility for the inventory.

Ministry of Environment

[2] SMED = Svenska MiljöEmissionsData (Swedish Environmental Emissions Data), a consortium comprising Statistics Sweden (SCB), the Swedish Meteorological and Hydrological Institute (SMHI), IVL Swedish Environmental Research Institute and the Swedish University of Agricultural Sciences (SLU)

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Contact: Mr. Christoffer Nelson

1.3.4. Inventory planning, preparation and management

The Swedish greenhouse gas inventory is compiled in accordance with the various reporting guidelines drawn up by the Intergovernmental Panel on Climate Change (IPCC) and the UNFCCC. The national system is designed to ensure the quality of the inventory, i.e. to ensure its transparency, consistency, comparability, completeness and accuracy. The Swedish quality system is based on the structure described in UNFCCC Decision 20/CP.7 and applies a PDCA (plan–do–check–act) approach.

Planning and development

In any given year, priorities are set since recommendations received from international and national reviews, the results of key category analysis, uncertainty analysis, ideas for improvements from the Swedish EPA and SMED consultants, and new requirements arising from international decisions, amongst others.

Based on these criteria, the Swedish EPA commissions development projects, which are undertaken by SMED consultants. On completion of these projects, the results are implemented in the inventory.

Preparation

Government agencies supply activity data to the Swedish EPA and SMED, which also gather activity data from companies and sectoral organisations, and from environmental reports. Emission factors may be plant-specific, developed at a national level, or IPCC default factors. Methods used to estimate emissions comply with current requirements and guidelines.

Quality control and quality assurance

All data are subjected to general inventory quality control (Tier 1), as described in the IPCC Good Practice Guidance (2000), Table 8.1. Certain sources also undergo additional checks (Tier 2). All quality control is documented by SMED in checklists. Data are also validated using the checks built into the CRF Reporter tool.

Quality assurance is carried out in the form of a national peer review by government agencies, as provided in the Ordinance on Climate Reporting (2014:1434). This national review covers choice of methods, emission factors and activity data and is a guarantee of politically independent figures. The reviewers also identify potential areas for improvement in future reporting. Their findings are documented in review reports. The timetables for quality assurance are included in the agreements between the government agencies and the Swedish EPA. The government authorities conducting the national review are marked in bold in Figure 1.14. From the 2016 submission, quality assurance is conducted in two steps, with an annual quality control and verification of the trends, national statistics used and, if relevant, changes in methods. Every year there is also an in-depth review of one sector. In addition, reporting is reviewed annually by the EU and UNFCCC.

An in-depth review of each sector will take place every five years as long as there are no specific recommendations from the EU or UNFCCC reviews, no changes in methodology have occurred, or the first-step review did not signal any problems. Sweden has also initiated meetings with experts from Denmark, Finland and Norway where GHG inventory compilers discuss problems, the need for revised methods and other relevant matters.

Finalisation, publication and submission

The preliminary results are published nationally in late November or early December each year. The Swedish EPA supplies a draft report to the Ministry of the Environment in the beginning of January. The EPA submits the inventory to the EU on 15th of January and to the UNFCCC on 15th of April.

Follow-up and improvements

Each year, suggestions for improvements from the national and international reviews, and from SMED and the Swedish EPA, are compiled into a list. Based on this list, priorities are set and development work is carried out in preparation for the following year's reporting. Any suggestions that are not implemented remain on the list for consideration in subsequent years.

1.3.5. Information on changes in the national system for GHG inventory

There have been no changes in the Swedish national system since the previous Biennial Report.

1.4. The national system for policies and measures and projections

According to Article 12 of Regulation (EU) No 525/2013 of the European Parliament and the Council on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change, every member state needs to have a national system for policies and measures and projections. The Swedish national system for policies and measures and projections was established in 2015. Its aim is to ensure that policies and measures and projections are reported in compliance with specified requirements to the Secretariat of the Convention (UNFCCC), the Kyoto Protocol (19/CMP.1) and the European Commission.

1.4.1. Legal arrangements

The legal basis for Sweden's national system for policies and measures and projections is the same as for the annual greenhouse gas inventory and is provided by the Ordinance on Climate Reporting (SFS 2014:1434). See more information on the Ordinance under section 1.2.1.1. The Ordinance includes all reporting according to EU/No 525/2013/EC on a mechanism for monitoring and reporting greenhouse gas.

Accompanying the Ordinance on Climate Reporting, formal agreements between the Swedish EPA and the agencies concerned have been established, specifying in detail the content and timeframe for each agency for providing information on policies and measures and projections.

1.4.2. Institutional arrangements

To prepare the reporting on policies and measures and projections, cooperation takes place between the Ministry of the Environment, the Swedish EPA and other government agencies, see Figure 1.15).

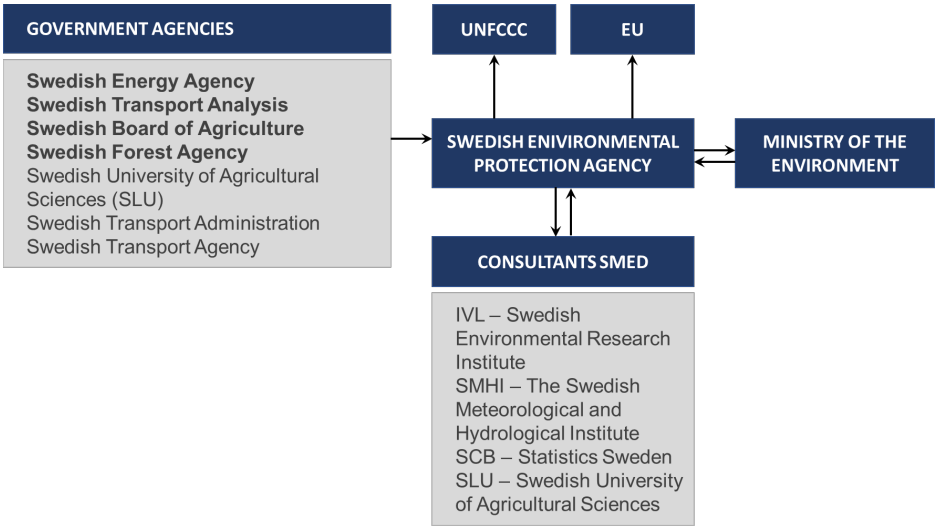

Figure 1.15 **Government agencies included in the Swedish national system for reporting on policies, measures and projections.**

The Ministry of the Environment is responsible for the national system and for ensuring that Sweden meets international reporting requirements in the area of climate change.

The Swedish EPA is responsible for producing the reports for the required reporting. The agency is thus responsible for coordinating Sweden's national system and for maintaining the necessary reporting system.

The other government agencies are responsible for providing the data and documentation necessary for reporting. In some cases, the agencies are responsible for peer review of different sectors.

The same contract with consultants (SMED[3]) as for the GHG inventory is used in the institutional process of policies and measures and projections.

1.4.3. Contact details of organisation responsible

The contact details are the same as for Sweden's national system for the GHG inventory (section 1.2.1.3).

[3] SMED = Svenska MiljöEmissionsData (Swedish Environmental Emissions Data), a consortium comprising Statistics Sweden (SCB), the Swedish Meteorological and Hydrological Institute (SMHI), IVL Swedish Environmental Research Institute and the Swedish University of Agricultural Sciences (SLU).

1.4.4. Inventory planning, preparation and management

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.

Planning and development

The report on policies and measures and projections is planned in due time before reporting. The report is compiled and includes quality control activities.

Work on the report on projections starts one year ahead of submission and includes planning and defining assumptions and sensitivity analysis. Underlying projections on activity data are provided by several government agencies. The projections on emissions are then produced and compiled by the Swedish EPA.

Work on the policies and measures (PaMs) report starts one year before submission and includes planning activities. The information on policies and measures is gathered by the Swedish EPA. Government agencies, in accordance with the Ordinance, then perform quality assurance activities.

Preparation

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 assessed and improved. Assumptions are made based on available data and on expert knowledge. Several government agencies are responsible for providing data according to the Ordinance and agreements. The Swedish EPA collects the additional data needed for reporting on policies, measures and projections and produces the reports.

Quality control and quality assurance

To ensure timeliness, transparency, accuracy, consistency, comparability and completeness, quality control activities are performed in parallel with work on projections and compilation of the information on policies and measures. Quality assurance activities are then performed according to the Ordinance before the report is finalised and submitted.

The timetables for quality assurance are included in the agreements between the government agencies and the Swedish EPA.

All data are subjected to general quality control activities throughout the process before submission. Quality assurance is carried out in the form of a national peer review by relevant government agencies, as provided in the Ordinance. The national review covers transparency, completeness, consistency, accuracy and comparability.

Finalisation and submission

After quality assurance activities and, if necessary, adjustments of the report, the Swedish EPA submits the reports to the EU on 15 March biennially.

Follow-up and improvements

The review identifies potential areas for improvement in future reporting. The findings are documented in the review report. For projections, sensitivity analysis are performed by applying a range of lower and higher estimates to the key assumptions.

1.4.5. Information on changes in the national system for policies and measures and projections

There have been no changes in the Swedish national system since the previous Biennial Report.

1.5. References

19/CMP.1, Guidelines for national systems under Article 5, paragraph 1, of the Kyoto Protocol

24/CP.19, Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention

EU/No/525/2013, Regulation No 525/2013/EC on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information and Union level relevant to climate change and repealing decision No 280/2004/EC

National Inventory Report Sweden 2019, Greenhouse gas emission Inventory 1990–2017, Submitted under UNFCCC and the Kyoto Protocol.

SFS 2009:400, Svensk författningssamling, Offentlighets- och sekretesslag, SFS 2009:400.

SFS 2014:1434, Svensk författningssamling; Klimatrapporteringsförordning, 2014:1434

2. Quantified economy-wide emission reduction target

This chapter explains the pledge of the EU and its Member States under the Climate Change Convention and the Swedish national targets for 2020, 2030, 2040 and 2045.

2.1. The pledge of the European Union and its Members States under the Climate Change Convention

The EU submitted a pledge under the United Nations Framework Convention on Climate Change (UNFCCC) in 2010 to reduce GHG emissions by 20 % compared with 1990 levels by 2020 (FCCC/CP/2010/7/Add.1). As this target under the Convention was submitted by the EU and its 28 Member States together (EU-28) and not by each Member State, there are no specified Convention targets for individual Member States. For this reason, Sweden, as part of the EU-28, takes on a quantified economy-wide emission reduction target jointly with all other Member States. See Table 2.1 for key facts on the Convention target for the EU-28. In addition to the Convention target, the EU and its Member States have a commitment under the Kyoto protocol for the period 2013–2020. For the EU as a whole, the Kyoto commitment is the same as the Convention target except that it also includes LULUCF (excluding aviation emissions).

The definition of the Convention target for 2020 is documented in the revised note provided by the UNFCCC secretariat[4]. In addition, the EU provided additional information relating to its quantified economy-wide emission reduction target in a submission as part of clarifying the developed

[4] FCCC/SB/2011/INF.1/Rev.1 of 7, June 2011

country Parties' targets in 2012[5]. In a workshop that also formed part of this clarification process, the EU gave a presentation of its target in May 2012[6].

Table 2.1 Key facts on the Convention target of the EU-28, (including Sweden)

Parameters	Targets
Base year	1990
Target year	2020
Emission reduction target	-20 % in 2020 compared with 1990
Gases covered	CO_2, CH_4, N_2O, HFCs, PFCs, SF6
Global warming potential	AR4
Sectors covered	All IPCC sources and sectors, as measured by the full annual inventory, partly international aviation.
Land Use, Land-Use Change, and Forests (LULUCF)	Excluded
Use of flexible mechanisms	Possible to certain extent under the EU Emissions Trading System (EU ETS) and the Effort Sharing Decision (ESD).
Others	Conditional offer to move to a 30 % reduction by 2020 compared with 1990 levels as part of a global and comprehensive agreement for the period beyond 2012, provided that other developed countries commit themselves to comparable emission reductions and that developing countries contribute adequately according to their responsibilities and respective capabilities.

With the 2020 climate and energy package, the EU has set internal rules which underpin the implementation of the target under the Convention. The 2020 climate and energy package introduced a clear approach to achieving the 20 % reduction of total GHG emissions from 1990 levels, which is equivalent to a 14 % reduction compared with 2005 levels. This 14 % reduction objective is divided between two sub-targets, where two thirds (21 %) of the reduction effort was assigned to the EU Emission Trading System

[5] The EU submission is documented in FCCC/AWGLCA/2012/MISC.1 from 24 April 2012 with the title "Additional information relating to the quantified economy-wide emission reduction targets contained in document FCCC/SB/2011/INF.1/Rev.1"

[6] Presentation provided by Arthur Runge-Metzger on 'Clarification of developed country Parties' pledges' at UNFCCC workshop on clarification of the developed country Parties quantified economy-wide emission reduction targets and related assumptions and conditions (AWG-LCA 15) on 17 May 2012, available at: https://unfccc.int/files/bodies/ awg-lca/application/pdf/02_eu.pdf.

(ETS) (EU Directive No 2009/29) and one third (10 %) to sectors covered by the Effort Sharing Decision (ESD) (EU Decision No 406/2009).

Under the revised EU ETS Directive[7] (EU Directive No 2009/29), one single EU ETS cap covers all EU Member States and the three participating non-EU Member States (Norway, Iceland and Liechtenstein), i.e. there are no further differentiated caps by country. For allowances allocated to the EU ETS sectors, annual caps have been set for the period from 2013 to 2020; these decrease by 1.74 % annually, starting from the average level of allowances issued by Member States for the second trading period (2008–2012). The annual caps imply interim targets for emission reductions in sectors covered by the EU ETS for each year until 2020. For more information on the EU ETS, see the fourth Biennial Report of the European Union.

In 2017, verified emissions from stationary installations covered under the EU ETS in Sweden totalled 19.7 Mt CO_2-eq. with total GHG emissions of 52.7 Mt CO_2-eq (without LULUCF), the share of ETS emissions is 37 %. Emissions included in EU ETS in Sweden are mainly coming from industry and distric heating.

The monitoring process for the ETS is harmonized for all EU Member States (Commission Regulation No 601/2012). The use of flexible mechanisms is possible under the EU ETS. For more information on the use of CER and ERU credits under ETS, see the fourth Biennial Report from the EU.

[7] Revision for the period 2013 - 2020

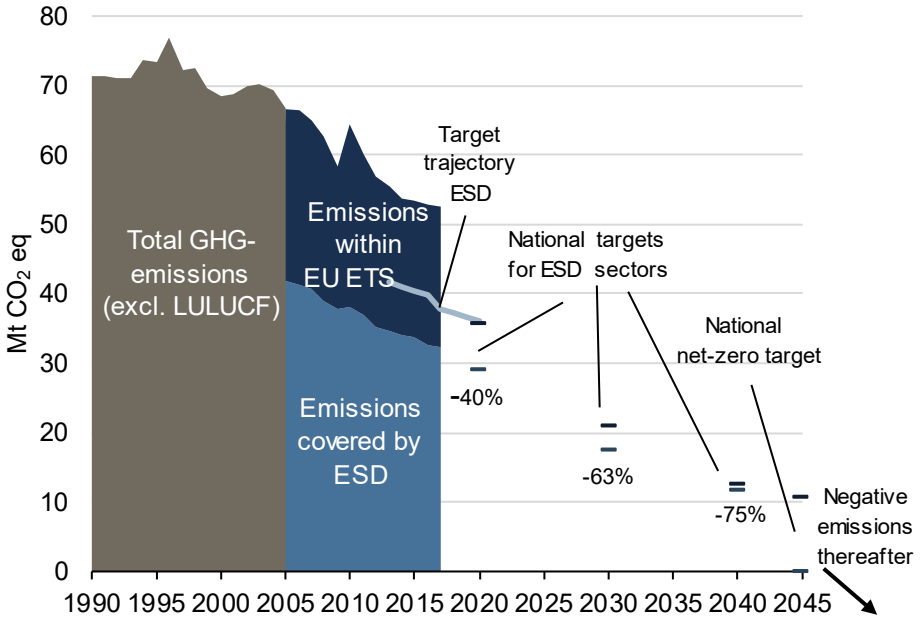

Figure 2.1 **Historic GHG emissions, separated into emissions included in the EU ETS and emissions covered by ESD[8,9], ESD trajectory 2013 - 2020 and the Swedish national targets under our national climate framework.**

Emissions not covered by the ETS are addressed under the Effort Sharing Decision (ESD) (Decision No 406/2009). The ESD covers emissions from all sources outside the EU ETS, except for emissions from international maritime, domestic and international aviation (which are included in the EU ETS since 1 January 2012) and emissions and removals from LULUCF. It thus includes a diverse range of small-scale emitters in a wide range of sectors: transport (cars, trucks), buildings (heating in particular), services, small industrial installations, emissions of fluorinated gases from appliances and other sources, agriculture and waste. Such sources currently account for about 60 % of total GHG emissions in the EU and for about 62 % in Sweden.

While the EU ETS target is to be achieved by the EU as a whole, the ESD target was divided into national targets to be achieved individually by each Member State. In the ESD, national emission targets for 2020 are defined as shares of the emission levels in 2005. These shares have been translated into binding quantified annual reduction targets for the period 2013 to 2020 (EU

[8] Note1: GHG emissions (submission 2019) excluding sources and sinks of LULUCF.

[9] Note2: ETS emissions are corrected to take account of the extended scope of the EU ETS for the third trading period.

Commission Decision of 26 March 2013) (Commission Implementing Decision of 31 October 2013), expressed in Annual Emission Allocations (AEAs). Sweden has committed to reducing emissions in sectors covered by the ESD by 17 % in 2020 compared with 2005 emissions. The quantified annual emission target is 41.7 million AEAs for 2013, decreasing to 37.2 million by 2020 (adjusted to 2013–2020 ETS period). The binding quantified annual reduction targets were revised (Commission Decision No 2017/1471), for the years 2017-2020, in August 2017, which means that the allocation for 2020 was reduced from 37.2 million AEAs to 36.1 million AEAs for Sweden.

The modalities and procedures for monitoring and review under ESD are harmonised for all EU Member States by the Monitoring Mechanism Regulation ((EU) No 525/2013). The use of flexible mechanisms is possible under the ESD.

The ESD allows Member States to make use of flexibility provisions for meeting their annual targets, with certain limitations. There is an annual limit of 3 % for the use of project-based credits for each Member State. These are not used in any specific year; the unused credits for that year can be transferred to other Member States or banked for own use until 2020. Because Sweden (together with Austria, Belgium, Cyprus, Denmark, Finland, Ireland, Italy, Luxemburg, Portugal, Slovenia and Spain) fulfils the criteria for using additional credits as stipulated in ESD Article 5(5), an additional use of credits is possible from projects in Least Developed Countries (LDCs) and Small Island Developing States (SIDS) up to an additional 1 % of their verified emissions in 2005. For Sweden these are 0.456 million ERs and ERUs. These credits are not bankable or transferable.

2.2. Sweden's national emission reduction targets exceeding EU targets

2.2.1. National environmental quality objectives

Sweden's overall environmental objective, called the generation goal, is intended to guide environmental action at every level of society. The generation goal indicates that "the overall goal of Swedish environmental policy is to hand over to the next generation a society in which the major environmental problems in Sweden have been solved, without increasing environmental and health problems outside Sweden's borders".

To provide a clear structure for environmental efforts in Sweden, the Swedish Parliament has adopted 16 environmental quality objectives that describe the quality of the environment that Sweden wishes to achieve. Sweden's environmental quality objectives cover different areas – from zero eutrophication to sustainable forest and a varied agricultural landscape. For each objective there are a number of 'specifications', clarifying the state of the environment to be attained.

One of these, Reduced Climate Impact, forms the basis for climate change action in the country. The objective is specified in line with the Paris Agreement´s temperature goal "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 action to address this goal." (Govt. Bill 2016/17:146).

2.2.2. The Swedish national targets for 2020

Current climate policy for 2020 is also set out in two Government Bills, entitled *An Integrated Climate and Energy Policy,* passed by Parliament in June 2009 (Govt. Bills 2008/09:162 and 163). The first of these Bills sets a national target for climate, calling for a 40 % reduction in emissions by 2020 compared with 1990. This is a more ambitious target than Sweden's commitment to ESD. 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 ETS and does not include the LULUCF sector. In addition, the Bills also set targets for energy efficiency and renewable energy (see Boxes 2.1 and 2.2).

BOX 2.1 Sweden's renewable energy target for 2020
The EU has adopted a mandatory target requiring a 20 % share of energy from renewable sources in overall energy consumption by 2020. The responsibility for meeting the target has been divided among the Member States. Based on the agreed burden sharing, the target for Sweden's renewable energy share in 2020 is 49 %. Parliament has decided that, by 2020, renewable sources are to provide at least 50 % of the total energy consumed. Meanwhile, the share of renewable energy in the transport sector is according to an EU target to be at least 10 %.

BOX 2.2 Sweden's energy efficiency target for 2020
The EU has adopted a target of a 20 % improvement in energy efficiency by 2020. This target has not been divided among the individual Member States. Sweden has chosen to

express its national target for improved energy efficiency by 2020 as a 20 % reduction in energy intensity between 2008 and 2020, which means that the energy supplied per unit of GDP at constant prices shall decrease over that period.

2.2.3. The Swedish target for 2030, 2040 and 2045

In June 2017, the Swedish Parliament adopted a proposal on a climate policy framework for Sweden which gives Sweden an ambitious, long-term and stable climate policy. The climate policy framework consists of a climate act, new climate targets and a climate policy council. For more information about the climate policy framework, see chapter 3.1.2.

The specific national targets are:

- By 2045 at the latest, Sweden is to have no net emissions of greenhouse gases into the atmosphere and should thereafter achieve negative emissions. This means emissions from activities on Swedish territory are to be at least 85 % lower by 2045 at lateset compared with 1990. Supplementary measures may count towards achieving zero net emissions, such as increased uptake of carbon dioxide in forests and land, investments in other countries or bioenergy with carbon capture and storage (BECCS). The effect of the supplementary measures shall be calculated in accordance with internationally agreed regulations.
- Emissions in Sweden outside of the EU ETS should, by 2030 at latest, be at least 63 % lower than emissions in 1990, and by 2040 at latest at least 75 % lower. To achieve these targets by 2030 and 2040, no more than 8 and 2 percentage points, respectively, of the emissions reductions may be realised through supplementary measures.
- Greenhouse gas emissions from domestic transport are to be reduced by at least 70 % by 2030 compared with 2010. Domestic aviation[10] is not included in the target since this subsector is included in the EU ETS.

[10] The emissions only include CO_2.

- International transport (aviation and shipping) is excluded from the abovemetioned targets.

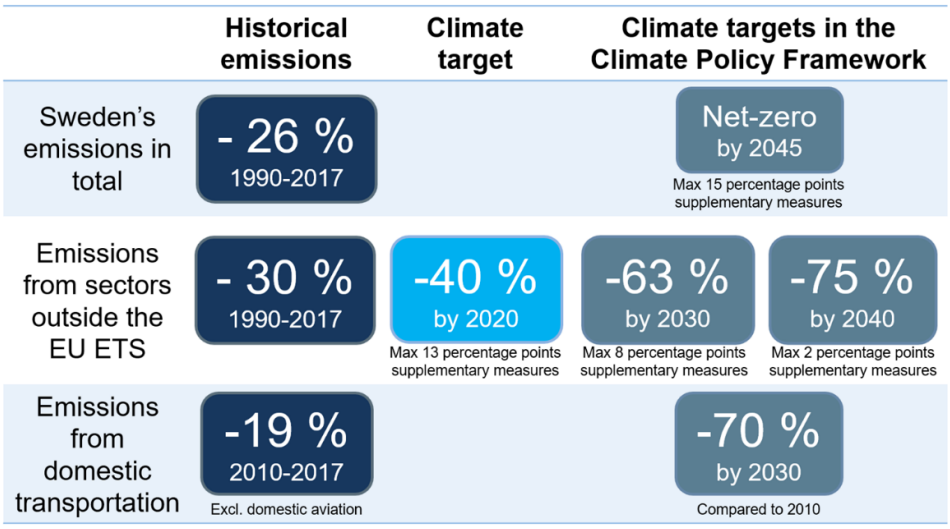

Figure 2.2 **Sweden's national targets included in the climate policy framework.**

2.3. References

FCCC/SB/2011/INF.1/Rev.1 of 7, June 2011, Compilation of economy-wide emission reduction targets to be implemented by Parties included in Annex I to the Convention.

EU Directive 2009/29, of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community (OJ L 140, 05.06.2009, p. 63) (http:// eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0063:0087:en:PDF).

Commission Regulation (EU) No 601/2012 of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council EU Commission decision of 26 March 2013 on determining Member States' annual emission allocations for the period from 2013 to 2020 pursuant to Decision No 406/2009/EC of the European Parliament and of the Council.

Decision (EU)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.

(2013/162/EU) Commission Implementing Decision of 31 October 2013 on the adjustments to Member States' annual emission allocations for the period 2013 to 2020 pursuant to Decision No 406/2009/ EC of the European Parliament and of the Council (2013/634/EU).

Commission Decision (EU) 2017/1471 of 10 August 2017 amending Decision 2013/162/EU to revise Member States' annual emission allocations for the period from 2017 to 2020 (notified under document C (2017) 5556).

EU/No/525/2013, Regulation No 525/2013/EC on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information and Union level relevant to climate change and repealing decision No 280/2004/EC.

Govt. Bill 2008/09:162: En sammanhållen klimat- och energipolitik – Klimat. Ministry of the Environment.

Govt. Bill 2008/09:163: En sammanhållen klimat- och energipolitik – Energi. Ministry of Enterprises, Energy and Communications.

3. Progress in achievement of quantified economy-wide emission reduction target and relevant information

This chapter provides information on the Swedish climate strategy as well as key policies and measures implemented or adopted in Sweden to reduce greenhouse gas emissions. The policies and measures that have been decided before 1st July 2018 are included in the projections of greenhouse gas emissions. Those policies and measures are reviewed in chapter 5[11]. Furthermore, the chapter includes information on the assessment of economic and social consequences of response measures. At the end of the chapter the policy instruments and their effects are summarized in a table. Institutional arrangements are presented in section 2.

3.1. Swedish climate strategy

Sweden's climate strategy has progressively developed since the late 1980s. It consists of objectives, policy instruments and measures, together with regular follow-up and evaluation. In June 2017, a new National Climate Policy Framework, ensuring long-term order and stability in climate policy, was adopted by the Swedish Parliament.

3.1.1. The Swedish environmental quality objective – Reduced Climate Impact

To provide a clear structure for environmental efforts in Sweden, The Swedish riksdag (Parliament) has adopted 16 environmental quality objectives. One of these, *Reduced Climate Impact*, forms the basis for climate change action in the country. The objective is specified as "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 action to address this goal." (Govt. Bill 2016/17:146).

[11] Some of the policy instruments are, due to recent date of decision, not included in the scenarios in chapter 5. Those are marked with a "*" in the summarizing table at the end of the chapter.

3.1.2. Sweden's national climate policy framework

In June 2017, the Swedish Parliament adopted a proposal on a national climate policy framework for Sweden (Govt. Bill 2016/17:146). The climate policy framework consists of a Climate Act, new national climate targets and a climate policy council. The climate policy framework is the most important and ambitious 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 imposes 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 reports on the progress. Sweden now has long-term climate targets beyond 2020 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.

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 annual Budget Bill, the government must submit a climate review to Parliament. 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 and their effects towards national and international climate goals.

Climate Policy Council

The climate policy council is an interdisciplinary expert body tasked to provide independent assessments of how the overall policy presented by the government is compatible with the national climate goals. The Council consists of members with high competence in the fields of climate science, climate policy, economics, social sciences and behavioral sciences.

By the end of March each year, the Climate Policy Council is required to submit a report to the Government with an assessment of the progress of climate work and emissions development, an assessment of whether the Government's policy is compatible with the climate targets, and other analysis and assessments made by the Council.

Moreover, three months after the government has submitted its climate policy action plan in accordance with the Climate Act, the Council shall submit a report to the government with an assessment of the action plan.

The Climate Policy Council should also contribute to increased discussion in society about climate policy.

National Targets

An overview of Swedish targets is presented in section 2.2.2.

3.1.3. Framework agreement on the Swedish energy policy

In June 2016, a cross-party framework agreement on Swedish energy policy was decided. The agreement sets out a target of 100 % renewable electricity production in Sweden by 2040. This is a target, not a deadline, for banning nuclear power. Moreover, in November 2016 a target of 50 % more efficient energy use by 2030 compared to 2005[12] was agreed.

3.1.4. Regional and local action on climate change

Since 1998, Sweden's county administrative boards (CABs) have been tasked with applying the national environmental quality objectives at the regional level. All 21 CABs have adopted regional climate objectives. As of 2005, their role also included developing regional action programs to achieve the environmental quality objectives. Since 2008, they have been entrusted with strategic coordination and leadership in regional efforts to implement government policies for a transition to renewable energy and reduced climate impact. The CABs develop and implement regional action plans in collaboration with other stakeholders. They support efforts by the business sector and municipalities in the area of climate and energy. Implementation of regional climate and energy strategies include a variety of measures, such as initiating cooperation and transferring knowledge between regional actors.

[12] Expressed in terms of primary energy use in relation to gross domestic product (GDP).

Regional energy offices also initiate and participate in a wide range of projects relating to energy efficiency and renewable energy sources, with funding from the Swedish Energy Agency, the EU, CABs, regional development councils and other organisations.

At the municipal level, a wide range of climate activities are being undertaken. Municipalities are obliged to have an energy plan, which often is combined with a climate strategy to reduce greenhouse gas emissions.

3.2. Policies and measures and their effects

3.2.1. Background

Sweden has introduced a range of policies and measures directly or indirectly affecting greenhouse gas emissions. The emphasis in the country's climate strategy is on the use of general economic instruments. However, in many cases the general economic instruments are supplemented with targeted measures, for example to support the development and market introduction of technology and eliminate barrier effects. Many instruments which interact with the carbon tax and emissions trading have also been adopted to achieve other policy goals than the climate objective, such as energy policy objectives.

Since the early 1990's, two key instruments in reducing Swedish emissions have been the energy and the carbon taxes. These taxes have been supplemented with other instruments, such as technology procurement, information, a differentiated annual vehicle tax and investment grants. Legislation, such as those involving prohibitions, standards, and urban planning, also plays an important part in curbing emissions. EU-wide policy instruments, in particular emission standards for new vehicles and the Emissions Trading System (EU ETS), also have a growing importance in Sweden. Of particular importance are investments made during previous decades in an expansion of district heating networks, public transport systems and carbon-free production of electricity.

Given the large number of policies and measures, many of them introduced with other objectives than climate mitigation, it can be difficult to evaluate the contribution by individual measures towards the climate objective. As several instruments interact, it is also hard to distinguish the effect of a single

instrument. Furthermore, separating out the effects of policy instruments from the impact of other external changes, such as energy prices, is often complicated.

It should also be noted that, even before 1990, there were instruments in the Swedish energy sector with a similar steering effect to those used after 1990. Through those instruments, incentives were created early on for the introduction of bioenergy and an expansion of district heating. For the energy supply sector and the residential and commercial/institutional sector it may, therefore, be difficult to disentangle the additional effects of policy instruments introduced in Sweden after 1990 from the effects that might otherwise have arisen if instruments had not been subsequently strengthened.

3.2.2. Cross-sectoral instruments

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, reporting,free allocation an 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. District heating and high efficiency cogeneration get around 30 percent free allocation.

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 planned to be implemented in EU law through a revision of the EU ETS legislation. Sweden is the administering Member State for approximately 90 aircraft operators, however not all of them will be subject to CORSIA.

Energy tax and carbon tax

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

Carbon tax

A carbon tax, based on the fossil carbon content in 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 1.18/kg (2019). 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[13]. 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 1950's.

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. 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. (National Institute of Economic Research, 2013).

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 tax and energy tax on motor fuels used for 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 0.8 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).[14] In July 2019 however, tax rates were lowered by the equivalent of the GDP-adjustment for 2019. The Government has proposed in its budget bill for 2020 a tax reduction to compensate inter alia for the additional GDP-adjustment of tax rates on petrol and diesel.

In June 2018, the energy tax on diesel (environmental class 1) was SEK 2.648 per liter and the carbon tax was 3.292 per liter, while the energy tax on

[13] 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).

[14] 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).

petrol was SEK 4.08 per liter and the carbon tax was 2.66 per liter. Sweden applied tax reductions for blended sustainable biofuels until July 2018. The energy tax reduction varied between different kinds of biofuels and was between 36 and 100 % compared to fossil equivalents in 2017.

As noted in chapter 2.2.4, the Swedish Parliament decided to introduce, from 1st July 2018, an emission reduction obligation scheme. The scheme was accompanied by a number of tax rule changes for petrol and diesel. In particular, low-blended biofuels that are covered by the reduction obligation scheme are subject to carbon tax and energy tax rates that correspond to the rates of their fossil equivalents. At the same time, the carbon tax rates for petrol and diesel are adjusted downwards to take account of the share of low-blended biofuel per liter full blend, as a result of the emission reduction scheme. In this way, the basic logic behind the carbon tax – to only target *fossil* carbon emissions – is preserved. 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. This relates to the portion of hydrogenated vegetable and animal oils and fats (HVO), biogas and other biofuels classed as diesel or gasoline, made from biomass (Swedish Tax Agency 2017a). 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.

Carbon 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 (Swedish Tax Agency 2017b).

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 tax and energy tax for electricity production

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

Carbon 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. 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 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 tax rates for fossil fuel used for heating purposes. Since then, the carbon tax reduction in the sectors has been reduced in steps. The carbon 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 from 1st January 2018. The energy tax paid is still 30 % of the general energy tax rate for heating fuels in these sectors.

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. From this date, the fuel is also subject to a tax reduction on the energy tax by SEK 0.19 per liter.

National and international commercial shipping

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

Local Climate Investment Program - The Climate Leap

To further stimulate the reduction of greenhouse gas emissions, a program for local investments was introduced in 2015, *the Climate Leap*. In total, SEK 4,855 million has been granted for investments within the program (as of December 2018). The Swedish Environmental Protection Agency (Swedish EPA) 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 programme together with the Charge at home-grant (see section 3.2.8) amounts to SEK 1,500 million. The combined budget will increase to SEK 1,955 million in 2020 according to the Government's proposed budget bill.

Effects of the Local Climate Investment Program

In total, the investments granted up until March 2019 are expected to generate a reduction of approximately 1.45 Mt CO_2-eq. per year during the technical lifespan of the investments[15]. Measures in the transport sector represents around 60 % of the total emission reductions while around 35 % of the reductions can be attributed to measures in residential and service sector along with the industry. It should, however, be noted that the measures in the investment program are of different character, including enabling activities for vehicle shifts such as infrastructure investments and

[15] The technical lifespan of the investments is in average 16 years.

supply of biofuel. Hence, all emission reductions cannot not be attributed to this policy instrument alone, as other instruments will also affect the emissions. E.g. electric vehicles need the infrastructure but are also affected by other national and EU policy instruments.(Swedish Environmental Protection Agency 2019a).

The Environmental Code and planning legislation

General environmental legislation 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 affect the environment. Significant environmentally hazardous activities are required to obtain a permit. Greenhouse gas emissions form part of the permit assessment procedure and the Code also includes requirements to use best available technology. However, since 2005, issuing 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. In 2018, changes were made in the 6th chapter in order to clarify that direct, indirect and cumulative impacts should be included in environmental impact assessments.

Measures relating to public planning chiefly impact emission trends in the longer-term and can therefore be significant. Measures in public planning are primarily governed by the Planning and Building Act (PBL) (SFS 2010:900). However, many measures, such as major infrastructure projects, are also covered by the Environmental Code. Since May 2011, the Planning and Building Act 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.

In December 2016, changes to annual report legislation came into force. Large corporations must now comply with new regulations for sustainability reporting. Sustainability reports must include information needed to understand a company's development, position, earnings and the consequences of their operations on 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 400 actors have signed the declaration and 13 roadmaps from different sectors have been submitted to the government. (Fossilfritt Sverige, 2019)

Climate change communication

Swedish governmental authorities have a 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. It is 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 and government grants relating to energy.

The Swedish Forest Agency and *the Swedish Board of Agriculture* focus on e-services and digital information to land and forest owners, forest officers and farmers

on how to reduce the climate impact of forestry, agriculture as well as on climate adaptation.

The Swedish Civil Contingencies Agency are in charge of prevention and mitigation of the effects of natural accidents and support measures to adapt the work of social protection and preparedness to a changing climate. During 2018, MSB sent out the brochure If Crisis or War Comes to 4.8 million households in Sweden, where climate events and potential energy crises are mentionned.

Public awareness

Public awareness on climate change is generally high in Sweden. The Swedish Environmental Protection Agency regularly conducts surveys of Swedes' attitudes on climate issues. The purpose is to measure the public preparedness on cutting emissions based on their own lifestyle and consumption, and the general attitudes on public climate change instruments. The survey conducted in 2018 shows that there is a great commitment among the public in Sweden to solve the climate issue. Swedes are keen to contribute and very positive about societal climate initiatives and corporate climate work.

Education and training

In cooperation with the Swedish Environmental Protection Agency, The National Swedish Agency for Education has clarified the connection between curriculum and syllabus and the national environmental goal Reduced Climate Impact. In-depth teaching on climate issues is common in upper secondary level. The National Swedish Agency for Education is currently working towards goal 4 in the Agenda 2030: Ensure inclusive and quality education for all and promote lifelong learning. The work is carried out together with relevant stakeholders.

Higher education institutions offer courses on the scientific basics of the climate and/or climate-related subjects like energy and forestry. There are various networks and centers of competence, for example, the Centre for Climate and Safety at Karlstad University and the Centre for Climate and Environmental Research at Lund University.

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.

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 (Govt. Bill 2016/17:1), 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 will result in a level of SEK 1.6 billion as of 2020, compared with the earlier level of SEK 1.3 billion.

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

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

Following these five societal challenges, energy research and innovation is carried out under nine different thematic areas: the transport system, bioenergy, buildings in the energy system, power systems and electricity generation, industry, a sustainable society, general energy system studies, business development and commercialisation, 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. It has therefore been decided to establish a

National ten-year Research Program for Climate and to increase funding by SEK 130 million by 2020.

3.2.3. Energy – production of electricity and district heating and residential and commercial/institutional

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 (Govt. Bill 2013/14:174). 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.

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. The directive shall be transposed by 25 June 2020, and by 25 October 2020 with regard to metering and billing.

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 54,5 % in 2017.

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. In 2017, the share of renewable energy in the transport sector in Sweden according to the renewable directive's calculation methodology was already 32.1 %.

3.2.4. Production of electricity and district heating

The production of district heating has risen by approximately 50 % since 1990. At the same time, emissions from this source have decreased. This is because the expansion has largely been achieved by the increased use of bioenergy, while the use of oil and coal has declined. The carbon tax is one of the main factors behind this trend, but the electricity certificate system is also important in replacing fossil fuels with renewables in the sector. The low emissions from electricity generation are explained by the fact that nuclear power and hydropower account for a dominant share of production, while additional production of electricity in recent years chiefly comes from biomass-fired combined heat and power plants (CHPs) and wind power.

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 system was also prolonged up until 2045 (Govt. Bill 2016/17:179). 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 (Govt. Bill 2016/17:187).

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).

Initiatives for wind power

The prospects for additional wind power generation have been improved by increased experience and technical development, which have resulted in lower wind energy costs. Furthermore, different programs have promoted the dissemination of knowledge and information about wind power. An example is the research program "Vindval", which aims to collect and provide scientific knowledge about wind power's impacts on humans and on nature (Swedish Environmental Protection Agency 2019b).

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 for wind power is roughly 8,000 km², representing about 1.5 % of the country's land area, including Swedish waters. (Swedish Energy Agency 2017a)

Government agencies are developing a strategy for wind-power expansion, which will propose means to enable sustainable large-scale wind farm deployment. Since 2018, the Swedish Energy Agency can provide support to municipalities that facilitate the establishment of wind power farms. (SFS 2017:1338)

Support for solar power

A subsidy for installations of solar power systems was initiated in 2009. The budget for this support is around SEK 4 billion for the period 2016–2020. All types of actors can 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.

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.

3.2.5. Residential and commercial/institutional

Greenhouse gas emissions from heating individual homes, commercial and institutional premises (heating other than district heating), have fallen dramatically since 1990. The energy and carbon taxes are seen as the instruments contributing most to reducing the use of fossil fuels in this sector in recent decades. The aggregate level of taxes on fossil fuel use for heating in the sector has risen steadily since 1990. This has made it considerably more expensive to use these fuels than if energy taxation was kept at its 1990 level (Profu 2017). Oil prices and the available technologies for fossil-fuel substitutes have also had a significant impact on trends in the sector.

Alongside carbon dioxide and energy taxes, there are several instruments targeting energy use in homes, commercial and institutional premises. Some

of the most important ones include building regulations, energy performance certificates, and the Ecodesign, Energy Labelling and Energy Efficiency Directives. In addition, there are instruments such as technology procurement, network initiatives and information campaigns at the local, regional and national levels.

Ecodesign Directive, Energy Labelling Directive and the Ecodesign Act

Energy labelling is mandatory for the product groups that are regulated by the Energy Labelling Directive[16] 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[17] 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

The Energy Performance of Buildings Directive[18] 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

[16] 2010/30/EU

[17] 2009/125/EC

[18] 2018/844/EC (replaces Directive 2010/31/EC)

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^{2}K).

Support for renovation and energy efficiency of rental apartments

During the period October 2016 to December 2018, a support scheme was implemented to incentivize renovation and energy efficiency of rental apartments in areas with socio-economic challenges (SFS 2016:837). The Government allocated almost SEK 5 billion for the scheme during the period 2016–2020. The support for energy efficiency was calculated based on the estimated level of energy efficiency after the renovation. Only cases in which the efficiency was improved by at least 20 % were eligible to receive support, and only projects including both renovation and energy-efficiency measures were approved. In December 2018, the Swedish Parliament decided to end the support scheme.

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[19]. (National Board of Housing and Planning 2016)

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

[19] Swedish Gymnasieskola

Swedish Energy Agency coordinates procurement networks for housing (BeBo), commercial and institutional premises (BeLok), small houses (BeSmå), public sector bodies that rent premises (HyLok) and food distribution (BeLivs).

3.2.6. Industrial emissions from combustion and processes (including emissions of fluorinated greenhouse gases)

Industrial emissions from combustion and processes

Total greenhouse gas emissions from combustion in manufacturing industries have decreased since 1997 but have been at the same level in recent years. The instruments affecting combustion emissions from the industrial sector are the EU ETS, energy and carbon dioxide taxes, the electricity certificate system, the Environmental Code, the Energy Step, Energy Audits, Energy and climate coaches and Energy efficiency networks.

Greenhouse gas emissions from industrial processes show an overall decreasing trend since 2006 but have increased somewhat since 2016. The instruments primarily affecting process related emissions are the EU ETS, the Environmental Code, the Industrial Leap, the Energy Step and Energy Audits.

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 supports the development of technology and processes to reduce the process-related greenhouse gas emissions in Swedish industry. The aim of this long-term reform is to support Swedish industry to reduce its process-related emissions. Financial support 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 is "Hydrogen Breakthrough Ironmaking Technology", HYBRIT, which which aims at getting rid of coal, traditionally needed for ore-based steel-making, and use hydrogen instead. Hydrogen is moreover planned to be coming from fossil-free electricity. The result would be the world's first 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. The Government has proposed an increase to SEK 600 million in its budget bill for the period 2020-2022, including the amendment to negative emissions. The Industrial Leap is administered by the Swedish Energy Agency.

Energy audits and the Energy Step

The law on energy audits in large enterprises aims at promoting improved energy efficiency (SFS 2014:266)[20]. The law requires large enterprises to conduct energy audits, including information of total energy use, as well as proposals of cost-efficient measures to improve energy efficiency. An audit must be conducted at least every fourth year. Enterprises that are subject to the law, and have conducted an energy audit, have 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.

Small and medium-sized enterprises[21] are, since 2010, 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 is 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 part-time climate and energy coach (SFS 2016:385). The coach provides targeted advisory services to small and medium-sized enterprises[22]. The support is available until June 2020. 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 (Swedish Energy Agency 2017b).

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

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

[22] Businesses using less than 300 MWh.

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 four-year period. By doing this, the enterprises will benefit from reduced costs, strengthened competitiveness and new opportunities for growth. (Swedish Energy Agency 2019)

3.2.7. Regulation governing emissions of fluorinated greenhouse gases

EU Regulation 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 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.

3.2.8. Domestic transport

Emissions from domestic transport, a sector dominated by road transport, increased after 1990 and reached a peak in 2007. Since then, emissions have been declining.

The decrease in emissions since 2006 can be attributed to policy instruments introduced both nationally and at the EU level. The most significant policy instruments include emission performance standards for new vehicles, vehicle taxes and vehicle fuel taxes, and more recently, a greenhouse gas emission reduction obligation for petrol and diesel. These have resulted in more energy-efficient vehicles and a greater use of renewable fuels. Reducing transport-related emissions is essential to meet the 2030 climate targets. Consequently, the government has implemented several policies and measures aimed at the transport sector in the last years, several of which will be reviewed 2019/2020 to ensure that they contribute to the achievement of existing climate targets.

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 CO_2/km by 2021. New vans should not emit an average of more than 175 g CO_2/km by 2017 and 147 g CO_2/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 has also adopted CO-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.

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 Fuel Change makes an important contribution to the phasing out of fossil fuels in transport. The obligation replaces the former tax exemption for low-blended biofuels, i.e. biofuels covered by the scheme will be subject to the same tax rate per litre as fossil equivalents. At the same time, both the carbon dioxide and energy tax rates for fuels covered by the Fuel Change 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 3.2.2.).

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 has commissioned the Swedish Energy Agency to propose reduction levels for the years 2021-2030. A common level for petrol and diesel, as well as the suitability of including highly blended biofuels in the reduction obligation, were also investigated. The assignment was completed in June 2019 and is being processed by the government.

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 on 1st January 2006. This requirement has resulted in an increased number of mainly E85 pumps. As of 1st 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.

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 intensity of energy supplied for road transport (low carbon fuel standard) by 6 percent until 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.

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 conditions. 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 was introduced on 1st 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.

Super-green car rebate

Buyers of passenger cars that meet EU exhaust requirements Euro 5 or Euro 6 and emit a maximum of 50 grams of carbon dioxide per kilometre were, until 2018, entitled to a super-green car rebate. The rebate was SEK 40,000 for private buyers of electric cars, which on 1st January 2016, was lowered to SEK 20,000 for buyers of hybrid cars. If the owner was a company or another organisation, the rebate was 35 or 17.5 % of the cost difference between the price of a super-green car and a non-super-green car of a similar type. The maximum rebate was SEK 40,000. This rebate aimed mainly to contribute to technology development and deployment, but also to create public awareness in order to lower barriers for a large-scale introduction of electric and hybrid electric cars in the future. The super-green car rebate was abolished and replaced by the bonus-malus-system for new light vehicles in 2018.

Tax exemption for environmentally friendly vehicles

Sweden has offered a tax exemption for environmentally friendly vehicles (EFVs) for new vehicles in their first five years according to a certain definition (SFS 2006:27). As of 1st January 2013, the definition of EFV is related to the car's curb weight and allows heavy 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 1st July 2018 but persists for cars sold before that date.

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.

Maximum bonus is given to clean electric cars / fuel cell cars with zero emissions from the exhaust pipe - SEK 60,000. The bonus then decreases by SEK 833 per gram of carbon dioxide per kilometer emitted, down to the lowest bonus level of SEK 10,000. At 60 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 climate emissions. In the emission range of 60-95 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.

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) 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.

Definition of green cars

Since 2013, a definition of a green car has been introduced in order to facilitate public procurement and companies' purchase of low emissions vehicles.

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

The regional public transport agencies, public transport companies, municipalities and limited companies[23] are eligible to apply for an electrical bus premium as of July 2016 (SFS 2016:836). The premium, which is administered by the Swedish Energy Agency, applies for electrical busses for public transportation use, ordered after 31st December 2015. The size of the premium depends on the number of passengers and whether the bus runs on electricity only or is a hybrid. The premium aims to contribute to the national environmental objectives 'Reduced climate impact', 'Clean air' and 'Good built environment' by promoting the market introduction of electrical busses. In the Government's budget bill for 2020, a premium is also proposed for electric and other low-emission heavy-duty vehicles as well as for electric working machinery. The proposed total budget for these premiums is SEK 120 million per year for 2020 and the scheme is set to last until 2023.

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 3.2.2.). In its budget bill for 2020, the government has proposed a budget of SEK 1,955 million for the Climate Leap as well as installation supports for charging stations.

Electric vehicle premium

Sweden previously had an 'electric vehicle premium' to improve the possibilities of commuting and transportation with electric bicycles or electric scooters. The Government allocated SEK 395 million during 2018

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

for a premium that covers up to 25 % of the purchase price. The aim of the electric vehicle premium was to encourage people to commute longer distances by bike, and to make large groups of people less car-dependent. The Swedish Parliament decided in December 2018 to end the premium.

Charge at home-grant

Private individuals are eligible to receive a rebate equaling 50 % of costs for buying and/or installing charging stations for electric vehicles in their homes. The maximum rebate is SEK 10,000. The rebate is administered by the Swedish EPA. The aim of the rebate is to make it easier and cheaper for households to switch to sustainable modes of transportation.

Urban environment agreements

Urban environment agreements are a scheme for investments in public transport and cycling infrastructure at the regional and local level in Sweden. The scheme commenced in 2015. 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 increased cycling and walking, lower vehicle speeds, parking policies and pricing. The scheme is administered by the Swedish Transport Administration.

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
- 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.

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. Also, under the Planning and Building Act (SFS 2010:900) there is a clear requirement to take environmental and climate issues into account in planning.

Eco-bonus system for heavy transport

In 2018, the government launched a temporary eco-bonus system aimed at stimulating the transfer of goods from road to shipping. The aim of the system is to reduce greenhouse gas emissions from heavy transport. The annual budget of theeco-bonus system is SEK 50 million. 200 million SEK have been allocated to this scheme 2018-2022.

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 day (in Stockholm for 2020: SEK 15–45, in Gothenburg for 2020: SEK 9–22) with a maximum amount per day of SEK 135 in Stockholm and SEK 60 in Gothenburg.

Low emission zone (LEZ)

Eight municipalities in Sweden have already set up low emission zones, restricting access to lorries and buses that don't meet specific requirements. Municipalities will even get the possibility from 2020 onwards to set restrictions on cars, based on two new environmental categories of low emissions zones.

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 (planned for 2020: SEK 62, 260 or 416). The Swedish Tax Agency is the competent tax authority.

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.

3.2.9. Waste

Methane emissions from landfill sites have declined significantly since 1990 and are expected to continue falling sharply over the next ten years. The factors behind this decline are an expansion of methane recovery from landfills and reduced landfill disposal of organic material, combined with increases in recovery of materials and waste incineration with energy recovery. These measures are a consequence of a series of policy instruments at both national and EU levels. Demand for waste as a fuel for district heating has also strongly encouraged diversion from landfill to incineration.

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 520 SEK per tonne landfilled waste in 2019.

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, while a similar ban was imposed for organic material in 2005. The ordinance also regulates the collection and disposal of methane gas from landfill. 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[24]. Producer responsibility aims to incentivise 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 landfills, environmental assessment, measures and monitoring. Both the national waste plan (Swedish Environmental Protection Agency 2012), and the national prevention program (Swedish Environmental Protection Agency 2015), act as guidance for the municipalities in developing their local plans and deciding on prioritized actions.

3.2.10. Agriculture

Greenhouse gas emissions from Swedish agriculture have fallen compared to 1990. As yet, there are relatively few policy instruments directly targeting greenhouse gas emissions in this sector. However, the Government has taken several initiatives to increase awareness and encourage the use of measures to curb emissions of greenhouse gases from manure and fertiliser management and from land use.

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

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

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 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. (Swedish Board of Agriculture 207) 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. Between January 2015 and September 2018, a total amount of SEK 176 million was shared among 66 biogas plants. Support for investments in new biogas plants can also be granted through the Rural Development Program.

3.2.11. Land use, land-use change and forestry (LULUCF)

Forest Policy and the Forest Act

The Swedish Forestry Act (as of 1993) has two overarching, equal objectives: support production and protect the environment.

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. Cultural heritage assets of forests and their aesthetic and social values should be safeguarded.

Under the current Forestry Act, production subsidies are abolished, and forest owners have considerable freedom and responsibility to independently conduct long-term sustainable forest management. The regulations 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 and voluntary disposal of land, are also positive for carbon stocks in forest biomass and soil coal by allowing them to be maintained or continue to increase.

Nature reserves

In Sweden, nature reserves[25] 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 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 chapter 11.

Nature conservation agreements

Nature conservation agreement is a civil law agreement(Swedish Environmental Protection Agency 2019c). The property owner and the state or a municipality agree on a certain financial compensation for the property owner, for example, to refrain from, for example, forestry. The Swedish Forest Agency and the Swedish Environmental Protection Agency together guide how to go about it. For the landowner it should not matter what authority you agree with.

The Swedish National Forest Program

The strategy for Sweden's national forest program was adopted by the government in May 2018. The work within the National Forest Program's strategy is guided by the program's vision: "The forest, the green gold, shall contribute with jobs and sustainable growth throughout the country, as well as the development of a growing bio-economy." An action plan has been developed for the strategy that contains concrete measures, based on the forest program's vision and goals. Access to sustainable biomass from Swedish forests has an important role to play in the continued transition to a fossil-free society. The action plan contributes to Sweden's climate work by setting goals and measures to increase the national range of bio-based alternatives.

Government advice and training

The Swedish Forest Agency provides information to forest owners on how climate change will affect their forests. It also offers guidance, adapted to the owners' specific holdings, on how to best manage their forests with the owners' specific goals in mind. The Swedish Forest Agency issued a report in 2016 on the effects of climate change on forests and the need for climate change adaptation in forest management.(Swedish Forest Agency 2017).

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

3.2.12. 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 2020: SEK 62, 260 or 416), with a yearly indexation. The Swedish Tax Agency is the competent tax authority.

ICAO

Within the ICAO, Sweden and the EU have been pressing for action to limit greenhouse gas emissions from international aviation, using a unified global measure. The ICAO decided in 2016 to develop a market-nased mechanism, Carbon Offsetting and Reduction Scheme for International Aviation, CORSIA, to compensate for extra GHG 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. Sweden is among the nations that have voluntarily participated in the scheme from its outset. Sweden is currently one of the members of ICAO Council and 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.

IMO

In the International Maritime Organization (IMO), Sweden has been one of the countries driving efforts to develop several technical and operational measures aimed at reducing greenhouse gas emissions. An Energy Efficiency Design Index (EEDI) – a standardized way to describe ships' energy efficiency – was made mandatory from 2013 for most (some 85 %) newly built vessels. The EEDI attained by any ship can be compared with a reference level based on an average for existing vessels. Ships whose contracts are placed after 2013 must be at least as energy-efficient as this level. A mandatory Ship Energy Efficiency Management Plan (SEEMP) has also been introduced. The EEDI end SEEMP applies to ships in international traffic with a gross tonnage of more than 400. This is to be used in ships' management systems to improve energy efficiency in both existing and new ships. In addition, a voluntary Energy Efficiency

Operational Indicator (EEOI) has been introduced as a tool and benchmark. This can be used by existing ships.

In October 2016 the IMO also approved a roadmap (for the period 2017 - 2023) for developing a 'Comprehensive IMO strategy on reduction of GHG emissions from ships', which foresaw an initial GHG strategy to be adopted in 2018. It contains a list of activities, including further IMO GHG studies with relevant timelines, and provides for alignment of those new activities with the ongoing work on the three-step approach to the ship energy-efficiency improvements mentioned above. This alignment provides a way forward to the adoption of a revised strategy in 2023 to include additional short-, mid-, and long-term measures as required, with implementation schedules. Under the roadmap, and to provide a long-term vision for the shipping sector, the IMO must address several important questions, such as what role the international shipping sector should play in supporting the goals of the Paris Agreement. Sweden participates actively and collaborates with other ambitious countries.

IMO have, during Marine Environment Protection Committee (MEPC) 72nd session 2018, 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 CO_2 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.

Sweden also actively promotes the use of alternative fuels, such as LNG and methanol, as well as related infrastructure. Using LNG also means a low NOx level in the flue gases, and very low sulphur and particulate emissions. The drawback of LNG as a fuel is that it emits a certain amount of methane and CO_2 into the atmosphere. This issue needs to be addressed. In 2015, IMO adopted a regulatory framework for ship operations using gas or other alternative marine fuels with a low flash point, the so-called IGF Code. Sweden is now working to include methanol in this code as another possible marine fuel.

Furthermore, many Swedish ports have invested in infrastructure allowing ships to use shore-side electricity, considerably reducing their emissions. The Port of Stockholm has even 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.

Global warming is driven not only by carbon dioxide, methane and other greenhouse gases. Another pollutant influencing climate, and also having considerable impact on the Arctic environment, is black carbon. The impacts of 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 proposing to set this issue on the IMO agenda and now works actively to identify possible reduction measures.

3.2.13. Efforts to avoid adverse effects of policies and measures introduced as part of the country's climate strategy

Parties under the UN Framework Convention of Climate Change should strive to implement policies and measures in such a way as to minimise adverse effects. These include the adverse effects of climate change, effects on international trade, and the social, environmental and economic impact on other parties, especially developing countries. Sweden has not made any changes since the sixth National Communication on climate change in the work to avoid adverse effects of policies and measures introduced as part of the country's climate strategy.

Under Sweden's policy for global development (PGD), all policy areas should interact in a coherent way, so the country can make an effective contribution to equitable and sustainable global development. When decisions in a given policy area are judged to affect this goal of equitable and sustainable global development, an impact assessment must be carried out. The policy's two perspectives – a rights perspective and the perspective of poor people on development – should serve as a guide. In the framework of the PGD, for example, coordination and collaboration take place through a reference group on trade policy at the Ministry for Foreign Affairs. Regular meetings of this group, which includes representatives of business, the Swedish International Development Cooperation Agency (Sida) and civil society organisations have created a basis for broad consultation on trade policy.

In connection with decision making on policies and measures in Sweden and at the EU level, impact assessments are carried out, including environmental

impact assessments. To the extent possible, such assessments include an appraisal of the risk of adverse effects on other countries. Both beneficial and adverse effects need to be taken into account. Sweden is helping to implement a range of measures that could improve the ability of developing countries to adapt to climate change and take action of their own to reduce their greenhouse gas emissions. Finally, Sweden has designed a broad-ranging climate strategy that encompasses many different types of measures and most sectors, both inside and outside the country. This, combined with all the greenhouse gases regulated by the Kyoto Protocol, represents a fundamental effort to minimise the risk of adverse effects.

3.3. Summary of policies and measures

Table 3.2 **Summary of policies and measures.**

Name of policy/measure	Primary objective	Greenhouse gas(es) primarily affected	Type of instrument	Status of instrument	Implementing agency	Estimate of mitigation impact in Mt CO_2-eq per year compared with 1990 instruments			
						2010	2015	2020	2030
Cross-sectoral									
Local climate investment program (Climate Leap)	Enhance and speed up reduction of greenhouse gas emissions	All	Economic	Ongoing (2015–	Swedish Environmental Protection Agency	N.E.	N.E.	N.E.	N.E.
Planning and Building Act	Promote sustainable development of society	All	Legislation	Ongoing (2011-	Swedish National Board of Housing, Building and Planning	N.E.	N.E.	N.E	N.E.
Fossilfree Sweden initiative	Strengthen dialogue with key actors to mitigate climate change	Carbon dioxide	Information	Ongoing (2015-	A national coordinator appointed by the government	N:E.	N:E.	N.E.	N.E.
Climate change communication	Greater awareness of climate change and possible measures	All	Information	Ongoing (1990-	Swedish Environmental Protection Agency, Swedish Meteorological and Hydrological Institution, Swedish Energy Agency, Swedish Forest Agency, the Swedish Board of Agriculture, The Swedish Contingencies Agency	N.E.	N.E.	N.E.	N.E.
Research and development	Development of technology with very low climate impact	All	Economic	Ongoing (1990-	Swedish Energy Agency (mainly)	N.E.	N.E.	N.E.	N.E.

Name of policy/measure	Primary objective	Greenhouse gas(es) primarily affected	Type of instrument	Status of instrument	Implementing agency	Estimate of mitigation impact in Mt CO_2-eq per year compared with 1990 instruments			
						2010	2015	2020	2030
Energy - production of electricity and district heating									
Energy tax	Fiscal, and to improve efficiency of energy use	Carbon dioxide	Economic	Ongoing (1957-	Swedish Tax Agency	14	18	19	14
Carbon tax	Reduce use of fossil fuels	Carbon dioxide	Economic	Ongoing (1991-	Swedish Tax Agency				
Electricity certificates system	Increase supply of electricity from renewable energy sources	Carbon dioxide	Economic	Ongoing (2003-	Swedish Energy Agency				
EU Emissions Trading System (EU ETS)	Reduce use of fossil fuels in trading sector	Carbon dioxide	Economic	Ongoing (2005-	Swedish Environmental Protection Agency and Swedish Energy Agency				
Initiatives for wind power	Increase supply of electricity from renewable energy sources	Carbon dioxide	Simplifying rules and information	Ongoing	Swedish Energy Agency	N.E	N.E	N.E	N.E
Support for solar power	Increase supply of electricity from renewable energy sources	Carbon dioxide	Economic	Ongoing (2009-	Swedish Energy Agency	N.E	N.E	N.E	N.E
Tax reduction for micro production of renewable energy	Increase micro production of renewable energy	Carbon dioxide	Economic	Ongoing (2015-	Swedish Tax Agency	N.E	N.E	N.E	N.E

Name of policy/measure	Primary objective	Greenhouse gas(es) primarily affected	Type of instrument	Status of instrument	Implementing agency	Estimate of mitigation impact in Mt-CO_2 eq per year compared with 1990 instruments			
						2010	2015	2020	2030
Residential and commercial/institutional sector									
Energy tax	Fiscal, and to improve efficiency of energy use	Carbon dioxide	Economic	Ongoing (1957-	Swedish Tax Agency	1.3	1.4	0.4	0.4
Carbon tax	Reduce use of fossil fuels	Carbon dioxide	Economic	Ongoing (1991-	Swedish Tax Agency				
Mandatory energy labelling	More efficient energy use	Carbon dioxide	Information	Ongoing (1995-	Swedish Energy Agency				
Ecodesign Directive	More efficient energy use	Carbon dioxide	Legislation	Ongoing (2010-	Swedish Energy Agency				
Law on energy performance certificates for buildings	More efficient energy use	Carbon dioxide	Legislation and information	Ongoing (2009-	Swedish National Board of Housing, Building and Planning				
Building regulations	More efficient energy use	Carbon dioxide	Legislation	Ongoing	Swedish National Board of Housing, Building and Planning				
Support for renovation and energy efficiency of rental apartments	More efficient energy use	Carbon dioxide	Economic	Expired (2016-2018)	Swedish Energy Agency	N.E	N.E	N.E	N.E
Training programs in building for low energy consumption	More efficient energy use	Carbon dioxide	Information	Ongoing (2016-	Swedish Energy Agency	N.E	N.E	N.E	N.E
Technology procurement	More efficient energy use and increased use of renewable energy	Carbon dioxide	Economic	Ongoing	Swedish Energy Agency	N.E	N.E	N.E	N.E

Name of policy/measure	Primary objective	Greenhouse gas(es) primarily affected	Type of instrument	Status of instrument	Implementing agency	Estimate of mitigation impact in Mt CO_2-eq per year compared with 1990 instruments			
						2010	2015	2020	2030
Industrial emissions from combustion and processes									
Energy tax	Fiscal, and to improve efficiency of energy use	Carbon dioxide	Economic	Ongoing (1957-	Swedish Tax Agency	-0.8	-0.5	-0.4	-0.1
Carbon tax	Reduce use of fossil fuels	Carbon dioxide	Economic	Ongoing (1991-	Swedish Tax Agency				
EU Emissions Trading System (EU ETS)	Reduce use of fossil fuels in trading sector	Carbon dioxide	Economic	Ongoing (2005-	Swedish Environmental Protection Agency and Swedish Energy Agency				
Industrial leap	Reduce emissions of carbon dioxide from processes in industry	Carbon dioxide	Economic	Ongoing (2018-	Swedish Energy Agency	N.E.	N.E.	N.E.	N.E.
Energy audit for large enterprises	More efficient energy use	Carbon dioxide	Legislation and information	Ongoing (2014-	Swedish Energy Agency	N.E.	N.E.	N.E.	N.E.
Energy step	More efficient energy use	Carbon dioxide	Economic	Ongoing (2018-	Swedish Energy Agency	N.E.	N.E.	N.E.	N.E.
Grants for energy audit to small and medium-sized enterprises	More efficient energy use	Carbon dioxide	Economic and information	Ongoing (2010-)	Swedish Energy Agency	N.E.	N.E.	N.E.	N.E.
Energy and climate coaches for small and medium-sized enterprises	More efficient energy use and reduction of greenhouse gases	Carbon dioxide	Information	Ongoing (2016-2020)	Swedish Energy Agency	N.E.	N.E.	N.E.	N.E.
Energy efficiency networks for small and medium-sized enterprises	More efficient energy use	Carbon dioxide	Information	Ongoing (2015-	Swedish Energy Agency	N.E.	N.E.	N.E.	N.E.
Environmental Code	Ecologically sustainable development	All	Legislation	Ongoing (1999-	Swedish Environmental Protection Agency	N.E.	N.E.	N.E.	N.E.

Name of policy/measure	Primary objective	Greenhouse gas(es) primarily affected	Type of instrument	Status of instrument	Implementing agency	Estimate of mitigation impact in Mt CO_2-eq per year compared with 1990 instruments			
						2010	2015	2020	2030
Product use									
EU regulation on fluorinated greenhouse gases and BREF	Reduce use of HFCs	HFCs	Legislation	Ongoing (new directive 2015-)	Swedish Environmental Protection Agency	0.2	0.5	0.7	N.E.
Swedish regulation on fluorinated gases	Reduce use of HFCs and ozone depleting substances	HFCs	Legislation	Ongoing	Swedish Environmental Protection Agency				
Transport									
Energy tax	Fiscal, and to improve efficiency of energy use	Carbon dioxide	Economic	Ongoing (1924-	Swedish Tax Agency	2	2	2.3	N.E
Carbon tax	Reduce use of fossil fuels	Carbon dioxide	Economic	Ongoing (1991-	Swedish Tax Agency				
Emission performance standards for new vehicles	Reduce carbon dioxide emissions	Carbon dioxide	Legislation	Ongoing (2015-)	Swedish Transport Administration	0.4	1.3	N.E.	N.E.
Differentiated vehicle tax	Reduce carbon dioxide emissions	Carbon dioxide	Economic	Ongoing (2006-	Swedish Tax Agency			N.E.	N.E.
Super-green car rebate	Reduce carbon dioxide emissions	Carbon dioxide	Economic	Expired (2012-2018)	Swedish Transport Agency			N.E.	N.E.
Tax exemption for environmentally friendly vehicles	Reduce carbon dioxide emissions	Carbon dioxide	Economic	Expired (2010-2018)	Swedish Tax Agency			N.E.	N.E.
Lower benefit value on cars with advanced environmental technology	Reduce carbon dioxide emissions	Carbon dioxide	Economic	Ongoing (1990-	Swedish Tax Agency			N.E.	N.E.

Emission reduction obligation (Fuel change)	Reduce carbon dioxide emissions	Carbon dioxide	Legislation	Ongoing (2018-		N.E.	N.E.		
Requirements for renewable fuels at filling stations	Reduce carbon dioxide emissions	Carbon dioxide	Legislation	Ongoing (2006-	Swedish Transport Agency	N.E.	N.E.	N.E.	N.E.
Bonus-malus-system for new light vehicles	Reduce carbon dioxide emissions	Carbon dioxide	Economic	Ongoing (2018-	Swedish Tax Agency	N.E.	N.E.		
Local climate investment program (Climate leap)	Enhance and speed up reduction of greenhouse gas emissions	All	Economic	Ongoing (2015-	Swedish Environmental Protection Agency	N.E.	N.E.	N.E.	N.E.
Electric vehicle premium	Reduce carbon dioxide emissions	Carbon dioxide	Economic	Expired (2018-2018)	Swedish Environmental Protection Agency	N.E.	N.E.	N.E.	N.E.
Charge at home grant	Reduce carbon dioxide emissions	Carbon dioxide	Economic	Expired (2018-	Swedish Environmental Protection Agency	N.E.	N.E.	N.E.	N.E.
Urban environment agreements	Reduce carbon dioxide emissions and incentivise building of public transport	Carbon dioxide	Economic	Ongoing (2015-	Swedish Transport Administration	N.E	N.E	N.E	N.E
Electrical bus premium	Reduce carbon dioxide emissions and other air pollutants	Carbon dioxide	Economic	Ongoing (2016-2019)	Swedish Energy Agency	N.E	N.E	N.E	N.E
Climate premiums for electrical buses, heavy-duty vehicles and working machinery[26]	Reduce carbon dioxide emissions and other air pollutants	Carbon dioxide	Economic	Planned (2020-	Swedish Energy Agency	N.E	N.E	N.E	N.E
Eco-bonus system for heavy transport	Reduce carbon dioxide emissions	Carbon dioxide	Economic	Ongoing (2018-)	Swedish Transport Administration	N.E.	N.E.	N.E.	N.E.
Congestion tax	Limit traffic congestion, reduce carbon dioxide emissions and other air pollutants	Carbon dioxide	Economic	Ongoing	Swedish Tax Agency	N.E.	N.E.	N.E.	N.E.
Low emission zone (LEZ)	Reduce carbon dioxide emissions and	Carbon dioxide	Legislation	Ongoing	Eight municipalities	N.E.	N.E.	N.E.	N.E.

[26] Not included in the projections of greenhouse gas emissions reviewed in chapter 4.

	other air pollutants								
Support for research and demonstration	Develop technology for sustainable growth and reduced fossil fuel dependence	Carbon dioxide	Economic	Ongoing	Vinnova and Swedish Energy Agency (mainly)	N.E	N.E	N.E	N.E
Tax on air travel	Reduce climate impact	Carbon dioxide	Economic	Ongoing (2018-	Swedish Tax Agency	N.E.	N.E.	N.E.	N.E.
Aviation in the EU ETS	Reduce carbon dioxide emissions	Carbon dioxide	Economic	Ongoing (2012-	Swedish Environmental Protection Agency	N.E.	N.E.	N.E.	N.E.

Waste

Landfill tax	Increase recycling	Methane	Economic	Ongoing (2000-	Swedish Tax Agency	1,4	1,7	1,9	N.E.
Ban on landfilling combustible and organic materials and regulation for methane collection	Improved landfill management, enhanced recycling, improved wastewater management systems	Methane	Legislation	Ongoing (2002-	Swedish Environmental Protection Agency				
Extended producer responsibility	Increase resource efficiency	Carbon dioxide	Legislation	Ongoing (1994-	Swedish Environmental Protection Agency				
Municipal waste planning requirement	Increase resource efficiency	Methane, Carbon dioxide	Legislation	Ongoing (1991-	Swedish Environmental Protection Agency				

Agriculture

Measures under the Rural Development Program	Reduced Climate Impact, a varied agricultural landscape and zero eutrophication	Nitrous oxide, methane and Carbon dioxide	Economic	Ongoing (2014-2020)	Swedish Board of Agriculture	N.E.	N.E.	N.E.	N.E.
Support for biogas production	Reducing emissions of greenhouse gases and production of biogas for	Methane	Economic	Ongoing (2015-	Swedish Board of Agriculture	N.E.	N.E.	N.E.	N.E.

	energy purposes								
The rural network	Reinforce implementation of the Rural Development Program	Nitrous oxide, methane and Carbon dioxide	Information	Ongoing (2007-	Swedish Board of Agriculture	N.E.	N.E	N.E	N.E

Land use, land use change and forestry (LULUCF)

Provisions of Forestry Act	Achieve environmental and production objectives for sustainable forest management	Carbon dioxide	Legislation	Ongoing	Swedish Forest Agency	N.E	N.E	N.E	N.E
Provisions of Envionmental Code including land drainage	Biodiversity	Carbon dioxide and methane	Legislation	Ongoing	County administrative boards	N.E	N.E	N.E	N.E
Provisions on nature reserves and habitat protection areas in Environmental Code, and nature conservation agreements	Biodiversity	Carbon dioxide	Legislation	Ongoing	Swedish Environmental Protection Agency and county administrative boards	N.E	N.E	N.E	N.E
Swedish National Forest Program	Increase the national supply of bio-based materials and energy	Carbon dioxide	Information	Ongoing	Swedish Forest Agency	N.E	N.E	N.E	N.E

3.4. Progress to quantified economy-wide emission reduction target

This section presents the estimates of emission reductions and removals and the use of units from market-based mechanisms and land use, land-use change and forestry (LULUCF) activities.

For quantification of progress towards the 2020 targets, the change in greenhouse gas emissions is a key indicator. The Convention target for a reduction of emissions of 20 % from 1990 to 2020 refers only to emissions of the EU-28 as a whole. Greenhouse gas emissions of the EU-28 are calculated as the sum of all member states' emissions. The Swedish

greenhouse gas emissions constitute 1.2 % of the entire EU-28 emissions when measured for the year 2017 (submission 2019).

The development of greenhouse gas emissions is reported in CTF Table 4 for Sweden. Emissions in the LULUCF sector are not included under the convention target, and therefore Sweden reports NA in the CTF Tables 4 and 4(a).

Use of flexible mechanisms takes place by operators in the EU Emissions Trading System (ETS) on the one hand, and by governments on the other hand to achieve the Effort Sharing Decision (ESD) target. More information on use in the ETS is contained in the fourth Biennial Report of the European Union.

The compliance assessment under the ESD[27] for the years 2013, 2014, 2015 and 2016 took place in 2016, 2017 and 2018. Sweden did not need to use any units for the compliance since Sweden overachieved on our commitment. In CTF Table 4b Sweden report NE.

For the moment, Sweden does not foresee any need to make use of flexible mechanisms under the ESD.

[27] Decision No 406/2009/EC

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4. Projections

This section presents projections of greenhouse gas emissions and removals for various sectors and in total. The information conforms to that submitted in Sweden's report to the EU[28] in accordance with the requirements of the EU decision on monitoring of greenhouse gases[29]. Projections with existing measures are based on policies and measures currently adopted by the EU and the Swedish Parliament up to June 2018.

Model-based calculations and, to some extent, expert evaluations were used to produce the projections. The projections are based on a number of assumptions, all of which are characterised by uncertainty. This should be taken into account when interpreting the results. The projections can be mainly regarded as a consequential analysis of the assumptions made. The method for estimating the projections was mainly developed for medium-term or long-term projections, so the projections do not take account of shorter-term variations.

In addition to projections with existing measures, sensitivity projections have been calculated for emissions in the energy sector and for the road transportation sector. Projections with additional measures are not provided since there were no planned measures in Sweden when producing the projections. However, policies and measures are continuously developed, and new measures have been planned since the scenarios were produced, see chapter 3.

4.1. Key parameters and assumptions

The key parameters and assumptions used in these projections are shown below. For more details see Annex B.

[28] Ministry of the Environment, 2019

[29] Regulation EU No 525/2013

	2013-2035
GDP	2.05
	2035
Crude oil price (USD/barrel)	126
Price of coal (USD/tonne)	131
Price of natural gas (USD/Mbtu)	13
Emissions trading (Euro/tonne CO_2)	43.5
Electricity certificates (TWh new renewable electricity)	28.4
Electricity price (SEK/kWh)	0.44

4.2. Greenhouse gas emission projections

Total greenhouse gas emissions in Sweden in 2017[30] were 52.7 Mt CO_2-eq. (excluding The Land Use, Land Use Change and Forestry sector). Total emissions decreased by 18.6 million tonnes, or 26 %, between 1990 and 2017. The projection results point to a gradual decline in total emissions of greenhouse gases (excl. LULUCF) over the projection period. Projected emissions for 2020 are 30 % below 1990 levels, and by 2030 total emissions are projected to be 35 % below 1990 levels. See Table 4.1 and Figure 4.1.

The LULUCF sector contributed to an annual net removal of carbon dioxide in Sweden during the period 1990–2017 and is expected to continue to do so during the projection period.

[30] National Inventory Report Sweden, Submission 2019

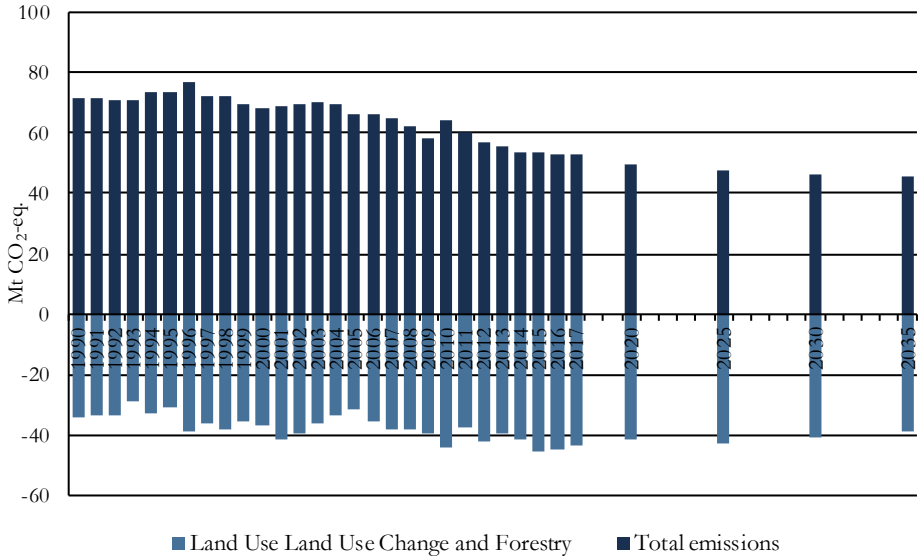

Figure 4.1 **Historical emissions of greenhouse gases and projected emissions and removals of greenhouse gases.**

Table 4.1 **Historical and projected emissions and removals of greenhouse gases by sector (Mt CO_2-eq.)**

	1990	2017	2020	2025	2030	2035	1990-2020	1990-2030
Energy exd. transport	33.3	20.1	19.5	18.9	18.5	18.4	-41%	-44%
Transport	19.0	16.6	14.8	13.9	13.4	13.2	-22%	-30%
Industrial processes and product use	7.6	7.6	7.7	7.5	7.3	7.2	1%	-4%
Agriculture	7.7	7.2	6.7	6.4	6.2	6.1	-13%	-19%
Waste	3.7	1.3	1.1	0.9	0.7	0.6	-72%	-81%
Total emissions	**71.3**	**52.7**	**49.7**	**47.7**	**46.1**	**45.6**	**-30%**	**-35%**
LULUCF	-34.4	-43.7	-41.4	-42.5	-40.6	-39.0	20%	18%

4.3. Projections by gas

In 2017, carbon dioxide emissions accounted for 80 % of greenhouse gas emissions, while methane emissions accounted for just over 9 %, nitrous oxide for almost 9 % and fluorinated greenhouse gases for almost 2 %. Between 2017 and 2035, emissions of all gases are projected to decrease. The

mix of greenhouse gases is expected to change over the projection period, with a slight increase in carbon dioxide's share of the total. See Table 4.2.

Table 4.2 **Historical and projected emissions of greenhouse gases per gas (Mt CO_2-eq.)**

	1990	2017	2020	2025	2030	2035	1990-2020	1990-2030
Carbon dioxide	57.4	42.1	40.0	38.6	37.7	37.4	-30%	-34%
Methane	7.4	4.5	4.1	3.7	3.4	3.3	-45%	-54%
Nitrous oxide	5.8	4.9	4.6	4.5	4.5	4.4	-20%	-23%
HFC	0.006	1.1	1.0	0.8	0.5	0.3	15237%	7659%
PFC	0.6	0.04	0.05	0.05	0.05	0.05	-92%	-92%
SF_6	0.1	0.05	0.04	0.04	0.04	0.03	-62%	-63%
Total emissions (exd. LULUCF)	**71.3**	**52.7**	**49.7**	**47.7**	**46.1**	**45.6**	**-30%**	**-35%**

4.4. Projections by sector

The projected trend in emissions differs between sectors. Over the projection period, emissions from transport, industrial processes and product use, agriculture and waste are expected to decrease to 2035, see Figure 4.2.

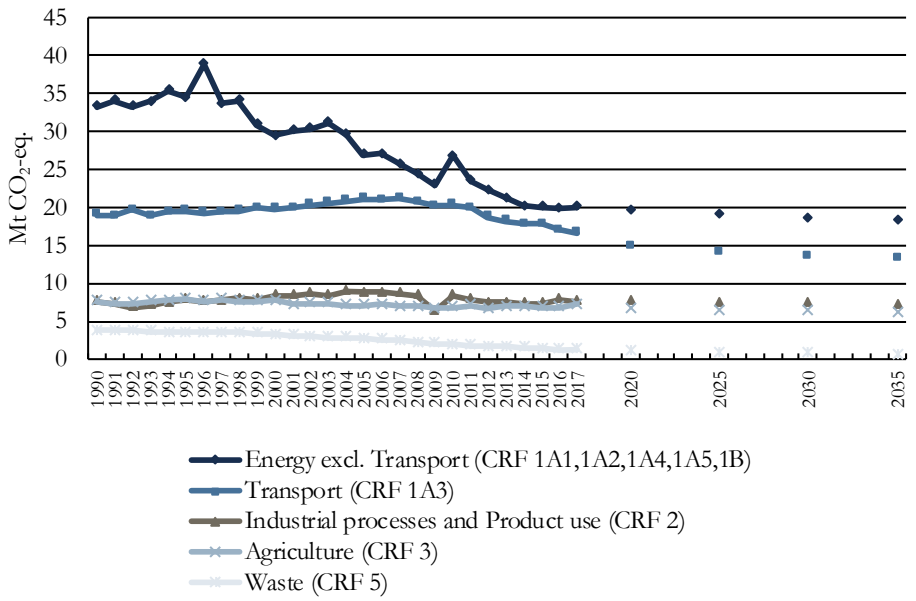

Figure 4.2 **Historical and projected emissions of greenhouse gases by sector.**

4.4.1. Energy industries (Electricity and heat production, Refineries, Manufacturing of solid fuels)

Emissions from energy industries, i.e. production of electricity and district heating, refineries and the manufacturing of solid fuels, are projected to decrease slightly to 2035. However, projections for subsectors show differing trends.

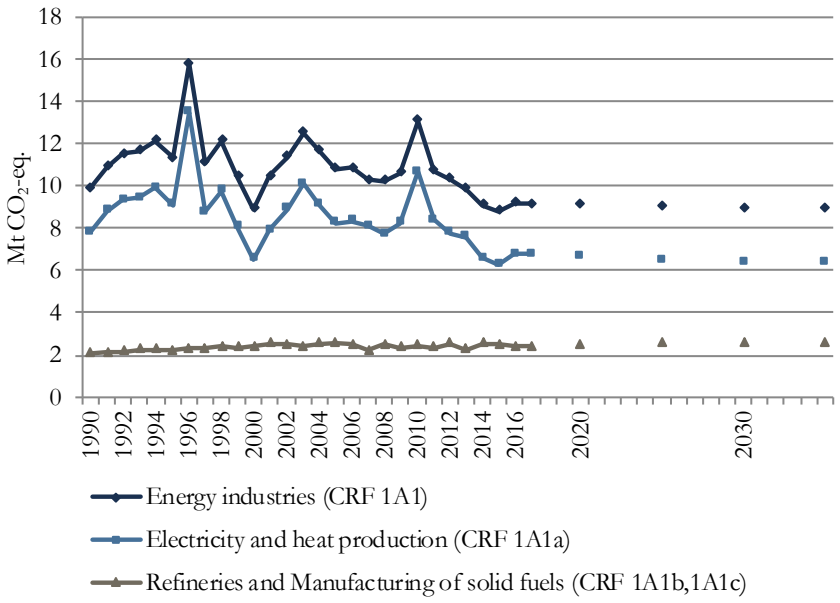

Figure 4.3 **Historical and projected emissions of greenhouse gases from energy industries.**

Emissions of greenhouse gases from electricity and heat production have varied since 1990, mainly due to temperature variations and precipitation. The production of electricity and heat is expected to increase during the projection period. However, emissions do not increase to the same extent as production, mainly due to a simultaneous increased production of electricity and heat from renewable sources such as biomass, waste and wind power. Emissions are projected to decrease to 2030 and then stabilize, see Table 4.3 and Figure 4.3. An increased use of waste contributes to the increase in emissions, but this increase is partly offset by increased use of biomass and wind power, as well as decreased use of oil and coal. The use of biomass increases in combined heat and power plants especially, which is promoted by the electricity certificate system and the EU ETS as well as the carbon tax on heat production. Production of electricity is assumed to grow more than consumption, resulting in a projected export of about 30 TWh by 2030.

Table 4.3 **Historical and projected emissions of greenhouse gases from electricity and heat production (Mt CO_2-eq.)**

	1990	2017	2020	2025	2030	2035	1990-2020	1990-2030
Carbon dioxide	7.7	6.5	6.4	6.2	6.1	6.1	-17%	-21%
Methane	0.02	0.05	0.05	0.05	0.05	0.05	203%	206%
Nitrous oxide	0.1	0.2	0.2	0.2	0.2	0.2	70%	74%
Total emissions	**7.8**	**6.8**	**6.6**	**6.5**	**6.4**	**6.4**	**-16%**	**-19%**

Emissions from refineries and manufacturing of solid fuels are projected to continue increasing slightly during the projection period, see Table 4.4 and Figure 4.3. The increase is due to increased production. This increase in production is due to a shift to products that meet higher quality standards in refineries. Emissions from refineries are also reported in the sector of fugitive emissions.

Table 4.4 **Historical and projected emissions of greenhouse gases from refineries and manufacturing of solid fuels (Mt CO_2-eq.)**

	1990	2017	2020	2025	2030	2035	1990-2020	1990-2030
Carbon dioxide	2.1	2.4	2.5	2.5	2.6	2.6	19%	24%
Methane	0.001	0.001	0.001	0.001	0.001	0.001	2%	7%
Nitrous oxide	0.001	0.001	0.001	0.001	0.001	0.001	-16%	-12%
Total emissions	**2.1**	**2.4**	**2.5**	**2.5**	**2.6**	**2.6**	**19%**	**24%**

4.4.2. Residential and commercial/institutional

Emissions from households and premises and from combustion in the agricultural, forestry and fishing sectors are projected to continue to decrease, see Table 4.5 and Figure 4.4. This decline is mainly due to a continuing 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. The shift to electric and district heating results in decreased emissions in this sector. However, since the increased production of electricity and heat is mainly based on wind power, biomass and waste, and with district heating being a more efficient way of heating, emissions on the whole still decrease.

Total emissions from combustion in the agricultural, forestry and fishing sectors are projected to decrease during the projection period. Emissions from energy consumption in the agricultural sector are expected to decrease to some extent during the projection period, due to a reduction in the use of diesel fuel for working machinery and a reduction in oil consumption for buildings. Emissions from working machinery in the forestry sector and from fishing are assumed to remain at about the same level as in 2017 during the entire projection period.

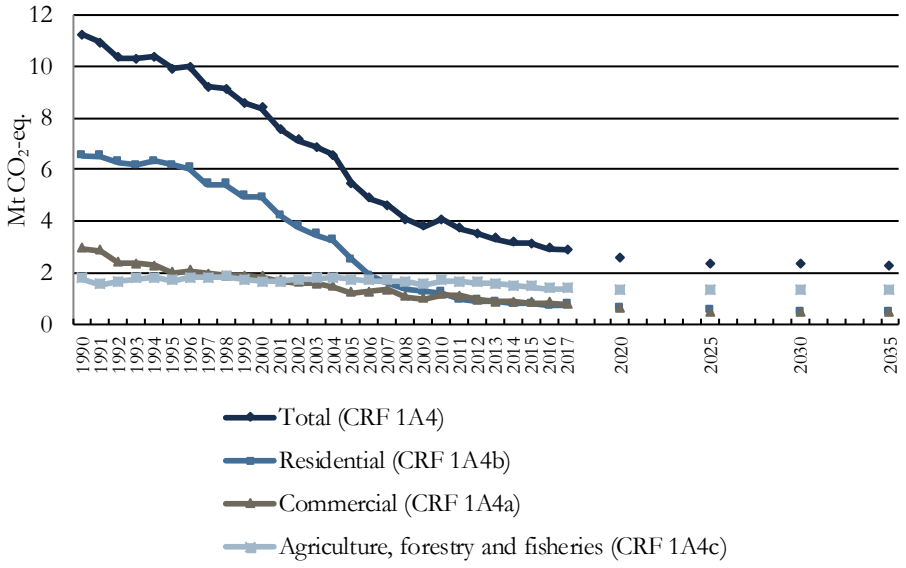

Figure 4.4 **Historical and projected emissions of greenhouse gases from combustion in households, premises, agriculture, forestry and fisheries.**

Table 4.5 **Historical and projected emissions of greenhouse gases from residential and commercial sectors (Mt CO_2-eq.)**

	1990	2017	2020	2025	2030	2035	1990-2020	1990-2030
Carbon dioxide	11.0	2.7	2.4	2.2	2.1	2.1	-79%	-81%
Methane	0.1	0.1	0.1	0.1	0.1	0.1	1%	-5%
Nitrous oxide	0.2	0.1	0.1	0.1	0.1	0.1	-34%	-35%
Total emissions	**11.3**	**2.9**	**2.6**	**2.4**	**2.3**	**2.3**	**-77%**	**-79%**

4.4.3. Industrial combustion

To cover all industry-related emissions, it is necessary to take account of process emissions, emissions from combustion, part of energy industries and fugitive emissions, which according to UNFCCC guidelines are to be reported under separate CRF (Common Reporting Format) categories.

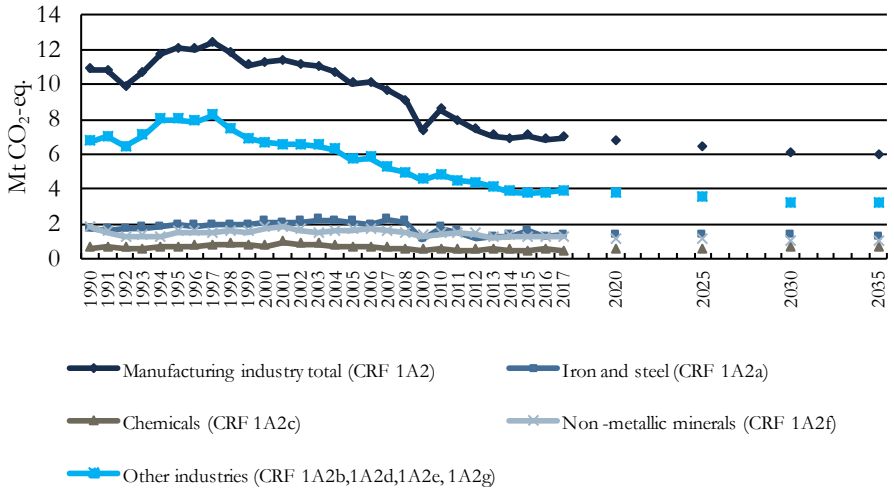

Figure 4.5 **Historical and projected emissions of greenhouse gases from combustion in manufacturing industries.**

Emissions from combustion in manufacturing industries are projected to decrease to 2035, because the use of biofuel and electricity is expected to increase more than the use of fossil fuels, see Table 4.6 and Figure 4.5. This decrease in emissions is mainly due to a shift in the pulp and paper industry from using fossil fuels to using biofuels. Emissions from the mineral industry are also expected to decrease, while emissions from the chemical industry and the iron and steel industry remain relatively stable in the projection.

Table 4.6 **Historical and projected emissions of greenhouse gases from combustion in manufacturing industries (Mt CO_2-eq.)**

	1990	2017	2020	2025	2030	2035	1990-2020	1990-2030
Carbon dioxide	10.7	6.8	6.6	6.2	5.9	5.8	-39%	-45%
Methane	0.02	0.02	0.03	0.03	0.03	0.03	4%	6%
Nitrous oxide	0.1	0.1	0.1	0.1	0.1	0.1	4%	2%
Total emissions	**10.9**	**6.9**	**6.7**	**6.4**	**6.1**	**6.0**	**-38%**	**-44%**

4.4.4. Fugitive emissions

The majority of fugitive emissions originate from refineries. Emissions are assumed to remain at the same level as in recent years to 2035, see Table 4.7.

Table 4.7 **Historical and projected emissions of greenhouse gases from fugitive emissions (Mt CO_2-eq.)**

	1990	2017	2020	2025	2030	2035	1990-2020	1990-2030
Carbon dioxide	0.3	0.8	0.9	0.9	1.0	1.0	202 %	219 %
Methane	0.1	0.06	0.06	0.06	0.06	0.06	-33%	-33%
Nitrous oxide	0.001	0.001	0.001	0.001	0.001	0.001	22%	22%
Total emissions	**0.4**	**0.9**	**0.9**	**1.0**	**1.0**	**1.0**	**145%**	**157%**

4.4.5. Industrial processes and product use

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

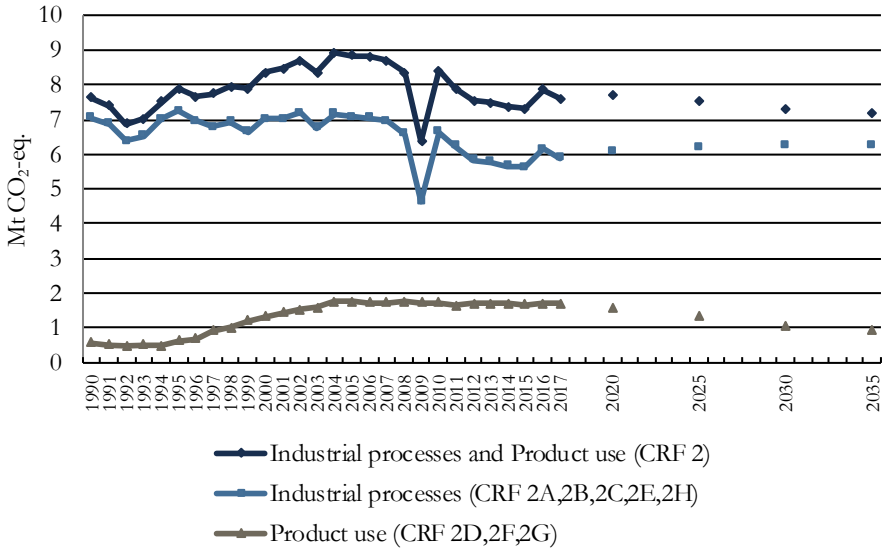

Figure 4.6 **Historical and projected emissions of greenhouse gases from industrial processes and product use.**

Greenhouse gas emissions from industrial processes and product use are projected to decrease slightly to 2035, see Table 4.8 and Figure 4.6. This

decrease is caused by a decrease in emissions of fluorinated greenhouse gases.

Carbon dioxide emissions are expected to increase slightly to 2035. This increase is mainly due to increased production in the mineral industry. Emissions from the mineral industry are expected to increase due to a projected increase in construction of new buildings. Iron and steel production is expected to increase slightly, leading to an increase in total greenhouse gas emissions compared to 2017. However, emissions are expected to be lower in 2030 compared to 1990 levels.

Emissions of fluorinated greenhouse gases are expected to decrease to 2035 due to a ban on their use that resulted from EU regulations.

Table 4.8 **Historical and projected emissions of greenhouse gases from industrial processes and product use sector (Mt CO_2-eq.)**

	1990	2017	2020	2025	2030	2035	1990-2020	1990-2030
Carbon dioxide	6.0	6.1	6.4	6.5	6.5	6.5	7%	9%
Methane	0.03	0.01	0.01	0.01	0.01	0.01	-65%	-63%
Nitrous oxide	1.0	0.2	0.2	0.2	0.2	0.2	-77%	-77%
Fluorinated greenhouse gases	0.7	1.2	1.1	0.8	0.6	0.4	59%	-13%
Total emissions	**7.6**	**7.6**	**7.7**	**7.5**	**7.3**	**7.2**	**1%**	**-4%**

4.4.6. Transport

Emissions from domestic transport, especially from road transport, are projected to decrease to 2035 for several reasons, see Table 4.9, Table 4.10 and Figure 4.7. For example, an assumed continuous improvement in the energy efficiency of the vehicle fleet due to EU CO_2 requirements that limit emissions from new cars and light-duty vehicles. In the projection, emission requirements are 95 and 147 grams of carbon dioxide per kilometre, respectively, for passenger cars and light-duty vehicles in 2021. After 2021, the energy efficiency of new vehicles continues to increase, but at a slower rate. Energy efficiency is expected to be improved due to fewer petrol cars. Another reason for the decrease is a greater use of biofuels. In particular, the low-blend of biofuels in diesel increases compared to the 2017 level in the projection.

Emissions from domestic aviation have decreased in recent years, mostly due to higher efficiency. In the projection, travel is assumed to increase from

today's level over the entire projection period, resulting in increasing emissions. Emissions from domestic navigation have varied between 0.3 and 0.7 Mt CO_2-eq. Emissions are assumed to be around 0.3 million tonnes between 2020 and 2035. Emissions from railways are projected to decrease during the projection period.

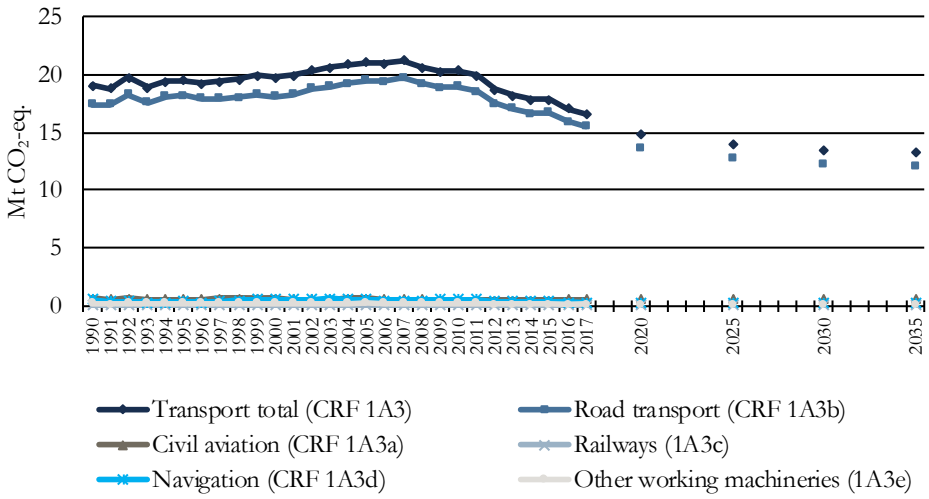

Figure 4.7 **Historical and projected emissions of greenhouse gases from the domestic transport sector.**

Table 4.9 **Historical and projected emissions of greenhouse gases from different domestic transport modes (Mt CO_2-eq.)**

	1990	2017	2020	2025	2030	2035	1990-2020	1990-2035
Road transportation	17.4	15.5	13.7	12.8	12.2	12.0	-22%	-30%
Civil aviation	0.7	0.6	0.6	0.6	0.7	0.7	-16%	-5%
Navigation	0.6	0.3	0.3	0.3	0.3	0.3	-43%	-43%
Railways	0.1	0.04	0.04	0.04	0.04	0.04	-59%	-63%
Other*	0.2	0.2	0.2	0.2	0.2	0.2	-21%	-21%

*includes mobile machinery not used in industry, agriculture, forestry, fisheries or residential/commercial

Table 4.10 **Historical and projected emissions of greenhouse gases from domestic transport (Mt CO_2-eq.)**

	1990	2017	2020	2025	2030	2035	1990-2020	1990-2035
Carbon dioxide	18.7	16.4	14.6	13.7	13.2	13.0	-22%	-29%
Methane	0.2	0.02	0.02	0.01	0.01	0.01	-89%	-91%
Nitrous oxide	0.2	0.2	0.1	0.2	0.2	0.2	-19%	-8%
Total emissions	**19.0**	**16.6**	**14.8**	**13.9**	**13.4**	**13.2**	**-22%**	**-30%**

Emissions from the CRF sector 'Other' (mainly emissions from military transport) are expected to remain at around the same level as in recent years during the entire projection period, see Table 4.11.

Table 4.11 **Historical and projected emissions of greenhouse gases from Other (Mt CO_2-eq.)**

	1990	2017	2020	2025	2030	2035	1990-2020	1990-2030
Carbon dioxide	0.8	0.2	0.2	0.2	0.2	0.2	-79%	-79%
Methane	0.001	0.00004	0.00004	0.00004	0.00004	0.00004	-96%	-96%
Nitrous oxide	0.02	0.003	0.003	0.003	0.003	0.003	-84%	-84%
Total emissions	**0.9**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**-79%**	**-79%**

4.4.7. Waste

Methane emissions from landfill are projected to decrease by 91 % to 2030 compared to 1990, see Table 4.12 and Figure 4.8. This decrease is mainly due to a ban, from 2002, on depositing combustible materials in landfills and a ban, from 2005, on depositing organic materials in landfill. Furthermore, a tax on depositing waste in landfill was introduced in 2000.

Emissions of carbon dioxide from waste incineration and nitrous oxide from wastewater treatment 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 are expected to increase slightly during the period, due to increased production of biogas.

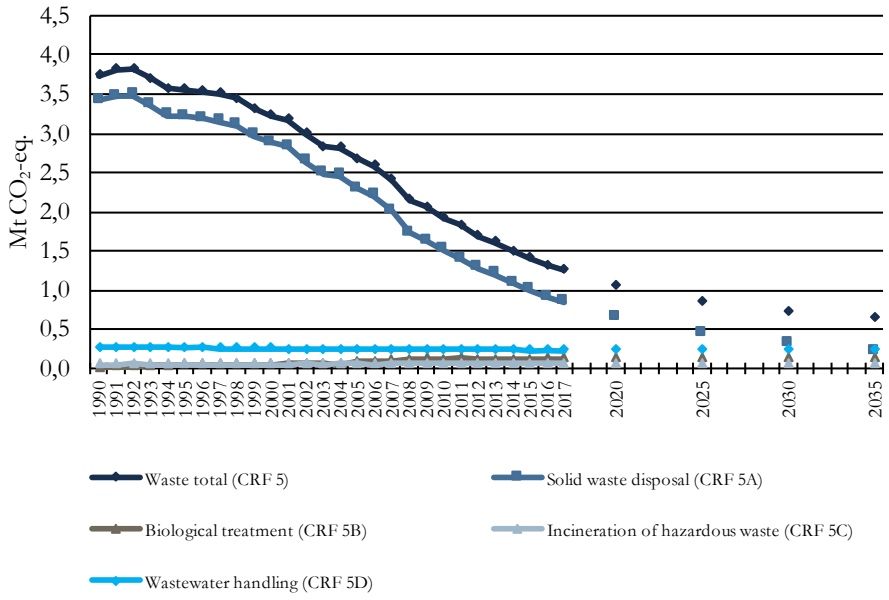

Figure 4.8 **Historical and projected emissions of greenhouse gases from the waste sector.**

Table 4.12 **Historical and projected emissions of greenhouse gases from the waste sector (Mt CO_2-eq.)**

	1990	2017	2020	2025	2030	2035	1990-2020	1990-2030
Carbon dioxide	0.04	0.06	0.06	0.06	0.06	0.06	28%	28%
Methane	3.5	1.0	0.8	0.6	0.4	0.3	-78%	-88%
Nitrous oxide	0.2	0.2	0.2	0.2	0.2	0.2	3%	3%
Total	**3.7**	**1.3**	**1.1**	**0.9**	**0.7**	**0.6**	**-72%**	**-81%**

4.4.8. Agriculture

Greenhouse gas emissions from agriculture have decreased since 1990, mainly due to improved production efficiency and fewer cattle. This in turn has led to lower methane emissions from the digestion process in ruminant animals and reduced emissions of methane and nitrous oxide from manure. Emissions of nitrous oxide from agricultural land have also declined as a result of reduced cereal acreage, reduced use of fertilizers, reduced nitrogen leaching and a transition from solid manure to slurry management.

Emissions are estimated to decrease as a result of a continuously declining cattle population. The reduced numbers of dairy cows for 2020 and 2030 are primarily a result of increased productivity, product pricing mechanisms and

continuous adaptation to EU agricultural policy regulations. Emissions from agricultural land are also projected to decrease to 2035, see Table 4.13, Table 4.14 and Figure 4.9.

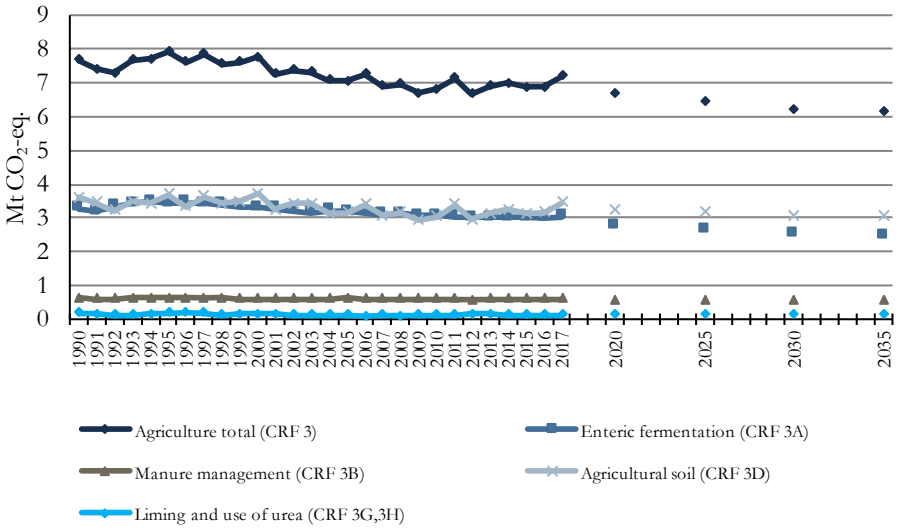

Figure 4.9 **Historical and projected emissions of greenhouse gases from agriculture.**

Table 4.13 **Historical and projected emissions of greenhouse gases from agriculture per gas (Mt CO_2-eq.)**

	1990	2017	2020	2025	2030	2035	1990-2020	1990-2030
Methane	3.5	3.3	3.0	2.9	2.7	2.7	-14%	-23%
Nitrous oxide	4.0	3.8	3.5	3.5	3.4	3.3	-11%	-15%
Carbon dioxide	0.2	0.1	0.1	0.1	0.1	0.1	-28%	-28%
Total emissions	**7.7**	**7.2**	**6.7**	**6.4**	**6.2**	**6.1**	**-13%**	**-19%**

Table 4.14 **Historical and projected emissions of greenhouse gases from agriculture (Mt CO_2-eq.)**

	1990	2017	2020	2025	2030	2035	1990-2020	1990-2030
Enteric fermentation	3.3	3.0	2.8	2.6	2.5	2.5	-16%	-24%
Manure management	0.6	0.6	0.6	0.6	0.5	0.5	-8%	-13%
Agricultural land	3.6	3.4	3.2	3.1	3.1	3.0	-10%	-15%
Liming/Use of urea	0.2	0.1	0.1	0.1	0.1	0.1	-28%	-28%
Total emissions	**7.7**	**7.2**	**6.7**	**6.4**	**6.2**	**6.1**	**-13%**	**-19%**

4.4.9. 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 1990–2017. Net removals for LULUCF are expected to decrease to 2035, see Table 4.15 and Figure 4.10. This trend is mainly due to a decrease in removals from forest land. The projected decrease in removals of carbon dioxide from forest land is based on the assumption that the harvest level will continue to gradually increase at about the same pace as in recent years. Continuously increasing harvests have been added to the projections mainly after 2025, since it is foreseen that demand for biomass will increase over time.

Net emissions from cropland have varied during the period 1990–2017. The emissions are projected to be at about the same level as the average for the last ten years. Net emissions from settlements are caused by felling due to urbanisation and the establishment of power lines and forest roads. These emissions are projected to be at the same level for the entire projection period as the average for the last ten years. The carbon stock changes in grassland and wetlands were small during the period 1990–2015 and are projected to stay low during the projection period.

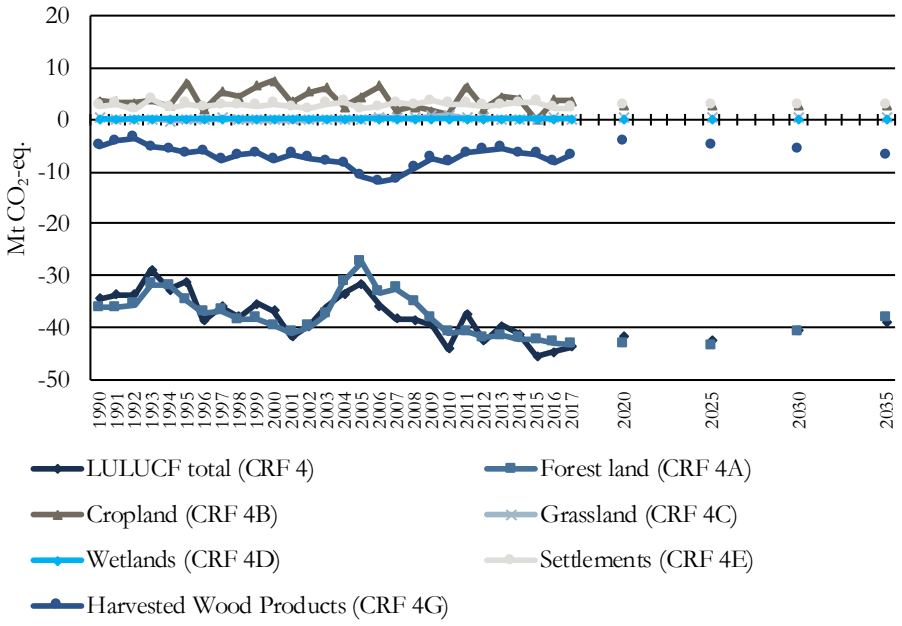

Figure 4.10 **Historical and projected emissions (+) and removals (-) from the LULUCF sector and its subcategories in Mt CO_2-equivalents per year.**

Table 4.15 **Historical and projected emissions (+) end removals (-) of greenhouse gases from LULUCF (Mt CO_2-eq.)**

	1990	2017	2020	2025	2030	2035	1990-2020	1990-2030
Forest land	-36.2	-43.2	-43.1	-43.6	-40.8	-38,0	19%	13%
Cropland	3.5	3.7	2.7	2.7	2.7	2.7	-24%	-24%
Grassland	0.3	0.1	0.3	0.3	0.3	0.2	-17%	-22%
Wetlands	0.1	0.2	0.2	0.2	0.2	0.2	135%	135%
Settlements	2.6	2.2	2.9	2.9	2.9	2.9	10%	10%
Other land	0.2	-0.007	-0.001	-0.001	-0.001	-0.001	-100%	-100%
HWP	-5.0	-6.7	-4.4	-5.0	-5.8	-7.0	-13%	16%
Total net removals	**-34.4**	**-43.7**	**-41.4**	**-42.5**	**-40.6**	**-39.0**	**20%**	**18%**

4.4.10. International transport

Emissions from bunkers for international transport are projected to increase to 2035, mainly due to increased emissions from international aviation, see Table 4.16 and Figure 4.11. This increase is explained by an expected increase in private consumption during the projection period, resulting in increased travel.

The increased use of fuel for international navigation is due to an increase in passenger traffic, growth in exports of goods and increased refuelling in Sweden. The projection is based on the assumption that transport volumes will increase as transportation becomes more efficient. This leads to projected emissions from international navigation at about the same level during the projection period. The number of international bunkers counted in Sweden also depends largely on where international ships and airplanes choose to refuel.

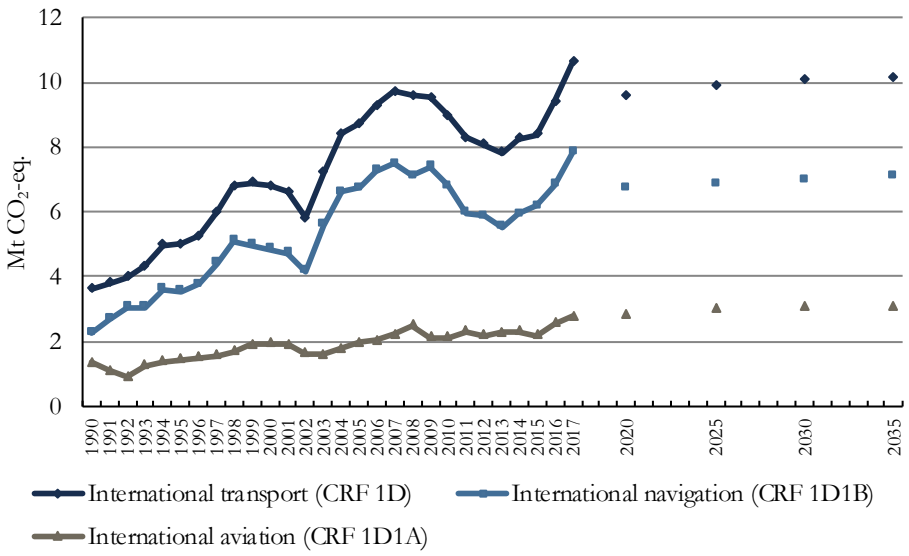

Figure 4.11 **Historical and projected emissions of greenhouse gases from international bunkers.**

Table 4.16 **Historical and projected emissions of greenhouse gases from international bunkers (Mt CO_2-eq.)**

	1990	2017	2020	2025	2030	2035	1990-2020	1990-2030
Navigation	2.3	7.8	6.8	6.8	6.9	7.0	198%	207%
Aviation	1.4	2.8	2.8	3.0	3.1	3.1	107%	129%
Total emissions	**3.6**	**10.6**	**9.6**	**9.9**	**10.0**	**10.1**	**164%**	**178%**

4.5. Sensitivity analysis

Sensitivity calculations were produced by varying some parameters in the energy sector (incl. transport) and some in the transport sector. Aggregated for all sectors, the sensitivity calculations show that the emission level in 2030 may be 34 to 37 % lower than 1990 levels, depending on the sensitivity projection, see Table 4.17. However, this does not include uncertainty in the calculations, which may expand the percentage span between the projections.

Table 4.17 **Historical and projected total emissions of greenhouse gases for different projections in the sensitive analysis excl. LULUCF (Mt CO_2-eq.)**

	1990	2017	2020	2025	2030	2035	1990-2020	1990-2030
Projections WEM	71.3	52.7	49.7	47.7	46.1	45.6	-30%	-35%
Energy sector including transport								
Projection "Lower fossil fuel prices"			50.3	48.4	47.1	46.6	-29%	-34%
Projection "Lower GDP"			49.5	47.3	45.5	44.8	-31%	-36%
Transport sector								
Projection "Electric vehides"			49.8	47.5	45.6	44.2	-30%	-36%
Projections "Lower mileage"			48.8	46.8	45.2	44.7	-32%	-37%

Two sensitivity projections were calculated for the energy sector including transport: one projection with 60 % lower fossil fuel prices and one with 20 % lower economic growth than in the reference projections. Lower fossil fuel prices also result in higher economic growth than in the reference projections. All other assumptions are identical to the assumptions in the reference projection.

Results of the sensitivity projections show that the projection with lower fossil fuel prices results in higher emissions in 2035 compared to the reference projection, as expected. Emissions are almost 1 Mt CO_2-eq. higher than in the reference projection in 2030. A lower fossil fuel price decreases the incentive to replace fossil fuels and increase energy efficiency in industry, giving 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 compared to the reference projection. In this case emissions are almost 0.6 Mt CO_2-eq. 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 industrial sector. Lower economic growth leads to a lower demand for the transportation of both goods and people.

For the road transportation sector, two additional sensitivity projections were performed separately, one with lower mileage and one with more

electric vehicles. In the calculation with more electric vehicles, the total amount of biofuels is assumed to decrease. All other assumptions are identical to the ones in the reference projections. In the projection, mileage is assumed to be 15 % lower in 2030 compared to the reference projection. Results show that the projections with lower mileage result in emissions that are approximately 0.9 Mt CO_2-eq. lower in 2030. In the projection with more electric vehicles, it is assumed that the share of electric vehicles in the fleet of passenger cars will be 20 % in 2030 compared to 10 % in the reference projections. The share of low-blend of biofuels is assumed to be the same as in the reference projections, resulting in an assumed decrease in the total amount of biofuels. These assumptions result in emissions around 0.5 Mt CO_2-eq. lower in 2030 and 1.3 Mt CO_2-eq. lower in 2035.

4.6. Comparison with third Biennial Report

The projections presented in 2017 in Sweden's third Biennial Report (BR3) showed reductions in total greenhouse gas emissions of 30 % between 1990 and 2020 and of 36 % between 1990 and 2030. The projection set out here, in the fourth Biennial report (BR4), uses partly different assumptions and assessments based on trends over the last few years, see Table 4.18. The new projections show a decrease in total greenhouse gas emissions of 30 % between 1990 and 2020 and of 35 % between 1990 and 2030. A comparison of percentage changes in emissions overall and by sector is shown in Figure 4.12.

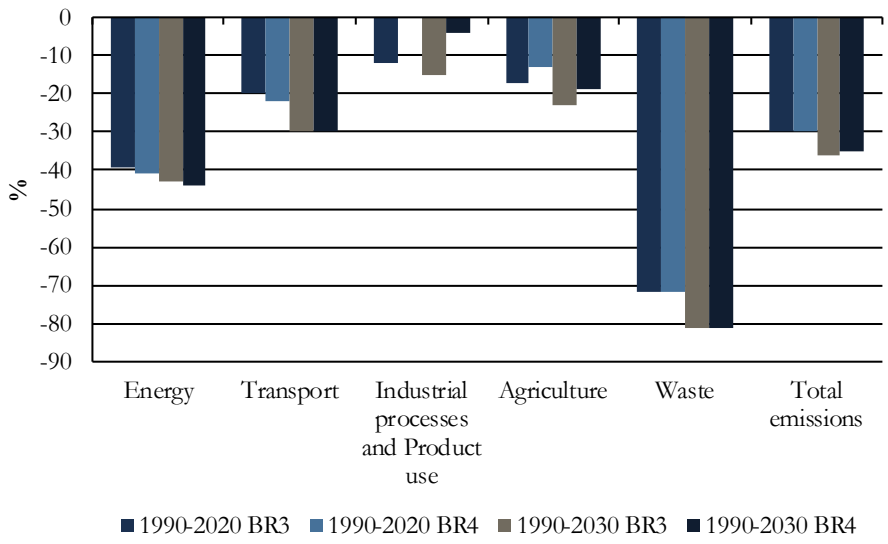

Figure 4.12 **Percentage changes in emissions between 1990 and 2020 and 2030 respectively as projected in BR3 and BR4, overall and by sector**

The projections presented here indicate a larger reduction of emissions by 2020 and 2030 for some sectors compared with those in BR3. The difference is mainly due to differing assumptions, for instance regarding fossil fuel prices, and assumptions based on the trend over the last few years.

Table 4.18 **Key assumptions in the third Biennial Report and in the fourth Biennial report**

	BR3		**BR4**	
	2013-2035		**2015-2035**	
GDP (annual change %)	2.28		2.05	
	2020 *(2013 prices)*	**2030** *(2013 prices)*	**2020** *(2015 prices)*	**2030** *(2015 prices)*
Price of crude oil (USD/barrel)	87	113	97	121
Price of coal (USD/tonne)	70	104	86	124
Price of natural gas (USD/MBtu)	9	11	10	12
Emissions trading (Euro/tonne CO_2)	15	33	15.5	34.7
Electricity prince (SEK/kWh)	0.33	0.53	0.35	0.44
Electricity certificates (new renewable electricity compared with 2012)	28.4 TWh by 2020		28.4 TWh by 2020	

4.7. Progress towards targets under the EU Climate and Energy Package

4.7.1. Sweden's commitment according to the Effort Sharing Decision

Under the EU Climate and Energy Package, greenhouse gas emissions from the EU are to be reduced by 20 % to 2020 compared to 1990. Emissions from installations included in the EU Emissions Trading System (EU ETS) are to fall by 21 % between 2005 and 2020 for the EU as a whole. Emissions not covered by the trading system are to be reduced from EU as a whole with 10 % to 2020 compared to 2005, in line with the Effort Sharing Decision (ESD) (EU Decision 406/2009/EC). For Sweden, this decision means that emissions in the ESD-sector must decrease by 17 % between 2005 and 2020, in line with a target emissions trajectory. This means that the ESD emissions must decrease linearly from 41.7 Mt in 2013 to 36.1 Mt in 2020[31].

Furthermore, Sweden can use credits from international project activities to meet the target. The annual use is restricted to 3 % of 2005 emissions[32], which equals 10.9 million tonnes for the entire period 2013–2020. In addition, 1 % of 2005 emissions can be used in international projects fulfilling certain requirements. This corresponds to 3.6 million additional tonnes for the entire period 2013–2020. The maximum possible annual use of international credits thus amounts to a maximum of 1.8 million tonnes. A member state may transfer up to 5 % of their allocated Annual Emissions Allocations (AEA) for a given year to other member states. Furthermore, 5 % of the AEA's can be carried over from the following year, and if there is a surplus of allowances it can be banked to following years or transferred to other member states.

Since 2013, Sweden's ESD-emissions have been lower than the ESD-targets, see Figure 4.13. The surplus amount of AEAs was over 5 million tonnes per year compared to the Swedish ESD target, see Table 4.19. The surplus for 2013-2016 was deleted. The government has proposed to the Swedish Parliament that also the surplus for 2017 should be deleted. Compliance for 2017 is planned to be performed in 2020.

[31] In 2017 the target for 2020 was adjusted from 37.2 to 36.1 million, because the historical emissions are lower due to methodological changes. Commission Decision 2017/1471 amending decision 2013/162/EU to revise Member States' annual emissions allocations for the period from 2017 to 2020.

[32] According to National Inventory Report submission 2012

The target for Sweden is set to 36.1 Mt CO_2-eq. in 2020 (EU Decision C(2013)1708). The projections indicate an overachievement in 2020 in relation to the ESD target. ESD emissions are projected to decrease to around 29.4 million tonnes in 2020. The overachievement in 2020, compared to the Swedish target, is estimated to be over 6 million tonnes, without the use of international credits. However, investments in international projects have already been made in case such credits would be required to meet the ESD target. The projections also indicate that Sweden will have a yearly surplus of allowances during 2018–2020. Note that these figures are uncertain and preliminary.

Table 4.19 **Sweden's historical and projected emissions of greenhouse gases (based on National Inventory Report submission 2019).** Emission data presented as total emissions, ETS emissions, CO_2-emissions from domestic aviation and emissions covered by the Effort Sharing Decision (ESD) in relation to ESD target (scope 2013-2020, excl. aviation) in Mt CO_2-eq.

	2013	2014	2015	2016	2017	2020	2030
Total emissions	55.4	53.8	53.5	52.9	52.7	49.7	46.1
ETS emissions	20.1	19.3	19.2	19.7	19.6	19.7	19.2
Domestic aviation	0.5	0.5	0.5	0.5	0.5	0.5	0.5
ESD emissions[33] [34]	34.7	34.0	33.7	32.7	32.5	29.4	26.0
ESD target[35]	41.7	41.0	40.4	39.8	37.8	36.1	
Overachievement in relation to ESD target (Sub2019)[36]	7.0	7.1	6.7	7.1	5.4	6.6	

[33] ESD emissions include emissions that are covered by the Effort Sharing Decision and are calculated as total emissions excl. LULUCF minus CO_2 emissions from domestic aviation minus emissions from EU ETS.

[34] Historical emissions are presented according to National Inventory Report submission 2019. The ESD emissions for compliance are based on relevant submission and the ESD-emissions in 2013 according to submission 2016 were 35.3 Mt CO_2-eq. which means a surplus of 6.4 million AEAs deleted. Emissions in 2014 were 34.5 Mt CO_2-eq. (sub 2016) a surplus of 6.5 million AEAs deleted. Emissions in 2015 were 33.9 Mt CO_2-eq. (sub2017), a surplus of 6.5 million AEAs deleted and emissions in 2016 were 32.6 Mt CO_2-eq. (sub2018), a surplus of 7.2 million AEAs deleted.

[35] According to the revised targets in 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.

[36] Overachievement according to compliance, see footnote 39.

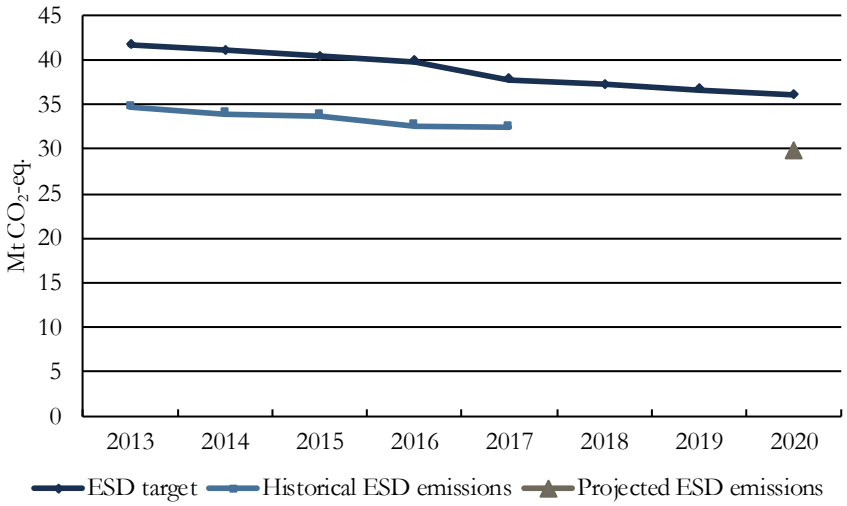

Figure 4.13 **The ESD target 2013-2020, the Swedish ESD emissions 2013–2017 and the projected Swedish ESD emissions 2020.**

4.8. Target fulfilment in relation to national targets

According to the 2009 climate policy resolution of the Swedish Parliament, the Swedish target for emissions that are not included in the EU ETS, must be reduced by 40 %, or around 20 Mt CO_2-eq., between 1990 and 2020[37], of which one third can be reduced through emission reductions in other countries.

In 2020, the national target will preliminarily be 28.6 Mt CO_2-eq.. Projections indicate that emissions will decrease to around 29.4 Mt CO_2-eq. and there will be a gap to target of approximately 0.9 Mt CO_2-eq. in 2020. In addition, uncertainties in the projections have to be taken into account. Note that numbers are preliminary until 2022–2023, when a definitive calculation can be done, based on reviewed inventory data. If a gap to the target still remains, it can be closed by emission reductions in other countries.

In June 2017, the Parliament in Sweden adopted a climate policy framework including targets for 2045. By 2045, Sweden is to have no net emissions of greenhouse gases into the atmosphere and should thereafter achieve negative

[37] 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, 2013–2020, the scope of the EU ETS was extended to include additional sectors. The target was consequently adjusted corresponding to emissions in the transferred sectors.

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 realised through supplementary measures such as increase in carbon sinks, verified emissions reductions through investments in other countries and carbon capiture and storage of biogenic carbon dioxide. A reduction of 63 % means that the target is preliminarily set to 17 Mt CO_2-eq. in 2030. The emissions outside EU ETS are projected to decrease to 26 Mt CO_2-eq. by 2030, which indicate a gap of around 9 Mt CO_2-eq. In addition, emissions from domestic transport are to be reduced by at least 70 % by 2030, compared to 2010. Emissions from domestic transport are projected to decrease by 35 % between 2010 and 2030.

4.9. References

Commission decision (EU) (2017/1471) of 10 August 2017 amending Decision 2013/162/EU to revise Member States' annual emission allocations for the period from 2017 to 2020

Commission Decision (2013/162/EU) of 26 March 2013 on determining Member States' annual emission allocations for the period from 2013 to 2020 pursuant to Decision No 406/2009/EC of the European Parliament and of the Council (notified under document C(2013) 1708)

Commission Implementing decision (2013/634/EU) of 31 October 2013 on the adjustments to Member States' annual emission allocations for the period from 2013 to 2020 pursuant to Decision No 406/2009/EC of the European Parliament and of the Council

EU 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.

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.

EU regulation No 525/2013 of the European Parliament and of the Council Decision on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC

Govt. Bill 2019/20:1 *Budgetpropositionen för 2020.* Ministry of Finance

Ministry of the Environment and Energy. 2019. *Report for Sweden on assessment of projected progress,* March 2019. In accordance with articles 13 and 14 under Regulation (EU) No 525/2013 of the European Parliament and of the Council Decision on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC

National Inventory Report Sweden, Submission 2019.

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

5.1. Introduction

Climate change is the defining issue of our time and a top priority for the Swedish government. Sweden has a long history of supporting climate action in developing countries, in an array of sectors and on a long-term basis but has raised its ambitions further since the adoption of the Paris Agreement. Sweden has consistently called for coherent and co-ordinated implementation of the Paris Agreement, Agenda 2030 and the Addis Ababa Action Agenda for development finance – on both global and national levels. Effective financing of climate action is facilitated by mainstreaming climate action in national budget and planning processes, thereby paving the way for successful national resource mobilisation.

A large number of Swedish actors, such as ministries, government agencies, state-owned companies, non-governmental organisations, universities and the private sector are engaged in climate actions such as providing grants and innovative finance, technology transfer, research and various forms of capacity building. There are a number of different forms of cooperation, policy instruments and support.

The continuous progress in the development of methodologies to track climate finance, as well as the efforts within the EU to harmonise methodologies, make it difficult to directly compare the numbers in this report with previous reports.

5.2. Governing policies and principles

5.2.1. Policy framework for Swedish development cooperation and humanitarian aid

In December 2016, the Government adopted a new policy framework outlining the direction of Swedish development cooperation and humanitarian aid. The purpose of the policy framework is to have a knowledge-based, broadly supported framework that is aligned with the internationally adopted 2030 Agenda for Sustainable Development. At the same time, the Swedish policy framework also goes beyond the 2030 Agenda in a number of aspects, such as gender equality, democracy and human rights.

Environment and climate change are one of the key areas of the policy, one of three top priorities of the government, and in addition, an environment and climate change perspective shall be integrated in all Swedish development cooperation. The policy highlights that Sweden will support low and middle-income countries' accession to, and implementation of, commitments under the climate convention, and the implementation of their Nationally Determined Contributions under the Paris Agreement.

5.2.2. Key principles

The principles contained in the Paris Declaration of 2005, the Accra Agenda of 2008 and the Busan Partnership of 2011 are important to international development cooperation and climate finance. National ownership is key to securing long-term sustainability of climate change-related initiatives. External actors should seek to improve coordination and alignment to the national systems and processes of developing countries, in order to ensure transparency and mutual accountability. Within the multilateral funds, Sweden has been a champion for direct access, where national authorities are able to directly access financing and manage all aspects of the projects/programs. In our bilateral work, the countries' and organisations' own needs, priorities and strategies are weighed into the strategies, and are a fundamental entry point for all contributions from Sida. This approach calls for increased efforts from developing countries in mainstreaming climate action in their development dialogues with development partners.

5.2.3. New and additional resources

According to the UN Framework Convention on Climate Change, *"The developed country Parties [...] shall provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in complying with their obligations"*. 'New and additional resources' is a complex term, used in many multilateral contexts. There is currently no international agreement on how it should be defined. One common definition, supported by many countries, is that climate financing should be additional to the international development aid goal of 0.7 % of gross national income (GNI).

Sweden is one of few OECD DAC members to have met, and even far exceeded, the UN target of 0.7 %. There is broad Parliamentary support to continue delivering 1 % of Sweden's GNI to Official Development Assistance (ODA). Figures for total Swedish ODA 2017-2018 are shown in Table 5.1, together with the share of climate finance compared to total ODA. Figure 5.1 shows climate finance based on type of support.

Table 5.1 **Total Swedish official development assistance (ODA), 2017–2018**

	2017[38]	2018
SEK million	47 558	50 788
USD million	5 564	5 844
% of GNI	1.20	1.04
Climate finance as share of total ODA[39]	10%	12%

All exchange rates used in this report are based on the annual average dollar exchange rates for OECD Development Assistance Committee (DAC) members[40].

In addition to climate finance within ODA, Sweden has also contributed to international climate finance through Other Official Flows, e.g. within the Swedish Program for International Climate Initiatives through the Kyoto Protocol's flexible mechanism. Sweden has chosen to voluntarily cancel purchased emission reduction units and report them as climate finance. The cancelled units cannot be utilised in any way, sold or used to fulfil Sweden's mitigation commitments (see section 5.4.3).

[38] Total ODA corresponds to amount reported to the OECD DAC. Source: OECD.Stat [DAC1].

[39] 4 964 SEK million / 47 558 SEK million = 10% in 2017 and 6 197 SEK million / 50 788 SEK million = 12% in 2018.

[40] OCED Exchange rate (2019).

Against this background, all climate finance provided by Sweden during 2017–2018 should be viewed as new and additional.

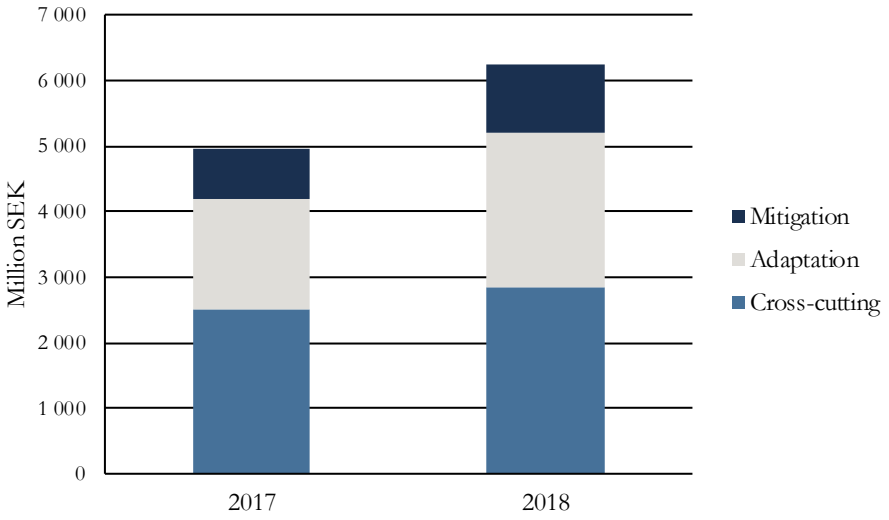

Figure 5.1 **Total Swedish climate finance, 2017-2018, excluding core funding to MDBs and UN organisations**.

5.3. Multilateral financial support

Sweden is the largest per capita donor in the world to the financial mechanism under the UN Framework Convention on Climate Change – the Green Climate Fund (GCF) and the Global Environment Facility (GEF).

In addition, Sweden provided substantial climate finance through a number of other multilateral climate change funds, such as the Adaptation Fund and the Least Developed Countries Fund. All contributions to multilateral climate funds are accounted as 100 % climate finance.

Multilateral climate finance (presented in CTF Table 7 and 7a) is mainly managed by the Ministry for Foreign Affairs, including core support to Multilateral Development Banks (MDB) and UN organisations.

Sweden considers core funding key for flexibility, rapid response and long-term planning, in line with the principles of aid effectiveness, and has thus chosen to present some of this support in Table 7a (please note that it does not provide an exhaustive list of all of Sweden's multilateral contributions). Final data regarding the climate specific share of core contributions was not available for all years and for all multilateral development banks and UN

organisations. Some data were however available from MDBs for 2017–2018, summarised in Table 5.2 below. Thus it can be concluded that Sweden's contribution to international climate finance exceeds the total figures presented in Annex A and the CTF-tables.

Table 5.2 **MDB climate finance as percentage of total MDB operations.**

	ADB	AfDB	ERDB	EIB	IDBG	WBG	Total MDB
2017	23 %	28 %	38 %	27 %	29 %	21 %	25 %
2018	18 %	32 %	29 %	29 %	27 %	32 %	29 %

The Ministry of Environment administered support to a number of strategic initiatives linked to the UNFCCC negotiations, such as the UNFCCC Trust Fund, the African Group of Negotiators working with the Africa Renewable Energy Initiative, the New Climate Economy, the Clean Energy Solution Centre and the International Institute for Sustainable Development's work with Fossil Fuel Subsidy Reform. The Swedish Energy Agency, the Swedish Environmental Protection Agency and the Swedish Meteorological and Hydrological Institute were also involved in important climate initiatives, programs and mechanisms, such as the Climate and Clean Air Coalition, and SIDS DOCK[41].

An overview of Sweden's multilateral support is presented in Figure 5.2 and Table 5.3. As pledged during COP21 in Paris, Sweden has doubled its multilateral climate finance from 2015 to 2016, and this support is now almost four times higher than in 2015.

[41] Small Island Developing States (SIDS) DOCKing station, is an initiative among member countries of the Alliance of Small Island States (AOSIS) to provide the Small Island Developing States (SIDS) with a collective institutional mechanism to assist them transform their national energy sectors into a catalyst for sustainable economic development and help generate financial resources to address adaptation to climate change.

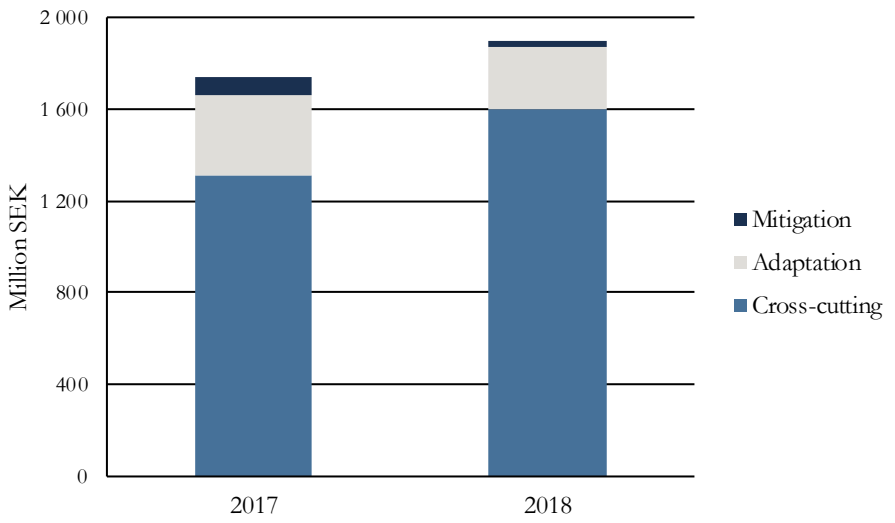

Figure 5.2 **Multilateral climate finance provided by Sweden through the Ministry for Foreign Affairs and the Ministry of Environment during 2017-2018, by type of climate action**.

Table 5.3 **Multilateral climate finance 2017-2018 through the Ministry for Foreign Affairs and Ministry of Environment.**

Year	Mitigation MSEK (% of total*)	Adaptation MSEK (% of total*)	Cross-Cutting MSEK (% of total*)	Total MSEK
2017	83 (5%)	352 (20%)	1 307 (75%)	1 743
2018	29 (2%)	270 (14%)	1 598 (84%)	1 897
	Mitigation MUSD (% of total*)	**Adaptation MUSD (% of total*)**	**Cross-Cutting MUSD (% of total*)**	**Total MUSD**
2017	9 (5%)	37 (20%)	136 (75%)	181
2018	3 (2%)	26 (14%)	156 (84%)	185

More detailed information for each year can be found in Annex A, CTF Table 7a.

Sweden has been a champion of gender integration in the multilateral climate funds, including the promotion of separate gender policies and action plans that support gender-responsive actions. Integration of gender issues is improving, thus also contributing to raising the efficiency and long-term sustainability of the projects and programs funded by multilateral climate funds.

5.4. Bilateral financial support

5.4.1. Methodology for tracking climate-related bilateral ODA

The Swedish bilateral support provided through Sida includes support to bilateral, regional and global institutions and organisations (including so-called 'multi-bi' support) and is reported in Annex A, CTF Table 7: summary financial information, 7b: details at component level, 8: examples of technology development contributions, and 9: examples of capacity building contributions.

Online publishing

Detailed information about Sida's operations is continuously published online according to the internationally agreed International Aid Transparency Initiative (IATI) standard at www.openaid.se. Sida is currently making efforts to enable climate finance reporting through IATI, and a pilot has been developed during 2018 (see www.climatefinance.se).

Tracking, coefficients and range of countries

Sida uses the OECD DAC Rio markers for climate change mitigation and climate change adaptation to track climate finance. The components are marked using a scale of 0–2, where 2 represents 'principal objective', 1 'significant objective' and 0 'not targeted'. In climate finance reporting, Sweden includes the full amount of finance to components that have climate change as a principal objective, but only 40% of the finance provided to components with climate change as a significant objective (see Table 5.4). In Annex A, CTF Table 7 and 7b, the disbursed amounts presented are already weighted with the coefficients. These standard coefficients are relatively simple to apply, while they help avoid over-reporting of finance that does not have climate change as the main objective. This approach is in accordance with the reporting of several donors, including the European Commission. To acknowledge the synergies between mitigation and adaptation, and ensure that there is no double counting, the type of climate change action is determined as mitigation, adaptation or cross-cutting according to Table 5.4.

Table 5.4 **Matrix of how the type of contribution is determined based on the two Rio Markers, climate change mitigation (CCM) and climate change adaptation (CCA), and the application of coefficients.**

Rio Marker	CCM 2	CCM 1	CCM 0
CCA 2	Cross-cutting; 100% of finance	CCA; 100% of finance	CCA; 100% of finance
CCA 1	CCM; 100% of finance	Cross-cutting; 40% of finance	CCA; 40% of finance
CCA 0	CCM; 100% of finance	CCM; 40% of finance	Not climate finance

Sweden reports on the climate finance it provided in 2017-2018 in the form of a Biennial Report (BR) to the UNFCCC as well as the annual Monitoring Mechanism Regulation (MMR) report to the EU. To be transparent, the same gross list of contributions that is presented in the Annex A, CTF Table 7b is used for both reports. The two reports focus exclusively on support to non-Annex I Parties, in line with the reporting guidelines. Sida's support to Kosovo is included in the gross list for transparency reasons but is excluded from the summarized amount since Kosovo is not yet a Party to UNFCCC. Palestine became party to UNFCCC 2016 and is included in the data. Some contributions are included in the CTF-table more than once. That is not double-counting, but a presentation of different components of a contribution separately, since climate change relevance is tracked at the component level (one contribution can have several components). To get a full picture of the climate finance to a contribution, the climate finance to the different components can be added up. In this report, the figures are based on the most recent and best available data at the time of reporting.

Gender equality integration

The OECD DAC gender policy marker is used to track gender equality integration in climate finance. The climate contributions that are marked with the gender policy marker 1 or 2 are considered gender integrated. Gender integration for Sweden's bilateral support in 2017 and in 2018 is presented in Annex A, CTF Table 7.

Mobilisation of finance

In addition to climate finance in the form of grants, Sida provides guarantees to support actors to mobilise climate finance from private and public sources; section 5.5.

5.4.2. Bilateral financial support through Sida

The majority of Swedish climate finance to low- and middle-income countries is channelled as bilateral ODA through Sida. It includes support provided to local and national institutions, bilateral support to multilateral organisations and other global and regional organisations. In the area of climate change, Sida provides significant climate change support at several levels. It is provided to partner organisations both with climate change as a main objective ('principal objective' according to DAC terminology), and as a secondary objective ('significant objective' according to DAC terminology), i.e. integrated in contributions that have other main objectives. This is done in cooperation with actors in low- and middle-income countries, including government institutions, multilateral organisations, research institutions, non-governmental organisations, the private sector and Swedish authorities. ODA channelled through Sida is disbursed at national, regional and global levels.

Table 5.5 **Climate finance provided by Sida during 2017–2018.**

Year	Adaptation MSEK (% of total)	Mitigation MSEK (% of total)	Cross cutting MSEK (% of total)	Total MSEK
2017	1 329 (41%)	689 (21%)	1 203 (37%)	3 222
2018	2 099 (48%)	1 012 (23%)	1 234 (28%)	4 345
Year[42]	Adaptation MUSD (% of total)	Mitigation MUSD (% of total)	Cross cutting MUSD (% of total)	Total MUSD
2017	155 (41%)	81 (21%)	141 (37%)	377
2018	242 (48%)	116 (23%)	142 (28%)	500

BOX 5.1 Sida supports the rehabilitation and upgrade of two hydro-electric power plants with a total capacity of about 100 MW along Rio Revué in the central part of Mozambique. The purpose of the contribaution is to increase the access to clean electricity through the use of modern technology. The rehabilitation contributes to the country's development by securing energy access with continued low greenhouse gas emissions. Sida's total contribution to the rehabilitation in 2018 was approximately 5.6 MSEK. Climate change mitigation is not identified as the primary objective of the contribution but a significant objective and therefore only 40 % of the total disbursement is considered climate specific, that is around 2.2 MSEK (see Section 5.4.1. above for more information about the methodology).

[42] For 2017, 1 USD = 8.549 SEK. For 2018, 1 USD = 8.693 SEK.

BOX 5.2 Sida provides funding to AdaConsortium, supporting Kenyan communities to address climate change vagaries through innovative climate financing mechanisms. By establishing legal frameworks at county level (County Climate Change Fund (CCCF) Laws) county governments can gain access to climate financing both at international and local level. The establishment of CCCF Laws is coupled with the empowerment of communities through Ward Adaptation Planning Committees, engaging with county governments to prioritize climate adaptation and the development agenda through capacity enhancement, including use of climate information for planning. The counties have set up regulations to implement CCCF laws which mandate them to set aside 1-2 % of their development budgets for climate change adaptation interventions.

BOX 5.3 The regional Pacific-European Union Marine Partnership Programme (PEUMP) addresses the effects of climate change, including rising sea temperatures, threatening the large-scale fishing industry in the region. The purpose of programme is to support improved sustainable management and development of fisheries for food security and economic growth, while addressing climate change, and conservation of marine biodiversity. By raising the level of education within the fishing industry, the initiative strengthens the capacity within the industry to manage marine resources sustainably in the face of climate change. The initiative is considered to have climate change adaptation as the primary objective. Hence, Sida's total disbursement in 2018 of approximately 23 MSEK is identified as climate finance.

BOX 5.4 The Beyond the Grid Fund for Zambia is a programme within the Power Africa partnership aiming to bring clean energy access to one million Zambians and accelerate private-sector growth in energy generation and distribution in the country. Since 2017, it has brought clean, affordable off-grid energy access to over 600,000 Zambians. It has also won the prestigious Ashden Award for Innovative Finance.

Table 5.6 **A summary of the top five countries receiving Sida climate finance during 2017–2018. All the countries are among Sweden's major bilateral development cooperation partners**.

2017	Country	Disbursed (MSEK)	Disbursed (MUSD)[43]
1.	Tanzania	229	27
2.	Kenya	180	21
3.	Mozambique	142	17
4.	Mali	127	15

[43] For 2017, 1 USD = 8.549 SEK.

5.	Ethiopia	119	14
2018	**Country**	**Disbursed (MSEK)**	**Disbursed (MUSD)[44]**
1.	Somalia	215	25
2.	Tanzania	209	24
3.	Mozambique	189	22
4.	Mali	155	18
5.	Afghanistan	145	17

Table 5.7 **A summary of the top five multilateral organisations receiving Sida climate finance during 2017–2018**

Organisation	**Climate output 2017 (MSEK)**
IBRD/INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT/THE WORLD BANK	290
UNDP/UNITED NATIONS DEVELOPMENT PROGRAMME	201
WFP/WORLD FOOD PROGRAMME	121
UNICEF/UNITED NATIONS CHILDRENS FUND	118
EBRD/EUROPEAN BANK FOR RECONSTRUCTION & DEVELOPMENT	80
Grand Total	810
Organisation	**Climate output 2018 (MSEK)**
UNDP/UNITED NATIONS DEVELOPMENT PROGRAMME	397
IBRD/INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT/THE WORLD BANK	359
FAO/FOOD AND AGRICULTURE ORGANIZATION	297
UNICEF/UNITED NATIONS CHILDRENS FUND	278
THE WORLD BANK	148
Grand Total	1 479

[44] For 2018, 1 USD = 8.693 SEK.

Since 2014, Sweden has a feminist foreign policy. Equality between women and men is a prerequisite for sustainability and for achieving the goals of UNFCCC and the Paris Agreement. Sida is committed to integrating the gender equality perspective throughout its operations, including the support for climate action. The overall level of gender integration is approximately 87-88 % and further stepping up of efforts can be sought. While there is a slight increase in the level of gender integration in contributions with cross-cutting target areas, there is scope for improvement within contributions targeting adaptation and those targeting mitigation. Sida's voluntary reporting of gender integration in the Biennial Report is done to track the progress, stimulate further integration and encourage other actors to do the same. Sweden has also been a champion for gender integration in the multilateral climate funds, including the promotion of separate gender policies and action plans. Overall integration of gender issues is improving, thus also contributing to the efficiency and long-term sustainability of the projects and programmes funded by multilateral climate funds.

5.4.3. The Swedish program for International Climate Initiatives

The Swedish Program for International Climate Initiatives focuses on the Kyoto Protocol's flexible mechanism and contribution to the development of new market mechanisms under the Paris Agreement. The objectives of the program have evolved over time in response to the development of the international climate negotiations and the international carbon markets. However, the core mission of the program has remained to support the development of international climate cooperation, to achieve cost-effective greenhouse gas reductions and to contribute to sustainable development in developing countries.

Support through the project-based flexible mechanisms under the Kyoto Protocol

Through the program, Sweden supports over 90 bilateral projects through the Clean Development Mechanism (CDM) and Joint Implementation (JI) as well as participation in ten multilateral carbon funds[45] with a total commitment of 2,3 billion SEK.[46] Priority project types include renewable energy, energy efficiency and waste management. Priority has been given to

[45] Future Carbon Fund (FCF), Asia Pacific Carbon Fund (APCF), Transformative Carbon Asset Facility (TCAF), Carbon Initiative for Development (Ci-Dev), Carbon Partnership Facility (CPF), Pilot Auction Facility for Methane and Climate Change Mitigation (PAF), Umbrella Carbon Facility Tranche 2 (UCF T2), Prototype Carbon Fund (PCF), Multilateral Carbon Credit Fund (MCCF) and Testing Ground Facility (TGF).

[46] Calculated with currency rates December 2018

projects in Sub-Saharan Africa (28 % of emission reduction units), South East Asia (17 % of emission reduction units) and India (17 % of emission reduction units). Other countries/regions with projects are China (14 % of emission reduction units), South America (12 % of emission reduction units) and other regions (12 % of emission reduction units).

During 2017-2018 7.9 million certified emission reduction units were delivered from the bilateral projects and multilateral carbon funds, at a cost of 370 million SEK.

All emission reduction units generated during the first commitment period of the Kyoto protocol, as well as all units from the second commitment period until the end of 2016 have been cancelled. [47] These units cannot be utilized to fulfil Sweden´s commitment under the Kyoto protocol. Since the main objective of the projects and carbon funds is climate change mitigation, the support provided up to 2016 is regarded as 100 percent climate finance according to the Rio markers (climate change mitigation is principal objective). The emission reduction units delivered in 2017-2018 have not been cancelled and therefore cannot be reported as climate finance. The figures för 2017 and 2018 are therefore not yet included in Annex A, CTF table 7 and 7b.

Contribution to the development of new market mechanisms under the Paris Agreement

Since 2018, the Swedish Energy Agency (SEA) has received funding aimed at financing efforts to develop new international forms of cooperation and results-based climate finance under the Paris Agreement, in particular Article 6.

The work is focused on method development with a special focus on monitoring, reporting and verification (MRV) and sustainable development. The efforts are preparatory with the aim to lead to concrete collaborations. In 2018 SEA commissioned nine virtual pilots to be developed in seven different countries. Based on actual data, national policy landscape (including NDC) and country-specific settings, the virtual pilots present examples of how different mitigation activities could be designed under Article 6. Each pilot has resulted in a report, presenting a fully developed blue-print of a mitigation activity in a real-world setting.

[47] Reference M2017/00821/KI, M2018/00973KI

5.5. Financial flows leveraged by bilateral climate finance

5.5.1. Mobilisation of capital through Sida

Since 2009, Sweden has an Ordinance for Financing of Development Loans and Guarantees for Development Cooperation. This provides opportunities to expand and leverage available resources for development by linking public measures with market finance. Guarantees stimulate mobilisation of both private and public capital, including partner countries' domestic capital. Sida helps lenders deal with risks by insuring eligible projects against losses relating to the different market risks. A common set-up is that Sida covers part of the loss if the borrower fails to repay the loan to the bank. Sida's guarantees are based on a set of simple key principles and conditions: additionality, risk-sharing, risk reflecting premium to be charged and that it should be non-distortionary. In 2018, Sida had guarantees to climate-relevant initiatives with a total guarantee volume of approximately 4.4 billion SEK, mobilising about 14 billion SEK. Note that part of the mobilised capital is provided by Development Finance Institutions (DFIs) that are partly or fully owned by public entities.

Table 5.8 **Guarantees provided by Sida in 2018 for climate-relevant investments**[48] [49]

	Agreement period	Guarantee volume (MSEK)	Mobilised capital (MSEK)	Main source of mobilised capital	Guarantee volume (MUSD)	Mobilised capital (MUSD)
10121* Portfolio Guarantee Georgia	2018-12 – 2025-12	220	440	Private	25	51
10154* Private Agriculture Sector Support (PASS)	2017-09 – 2024-09	190	264	Mixed	22	30
11016* TRINE, 2018-2022, Crowdfunding Renewable Energy	2018-03 – 2023-03	60	100	Private	7	12
12866* Lendahand crowdfunding guarantee	2018-12 – 2023-12	60	120	Private	7	14
10421* NEFCO guarantee energy efficiency Ukraine education	2017-11 – 2032-12	270	1 500	Public	31	173
54020084* Guarantee BiH Sberbank in cooperation with USAID	2010-09 – 2020-09	25	42	Private	3	5
54020111* Deutsche Bank Consortium II: Guarantee 2012-2018	2012-08 – 2020-01	14	835	Private	2	96
54020115* Pakistan - Guar Windpower	2013-10 – 2024-11	480	1 071	Public	55	123

[48] 1 USD = 8.693 SEK.

[49] Note that this is a complete list of all the climate relevant guarantees that are currently ongoing. The amounts included in the table refer to the total amount of the guarantee (not the yearly amount), i.e. the guarantees included in this list run over several years. All climate relevant guarantees that are currently active are included for transparency reasons.

54020123* Agri Guarantee USAID_Multi Party	2012-10 – 2019-10	37	51	Private	4	6
54020124* Agri Guarantee USAID_Zanaco	2012-10 – 2019-03	26	46	Private	3	5
54020134* Conflict-Affected and Fragile Economies Facility (CAFEF/MIGA)- Guarantee	2013-06 – 2034-06	200	684	Private	23	79
54020146* Portfolio Guarantee - Asian Development Bank	2016-10 – 2026-12	2 000	4 235	Public	230	487
54020158* Global Guarantee Facility Household Technologies	2014-12 – 2029-09	160	210	Mixed	18	24
54020125* LPG Sustainable Energy Moldova	2014-04 – 2029-04	9	15	Private	1	2
54020179* Zambia, bioenergy Madison Finance LPG guarantee	2015-09 – 2022-09	26	33	Private	3	4
54020155* NEFCO Portfolio guarantee	2015-01 – 2029-12	300	600	Public	35	69
54020185* Guarantee of IFC´s loan portfolio	2017-11 – 2042-11	535	3 842	Mixed	62	442
55190036* Colombia-Loans & Guarantees for rural dev	2018-12 – 2025-06	45	90	Private	5	10
Total**		**4 385**	**14 077**		**504**	**1 619**

*The eight-digit number is a project code that can be used to find information on the specific projects on the openaid.se webpage.

**The values for each guarantee have been rounded off. The totals refer to the sums of more specific values of the guarantees.

5.5.2. Mobilisation of private capital through Swedfund

Swedfund International Ltd is Sweden's development finance institution. It is a limited liability company entirely owned by the Swedish state. The Ministry of Enterprise and Innovation assumes responsibility for administration of the Swedish state's ownership of Swedfund, whereas the Ministry of Foreign Affairs is responsible for the company's development policy mission and financial contributions. Swedfund's mission is to contribute to the goal of Sweden's development policy and Sweden´s Policy for Global Development. Swedfund's mission is to contribute to poverty reduction by investing in sustainable businesses - investments that are financially, environmentally and climate-related, and socially sustainable. Since 1979, Swedfund has invested in companies and funds located in Africa, Asia, Latin America, Eastern Europe and the Middle East. At the end of 2018 Swedfund had 58 investments in companies and funds in 18 countries, of which 63 percent of investments were located in Africa. Environmental, climate and social aspects are of paramount importance in all Swedfund's investments, as established in the owner's instruction for Swedfund and demonstrated in Swedfund's business model and comprehensive Policy for Sustainable Development. In order to measure

performance, Swedfund has adopted four strategic sustainability goals. Indicators have been developed which are carefully measured and followed up during the value-creation phase of each investment. Swedfund is always a minority investor, thereby ensuring that an investment made by Swedfund is catalytic and leads to financial commitments from both industrial and financial partners. Swedfund's additionality as an investor is viewed not only in financial terms, but also in terms of knowledge transfer, e.g. with respect to climate and environmental impact, social impact and other sustainability criteria such as good governance and anti-corruption.

In recent years, Swedfund has increased its investments substantially in the energy and climate sector. In accordance with the owner's instruction, Swedfund only invests in renewable energy. In 2018, Swedfund invested in Husk Power Systems (Husk). Husk generates and distributes renewable electricity to households and small businesses through its own mini-grids in India and Tanzania. At the time of the investment, Swedfund established an Environmental, Social and Governance Action plan and has worked closely with the company to support the implementation of this action plan.

In 2018, Swedfund invested 15 million USD in Climate Investor One (CIO). This innovative financing facility was established by the Dutch development bank FMO and Sanlam InfraWorks, part of the South African Sanlam Group. CIO focuses on developing, constructing and operating businesses that produce renewable energy, with a focus on Africa and parts of Asia. CIO offers tailored financing throughout the life-cycle of a project, with the overarching aim of developing renewable energy capacity faster. The facility has been developed based on the knowledge that different stages of a project's life-cycle are suited for financing with different types of capital and enables different to participate in line with their own risk profile.

In 2018, Swedfund analysed how climate and environmental risks impact on Swedfund's investments and how, in turn, these risks can impact on Swedfund's financial position. To conduct the analysis, Swedfund developed a method to take account of the climate risks and the requirements concerning mitigation that Swedfund imposes on portfolio holdings.

In addition to financial commitments, Swedfund has continued to contribute to renewable energy in developing countries by, for example, cooperating with the wider European development community within the realm of ElectriFI, a facility set up to develop early-stage electrification projects using renewable resources.

In 2018, Swedfund made the investments and helped mobilise the amounts of capital listed below. (The World Bank definition of mobilized capital is used).

Table 5.9 **Swedfund - New investments 2018 (Contracted) - Total**

Portfolio company	Swedfund's investment	Mobilized capital	Source of capital
TLG Credit Opportunites Fund	8.7 MEUR	0.9 MEUR	Debt (Fund)
Victoria Commerical Bank	4.4 MEUR	8.7 MEUR	Debt
Catalyst II	8.7 MEUR	1.0 MEUR	Equity (Fund)
Climate Investor I	13.1 MEUR	10.1 MEUR	Equity (Fund)
Prasac	8.7 MEUR	5.8 MEUR	Debt
d.light	6.2 MEUR	4.9 MEUR	Equity (Direct)

5.6. Capacity building

5.6.1. Capacity building through official development assistance (ODA)

Capacity and institutional development is central for development and represents a fundamental entry point in all of Sida's operations. The majority of the climate finance support that Sweden provides through Sida therefore has capacity building integrated into the core of its operations. Capacity building takes place at the organisational level, individual level, level of institutional frameworks, and often a combination of the three.

Examples of Sweden's support to building climate change capacity are provided in Annex A, CTF Table 9 and the boxes below. The examples are selected to represent different types of capacity building support that Sida provides. These include initiatives where building climate change capacity is the main objective, other contributions where climate is part of contributions aiming to develop wider capacity to report under international conventions and improve negotiations skills in international fora, and contributions where climate change is integrated in operations building capacity in areas such as energy, disaster risk reduction (DRR), forestry or agriculture. It often includes support directly to low-income country

government institutions. Examples include support given to county governments in Kenya to enable further access to climate financing and support via multilateral institutions as in the case of the Landscape and Forests Management Multi Donor Trust Fund with the World Bank in Mozambique. It includes support to regionally owned institutions, such as the Asia Disaster Preparedness Center (ADPC), to civil society-based organisations, for example through the Pan African Climate Justice Alliance (PACJA), which works with the participation of African CSOs in the climate governance discourse, and in cooperation with Swedish Authorities, such as the Water and Climate Change Information Services for Ethiopia implemented together with the Swedish Meteorological and Hydrological Institute.

BOX 5.5 Sida supports the Water and Climate Change Information Services for Ethiopia (WACCA-Ethiopia), a country driven initiative to strengthen and accelerate efforts at national and regional levels across Ethiopia in the development of climate and water information and early warning services. This is done, in cooperation with the Swedish Meteorological and Hydrological Institute, by building technical capacity and institutional sustainability for the provision of these key services.

BOX 5.6 The contribution provides support to the UN Climate Change secretariat (UNFCCC) for building the capacity of developing countries in terms of monitoring, reporting and verification of global greenhouse gas emissions in accordance with the Paris Agreement and the transparency framework. Some of the activities include technical support to national experts, exchanges of experiences and lessons learnt between countries and e-learning courses for the certification of national experts from developing countries. During 2018, the secretariat trained 484 individuals from developing countries on GHG inventories.

BOX 5.7 In response to the need for climate-smart investments in low- and middle-income countries, the International Finance Corporation (IFC) has created a fund investing in green bonds in emerging markets. Green bonds are instruments that raise ear-tagged financing for pre-defined purposes (such as renewable energy and energy efficiency) while informing investors of results. The fund, Amundi Planet Emerging Green One, is the world's largest green bond fund in emerging markets and has mobilised institutional capital to invest 2 billion USD in green bonds. As part of the Fund, Sida is co-financing a technical assistance programme to build local capacity on green bond markets and provide technical support on green bond issuances and reporting. The programme also involves the establishment of regulatory frameworks that contribute to making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.

In summary, Sweden provides extensive support to climate change capacity building, with different approaches and in cooperation with different types of actors. This diversity is needed to respond to different partner countries' or organisations' specific needs and contexts.

5.6.2. Capacity building through other official flows (OOF)

Many of today's environmental challenges are transboundary and cannot be solved only within the borders of Sweden. The major emerging national economies of Brazil, Russia, India, Indonesia, China and South Africa (BRIICS) have extensive manufacturing industries that provide products to both the domestic and global market. These populous countries have a major impact on global resource use and environmental performance and are, therefore, key players in global environmental and climate cooperation. Developing relationships with strategic countries is positive for tackling environmental challenges, but also in terms of industry, export trade, foreign policy and security policy.

The Swedish Environmental Protection Agency (EPA) is carrying out several capacity building projects on behalf of the Swedish Government. The EPA contributes for example in Brasil in developing a methodology for faster diagnoses of urban air environment problems (cf. Box 5.8). In China and India, the EPA contributes to phasing out the powerful greenhouse gas fluorocarbon. In South Africa, the EPA contributes to analyzing levels of, for example, blacks soot particles. Cooperation in the US both for more efficient trading systems allowances and transport-efficient communities. Cooperation with Russia contributes of energy efficiency in buildings and industries. Activities in the Barents region contributed to the implementation of the Barents Council climate plan. Within the Arctic Council supported the cooperation the ongoing work within expert groups for short-lived climate gases.

BOX 5.8 SMHI has collaborated with the city Curitiba in Brazil with local and regional environmental authorities and universities. In this project, participants are developing a method to determine the emissions of particles and their impact on the city's air quality. The first phase of the project was initiated in 2016 and includes an inventory of the existing sources and emissions from air pollutants. As a result of this project, the city's department of urban planning and mobility has taken an interest in the environment impact of air pollutants and how to reduce the pollutants through urban planning. Under 2018 activities aiming to defining scenarios for urban planning opportunities and alternative traffic solutions was undertaken.

BOX 5.9 Swedish Meteorological and Hydrological Institute (SMHI) has together with experts from, among others, India participated in a conference in Nepal about difficulties and knowledge gaps with regard to modeling of air quality. In 2018 SMHI has also contributed in a conference in China about regional climate information.

5.7. Technology development and technology transfer

5.7.1. Technology development through official development assistance (ODA)

A large proportion of Sweden's development cooperation includes climate-friendly technology development or technology transfer. Transfer of technology is often combined in an integrated way with capacity building to ensure long-term sustainability. Examples are presented in the Annex A, CTF Table 8. The examples represent different types contributions, including mitigation and adaptation technologies, and are from a range of actors and contexts in Africa, Asia and Europe and global partnerships, soft as well as hard technologies, and within a number of different sectors, including energy, agriculture and disaster risk reduction. Note that this is only a selection of examples and not an exhaustive list.

BOX 5.10 Securing Water for Food is a challenge fund in partnership with USAID, the Ministry of Foreign Affairs of the Netherlands and the Department of Science and Technology of South Africa to source and scale innovative solutions from the private sector for improved water resource efficiency along the food value chain to enhance food security. The fund has so far among other things saved 11.4 billion litres of water, produced 3.7 million tons of food and reached approximately 6.25 million farmers.

BOX 5.11 Sida supports via FAO and UNICEF a program in Guatemala focusing on the recovery of livelihoods affected by drought. The low-cost technologies introduced include rainwater harvest systems for families and communities; manual water pumps; drought resistant crops; soil moisture retention practices; and microwatersheds management support. The target group is the most impoverished farmers and so far approximately 7,000 families have received support in order to better manage drought.

5.7.2. Technology development through other official flows (OOF)

Technology transfer is a component in most of Sweden's climate related cooperation with focus on mitigation and adaptation. Climate technology,

both for adaptation and mitigation, is an essential part of climate action and economic development. For this reason, it is not possible to report on climate finance which is only directed to technology transfer. However, some examples will be highlighted in this section of cooperative action on technology transfer.

Support to the technology mechanism under the UNFCCC and Paris Agreement

According to article 10 in the Paris Agreement, parties share a long-term vision on the importance of fully realizing technology development and transfer in order to improve resilience to climate change and to reduce greenhouse gas emissions. According to article 10, parties shall strengthen cooperative action on technology development and transfer under the Paris Agreement, and the Technology Mechanism established under the UNFCCC shall also serve as a mechanism under the Paris Agreement.

Sweden is participating in technology cooperation through support to the UNFCCCs technology mechanism, the Technology Executive Committee (TEC) and the Climate Technology Centre and Network (CTCN). The CTCN promotes the accelerated transfer of environmentally sound technologies for low carbon and climate resilient development at the request of developing countries. CTCN provides technology solutions, capacity building and advice on policy, legal and regulatory frameworks tailored to the needs of individual countries. CTCN has reported results from its first five years of operations.

Sweden has supported the CTCN with 479 574 USD in total for 2017 and 2018. Sweden's National Designated Entity, which is the focal point to the technology mechanism, is the Swedish Energy Agency.

Enhanced cooperative action on technology transfer

The Swedish Energy Agency offers technology transfer through various programs, such as accelerator programs that supports small and medium-sized enterprises (SMEs) with innovative energy solutions to reach out to other countries. These programs demonstrate innovative technology in India and Indonesia in cooperation with local stakeholders. Other programs have a sectoral focus such as the sustainable heating and cooling efforts in China. The main objective in the long run with all of the Swedish Energy Agency's programs is a sustainable energy future, in line with the 1.5-degree target. The programs are financed by the R&D budget of the Swedish Energy

Agency. A few examples of technology transfer are presented below, these are examples only and not an exhaustive list.

Technology transfer cooperation with India

The Swedish Energy Agency has been active in India since 2009 within the framework of the Swedish-Indian cooperation in the field of energy. Its overall objective is to build long-term relationships based on trade, research cooperation and knowledge development from the Swedish side. This will contribute to the Agency's mission of developing the energy system and achieving climate commitments. In line with this objective the Energy Agency has, since 2013, developed the program India-Sweden Innovations Accelerator (ISIA). This program supports business-oriented innovation development and dissemination by promoting networking, knowledge sharing and development of relations between Swedish and Indian actors active in innovative technologies for sustainable energy systems.

Since the start the ISIA program has facilitated the introduction of more than 45 Swedish SMEs to the Indian market. Around half of them are still active in different collaboration projects, from pilots to commercial cooperation. In 2017-2018 ten new innovations, from energy efficient water pumps for small scale farmers to smart grid solutions, where introduced to the Indian market through the ISIA.

As a continuation of its efforts, the ISIA program has taken a new step by launching a cleantech showroom at Business Sweden's office, the Embassy of Sweden in New Delhi, India. "Sustainability by Sweden – Showroom India" is the first showroom of its kind to showcase Swedish cleantech, renewable and energy efficiency technologies outside Sweden and with a focus on the context of the local market. The showroom was inaugurated on the 30th of November 2018.

One of the success cases of the ISIA program is the cooperation between the Swedish SME FOV Biogas and Indian stakeholders, such as the dairy company Amul, universities, micro grid developers and others. Today they have built over 70 biogas plants in India. FOV Biogas's innovative, fabric based and cost-effective biogas reactors where initially introduced to the Indian market through the ISIA program in 2014.

Technology transfer cooperation with Indonesia

The Swedish Energy Agency has had a cooperation with the Indonesian Secretariat of the National Energy Council (NEC) since 2013. In 2017 a

Memorandum of Understanding was signed between the energy ministers of the two countries, to cooperate in the fields of energy efficiency and renewable energy.

The Swedish Energy Agency also works closely with Business Sweden and ISPC Apindo to assist Swedish innovative SME:s, in the renewables and energy efficiency sector, to explore the Indonesian market and find local stakeholders to continue working with in Indonesia. During 2017-2018 six new innovations, mostly smart grid solutions, where introduced to the Indonesian market.

Another long-term area for cooperation between Sweden and Indonesia is the waste management and waste-to-energy sector. In 2018 the Swedish Energy Agency supported the city of Probbolingo to develop an action plan for their waste management.

Technology transfer cooperation with China

Furthermore, The Swedish Energy Agency is aiming to strengthen the long-term cooperation with China in the cleantech sector. The Swedish Energy Agency actively participated in the eight Clean Energy Ministerial (CEM) global forum and the third Mission Innovation global initiative that took place in Beijing in 2017. In the same year, a Memorandum of Understanding was signed by the energy ministers on Swedish-Chinese cooperation in the energy area.

The Swedish Energy Agency's efforts to promote collaboration and sustainability include setting up a Cleantech Hub program in Shanghai, which was inaugurated by the energy minister of Sweden in 2017. The program's long-term vision is to accelerate the expansion of cleantech innovation as a means to lower CO2 emissions and increase energy efficiency and security. The possible increase of implementing of innovative technologies on the Chinese market is considered to a great extend within the program.

The export and investment platform Smart City Sweden, showcasing smart and sustainable city solutions, facilitates cooperation and technology transfer between Sweden and other countries. The platform welcomes international delegations on decision-making level to explore Swedish cutting-edge solutions on the place. There has been a growing interest from Chinese stakeholders to know more about Swedish innovative cleantech companies operating in the smart city sector. Swedish companies have been active in

district energy in China for many years. In 2018 the Swedish Energy Agency initiated a more focused effort to promote suppliers to the district energy sector to penetrate the Chinese market, both on heating and cooling.

Support to Clean Energy Ministerial and Mission Innovation

The Clean Energy Ministerial (CEM), created in 2010, is a global forum where major economies and forward leaning countries work together to share best practices and promote policies and programs that encourage and facilitate the transition to a global clean energy economy. CEM members account for approximately 75% of global greenhouse gas emissions and 90% of global clean energy investments. The CEM's initiatives and campaigns enable low-cost, high-impact technical work that amplifies each government's clean energy deployment efforts. They seek to catalyse public and private actions towards ambitious but realistic targets. To achieve its goals, the CEM works with partners from the private sector, international organisations and civil society to bring their respective abilities, strengths, and resources to the table.

Sweden has been active in different initiatives, networks, working groups and campaigns to promote tech transfers. In 2018 Sweden co-hosted the 10th Clean Energy Ministerial and 4th Mission Innovation Ministerial meetings together with Denmark, the Council of Nordic States and the European Commission. The funding from Sweden amounted to 2 million SEK.

Mission Innovation (MI) is a global initiative of 24 countries and the European Commission, on behalf of the European Union. These 25 members have committed to seek to double public investment in clean energy RD&D and are engaging with the private sector, fostering international collaboration and celebrating innovators.

The Mission Innovation 1.5°C Compatible Solutions Framework, developed and led by Sweden, is supporting accelerated uptake of disruptive solutions by providing increased transparency of actual and potential emissions reductions, making it easier for governments, companies and investors to identify, support and fund the next generation of innovators. The Framework builds on existing initiatives from small and large companies, incubators, academia and other organisations that have begun to quantify the greenhouse gas impacts of goods and services.

At the heart of the methodology is a comparison between two lifecycle assessments. First the emissions from the existing system are assessed, including the underlying infrastructure when that is relevant. Then the emissions from the new way of providing the service using a new solution is assessed, together with the rebound effects. The difference in emissions between the two scenarios is the avoided emissions. The avoided emissions assessment can be used to inform strategic decisions, enabling the comparison of different options according to their reduction potential.

Figure 5.3 **Methodology in Mission Innovation 1.5°C Compatible Solutions Framework**

The Framework enables innovators to assess their solutions to maximise emissions reduction; incubators to identify start-ups with 1.5°C compatible solutions; investors to evaluate options for investment; and cities to move beyond incremental improvements to the existing system to transformative solutions with a positive impact.

The Framework have already begun to see how a solution perspective is generating significant interest. In 2018 calculations of 100 solutions were done with the total potential to avoid 3 Gigaton of emissions if rolled out globally by 2030. 1000 solutions with a potential to avoid 40–60 Gigaton, more than total global emissions, will be brought to the table at the 5th Mission Innovation Ministerial in mid-2020.

The support to CEM and MI is in the form of funding for the secretariats, paid by the Swedish Government, and through participation in the Workstreams and Innovation Challenges. These costs are covered by all the participants themselves.

5.8. References

OCED Exchange rate (2019).
https://data.oecd.org/conversion/exchange-rates.htm

6. Other reporting matters

6.1. Domestic monitoring and assessment

See section 3.1.2 for more information on Sweden's Monitoring under the new national climate policy framework.

6.2. Additional monitoring

In addition to the institutional set up under the national climate framework, monitoring takes place at both the EU and the national level. Under the EU's monitoring mechanism (Regulation (EU) No 525/2013), Sweden reports every two years on policies and measures, implemented and planned, to achieve the climate target for 2020. At a national level, regular evaluations have been performed of the country's climate policy. The first was a 'checkpoint' review that started in 2004 (leading to a climate policy decision in 2006), and the second was initiated in 2007 (resulting in the 2009 climate policy decision). To analyse progress towards the objectives, as well as the state of knowledge, a further checkpoint review was undertaken in 2015.

The Swedish domestic institutional arrangement for self-assessment is using the national system for the GHG inventory and policies and measures and projections, as described in section 1.3 and 1.4 above.

Annex A Projections methodology and calculation assumptions

Methodology

Different projection methods are used for different sectors. The methods that 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 B.1. Expert assessments are an important element in all stages of the process.

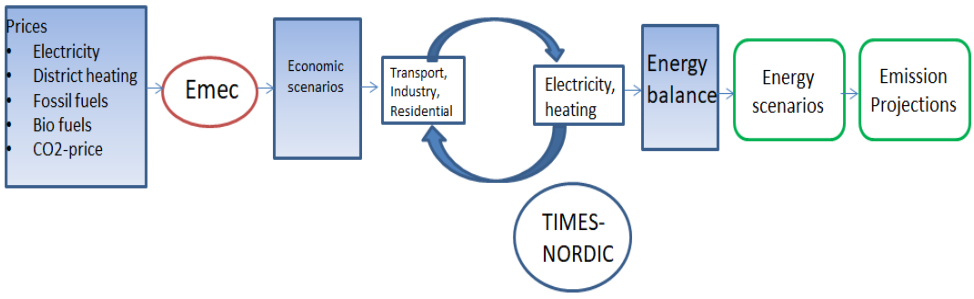

Figure B.1 **Projection process for emissions from the energy sector.**

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. Not just the Swedish energy system, but the Nordic energy system, is therefore optimised.

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.

Industry sector

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

Transport sector

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

The projections for road transport are based on assessments on transport demand and on the development of the vehicle fleet. The demand for transport with passenger cars is expected to be mainly influenced by demography, fuel prices and income in households, while the demand for freight transport is based on assumptions on economic development and trading overseas. The development of the vehicle fleet is based on the assumptions on the allocations of fuels and annual efficiency, which are a result of existing instruments and historical trends. 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, 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.

Assumptions underlying the calculations

Calculation assumptions for energy sector

General assumptions on which estimates for the energy sector are based:

- Within the EU emissions trading scheme, a price of 15.5 euros was assumed per tonne of carbon dioxide 2020 and 43.5 euros per tonne 2035 (in 2015 price level).
- 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 2035.
- In general, current taxes and other instruments (in place 1st July 2018) are assumed to remain unchanged until 2035.
- National Institute of Economic Research estimates of economic development (%/year):

	Reference
	2015-2035
GDP	2.05
Private consumption	2.52
Export	3.1
Import	3.01

- The trends in fossil fuel prices are given by the European Commission (2015 prices)

	Base year	Reference
	2015	**2035**
Crude oil (USD/barrel)	56	126
Coal (USD/tonnes)	66	131
Natural gas (USD/Mbtu)	8	13

- The Swedish Energy Agency's evaluation of price trends for biofuels (SEK/MWh (2015 prices):

	2015	2035
Wood chips	187	250

- The projection is based on normal production conditions. Changes due to future climate effects have not been taken into consideration.

Assumptions on which estimates for energy industries are based:

- 2 of Sweden's 8 reactors are to shut down by 2020. This leads to a decrease in nuclear capacity in Sweden. The remaining nuclear power plants are assumed to have an economic working life of 60 years, which means no further decommissions during the projection period.
- Projections of the Swedish sector price for electricity for the years 2020 and 2035. (Annual average, 2015 price level in SEK/kWh)

	2015	2020	2035
Electricity price	0.21	0.35	0.44

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

	2016	2035
Hydropower	62	69
Nuclear power production	61	47

- For the refinery sector, emissions are assumed to increase during the projection period, in accordance with the expansion plans of this sector. For the period 2016—2035, projected emissions indicate an increase in economic growth for the petrochemical industry, which according to the National Institute of Economic Research, is 1.4% per year.

Assumptions on which estimates for residential, commercial/institutional and combustion in agricultural, forestry and fishing sectors are based:

- The projections on energy use in residential, commercial/institutional and combustion in 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.

- The number of new apartments in single-dwelling houses and multi-dwelling houses in the projection is assumed to increase by 413 000 from 2017 to 2025 and by 528 000 from 2025 to 2050.
- Heated area of new single dwelling houses and new apartment buildings is assumed to be 149 m^2 and 65 m^2 respectively.
- Future climate effects have not been taken into consideration for assumptions on future heating demands
- Projections for households and premises are normal-year corrected, while historical emissions are not. Projected emissions are, therefore, high compared to the historical time series, since the latest years have been warmer than a normal year.

Calculation assumptions for industry

Assumptions on which estimates for industrial combustion 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 between 2015 and 2035 (National Institute of Economic Research):

Industry	Annual growth (%) 2015-2035
Pulp and paper industry	1.63
Chemical industry	1.92
Iron and steel industry	0.60
Manufacture of non-metallic mineral products	1.17
Non-ferrous metalworks	1.14
Engineering industry	2.43
Mining	1.52

Assumptions on which estimates for industrial processes and product use are based:

- The projection is based on historical trends as well as economic projections for each industry.

- The assumption on projected value added is the same as those for manufacturing industries.

Assumptions on which estimates for transport are based:

- 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.
- The prices assumed for ethanol (E85 and E95) and CNG (Compressed Natural Gas) are assumed to be profitable in relation to petrol/diesel during the whole period. Only fuels that are on the market as of today are included.

Fuel prices, SEK/litre, including tax and excluding VAT, 2016-year fixed prices	2016	2035
Petrol, with low-blend ethanol	10.9	16.7
Diesel, with low blend biodiesel	9.8	16.6

- Since 1st July 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. Current tax levels are assumed during the whole period. According to the Fuel Quality Directive a low blend of up to 10 % of ethanol in petrol is permitted. Up to 7% of FAME may be blended in to conventional diesel. The low blending of HVO 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 diesel usage. Renewable fuel that is sold without being blended with non-renewable fuel is fully exempted from tax.

Calculation assumptions for the waste sector

Assumptions on which estimates for the waste sector are based:

- The projections are based on 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.

- Projections of emissions from biological treatment of solid waste are based on future biogas production data.

Calculation assumptions for the agriculture sector

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 average prices for 2013-2017 in Sweden and price projections from OECD/FAO[50], extrapolated to 2035.
- 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 common agricultural policy (CAP) in 2017 is assumed to continue until 2035.

Calculation assumptions for the LULUCF- sector

Assumptions on which estimates for the LULUCF-sector are based:

Forest land

- The projections are based on the business as usual scenario in an analysis of forest development (SKA-15) in terms of *inter alia* management, climate effect and nature conservation.
- Harvest is assumed to continue to increase in the future and further increase after 2025, since it is foreseen that the demand for biomass will increase.

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

- The reported projection is based on a scenario 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 annual reporting under the UNFCCC and the Kyoto protocol.
- In the scenario 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 822 000 ha is set aside for nature conservation through legal protection and 2 953 000 ha is set aside through nature conservation measures in forest management and through voluntary measures by forest owners.
- In the scenario, 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

- Projections for each carbon pool are based on the mean net annual carbon stock change for the period 2008-2017 as reported in the National Inventory Report, submission 2019.
- Mean annual carbon stock change per area is multiplied with the projected area of cropland estimated by areas provided by the Swedish Board of Agriculture.

Wetlands, Settlements

- Projected emissions/removals for each reported carbon pool are assumed to be constant and estimated as a mean for the period 2008-2017 as reported in the National Inventory Report, submission 2019.

Harvested Wood Products (HWP)

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

Assumptions on which estimates for the sensitive alternatives for the energy sector are based:

- Import prices on fossil fuels and exchange rates, (2015 prices)

	Base year	Reference and Lower GDP	Lower fossil fuel prices
	2015	**2035**	**2035**
Crude oil (USD/barrel)	56	126	46
Coal (USD/tonnes)	66	131	55
Natural gas (USD/Mbtu)	8	13	6

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

	Reference	Lower GDP	Lower fossil fuel prices
	2015-2035	**2015-2035**	**2015-2035**
GDP	2.05	1.6	2.2
Private consumption	2.52	1.82	3.0
Export	3.1	2.52	3.14
Import	3.01	2.59	3.68