

# The Swedish CO<sub>2</sub> tax – an overview



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## Summary

This report describes the Swedish carbon dioxide (CO<sub>2</sub>) taxation between 1991-2018, as well as the political process before the implementation. Sweden was one of the first countries to introduce a CO<sub>2</sub> tax on fossil fuels and did so as a part of a major tax reform. The CO<sub>2</sub> emissions have decreased by 26 percent since the tax was introduced.

The report has been written by Anthesis Enveco AB under a contract from Borg & Co AB for The Institute of Energy Economics, Japan (IIEJ) during January and February 2018. Henrik Scharin and Jenny Wallström at Anthesis Enveco have been responsible for writing this report.

The report contains the following.

- A description of the tax (section 2). In this section the tax is described with regard to the sources it is directed at as well as its design. The way it is collected and how much revenues it generates to the government is also addressed in this section. The Swedish CO<sub>2</sub> tax is relatively high in comparison to CO<sub>2</sub> taxes in other countries. However, for most of its duration the tax has differed between households and service sectors on one side and the industrial sector on the other side, in that the latter has paid a lower rate. It is fair to say that this lower rate has been the prerequisite for the significant increases of the higher rate for households and service sector companies. The administrative costs are low due to the facts that the tax, which is based on internationally acknowledged average fossil carbon content of the main categories of fuels, is collected in the same administrative way as the already existing energy tax from around 300 registered tax payers. Tax revenues to the Treasury are significant and have originated mainly from households and transportation. Since it is a Swedish policy not to ear-mark tax revenues it is not possible to determine the use of these revenues.
- The political process before, during and after implementation of the tax (section 3). There were a number of different political processes and a few reports before the introduction of the tax in 1991 as a part of a major tax reform including mainly significant reduction of income taxes. The already existing energy tax was to some extent lowered to ease the introduction of the CO<sub>2</sub> tax. However, adding the CO<sub>2</sub> tax to the tax system meant tax increases for all fossil fuels. In the end there was a strong political support to suggest a tax on CO<sub>2</sub> as a part of this reform and there has ever since been a broad political consensus in Sweden on using the CO<sub>2</sub> tax as the primary instrument in Sweden to reduce emissions of greenhouse gases. As it was only a small part of a big tax reform the introduction did not receive that much attention. The tax rate has step-by step been increased over the years and changes has also been made regarding the exemptions. Sweden became a member of the EU in 1995 and especially the

implementation of EU ETS in 2005 had implication for the tax. Over the years work has been done to phase out the tax deductions and exemptions. As of this year (2018), all sources subject to the tax are confronted with the same tax rate.

- How the tax has performed with regard to emission reduction, cost-effectiveness and public acceptance of the tax (Section 4). How the tax relates to other policy instruments aimed at climate change is also discussed in this section. Even though it is difficult to determine the actual effect the tax has had on CO<sub>2</sub> emissions, it can be concluded that emissions have been reduced significantly since the implementation, and especially within those sectors that have been subject to the full tax rate over the time period. At the same time that emissions were reduced the Swedish GDP have increased indicating decoupling between the two. That a tax on emissions creates incentives for taking cost-effective measures is supported both in theory and empirically. There have of course been some distributional effects of the tax since its implementation. But since the implementation and subsequent increases of the tax often have been offset by reduction of other taxes, the public have in general accepted the tax.
- The report discusses whether there exist any possibilities to improve the tax (Section 4.5). Since the tax performs well with regards to most of the criteria's the potential for improvement is limited. However, by taking away still existing exemptions and deductions the cost-effectiveness of the tax could be improved.
- Finally, a summary of the report together with a discussion is given (Section 5). The report finds the tax to be a successful policy instrument for combating CO<sub>2</sub> emissions. The broad political consensus and support of the tax over the years plays a major part in the public acceptance of the tax. The step-wise increase of the tax over the years have provided stakeholders with time to take measures reducing the burden of the tax.

# 1 Introduction

The global climate change requires efficient strategies to reduce greenhouse gas (GHG) emissions. A carbon dioxide (CO<sub>2</sub>) tax is a cost-effective economic instrument to achieve emission reduction targets. It creates a price for CO<sub>2</sub> emission regardless of what kind of fossil fuel is being used.

In Sweden, there are two types of fuel taxes - energy tax and CO<sub>2</sub> tax. The general energy tax was introduced in the 1950's and had mainly a fiscal purpose. It is levied on almost all energy used for engines and heating, except for most biofuels. In 1991, a CO<sub>2</sub> tax was introduced and the general energy tax was reduced. The purpose of the tax was to reduce the CO<sub>2</sub> emissions from burning fossil fuels. Sweden was among the first countries in the world to introduce a tax on CO<sub>2</sub> (next to Finland and Norway who introduced it 1990 and 1991 respectively) (Sterner & Köhlin, 2015). The main reason was the growing importance of environmental concerns on the political agenda (Hammar & Åkerfeldt, 2011). Over the years the CO<sub>2</sub> tax increased, from 250 SEK/tonne CO<sub>2</sub> in 1991 to the current one of 1 150 SEK/tonne.

The CO<sub>2</sub> tax is regarded as the corner stone of Swedish climate policy. The latest statistics shows that the total amount of GHG emissions from Sweden has decreased by 26 percent since the introduction of the CO<sub>2</sub> tax (Naturvårdsverket, 2017a). Sweden has low emissions per capita (4.5 tonne in 2014) compared to the EU27 average (6,4 tonne) (World Bank, 2018).

This report gives a background to the Swedish tax on CO<sub>2</sub> and explains the tax structure, the political process, and the economic and environmental effects. The work is based on interviews with key experts and a literature review. At first, a description of the tax is provided in chapter 2. Chapter 3 gives an overview of the political process before, during and after the implementation of the CO<sub>2</sub> tax. Chapter 4 presents the actual effects of the tax, e.g. on CO<sub>2</sub> emissions and distributional effects and discusses possibilities of improving the tax and chapter 5 discusses the findings and draws conclusions.

## 2 Description of the tax

The CO<sub>2</sub> tax targets fossil fuels used as motor fuels and for heating purposes and is levied on most products causing CO<sub>2</sub> emissions when combusted, such as petrol, oil and coal (Skatteverket, 2018). Biofuels and peat are not taxed since they in Sweden are not regarded as fossil fuels. The tax is levied based on the fossil carbon content of the fuel (the emitted quantities of carbon dioxide). The current tax rate in 2018 is 1 150 SEK/tonne CO<sub>2</sub>. This can be compared to the price of tradable permits within the EU Emission Trading Scheme (EU ETS) which is about 94 SEK/tonne.<sup>1</sup> Up until 2018 industry paid a reduced CO<sub>2</sub> tax rate. Use of fossil fuels for non-heating purposes within certain industrial processes have been and still are subject to tax exemptions. Those industries included in the EU ETS has been exempted from the tax in order to avoid double pricing of emissions.<sup>2</sup>

The tax was until 2018 differentiated in that the industry was subject to only a part of the full tax level. Since 2011, industries covered by the EU ETS are exempt from paying the CO<sub>2</sub> tax (Hammar & Åkerfeldt, 2011). The state legislators use average carbon content of the fuels to calculate tax rates and not actual emissions. This works since there exists a sufficiently strong relation between fossil carbon content of fuels and the CO<sub>2</sub> emissions when these fuels are combusted (Hammar & Åkerfeldt, 2011). Table 1 shows current CO<sub>2</sub> tax rates for different fuels. Certain areas of use are qualified for tax reliefs, such as aviation petrol when used for commercial air navigation and bunker fuels used in shipping.

**Table 1. CO<sub>2</sub> tax rates in Sweden, 2018 (Skatteverket, 2018).**

Product	CO <sub>2</sub> tax
Petrol	2.66 SEK/litre
Aviation petrol	2.66 SEK/litre
Diesel	3.29 SEK/litre
Heating/fuel oil	3 292 SEK/m <sup>3</sup>
Gas oil	3 463 SEK/1 000 kg
Coal	2 865 SEK/1 000 kg
Natural gas	2 465 SEK/1 000 m <sup>3</sup>

<sup>1</sup> Based on a price of 9,53 € 2/16/2018 and exchange rate of the same date.

<sup>2</sup> However, in 2018 the Government reintroduced the CO<sub>2</sub> tax for combined heat and power plants that are also covered by the EU ETS.

## 2.1 Collection of the tax

The CO<sub>2</sub> tax is collected by taxing the fuels in accordance with the prevailing EU rules as regards taxation of energy products, which means that registered tax payers may hold products under tax suspension until consumption or delivery to a non-registered tax payer. There is no fossil fuel production in Sweden so the tax payers consist only of importers, distributors or large consumers. In Sweden, there are about 300 registered tax payers (i.e. taxation points) (Hammar & Åkerfeldt, 2011). Since there are so few production points compared to consumption points, the collection process and control is simple implying low administrative costs of the tax. Petrol stations, for example, receives already taxed petrol and are therefore not burdened by any administration. However, the design can have negative effects on the financial liquidity of concerned businesses since they have to pay the tax before their products are sold. It also makes it difficult to differentiate the tax between different oil products (which differ somewhat with regard to emissions).

Oil distribution companies and owners of petrol stations pay the price by lower profit or lower wages, and owners of petrol driven cars face the burden of the tax via higher petrol prices. Consumers are usually aware of the fact that a large part of the petrol price consists of taxes, even though they might not be aware of the size of the CO<sub>2</sub> tax in relation to the energy tax and the sales tax. Figure 1 shows what the 2017 average petrol price (of 14.13 SEK/litre) consisted of.

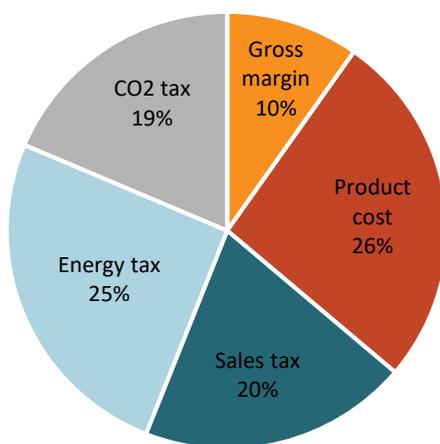


Figure 1. Content of the average petrol retail price in 2017 (SPBI, 2018).

Figure 2 shows the content of the price over time. As can be seen from the figure, production costs have fluctuated over time but in general increased some. It is not likely that the customer paying the petrol is aware of whether an increase in the price is caused by increased production costs or increased tax levels.

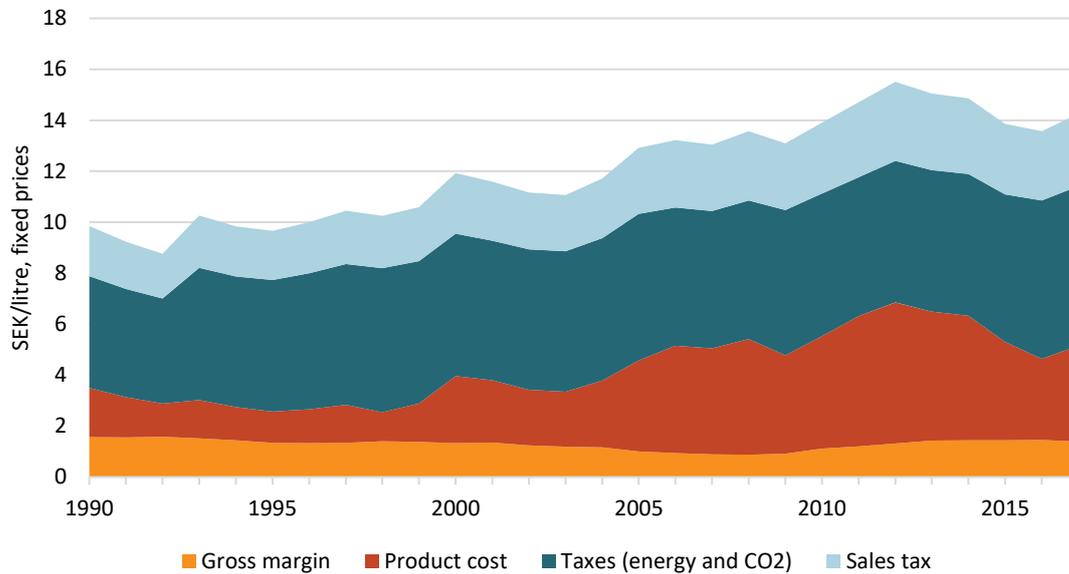


Figure 2. Content of the average petrol retail price 1990-2017 (SPBI, 2018).

## 2.2 Tax revenues

Figure 3 shows the CO<sub>2</sub> tax revenues since 1993. The revenues increased substantially until 2004 after which point they have been more stable and sometimes even decreased. This stagnation can be explained by the fact that the tax level has increased (especially after 2000) at the same time as the use of fossil fuels has decreased.

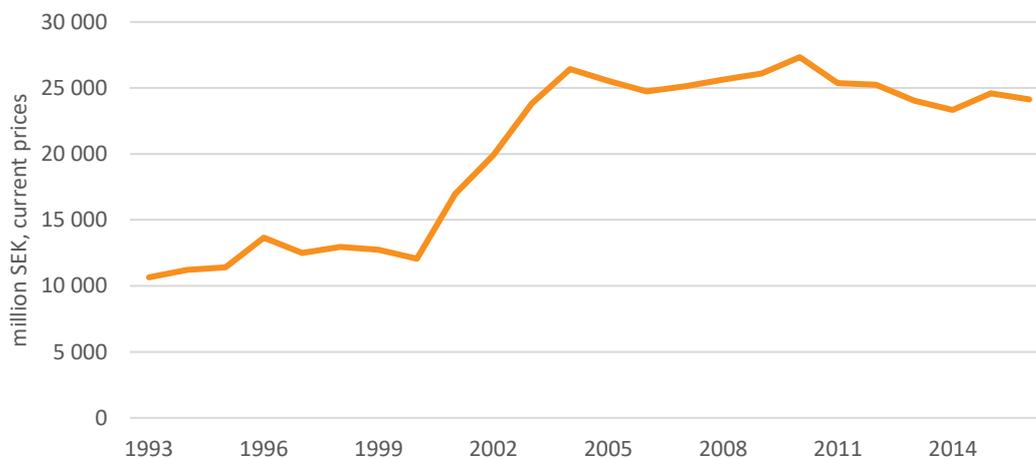
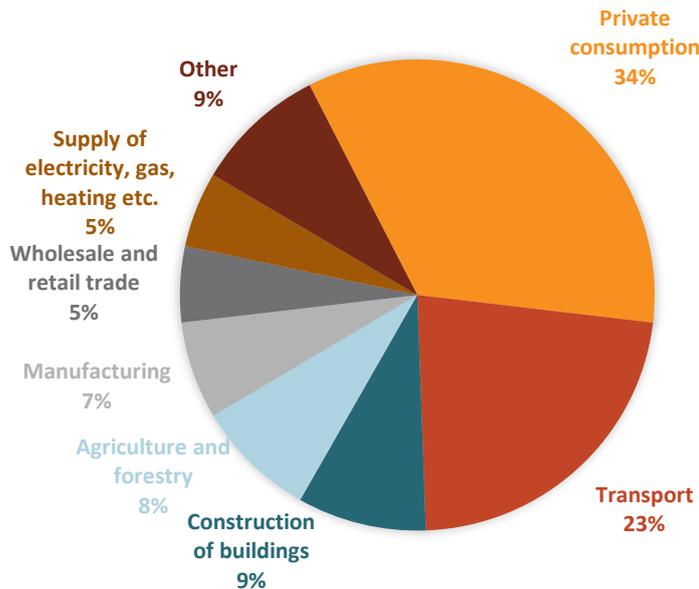


Figure 3. CO<sub>2</sub> tax revenues (SCB, 2017a).

Currently the CO<sub>2</sub> tax revenues accounts for about a quarter of all revenues for environmental taxes (SCB, 2017a).<sup>3</sup>

Figure 4 shows from which sector the CO<sub>2</sub> tax revenues come from. The greatest share of the CO<sub>2</sub> tax revenues can be related to private consumption, followed by transportation (SCB, 2017b). This is not that surprising since households have been subject to the full tax rate since the implementation.



**Figure 4. CO<sub>2</sub> tax revenues by industry, 2015 (SCB, 2017b).**

Since tax revenues are not ear marked in Sweden the tax revenues from the CO<sub>2</sub> tax goes straight into the treasury. How these revenues are used in the end depends on the ruling government, but there is no possibility to link the tax revenues with a specific state expenditure. However, significant parts of the state budget have over the years been allocated to various projects of relevance for reducing total GHG emission such as better public transport, an increased use of bio-fuelled district heating and housing insulation (Hammar & Åkerfeldt, 2011).

<sup>3</sup> The CO<sub>2</sub> tax together with the energy tax, the nuclear charge and the vehicle tax accounts for 88 percent of all revenues from environmental taxes.

### 3 The political process of the tax<sup>4</sup>

This section provides an overview of the political process before, during and after the implementation of the tax up to present date. It describes how the idea of a tax evolved and the main drivers behind the tax.

#### 3.1 Before implementation

Sweden has a long history of energy taxation. Petrol has been taxed since 1924 and diesel since 1937 (Åkerfeldt & Hammar, 2015). Since the 1950's an energy tax on electricity as well as oil and coal used for heating purposes has been collected. Later on, also natural gas and LPG (Liquefied Petroleum Gas) have been added to the tax base. However, up until the 70's the energy tax was purely financial in that its primary purpose was to raise public revenues. During the oil crisis of the 70's the energy tax was also seen as a means to reduce the oil dependency (Energimyndigheten, 2006).

Erik Dahmén, professor in economics, published a book in which he argued for pricing environmental damages (Dahmén, 1968). A common objection against environmental fees at this time was that it enabled the polluter to pay for the right to pollute. However according to a commission of 1978 (SOU 1978:43) a system without pricing means that the polluter gets permission to pollute for free even though the emissions generates socio-economic costs to the society.

The dominating political party at that time, The Social Democratic Party, was at first sceptical to using economic instruments to protect the environment. They did not support the idea that it would be possible to buy off your obligation to reduce your environmental damage. They instead advocated administrative instrument, i.e. rules and laws.

In 1988, a commission on economic instruments in environmental policy (the Environmental Charge Commission) was established to investigate the possibilities of to a larger extent using economic instruments in environmental policies. A first report on fees and taxes on sulphur and chlorine was published in July 1989. A CO<sub>2</sub> tax was not analysed at this point. However, the climate change was on the political agenda and the same year, the Swedish Parliament decided to request a programme to reduce CO<sub>2</sub> emissions. (Ministry of Environment and Natural Resources, 1991)

A major tax reform, popularly known as the "Tax reform of the century", was planned at the same time. The main purpose was to significantly reduce the marginal income tax rate. During the 1980's, the marginal tax rate was over 80 percent for some groups, but in this new tax system the marginal tax rate was not to exceed 50 percent (Nationalencyklopedin, 2017.). The Swedish Liberal Party demanded that

<sup>4</sup> The text in this section is to a large extent based on personal communication with Hammar and Åkerfeldt (2018) and Ericsson (2018).

environmental fees and taxes should be a part of the planned tax reform. Since it was necessary for the Social Democratic Party to get support from the Liberal Party to realize the tax reform, this speeded up the process of the Environmental Charge Commission to analyse the possibilities for economic instruments on energy and traffic, including a CO<sub>2</sub> tax. The Commission had then less than six months to propose policy instruments aimed at emissions from energy and transportation (SOU 1989:83).

Most interest groups were represented in the commission, including political parties, experts, the steel industry, the petrochemical industry, the Confederation of Swedish Enterprise, the Federation of Swedish Farmers, the Swedish Environmental Protection agency (EPA) and the Swedish Trade Union Confederation. During the negotiation, the Liberal Party, the Green Party and the Swedish EPA argued that since the purpose of the general energy tax is financial, it should be removed completely and replaced with a pure CO<sub>2</sub> tax. This would give a great control power which was essential to reach the climate targets. The energy intensive industry, the confederation of Swedish enterprise and the Moderate Party did not agree, their main concern was that the total tax burden would increase and affect the business. The industry was also already subject to energy tax deductions and did not want to lose their benefits. The Center Party and the Federation of Swedish Farmers lobbied for solutions that would benefit bioenergy and forestry. Over all, there was a political consensus on introducing a CO<sub>2</sub> tax, but different opinions on how it should be designed. (SOU 1989:83)

In a partial report by the commission (SOU 1989:83), a committee report was delivered which included a proposal that a CO<sub>2</sub> tax should be implemented on oil-based fuel products. The proposal was a compromise, implying a 50 percent reduction of the general energy tax and the rest replaced with a CO<sub>2</sub> tax. The report also included comments and reservations from different participants and stakeholders. Some of these argued that the time for the commission to analyse and propose environmental charges and taxes were too short. The report was also criticized for not thoroughly addressing the environmental and economic effects (especially the indirect economic effects). Some argued that there was no point for Sweden to act alone in solving a global problem such as the climate change, while others argued that the suggested design and level of the CO<sub>2</sub> tax was not enough to reach the targeted emission reductions of greenhouse gases. A broad hearing with different interests in the Swedish society was undertaken and thereafter a Governmental Bill suggesting a CO<sub>2</sub> tax was sent to the Swedish Parliament (Prop. 1989/90:111). The proposal in the bill differed little from the commission proposal. The bill was followed by a parliament decision to implement a CO<sub>2</sub> tax by law (SFS 1990:582).

## 3.2 Implementation phase

When the CO<sub>2</sub> tax was introduced in 1991, the tax level was 250 SEK/tonne CO<sub>2</sub> for all fuels. Since the energy tax was halved at the same time, the total tax on fossil fuels was marginally affected by the CO<sub>2</sub> tax introduction. However, the tax on coal was heavily increased.

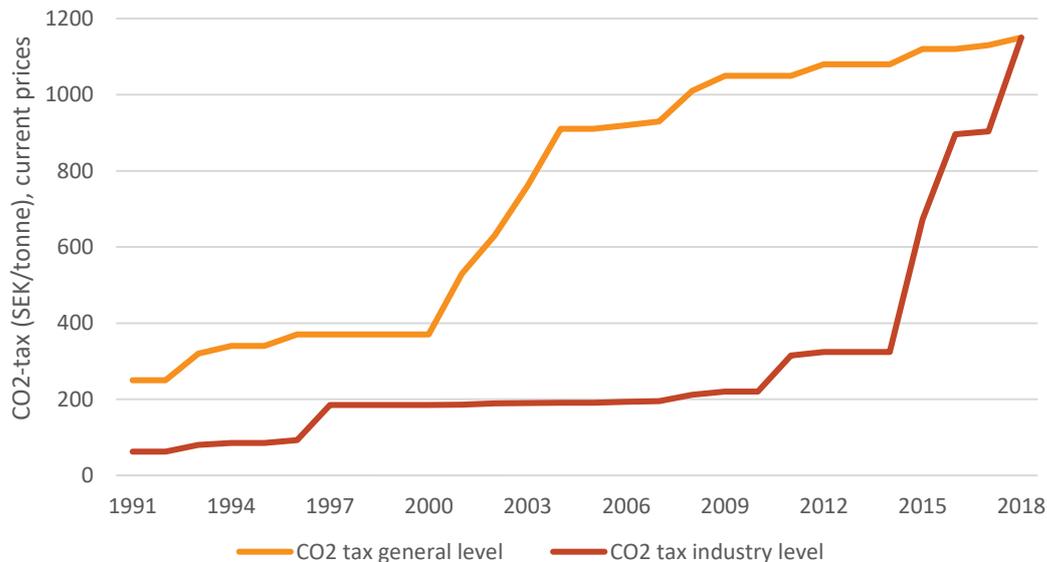
Thus, a lower tax level has ever since the introduction of the CO<sub>2</sub> tax been applied on fuels used for heating purposes by the industry. Such a lower tax level has been the prerequisite for a high tax level for other sectors and one important cause of the emission reductions achieved in these sectors.

Special reduction rules for industry with high energy use and horticulture was already in place for the energy tax and these rules were made applicable also to the CO<sub>2</sub> tax. Under these rules tax reliefs were granted to energy intensive industrial companies by individual Government decisions. For horticulture a lower tax level of 15 % of the general CO<sub>2</sub> tax was applied. The reason behind the differentiation was to avoid negative impacts on the international competitiveness of the local industry. The fear was that the production from industries would move abroad due to the CO<sub>2</sub> tax and not only affect the Swedish economy, but also lead to so called carbon leakage, i.e. increased emissions abroad.

The CO<sub>2</sub> tax was implemented as a part of the major tax reform in 1990-1991 aiming at lowering the personal marginal income tax rate. It also implied reduced energy taxes, the elimination of various tax shelters and base broadening of the value added tax. The reform attempted to be revenue neutral in the sense that an increase in certain tax revenues (e.g. from the CO<sub>2</sub> tax) would be offset by decreasing other tax revenues (e.g. from labour income tax and energy tax). The transition from the old tax system (with only a general energy tax) to the current system (with both energy tax and CO<sub>2</sub> tax) did not generate any administrative difficulties. This principle of taxing energy according to CO<sub>2</sub> emissions was widely accepted. (Ministry of the Environment, 1991)

### 3.3 Post implementation

The level of the CO<sub>2</sub> tax has been raised over the years in a step-wise approach in order to enable households and firms time to adjust. Figure 5 illustrates the tax levels over time and Table 2 shows a timeline with major changes affecting the tax.



**Figure 5. The CO<sub>2</sub> tax level (general and industrial) since the introduction (based on calculations from the Ministry of Finance).**

This system with individual tax reliefs to energy intensive industry granted by Governmental decision was administrative burdensome and non-transparent. Furthermore, it also risked to distort competition between enterprises as well as between different industrial sectors. Therefore, on 1 January 1993, the present two-level tax system was introduced in which all industries paid a lower tax rate corresponding to approximately 25 percent of the general CO<sub>2</sub> tax level (Government Bill 1991/92:150, Annex I:5). However, a special rule for energy intensive industry gave them the possibility to obtain further reductions of the CO<sub>2</sub> tax.<sup>5</sup>

In 1995, Sweden became a member state of the European Union and had to adapt its existing legislation to the relevant community law (community law refers to the common EU legislative framework). The design of the CO<sub>2</sub> tax could remain the same since it was in line with the relevant EU rules.

However, the reduction for industries was due to an EU Court ruling in the early 2000's regarded as a state aid by the EU legislation, and therefore Sweden has ever since had

<sup>5</sup> The general construction has been a linkage between tax paid and a certain percentage of the value added for the manufactured products.

to file an approval by the EU Commission or such subsidies for a certain time period at a time.

In 2000, the government decided on a new tax reform in which activities damaging the environment were more expensive and the marginal tax increased. As a part of this so called green tax reform, the CO<sub>2</sub> tax was increased between the years 2000-2005 from 370 SEK/tonne to 910 SEK/tonne. Also, the energy tax was increased to the same extent so that the relative competition between electric and fossil fuels was not altered (Energimyndigheten, 2006). For motor fuels the CO<sub>2</sub> tax increases was to some extent offset by a reduction of the energy tax).

**Table 2. Timeline of the development of the Swedish CO<sub>2</sub> tax.**

1991	Introduction of the CO <sub>2</sub> tax, with lower tax levels for energy intensive industry and horticulture.
1993	The reduction rules were replaced by a general lower CO <sub>2</sub> tax level for the industry
1995	Sweden became a member state of the European Union
2000	Green tax reform
2005	The EU Emission Trading Scheme (EU ETS) was introduced
2008	The government raised the CO <sub>2</sub> tax with 60 SEK per tonne to 1010 SEK per tonne
2009	The government bill on climate (2009/10:41) proposed a more uniform national price on fossil CO <sub>2</sub> by removing existing deviations from the general tax level.
2011	Industries covered by the EU ETS were exempted from the CO <sub>2</sub> tax. The CO <sub>2</sub> tax for the industry outside the EU ETS was increased.
2015	The CO <sub>2</sub> tax for the industry outside the EU ETS was increased again.
2017	New climate goals.
2018	The reduced tax rate for industry outside the EU ETS was totally abolished (all sectors were subject to the same tax level).

The EU Emission Trading Scheme (EU ETS) was introduced in 2005. This market-based EU community policy instrument was directed at GHG emissions from the energy intensive industrial installations, which in Sweden was already subject the CO<sub>2</sub> tax. The financial burden of EU ETS was initially low since the permits were given out without a cost based on previous emissions (so called grandfathered) and that the market price of these permits started out a low level.<sup>6</sup>

In the budget for 2008 (Prop. 2007/08:1) the Government raised the CO<sub>2</sub> tax with 60 SEK per tonne to 1010 SEK per kilogram of emissions. In the 2009 government bill on climate (2009/10:41) economic instruments, and in particular the CO<sub>2</sub> tax, played a

<sup>6</sup> Due to the free allocation of permits some industries initially actually made a profit on the EU ETS since they could sell permits they did not need.

major role. The bill proposed a number of changes regarding the CO<sub>2</sub> tax. One of these changes was to take steps towards a more uniform national price on fossil CO<sub>2</sub> by reducing existing deviations from the general tax level. The changes of the proposal entered into force in four different steps in 2010, 2011, 2013 and 2015. It was stated that the CO<sub>2</sub> tax should be increased in such a way so that it, in combination with other policy instruments targeting climate, reached the targeted emission levels of 2020 (Naturvårdsverket, 2012). The changes of the proposal entered into force in four different steps in 2010, 2011, 2013 and 2015 (Hammar & Åkerfeldt, 2011). Apart from increased environmental taxes there were made significant cuts in the labour taxes between 2007 and 2013.

In 2011 industrial emissions included in the EU ETS were exempted from the CO<sub>2</sub> tax. This decision was based on the argument that sectors should be subject only to one general economic instrument. However, Sweden introduced an energy tax in these sectors in order to fulfil the EU minimum tax levels set by the EU Energy Taxation Directive (Council Directive 2003/96/EC), which limited the impact of this exemption on the actual CO<sub>2</sub> emissions. Since the industry outside the EU ETS is less energy intensive and has lower energy costs, their competitiveness is less affected by the tax. Therefore, it was possible to increase the lower tax level of these sectors after 2011. This lower level was increased at first in 2011 from 21 to 30 percent of the general tax level and then in 2015 from 30 to 60 percent (see Figure 5).

In 2017, the Swedish Parliament decided to introduce a climate policy framework for Sweden containing new climate goals (Regeringskansliet, 2017). The aim is to have no net greenhouse gas emissions to the atmosphere by 2045, and after 2045 achieve negative emissions.<sup>7</sup> The target can be met by reducing domestic emissions and also to some extent by investing in measures that reduce emissions abroad. However, the emissions from activities within Sweden should by 2045 be at least 85 percent lower than 1990 emissions. Furthermore, by 2030 the GHG emissions from domestic transports (aviation excluded<sup>8</sup>) should be reduced by 70 percent compared to 2010.

Since 2014, work has been done to phase out the CO<sub>2</sub> tax reductions. In January 2018, the reduced tax rate was totally abolished for industry outside the EU ETS, implying that all sources are subject to the same tax level (see Figure 5). Additionally, the Government reintroduced the CO<sub>2</sub> tax for combined heat and power plants that are also covered by the EU ETS at 11 percent of the full tax rate.

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<sup>7</sup> Negative emissions mean that the amount of carbon dioxide taken up by nature as part of the cycle is greater than the emissions.

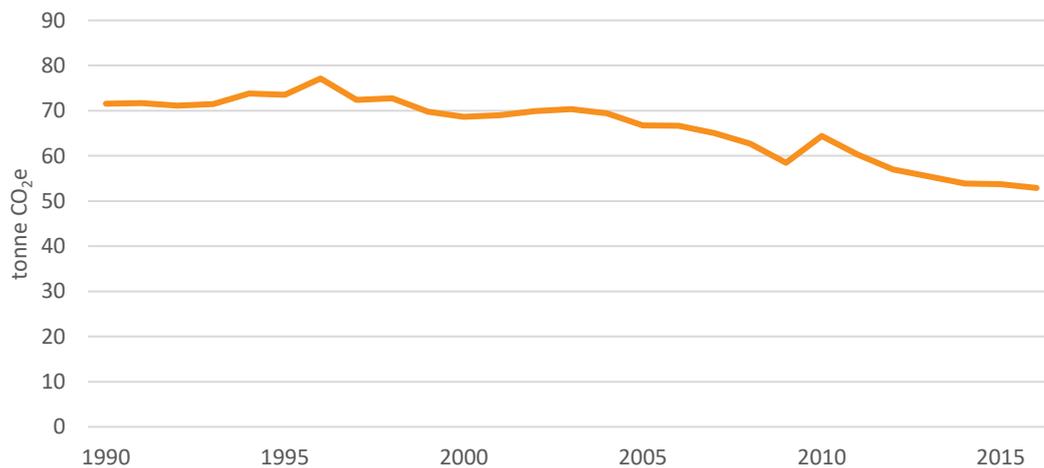
<sup>8</sup> The reason why domestic aviation is not covered in this target is because they were to be included in the EU ETS.

## 4 Effects of the CO<sub>2</sub> tax

This chapter addresses the question of whether the CO<sub>2</sub> tax has been successful or not. It discusses the impacts of the tax on different sectors and their emissions, the cost-effectiveness of the tax, the CO<sub>2</sub> tax in relation to other policy instruments, distributional effects of the tax and how the households have responded. Emission figures below include all greenhouse gases expressed in CO<sub>2</sub>-equivalents (CO<sub>2</sub>e).<sup>9</sup> The CO<sub>2</sub> emissions account for 81 percent of total greenhouse gas (GHG) emissions in Sweden (Naturvårdsverket, 2017d).

### 4.1 Changes in emissions from different sectors

The total Swedish emissions of GHG from domestic sources have decreased by 26 percent since 1990 (see Figure 6).

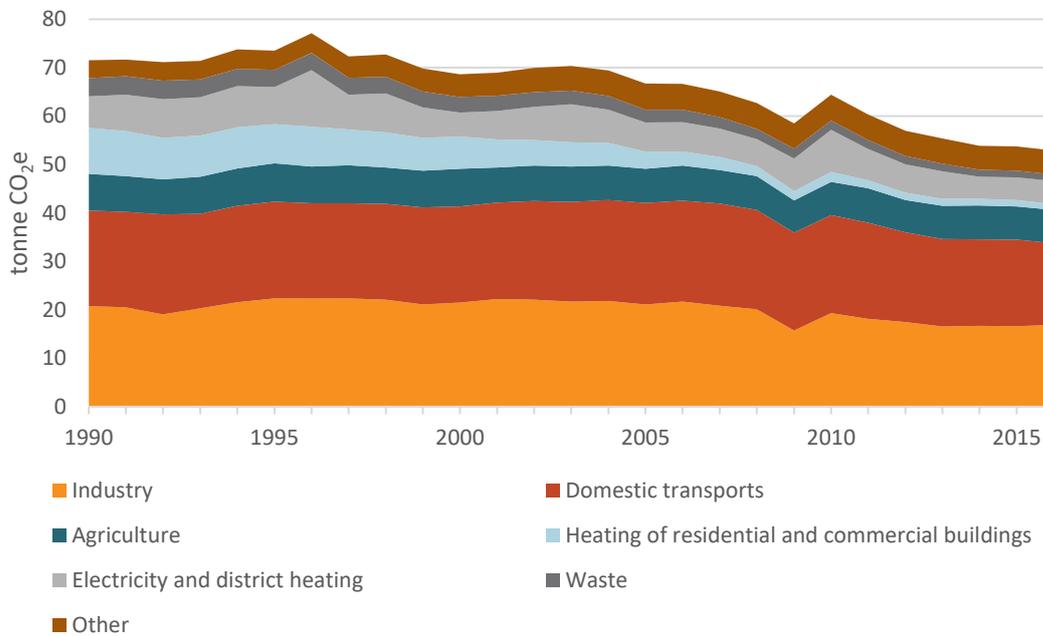


**Figure 6. Total CO<sub>2</sub>e emissions 1990–2016 in Sweden (Naturvårdsverket, 2017b).**

The CO<sub>2</sub> tax has been the primary instrument to reduce the fossil fuel consumption and the CO<sub>2</sub> emissions. But the emission reductions can also be explained by the fact that Sweden has access to some major national renewable energy resources, such as hydro power and biomass from the forest. The greatest reduction has taken place after 2003 and can partly be explained by a stalled growth in industry production and partly by implemented measures.

<sup>9</sup> Carbon dioxide equivalency is a quantity that describes, for a given mixture and amount of greenhouse gas, the amount of CO<sub>2</sub> that would have the same global warming potential (GWP), when measured over a specified timescale (generally, 100 years).

When looking at changes in CO<sub>2</sub> emissions over the time, the major contribution to the reduction of carbon emissions have been achieved in residential and commercial buildings, as well as in the industry (see Figure 7).



**Figure 7. CO<sub>2</sub>e emissions from different sectors (Naturvårdsverket, 2017b).**

Measures reducing the CO<sub>2</sub> emissions have been taken for a long time in Sweden. Some of them were implemented even before 1990, such as development of fossil fuel free electric production (hydropower, nuclear power and more recently bio power and wind power), extension of municipal district heating systems, increased use of biofuels and waste as fuel for electricity and district heating, a fuel shift in the industry, and reduced landfill of waste (Naturvårdsverket, 2017a).

It is hard to say exactly how much of the emission reduction is due to the tax. The actual emissions are also affected by other policy instruments (such as subsidies for electric cars, energy efficiency legislation, certificates for renewable electricity) aimed at reducing CO<sub>2</sub> emission. Furthermore, it is hard to know what would have been the emission level if there were no policy instruments. It is, for example, possible that some relocation of domestic industrial production to other countries would have taken place regardless of the CO<sub>2</sub> tax. The fact that business cycles and weather (e.g. extreme cold winters increase energy use) also have an impact on carbon emissions makes it difficult to determine the effect of the tax.<sup>10</sup> However, the CO<sub>2</sub> tax has probably been an

<sup>10</sup> As can be seen in Figure 7, almost all sectors' emissions dropped during the global financial crisis in 2007-2008.

important driving force by giving incentives to households and firms to reduce their emissions.

In 2016, the emissions from the sectors outside the EU ETS amounted to 32,6 million tons CO<sub>2</sub>e, which implies a reduction by 30 percent compared to the levels of 1990. Since 2005, the annual reductions have in average been about 2 percent. This is still too low for reaching the climate targets, which requires an annual reduction of 4 percent (Naturvårdsverket, 2018).

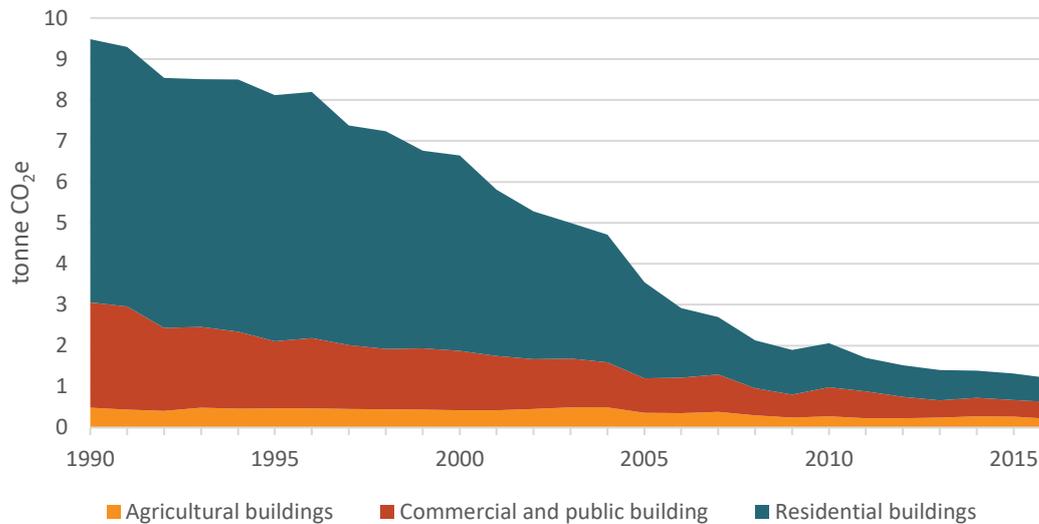
In all fairness, the emission caused by the Swedish consumption (instead of its production) should also be considered when discussing the Swedish contribution to the global GHG emissions. This would include emissions that emanate from production of goods outside Sweden and exclude emissions from Swedish products consumed abroad. In 2015 the consumption-based emissions amounted to almost 66 million tons CO<sub>2</sub>e (Naturvårdsverket, 2017a).

### Heating

The CO<sub>2</sub> tax has had the greatest impact on the heating sector (which has been subject to the full tax). Since 1990, the CO<sub>2</sub> emissions from this sector have decreased by 87 percent (Naturvårdsverket, 2017c), whereas the biggest reduction can be seen in residential buildings (see Figure 8). Oil have almost completely been phased out as a heating source in buildings and has been replaced with district heating, electric heat pumps and to some degree electric resistance heating.<sup>11</sup> According to the Swedish EPA, the big shift to fossil fuel free heating in Sweden can be explained by the expansion of the district heating system and the CO<sub>2</sub> tax. The control power effect on the heating sector has steadily increased since the CO<sub>2</sub> tax was introduced. In addition, temporary aid schemes aimed at the conversion to renewable energy have been implemented by the government. Currently, fossil fuel-based heating only accounts for 2 percent of Sweden's total GHG emissions (Naturvårdsverket, 2017c).

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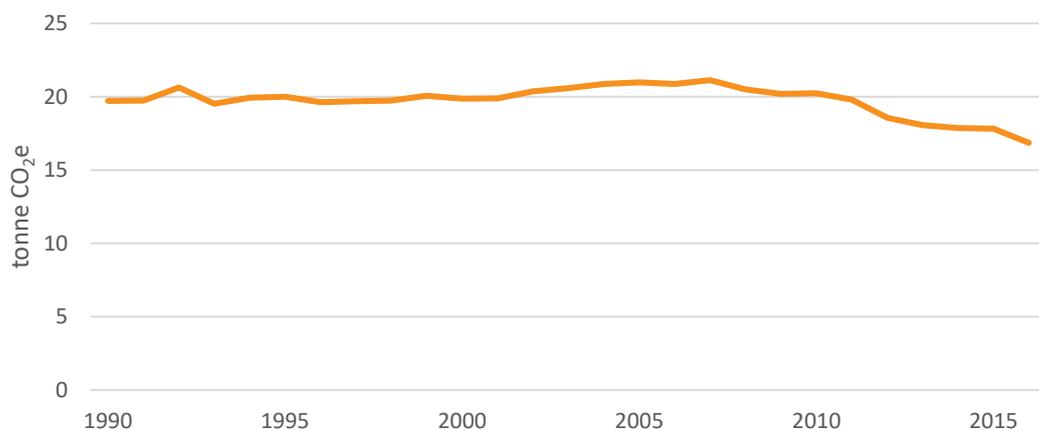
<sup>11</sup> Household waste is commonly used as an energy source for district heating.



**Figure 8. CO<sub>2</sub>e emissions from heating of different kinds of buildings (Naturvårdsverket, 2017b).**

### Transport

Domestic transportation accounts for about a third of Sweden's total GHG emissions. The sector's emissions increased and reached its top in 2007 by 21 million tonnes CO<sub>2</sub>e (see Figure 9). Between 2007 and 2016, the emission level gradually decreased and today it is 15 percent lower than 1990. The emission reduction can mainly be explained by an increased use of diesel and biofuels (Naturvårdsverket, 2017a). Older vehicles have also been replaced by new energy-efficient passenger cars, which contributed to the reductions. During 2014 and 2015, the emissions remained about constant, which can be explained by an increase in transportation enough to offset the improvements in the cars fuel efficiency, substitution to bio fuels and increase of electric vehicles. This trend was broken by a decrease in emissions by five percent between 2015 and 2016.



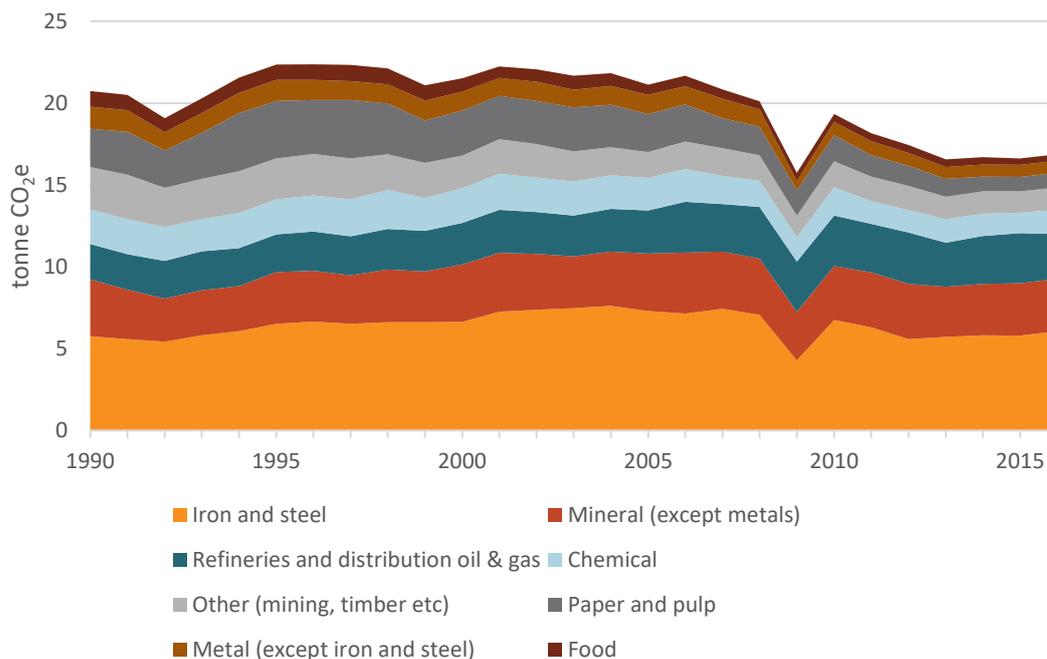
**Figure 9. CO<sub>2</sub>e emissions from domestic transportation 1990-2016 (Naturvårdsverket, 2017b).**

Even though the major part of the domestic transportation sector always has been subject to the full tax rate, it remains a major challenge to reach the target of a fossil free transport sector by 2030. Studies from the National Institute of Economic Research (Konjunkturinstitutet, 2013) estimates that the CO<sub>2</sub> tax on petrol would have to increase by 900 percent in order to reach this target.

Swedish GHG emissions from *international transportation* have more than doubled since 1990 due to increased transportation of goods and travel. But then again, these are not subject to either the CO<sub>2</sub> tax or the EU ETS.

## Industry

The industrial sector accounts for about a third of the Swedish GHG emissions (land use excluded). The major part of the industrial emissions is caused by the iron and steel industry, mining industry and refineries (see Figure 10). Industrial emissions are generated in the manufacturing process, fuel combustion and so called diffuse emissions (e.g. leakage of as pipes).



**Figure 10. CO<sub>2</sub>e emissions from different industrial sectors (Naturvårdsverket, 2017b).**

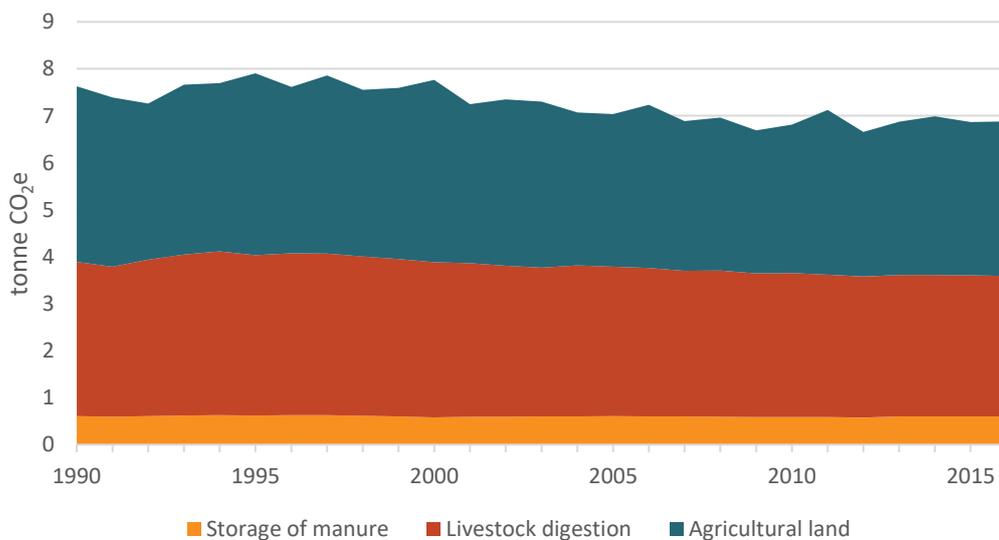
Since 1990, the emissions from the industrial sector have decreased by 19 percent. However, the emission level was almost constant until the financial crisis of 2007-2008. Since then, it has decreased due to reduced production volumes and new technologies, as well as on-going energy efficiency (Naturvårdsverket, 2017a). The paper- and pulp mill industry stands for the largest emission reductions due to a

substitution from oil to biofuels. The food, chemical and metal industry have also reduced their emissions. After a long period of increased emissions for refineries and oil- and gas distribution these emissions have stabilized.

The effect the tax might have had on emissions from the industrial sector have, of course, varied over time due to the deductions as well as the exemption from the tax for the energy intensive industries included in EU ETS. Economic fluctuations also cause changes in industrial emissions due to changes in production levels.

### Agriculture

Emissions from the agriculture accounts for a little more than 10 percent of the total emissions and can originate from storage of manure, livestock digestions and agricultural land. These emissions were about 10 percent lower 2016 in comparison to 1990. The major part of this reduction is explained by less livestock holding, increased productivity and reduced application of mineral fertilizers (Naturvårdsverket, 2017a). However, the last four years these emissions have remained pretty much the same.



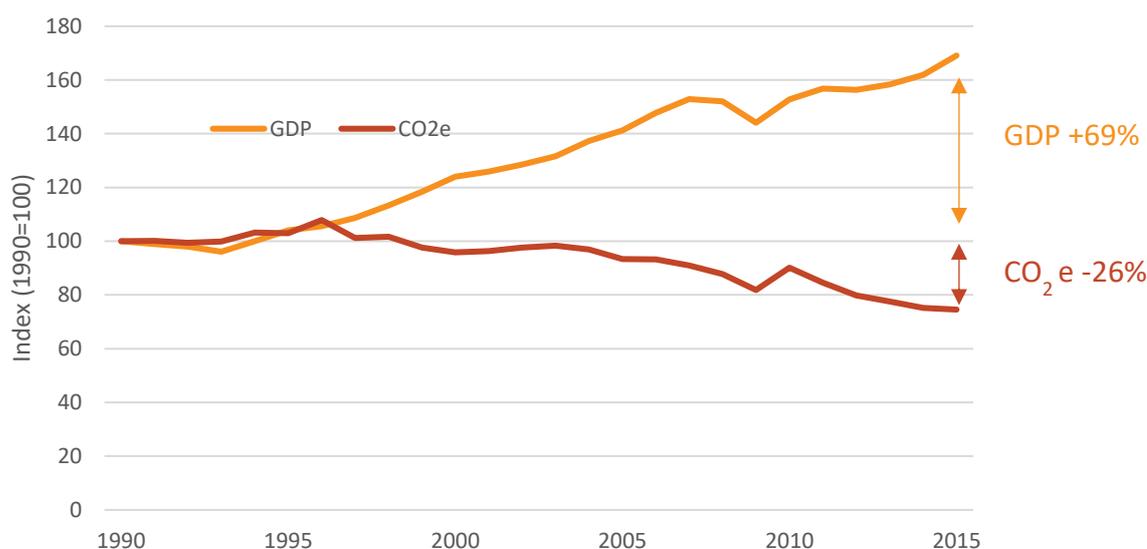
**Figure 11. CO<sub>2</sub>e emissions from the agriculture (Naturvårdsverket, 2017b).**

### Emissions and economic growth

It is hard to empirically determine if the CO<sub>2</sub> tax have had a negative impact on the Swedish economy. However, since its introduction in 1991 there has been a decoupling between economic growth and CO<sub>2</sub> emissions. Since the introduction of the CO<sub>2</sub> tax in 1991, the GDP has increased by 69 percent while the CO<sub>2</sub> emissions have decreased by 25 percent (see Figure 12). However, to which extent this can be explained by the tax is uncertain since there also been structural changes in the economy during this time period. The fact that some parts of the industrial production (and their GHG emissions)

have moved out of the country during this time period (probably for other reasons than the tax) can also be an explanation behind this decoupling.

It is important to emphasise that the CO<sub>2</sub> tax also has had positive synergy effects due to the fact that many measures used to reduce CO<sub>2</sub> emissions also leads to the reduction of other emissions. The combustion of fossil fuels also generates emissions such as sulphur dioxide, nitrogen oxides and particulates. These emissions are also reduced when the CO<sub>2</sub> emissions are reduced (Söderholm & Hammar, 2005).



**Figure 12. The Swedish GDP and GHG emissions 1990-2015 (based on calculations from the Ministry of Finance).**

It is hard to estimate whether the CO<sub>2</sub> tax has caused any carbon leakage since there are so many other factors (e.g. labour wages) explaining the movement of energy intensive production to other countries. Furthermore, industries did not pay the full tax before 2018 due to the risk of leakage and since 2011 the most energy intensive industries which are included in the EU ETS (which started 1/1 2005) has been exempted from the tax.

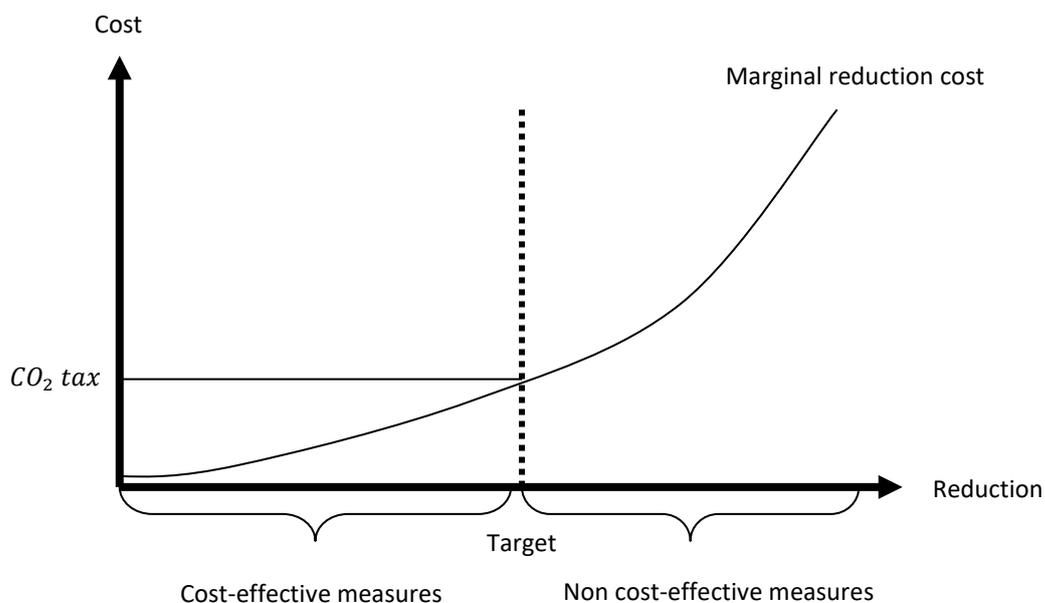
### Summary

The fact that the major reductions the past 25 years have been observed in sectors subject to the tax provides arguments that the tax has had some effect of emissions. The Swedish experience is that the CO<sub>2</sub> tax base is inelastic to price changes when it comes to petrol and diesel implying quite stable tax revenues. The general perception amongst politicians and stakeholders within the energy sector is that the CO<sub>2</sub> tax has been the single most important policy instrument influencing the strong development of biofuel use in the district heating sector and the decrease of oil for heating of single households and business buildings (Energimyndigheten, 2006).

## 4.2 Cost-effectiveness

The economic definition of cost-effectiveness is that a target is reached at lowest possible cost to the society (or the largest environmental improvement is reached with a given budget). The cost-effectiveness of the tax lies in that the government does not have to engage in the often costly and inefficient process of “picking a winner” (e.g. a specific technology or fuel type), but allows the households and industries paying the tax to choose the measures they prefer (which usually coincide with the least cost). Such measures could include change in behaviours (e.g. driving less), or investments in new technologies (e.g. solar panels). That is, the tax is technology neutral. According to theory, a household or industry chooses to implement a certain measure if its marginal reduction cost is less than the tax (see Figure 13).

Since the area under the marginal cost curve represents total costs a tax generates the implementation of cost-effective measures. That is, target is reached at least economic cost to the society.



**Figure 13. Cost-effectiveness of the tax.**

Söderholm & Hammar (2005) give some reasons why it might be difficult to evaluate the cost-effectiveness of the CO<sub>2</sub> tax. First of all, it is hard to determine the incentives created by the tax. This is especially true for the effect the tax has on technological development. The fact that there exist so many other policy instruments aimed at climate change, and they change over time, makes it hard to deal with the “everything else equal” (*ceteris paribus*) assumption. Furthermore, a partial analysis misses the indirect effects of a tax that spans over the whole economy. The tax is likely to have

large effects on certain companies and sectors generating socioeconomic costs that might be hard to capture.

However, Söderholm & Hammar (2005) as well as Sterner & Köhlin (2015) find several strong reasons to why the CO<sub>2</sub> tax is cost-effective:

- It is technology neutral, implying that it is up to the tax payers to choose the measure, which usually is the one with the lowest cost.
- The same price tag for everyone, implying the fulfilment of the marginal cost condition between these.
- There are low administrative costs (1% of revenue) in comparison to other policy instruments.
- The tax creates constant incentives for technological innovation aimed at reducing emissions.

The marginal cost of measures reducing carbon emissions is generally larger in Sweden than in other countries. This is due the fact that many low-cost measures already have been implemented, but also because the share of fossil fuels in or energy system is relatively low.

An advantage of the tax is that it provides more certainty regarding the emission prices in comparison to emission trading schemes such as the EU ETS which is subject to price oscillations.<sup>12</sup> This price certainty is of great importance to the dynamic cost-effectiveness since the it creates strong and less fluctuating incentives for mobilizing investment into clean technologies and other technologies of relevance for battling the climate problem.

### 4.3 Acceptance of the tax

The CO<sub>2</sub> tax's pros and cons has been debated among scientists, politicians and others. The main arguments for the tax is that it is the main explanation to the last decades' great reduction of CO<sub>2</sub> emissions. However, some argue that the current CO<sub>2</sub> tax is not high enough to generate all the measures required in order to meet the objective of a fossil free economy. Others claim that the tax harms the Swedish economy without giving any obvious benefits as long as other countries do not reduce their emissions. The low administrative costs of the tax and the fact that it creates incentives for cost-effective measures are two other arguments. From a state financial point of view the tax is also favoured due to the tax revenues it brings in to the treasury. The tax also fulfils

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<sup>12</sup> Such oscillation will allow automatic adjustment of the price e.g. in case of economic downturn or upturn when consumption decreases or increases. In case of a CO<sub>2</sub> tax, the rate will have to be adjusted through a law change in case changes in economic activity require a decrease or increase of the price.

the Polluter Pays Principle (PPP), since the damage costs caused by the fossil carbon emissions is shifted back to the polluters.

The acceptance of the tax by different stakeholders in the society can to a large degree be explained by the distributional effects of the tax. In Sweden, the distributional effects of the CO<sub>2</sub> tax have been dealt with by starting at a low level and increase the tax over time so that people can take measures to reduce the financial burden of the tax (e.g. by stop using oil for heating and transfer to biofuels or district heating). At the same time, the government have implemented subsidies and grants lowering the cost of these transformations for the households. The government has also helped in allocating resources to substitutes, for example by improving public transportation infrastructure. Also, the financial revenues generated by the tax can be used to compensate for distributional effects and/or help finance necessary adaption and mitigation measures.

Individuals and households in more rural areas that are dependent on the car as a major means of transportation might be more vulnerable to the tax than households in urban areas where other means of transportation are more accessible. Since the tax is applied uniformly over all users it is regressive in that low-income households will have to pay a larger proportion of their income to the tax as opposed to high-income households. However, such distributional effects can be solved by distributional policies, and to some extent this was also the case in the tax reform of 1991 in that it included an increase in basic income tax reductions for low and middle-income households. It has also been the case during increases of the tax that other taxes affecting the households (e.g. the income tax) have been reduced. How the tax has affected the industrial sector will differ widely depending on the energy intensity of a specific sector. The possibility of the specific industry to pass on the cost increase to the consumers (which depend on their market position) also matters.

Swedish citizens in general regard climate change as a real problem which might be the major explanation why the CO<sub>2</sub> tax is accepted by households as well as companies. The fact that also all political parties sees climate change as a real threat and regard the tax as the main policy instrument to reduce CO<sub>2</sub> emissions from domestic sources also contributes to this acceptance. It is therefore often easier to get public and political acceptance for a raise of the CO<sub>2</sub> tax than for example income and sales taxes, since the former is motivated for environmental reasons.

However, there has been some objections among citizens when it comes to raising the CO<sub>2</sub> tax, especially in the rural areas since people who live there are more dependent on cars and can get more affected by high fuel prices (Ericsson, 2018, pers. comm.). The CO<sub>2</sub> tax on petrol is a recurring question in the election campaigns. But despite the governments in Sweden has shifted several times between left-wing and right-wing since the tax introduction, no significant deviations have been made with regard to the CO<sub>2</sub> tax. The tax rate has over its time period never been reduced (see Figure 5).

In order for the tax to be accepted, there must be alternatives. Sweden has gradually built up the district heating network and public transport, which has enabled citizens and firms to reduce their emissions. Another strategy to increase the public's acceptance is to present political proposals on green investment to compensate for the raised CO<sub>2</sub> tax.

Over time, the industrial sector seems to have accepted the tax well. That fact that the tax was implemented as a small part of a large tax reform which included reduction of other taxes (e.g. the energy tax) aimed at this sector is one explanation for this acceptance. Another reason is that industries have been subject to lower tax levels (until 2018) and exemptions making the financial burden less. Furthermore, the industry and other stakeholders are involved in the decision-making process since proposals are sent for general public consultation before the government presents them to parliament (Hammar & Åkerfeldt, 2011).

#### 4.4 The tax in relation to other policy instruments

As mentioned earlier, one reason behind the difficulties of quantifying the actual effect the tax has had on emission is that there exist other policy instruments (e.g. legislation, subsidies, other taxes, information campaigns) aimed at the same target. Even though a large number of such instruments exist only a few are discussed in this section.

As a complement to the tax and in order to reduce the burden of investing in emission reducing measures, state resource have been allocated to subsidies/grants helping finance such measures. Examples of such financial support are grants for purchasing less polluting cars, investments in local public transportation (e.g. improved bike paths), grants for investments in geothermal heating of households etc.

##### Energy tax

The CO<sub>2</sub> tax is closely attached with the tax on energy. Even if both taxes have an effect on GHG emissions, the main reason for the energy tax is to generate state revenues (Energimyndigheten, 2006). The introduction of the EU ETS in 2005 led to changes in the CO<sub>2</sub> tax with regard to design and what sectors that are subject to the tax. For a while, some emission sources were subject to the tax as well as the trading scheme but in 2011 the tax was abolished for these sectors. Even if the purpose of the energy tax is to generate revenues it will also create financial incentives to implement energy saving measures that in many cases also implies reduction of CO<sub>2</sub> emissions. For example, the demand for more efficient cars is to a large extent driven by the petrol price which, in addition to the CO<sub>2</sub> tax, includes an energy tax. However, if the only objective were to reduce GHG emissions it would be more efficient to abolish the energy tax and only have a CO<sub>2</sub> tax.

### Climate investments

From 2003 and ending in 2012, more than one billion SEK were used for government grants to support climate investments within the so-called Climate Investments Programs (KLIMP) (Naturvårdsverket, 2013). Most of the measures were linked to energy, traffic and biogas, as well as information measures. The main purpose was to reduce GHG emissions, energy conversion and reduced energy use.

Currently, the government invests 1–2 billion SEK yearly within in the program “Klimatklivet” in climate measures. The measures are at a local level, for example in a city or municipality, at a company, in a school or in a county. The objective of the program was to finance cost-effective measures, i.e. biggest reduction of greenhouse gases per Swedish krona. That KLIMP was a cost-effective policy instrument have, however, been questioned (see Samakovlis & Vredin Johansson, 2007)

The Swedish Environmental protection agency (Naturvårdsverket) has been the governmental agency in charge of both these programs. The programs can be seen as a compliment to the CO<sub>2</sub> tax since they to some extent aim at promoting the positive externalities of innovative measures. Furthermore, the tax creates strong incentives (as a price signal) for different actors to apply to these grants.

### The tradable renewable electricity certificate scheme

The Swedish tradable renewable electricity certificate scheme is a market-based support system aimed at stimulating the introduction of renewable energy sources in the electricity sector. It was introduced in 2003 and was designed so that electricity producers obtained a certificate for every MWh of renewable electricity generated (Sterner & Köhlin, 2015).<sup>13</sup> In other words, the supply of electricity certificates is created by renewable electricity generation. Producers of electricity with renewable energy sources, through the sale of electricity certificates, receive an additional income for their electricity production (Naturvårdsverket, 2012). This policy instrument can be seen as a complement to the CO<sub>2</sub> tax in that it helps to meet the demand for renewable energy by providing some certainty for the suppliers of renewables.

### Summary

The CO<sub>2</sub> tax works as an engine with regard to the effect from the majority of other policy instruments aimed at reducing the nations GHG emissions. The incentive of a car buyer to purchase an environmental car is not only a function by the premium given by the government to those buyers but also on the savings made by the car buyer from reduced expenditures on fuel prices (which are subject to the tax). The effect on GHG emissions from these subsidies (as well as other policy instruments such as information and legislation) would most certainly have been less in the absence of a CO<sub>2</sub> tax.

<sup>13</sup> Renewable energy production qualifying for the scheme includes wind power, certain hydropower, certain biofuels, solar energy, geothermal energy, wave energy and peat in CHP plants.

Furthermore, the reduction of CO<sub>2</sub> emissions has often led to positive synergy effects in that other types of emissions also been reduced.

## 4.5 Possibilities of improving the tax

This section discusses in what ways the tax can be improved in order to meet specific criteria such as target fulfilment, cost-effectiveness, flexibility, incentives for innovation, etc.

With regard to cost-effectiveness the tax was improved this year (2018) in that all sectors became subject to the same tax level. However, if the exemptions for working machines in agriculture, forestry, and fishing also were removed the cost-effectiveness would increase. The cost-effectiveness of the tax could also be improved if the favorable tax treatment of diesel fuel used in transport was abolished. (OECD, 2014; Konjunkturinstitutet, 2015a, 2015b). Since administrative costs of the tax are as low as they are it is not likely that the tax can be improved with regard to these costs, but an increased transparency regarding future tax levels would reduce uncertainties for investments.

Another way to improve the tax would be to apply it to all greenhouse gases (e.g. methane, nitrous oxides, ozone) and not only carbon dioxides. This is possible to express the gases in terms of CO<sub>2</sub>- equivalents. However, it might be practically difficult for some sources to obtain actual estimates of these emissions (e.g. methane emissions from livestock).

Sweden has made a commitment to become net carbon neutral by 2045 and the CO<sub>2</sub> tax is considered a key policy instrument (Regeringskansliet, 2017).<sup>14</sup> As it is the political will that the tax is the main tool to reach the national climate targets it might be necessary to increase and widen the tax in the future in order to reach this target.

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<sup>14</sup> The aim is also to reduce CO<sub>2</sub> tax exemptions in a step-by-step process.

## 5 Conclusions and discussion

The implementation of the CO<sub>2</sub> tax was simplified by the fact that it was a part of a major tax reform, which meant less focus on the CO<sub>2</sub> tax and less objections. There was also a strong public support for environmental policies and an understanding for using economic instruments. The tax was introduced at a low level and increased gradually so that households and companies have time to make adjustments. That the tax rate was lower for the industrial sector and that certain use was exempted from the tax is another factor behind the acceptance. Last, but not least, increases in CO<sub>2</sub> tax have often been accompanied by decreases of other taxes (e.g. energy tax and labour tax).

The effect on the industry has been small since they were subject to a lower tax level than the households. The lower tax level for industrial emissions has been the prerequisite for the high general tax level. Not only was it necessary for the acceptance of the tax level but it also served as a way to reduce the risk of carbon leakage.

Throughout the years there has been a broad political consensus regarding the basic structure of the CO<sub>2</sub> tax and that it is the primary national policy instrument to achieve reductions of greenhouse gas emissions. Even though Sweden has changed governments several times since the tax introduction, the tax level has continued to increase and is regarded to be a cornerstone of Swedish climate policy which indicates a strong political support for the tax.

The transparency about future changes and the start at a low level that gradually increases so that households and companies have time to make adjustments have played a major role in reducing the financial impacts of the tax.

The tax is a cost-effective policy instrument that also improves the effect of other climate policy instruments such as subsidies, information and legislation. Some minor improvements could be made, such as better transparency about future changes and removal of tax exemptions, but overall the CO<sub>2</sub> tax is most probably one of the more efficient policy instruments aimed at reducing greenhouse gas emissions.

## References

**Note:** Titles of reports in Swedish have been given an approximate translation in English in parentheses immediately following each reference. All of these translations are intended to give an indicative title in English and they do not represent an official English translation.

Lagen (1994:1776) om skatt på energi (in Swedish), current version of the legal text, <http://www.notisum.se/rnp/Sls/lag/19941776.htm>. (*Act of Excise Duties on Energy*.)

Andersen. M. S., N. Dengsøe och A. B. Pedersen, 2000. An Evaluation of the Impact of Green Taxes in the Nordic Countries, TemaNord 2000:561, Nordic Council of Ministers, Köpenhamn.

Dahmén, E., 1968. Sätt pris på miljön. Samhällsekonomiska argument i miljöpolitiken. Sthlm 1968. Studieförbundet Näringsliv och Samhälle. (Book title: *Put a price on the environment*.)

Energimyndigheten (Swedish Energy Agency), 2006. Ekonomiska styrmedel i energisektorn: en utvärdering av dess effekter på koldioxidutsläppen från 1990, ER 2006:06 (in Swedish). (*Economic instruments in the Energy Sector: An evaluation of the effects on Carbon Dioxide Emissions from 1990*.)

Ericsson, Siv, 2018. Previous member of the Environmental Fee Commission of 1989 (SOU 1989:83). Personal communication, January 22.

Government Bill 1991/92:150 Annex I:5. (1991) Regeringens proposition 1991/92:150 med förslag om slutlig reglering av statsbudgeten för budgetåret 1992/93, m.m., Bilaga I:5 (in Swedish), [http://www.riksdagen.se/Webbnav/index.aspx?nid=37&dok\\_id=GF03150](http://www.riksdagen.se/Webbnav/index.aspx?nid=37&dok_id=GF03150) (Government budget proposal for the year 1992/93.)

Hammar, H., Åkerfeldt, S., 2011. CO2 Taxation in Sweden - 20 Years of Experience and Looking Ahead. The Swedish Ministry of Finance.

Hammar, Henrik & Åkerfeldt, Susanne, Senior Advisers, Swedish Ministry of Finance, Tax and Customs Department 2018. Ministry of Finance. Personal communication, January 17.

Konjunkturinstitutet (National Institute of Economic Research), 2013. Miljö, ekonomi och politik 2013 (In Swedish). (*Environment, Economics and Policy 2013*.)

Konjunkturinstitutet (National Institute of Economic Research), 2015a. Miljö, ekonomi och politik 2015. (In Swedish). (*Environment, Economics and Policy 2015*.)

Konjunkturinstitutet (National Institute of Economic Research), 2015b. Kommentarer till budgetpropositionens förslag inom miljöekonomiska området, 2015-09-21 <https://www.konj.se/om-ki/aktuellt/nyhetsarkiv/2015-09-21-kommentar-till-budget->

[propositionen-for-2016/miljoekonomisk-kommentar.html](#). (*Comments on the government budget bill regarding environmental economics, 21 September 2015.*)

Ministry of the Environment and Natural Resources, 1994. The Swedish Experience – taxes and charges in environmental policy. The printing works of the cabinet office and ministries.

Ministry of the Environment, 1991. Economic Instruments in Sweden - with emphasis on the energy sector. Regeringskansliets Offset Central.

Nationalencyklopedin, 2017. Skattepolitik. Skattereformen.

<http://www.ne.se/uppslagsverk/encyklopedi/lang/skattepolitik>. (*The Swedish National Encyclopaedia, on-line resource, 2017: Article on Taxation and the Tax Reform.*)

Naturvårdsverket (Environmental Protection Agency), 1997. Miljöskatter i Sverige - ekonomiska styrmedel i miljöpolitiken, Stockholm: Naturvårdsverkets Förlag. (*Environmental taxes in Sweden - Economic instruments in environmental policy*).

Naturvårdsverket (Environmental Protection Agency), 2012. Styrmedel för att nå miljö kvalitetsmålen: en utvärdering (in Swedish with English summary), Rapport 6415, Stockholm. (*Policy Instruments for Achieving Sweden's Environmental Quality Objectives: An Evaluation.*)

Naturvårdsverket (Environmental Protection Agency), 2013.

Klimatinvesteringsprogrammen Klimp 2003–2012, Slutrapport: Redovisning till regeringen januari 2013 (in Swedish), Rapport 6517. (*Climate Investment Programmes KLIMP 20013–2011. Final Report to the Government, January 2013.*)

Naturvårdsverket (Environmental Protection Agency), 2017a. Fördjupad analys av svensk klimatstatistik 2017 (in Swedish), Rapport 6782, Stockholm. (*In-depth Analysis of Swedish Climate Statistics.*)

Naturvårdsverket (Environmental Protection Agency), 2017b, Så mår miljön. Fakta och statistik. Statistik A-Ö. Klimat. <http://www.naturvardsverket.se/Sa-mar-miljon/Statistik-A-O/?topic=37>. (On-line resource: *How the Environment is Doing: Facts and Statistics. Section on Climate.*)

Naturvårdsverket (Environmental Protection Agency), 2017c, Så mår miljön. Fakta och statistik. Utsläpp av växthusgaser från uppvärmning av bostäder och lokaler. <http://www.naturvardsverket.se/Sa-mar-miljon/Statistik-A-O/Vaxthusgaser-utslapp-uppvarmning-av-bostader-och-lokaler/>. (On-line resource: *How the Environment is Doing. Facts and Statistics. Section on emissions of greenhouse gases from the building sector.*)

Naturvårdsverket (Environmental Protection Agency), 2017d. National Inventory Report: Greenhouse Gas Emission Inventories 1990-2015, Submitted under the United Nations Framework Convention on Climate Change and the Kyoto Protocol, Stockholm.

- Naturvårdsverket (Environmental Protection Agency), 2018. Stöd i miljöarbetet. Bidrag. Klimatklivet. Om Klimatklivet. <http://www.naturvardsverket.se/Stod-i-miljoarbetet/Bidrag/Klimatklivet/Om-Klimatklivet/>. (*Support for Environmental Action. About the "Klimatklivet" ["Step for Climate"] programme.*)
- OECD, 2014. OECD Environmental Performance Reviews: Sweden, OECD Publishing, Paris, <http://dx.doi.org/10.1787/9789264213715-en>.
- Regeringskansliet (Government Offices of Sweden), 2017. Vissa punktskattefrågor inför budgetpropositionen för 2018, (in Swedish) June 1, 2017. (*Certain Excise Duty Considerations before the 2018 Government Budget Bill.*)
- Samakovlis, E. & M. Vredin Johansson, 2007. Soppa med Klimp? – Utvärdering av kostnadseffektiviteten i klimatinvesteringsprogrammen, Ekonomisk Debatt, årg 35, nr 7, s 31-43. (*Evaluation of the Cost Effectiveness of the Climate Investment Programmes*).
- SCB, 2017a. Hitta statistik. Miljö. Miljöräkenskaper. Branschfördelade miljöskatter 2015: Stor ökning av miljöskatteintäkterna. <https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/miljoekonomi-och-hallbar-utveckling/miljorakenskaper/pong/statistiknyhet/branschfordelade-miljoskatter-2015/>. (*On-line resource provided by Statistics Sweden: Find statistics | Environment | Environmental Accounting | Environmental Taxation by Sector in 2015.*)
- SCB, 2017b. Hitta statistik. Miljö. Miljöräkenskaper. Koldioxidskatt per bransch 2008–2015. <https://www.scb.se/hitta-statistik/statistik-efter-amne/miljo/miljoekonomi-och-hallbar-utveckling/miljorakenskaper/pong/tabell-och-diagram/miljoskatter/koldioxidskatt-per-bransch-20082014/>. (*On-line resource provided by Statistics Sweden: Find statistics | Environment | Environmental Accounting | Carbon Dioxide Emissions by Sector 2008–2015.*)
- Skatteverket, 2018. Skattesatser och växelkurser. Skattesatser på bränslen och el under 2018. <https://www.skatteverket.se/foretagochorganisationer/skatter/punktskatter/energiska-tter/skattesatserochvaxelkurser.4.77dbcb041438070e0395e96.html>. (Swedish Tax Authority: Tax Rates and Exchange Rates. Taxation Rates for Fuel and Electricity for 2018).
- SOU (Statens Offentliga Utredningar). 1978. Miljökostnader (SOU 1978:43)
- SOU (Statens Offentliga Utredningar), 1989. Miljöavgiftsutredningen, Ekonomiska styrmedel i miljöpolitiken: energi och trafik. (SOU 1989:83), Bilagedel. Stockholm: Allmänna förl. (in Swedish with English Summary). (*Swedish Government Enquiry: The Investigation on Environmental Fees: Financial Instruments in Environmental Policy: Energy and Transportation.*)

SPBI, 2018. Svenska Petroleum & Biodrivmedel Institutet. Statistik. Bensin. Priser & Skatter. <http://spbi.se/statistik/priser/bensin/>. (*Swedish Petroleum and Biofuels Institute 2018: Statistics. Petrol, Prices and Taxes.*)

Sternler, T. and G. Köhlin, 2015. "Pricing carbon: The challenges" in Barrett S., C. Carraro and J. de Melo "Towards a Workable and Effective Climate Regime", CEPR Press, London.

Söderholm, P and H. Hammar, 2005. Kostnadseffektiva styrmedel i den svenska klimat- och energipolitiken? Metodologiska frågeställningar och empiriska tillämpningar (in Swedish) Konjunkturinstitutet (National Institute of Economic Research). (*Cost-effective policy instruments in the Swedish climate and energy policy? Methodological considerations and empirical applications Cost-Effective Instruments in Swedish Climate and Energy Policy? Methodological Considerations and Empirical Applications.*)

World Bank, 2018. World Development Indicators. CO2 emissions (metric tons per capita). <https://data.worldbank.org/indicator/EN.ATM.CO2E.PC>.

Åkerfeldt, S., Hammar, H., 2015. La Taxe Carbone en Suède (CO2 Taxation in Sweden - Experiences of the Past and Future Challenges) (in French). Revue Projet, number 348.

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