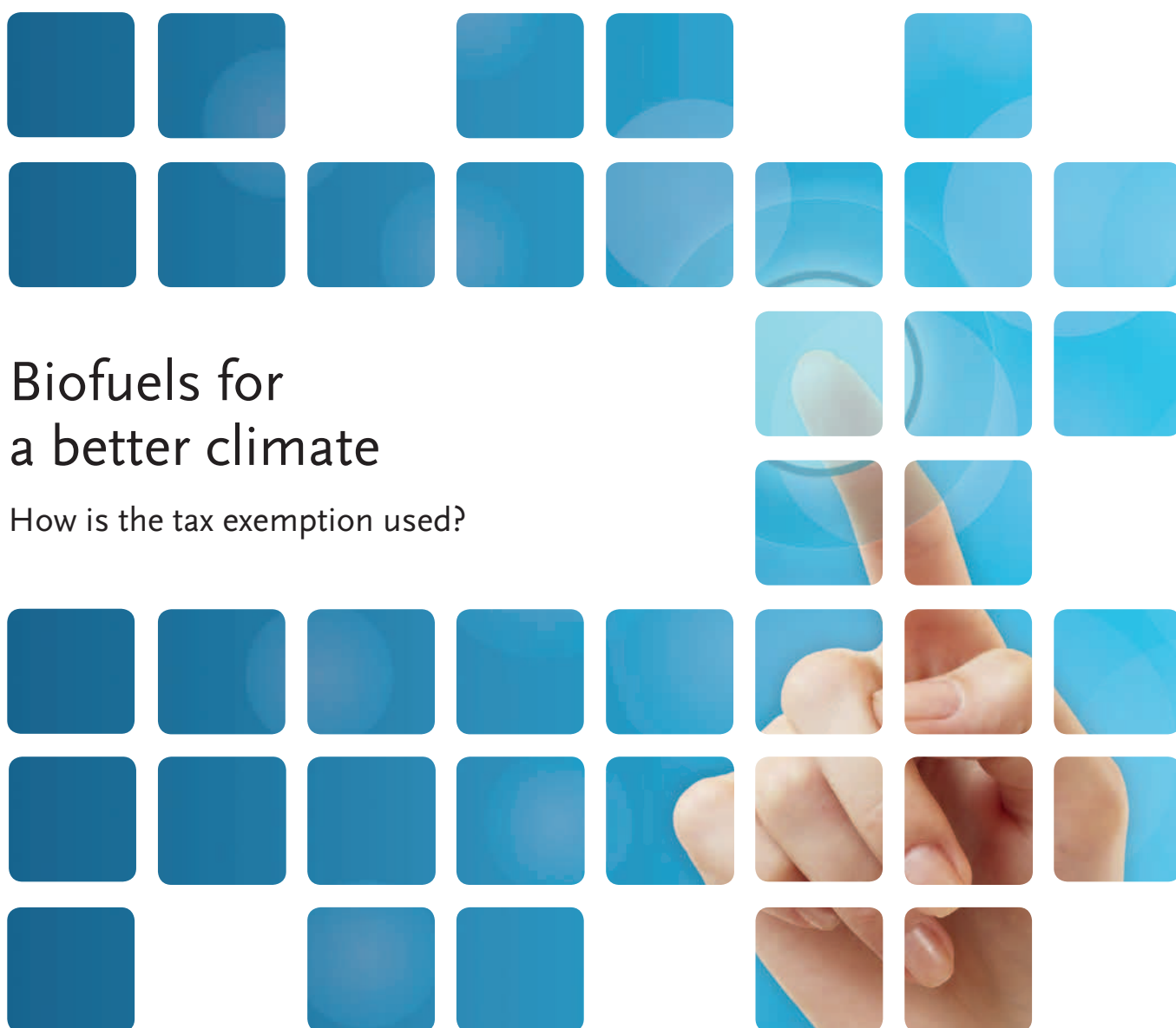




RIKSREVISIONEN



Biofuels for a better climate

How is the tax exemption used?

The Swedish National Audit Office is one of the bodies charged with exercising the powers of scrutiny vested in the Swedish Parliament. Our task is to audit state administration so as to contribute to an efficient economic use of resources, and to an effective administration.

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RIKSREVISIONEN

RiR 2011:10

Biofuels for a better climate

How is the tax exemption used?

To the Riksdag

Date: 10/02/2011
Ref. no.: 31-2010-0038
RiR: 2011:10

The following report on the performance audit is hereby submitted in accordance with section 9 of the Swedish Act (2002:1022) on Auditing of State Activities, etc.:

Biofuels for a better climate How is the tax exemption used?

The Swedish National Audit Office has audited the tax exemption for biofuels. The results of the audit are reported in this performance audit report.

Representatives of the Government Offices and the Swedish Energy Agency have been given an opportunity to check the facts and otherwise put forward their views on a draft of the final report.

The report contains conclusions and recommendations relating to the government.

Auditor General *Claes Norgren* has adopted decisions in this case. Audit Director *Anneli Josefsson* presented the report. Head of Programme *Lena Björck* and auditor *Mathilda Fält Zaar* were involved in the final processing.

Claes Norgren

Anneli Josefsson

For information purposes:

The Swedish Government, Ministry of Finance,
Ministry of the Environment,
Ministry for Rural Affairs,
Swedish Energy Agency.

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Summary

Riksrevisionen [The Swedish National Audit Office (SNAO)] has audited the tax exemption for biofuels.

Background to the audit

Reason for the audit: The Swedish government has been able to decide on tax relief or tax exemptions for biofuels since 1995. The purpose of the tax exemption is to contribute to the technological development of more environmentally-friendly fuels in order, among other things, to reduce greenhouse gas emissions from the transport sector. Even though it has proved difficult to reduce emissions from the transport sector, there has been no examination as to whether a tax exemption for biofuels is the best way to reduce these emissions. Previous studies have shown that the tax exemption is expensive and is also a blunt instrument. Recently, the cost of the tax exemption has risen significantly and there is a risk that it will continue to rise.

Purpose of the audit: The audit has focused on examining the extent to which the tax exemption for biofuels contributes to the achievement of the climate objectives and at what cost. The audit focuses on how the tax exemption for biofuels is structured and managed, particularly in relation to other policy instruments, and the problems and risks it entails. No specific evaluation of the effects of the tax exemption has been possible because it is not the only support aimed at increasing the use of biofuels.

Performance of the audit: The SNAO has reviewed the Swedish government's decisions on tax relief for biofuels for the 1995–2000 period and the monitoring of the tax exemption carried out by Energimyndigheten [The Swedish Energy Agency] for the same period. The SNAO, with help from Statistiska centralbyrån [Statistics Sweden], has also conducted a survey of owners of green cars to investigate what factors are important when deciding to purchase a green car and when choosing fuel. To illustrate the impact of the tax exemption on the use of biofuels and extent to which the use of biofuels contributes to reducing emissions, the SNAO has put together a compilation of existing statistics and has also carried out calculations of its own. The audit has also been supplemented by interviews in the Government Offices of Sweden and the Swedish Energy Agency, a review of government bills and other material and a review of the relevant EU legislation with the support of EU legal expertise.

The results of the audit

The audit has resulted in the following main conclusions and observations:

A tax exemption for biofuels contributes towards achieving the Riksdag's climate objectives – but not at a reasonable cost

The tax exemption has been necessary to increase the use of biofuels, but is a relatively expensive way of reducing greenhouse gas emissions. Nowadays, virtually all gasoline and diesel contain a low-level blend of biofuels. The tax exemption has been crucial for this development. However, to enable biofuels also to be used in high-level blends such as E85, a mere tax exemption is not enough because investment in vehicles and infrastructure is also required. Sweden is practically the only EU Member State that has created a market for E85.

It is not fully clear how emissions from biofuels should be measured. Different studies yield different results depending on the assumptions made. The SNAO has estimated that the use of biofuels may have brought about a reduction in emissions of approximately 0.4 to 1.1 million tonnes of carbon dioxide equivalents per year for 2007–2009. That reduction represents approximately 1 per cent of Sweden's total greenhouse gas emissions. However, counteractive effects may mean that the reduction is smaller.

The loss of tax revenues resulting from the tax exemption has increased steadily since the year 2000 and currently amounts to around SEK 2 billion per year. The reduction in emissions to which the use of biofuels gives rise therefore involves a cost for the government of around SEK 3 per kg of carbon dioxide reduction. Compared to, for example, the carbon dioxide tax of SEK 1.05 per kg of carbon dioxide, a full tax exemption for biofuels is thus a relatively expensive means of reducing greenhouse gas emissions.

The government's management of the tax exemption has not brought about long-term, predictable conditions

In order to provide long-term, predictable conditions for biofuels, the government has devised principles to serve as a basis for decisions on tax relief. Despite the government's ambitions, in most cases its decisions on tax relief have related to relatively short periods of time – one to two years – which limits companies' ability to plan. Also, the government's reasons for granting tax relief have varied. Different companies have not been treated equally. This unequal treatment is unsatisfactory, not only from the point of view of transparency and competitiveness, but also because technology neutrality between biofuels is not guaranteed, which is desirable from the point of view of effectiveness.

Since the tax exemption has primarily contributed to low-level blending of biofuels, it has also not had any great impact in terms of driving technology forward. Low-level blending is an efficient way to get large volumes of biofuels on to the market quickly, but it does not contribute to the development of new fuels. Therefore, there is a risk that the tax exemption contributes to settling for technologies that are neither long-term nor able to serve as a bridge to long-term solutions.

The Riksdag has now decided, in response to a proposal by the government, that the government may continue to grant tax relief for biofuels in special cases without any need for it to relate to pilot projects. However, the government has not made clear in which special cases it intends to grant tax relief for biofuels. Neither has the government released information on what will happen to the tax exemption after 2013, when the approval for Sweden's State aid expires. Overall, this contributes to unclear rules of the game for companies as well as for consumers.

The tax exemption for biofuels gives rise to side effects – or counteracting effects

A tax exemption for low-level blended biofuels in gasoline and diesel will, all other things being equal, contribute to lower prices for gasoline and diesel and therefore to higher consumption of fuel overall. According to the SNAO's assessment, even a marginal increase in total fuel consumption can cut the reduction in emissions brought about by the low-level blending of biofuels by almost a quarter.

There has been a considerable increase in recent years in the number of cars that can run on E85 as well as in the number of fuel stations supplying E85. However, the exemption has not been sufficient to sustain consumption of E85 when the price of gasoline has fallen. In 2009, many ethanol-powered car owners refuelled with gasoline instead of E85 as a result of lower gasoline prices. This leads to an increase in emissions because cars able to run on E85 have higher fuel consumption on average than gasoline-powered cars. If the tax exemption for low-level blending also contributes to lower gasoline prices, this may also counteract the use of E85.

The EU does not allow the tax exemption to lead to over-compensation of biofuels relative to gasoline or diesel. Since the tax exemption is difficult to differentiate between different biofuels, the government has solved the problem by making the tax exemption subject to a special customs tariff. The customs tariff means that the highest rate of duty must be levied in order for a tax exemption to be granted for ethanol imported for low-level blending, which favours ethanol produced in Sweden or in the rest of the EU. Since the production cost for this ethanol is higher than for imported ethanol, the tariff leads to a higher cost. This higher cost is not matched by greater climate benefits. The customs tariff thus favours ethanol that brings about lower reductions in emissions at the expense of ethanol that could bring about larger reductions in emissions.

The government's monitoring of the tax exemption has been inadequate and insufficient

The government has not presented any comprehensive strategy for how efforts to promote biofuels should best be designed. Neither has the government monitored and commented on the full extent of the tax exemption and its effects in any of the fiscal bills in recent years.

The customs tariff that the government has introduced to address the question of over-compensation entails additional support for domestically produced biofuels. For that reason it is of interest also to follow up the issue of over-compensation and the effects of the customs tariff in other contexts, besides for reporting to the EU. The government has not presented any considerations regarding the effects of the customs tariff on domestic production weighed against the access to cheaper imported, more climate-friendly ethanol.

The tax exemption is not structured so as to be sustainable in the long term

It is not considered possible for Swedish production of biofuels to increase to any great extent unless new biofuels are developed. Despite investments in research and development over a long period, the development of new, advanced biofuels has proved difficult.

The required reductions in emissions imposed by the EU in order for biofuels to be considered sustainable are also modest compared to Swedish conditions. The requirements are therefore not likely to contribute to the development of new biofuels or make the tax exemption more cost-effective in relation to the climate objectives. Unilateral requirements on biofuels could also mean that emissions move to other products or sectors instead. To reduce emissions at as low a cost as possible, it is important not to aim measures against any specific type of production.

If the use of biofuels increases, a continued tax exemption for biofuels will mean that the loss of tax revenues will continue to rise. This may make it less likely that the tax exemption can be maintained in the long term. Neither will Sweden be permitted to retain the tax exemption after 2020 unless EU regulation is changed. The tax exemption for biofuels in existence today is therefore not sustainable in the long term.

The SNAO's recommendations

The SNAO has found no evidence that a tax exemption for biofuels contributes to achieving the Riksdag's climate objectives at a reasonable cost to society. Neither has the tax exemption stimulated the development of new and more advanced biofuels. It is therefore questionable whether it is effective for the government to continue to grant a full tax exemption for biofuels – at any rate in the way in which the tax exemption has been managed, structured and monitored up to now.

In the 2011 Budget Bill, the government announced an extended tax exemption for low-level blending of biofuels from 1 January 2011. The Riksdag has also decided, in response to a proposal by the government, that the government will be empowered to continue granting tax relief for biofuels in special cases. In view of this, the SNAO puts forward the following recommendations to the government:

- The government should improve its reporting and monitoring of the tax exemption for biofuels for the purpose of increasing transparency.
- The government should report more clearly on how the tax exemption, in combination with the customs tariff, affects Swedish production, imports and use of biofuels and what effects it entails.
- The government should clearly specify the cases in which a tax exemption can be granted to avoid a situation whereby different companies and biofuels are treated differently.
- In order to give companies and consumers a reasonable chance to plan ahead, the government needs to make clear in the short term how the tax exemption is to be managed from now on. In the longer term, the government needs to analyse which measures best achieve the climate objectives.

Fact box

More on the tax exemption for biofuels: Liquid biofuels such as ethanol and biodiesel are currently exempt from energy and carbon dioxide tax. The tax exemption does not mean that there is a general exemption for liquid biofuels in the Swedish Act (1994:1776) on Energy Tax. Instead, the government adopts a decision on a tax exemption in response to an application by each individual producer or supplier.

Relevant viewpoints from the Riksdag: The Riksdag has pointed out on several occasions that the climate objectives should be achieved at the lowest possible cost to society, in other words taking into consideration socio-economic effectiveness and by adopting cost-effective measures (Committee Reports 2001/02:MJU10 and 2008/09:MJU28). During the parliamentary discussion on the latest climate policy bill, the Committee on Environment and Agriculture stated that promoting renewable fuels should form a central part of Swedish climate policy (Committee Report 2008/09:MJU28). The bill also makes it clear that the tax exemption for biofuels is the main policy instrument behind the introduction of biofuels (Government Bill 2008/09:162). The Riksdag has also requested an in-depth review and account of various efforts in the subject area of the climate (Committee Reports 2009/10:MJU1 and 2010/11:MJU1).

1 Introduction

The central government has been making efforts to increase the proportion of biofuels in the transport sector for a long time. These efforts have been motivated by a variety of reasons and aims, such as the desire to reduce dependence on oil and increase the security of the energy supply and also the desire to overhaul agricultural policy. There have also been reasons concerned with environmental policy such as the desire to improve air quality in densely populated areas, but it was only from the 1990s onwards that efforts and support began to be motivated by climate policy goals. A binding requirement from the EU that the proportion of renewable energy¹ in the transport sector should be at least 10 per cent by 2020 has also been in place for a number of years.

Liquid biofuels such as ethanol and biodiesel are currently exempt from energy and carbon dioxide tax through a special decision-making procedure. The decision-making procedure involves the government adopting a decision on a tax exemption in response to an application by each individual producer or supplier. Examples of other central governmental efforts to increase the use of biofuels include the so-called *pumplagen* [Pump Act] and a five-year exemption from vehicle tax for new green cars.

1.1 Reason for the audit

Even though there have been several different reasons for granting subsidies for biofuels, the link to the climate issue has become more pronounced in recent times (see also Chapter 2). During the parliamentary discussion on the latest climate policy bill, the Committee on Environment and Agriculture stated that promoting renewable fuels should form a central part of Swedish climate policy.² The bill also states that the tax exemption for biofuels is the main policy

¹ Road traffic accounts for just over 90 per cent of energy use in the transport sector. See Statens energimyndighet (2010a), *Transportsektorns energianvändning 2009* [The Swedish Energy Agency (2010a), *Energy use in the transport sector, 2009*], page 13. The use of biofuels will therefore be important for achieving the objective.

² Bet. 2008/09:MJU28, *Riktlinjer för klimatpolitiken m.m.* [Committee Report 2008/09: MJU28, *Guidelines for climate policy, etc.*], page 41.

instrument behind the introduction of biofuels.³ In addition, the government has stated on several previous occasions that the main aim of the tax exemption for biofuels is to stimulate the continued introduction and technical development of alternative fuels in order, among other things, to reduce carbon dioxide emissions from the transport sector.⁴ At the same time, it has proved difficult to reduce emissions in the transport sector in particular.⁵

However, monitoring implies that the tax exemption is both expensive and a blunt instrument.⁶ The tax exemption also appears to lead to side effects which may to some extent counteract the original intentions. There are also studies that indicate that current production of biofuels is not sustainable either economically or in climate terms. Sweden's tax subsidies for biofuels are also high by European standards. They currently amount to a total of around SEK 2 billion per year. At the same time, subsidies have largely gone on existing technologies and their impact on technological development is thus questionable.⁷

It is therefore relevant to examine the tax exemption for biofuels from the point of view of efficiency, cost and impact on the climate. The tax exemption is the single largest subsidy for biofuels.

1.2 Purpose and audit questions

The purpose of the audit is to examine the extent to which the tax exemption for biofuels contributes to achieving the climate objectives and at what cost. No specific evaluation of the effects of the tax exemption has been possible because it is not the only aid aimed at increasing the use of biofuels. The tax exemption is also intended for purposes other than to contribute to achieving the climate objectives. The audit therefore focuses on how the tax exemption for biofuels has been structured and managed, particularly in relation to other instruments, and the problems and risks it entails. The aim is therefore not to evaluate the actual outcomes of the tax exemption.

³ Prop. 2008/09:162, *En sammanhållen klimat- och energipolitik – Klimat* [Government Bill 2008/09:162, *An integrated climate and energy policy – Climate*], p. 86.

⁴ See also prop. 2001/02:1, *Budgetpropositionen för 2002*, s. 201, prop. 2001/02:55, *Sveriges klimatstrategi* [Government Bill 2001/02:1, *The 2002 Budget Bill*, page 201, Government Bill 2001/02:55, *Sweden's climate strategy*], page 83.

⁵ See prop. 1994/95:54, *Ny lag om skatt på energi, m.m.*, bet. 1994/95:SkU4, rskr. 1994/95:152, lag (1994:1776) om skatt på energi (energiskattelagen) [Government Bill 1994/95:54, *New law on taxation of energy, etc.*, Committee Report. 1994/95:SkU4, Riksdag Communication 1994/95:152, Swedish Act on Energy Tax (1994:1776) (the Energy Tax Act)].

⁶ Naturvårdsverket (2004), *Skattebefrielsen för biodrivmedel – leder den rätt?* [The Swedish Environmental Protection Agency (2004), *The tax exemption for biofuels – is it leading in the right direction?*]

⁷ There is no restriction on which biofuels may be granted a tax exemption. All use of biofuels, regardless of the technology involved, may now be granted a tax exemption.

The audit is based on the following audit questions:

1. Does the tax exemption for biofuels contribute to achieving the Riksdag's climate objectives at a reasonable cost?
2. Has the government designed and managed the tax exemption in such a way that it guarantees long-term, competitive conditions for the development of biofuels?
3. Does the tax exemption give rise to significant side effects or counteracting effects?
4. Has the government monitored and reported the tax exemption in a suitable manner?
5. Is a tax exemption for biofuels structured in such a way as to be sustainable in the long term?

1.3 Delimitations

In the audit we do not examine the extent to which the tax exemption has helped achieve objectives other than the Riksdag's climate objectives. Furthermore, the audit is confined to the tax exemption for liquid biofuels. In the survey we conducted with help from Statistics Sweden, we used cars that are able to run on vehicle gas (biogas or natural gas) for the purposes of comparison. However, the comparison does not mean that we are also auditing the tax exemption for biogas.

1.4 Assessment criteria

The audit of the tax exemption for biofuels takes as its starting point the Riksdag's view of the climate objectives and how they are to be achieved and on the motives behind the tax exemption for biofuels.

The Riksdag has pointed out in several different contexts that the climate objectives should be achieved at the lowest possible cost to society, in other words taking into consideration socio-economic effectiveness and adopting cost-effective measures.⁸

In order for greenhouse gas emissions to be reduced in accordance with the climate objectives, both the government and the Riksdag have indicated that a number of measures need to be implemented. One important measure is to

⁸ See also prop. 2001/02:55, bet. 2001/02:MJU10, rskr. 2001/02:163, prop. 2008/09:162, bet. 2001/02:MJU28, rskr. 2008/09:300 [Government Bill 2001/02:55, Committee Report 2001/02:MJU10, Riksdag Communication 2001/02:163, Government Bill 2008/09:162, Committee Report. 2001/02:MJU28, Riksdag Communication 2008/09:300].

increase the use of renewable energy in the transport sector.⁹ The tax exemption for biofuels has for some considerable time aimed to promote the development of biofuels by guaranteeing long-term, competitive conditions for these fuels.¹⁰ The Riksdag has also pointed out that measures to promote biofuels should be technology-neutral and that the extremely important development of biofuels must take place in such a way as to avoid giving rise to undesired effects.¹¹

To make the effects brought about by various measures visible, the Riksdag has pointed out on several occasions that results in the subject area of the climate should be reported in more detail. There should be a clearer focus on reporting and analysing the results achieved, rather than reporting on new measures. Different measures should be reported as a compilation because the efforts often take place in different areas.¹² There are also general requirements for government reports to the Riksdag. According to the Swedish Budget Act, the government must report to the Riksdag on the goals pursued and the results achieved in various activities.¹³

The Riksdag has also stated that the government should investigate and report back to the Riksdag with concrete proposals for policy instruments to create stable rules for production and development of biofuels, regardless of the position with regard to State finances.¹⁴

Finally, the audit has been guided by the polluter pays principle enshrined in the Swedish Environmental Code.¹⁵

⁹ Prop. 2008/09:162, bet. 2008/09:MJU28, rskr. 2008/09:300 and prop. 2008/09:163, *En sammanhållen klimat- och energipolitik – Energi*, bet. 2008/09:NU25, rskr. 2008/09:301 [Government Bill 2008/09:162, Committee Report. 2008/09:MJU28, Riksdag Communication 2008/09:300 and Government Bill 2008/09:163, *A coherent climate and energy policy – Energy*, Committee Report 2008/09:NU25, Riksdag Communication 2008/09:301].

¹⁰ See also prop. 1994/95:54, bet. 1994/95:SkU4, rskr. 1994/95:152, prop. 2001/02:1, bet. 2001/02:FiU1, rskr. 2001/02:34, prop. 2003/04:1, *Budgetpropositionen för 2004*, bet. 2003/04:FiU1, rskr. 2003/04:42 [Government Bill 1994/95:54, Committee Report. 1994/95:SkU4, Riksdag Communication 1994/95:152, Government Bill 2001/02:1, Committee Report. 2001/02:FiU1, Riksdag Communication 2001/02:34, Government Bill 2003/04:1, *The 2004 Budget Bill*, Committee Report 2003/04:FiU1, Riksdag Communication 2003/04:42].

¹¹ See bet. 2005/06:TU:6, *Skyldighet att tillhandahålla förnybara drivmedel*, bet. 2007/08:MJU15, *Vatten- och luftvård*, and bet. 2008/09:MJU28, rskr. 2008/09:300 [Committee Report 2005/06:TU:6, *Obligation to supply renewable fuels*, Committee Report 2007/08: MJU15, *Water and air protection*, and Committee Report 2008/09:MJU28, Riksdag Communication 2008/09:300].

¹² See bet. 2009/10:MJU1, *Utgiftsområde 20 Allmän miljö- och naturvård* and bet. 2010/11:MJU1, *Utgiftsområde 20 Allmän miljö- och naturvård* [Committee Report 2009/10:MJU1, *Expenditure area 20 General environment and nature conservation* and Committee Report 2010/11:MJU1, *Expenditure area 20 General environment and nature conservation*].

¹³ 2§ lagen (1996:1059) om statsbudgeten (*budgetlagen*) [Section 2 of the Act on the State Budget (1996:1059) (*The Swedish Budget Act*)].

¹⁴ Bet. 2005/06:TU:6 [Committee Report 2005/06:TU:6], page 12 f.

¹⁵ 2 kap. 3 § miljöbalken (1998:808) principen om att förorenaren betalar (*miljöbalken*) [The principle that the polluter pays contemplated in Chapter 2. paragraph 3 of the Swedish Environmental Code (1998:808) (*the Environmental Code*)].

1.5 Relevant authorities

The authorities affected by the audit are *Regeringskansliet* [the Government Offices of Sweden] and the Swedish Energy Agency. The Government Offices of Sweden are affected since the Ministry of Finance adopts decisions on tax exemptions for biofuels. The tax exemption is also an important policy instrument for work on climate objectives and for achieving the objective of 10 per cent renewable energy in the transport sector by 2020 through increased use of biofuels. Work on these objectives falls within the sphere of responsibility of the Ministry of the Environment and the Ministry of Industry, Employment and Communications. Finally, the Swedish Energy Agency has been entrusted by the government with the task of monitoring the tax exemption for biofuels since 1998.

1.6 Method and implementation

We have used several different methods and sources to throw light on all the questions. In most cases, each method and source provides data that answers more than one audit question.

To answer audit question 1 – whether the tax exemption for biofuels helps achieve the Riksdag’s climate objectives at a reasonable cost – we examine, among other things, the significance of the tax exemption for the use of biofuels. This part of the audit is based on a summary of existing statistics on the structure of and changes in the use of biofuels, a review of the government’s decisions on tax relief for biofuels in the 1995–2010 period and a review of which other subsidies were in force at the same time as the tax exemption and therefore acted in conjunction with it. In addition, with help from Statistics Sweden, we have conducted a survey of owners of green cars that are able run on either gasoline or biofuels. The sample for the survey was taken from the vehicle register. One of the aims of the survey was to obtain better supporting data on what factors are important when choosing to purchase a green car and how important the relative price is when choosing to refuel with biofuels or gasoline.

To obtain an indication of whether the tax exemption is expensive in relation to the climate objectives, we have compared the costs of the tax exemption (reduction in revenues) with numerical examples of the extent of the reduction in emissions when biofuels are used instead of fossil fuels. The loss of revenues due to the tax exemption has been estimated on the basis of the government’s assessments in various government bills as well as monitoring by the Swedish Energy Agency and our own calculations. The numerical

examples of the extent to which the use of biofuels helps reduce emissions are based on, among other things, the emission values used in the *Trafikverket* [Swedish National Transport Administration] and *Naturvårdsverket* [Swedish Environmental Protection Agency] index on new cars' impact on the climate.

In order to answer audit question 2 – whether the government's management of the tax exemption has brought about long-term, competitive conditions for the development of biofuels – we have mainly used the review of the government's decisions on tax relief for biofuels in the 1995–2010 period referred to above as a basis. We have also carried out a review of government bills, supporting data for State Aid cases and monitoring by the Swedish Energy Agency in the same period.

To illustrate possible side effects of the tax exemption and thus provide supporting data for audit question 3, we present various numerical examples of how the exemption works in the case of low-level and high-level blending. The Swedish Energy Agency's monitoring of the tax exemption and the information produced by the Agency during that monitoring forms an important basis for these calculations. Other important supporting data consists of the questionnaire for green car owners we referred to above, statistics from the vehicle register and Statistics Sweden's mileage database and reports from the Swedish National Transport Administration and the Swedish Environmental Protection Agency.

Audit question 4 – whether the government has monitored and reported the tax exemption in an appropriate manner – is mainly based on document studies of government bills and documents, committee reports and monitoring by the Swedish Energy Agency.

Finally, in order to answer audit question 5 – whether the tax exemption is structured so as to be sustainable in the long term – we have reviewed relevant EU legislation with support from external experts in EU law. In order to illustrate the fact that the development of new fuels requires time and large-scale investment, the audit has been supplemented with a document study of how the central government has funded research and development of biofuels – or other alternative fuels – over the past 35 years.

The audit was conducted by a project team consisting of Anneli Josefsson (project leader), Anna Carlsson and Mathilda Fält Zaar.

1.7 Structure of the report

The structure of the report does not follow the structure of the audit questions, but is instead set out according to the empirical evidence we used in the audit. The reason for this, as stated above, is that each source of empirical evidence provides supporting data to answer more than one audit question.

Chapter 2 provides a background description of the measures introduced to increase the use of biofuels and the objectives they aim to achieve. The chapter also contains a brief account of current production and use of biofuels.

Chapter 3 contains a review of the principles forming the basis for the government's decisions on tax relief and a review of the government's decisions on tax exemptions in the 1995–2010 period and their monitoring by the Swedish Energy Agency. The chapter also presents an estimate of the cost of the tax exemption and how the government has chosen to monitor and report the tax exemption in fiscal bills in recent years.

In Chapter 4 we describe what impact the tax exemption and other subsidies for biofuels have had on the use of biofuels.

The significance of the tax exemption on low-level blended and high-level blended biofuels is discussed in more detail in Chapters 5 and 6. In these chapters we also report on some possible side effects of the tax exemption.

In Chapter 7 we describe various methods that can be used to calculate reductions in emissions from biofuels. We also provide numerical examples in which these methods are applied.

In Chapter 8 we describe the risks with regard to the long-term sustainability of the tax exemption.

The concluding chapter, Chapter 9, contains the SNAO's conclusions and recommendations. In this chapter we describe how the various sections containing empirical evidence help answer the audit questions.

2 Background and history

The purpose of this chapter is to explain the background and reasons for the various measures the central government has introduced to increase the use of biofuels. The chapter begins with a description of what biofuels are and how the use of biofuels has developed in Sweden.

2.1 Biofuels in Sweden and internationally

2.1.1 *What are biofuels?*

A biofuel is a renewable fuel produced from biomass that is used to run a vehicle.¹⁶ The biofuels currently available are produced mainly from traditional agricultural products with the aid of production technologies that have been known for a long time. The most common forms of biofuel on the market today are ethanol, biodiesel (FAME, RME)¹⁷ and biogas.

Ethanol is the largest biofuel on the world market, followed by biodiesel. During the period from 2007 to 2009, global ethanol production was estimated at an average of 74 million m³ a year. Just over 80 per cent of ethanol is produced in the USA and Brazil. However, the production of biodiesel predominates in the EU. On average, the EU accounted for just over 50 per cent (or 8 million m³) of global biodiesel production in the period from 2007 to 2009.¹⁸ Biogas is not as widespread in global terms, being used mainly in Sweden and a few other countries.¹⁹

¹⁶ As its name suggests, biofuel is biomass fuel used in the transport sector. However, biomass fuels can be used for a number of different purposes, such as heating. In this report we will in general use the term “biofuels” to mean alternative fuels, renewable fuels and biofuels.

¹⁷ FAME (fatty acid methyl esters) is produced from oil-seed crops. In Sweden, the most common raw material is rapeseed oil which is esterified to RME (rapeseed methyl ester). In this report we will in general use the term “biodiesel” instead of FAME or RME.

¹⁸ OECD-FAO (2009), *Agricultural Outlook 2009–2018*.

¹⁹ Statens energimyndighet (2009a), *Kvotpliksystem för biodrivmedel* [The Swedish Energy Agency (2009a), *Compulsory quota system for biofuels*].

Biofuels are today used mainly for blending in low quantities in gasoline or diesel, so-called low-level blending.²⁰ In Sweden, ethanol is also used for E85, a fuel consisting of 85 per cent ethanol and 15 per cent gasoline.²¹ Use of E85 requires cars with adapted engines, so-called flexifuel (FFV) cars.²² There are also special gas cars that are able to run on both gasoline and vehicle gas. Vehicle gas is produced from either biogas, natural gas or a mixture of biogas and natural gas. Some specially adapted heavy vehicles, for example ethanol buses, are able to use pure, or practically pure, biofuels.²³

Biofuels under development

The biofuels available today are usually referred to as “first generation” biofuels.²⁴ Since these are relatively expensive to produce, considerable efforts are being made to develop second generation biofuels. Second generation biofuels are considered to have tremendous potential for higher energy efficiency and lower costs. At the same time, second generation biofuels are based on production technologies that are not yet commercially viable. There is therefore some uncertainty as to how effective these fuels will be. Third generation biofuels are an alternative that lies further in the future, involving hydrogen gas for example. See Table 2.1.

²⁰ Low-level blending with 5–10 per cent ethanol or biodiesel in gasoline and diesel is the most common usage.

²¹ In winter, E85 contains a lower percentage of ethanol, typically 70–80 per cent, to improve the cold-start properties of the fuel.

²² The term “ethanol-powered cars” is used in the report.

²³ This fuel is usually referred to as ED95 and consists of 95 per cent ethanol and 5 per cent ignition improver.

²⁴ There is no uniform definition of which biofuels are to be ascribed to which generation. Typically, however, they are classified according to either the technology or the raw material used in production.

Table 2.1. Raw materials and production processes for a range of biofuels

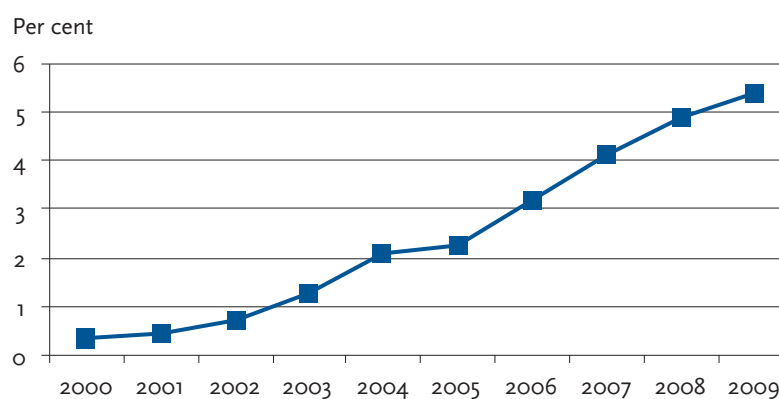
	Definition according to raw material		Definition according to technology
“1 st generation”	Ethanol from sugar cane, grain, sugar-beet, etc.	FAME from vegetable and animal oils, residue.	Available commercial technology.
“2 nd generation”	Ethanol from biomass (Lignocellulose) DME from black liquor.	Biomass for liquid fuels Hydrogenated oils. FAME from new plants.	Technology for implementation or in pilot facilities.
“3 rd generation”	Hydrogen gas.	Biodiesel from algae.	Technology at the research stage.

Source: The SNAO’s translation of a summary of a research programme carried out as a collaboration between the European Commission Joint Research Centre, EUCAR and CONCAWE, the JEC Biofuel programme.

2.1.2 Biofuels in Sweden

The use of biofuels has increased considerably in Sweden since 2000. In 2009, the use of biofuels accounted for around 5.4 per cent of total road traffic fuel use, compared with 0.3 per cent in 2000.²⁵

Chart 2.1. Proportion of biofuels in road transport, 2000–2009, as a percentage

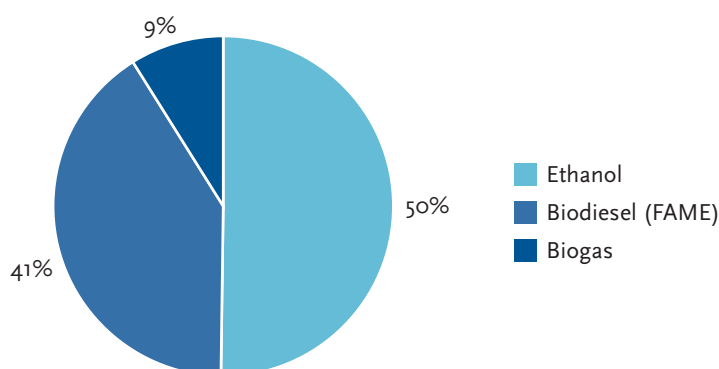


Source: The Swedish Energy Agency.

²⁵ Statens energimyndighet (2010a), *Transportsektorns energianvändning 2009* [The Swedish Energy Agency (2010a), *Energy use in the transport sector 2009*].

The most common biofuels on the Swedish market are ethanol, biodiesel and biogas. Chart 2.2 below illustrates how the use of biofuels was distributed among the various fuels in 2009. In 2009, ethanol accounted for around 50 per cent of biofuel use, compared with just under 60 per cent in 2007 and 2008. Biodiesel, by contrast, has increased its share, and accounted for just over 40 per cent of use in 2009. Biogas's share has also risen since the previous year.²⁶

Chart 2.2. Biofuels in road traffic in 2009 distributed by type of fuel (TWh)



Source: The Swedish Energy Agency.

It is currently permissible to blend 5 per cent ethanol by volume in gasoline. There is no corresponding limit on the proportion of biodiesel that may be blended in diesel. However, in practice, blending of biodiesel in diesel has been restricted to 5 per cent by volume.²⁷

Over 90 per cent of the gasoline sold in Sweden is a low-level blend of 5 per cent by volume of ethanol (E5). The corresponding figure for diesel is just over 80 per cent. However, the quantity of low-level blended ethanol has fallen slightly in recent years due to a reduction in gasoline consumption. At the same time, the quantity of low-level blended biodiesel has risen.²⁸

²⁶ Statens energimyndighet (2010a), *Transportsektorns energianvändning 2009* [The Swedish Energy Agency (2010a), *Energy use in the transport sector 2009*].

²⁷ Blending of biodiesel in diesel has been restricted to the levels set out in the Swedish specifications for environmental classification of diesel fuel. The possibility of low-level blending of 5 per cent by volume of biodiesel in diesel without any change in the environmental classification of the fuel was introduced on 1 August 2006. Prior to that, the minimum blending level had been set at 2 per cent. Prop. 2005/06:181, *Miljöklassning av alternativa motorbränslen, m.m.*, bet. 2005/06:MJU:28, rskr. 2005/06:345, lag (2006:927) om ändring i lagen (2001:1080) om motorfordons avgasrening och motorbränslen och lag (2006:925) om ändring i lagen (1994:1776) om skatt på energi [Government Bill 2005/06:181, *Environmental classification of alternative motor fuels, etc.*, Committee Report 2005/06:MJU:28, Riksdag Communication 2005/06:345, the Act (2006:927) amending the Act on Motor Vehicle Exhaust Emission Control and Motor Fuel (2001:1080) and the Act (2006:925) amending the Energy Tax Act (1994:1776)]. The low-level blending percentage was raised to 10 per cent by volume for ethanol and 7 per cent by volume for biodiesel from the beginning of 2011.

²⁸ Statens energimyndighet (2010a), *Transportsektorns energianvändning 2009* [The Swedish Energy Agency (2010a), *Energy use in the transport sector 2009*].

2.1.3 Swedish imports and production of biofuels

Much of the biofuel used in Sweden is imported. In 2009, approximately 60 per cent of ethanol was introduced from another EU country or imported. Most of the ethanol came from Brazil.²⁹

The ethanol produced in Sweden is produced in Norrköping, where Lantmännen Agroetanol produces ethanol through fermentation of cereals, and in Örnsköldsvik, where SEKAB produces ethanol using a sugar-rich lye from sulphite pulp manufacture at the Domsjö factories.³⁰

Biodiesel is currently produced in several small-scale facilities in different parts of Sweden. However, according to the available studies, Swedish conditions are not particularly suitable for production of biodiesel. It is therefore not considered possible for domestic production to grow to any great extent.³¹ As the demand for biodiesel has increased in recent years, imports and the introduction of biodiesel from other EU States have also increased. In 2009, the proportion of biodiesel imported or introduced amounted to around 40 per cent.³²

2.2 Reasons for providing support for biofuels

2.2.1 Why does Sweden wish to increase the use of biofuels?

Both in Sweden and elsewhere, investments in biofuels have been motivated by a number of different reasons and aims. It is only since the 1990s that investment and funding support has been motivated by climate policy goals.

Swedish reasons

The desire to increase the use of biofuels was initially founded on a desire to increase security of supply and reduce dependence on oil, along with agricultural policy and environmental considerations. As far as agricultural

²⁹ Previously, 85–90 per cent of the ethanol had been imported. See *Statens energimyndighet (2010c), Övervakningsrapport avseende skattebefrielse för biodrivmedel år 2009, dnr. 00-10-848* [the Swedish National Energy Agency (2010c), *Monitoring report on the tax exemption for biofuels in 2009, reg. no. 00-10-848*].

³⁰ *Bioenergi (2008), Produktion av biodrivmedel i Sverige, nr 4 2008* [Bioenergy (2008), *Production of biofuels in Sweden, no. 4 2008*]. These plants have a production capacity of 210,000 m³ and 11,000 m³, respectively. SEKAB has reduced its ethanol production in Sweden over the past year.

³¹ Börjesson, P., Tufvesson, L. and Lantz, M. (2010) *Livscykelanalys av svenska biodrivmedel samt SOU 2007:36, Bioenergi från jordbruket – en växande resurs* [Life-cycle analysis of Swedish biofuels and SOU 2007:36, *Bioenergy from agriculture – a growing resource*].

³² *Statens energimyndighet (2010c), Övervakningsrapport avseende skattebefrielse för biodrivmedel år 2009, dnr 00-10-848* [The Swedish Energy Agency (2010c), *Monitoring Report on the tax exemption for biofuels in 2009, reg. no. 00-10-848*].

policy is concerned, the production of biofuels was seen as a potential future market for the Swedish agricultural sector when agricultural policy was reformed at the beginning of the 1990s. The environmental reasons were mainly based on avoiding harmful local emissions in densely populated areas.

Since the mid-1990s, support for biofuels has been increasingly motivated by climate issues. The UN Framework Convention on Climate Change (UNFCCC), also known as the “Climate Convention” was signed in Rio de Janeiro in 1992. When Sweden ratified the Climate Convention, the Riksdag adopted a climate strategy whereby Swedish greenhouse gas emissions in 2000 would be stabilised at 1990 levels and thereafter reduced. The measures emphasised by the government to achieve the climate strategy included abolishing the tax on unblended ethanol. A strategy was also introduced to reduce the transport sector’s impact on the climate.³³

The Riksdag has subsequently adopted a national environmental quality objective: Reduced impact on the climate. The environmental quality objective is linked to the Climate Convention. The objective means that Sweden, along with other countries, is responsible for ensuring that the content of greenhouse gases in the atmosphere is stabilised at such a level that human impact on the climate system does not become dangerous.³⁴ The Riksdag has also decided on interim targets and intermediate objectives for the environmental quality objective.

In 2002, the Riksdag decided on an interim target for the environmental quality objective whereby Swedish emissions of greenhouse gases for the 2008–2012 period will fall by at least 4 per cent compared to 1990. In connection with that decision, the Riksdag also stated, through the Committee on Environment and Agriculture, that a policy to promote the introduction and increased use of alternative fuels is an important measure for limiting the transport sector’s impact on the climate.³⁵

The milestone target for the environmental quality objective that the Riksdag decided on in 2009 means that Sweden’s greenhouse gas emissions in 2020 will be 40 per cent lower than in 1990. The target applies to activities not covered by the emissions trading scheme, including domestic transport services. The target means that greenhouse gas emissions in 2020 will be approximately 20 million tonnes of carbon dioxide equivalents lower for the non-trading sector

³³ Prop. 1992/93:179, *om åtgärder mot klimatpåverkan m.m.*, bet. 1992/93/10U19, rskr. 1992/93:361 [Government Bill 1992/93:179, *on Measures to prevent the impact on the climate, etc.*, Committee Report 1992/93/10U19, Riksdag Communication 1992/93:361].

³⁴ Prop. 1997/98:145, *Svenska miljömål*, bet. 1998/99:MJU6, rskr. 1998/99:183 [Government Bill 1997/98:145, *Swedish environmental objectives*, Committee Report 1998/99:MJU6, Riksdag Communication 1998/99:183].

³⁵ Prop. 2001/02:55, bet. 2001/02:MJU10, rskr. 2001/02:163 [Government Bill 2001/02:55, Committee Report 2001/02: MJU10, Riksdag Communication 2001/02:163].

in comparison with the 1990 level. In the government bill that preceded the milestone target, the government considered that investment in renewable fuels should form a central part of Swedish climate policy.³⁶

The Riksdag has also decided on a number of objectives aimed more specifically at the use of biofuels. These are largely linked to EU initiatives and requirements (see below). In 2004 the Riksdag adopted a national target of 3 per cent renewable transport fuels calculated as a proportion of total energy use in the transport sector in 2005.³⁷ In response to a proposal by the government, the Riksdag also decided that Sweden would have a national objective for guidance purposes that at least 5.75 per cent of fuel must consist of non-fossil fuels by 2010.³⁸ The Riksdag later decided that the proportion of renewable energy in the transport sector must be at least 10 per cent by 2020.³⁹

2.2.2 EU requirements

In addition to reasons connected with Swedish policy, the desire to increase the use of biofuels has been motivated by EU requirements. From 2003 onwards, the EU has adopted a series of initiatives to stimulate the development of biofuels. The “Biofuels Directive” was adopted in 2003. The directive contained targets for the purposes of guidance whereby the use of biofuels should account for 2 per cent of the total use of gasoline and diesel for transport purposes by 2005 and 5.75 per cent by 2010.⁴⁰

Under the Renewables Directive, which was adopted in 2009, there is now a mandatory requirement that all Member States must reach a target of at least 10 per cent renewable energy in the transport sector by 2020.⁴¹ The same level applies to all Member States.

³⁶ Prop. 2008/09:162, bet. 2008/09:MJU28, rskr. 2008/09:300 [Government Bill 2008/09:162, Committee Report. 2008/09:MJU28, Riksdag Communication 2008/09:300].

³⁷ Prop. 2004/05:1, *Budgetpropositionen för 2005*, UO 7, bet. 2004/05:FiU10, rskr. 2004/05:144 [Government Bill 2004/05:1, *The 2005 Budget Bill*, UO 7, Committee Report 2004/05:FiU10, Riksdag Communication 2004/05:144].

³⁸ Prop. 2005/06:16, *Skyldighet att tillhandahålla förnybara drivmedel*, bet. 2005/06:TU6, rskr. 2005/06:134 [Government Bill 2005/06:16, *Obligation to supply renewable fuels*, Committee Report 2005/06:TU6, Riksdag Communication 2005/06:134].

³⁹ Prop. 2008/09:163, bet. 2008/09:NU25, rskr. 2008/09:301 [Government Bill 2008/09:163, Committee Report. 2008/09:NU25, Riksdag Communication 2008/09:301].

⁴⁰ Europaparlamentets och rådets direktiv 2003/30/EG av den 8 maj 2003 om främjande av användningen av biodrivmedel eller andra förnybara drivmedel (*biodrivmedelsdirektivet*) [Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport (*the Biofuels Directive*)].

⁴¹ Europaparlamentets och rådets direktiv 2009/28/EG av den 23 april 2009 om främjande av användningen av energi från förnybara energikällor och om ändring och ett senare upphävande av direktiven 2001/77/EG och 2003/30/EG (*förnybarhetsdirektivet*) [Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (*the Renewables Directive*)].

The Renewables Directive also states that increased use of energy from renewable sources, along with other measures such as improved energy efficiency, is important for reducing greenhouse gas emissions. In order to count towards the target, biofuels are required to meet the so-called sustainability criteria set out in the directive. This is also a prerequisite in order for tax reductions or other support to be permitted.⁴²

A new Fuel Quality Directive was adopted in April 2009. Under the directive, all suppliers of vehicle fuels in the EU must cut greenhouse gas emissions by an average of 6 per cent per unit of energy by 2020. To achieve this target, suppliers may only be credited with sales of biofuels that fulfil the same sustainability criteria as in the Renewables Directive. The fulfilment of the target will depend on the possibility of using low-level blending of biofuels in gasoline and diesel respectively. The new Fuel Quality Directive therefore permits low-level blending at higher levels than previously: 10 per cent ethanol by volume in gasoline and 7 per cent biodiesel by volume in diesel fuel.⁴³

2.2.3 *Strategies for increasing the use of biofuels in Sweden*

The exemption from energy tax and carbon dioxide tax is the single largest and most significant measure for increasing the use of biofuels. The tax exemption is also the main focus of this audit and is described at length in Chapter 3.

A series of targeted measures have also been introduced in recent years to develop the infrastructure (fuel stations), and increase the number of green cars able to run on biofuels. Below we provide a brief explanation of how Sweden has attempted to increase the use of biofuels in ways other than through tax exemptions.

The “Pump Act” was passed in 2006 to regulate the supply and availability of biofuel.⁴⁴ The Act contains certain obligations for petrol stations to supply

⁴² Artikel 17, p 1, förnybarhetsdirektivet [Article 17, section 1 of *the Renewables Directive*].

⁴³ Europaparlamentets och rådets direktiv 2009/30/EG av den 23 april 2009 om ändring av direktiv 98/70/EG, vad gäller specifikationen för bensin, diesel och gasolja och införande av ett system för hur växthusgasutsläpp ska övervakas och minskas, om ändring i av rådets direktiv 1999/32/EG, vad gäller specifikationen för bränsle som används av fartyg på inre vattenvägar, och upphävande av direktiv 93/12/EG (*bränslekvalitetsdirektivet*) [Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of gasoline, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC (*the Fuel Quality Directive*)]. The directive must be transposed into Swedish law no later than 31/12 2010. A government bill was issued in January 2011. See prop. 2010/11:51, *Nya lagar om avgasrening och drivmedel* [Government Bill 2010/11:51, *New laws on exhaust emission control and fuel*].

⁴⁴ Prop. 2005/06:16, bet. 2005/06:TU6, rskr. 2005/06:134, lag (2005:1248) *om skyldighet att tillhandahålla förnybara drivmedel* [Government Bill 2005/06:16, Committee Report 2005/06:TU6, Riksdag Communication 2005/06:134, Act (2005:1248) *on the obligation to supply renewable fuels*]. The Act only covers liquid and gaseous biofuels. Renewable electricity is not included.

renewable fuels. Because the Pump Act primarily favours ethanol fuel stations, the Riksdag has also introduced a subsidy for investments to expand fuel stations to allow them to supply biogas and other renewable fuels besides ethanol.⁴⁵

The government has also aimed certain measures more directly at consumers. Since 1999, the value of green cars as a salary benefit has been reduced.⁴⁶ A carbon dioxide-based vehicle tax for new cars was introduced in 2006 to persuade car buyers to choose more fuel-efficient vehicles.⁴⁷ In order to direct purchases more specifically towards cars able to run on biofuels, the government introduced a miljöbilspremie [green car rebate] in 2007.⁴⁸ From July 2009, the green car rebate was replaced by an exemption from vehicle tax for green cars for the first five years. At the same time, the definition of which cars would benefit from the reduction was widened to include fuel-efficient gasoline and diesel cars.⁴⁹

In addition to these efforts, the government has been contributing targeted funding for research and development of alternative fuels for a long time.⁵⁰ As an example, in 2009–2012 the Swedish Energy Agency has a special research programme aimed at second generation biofuels with total funding of SEK 875 million.⁵¹

Indirect funding is also provided. The production of ethanol in particular is protected by high customs tariffs in Sweden and the EU. EU agricultural subsidies have also been important for the development and production of

⁴⁵ Prop. 2005/06:100, 2006 års ekonomiska vårproposition, bet. 2005/06:FiU:21, rskr. 2005/06:370. Se även förordning (2006:1591) om statligt stöd till åtgärder för främjande av distribution av förnybara drivmedel.

⁴⁶ Prop. 1999/2000:6, *Förmånsbeskattning av miljöbilar, m.m.*, bet. 1999/2000:SkU7, rskr. 1999/2000:66, lag (1999:1048) om ändring i kommunalskattelagen (1928:370) [Government Bill 1999/2000:6, *Taxation of benefits relating to green cars, etc.*, Committee Report 1999/2000:SkU7, Riksdag Communication 1999/2000:66, Act (1999:1048) amending the Municipal Tax Act (1928:370)].

⁴⁷ Prop. 2005/06:65, *Ny vägtrafikskattelag, m.m.*, bet. 2005/06:SkU15, rskr. 2005/06:167, vägtrafikskattelag (2006:227) [Government Bill 2005/06:65, *New Act on Road Traffic Taxes, etc.*, Committee Report 2005/06:SkU15, Riksdag Communication 2005/06:167, Road Traffic Tax Act (2006:227)].

⁴⁸ Prop. 2006/07:100, 2007 års ekonomiska vårproposition, bet. 2006/07:FiU21, rskr. 2006/07:222 [Government Bill 2006/07:100, *2007 Spring Finance Bill, Committee Report 2006/07:FiU21, Riksdag Communication 2006/07:222*].

⁴⁹ Prop. 2009/10:41, *Vissa punktskattefrågor med anledning av budgetpropositionen för 2010*, bet. 2009/10:SkU21, rskr. 2009/10:122, lag (2009:1467) om ändring i vägtrafikskattelagen (2006:227) [Government Bill 2009/10:41, *Certain excise duty issues due to the 2010 Budget Bill*, Committee Report 2009/10:SkU21, Riksdag Communication 2009/10:122, Act (2009:1467) amending the Road Traffic Tax Act (2006:227)].

⁵⁰ In recent years, the government has invested between SEK 120 million and SEK 170 million annually on research and development of biofuels.

⁵¹ Prop. 2008/09:1, *Budgetpropositionen för 2009*, UO 21, bet. 2008/09:FiU1, rskr. 2008/09:46 [Government Bill 2008/09:1, *The 2009 Budget Bill*, UO 21, Committee Report 2008/09:FiU1, Riksdag Communication 2008/09:46].

biofuels in the EU. Machinery used in agriculture and forestry is currently eligible for reductions in carbon dioxide tax on fuels. Because today's biofuels are largely only produced from agricultural raw materials, the tax reduction means that biofuels are also subsidised at the stage of production of the raw materials (except for the tax exemption for biofuels that takes effect at a later stage).⁵²

⁵² Kutas, G., Lindberg, C. and Steenblik, R. (2007), *Biofuels at what costs? Government support for ethanol and biodiesel in the European Union*, Hammarlund, C. et. al. (2010), *Bränsle för ett bättre klimat – Marknad och politik för biobränslen* [*Fuel for a better climate – Biofuels market and policy*].

3 The taxation of biofuels

This chapter describes the background to how taxation of biofuels has developed and why the government is now responsible for decisions on tax relief. We also review government decisions on tax relief for biofuels in the 1995–2009 period. The aim of this review is to shed light on the principles forming the basis for the government’s decisions to allow tax exemptions for biofuels and the extent to which decisions have been uniform over time. This is in view of the fact a stated aim of the government is that biofuels should be provided with long-term, predictable conditions. In this chapter we also investigate how the government has monitored the tax exemption for biofuels and what accounts the government has presented to the Riksdag. The chapter begins with a summary of our main observations.

3.1 A summary of our observations

- In order to provide long-term, predictable conditions for biofuels, the government has devised a set of principles to form the basis of decisions on tax relief for biofuels. However, the government’s decisions on tax relief have differed from one company to another. Only one company was granted a full tax exemption for several years for ethanol during the 1995–2001 period. However, several companies applied for equivalent conditions, but met with a refusal.
- Despite the government’s aim to provide biofuels with long-term, predictable conditions, many decisions on tax relief only relate to a period of one to two years.
- Exemptions for pilot projects have lost any practical significance. This has also served to weaken the requirement that tax relief for biofuels should focus on the development of more environmentally-friendly fuel.
- The government originally decided to allow tax relief for biofuels because, according to the government, a uniform, consistent interpretation of the concept of pilot project was required. The legislative changes introduced from the start of 2011 enable the government to adopt decisions on tax relief for biofuels in special cases. However, which special cases this refers to is not clear.

- The tax exemption serves primarily as a support for existing technologies. In its monitoring of the tax exemption, the Swedish Energy Agency has been unable to discern any development towards new technologies or technologies other than those that have already been known for a long time.
- The Swedish Energy Agency monitors the exemption in accordance with a requirement imposed by the EU. Despite the fact that the government entrusted the Agency with the ambitious task of monitoring the exemption, the government has seldom used the results of the Swedish Energy Agency's monitoring as a basis for its decisions on tax relief or in its reports to the Riksdag.
- The loss of tax revenues as a result of tax relief for biofuels has increased steadily (exponentially) since 2000. Based on sales of biofuels in 2009, the total loss of tax revenues is estimated at around SEK 2 billion. However, the budgeted amount that the government has reported in recent years' budget bills is somewhat lower.
- The government has not commented on the overall cost of the tax exemption or its impact on the climate objectives in any of the budget bills in recent years. On the whole, the government has submitted very little monitoring data and very few reports to the Riksdag on the results of the tax exemption. Not enough of the supporting data previously requested by the Riksdag has been reported, which has resulted in a lack of transparency.

3.2 Sweden's entry into the EU changed the taxation of fuel in Sweden

Excise duties are taxes on specific goods and services and they are often intended to impact on patterns of consumption and production. Fossil fuels have been subject to excise duties in Sweden for a long time. However, most biofuels were either fully exempt from tax or were subject to a lower tax rate until Sweden became a Member of the EU in 1995.⁵³

⁵³ Mixed fuels consisting of less than 70 per cent mineral oil were fully exempt from tax. A lower tax rate was introduced for motor alcohols (ethanol and methanol) from 1980. Motor alcohols were also excluded from carbon dioxide tax when it was introduced in 1991. The energy tax on pure ethanol as a fuel was also abolished in 1992 and a general exemption from excise duty for vegetable and animal oils in mixed fuels was introduced in 1993. See also prop. 1978/79:115, *om riktlinjer för energipolitiken*, bet. SkU 1978/79:44, rskr. 1978/79:430, prop. 1989/90:111, *om reformerad mervärdesskatt m.m.*, bet. 1989/90:SkU31, rskr. 1989/90:357, prop. 1991/92:67, *om skatten på etanol, m.m.*, bet. 1991/92:SkU6, rskr. 1991/92:99, bet. 1992/93:SkU34, *Sänkning av dieseloljeskatten*, rskr. 1992/93:370 [Government Bill 1978/79:115, *on energy policy guidelines*, Committee Report SkU 1978/79:44, Riksdag Communication 1978/79:430, Government Bill 1989/90:111, *on reformed value added tax, etc.*, Committee Report 1989/90:SkU31, Riksdag Communication 1989/90:357, Government Bill 1991/92:67, *on tax on ethanol, etc.*, Committee Report 1991/92:SkU6, Riksdag Communication 1991/92:99, Committee Report. 1992/93:SkU34, *Reduction in diesel oil tax*, Riksdag Communication 1992/93:370].

When Sweden became a Member of the EU, a general obligation to pay excise duty was introduced for all motor fuels, regardless of how they were produced. For Sweden, this meant that excise duty in the form of energy tax and carbon dioxide tax would also be payable for biofuels. The change was part of the process of adapting taxation in Sweden to EU law.

However, in Community law there are some possible ways to provide tax relief for fuel used within the framework of so-called “pilot projects” aimed at developing more environmentally-friendly fuels. It is also possible to allow general tax relief. General tax relief for biofuels required a Council Decision in accordance with a special provision for a waiver at the time of Sweden’s entry to the EU.⁵⁴

To ensure that the taxation of biofuels would not be affected by EU membership, Sweden chose to take the opportunity to provide tax relief for pilot projects. A provision to that effect was therefore inserted in Act (1994:1776) on the taxation of energy (the Energy Tax Act) in January 1995.⁵⁵

3.3 The government decides to provide tax relief for biofuels

The exemption provisions contained in the Energy Tax Act give the government the opportunity to decide to allow tax relief for pilot projects aimed at developing more environmentally-friendly fuels.⁵⁶ Therefore, since 1995 it has been necessary for users and producers of liquid biofuels to apply to the government for tax reductions or tax exemptions. The fact that the government was made responsible for such decisions was justified, according to the government, by the need for a uniform, consistent interpretation of the concept

⁵⁴ The possibility of tax relief for pilot projects was contemplated in *artikel 8.2 d i rådets direktiv 92/81/EEG av den 19 oktober 1992 om harmonisering av strukturerna för punktskatter på mineraloljor (mineraloljedirektivet)* [Article 8.2 d of Council Directive 92/81/EEC of 19 October 1992 on the harmonization of the structures of excise duties on mineral oils (the Mineral Oil Directive)]. Article 8.4 of that same directive contained a possibility for Member States to apply for permission from the Council to apply tax relief in cases other than those contemplated in the special provisions contained in the directive. The provisions on pilot projects are now contained in *artikel 15.1 a i rådets direktiv 2003/96/EG av den 27 oktober 2003 om en omstrukturering av gemenskapsramen för beskattning av energiprodukter och elektricitet (energiskattedirektivet)* [Article 15.1 of Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for taxation of energy products and electricity (the Energy Tax Directive)]. Article 16 of the Energy Tax Directive also introduced a general possibility of providing tax relief for biofuels under certain specified conditions without any requirement for a Council Decision.

⁵⁵ Prop. 1994/95:54, bet. 1994/95:SkU4, rskr. 1994/95:152 [Government Bill 1994/95:54, Committee Report. 1994/95:SkU4, Riksdag Communication 1994/95:152].

⁵⁶ Chapter 2, section 12 of *energiskattelagen [the Energy Tax Act]*. The exemption provision allowing the government to adopt decisions on tax relief for biofuels in special cases was amended from 1 January 2011. See prop. 2010/11:32, *Förfaranderegler för alternativa drivmedel*, bet. 2010/11:SkU17, rskr. 2010/11:76, lag (2010:1824) *om ändring i lagen (1994:1776) om skatt på energi* [Government Bill 2010/11:32, *Procedural rules for alternative fuels*, Committee Report 2010/11:SkU17, Riksdag Communication 2010/11:76, Act (2010:1824) *amending the Act (1994:1776) on the taxation of energy*].

of “pilot project”. It would not therefore be possible for the government to delegate administration of applications for tax relief for pilot projects to a government agency.⁵⁷

The government’s decisions on exemptions governs the scope of the tax relief. However, biofuels must be dealt with in accordance with the procedural rules contained in the Energy Tax Act. In order to benefit from a decision on tax relief, the person applying for the tax relief must also be liable for tax on fuel under the same Act.⁵⁸

3.3.1 *The principles for decisions on tax relief have changed over time*

No more detailed criteria for when a tax exemption would be granted were required when the exemption provision was introduced in 1995. The committee report states only that tax exemptions would be granted to the same extent as before. The government’s decision would therefore conform to previous practice, which meant that biofuels in the form of vegetable and animal oils and ethanol for high-level blending would be granted a full tax exemption. Ethanol used for low-level blending would be exempt from carbon dioxide tax and would be granted a reduction in energy tax.⁵⁹

In order to guarantee long-term, predictable conditions for biofuels, the government has devised a set of principles to form the basis for decisions on tax relief for biofuels. A general summary of these principles is given in the table below.

⁵⁷ See prop. 1994/95:54, s. 56 f. samt bet. 1994/95:SkU4 [Government Bill 1994/95:54, page 56 f. and Committee Report 1994/95:SkU4], page 46. The committee report shows that there were several motions containing a great deal of criticism of the proposed solution. Among other things, there were misgivings that granting exemptions restrictively could put a brake on the development of more environmentally-friendly fuels. The committee responded to these misgivings by stating that the rule would be applied in such a way that no change in taxation would take place for the period prior to EU entry. The exemption provision would therefore not be any obstacle to new projects.

⁵⁸ The procedural rules have been amended from 1 January 2011 so that a person liable for tax now makes the relevant deduction for fuel tax in his energy tax declaration to the extent laid down in the decision to allow an exemption. A system of offsetting had previously been applied, which means that no visible deduction was entered in the declaration. See prop. 2010/11:32, bet. 2010/11:SkU17, rskr. 2010/11:76 [Government Bill 2010/11:32, Committee Report 2010/11:SkU17, Riksdag Communication 2010/11:76].

⁵⁹ The reduction in energy tax meant that ethanol for low-level blending received tax relief equivalent to approximately 80 per cent of the excise duty on gasoline.

Table 3.1. The government's principles for decisions on tax relief for biofuels after entry to the EU

Clarification/change	Reason	State aid clearance
Guidelines in accordance with the 1998 Budget Bill ⁶⁰		
Exemption from carbon dioxide tax for all biofuels. Exemption from energy tax and carbon dioxide tax for ethanol regardless of usage. Decision that the tax exemption would apply up to and including 2003 at the latest and could be extended thereafter.	Guarantee long-term conditions for ethanol in particular.	Approved individual State aid 1998.
The tax strategy for alternative fuels in the 2002 Budget Bill ⁶¹		
Exemption from energy tax and carbon dioxide tax for pilot projects and a general carbon dioxide tax exemption for other biofuels.	Guarantee long-term conditions for alternative fuels.	Approved State aid in 2003, with certain conditions.
Expansion of the tax strategy for alternative fuels in the 2004 Budget Bill ⁶²		
Exemption from energy tax and carbon dioxide tax for all biofuels. Tax exemption for pilot projects is expanded to include alternative fuels of non-biological origin. The conditions would apply from 2004 to 2008.	A previous strategy was insufficient to guarantee adequate competitive conditions for biofuels. Tax exemptions for pilot projects had lost their significance.	Approved State aid in 2005 (for the pilot project part) and 2006.

Source: Government Bill 1997/98:1, Government Bill 2001/02:1, Government Bill 2003/04:1.

The government's principles mean a number of changes compared to the practices that applied when Sweden joined the EU. The guidelines in the 1998 Budget Bill meant, for example, that ethanol for low-level blending would also be granted an exemption from both energy tax and carbon dioxide tax. According to previous practices, this was reserved for ethanol for high-level blending only. The tax strategy for alternative fuels launched by the government

⁶⁰ Prop. 1997/98:1, *Budgetpropositionen för 1998*, avsnitt 8.6.3, Principer för beviljandet av pilotprojektdispenser för etanol [Government Bill 1997/98:1, 1998 Budget Bill, Section 8.6.3, Principles for granting pilot project exemptions for ethanol]. The Riksdag does not comment on the principles during budget discussions. However, in later reports the tax committee stated said that it was in favour of the views expressed in the government's guidelines. See bet. 1998/99:SkU13, *Vissa punktskattefrågor* [Committee Report 1998/99:SkU13, *Some excise duty issues*], page 19.

⁶¹ Prop. 2001/02:1, bet. 2001/02:FiU1, rskr. 2001/02:34 [Government Bill 2001/02:1, Committee Report. 2001/02:FiU1, Riksdag Communication 2001/02:34].

⁶² Prop. 2003/04:1, bet. 2003/04:FiU1, rskr. 2003/04:42 [Government Bill 2003/04:1, Committee Report. 2003/04:FiU1, Riksdag Communication 2003/04:42].

in the 2002 Budget Bill made it possible for all biofuels to obtain an exemption from carbon dioxide tax, even when they were not related to pilot project.⁶³ That tax strategy was later extended in the 2004 Budget Bill so that all biofuels could obtain an exemption from both energy tax and carbon dioxide tax without any need for a link to a pilot project. The tax exemptions for pilot projects thus came to lose their practical significance. This has also served to weaken the requirement that tax relief for biofuels should focus on the development of more environmentally-friendly fuel.

3.3.2 *Tax relief for pilot projects now lacks a state aid funding support decision*

One important reason why tax exemptions for pilot projects lost their practical significance is the practice developed in EU law relating to how pilot projects should be defined.⁶⁴ At present, Sweden also lacks a State aid decision for a tax exemption for pilot projects. The most recent State aid decision expired in 2008.

A tax reduction or tax exemption is considered by the EU to be State aid.⁶⁵ However, some State aid may be accepted, for example if it is intended to promote environmental issues. The Commission controls and examines whether the State aid granted to companies by Member States can be authorised under the rules for State aid.⁶⁶ The guidelines drawn up by the government as a basis for tax relief for biofuels have undergone such an examination.⁶⁷

⁶³ In accordance with Article 8.4 of *mineraloljedirektivet* [the Mineral Oil Directive].

⁶⁴ This is in accordance with the practice developed in the area. See *Förstainstansrättens dom den 27 december 2000 i mål T-184/97, BP Chemicals Ltd mot Europeiska kommissionen, REG 2000* [the judgment of the Court of First Instance of 27 December 2000 in Case T-184/97, BP Chemicals Ltd. v Commission of the European Communities, ECR 2000] Page II-03145. The judgment of the Court of First Instance contains a clarification of the concept of "pilot project". According to the Court of First Instance, the expression means "pilot projects for the technological development of more environmentally-friendly products", not that Member States are given the right to grant tax reductions to all pilot projects relating to the development of more environmentally-friendly products. Instead, the Court of First Instance stated that: "That provision expressly requires such projects to pursue the technological development of such products, thereby limiting the type of pilot projects that can come within its scope."

⁶⁵ Consolidated versions of *fördraget om Europeiska unionen och fördraget om Europeiska unionens funktionssätt artikel 107 (före detta artikel 87 FEG)* [the Treaty on European Union and the Treaty on the Functioning of the European Union, Article 107 (ex Article 87 TEC)].

⁶⁶ The Member States must therefore notify the European Commission of any funding support. The funding support must also be approved by the Commission before it can enter into force.

⁶⁷ *Statsstödsärende N512/02 Stöd till förmån för pilotprojekt för biobränslen* [State Aid cases N512/02 Aid in favour of pilot project for bio-propellant] and *N480/02 Punktskattelättnad för koldioxidneutrala drivmedel* [N480/02 Excise duty relief for CO₂-neutral fuels]. See also *statsstödsärende N187/2004 Nedsättning eller befrielse från skatt för pilotprojekt för alternativa drivmedel* [State Aid cases N187/2004 Reduction or exemption from tax for pilot projects for alternative fuels] and *N112/2004 Skattebefrielse för biodrivmedel* [N112/2004 Tax exemptions for biofuels].

The supporting data that the government submitted to the Commission shows that tax relief should not be granted to pilot projects relating to ethanol from agricultural products. This is because the technology used in the production of biofuels from agricultural products is already fairly well-developed. Instead, the government has stated in the supporting data that tax relief for biofuels should be provided in the form of general tax relief.⁶⁸ The Commission has no objection to this arrangement.

The Commission's latest approval for the tax exemption for pilot projects expired in 2008.⁶⁹ The government had not submitted an application to the Commission to extend the tax exemption for pilot projects after 2008. However, the government has notified the Commission and received approval for an extension of the general tax exemption for biofuels to 2013.⁷⁰

3.3.3 *There has been no national legal basis for a general tax exemption*

The provision of the Act on Energy Tax (1994:1776) that empowers the government to adopt decisions concerning tax relief for biofuels only relates to tax relief for pilot projects, not general tax relief. Since 1998, the government has repeatedly commented in decisions, government bills and supporting documentation for applications for State aid clearance that regulations regarding a general tax exemption for biofuels should be introduced in the Energy Tax Act.⁷¹ This is regardless of whether the exemption relates only to carbon dioxide tax or to both energy tax and carbon dioxide tax. Nevertheless, the government has not put forward any proposals to the Riksdag for any such change in the law.⁷²

In November 2010, the government presented a bill to the Riksdag containing draft revised rules of procedure for alternative fuels. The changes proposed by the government included a proposed amendment to Chapter 2, section 12 of the Energy Tax Act. In accordance with the proposal, from 1 January 2011 the

⁶⁸ Pursuant to Article 16 of *energiskattedirektivet [the Energy Tax Directive]*.

⁶⁹ Statsstödsärende N187/2004 *Nedsättning eller befrielse från skatt för pilotprojekt för alternativa drivmedel* [State Aid case N187/2004 *Reduction or exemption from tax for pilot projects for alternative fuels*].

⁷⁰ Statsstödsärende N592/2006 *Skattebefrielse för biodrivmedel – förlängd tillämpning* [State Aid case N592/2006 *Tax exemption for biofuels – prolongation*].

⁷¹ See also prop. 1997/98:1, avsnitt 8.6.3, statsstödsärende N93/98, *Befrielse från energi- och koldioxidsskatt för företaget Agroetanol AB* [Government Bill 1997/98:1, section 8.6.3, State Aid case N93/98, *Exemption from energy and carbon taxes for the company Agroetanol AB*] and prop. 2007/08:1, avsnitt 5.6.13 [Government Bill 2007/08:1, section 5.6.13].

⁷² This was also taken up by the Constitutional Committee in an audit of the government's management of the tax exemption for 2005. See bet. 2006/07:KU10, *Granskning av statsrådets tjänsteutövning och regeringsärendenas handläggning* [Committee Report 2006/07: KU10, *Audit of the government's exercise of its duties and administration of government cases*]. In its audit, the Constitutional Committee established that the government based its decisions on tax exemptions for biofuels on a number of principles and that a draft law was being drawn up.

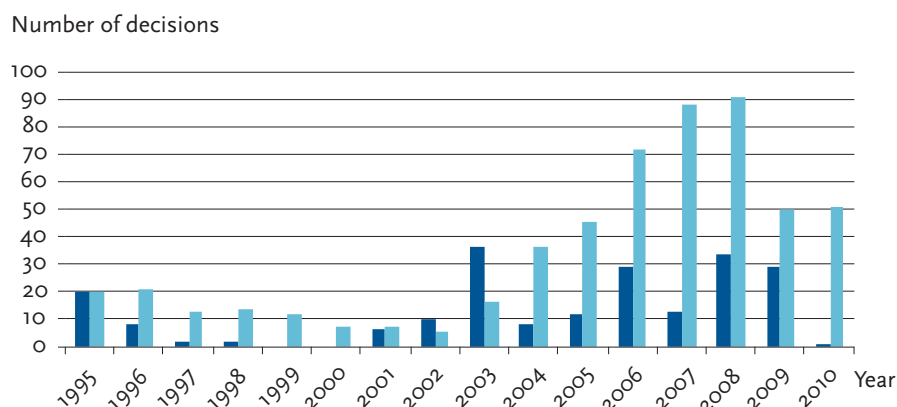
government will be empowered to make decisions on tax relief for biofuels in special cases without any need for them to relate to pilot projects. The Riksdag has adopted a decision in line with the government’s proposals.⁷³

3.4 Differences between principles and decisions on tax relief

The principles formulated by the government as a basis for decisions on tax relief for biofuels, which we have described briefly above, aimed to provide biofuels with long-term, predictable conditions. At the same time, those principles have changed over time. The SNAO’s review of government decisions on tax relief for biofuels in the 1995–2010 period also shows that the government has not always obeyed the principles it formulated, particularly in previous years. However, the government’s reasons for choosing not to formulate decisions in accordance with the stated principles have varied.

Chart 3.1 contains a summary of the number of decisions where the government approved an application for tax relief and how many tax exemptions have therefore been in force per year.⁷⁴

Chart 3.1. Number of government decisions where tax relief was granted and the number of tax exemptions in force per year, 1995–2010



Source: The SNAO’s summary of government decisions on tax relief for biofuels.

⁷³ Prop. 2010/11:32, 2010/11:SkU17, rskr. 2010/11:76 [Government Bill 2010/11:32, 2010/11:SkU17, Riksdag Communication 2010/11:76]. In the bill, the government states that tax relief may be granted in two different situations, either for fuel produced from biomass or for consumption of other alternative fuel in pilot projects. Tax relief for fuel produced from biomass falls under Article 16 or Article 15.1 of *energiskattedirektivet* [the Energy Tax Directive]. One prerequisite in the case of tax relief for fuels other than those produced from biomass is that the scope of use of the fuel should fall within the concept of “pilot project”.

⁷⁴ Because the government often decided to grant exemptions lasting more than one year, the number of approvals will be lower than the number of exemptions in most years.

As shown in Chart 3.1, relatively few tax relief applications were approved up to 2003. This is not just because there were few applications.

During the years from 1997 to 2001, the government granted virtually no tax relief, despite a relatively large number of applications. The government rejected all new applications for tax relief – 27 in total. The government rejected the applications partly for budgetary reasons and partly, according to the government, because there were uncertainties as to whether the increased use of biofuels would actually bring about any significant climate or environmental benefits. The few applications for tax relief that were approved during the period were all extensions of previous decisions. The tax relief granted in these cases was extended by successive periods of one year with unchanged terms and volumes, with the exception of two cases of tax relief for natural gas. In 2002, the government also began to grant new tax relief to a limited extent in the form of decisions with a duration of one year and involving lower volumes than stated in the application.

It was only in 2003 that the government began to grant new tax relief for more than one year. Virtually all decisions on tax relief issued between 2003 and 2007 were valid up to and including 2008.⁷⁵

3.4.1 *Many short-term decisions despite long-term goals*

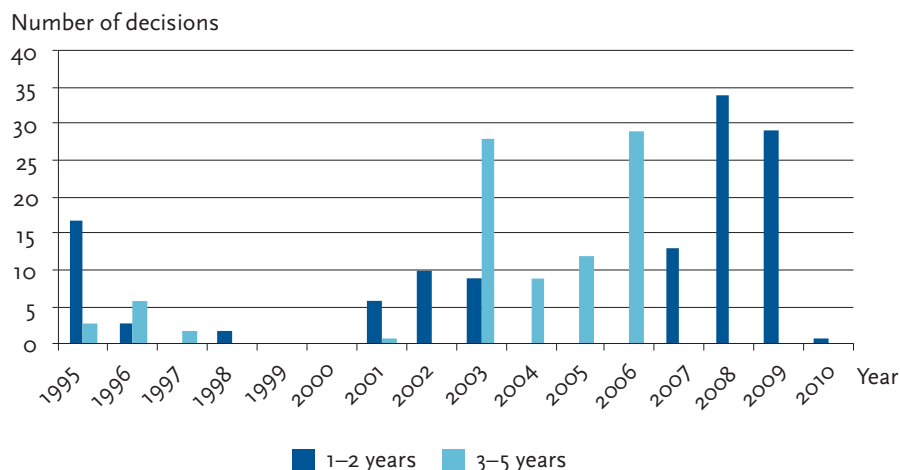
The guidelines forming the basis for decisions on tax relief for biofuels aimed to provide long-term, predictable conditions for biofuels. In some cases the government has also expressly stated in the guidelines that tax relief should be granted for a specific period. This is stated, for example, in the principles announced by the government in the budget bills for 1998 and 2004. In other cases this has been expressed in the government's supporting data for State aid clearance. However, the government's decisions on tax relief for biofuels have consistently involved relatively short periods of time. There are relatively few decisions on tax relief involving periods longer than one to two years. Most of these were granted in the years from 2003 to 2006.

The tax relief that the government has decided to grant in recent years, from 2008 onwards, all applies up to and including 2010. However, several companies have applied for tax exemptions up to and including 2013 or longer in some cases, when Sweden's State aid approval for the tax exemption expires.

The chart below shows the number of decisions with terms of one to two years and three to five years.

⁷⁵ This is in line with the strategy announced by the government in *2004 års budgetproposition [the 2004 Budget Bill]*. From mid-2005 onwards, the government also began to specify in its decisions that the tax relief related to the bio-based component of the fuel to which the application related.

Chart 3.2. Number of decisions on tax relief for 1–2 years and 3–5 years



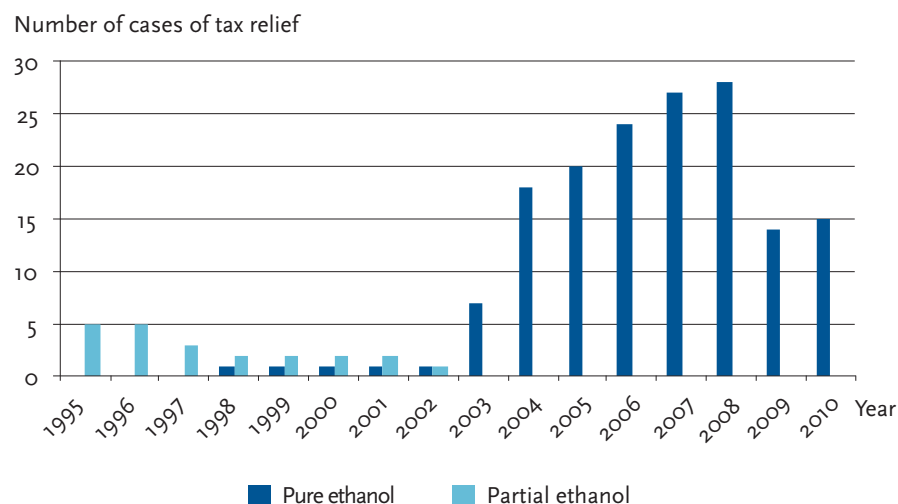
Source: The SNAO's summary of government decisions on tax relief for biofuels.

3.4.2 Differing, unclear conditions in decisions on tax relief for ethanol

Most of the government's decisions on tax relief have involved exemptions from both energy tax and carbon dioxide tax. It is largely only ethanol that has been granted partial tax relief, i.e. an exemption from carbon dioxide tax and a reduction in energy tax.⁷⁶ However, up to 2002, it is not possible to discern any clear principle in the government's decisions for when ethanol should be granted a full or partial tax exemption. According to the practices developed prior to Sweden's EU membership, ethanol used for high-level blending would be granted a full tax exemption, whereas ethanol used for low-level blending would be granted an exemption from carbon dioxide tax and a reduction in energy tax. However, in the 1998 Budget Bill the government stated that ethanol for low-level blending would also be granted a full tax exemption. See section 3.3.1.

⁷⁶ Natural gas was also previously granted partial tax relief. In recent years this has also occurred in the case of some synthetic fuels.

Chart 3.3. Number of cases of tax relief involving full and partial tax exemptions for ethanol



Source: *The SNAO's summary of government decisions on tax relief for biofuels.*

In the 1995–2002 period, two companies were granted a full tax exemption for ethanol for one and five years respectively.⁷⁷ Applications from the other companies were either refused or were granted an exemption from carbon dioxide tax and a reduction in energy tax.⁷⁸ None of the decisions contain any requirements as to how the ethanol would be used, i.e., whether it would be used for high-level or low-level blending. However, it is clear from the decisions in the period in question that several companies stated that they wanted the same conditions for their tax relief as the company that received a full five-year tax exemption for ethanol.

⁷⁷ See *regeringsbeslut 1997-09-04, dnr F195/5322* [the government decision of 04/09/1997, reg. no. F195/5322] and *regeringsbeslut 1998-02-26, dnr F197/2786* [the government decision of 26/02/1998, reg. no. F197/2786]. A full tax exemption means an exemption from both carbon dioxide tax and energy tax.

⁷⁸ Seven companies had their applications for a full tax exemption for ethanol completely rejected. Three companies received a partial rejection, i.e. a full exemption from carbon dioxide tax and a reduction in energy tax.

3.5 Monitoring by the Swedish Energy Agency – a requirement imposed by the EU

The European Commission has established a requirement that it must be possible for tax relief for pilot projects on biofuels to be checked and monitored. The Swedish Energy Agency has therefore been entrusted with that monitoring task since 1999.⁷⁹

The task ascribed to the Swedish Energy Agency by the government is ambitious in scope. Besides a requirement that the Agency should provide data on the scale of biofuel use and the economic conditions relating to biofuels, the reports should also give an account of environmental impact, the characteristics of emissions and technological development. The government allocated SEK 1 million for the task in the 1999 budget. The task should result in an annual report to the government.

The Swedish Energy Agency's reports are based on questionnaires completed by the companies that have been granted tax relief. Up to and including the report for 2007, the reports have focused primarily on scale of use, prices and economic conditions and to some extent on environmental impact and technological development. In recent years the reports have focused fully on the issue of whether or not the tax exemption leads to over-compensation.

This is because Community law does not allow tax relief for biofuels to lead to over-compensation of biofuels relative to the fossil fuels they replace.⁸⁰ This means that tax relief must not mean that biofuels become cheaper than fossil fuels. The government is obliged to ensure that tax relief for biofuels does not lead to over-compensation.⁸¹

3.5.1 *Difficult to discern any technological development*

In monitoring reports up to 2007, the Swedish Energy Agency notes that it is impossible to discern any development in production technology from the information the Agency collects from companies.⁸² According to the Agency, tax exemptions have primarily been granted to production of ethanol from cereals

⁷⁹ See regeringsbeslut den 19 november 1998, *Uppdrag till Statens energimyndighet avseende kontroll och utvärdering av pilotprojekt som avses i lagen (1994:1776) om skatt på energi*, dnr Fi1998/3032 [the government decision of 19 November 1998, *Assignment for the Swedish Energy Agency regarding the checking and evaluation of pilot projects as contemplated in the Swedish Act on Energy Tax (1994:1776)*, reg. no. Fi1998/3032].

⁸⁰ Both *statsstödsreglerna* [the State aid rules] and Article 16 paragraph 3 of *energiskattedirektivet* [the Energy Tax Directive] clearly state that tax relief for biofuels must not lead to over-compensation.

⁸¹ According to *statsstödsbeslut* [State aid decisions] issued by the Commission, the government is obliged to ensure that no over-compensation takes place. Relatively detailed information is collected from the beneficiary of the aid to allow the government to fulfil its monitoring obligations.

⁸² The Agency asks about this in the questionnaires.

and biodiesel from rapeseed oil. These biofuels are produced, according to the Agency, using technologies that are already known and that have relatively little development potential.

However, the Agency considers that production technologies for biofuels from new raw materials could take a significant step forward within the space of four to six years, with the timespan varying somewhat from one monitoring report to another. In its monitoring report from 2000, the Swedish Energy Agency considers that commercialisation of biofuels from new raw materials may begin within four years. In the reports for 2001 and 2002, the Agency considers that it should be possible for production of biofuels from new raw materials, including forest residues, to begin in just over six years. In the 2003 report, the Agency judges that production technologies from alcohols from biomass could take a significant step forward within the space of five years. However, the tax exemption must continue in order for these technological developments to be possible.⁸³

The Swedish Energy Agency also draws the conclusion that a tax exemption is likely to stimulate the development of technology more if it is aimed at biofuels in a more or less pure form rather than biofuels intended for low-level blending.

3.5.2 *The Riksdag does not have access to the monitoring carried out by the Swedish Energy Agency*

The material that the Swedish Energy Agency collects through its questionnaires is unique. The material is used almost exclusively for reports that the government must submit to the European Commission. The government has not referred to the monitoring carried out by the Swedish Energy Agency in decisions on tax relief or when reporting to the Riksdag.

As stated in Section 3.4, the government rejected many applications for tax relief for biofuels between 1997 and 2001 for budgetary reasons. At the same time, monitoring by the Swedish Energy Agency shows that many companies

⁸³ See Statens energimyndighet, *Redovisning av regeringsuppdrag avseende kontroll och utvärdering av pilotprojekt som avses i lagen (1994:1776) om skatt på energi*, dnr 552-98-3701 [Swedish Energy Agency, *Report on the government assignment regarding the checking and evaluation of pilot projects as contemplated in the Swedish Act on Energy Tax (1994:1776)*, reg. no. 552-98-3701], *Redovisning av regeringsuppdrag i enlighet med regleringsbrevet för 2002 om kontroll och utvärdering av pilotprojekt som avses i lagen (1994:1776) om skatt på energi*, dnr 00-02-205 [Report on the government assignment in accordance with the appropriation directions for 2002 on checking and evaluation of pilot projects as contemplated in the Swedish Act on Energy Tax (1994:1776)], reg. no. 00-02-205], *Redovisning av regeringsuppdrag i enlighet med regleringsbrevet för 2003 om kontroll och utvärdering av pilotprojekt som avses i lagen (1994:1776) om skatt på energi*, dnr 530-2003-01063 [Report on the government assignment in accordance with the appropriation directions for 2003 on checking and evaluation of pilot projects as contemplated in the Swedish Act on Energy Tax (1994:1776)], reg. no. 530-2003-01063].

did not make use of their opportunities for tax relief. The loss of tax revenues for those years was therefore not as great as estimated by the government.

The previous rejections by the government were also due to the uncertainty as to whether the increased use of biofuels would really bring about any significant environmental or climate benefits. However, the Swedish Energy Agency's task includes reporting on the environmental impact to which biofuels give rise, which the Agency has also done. In the monitoring reports in the first few years, the Swedish Energy Agency indicates that biofuels have great potential to contribute to reductions in greenhouse gases. As far as other emissions are concerned, the differences between biofuels and fossil fuels are declared to be negligible. The government has not referred to the Swedish Energy Agency's assessments in its decisions.

In its reports for recent years – 2008 and 2009 – the Swedish Energy Agency no longer provides any assessments of environmental impact or technological development. Instead, the reports focus on calculations concerning whether the tax relief for biofuels has led to over-compensation. This aspect was added to the Agency's task in the appropriation directions for 2007.

The government uses the material produced by the Swedish Energy Agency in its report to the Commission to show that tax relief for biofuels does not lead to over-compensation. The material produced by the Swedish Energy Agency is thus a necessary prerequisite in order for the government to meet the requirements imposed on the government by the Commission in its State aid decisions.⁸⁴ The material could also be used as a basis for other reports and monitoring in addition to that required by the EU.

3.6 The tax relief leads to a steadily increasing loss of tax revenues

The size of the loss of tax revenues to which the tax exemption gives rise cannot be estimated only on the basis of the number of decisions. The loss of tax revenues depends on how much of the tax relief has actually been used and what volumes are exempt from tax. The latter have risen sharply, particularly in recent years, as is shown in the next chapter.⁸⁵

⁸⁴ According to the tax department of the Ministry of Finance, if the government failed to supply the information to the Commission it would be in breach of decisions relating to the tax relief.

⁸⁵ According to monitoring by the Swedish Energy Agency, on average, 40 per cent of the tax relief granted was used in the 2004–2008 period.

It is clear from the Swedish Energy Agency's monitoring that, up to 2002, relatively few companies and producers made use of the tax relief granted to them. Neither were any large volumes of biofuels traded. Because a lot of the tax relief was not used, the actual loss of tax revenues was significantly lower than budgeted. According to the Swedish Energy Agency, the actual loss of tax revenues for the period from 1995 to 2002 is estimated to be in excess of SEK 600 million, which means an average loss of tax revenues of around SEK 80 million a year. The estimated or budgeted loss of tax revenues was approximately double that figure – around SEK 1.2 billion for the whole period.⁸⁶

In the 2002 Budget Bill, the government budgeted for an annual amount of SEK 900 million for the tax exemption for biofuels. This was subsequently increased in the 2004 Budget Bill to almost SEK 1.2 billion per year. As a result of an increase in low-level blending of biodiesel in diesel, the budgeted amount was thereafter raised by SEK 120 million from 2007 and SEK 410 million from 2009.⁸⁷ If next year's budget changes are also included, the budgeted amount for the tax exemption now amounts to around SEK 2 billion a year from 2011.⁸⁸

The loss of tax revenues was estimated at a significantly higher amount in the supporting data submitted by the government to the Commission prior to the State aid clearance for the tax exemption. In the supporting data from September 2006 submitted to the Commission, the government estimated the cost or loss of tax revenues for the tax exemption at SEK 1.8 billion a year between 2009 and 2013.⁸⁹ In later supporting data from October 2008, the overall loss of tax revenues for the tax exemption was estimated at SEK 2.5 billion a year.⁹⁰

⁸⁶ Statens energimyndighet, *Redovisning av uppdrag i enlighet med regleringsbrevet för 2003 om kontroll och utvärdering av pilotprojekt som avses i lagen (1994:1776) om skatt på energi*, dnr 530-2003-01063 [The National Energy Agency, *Report on an assignment in accordance with the appropriation directions for 2003 on checking and evaluation of pilot projects as contemplated in the Swedish Act on Energy Tax (1994:1776)*, reg. no. 530-2003-01063].

⁸⁷ Prop. 2001/02:1 [Government Bill 2001/02:1], section 8.9, prop. 2003/04:1 [Government Bill 2003/04:1], section 8.9 and prop. 2006/07:1, *Budgetpropositionen för 2007* [Government Bill 2006/07:1, *2007 Budget Bill*], section 5.11.

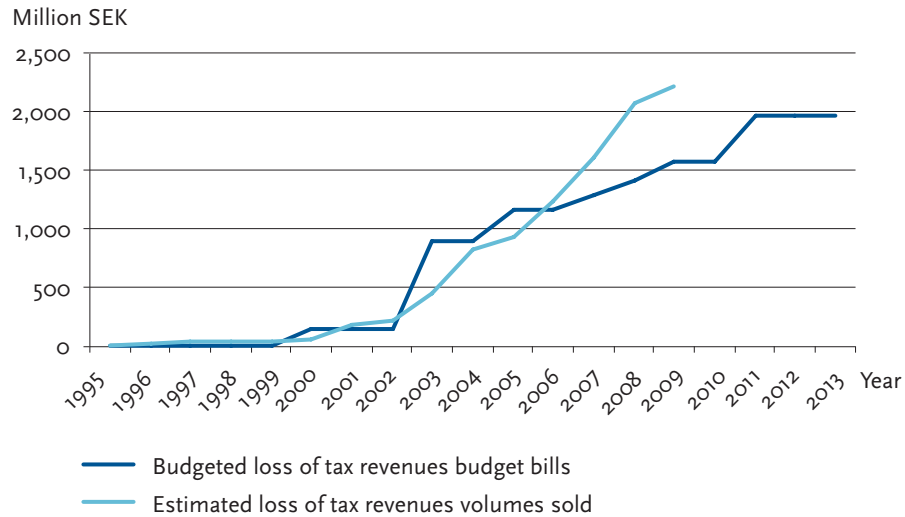
⁸⁸ The increased tax exemption for low-level blending in ethanol by up to 6.5 per cent by volume is estimated in the latest budget bill to mean further losses of tax revenues of SEK 400 million a year. See prop. 2010/11:1, *Budgetpropositionen för 2011* [Government Bill 2010/11:1, *2011 Budget Bill*], section 6.11.

⁸⁹ See the supporting data for statsstödsärende N592/2006, *Skattebefrielse för biodrivmedel – förlängd tillämpning* [State Aid case N592/2006, *Tax exemption for biofuels – prolongation*].

⁹⁰ See the supporting data for statsstödsärende N530/2008, *Skattebefrielse för biodrivmedel ändrad tillämpning* [State Aid case N530/2008, *Tax exemption for biofuels, amended application*].

Chart 3.4 below shows a summary of the budgeted or forecast loss of tax revenues per year between 1995 and 2013, based on what data could be obtained from official documents and the actual loss based on volumes of biofuels sold in the years from 1995 to 2009.

Chart 3.4. Loss of tax revenues due to tax relief for biofuels per year 1995–2009 (2013), million SEK



Source: Compilation of data in the budget bill and monitoring carried out by the Swedish Energy Agency and the SNAO's own calculations.

Note: Refers only to ethanol and biodiesel. Statistics on the development of other (bio) fuels are difficult to obtain.

As the chart shows, there is a difference between the budgeted loss of tax revenues and the actual loss that can be calculated on the basis of sales of biofuels. This is especially true in relation to the data presented in budget bills for recent years. From 2005 onwards, the budgeted amounts presented in the budget bills are consistently lower.

3.7 Government reports to the Riksdag have been few and far between

3.7.1 *The government has not presented an overall strategy for investment in biofuels*

Since the costs of the tax exemption have risen dramatically, there may be good reasons for producing more compiled supporting data to describe the central government's investment in biofuels as a whole. The Riksdag has also requested an overall strategy for policy instruments to promote the production of biofuels, stimulate technical development, bring about reasonable conditions for existing facilities, avoid disruptions in the operation of the market for biofuels and establish stable rules regardless of the situation regarding State finances.⁹¹ However, no such strategy has been presented by the government.

3.7.2 *The government has not monitored the effects of the tax exemption*

According to the Swedish Budget Act, the government must report to the Riksdag on the goals pursued and the results achieved in various areas of activity.⁹² The Riksdag has also pointed out on several occasions that more detailed results should be reported in the climate area. The government should focus more clearly on reporting and analysing the results achieved, rather than reporting on new measures.⁹³

A review of the budget bills for 2007 to 2011 and the tax expenditure accounts for 2009 and 2010 shows that the government does not report on any continuous monitoring of the tax exemption for those years. The government does not comment on the scope of the tax exemption or its impact in any of the budget bills. Instead, the focus is on describing future changes.

In the 2007 Budget Bill, the government states that carbon dioxide-neutral fuels should continue to be exempt from carbon dioxide tax and energy tax in the period from 2009 to 2013.⁹⁴

In the 2008 Budget Bill, the government reports that legislation on a general tax exemption for carbon dioxide-neutral fuels should be introduced in the Energy Tax Act and should enter into force on 1 January 2009. Furthermore, the government states that the general tax exemption should apply only up to and

⁹¹ Bet. 2005/06:TU6 [Committee Report 2005/06:TU6].

⁹² 2 § *lagen (1996:1059) om statsbudgeteten (budgetlagen)* [Section 2 of the Swedish State Budget Act (1996:1059) (the Budget Act)].

⁹³ See bet. 2009/10:MJU1 [Committee Report 2009/10:MJU1] and bet. 2010/11:MJU1 [Committee Report 2010/11:MJU1].

⁹⁴ Prop. 2006/07:1 [Government Bill 2006/07:1], section 5.6.6.

including 2013. The government also promises that the special tariff whereby ethanol used for low-level blending in gasoline is exempt from tax should be abolished as soon as possible but no later than 1 January 2009.⁹⁵

In the 2009 Budget Bill, the government states that it intends to explore various options for continuing to provide stable conditions for Swedish ethanol production. The government intends to urgently investigate a quota requirement to bring about conditions for increasing the proportion of renewable fuels.⁹⁶

The government had not yet proposed any legislation for a general tax exemption when the 2010 Budget Bill was presented. Neither had the government modified the special tariff applying to the tax exemption for ethanol for low-level blending. This is despite the fact that the government reported in the 2008 Budget Bill that this was its intention.

Instead, the government indicated that the tax relief for biofuels should be assessed when the introduction of a compulsory quota system for these fuels is considered and when the new fuel specifications in the Fuel Quality Directive are implemented.⁹⁷ The government also announced that a future increase in low-level blending of biodiesel in diesel and ethanol in gasoline is possible in accordance with the future Fuel Quality Directive.⁹⁸

In the 2011 Budget Bill, the government commented on the need for a tax exemption in order for low-level blending of biofuels to increase, according to the higher blending levels permitted in the new Fuel Quality Directive.⁹⁹ At the same time, the government considers that a full tax exemption should not be granted for the new low-level blending levels.¹⁰⁰ The initiative to subsidise higher levels of low-level blending than previously is also described in a section dealing with measures for a changeover to a fossil-fuel independent vehicle

⁹⁵ Prop. 2007/08:1, *Budgetpropositionen för 2008* [Government Bill 2007/08:1, *2008 Budget Bill*], section 5.6.13. The special tariff means that, since 1 January 2006, the government has stipulated that imported ethanol used for low-level blending may only be granted a tax exemption if the highest rate of customs duty is charged. Ethanol can be imported at three different rates of customs duty.

⁹⁶ Prop. 2008/09:1 [Government Bill 2008/09:1], section 6.2.5.4. A quota requirement means that sales of biofuels must account for a certain percentage of fuel sales.

⁹⁷ Prop. 2009/10:1, *Budgetpropositionen för 2010* [Government Bill 2009/10:1, *2010 Budget Bill*], section 7.2.5.10. The new fuel specifications allow for blending of up to 10 per cent ethanol in gasoline and 7 per cent biodiesel in diesel oil.

⁹⁸ Prop. 2009/10:1, *UO20* [Government Bill 2009/10:1, *UO20*], page 36.

⁹⁹ Prop. 2010/11:1 [Government Bill 2010/11:1], section 6.6.2.

¹⁰⁰ The government considers that an exemption from carbon dioxide tax and energy tax from 1 January 2011 onwards should apply to low-level blending up to and including 6.5 per cent by volume of ethanol in gasoline and 5 per cent by volume of biodiesel in diesel. An exemption from carbon dioxide tax and energy tax should also be granted through a decision on exemption for E85 and other high-level blends of biofuels and for biofuels without any fossil content whatsoever.

fleet.¹⁰¹ The initiative is also mentioned in a report on how energy policy objectives for 2020, including the objective relating to a higher proportion of renewable energy, are to be achieved.¹⁰² To sum up, the government does not comment on the total extent of the tax exemption or its effects in any of the budget bills for the years from 2007 to 2011.

The government's communications on tax expenditure accounting for 2009 and 2010 refer to the tax exemption as a reduction in energy tax under the heading "Energy tax exemption for carbon dioxide-neutral biofuels". These communications establish that the tax exemption applies to carbon dioxide-neutral fuels and that the standard consists of the energy tax rate for gasoline in environmental class 1. The exemption from carbon dioxide tax is not mentioned because carbon dioxide tax should not be payable on carbon dioxide-neutral fuels. Consequently, the tax expenditure reported for the tax exemption is slightly lower than the estimates of the loss of tax revenues presented by the government in other documents.¹⁰³

¹⁰¹ Prop. 2010/11:1, UO20 [Government Bill 2010/11:1, UO20], page 43.

¹⁰² Prop. 2010/11:1, UO21 [Government Bill 2010/11:1, UO21] page 47. In this area of expenditure, the government also provides a short report on the government bills that have been put forward during the year to implement *förnybarhets- och bränslekvälighetsdirektiven* [the *Renewables Directive and the Fuel Quality Directive*], page 36.

¹⁰³ Skr. 2008/09:183, Redovisning av skatteutgifter 2009, s. 25 och s. 40, skr. 2009/10:195, Redovisning av skatteutgifter, s. 24 och s. 39.

4 The importance of the tax exemption for the use of biofuels

This chapter aims to illustrate how the tax exemption is intended to work. In this chapter we also discuss how important the tax exemption, along with other support for biofuels, has been for the use of biofuels. Since the tax exemption works differently for high-level blends and low-level blends of biofuels, these are discussed in more detail in Chapters 5 and 6. The chapter begins with a summary of our main observations.

4.1 A summary of our observations

- The tax exemption is a fairly blunt instrument. It aims to level out differences in production costs between biofuels and fossil fuels. However, the subsidy provided by the tax exemption is largely dependent on the tax rate for the fossil fuels being replaced, not on differences in production costs.
- The tax exemption is the main instrument for increasing the use of biofuels. A mere tax exemption is not sufficient for biofuels to be used as high-level blended fuels. Investment in vehicles and infrastructure is also required.
- The tax exemption has mainly contributed to an increase in low-level blending of biofuels in gasoline and diesel. In recent years, the rate of increase has slowed as a result of a reduction in fuel consumption and the fact that the maximum permitted low-level blending has largely been achieved. However, the proportion of high-level blended biofuels has continued to rise slightly.

4.2 The tax exemption will level out differences in production costs

Excise duty in the form of energy tax and carbon dioxide tax on fuel is an indirect tax. “Indirect tax” means a tax that is normally charged to consumers but in this case is charged and paid by producers. As far as tax relief or an exemption from excise duty on biofuels is concerned, it is intended to benefit consumers through being reflected fully or partially in the retail price.

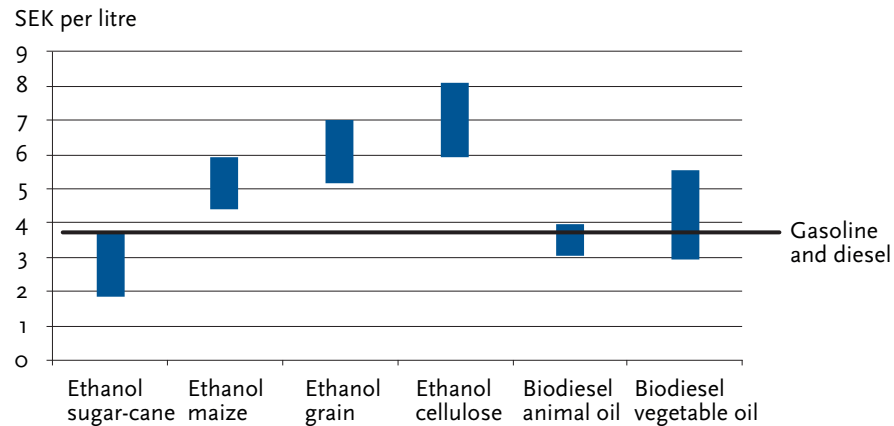
The tax exemption for biofuels therefore works by levelling out the differences in prices and production costs between biofuels and fossil fuel.¹⁰⁴ Production costs for biofuels are generally higher than the equivalent costs for the production of gasoline or diesel. Therefore, without some form of support or subsidy it would be difficult for biofuels to compete with fossil-fuel alternatives.

There are also differences in production costs between different biofuels. A single biofuel can be made from several different raw materials and using different production technologies, which affects the production costs and ultimately the price.

Chart 4.1 below shows that the production costs of most biofuels are too high to enable them to compete with gasoline or diesel. The chart also gives an approximate idea of how production costs for different biofuels can vary depending on the raw material used. The bars indicate the range within which production costs for different biofuels can vary depending on the raw material. For the purposes of comparison, the line corresponds to the average production cost for gasoline and diesel in 2007.

¹⁰⁴ See the supporting data for statsstödsärende N480/2002 *Punktskattelättnad för koldioxidneutrala drivmedel* [State Aid case N480/2002 *Excise duty relief for carbon dioxide-neutral fuels*], where the aim of the tax exemption is described in detail.

Chart 4.1. Estimated production costs for different biofuels and for gasoline and diesel taking into account differences in energy content, SEK per litre



Source: IEA 2007, average exchange rate according to the Riksbank and the Swedish Petroleum Institute.

The chart shows that it is largely only ethanol from sugar cane that is able to compete with gasoline and diesel without any form of subsidy. At the same time, the chart provides a snapshot of how the production costs relate to each other. The production costs for biofuels can vary considerably depending on demand, weather and crop harvest. Production costs for ethanol from sugar cane have risen slightly in recent years.

4.2.1 Production costs for Swedish biofuels vary

The biofuels mainly used in Sweden are ethanol and biodiesel, which are mainly produced from sugar cane, wheat and rapeseed oil. The production costs for these biofuels have varied over the years depending on the origin of the biofuel and the raw material used.

Swedish production of ethanol was previously relatively low in relation to the proportion of imported ethanol. Between 2004 and 2008, a large proportion (80–90 per cent) of the ethanol used in Sweden was imported. Most of this came from Brazil and was produced from sugar cane. This situation changed in 2009 when domestic production of ethanol increased to around 40 per cent as a result of expanded production capacity at the company that has so far accounted for most of the domestically-produced ethanol. At the same time, the proportion of imported ethanol from Brazil also fell as a result of smaller yields and higher prices. In 2009, just under 40 per cent of ethanol was

imported from Brazil, while around 20 per cent was introduced from another EU country.¹⁰⁵

As far as biodiesel is concerned, the trend has been different. Swedish production has largely been sufficient to supply the market. In recent years, imports have risen as a result of increased demand. In 2009, around 60 per cent of the biodiesel used was produced in Sweden.¹⁰⁶

Differences in production and import patterns affect the production cost for the Swedish use of biofuels. Based on monitoring of the tax exemption for biofuels carried out by the Swedish Energy Agency, it is possible to give a rough estimate of the production costs for the biofuel used in Sweden. See Table 4.1.¹⁰⁷

Table 4.1. Estimated production cost including shipping and excluding customs duty for Swedish biofuel use, SEK per litre.

Year	Ethanol E85	Ethanol low-level blending	Biodiesel
2008	3.69	5.01	8.00
2009	3.64	5.35	7.12

Source: The Swedish Energy Agency.

The table shows that the production costs for ethanol for low-level blending differ from the production costs for ethanol for E85. This is partly due to the fact that the ethanol used in low-level blending is, to a greater extent, domestically-produced or produced within the EU, whereas the ethanol used in E85 is mainly Brazilian sugar cane ethanol. However, the above presentation is simplified because we have not included any customs charges. The production costs will even out if we also include customs charges. See section 5.3.1.

¹⁰⁵ Statens energimyndighet (2010c), *Övervakningsrapport avseende skattebefrielse för biodrivmedel år 2009*, dnr 00-10-848 [The Swedish Energy Agency (2010c), *Monitoring Report on the tax exemption for biofuels in 2009*, reg. no. 00-10-848].

¹⁰⁶ Ibid. Swedish Energy Agency (2010c).

¹⁰⁷ Statens energimyndighet (2010b), Underlag till Riksrevisionen 29 november 2010, Statens energimyndighet (2010c) [Swedish Energy Agency (2010b), Supporting data for the SNAO 29 November 2010], *Övervakningsrapport avseende skattebefrielse för biodrivmedel år 2009*, dnr 00-10-848 [Swedish Energy Agency (2010c), *Monitoring Report on the tax exemption for biofuels in 2009*, reg. no. 00-10-848], Statens energimyndighet (2009b), *Övervakningsrapport avseende skattebefrielse för biodrivmedel och alternativa drivmedel*, dnr 00-09-558 [Swedish Energy Agency (2009b), *Monitoring Report on the tax exemption for biofuels and alternative fuels*, reg. no. 00-09-558].

4.2.2 *The size of the tax exemption depends on what is being replaced*

The total energy tax and carbon dioxide tax levied on gasoline differs from that levied on diesel. The size of the tax exemption for biofuels therefore varies according to which fossil fuel the biofuel in question is intended to replace. Table 4.2 shows the total energy tax and carbon dioxide tax per litre of fuel for gasoline and diesel in environmental class 1.

Table 4.2. Total energy tax and carbon dioxide tax on gasoline and diesel, SEK per litre

Year	Gasoline (environmental class 1)	Diesel (environmental class 1)
2007	5.06	3.72
2009	5.29	4.16
2009	5.52	4.34

Source: Skatteverket [The Swedish Tax Agency].

It is clear from the table that biofuels that replace gasoline will be granted a slightly higher tax exemption per litre than biofuels that replace diesel. This is because the total energy tax and carbon dioxide tax on gasoline is higher than the total energy tax and carbon dioxide tax on diesel fuel.

4.2.3 *The size of the subsidy also depends on the energy content*

The size of the subsidy actually provided by the tax exemption will, however, be somewhat lower than is indicated by the formal tax rates in Table 4.2. This is because a litre of biofuel can not fully replace a litre of gasoline or diesel because in most cases biofuel has a lower energy content and thus does not give as much mileage.¹⁰⁸ If we assume that all ethanol is used to replace gasoline and all biodiesel is used to replace diesel fuel, the subsidy provided by the tax exemption is calculated as shown in the table below.¹⁰⁹

¹⁰⁸ The energy content is calculated according to the calorific values of various fuels. On the basis of its energy content, 1 litre of gasoline is equivalent to 1.54 litres of ethanol, whereas 1 litre of diesel is equivalent to 1.07 litres of FAME and 1.66 litres of ethanol. See Statens Energimyndighet [the Swedish Energy Agency] or Naturvårdsverket [the Swedish Environmental Protection Agency] for information on calorific values.

¹⁰⁹ According to previous monitoring by the Swedish Energy Agency, these assumptions tally quite well. Approximately 6 per cent of the ethanol was used in bus fuel or diesel replacement in 2004. See Energimyndigheten (2005), *Redovisning av uppdrag i enlighet med regleringsbrevet för 2005 om kontroll och utvärdering av pilotprojekt som avses i lagen (1994:1776) om skatt på energi*, dnr 00-04-7202 [the Swedish Energy Agency (2005), *Report on an assignment in accordance with the appropriation directions for 2005 on checking and evaluation of pilot projects as contemplated in the Swedish Act on Energy Tax (1994:1776)*, reg. no. 00-04-7202]. On the basis of statistics on sales of E85 and proportions of ethanol for high-level blending, the current proportion of ethanol to diesel replacement may be estimated at around 4 per cent.

Table 4.3. Subsidy per litre in relation to differences in the energy content of the fuel, SEK per litre

Year	Ethanol	Biodiesel
2007	3.28	3.48
2008	3.43	3.89
2009	3.58	4.06

Source: Swedish Energy Agency and the SNAO's own calculations.

If the different energy content of fuels are not taken into account, biofuels will be at a disadvantage in relation to fossil fuels. Table 4.3 can also be read as the tax rate at which ethanol or biodiesel is compensated for its lower energy content.¹¹⁰

As shown in Table 4.3, the subsidy will continue to differ from one biofuel to another depending on the fossil fuels they replace, though the difference becomes smaller. The subsidy will also be slightly higher for biodiesel than for ethanol, but that may be considered reasonable since the production costs for biodiesel are higher.

4.2.4 *The exemption does not take varying production costs into account*

To assess whether the subsidy has been well balanced it needs to be compared to the difference in production costs between the biofuel and the fossil fuel it replaces. In a balanced subsidy, the difference should be close to zero because the tax exemption is intended to level out differences in production costs. Table 4.4 below shows the production costs for gasoline and diesel as well as for ethanol and biodiesel, taking into account differences in energy content for 2009. The last two rows show differences in production costs before and after the subsidy.¹¹¹

¹¹⁰ Despite the fact that neither *energiskattelagen* [the Energy Tax Act] nor *energiskattedirektivet* [the Energy Tax Directive] is designed in such a way that taxation takes place according to energy content, this forms an important part of the calculation of the tax subsidy for biofuels.

¹¹¹ The presentation has been simplified somewhat. When biofuels are used for low-level blending, they are a complement to the fossil fuel rather than a substitute for a given degree of low-level blending. See Chapter 5.

Table 4.4. Differences in production cost between ethanol and gasoline and between biodiesel and diesel in terms of differences in energy content before and after subsidies in 2009, SEK per litre

Year	Ethanol for E85	Ethanol for low-level blending	Biodiesel
Production cost of gasoline or diesel	3.58	3.58	4.03
Production cost of ethanol or biodiesel*	5.61	8.25	7.61
Difference in production cost before subsidies	-1.72	-4.36	-3.58
Difference in production cost after subsidies	1.85	-0.78	0.48

Source: Swedish Energy Agency and the SNAO's calculations.

* Converted to gasoline and diesel equivalent to take account of biofuels' lower energy content.

On the basis of the data presented in Table 4.4, the subsidy appears to have been sufficient, except for ethanol for low-level blending. The apparent over-subsidy for ethanol for E85 arises because we only compare differences in production costs between biofuels and gasoline and diesel.¹¹² The purpose of this presentation is to illustrate the fact that the tax exemption does not take into account variations in production costs from one biofuel to another and for the same biofuel.

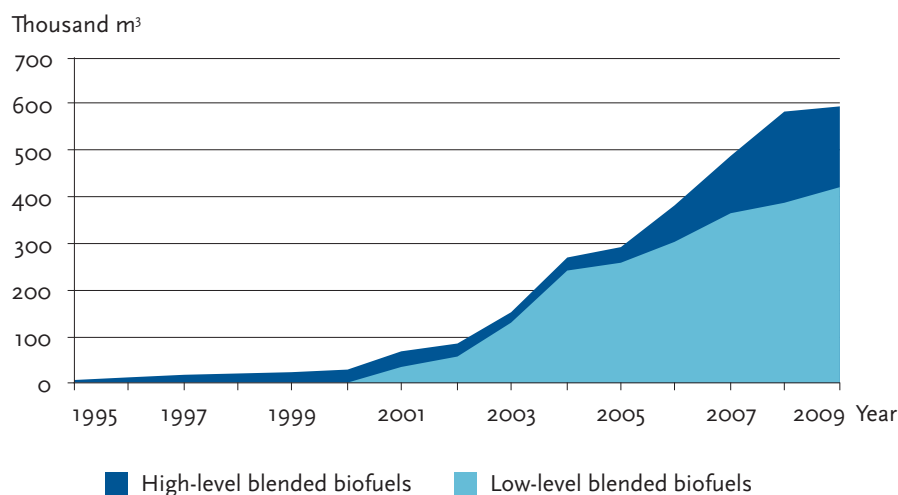
4.3 The tax exemption has mainly contributed to an increase in low-level blending

Most of the current biofuel use is for low-level blending in gasoline and diesel. As shown in Chart 4.2 below, the proportion of low-level blended biofuels has increased steadily since around 2000. The increased use has consisted mainly of ethanol for low-level blending in gasoline. In recent years, the proportion of biodiesel used for low-level blending in diesel has also begun to rise. At present, low-level blended ethanol accounts for around 40 per cent of biofuel use and low-level blended biodiesel accounts for around 30 per cent. So-called high-level blended biofuels account for only 30 per cent of biofuel use.¹¹³

¹¹² The data submitted by the Swedish Energy Agency in its monitoring reports includes several cost items.

¹¹³ ED95, E85 and biodiesel in pure form.

Chart 4.2. Total use of biofuels divided into high- and low-level blended biofuels 1995–2009, thousand m³



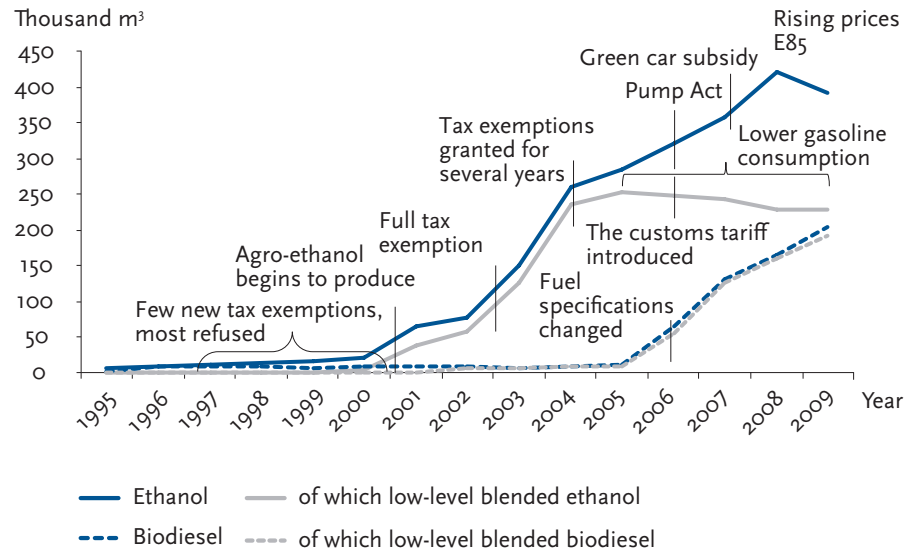
Source: The SNAO's compilation of data from the Swedish Energy Agency.

The tax exemption has played an important part in this development. However, as stated in the previous chapter, the focus of the government's decisions on tax relief for biofuels has varied over the years, which may have affected development. At the same time, the tax exemption works alongside a number of other instruments, so it is difficult to isolate the effects attributable to each instrument. However, most of the other instruments are aimed at the use of high-level blended biofuels. High-level blended biofuels require investment in other vehicles and infrastructure.¹¹⁴

Chart 4.3 below shows the development of liquid biofuels distributed according to biofuel and use. The chart has also been supplemented by changes in the decisions made by the government and the introduction of some important policy instruments.

¹¹⁴ SOU 2004:133, *Introduktion av förnybara fordonsbränslen* [SOU 2004:133, *Introduction of renewable fuels*], page 207.

Chart 4.3. Use of biofuels, decisions made by the government and the introduction of some important policy instruments



Source: Compiled by the SNAO.

Chart 4.3 shows that the use of biofuels was relatively modest up to around 2000. As stated in Chapter 3, the government also rejected most applications for tax relief in those years.

The use of ethanol took off around 2000, which coincides with the moment when production began at the company that accounted for most of the Swedish production. The government granted a full five-year tax exemption for this ethanol, which was mainly used for low-level blending.¹¹⁵ In 2002, the use of ethanol increased further at the same time as the government began granting full tax exemptions for all biofuels. In the years that followed, the proportion of imported ethanol in particular rose sharply.

Until around 2004, most of the ethanol was used for low-level blending in gasoline. Around 2005, this use began to become saturated since virtually all gasoline (90–95 per cent) contained 5 per cent ethanol. The increase in ethanol use from 2005 onwards has therefore mainly consisted of ethanol for high-level blended biofuels such as E85. That increase coincides with the introduction of the Pump Act (2006) and the green car rebate (2007), but is also due to a rise in the number of ethanol-powered cars.¹¹⁶

¹¹⁵ See supporting data for statsstödsärende N93/98, *Befrielse från energi- och koldioxidskatt för företaget Agroetanol AB* [State Aid case N93/98, *Exemption from energy tax and carbon dioxide tax for Agroetanol AB*].

¹¹⁶ As shown in Chapter 6, the rise in the number of ethanol-powered cars is not only attributable to the Pump Act and the green car rebate.

Use of biodiesel began to rise in 2006, which coincided with the change in fuel specifications for diesel fuels containing biofuels. The revised fuel specifications made low-level blending levels of up to 5 per cent possible. Previously only low-level blending of 2 per cent had been possible.¹¹⁷ Just over 80 per cent of all diesel now contains 5 per cent biodiesel.

¹¹⁷ Prop. 2005/06:181, bet. 2005/06:MJU28, rskr. 2005/06:345 [Government Bill 2005/06:181, Committee Report. 2005/06:MJU28, Riksdag Communication 2005/06:345].

5 The side effects of the tax exemption in the case of low-level blending

In this chapter we describe how the tax exemption for biofuels works when the biofuels are used for low-level blending, i.e. as part of ordinary gasoline and diesel. We also review the possible effects of a tax exemption for low-level blending and the importance of the special customs tariff applying to ethanol used for low-level blending in gasoline. The chapter begins with a summary of our main observations.

5.1 A summary of our observations

- A tax exemption for low-level blending contributes to lower prices for gasoline and diesel, all other things being equal. Therefore, the tax exemption for low-level blending may very well give rise to an increase in fuel consumption. However, the effect of the tax exemption on gasoline and diesel consumption may be assumed to be fairly small.
- Even if the tax exemption only involves a small increase in fuel consumption, this will also lead to increased emissions of greenhouse gases.
- The tax exemption levels out production costs between biofuels and fossil fuels, but not between different biofuels or the same biofuel. Over-compensation occurs because the tax exemption cannot be differentiated according to the different production costs for biofuels.
- The customs tariff provides special protection for ethanol produced in Sweden and the EU. Since the production costs for this ethanol are higher than for imported ethanol, the customs tariff gives rise to a higher cost for consumers.
- The government did not inform the Riksdag when the customs tariff was introduced. Neither has the government reported any assessment of the effects of the customs tariff on Swedish production, imports and use of biofuels. Overall, this means less transparency.

- The over-compensation calculations are sensitive to whatever assumptions are made regarding the lower energy content of ethanol. The compensation provided for differences in energy content between ethanol and gasoline favours ethanol with higher production costs produced in Sweden or the EU compared to imported ethanol with lower production costs. At the same time, there are no differences in energy content between more expensive and cheaper ethanol.

5.2 A tax exemption for low-level blending can lead to higher gasoline and diesel consumption

Biofuels for low-level blending are a complement to fossil fuels. When the degree of low-level blending has become saturated, the proportion of low-level blended biofuels can only increase if consumption of fossil fuels increases, or if the degree of low-level blending is increased. There is therefore good reason to investigate the extent to which a tax exemption for low-level blending can affect consumption of gasoline or diesel and thereby counteract any reductions in emission. This is particularly important as the cost of a tax exemption is borne jointly by all taxpayers.

As stated above, the tax exemption aims, among other things, to level out production costs between different biofuels. When biofuels used for low-level blending in fossil fuels are granted tax exemptions, the price and consumption of the fossil fuel are also affected. This is an effect that is seldom noted.¹¹⁸

The extent to which fossil fuel consumption is affected by a tax exemption for low-level blended biofuels is an empirical question. At the same time, there are few studies in which the impact on consumption is estimated. We will therefore illustrate how the tax exemption could affect consumption of gasoline and diesel with the aid of a numerical example.

¹¹⁸ According to available studies of policy instruments for biofuels, a tax exemption for low-level blending means lower fuel prices. See, for example, Vedenov, D. and Wetzstein, M. (2008), *Toward an optimal U.S. ethanol fuel subsidy* and De Gorter, H. and Just, D. (2008), *The law of unintended consequences: How the U.S. biofuel tax credit with a mandate subsidizes oil consumption and has no impact on ethanol consumption*.

5.2.1 A tax exemption leads to lower prices for gasoline and diesel

In the numerical example below, we assume that biofuels would have been used to the same extent with and without a tax exemption. This is a common approach used to isolate effects when analysing different changes in legislation. However, in the case where there is no tax exemption, the cost for the low-level blending would be passed on in the consumer prices. The example therefore shows that the tax exemption contributes to lower prices for fossil fuels, all other things being equal.

In order to estimate the possible impact of the tax exemption on fuel prices, we use price data from the Swedish Petroleum Institute.¹¹⁹ Based on these prices, we present the impact of the tax exemption on fuel prices by calculating the average difference in price including and excluding a tax exemption for the 2006–2009 period, all other things being equal. For diesel, we calculate only the price difference for the last two years because diesel previously did not contain such large volumes of low-level blended biodiesel. We also take into account the effect of value added tax for both gasoline and diesel. The results of the calculations are presented in Table 5.1.

Table 5.1. Average gasoline and diesel price including and excluding a tax exemption (SEK per litre)

	Price including a tax exemption	Price excluding a tax exemption	Average difference in price with and without a tax exemption
Average for gasoline 2006–2009	11.95	12.28	–0.33
Average for diesel 2008–2009	11.28	11.55	–0.27

Source: Own calculations based on data from the Swedish Petroleum Institute.

According to Table 5.1, the tax exemption for low-level blended ethanol is estimated to have resulted in a gasoline price that is around 3 per cent, or just over SEK 0.30 lower per litre, including the impact of value added tax, all other things being equal. The tax exemption for low-level blended biodiesel in diesel fuel can be similarly estimated to have led to a diesel price that is 2 per cent, or just under SEK 0.30 lower per litre.

¹¹⁹ See <http://spi.se/statistik/priser>, 25/11/2010.

5.2.2 *A tax exemption for low-level blending may lead to higher gasoline and diesel consumption*

How the price changes calculated above affect the total consumption of fuel depends on the price-sensitivity of consumption, i.e. on the price elasticity of fuel. In the short term, consumption of gasoline and diesel is often assumed to be relatively price-insensitive. This means that consumption is not affected to any great extent by a change in the price. In the longer term, when it is also possible to invest in new vehicles, etc., consumption is considered to be significantly more sensitive to price changes.¹²⁰

Since the oil crises of the 1970s, a large number of price elasticities for fuel have been estimated for different countries. Even though the estimated elasticities differ depending on the model and the data used, the differences between countries are small.¹²¹

A report from 2006 summarises the extensive literature available on the price sensitivity of the demand for gasoline. The study shows that the price elasticity of gasoline is higher in the long term than in the short term. In the very short term (one year), the price elasticity can be estimated at around -0.2 per cent, while the long term it generally falls within the -0.8 to -0.65 per cent range.¹²²

Reports containing supporting data for checkpoints in 2008¹²³ also contain price elasticities for diesel. In general these are lower than for gasoline due to the fact that diesel is largely used in commercial and goods transport. There may also be reason to believe that the price elasticity of gasoline and diesel in road traffic in Sweden is lower than the international average. This is because the Swedish car fleet has a higher kerb weight and engine power than the average for Europe, for example. From a longer-term perspective, however, the elasticity may be assumed to be higher because of the greater possibilities for adaptation in the longer term.¹²⁴

¹²⁰ A product's price elasticity shows the percentage change in consumption of the commodity when the price rises by 1 per cent. Under normal circumstances, elasticity is a negative number, i.e. consumption falls when the price rises. Low price elasticity means that consumption is not affected as much by a change in the price. High elasticity means that the price is extremely important for consumption.

¹²¹ Sterner, T. (2006), Survey of transport fuel demand elasticities.

¹²² Ibid. Sterner, T. (2006).

¹²³ According to the climate strategy from 2002, Swedish work in relation to the climate and the national objectives will be continuously monitored and evaluated. So-called "checkpoints" were set up in 2004 and 2008.

¹²⁴ Naturvårdsverket [The Swedish Environmental Protection Agency] and Statens energimyndighet [the Swedish Energy Agency] (2007), *Styrmedel i klimatpolitiken – Delrapport 2 i Energimyndighetens och Naturvårdsverkets underlag till Kontrollstation 2008* [Instruments in climate policy – Interim Report 2 of the Swedish Energy Agency and the Swedish Environmental Protection Agency's supporting data for Checkpoints in 2008].

Based on these studies, we assume three different price elasticities for gasoline and diesel.¹²⁵ Short-term elasticity that will reflect how consumption changes in one year, medium term elasticity to estimate the change within a few years from now and long-term elasticity. For diesel, price elasticity is a weighted average based on the proportion of diesel consumption used for commercial traffic and passenger traffic.¹²⁶ The results of the full numerical example are shown in Table 5.2.

Table 5.2. Changes in fuel consumption at a gasoline price lower by SEK 0.30 per litre, or 3 per cent, and a diesel price lower by SEK 0.27 per litre, or 2 per cent

	Short-term	Medium-term	Long-term
Change in gasoline use (1000 m ³)	30	61	121
Change in gasoline use (%)	0.5%	1%	2%
Change in diesel use (1000 m ³)	9	17	34
Change in diesel use (%)	0.2%	0.5%	1%
Increase in emissions (million tonnes of CO ₂ equivalents.)	0.09–0.11	0.19–0.21	0.37–0.43

Source: The SNAO's own calculations.

Table 5.2 shows that fuel consumption is only marginally affected by lower prices for gasoline and diesel. The effect is greater on gasoline consumption than on diesel consumption. Assuming short-term price elasticity of -0.2 , a gasoline price which is 3 per cent lower means that gasoline consumption rises by just over 0.5 per cent. If we instead assume a price elasticity of -0.4 , consumption can be estimated to rise by around 1 per cent. In the longer term, when it is also possible to invest in new vehicles, it may be reasonable to expect a higher elasticity, for example -0.8 , which will result in a rise in consumption of around 2 per cent.

For diesel, the changes are much less significant because it is assumed that there is less price-sensitivity. It is only in the long-term elasticities that the change in diesel consumption begins to approach 1 per cent. This is because a large proportion of diesel is used for commercial and goods transport, which are not as sensitive to changes in fuel prices as passenger traffic. However the

¹²⁵ For gasoline, we assume a short-term price elasticity of -0.2 , a medium-term price elasticity of -0.4 and a long-term price elasticity of -0.8 .

¹²⁶ For commercial traffic, we use the price elasticities in the reports containing supporting data for checkpoints in 2008, whereas for private traffic we use the same elasticities as for gasoline. We therefore obtain a short-term price elasticity of -0.1 , a medium-term price elasticity of -0.2 and a long-term price elasticity of -0.4 .

number of light diesel vehicles has risen in recent years, which has led to an increase in private diesel consumption. There may therefore be good reason to believe that the price sensitivity of diesel could increase in future.

The changes in consumption projected above are too small to be noticeable in statistics at an aggregate level. Both fuel prices and consumption normally vary more in one year than the changes shown in Table 5.2 above. Furthermore, gasoline use has fallen in recent years.¹²⁷

5.2.3 *The tax exemption may have a counter-productive effect on emissions*

The numerical example above illustrates that a tax exemption of low-level blended biofuels may give rise to effects that are counter-productive to the intention that low-level blending should bring about a reduction in greenhouse gas emissions. This becomes clear if we convert the rise in fuel consumption to CO₂ equivalents.¹²⁸ Even if the tax exemption for low-level blending only has a marginal effect on fuel consumption, that effect is sufficient to counteract the total reduction in emissions from low-level blended biofuels, all other things being equal. The increase in emissions that may derive from the rise in consumption of gasoline and diesel in our numerical example could offset almost a quarter of the estimated reductions in emissions from low-level blended biofuels. If the degree of low-level blending is raised and all low-level blending continues to be exempt from tax, the effects illustrated above will become more pronounced. The fact that the various calculations assume that every litre of gasoline-equivalent ethanol and diesel-equivalent biodiesel replaces the equivalent quantity of gasoline or diesel is therefore in danger of becoming misleading.

5.3 **The tax exemption for low-level blending is primarily aimed at domestic production**

In Chapter 4 we saw that the production costs of various biofuels, or of the same biofuels, may vary depending on the raw material and the production method. The difference in production costs between different biofuels means that a tax exemption that is sufficient for one biofuel could constitute over-compensation for another. Similarly, different producers of a particular biofuel can be over-compensated. This is a problem because Community law does not allow over-compensation of biofuels in relation to the fossil fuels they are to replace.

¹²⁷ However, total use of fossil fuels has not fallen because diesel use has risen, except for last year. See Statens energimyndighet (2010a), *Transportsektorns energianvändning 2009* [the Swedish Energy Agency (2010a), *Energy use in the transport sector 2009*].

¹²⁸ In this section we use the same emission coefficients as in Chapter 7.

5.3.1 *The customs tariff for low-level blended ethanol levels out production costs between biofuels*

From the supporting data accessed by the SNAO, it appears that the risk of over-compensation is greatest when ethanol is used for low-level blending in gasoline.¹²⁹ Most of the ethanol used in Sweden has previously been imported from Brazil. This production costs for this ethanol are relatively low and it is able to compete with fossil alternatives without a subsidy in favourable years. A full tax exemption therefore means over-compensation according to the government's earlier estimates. To solve the problem of over-compensation, the government has introduced a special customs tariff. The customs tariff means that an exemption will only be allowed for low-level blended ethanol if the ethanol has been imported at the highest possible customs rate.¹³⁰

In section 4.2.1 we noted that the production costs for Swedish biofuel use, particularly ethanol, vary as a result of differences in production and import patterns. However, the production costs we presented in Chapter 4 did not include customs duty. If we also take into account the customs duties payable for imported ethanol, the production costs are levelled out. In Table 5.3 below we show that the customs charge for low-level blended ethanol compensates almost exactly for the higher production costs for ethanol produced in Sweden or in the EU. The higher customs duty payable for ethanol for low-level blending therefore means that native ethanol or ethanol produced within the EU is able to compete with imported ethanol as far as production costs are concerned.

Table 5.3. Production cost of Swedish biofuels excluding and including customs duty, SEK per litre

Year	Ethanol E85 (excluding customs duty)	Ethanol low-level blending (excluding customs duty)	Difference before customs duty	Ethanol E85 (including customs duty)	Ethanol low-level blending (including customs duty)	Difference after customs duty
2008	3.69	5.01	-1.32	5.56	5.51	0.05
2009	3.64	5.35	-1.71	5.59	5.57	0.02

Source: Swedish Energy Agency and the SNAO's calculations.

¹²⁹ See the government decision of 10/11/2005, *Beslut om justering av tidigare beslut rörande befrielse från energiskatt och koldioxidskatt på visst motorbränsle*, dnr Fi2005/3169 [Decision on adjustment of a previous decision relating to an exemption from energy tax and carbon dioxide tax on certain motor fuels, reg. no. Fi2005/3169].

¹³⁰ Ethanol can be imported at three different customs rates depending on whether the ethanol is considered to be an industrial or an agricultural product. For imports of industrial goods, the customs duty is 6.5 per cent of the value of the goods (the same customs rate applies to FAME). When ethanol is imported as an agricultural product it can either be assessed for duty as denatured (blended) ethanol at 10.2 € per hundred litres or as undenatured (unblended) at 19.2 € per hundred litres.

Higher customs duties also mean higher revenues for the State. However, most of the customs revenues, 75 per cent, go to the EU budget. At the same time, the higher customs duty for low-level blended ethanol increased costs for the consumers because production is diverted towards more expensive ethanol. This may of course take place for reasons of supply. The more expensive ethanol in this case is produced in Sweden or in another EU country. It can also be justified for environmental reasons if the more expensive ethanol has better environmental characteristics.

In October 2008, the government applied for State aid to abolish the customs tariff for ethanol for low-level blending. The government's assessment that abolishing the customs tariff for low-level blended ethanol would not lead to over-compensation was questioned by industry representatives. The Commission therefore requested some clarification with regard to the matter. Because of this, the government changed its application so that ethanol for low-level blending would be assessed for customs duty at the second-highest customs rate in order to be granted tax relief.¹³¹ The government withdrew its application in October 2009.¹³²

The government did not inform the Riksdag when the customs tariff was introduced. It did however inform it of its intention to discontinue it. The government has not reported any assessments of the effects of the customs tariff on domestic production and the availability of cheaper Brazilian sugar ethanol. However, the government has estimated that abolition of the tariff could lead to a reduction in the price of ordinary gasoline by up to SEK 0.10 a litre.¹³³

5.3.2 *Compensation for energy content benefits biofuels with higher production costs*

One side effect of the customs tariff is that it levels out the production costs between ethanol produced in Sweden or the EU and ethanol imported from countries outside the EU. However, the purpose of the higher customs duty for low-level blended ethanol is to ensure that a tax exemption for low-level blended ethanol does not lead to over-compensation. Over-compensation occurs when a support measure such as a tax exemption leads to a product becoming cheaper than the alternative it replaces. As far as ethanol is concerned, over-compensation occurs when the price of ethanol exempt from excise duty is lower than the price of gasoline including excise duty.¹³⁴

¹³¹ See the supporting data for statsstödsärende N530/2008 [State Aid case N530/2008].

¹³² Finansdepartementet, pressmeddelande 2009-10-28, *Sveriges ansökan om slopat etanolvillkor dras tillbaka* [The Ministry of Finance, press release on 28/10/2009, *Sweden's application to abolish the ethanol tariff is withdrawn*].

¹³³ Prop. 2007/08:1 [Government Bill 2007/08:1], section 5.6.13.

¹³⁴ Government decision 10/11/2005, reg. no. F2005/3169.

The decisive factors for the question of when over-compensation occurs are the extent to which production costs for biofuels and fossil fuels vary in relation to one another and what assumptions are made with regard to the energy content of different fuels and what fuel is used as a comparison.

To calculate whether tax relief for different biofuels leads to biofuels being over-compensated, the Swedish Energy Agency uses a calculation method that was devised in consultation with the Ministry of Finance. The same method is also used by other countries. Since the calculation of over-compensation determines how the tax exemption is structured, it is interesting to illustrate the calculation method used. The method involves comparing an estimated price for one litre of pure ethanol (or biodiesel) to the price of one litre of gasoline (or diesel). The estimated prices are then adjusted for differences in energy content. See Table 5.4.

Table 5.4. Cost calculation for ethanol for low-level blending compared to gasoline in 2009, SEK per litre

	Imported ethanol, second-highest tariff	Imported ethanol, including customs tariff	Swedish or European ethanol	Gasoline 95 octane including E5
Total production cost	6.03	6.94	6.92	4.43
Energy tax and CO ₂ tax	–	–	–	5.24
Price including excise duty	6.03	6.94	6.92	9.67
Price including value-added tax	7.53	8.68	8.65	12.09
Adjustment of energy content in SEK per litre	4.07	4.68	4.67	0.21
Price after adjustment of energy content	11.60	13.36	13.32	12.30

Source: The Swedish Energy Agency and the SNAO's own calculations and price data from the gasoline companies' websites.

Table 5.4 compares the average production costs and prices for ethanol imported at different customs rates to the average production costs for gasoline and ethanol produced in Sweden or other EU countries. The table shows that the total production cost for ethanol exceeds the production cost for gasoline

before tax. This applies regardless of whether the calculation is based on Swedish or European ethanol or ethanol imported from countries outside the EU. However, if excise duty in the form of energy tax and carbon dioxide tax is included, the price of the ethanol exempt from excise duty will be lower than the price of gasoline including excise duty. It thus appears that ethanol may have been over-compensated despite the customs tariff. This is a consequence of the current method of levying energy tax on fuel. Taxation is based on volume and is not proportional to the energy content of the different fuels. In order to avoid penalising ethanol for its lower energy content, the calculation is therefore adjusted to take this into account.

The adjustment for energy content varies depending on the production cost of the ethanol. Ethanol with a higher production cost receives somewhat higher compensation in SEK per litre compared to ethanol with a lower production cost. At the same time, there are no differences in energy content between more expensive and cheaper ethanol. The method used to calculate whether the tax exemption leads to over-compensation will therefore favour the more expensive ethanol, in this case the ethanol produced in Sweden or the EU. With an equal adjustment for energy content in SEK per litre, as for ethanol produced in Sweden or the EU, it is not certain that imported ethanol would have been over-compensated at current prices.

However, it is by no means self-evident that a full adjustment for the energy content should be made when biofuels are used for low-level blending. In theory, gasoline containing 5 per cent ethanol will have an energy content just under 2 per cent lower than gasoline without low-level blending.¹³⁵ This difference in energy content is hardly noticeable to the normal driver. Experience from various countries also shows that consumers do not alter their fuel consumption to take into account the lower energy content of ethanol in the case of low-level blending of up to 10 per cent, all other things being equal.¹³⁶ Swedish experience of previous attempts with low-level blending of ethanol, around 4 per cent, in gasoline also shows that fuel consumption is not affected.¹³⁷ An adjustment for energy content is therefore not significant for consumption.

¹³⁵ In the case of low-level blending at 6.5 per cent, the theoretical energy content is just over 2 per cent lower. For diesel used for low-level blending with 5 per cent biodiesel, there is no difference in energy content. However, this is in theory. In reality, fuel consumption is also determined by a number of factors such as humidity, driving patterns, car engines, etc.

¹³⁶ See, for example, De Gorter, H. and Just, D. (2008), "Water" in the U.S. ethanol tax credit and mandate: Implications for rectangular deadweight costs and the corn-oil price relationship.

¹³⁷ These studies, however, relate to cars without catalytic converters. See SOU 1986:51, *Alkoholer som motorbränsle* [SOU 1986:51, *Alcohols as motor fuels*], page 72. According to the Swedish Energy Agency, there are studies showing that fuel consumption can be reduced using ethanol additives. See an e-mail of 25/11/2010 comments for fact-checking.

6 The use of high-level blended biofuels – the case of E85

Investments in vehicles and infrastructure are required in order to establish a market for high-level blended fuel. Several measures have been introduced to establish a market for E85 in particular. In this chapter we outline the main measures and how these measures, along with the tax exemption, have affected the consumption of E85. Finally, we describe factors that counteract the increased use of high-level blended biofuels and how these can affect carbon dioxide emissions. The chapter begins with a summary of our main observations.

6.1 A summary of our observations

- Up to 2008 there was a strong correlation between the increased consumption of E85, the number of ethanol-powered cars and the number of E85 fuel stations.
- Most ethanol-powered car owners vary between E85 and gasoline when refuelling. The refuelling rate for E85 fell in 2009 as a result of lower gasoline prices.
- Consumption of E85 is greatly affected by the price of gasoline. When gasoline is cheaper in comparison to E85, the tax exemption is not sufficient to sustain the use of E85.
- Both the desire to reduce the impact on the climate and economic factors are important factors for the choice of ethanol and gas cars.
- The desire to reduce the impact on the climate is very important to gas car owners when choosing fuel compared to ethanol-powered car owners. Distance to the fuel station is now less important for ethanol-powered car owners.
- Ethanol-powered cars have higher fuel consumption on average than gasoline cars. Compared to gasoline cars, ethanol-powered cars therefore give rise to increased emissions when run on gasoline.

6.2 Many measures have contributed to a market for E85

6.2.1 *The Swedish E85 initiative is unique in Europe*

In recent years, several European countries have introduced various measures to increase the use of biofuels. These measures have been motivated by a desire to reduce the impact on the climate and increase fuel self-sufficiency and EU objectives in this area. In most cases, the increasing use of biofuels has consisted of low-level blending of biofuels in gasoline or diesel. Sweden was the first country in the EU to create a market for high-level blended ethanol (E85) through administrative and economic policy instruments. Markets for E85 are now being developed in the rest of Europe.¹³⁸

6.2.2 *More and more cars are able to run on biofuels*

High-level blended biofuels such as E85 require adapted vehicles. For that reason, a number of measures have been introduced to stimulate sales of these cars, for example company car taxation relief, exemptions from congestion charges, the green car rebate and exemptions from motor vehicle tax for green cars for the first five years. In addition, there have been a number of instances of local subsidies and instruments such as cheaper parking and state and municipal procurement guidelines. The total cost of these measures can be estimated at around SEK 300 million per year, which is significantly lower than the annual loss of tax revenues as a result of the tax exemption for biofuels.¹³⁹

The number of cars that are able to run on biofuels has risen sharply. In 2009, there were almost 180,000 ethanol-powered cars, compared to around 20,000 cars in 2005. In relation to the total fleet of vehicles, however, the proportion of cars that are able to run on biofuels remains relatively small. According to statistics from the vehicle register, in 2009 around 4 per cent of all registered cars ran on E85. The corresponding proportion for gas cars was just under 0.5 per cent.

¹³⁸ For example, the number of E85 fuel stations is increasing in the rest of Europe. E85 now exists in France, Germany, Hungary, Switzerland, the Czech Republic, Ireland, the Netherlands, Austria, the UK, Norway, Spain, Lithuania, Finland, the Ukraine, Latvia, Slovakia, Italy and Iceland. See <http://www.ethanol.nu>. See also the reports to the Commission within the framework of the earlier Biofuels Directive. http://ec.europa.eu/energy/renewables/biofuels/ms_reports_dir_2003_30_en.htm.

¹³⁹ See prop. 1999/2000:1, *Budgetpropositionen för 2000* [Government Bill 1999/2000:1, 2000 *Budget Bill*], section 8.8.2, prop. 2001/02:1 [Government Bill 2001/02:1], section 8.9, prop. 2003/04:1 [Government Bill 2003/04:1], section 8.2.5, prop. 2005/06:1, *Budgetpropositionen för 2006* [Government Bill 2005/06:1, 2006 *Budget Bill*], section 5.2.6 and prop. 2009/10:1 [Government Bill 2009/10:1], section 7.2.8.

6.2.3 *The Pump Act has increased the availability of E85*

As well as the need for special vehicles, consumption of high-level blended biofuels presupposes that fuel is available to buy. The so-called “Pump Act” was passed in 2006 in order to steer development towards new distribution networks for biofuels.¹⁴⁰ Since the Pump Act was introduced, the number of fuel stations offering biofuels for sale has increased sharply. In January 2005, there was a total of 3,839 fuel stations in Sweden. Of these, 385 fuel stations supplied some biofuel. In January 2009, the total number of fuel stations had fallen to 3,245, while the number of fuel stations for biofuel had risen to 1,653. Over 90 per cent of those supply E85.¹⁴¹

However, according to the Swedish Petroleum Institute, the Pump Act has meant significant costs at distributor level, equivalent to SEK 1.2 billion.¹⁴² The traffic committee commissioned a detailed study to monitor the Pump Act and its effects. In that study, the cost per pump is estimated at SEK 300,000 to 400,000.¹⁴³

Monitoring by the traffic committee also reveals that since 2006 the Pump Act has played an important part in the increased availability of biofuels, particularly of E85. The monitoring also reveals that there are no great differences in the availability of E85 from one county to another. However, there is a difference between densely populated and more sparsely populated areas. It is also clear from the monitoring that the issues concerning biofuels are of limited relevance in many sparsely populated and rural communities and that, instead, it is mainly a question of having access to fuel within a reasonable distance.¹⁴⁴

¹⁴⁰ Prop. 2005/06:16, 2005/06:TU6, rskr. 2005/06:134, lag (2005:1248) om skyldighet att tillhandahålla förnybara drivmedel (pumplagen) [Government Bill 2005/06:16, 2005/06:TU6, Riksdag Communication 2005/06:134, Act (2005:1248) on the obligation to supply renewable fuel (the Pump Act)].

¹⁴¹ See <http://spi.se/statistik/forsaljningsstallen>, 25/11/2010, 2009/10:RFR7, *Pumplagen – uppföljning av lagen om skyldighet att tillhandahålla förnybara drivmedel* [2009/10:RFR7, *The Pump Act – monitoring of the Act on the obligation to supply renewable fuel*] and Trafikverket (2010), *Index över nya bilar klimatpåverkan 2009 i riket, länen och kommunerna* [the Swedish National Transport Administration (2010), *The index of new vehicles' impact on the climate in 2009, nationally, in the counties and in the municipalities*].

¹⁴² Data from a meeting with Svenska Petroleuminstitutet [the Swedish Petroleum Institute] on 08/06/2010.

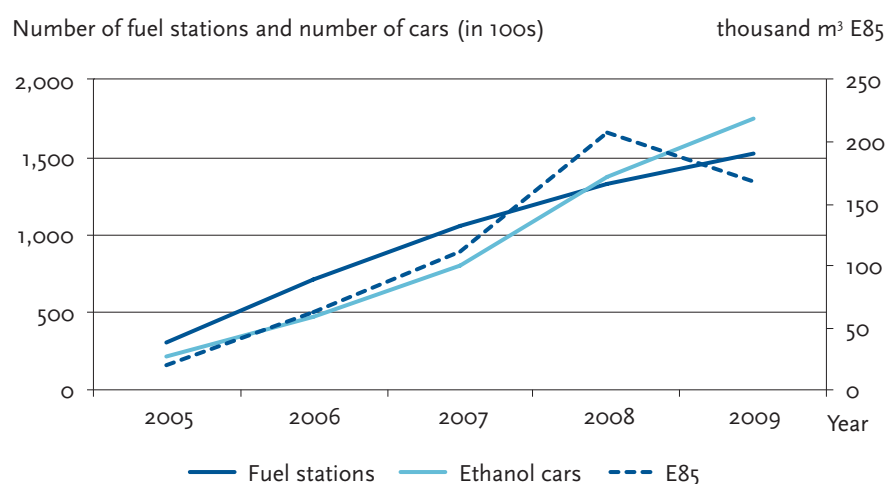
¹⁴³ 2009/10:RFR7, *Pumplagen – uppföljning av lagen om skyldighet att tillhandahålla förnybara drivmedel* [2009/10:RFR7, *The Pump Act – monitoring of the Act on the obligation to supply renewable fuel*], page 153.

¹⁴⁴ 2009/10:RFR7, *Pumplagen – uppföljning av lagen om skyldighet att tillhandahålla förnybara drivmedel* [2009/10:RFR7, *The Pump Act – monitoring of the Act on the obligation to supply renewable fuel*], page 157 et seq.

6.2.4 The refuelling rate for E85 fell in 2009

Approximately 168 million litres of E85 were used in 2009.¹⁴⁵ Despite a slight decline compared to 2008, this is more than eight times as much as in 2005. It is difficult to determine the impact of each individual government action on developments in this area. However, it is clear that there is a strong correlation between the rise in consumption of E85 and the number of ethanol-powered cars and fuel stations supplying ethanol. See Chart 6.1.

Chart 6.1. Number of fuel stations supplying E85, number of ethanol-powered cars and sales of E85 2005–2009



Source: *The Swedish Petroleum Institute and Statistics Sweden.*

As shown in Chart 6.1, sales of E85 fell between 2008 and 2009. This is despite the fact that the number of fuel stations supplying E85 and the number of ethanol-powered cars continued to rise, albeit at a somewhat slower rate. The correlation that previously existed between progress in terms of fuel stations supplying E85, the number of ethanol-powered cars and sales of E85 therefore appears to have been broken.

¹⁴⁵ See <http://spi.se/statistik/volymer?gbo=year&dfo=2005-01-01&dto=2010-12-31>. Relates to volumes delivered and not consumed.

Sales of E85 have fallen because many ethanol-powered car owners switched to gasoline instead of E85. On the basis of information from *Trafikverket* [the Swedish National Transport Administration], formerly *Vägverket* [the Swedish National Road Administration], it is possible to monitor annual progress in the *refuelling rate*, i.e. the extent to which ethanol-powered cars are refuelled with E85. The refuelling rate was 60 per cent in 2009, compared to 90 per cent in 2008 and 2007.¹⁴⁶ The SNAO's own estimates for 2008 and 2009 show slightly lower refuelling rates of 81 and 48 per cent. The difference between estimates of the SNAO and those of the Swedish National Transport Administration is that the SNAO did not have access to detailed information on fuel consumption.

6.3 Consumption of E85 is greatly affected by the price of gasoline

The availability of a new fuel and the number of cars that are able to run on the fuel in question is of decisive importance for establishing a market. Once a market has been established, however, other factors may be more important for the choice of fuel and thus how volumes of fuel will develop.

In Chapter 5 we noted that biofuels for low-level blending are a complement to fossil fuels. The proportion of low-level blended fuels will therefore largely follow sales of fossil fuels. However, high-level blended fuels as E85 are a substitute for fossil fuels. They therefore compete with the price of fossil fuels in a different way to low-level blends. There is therefore reason to study how the price relationship between gasoline and E85, the so-called relative price, affects sales of E85.

6.3.1 Sales of E85 follow the relative price between gasoline and E85

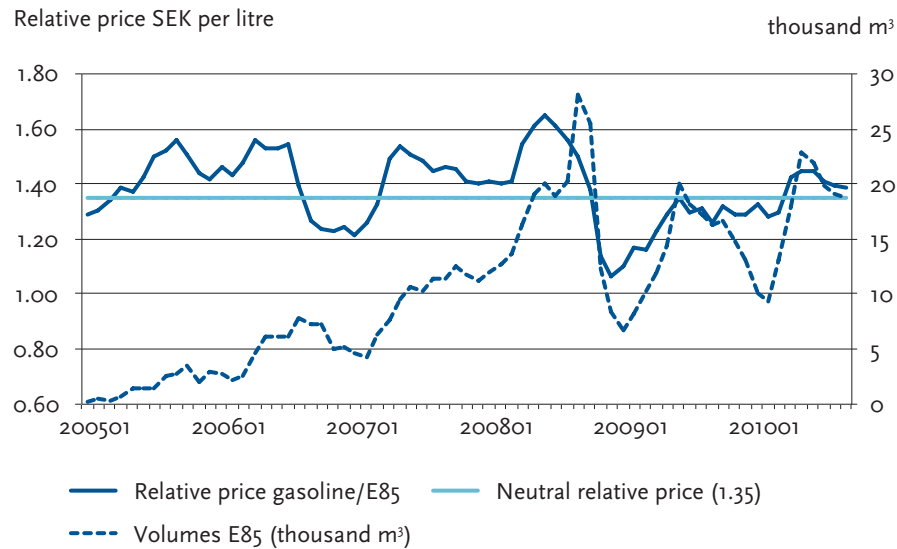
Price statistics from the petroleum companies and the Swedish Petroleum Institute show that sales of E85 and the relative price between gasoline and E85 have followed each other fairly closely since the beginning of 2008. See Chart 6.2.

To determine whether the price difference between gasoline and E85 benefits gasoline or E85, we must take into account the difference in energy content because ethanol has a lower energy value than gasoline. On average, driving a given distance takes 35 per cent more E85 than gasoline. This means that if

¹⁴⁶ Trafikverket (2010), *Index över nya bilars klimatpåverkan 2009 i riket, länen och kommunerna* [The Swedish National Transport Administration (2010), *The index of new vehicles' impact on the climate in 2009, nationally, in the counties and in the municipalities*], page 49.

the price ratio between gasoline and E85 is higher than 1.35, gasoline is more expensive than E85. If the price ratio is lower than 1.35, E85 is more expensive than gasoline.¹⁴⁷

Chart 6.2. Sales of E85 and the relative price of gasoline and E85, 2005–2010, monthly average



Source: *The Swedish Petroleum Institute and Statistics Sweden.*

In autumn 2008, the price of gasoline fell while the price of E85 rose. It therefore became more expensive to refuel with E85 than with gasoline, and in the months that followed sales of E85 collapsed. At the beginning of 2009, gasoline prices began to rise relative to E85 while sales of E85 also rose slightly. However, sales have not reached mid-2008 levels. Although there is a full tax exemption on the ethanol used in E85, it is not able to level out all the price differences between E85 and gasoline.

Sales of E85 have also varied a great deal over the past year when, for example, sales fell quite sharply during the cold winter of 2009/10. One explanation for the drop in sales of E85 during the winter may be the increase in the proportion of gasoline from 15 per cent to around 25 per cent, which means that the price of E85 also rises.¹⁴⁸ See also section 6.4.4.

¹⁴⁷ Statens institut för kommunikationsanalys (2010), *Fordon 2009* [Swedish Institute for Transport and Communications Analysis (2010), *Vehicles 2009*].

¹⁴⁸ See <http://spi.se/faktadatabas/artiklar/e85-vinterkvalitet,25/11/2010>.

6.3.2 Lower price of gasoline results in lower consumption of E85

A study from the United States on how E85 acts as a substitute for gasoline shows that groups of consumers respond differently to changes in relative prices between gasoline and E85. Some groups refuel with E85 even when it is not economically advantageous. In view of this, the average so-called cross-price elasticities¹⁴⁹ between E85 and gasoline are estimated at 2.5–3.0.¹⁵⁰

These values are fairly high when compared to other estimated cross-price elasticities, for example gasoline and other transportation.¹⁵¹ However, the estimated elasticities in the US study are extremely short-term compared to other estimated cross-price elasticities. They apply, in principle, to the choice of fuel when the consumer is at the fuel station and is able to directly compare the price of E85 and gasoline. This is different from cross-price elasticities between different modes of transport such as car, train or bus, for example, which are not as directly interchangeable.

The estimated elasticities are valid for US data and conditions. However, a typical result from the literature on the price sensitivity of different vehicle fuels is that the results do not differ very much from one country to another.¹⁵² To illustrate how the consumption of E85 may be affected by a lower gasoline price, we apply the above cross-price elasticities to the numerical example we presented in Chapter 5. A 3 per cent reduction in the gasoline price would then lead to a reduction in consumption of E85 of between 7.5 and 9 per cent.¹⁵³

6.4 The SNAO's questionnaire for ethanol and gas car owners

The consumers' choice is extremely important for the effectiveness of government efforts to increase the use of high-level blended biofuels. In order to obtain better supporting data on how different green cars are used and what factors influence the decision to buy such a car, the SNAO, in collaboration with Statistics Sweden, sent a questionnaire to 2,500 ethanol and gas car

¹⁴⁹ Cross-price elasticity is a measure of how much the consumption of a particular product changes when the price of another product changes.

¹⁵⁰ Anderson, S. (2010), *The Demand for Ethanol as a Gasoline Substitute*. In this study, checks have been carried out for factors such as changes in the stock of ethanol-powered cars, availability of fuel stations, etc.

¹⁵¹ See, for example, SOU 2003:2, *Fördelningseffekter av miljöpolitik* [SOU 2003:2, *Distribution effects of environmental policy*], page 98.

¹⁵² Sterner, T. (2006), *Survey of transport fuel demand elasticities*.

¹⁵³ At cross-price elasticity between E85 and gasoline of 2.5, a 3 per cent reduction in the gasoline price means that demand for E85 falls by $(-3 * 2.5 = -7.5)$ 7.5 per cent. If, instead, we take a cross-price elasticity of 3.0, the demand for E85 $(-3 * 3 = -9)$ falls by 9 per cent.

owners. In the questionnaire, the SNAO asked how important support and subsidies are for the choice of car and what factors are important for car owners' choice of fuel. The responses from the gas car owners are used for the purposes of comparison when analysing the results of the survey.

Since the proportion of green cars can vary between metropolitan areas and small municipalities, the sample has been designed to take this into consideration. The results of the survey have also been weighted so that they can be extrapolated to the total population of ethanol and gas car owners.¹⁵⁴

6.4.1 *Both climate and economics are important when choosing an ethanol or gas car*

The survey by the SNAO clearly shows that the desire to reduce the impact on the climate is an important factor when choosing an ethanol or gas car. Many ethanol and gas car owners also stated that various economic factors were extremely important for the choice of car.

In the questionnaire, the car owners had to state which reasons, in no particular order, were more important and less important when choosing an ethanol or gas car. Table 6.1 below shows a summary of the most common factors that are very important for the choice of car. The proportions will therefore not add up to 100 per cent. The proportions shown in the table are also rounded up to totals. A full report on all responses is provided in appendix 2.

Table 6.1. Very important reasons why car owners' chose an ethanol or gas car

	Proportion of ethanol-powered car owners (%)	Number of responses
Reduces the impact on the climate	55%	865
Green car rebate/lower vehicle tax	31%	818
Expectation of higher gasoline price	25%	816

	Proportion of gas car owners (%)	Number of responses
Reduces the impact on the climate	77%	832
Expectation of lower running costs	50%	815

¹⁵⁴ See appendix 1 for more information on the design of the questionnaire, response rates and an analysis of the responses.

The most common very important reason for the choice of car, among both ethanol and gas car owners, is the desire to reduce the impact on the climate. However, a higher proportion of gas car owners than ethanol-powered car owners consider this factor to be very important.

The survey also shows that the green car rebate or reduction in vehicle tax was extremely important for the choice of car for around a third of the ethanol-powered car owners. The corresponding figure for gas car owners is just under 20 per cent. It may also be noted that the expectation of higher gasoline prices was very important for the choice of car for one ethanol-powered car owner in four. A higher proportion of ethanol-powered car owners than gas car owners considered various forms of economic subsidy such as the green car rebate, lower vehicle tax and exemptions from congestion charges to be very important. However, exemptions from congestion charges only have an impact in big-city municipalities. However, previous studies have shown that the exemption from congestion charges is the single most important measure for the decision to buy a green car.¹⁵⁵

6.4.2 *Most ethanol-powered car owners vary between E85 and gasoline*

The individual ethanol-powered car owner's refuelling choices are decisive for how much E85 will be used. According to the SNAO survey, most ethanol-powered car owners vary between E85 and gasoline.

One result from the survey is that the proportion of ethanol-powered car owners who only refuel with E85 is lower than the proportion of gas car owners who only refuel with vehicle gas. This is despite the fact that there are far fewer fuel stations for vehicle gas compared to E85. Table 6.2 shows that 20 per cent of ethanol-powered car owners consistently refuel with E85, while 10 per cent only refuel with gasoline, even though they own an ethanol-powered car.

¹⁵⁵ Lindfors, A. and Roxland, M. (2009), An analysis of the Swedish green car rebate and the City of Stockholm (2009), Promoting Clean Cars – Case Study of Stockholm and Sweden.

Table 6.2. Which fuel do you usually refuel your car with?

Ethanol-powered car owners	Always E85	Usually E85	Usually gasoline	Always gasoline
Proportion (%)	20	47	23	10

Gas car owner	Always vehicle gas	Usually vehicle gas	Usually gasoline	Always gasoline
Proportion (%)	57	34	7	1

Number of responses: 1,738

6.4.3 The price is fairly important or very important for the choice of fuel

The difference in price between E85 and gasoline is fairly important or very important for the choice of fuel for almost 75 per cent of ethanol-powered car owners. See Table 6.3 below. The corresponding figure for gas car owners is around 70 per cent. It is also interesting to note that for around 13 per cent of ethanol-powered car owners and gas car owners the price difference between E85 and gasoline is of no importance for the choice of fuel.

Table 6.3. How important is the price difference between E85 and gasoline and vehicle gas and gasoline for your choice of fuel?

	Not important at all	Not very important	Fairly important	Very important
Proportion of ethanol-powered car owners (%)	13	10	31	43
Proportion of gas car owners (%)	13	18	31	37

Number of responses: 1,736

The questionnaire also included questions about the price difference at which the car owners chose to refuel with different fuels. The questions differ slightly between ethanol and gas car owners and are therefore not comparable. Only the results for ethanol-powered car owners are shown here.

According to the survey, around 60 per cent of the ethanol-powered car owners for whom the price difference between E85 and gasoline is important for the choice of fuel will use gasoline if gasoline is up to 40 per cent more expensive than E85. See Table 6.4. If gasoline is more than 40 per cent more expensive, most of them will refuel with E85. However, the results should be interpreted

with extreme caution because a third of the respondents answered “Don’t know” to this question. At the same time, the results tally with the fact that E85 has an energy content that is around 30–35 per cent lower and therefore requires a corresponding price premium.

Table 6.4. Percentage price difference between E85 and gasoline, where the car owners choose to use gasoline

	< 20%	21–40%	41–60%	> 60%	Don't know
Proportion of ethanol-powered car owners (%)	29	32	8	1	30

Antal svar: 782

6.4.4 Not just the price that determines what fuel is used

The SNAO also asked what individual factors, besides price, were of more important or less important for the choice of E85 or vehicle gas. The questions included multiple choice answers in no particular order. Table 6.5 shows the three options that were most important for the choice of fuel for most ethanol- and gas car owners. Since the options that are less important for the choice of fuel are not shown in the table, the percentages do not add up to 100.

Table 6.5. Most important reasons for choosing E85 or vehicle gas, (other than price)

	Proportion of ethanol-powered car owners (%)	Number of responses
Reduces the impact on the climate	58	869
Seems logical when you have an ethanol-powered car	47	849
Time of year – use less E85 in winter/ at sub-zero temperatures	30	846

	Proportion of gas car owners (%)	Number of responses
Reduces the impact on the climate	81	833
Seems logical when you have a gas car	78	822
Distance to a fuel station with vehicle gas	45	807

The table shows that the most common very important reason for choosing E85 or vehicle gas is “Reduces the impact on the climate”, followed by “Seems

logical when you have an ethanol or gas car”. The time of year is also very important for the choice of fuel for about a third of the ethanol-powered car owners. They simply refuel less with E85 in the winter or when it is cold and temperatures are sub-zero.

6.4.5 *Distance to the fuel station is less important for ethanol-powered car owners*

The survey also shows that proximity to the point of sale is less important for ethanol-powered car owners than for gas car owners. Distance to a fuel station that sells E85 is very important for the choice of fuel for 11 per cent of ethanol-powered car owners in large municipalities and 21 per cent in medium-sized or small municipalities . This is in contrast to gas car owners, where the distance to a fuel station with vehicle gas is very important for almost half of the car owners. See Table 6.5.

This result is probably explained by the fact that there are now so many fuel stations supplying E85. The survey also shows that just over 90 per cent of the ethanol-powered car owners in large municipalities have a fuel station that supplies E85 within a distance of 10 kilometres. See Table 6.6. That is true for just under 80 per cent of ethanol-powered car owners in small or medium-sized municipalities. The corresponding proportions for gas car owners are 75 and 43 per cent.

Table 6.6. Proportions with than 10 km and less than 10 km to the nearest fuel station with E85 and vehicle gas

Proportion of ethanol-powered car owners (%)	< 10 km	> 10 km
Large municipalities	93%	7%
Medium-sized or small municipalities	78%	22%

Proportion of gas car owners (%)	< 10 km	> 10 km
Large municipalities	75%	25%
Medium-sized or small municipalities	43%	57%

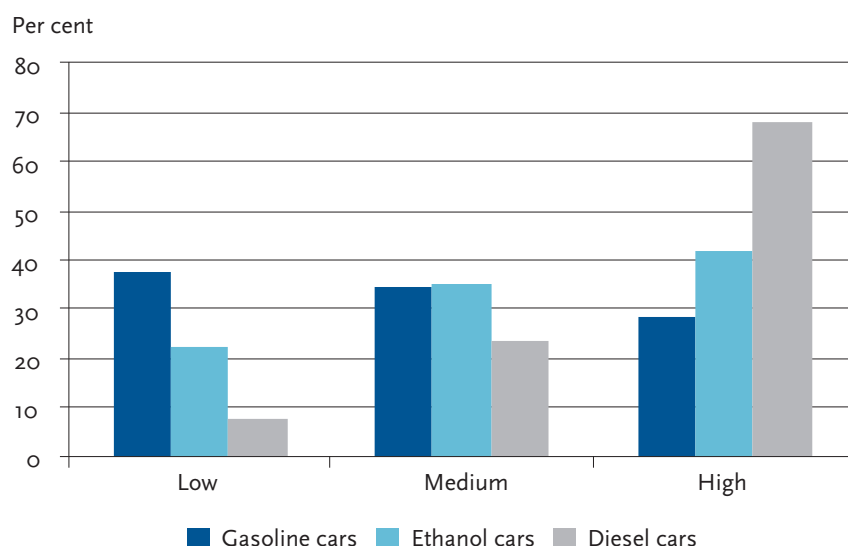
6.5 Ethanol-powered cars cause higher emissions when running on gasoline than gasoline cars

When ethanol vehicles are fuelled with gasoline, the emissions increase compared to when a gasoline car is fuelled with gasoline. The effect is exacerbated by the fact that ethanol-powered cars, on average, cover longer distances than gasoline cars.

6.5.1 Ethanol-powered cars have higher fuel consumption on average than gasoline cars

Data from the vehicle register shows that ethanol-powered cars have a higher kerb weight on average than gasoline cars. However, diesel cars are significantly heavier. See Chart 6.3. The average ethanol-powered car is around 5 per cent heavier than the average gasoline car.

Chart 6.3. Distribution of average kerb weight for gasoline, ethanol and diesel cars in 2009



Source: The SNAO's own compilation from the vehicle register.

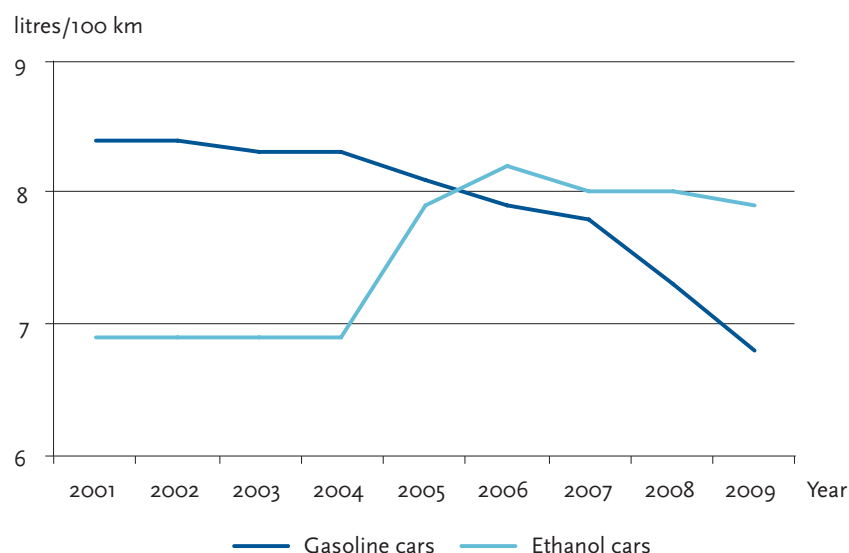
Kerb weight is related to fuel consumption because a heavier car often requires more fuel. Ethanol-powered cars also have higher average fuel consumption than gasoline cars running on gasoline.

The Swedish National Transport Administration, formerly the Swedish National Road Administration, reports on average fuel consumption for new gasoline and ethanol-powered cars each year. In 2009, the average fuel consumption when running on gasoline was 16 per cent higher for a new ethanol car than for a gasoline car. Whereas new gasoline cars became much

more fuel efficient in the 2000s, the fuel consumption of new ethanol-powered cars has risen instead, albeit with some reduction in recent years.¹⁵⁶ See Chart 6.4.

According to the Swedish National Transport Administration, high fuel consumption, combined with the low refuelling rate for E85, means that in 2009 reductions in emissions from new ethanol-powered cars were only 20 per cent higher than reductions from new gasoline cars. This is a deterioration compared to 2008, when reductions in emissions from new ethanol-powered cars were 43 per cent higher than those of new gasoline cars.¹⁵⁷

Chart 6.4. Average fuel consumption of new cars when running on gasoline 2001–2009, litres per 100 kilometres



Source: Swedish National Road Administration.

The relatively high fuel consumption of ethanol-powered cars may be seen in terms of the usual definition of “green car”. However, there is no uniform definition of which cars should be regarded as “green cars”. According to the definition applying for both the former green car rebate and the present reduction in vehicle tax, gasoline cars may consume a maximum of 5 litres of gasoline per 100 kilometres in order to be classified as green cars. For ethanol-powered cars, the limit is 9.2 litres per 100 kilometres when running on gasoline.

¹⁵⁶ Vägverket (2010), *Minskade utsläpp från vägtrafiken men stora utmaningar väntar*, PM 2010-02-18 [Swedish National Road Administration (2010), *Reduced emissions from road traffic but major challenges lie ahead*, Memorandum of 18/02/2010].

¹⁵⁷ Trafikverket (2010), *Index över nya bilars klimatpåverkan 2009 i riket, länen och kommunerna* [The Swedish National Transport Administration (2010), *The index of new vehicles' impact on the climate in 2009, nationally, in the counties and in the municipalities*], page 46.

6.5.2 *Ethanol-powered cars travel greater distances than gasoline cars*

The impact on the climate caused by the fact that ethanol-powered cars have high fuel consumption and are often run on gasoline is also exacerbated since these cars travel greater distances on average than gasoline cars. In 2008, the average ethanol-powered car was driven 24 per cent further than the average gasoline car. In 2009, this difference had increased to 41 per cent. However, diesel cars are in a class of their own in terms of distance driven, travelling twice as far as gasoline cars in both years.

7 Emissions from biofuels

In this chapter we describe how emissions from biofuels can be calculated and the possible reductions compared to fossil fuels given by different calculation methods. In this chapter, we assume that the tax exemption was necessary for bringing about the use of biofuels. Thus, the costs of reductions in emissions caused by biofuels are calculated and compared with possible reference values, based on the aim that Sweden's climate efforts should be cost-effective. The chapter begins with a summary of our main observations.

7.1 A summary of our observations

- Biofuels are often assumed to be carbon dioxide-neutral. In practice, however, the production of biofuels requires input goods that cause emissions. Life-cycle analyses are used in order to take emissions into account.
- The extent of the reduction in emissions compared to emissions from fossil fuels from a life-cycle perspective depends on a range of calculation factors and a number of assumptions.
- The EU has introduced sustainability criteria to ensure that increased use of biofuels does not lead to an increase in emissions. The sustainability criteria specify the extent to which emissions from biofuels must be reduced in order for biofuels to be eligible for support such as tax relief.
- On the basis of the emissions values given by the EU in its sustainability criteria and data from the Swedish National Transport Administration and the Swedish Environmental Protection Agency, the SNAO has estimated the extent of the reductions in emissions that Swedish use of biofuels could bring about. Overall, the use of biofuels could lead to reductions in emissions of around 0.4–1.1 million tons of carbon dioxide equivalents. The reductions in emissions represent approximately 1 per cent of Sweden's total emissions.

- By comparing the reductions in emissions to the costs of the tax exemption, the cost per kg reduction in emissions can be estimated. The cost of the tax exemption per kg reduction in emissions can thus be estimated at around SEK 3, which is a much higher cost than the carbon dioxide tax, for example.
- In order to achieve reductions in emissions of the same magnitude to those brought about by the use of biofuels in 2009, the carbon dioxide tax would need to be increased by between 0.40 SEK and 1.20 SEK. An increase in the carbon dioxide tax is thus a cheaper measure than a full tax exemption for biofuels.

7.2 Different ways of calculating emissions give rise to different results

7.2.1 *Biofuels are assumed to be carbon dioxide-neutral*

Biofuels are often assumed to be carbon dioxide-neutral. Reasons for providing aid to biofuels include the fact that biofuels do not generate any new emissions of greenhouse gases. The emissions that occur when biofuels are burned are thus assumed to be equivalent to the carbon sink, i.e. the removal of carbon dioxide that occurs when the raw materials grow. If biofuels are assumed to be completely carbon dioxide-neutral, they will result in reductions in emissions of 100 per cent compared with fossil fuels.

There are no official records of the size of the reductions in emissions that biofuels have brought about to date. Swedish emissions of greenhouse gases are reported annually to the UN and the EU in accordance with the guidelines contained in the climate convention. Emissions from combustion of biomass, including biogas, ethanol and biodiesel, are included in the reports but are not included in total Swedish emissions.¹⁵⁸

7.2.2 *Emissions can also be estimated from a life-cycle perspective*

To assume that biofuels are carbon dioxide-neutral means disregarding the emissions that occur when biofuels are produced. The production of biofuels involves emissions from cultivation and harvesting of raw materials and production and transportation of fuel. So called “life-cycle analyses” are used in order to take these emissions into account.

¹⁵⁸ Naturvårdsverket [The Swedish Environmental Protection Agency] (2010a), National inventory report 2011 Sweden, page 112.

A life-cycle analysis means that the calculations take into account emissions from all stages of production, such as cultivation, transportation and production. Emissions from combustion are also taken into account, as well as the carbon sink involved in the growing process, even though they are later assumed to cancel each other out.

The production of fossil fuels also involves greenhouse gas emissions during extraction, production and transportation. When the emissions from fossil fuels are compared to biofuels, the emissions from the fossil fuels should also be calculated from a life-cycle perspective.

7.2.3 *The size of the emissions varies greatly, depending on how they are calculated*

The calculation of emissions from a life-cycle perspective is highly dependent on the assumptions made, the method for calculating the various steps and, not least, where the borderline for which stages of the production process are to be included is drawn.

There are a number of research reports containing life-cycle analyses of biofuels.¹⁵⁹ One of the most established and widely-accepted studies is the so-called Concauwe report produced by the European Commission's independent research council, the European oil industry's environmental organisation, and the European automobile industry's research council.¹⁶⁰

The results of different life-cycle analyses vary greatly depending on what assumptions are made. The biggest differences between different life-cycle analyses relate to how by-products are allocated in the calculation, how emissions from the cultivation of raw materials is calculated and what type of energy is used in the manufacturing process. The calculation is also affected by the raw material used.

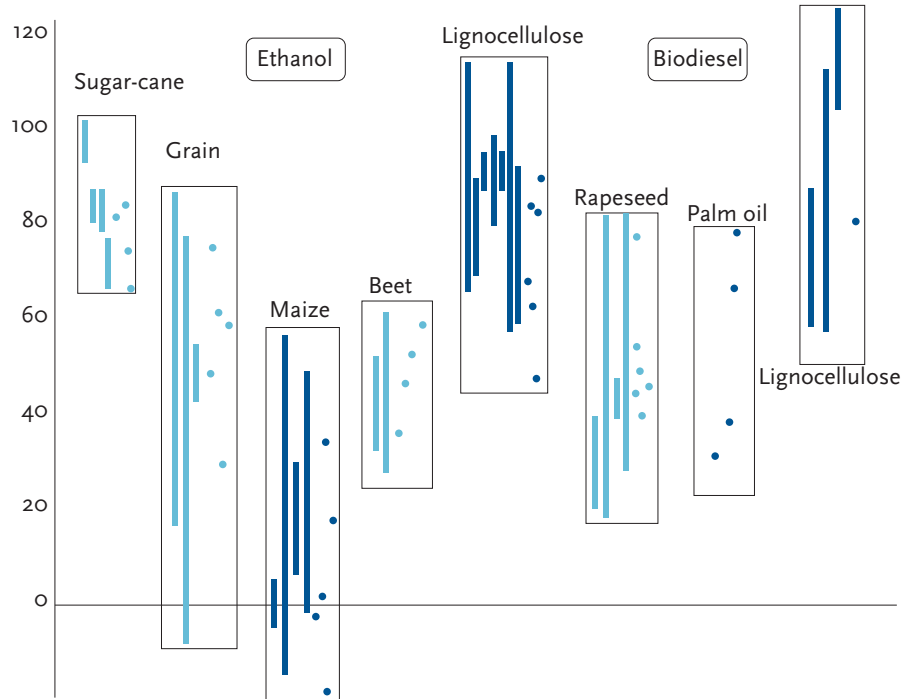
The OECD compiled results from life-cycle analyses of emissions from biofuels in a range of studies in 2008.¹⁶¹ Chart 7.1 shows the results of that compilation. The dots and lines represent intervals and point estimates for the various studies. The chart illustrates that the estimated reductions in emissions vary greatly compared to gasoline and diesel.

¹⁵⁹ One current Swedish study is Borjesson et al. (2010), *Livscykelanalys av svenska biodrivmedel* [Life-cycle analysis of Swedish biofuels].

¹⁶⁰ EUCAR/JRC/CONCAWE, Well-to-Wheels analysis of future automotive fuels and powertrains in the European context.

¹⁶¹ OECD (2008), Biofuel Support Policies: An economic assessment, page 47 f.

Chart 7.1. Reduction of greenhouse gas emissions from biofuels based on different life-cycle analyses, per cent



Source: OECD (2008) and AgriFood Economics Centre (2010).

7.2.4 7.2.4 The EU has agreed on sustainability criteria for biofuels

The EU Renewables Directive¹⁶² and Fuel Quality Directive¹⁶³ contain an identical list of criteria in order for biofuels to be defined as sustainable – the so-called “sustainability criteria”.

The sustainability criteria mean that the EU imposes requirements in order for biofuels to be included in the targets for the share of renewable energy applying to each Member State. Fulfilment of the sustainability criteria is also decisive in order for Member States to be allowed to provide financial aid for biofuels, for example in the form of a tax exemption.

¹⁶² Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (the Renewables Directive).

¹⁶³ Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of gasoline, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC (the Fuel Quality Directive).

The sustainability criteria are based on a life-cycle perspective. One criterion is that the biofuel must give rise to a certain percentage reduction in emissions, initially 35 per cent, compared to fossil fuels.¹⁶⁴ The directives provide emission values for calculating reductions in emission for biofuels produced from different raw materials and using different production methods.¹⁶⁵ The emission values can also be used if the raw materials have been cultivated outside the European Union.¹⁶⁶

7.3 Swedish biofuel use gives rise to reductions in emissions

7.3.1 *Reduced imports mean higher emissions from Swedish use of biofuels*

Emissions from biodiesel, ethanol for E85 and ethanol for low-level blending can be calculated from the supporting data that the Swedish Environmental Protection Agency and the Swedish National Transport Administration (formerly the Swedish National Road Administration) use in their index of new cars' impact on the climate.¹⁶⁷ For 2007 and 2008, the authorities based their conclusions on the CONCAWE data and the emission values contained in the EU's sustainability criteria in 2009.

Table 7.1 shows the extent of the reductions in emissions that could have come about from the use of biofuels compared to fossil fuels. The calculation is based on the estimated emissions for both biofuels and fossil fuels from a life-cycle perspective. The calculation also takes into account the lower energy content of biofuels. The supporting data for the calculation is taken from the Swedish National Transport Administration and the Swedish Environmental Protection Agency index for new cars and the emissions values set out in the EU's sustainability criteria. Appendix 2 contains a more detailed account of how the reductions in emissions have been obtained.

¹⁶⁴ Article 17, paragraph 2 of the Renewables Directive and Article 7b, paragraph 2 of the Fuel Quality Directive.

¹⁶⁵ Appendix V of the Renewables Directive and Appendix IV of the Fuel Quality Directive.

¹⁶⁶ Article 19, paragraphs 1–3i of the Renewables Directive and Article 7b, paragraphs 1–3 of the Fuel Quality Directive.

¹⁶⁷ Naturvårdsverket (2008), *Index över nya bilar klimatpåverkan 2007 i riket, länen och kommunerna* [The Swedish Environmental Protection Agency (2008), *The index of new vehicles' impact on the climate in 2007, nationally, in the counties and in the municipalities*], Naturvårdsverket (2009), *Index över nya bilar klimatpåverkan 2008 i riket, länen och kommunerna* [the Swedish Environmental Protection Agency (2009), *The index of new vehicles' impact on the climate in 2008 nationally, in the counties and in the municipalities*] and Trafikverket (2010), *Index över nya bilar klimatpåverkan 2009 i riket, länen och kommunerna* [the Swedish National Transport Administration (2010), *The index of new vehicles' impact on the climate in 2009, nationally, in the counties and in the municipalities*].

Table 7.1. Reductions in emissions from biofuels compared to equivalent transport work using the fossil alternative, 2007–2009

	2007	2008	2009
Ethanol for E85	89%	89%	69%
Ethanol for low-level blending	71%	71%	63%
Biodiesel	46%	46%	47%

Source: The SNAO's compilation based on data from the Swedish Environmental Protection Agency and the Swedish National Transport Administration.

Table 7.1 shows that the reductions in emissions for ethanol for E85 and low-level blending were slightly lower in 2009 compared to 2007 and 2008. This is mainly due to the fact that the composition of Swedish ethanol use changed between 2007 and 2009, partly as a result of the structure of the customs tariff. Brazilian sugar-cane ethanol and Swedish sulfite ethanol from SEKAB has largely been replaced by European ethanol with higher emissions.

The differences in reductions in emissions between one year and another have been somewhat overestimated. This is because it is difficult to obtain emissions values that are comparable from year to year. In the calculation for 2009 we use the emission values from the EU's sustainability criteria in which, for example, emissions from sugar-cane ethanol are estimated at a significantly higher level than in the data in the Concawe study. This is because the calculation method used in the EU's sustainability criteria does not allocate a proportion of the emissions from cultivation and production to the by-product, so called bagasse or haulm, that remains after the sap has been extracted from the sugar cane.¹⁶⁸ The fact that the bagasse, which is used in paper pulp production among other things, is not included can be seen as a way for the EU to systematically underestimate the climate benefits of Brazilian ethanol.

¹⁶⁸ An account is given of each calculation method at http://re.jrc.ec.europa.eu/biof/html/input_data_ghg.htm.

7.3.2 *Estimated reductions in emissions are equivalent to approximately 1 per cent of Sweden's emissions*

Based on the reductions in emissions described above, the total reduction in emissions as a result of Swedish use of biofuels in 2009 is estimated at approximately 1.2 per cent of Sweden's total emissions for that year.

Together with the data in Section 7.2.1, we can calculate the total reduction in emissions resulting from the use of biofuels using the Swedish Energy Agency data on the use of volumes of ethanol and biodiesel as a basis.¹⁶⁹ The results are presented in Table 7.2. The use of biofuels can be estimated overall to have brought about a reduction of approximately 0.7–0.8 million tonnes of carbon dioxide equivalents per year, depending on the assumptions made. This can be compared to Sweden's total annual emissions, which amounted to around 60–70 million tonnes during the 2000s.

Table 7.2. Total change in emissions from Swedish consumption of biofuels 2007–2009, million tonnes of CO₂ equivalents

	2007	2008	2009
Emissions from biofuels	0.3	0.4	0.6
Emissions for equivalent fossil fuel*	1.0	1.2	1.3
Change compared to fossil fuel	-0.7	-0.8	-0.7

Source: *The SNAO's own calculations.*

* *The emission values from gasoline and diesel are used here from a life-cycle perspective.*

Estimating the emissions from the use of biofuels is sensitive to different assumptions and calculation methods. For example, the fact that the contribution to the reductions in emissions appeared to decrease between 2008 and 2009 is due to differences in the assumptions made in calculations from one year to another. One alternative way of calculating is therefore to assume that biofuels do not give rise to any emissions, i.e., assume that they are carbon dioxide-neutral.

In order to give a wider picture of how the total reductions in emissions can vary, we have calculated the emissions on the basis of the assumption that biofuels are carbon dioxide-neutral or that the emissions correspond precisely to the EU requirement for a 35 per cent reduction in emissions in accordance with the sustainability criteria. The results of these calculations are shown in Table 7.3.

¹⁶⁹ Statens energimyndighet (2010a), *Transportsektorns energianvändning 2009* [The Swedish Energy Agency (2010a), *Energy use in the transport sector in 2009*], page 15.

Table 7.3. Total reductions in emissions from biofuels are assumed to be carbon dioxide-neutral and to meet the EU's requirements for 2007–2009, million tonnes of CO₂ equivalents

Assumptions on climate characteristics	2007	2008	2009
Carbon dioxide-neutral*	0.9	1.0	1.1
Correspond precisely to EU requirements	0.4	0.4	0.4

Source: The SNAO's own calculations.

* Emission values for gasoline and diesel are used for calculating the reduction in emissions without taking into account emissions from the whole production chain.

As shown in Table 7.3, an assumption of complete climate neutrality means slightly higher reductions in emissions compared to those shown in Table 7.2. If we instead assume that the emissions precisely correspond to the EU requirement for reductions in emissions, the reductions in emissions are lower. Another difference from the calculation method used in Table 7.2 is that the reduction in emissions now rises between 2008 and 2009.

7.4 The tax exemption is a relatively expensive climate measure

The use of biofuels has resulted in a reduction in emissions. The tax exemption was a prerequisite for this. However, the tax exemption leads to a relatively large loss of tax revenue, around SEK 2 billion in 2009. To calculate whether the tax exemption is a cost-effective way of achieving the climate objectives, the estimated reductions in emissions need to be set against the cost of the loss of tax revenues. This is done in the following section in the form of calculations and comparisons with possible reference values.

It should be noted that the achievement of other objectives, such as the aim to achieve a fossil-fuel independent vehicle fleet or greater self-sufficiency, is not taken into account in this assessment. What is a costly measure in terms of climate objectives may be a cheap measure in terms of other objectives.

7.4.1 *The cost per kg of reduced emissions varies widely depending on how it is calculated*

The cost to the State per kg of reduced emissions brought about by the tax exemption, through the use of biofuels, is equivalent to around SEK 3. This calculation does not take into account the cost of other government efforts to increase the use of those fuels. Neither are any costs in other sectors, such as the introduction of the Pump Act, taken into account.

Based on the costs of the tax exemption and the reductions in emissions estimated above for each biofuel, the cost per kg of reduced emissions can be estimated as shown in table 7.4.

Table 7.4. Cost per kg of reduced carbon dioxide emissions in 2009, SEK per kg

Cost per kg of reduced carbon dioxide emissions in 2009, SEK per kg	Reduction in emissions accordance to the car index*	Carbon dioxide-neutral	Corresponds precisely to the EU requirements
Biodiesel	3.07	1.71	4.08
Total ethanol	3.06	2.34	5.71
Ethanol for low-level blending	3.19		
Ethanol for E85	2.88		

Source: The SNAO's own calculations.

* The calculation of reductions in emissions is based on the supporting data and emissions values used in the Swedish National Transport Administration index of new cars' impact on the climate in 2009.

As shown in Table 7.4, the cost per kg of reduced emissions will vary depending on the size of the reduction in emissions that biofuels is assumed to bring about.

If biofuels are assumed to be carbon dioxide-neutral, the cost per kg of reduced emissions will amount to around SEK 2. If it is assumed instead that biofuels give rise to reductions in emissions that correspond precisely to the EU requirement for a 35 per cent reduction in emissions, the cost per kg of reduced emissions amounts to SEK 4 for biodiesel and almost SEK 6 for ethanol. The fact that the tax exemption for ethanol becomes more expensive than the tax exemption for biodiesel is a function of the fact that gasoline tax is higher than diesel tax.

If we instead base our calculation on the emission values used in the Swedish National Transport Administration car index, the cost for reduction in emissions will amount to around SEK 3 per kg of reduced emissions. The cost of biodiesel now becomes higher relative to the cost of ethanol because biodiesel gives rise to lower reductions in emissions. Similarly, ethanol for low-level blending will be more expensive than the ethanol used for E85. At the same time, other government efforts have contributed to the use of E85. For the ethanol used for E85, the total state cost per kg of reduced emissions becomes, in another words, slightly higher than indicated in Table 7.4.

7.4.2 *The tax exemption costs more than other climate measures*

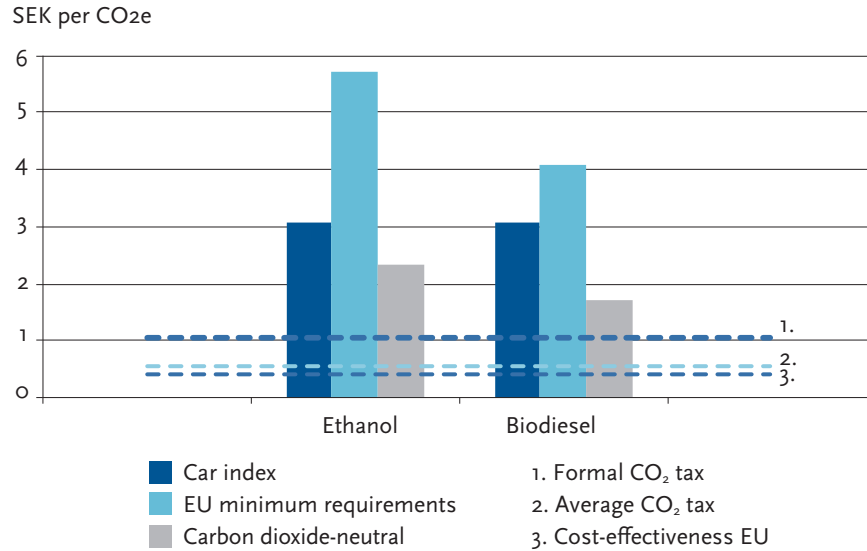
Are these costs reasonable based on the contribution that the use of biofuels makes to the climate objectives? To assess this, we must make a comparison with a reference value. Chart 7.2 compares the costs of measures with three different possible reference values:

- Carbon dioxide tax: Through its decision on carbon dioxide tax, the Riksdag has stated how much emissions of a certain quantity of carbon dioxide will cost and has thereby put a price on emissions. In 2009, the carbon dioxide tax amounted to SEK 1.05 per kg of carbon dioxide.
- Average carbon dioxide tax: Carbon dioxide tax contains many exceptions and for that reason the average carbon dioxide tax is much lower than the formal amount. Based on the revenues from carbon dioxide tax and total emissions of carbon dioxide, the average carbon dioxide tax is estimated at SEK 0.55 per kg of carbon dioxide.
- Cost-effectiveness according to the EU: The Commission has estimated what it would cost to achieve the EU's emissions and renewables targets using cost-effective measures. The cost is estimated at 40 euro, or approximately SEK 400 per tonne of carbon dioxide equivalent.¹⁷⁰

Chart 7.2 shows the cost of reducing emissions through the tax exemption for ethanol and biodiesel using all three calculation methods that we have used in this chapter up to now. In other words, the costs per kg of reduced emissions are presented on the basis of assumptions and data from the car index, assumptions that biofuels only give rise to reductions in emissions that correspond precisely with the EU minimum requirement (the sustainability criteria) and an assumption that biofuels are carbon dioxide-neutral.

¹⁷⁰ Commission of the European communities, SEC(2008) 85, VOL. II, page 40.

Chart 7.2. The costs for reducing emissions through the tax exemption and the reference values, SEK per kg of carbon dioxide equivalent



Source: The SNAO.

As the chart shows, the cost of measures calculated using all three calculation methods is higher than the reference values. In other words, a tax exemption for biofuels is a comparatively expensive way of achieving reductions in emissions.

However, in the introduction to this section we noted that cost comparisons of this kind do not illustrate all aspects of a measure's effects. There are also reasons for wishing to increase the use of biofuels besides just climate policy.

7.4.3 Carbon dioxide tax is a cheaper way of reducing emissions

The tax exemption is more expensive than carbon dioxide tax because it consists of an exemption from both carbon dioxide tax and energy tax. In order to achieve reductions in emissions of equal magnitude to those brought about by the use of biofuels in 2009, carbon dioxide tax would need to be raised between SEK 0.39–1.12 per kg of carbon dioxide for gasoline and SEK 0.41–1.17 per kg of carbon dioxide for diesel. See Table 7.5.

Table 7.5. Increase in carbon dioxide tax corresponding to reductions in emissions from biofuels in 2009, SEK per kg

Fuel	Reduction in emissions accordance to the car index	Carbon dioxide-neutral	Corresponds precisely to the EU requirements
Diesel	0.55	1.17	0.41
Ethanol	0.73	1.12	0.39

Source: The SNAO's own calculations. The calculation is based on the short-term price elasticities presented in Chapter 5.

If we compare the estimate in Table 7.4 with the estimate in Table 7.5, the required increase in carbon dioxide tax is somewhat smaller than the cost per kg of reduced emissions brought about by the use biofuels through the tax exemption. According to a rough estimate by the SNAO, it would therefore have been cheaper to raise carbon dioxide tax.

8 The long-term sustainability of the tax exemption

In this chapter we describe some future changes that are relevant to the tax exemption. To some extent these relate to the EU legal situation and also to how the production of biofuels develops in global terms. Furthermore, we highlight the importance of funding of research to produce new biofuels. The chapter begins with a summary of our main observations.

8.1 A summary of our observations

- It is not considered possible for domestic production of biofuels to increase to any great extent unless new biofuels are developed. One challenge is therefore to minimise the risk of negative side effects of an increase in international production.
- There has been great confidence in research to develop second generation biofuels over the years, but research takes time. Therefore, there is reason to be cautious when making forecasts as to when second-generation biofuels will be on the market.
- EU requirements on reductions in emissions are modest compared to Swedish conditions. The requirements are not likely to help the tax exemption to become more cost-effective in relation to the climate objectives. However, the SNAO's assessment is that it would be possible to encourage further reductions in emissions for biofuels by differentiating the tax exemption on the basis of the size of the reductions in emissions to which different biofuels give rise.
- Sweden may not retain the current tax exemptions after 2020 unless EU provisions are amended. This imposes a requirement to develop other instruments if biofuels are to be provided with long-term, predictable conditions.

8.2 Long-term climate benefits require controlled expansion

8.2.1 *The acreage used is considered to increase with the consumption of biofuels*

As described in a previous chapter, the tax exemption has been important for increasing the use of biofuels. In 2009, biofuels accounted for approximately 5.4 per cent of total fuel used. The use of biofuels will need to increase further in order to reach the target of 10 per cent renewable energy in the transport sector by 2020.

Current Swedish biofuel consumption is partly, but not mainly, based on domestic production. Approximately 5 per cent of Swedish land under cultivation is used for production of biofuels. This means that the acreage used for biofuel production in agriculture can be expected to rise as the use of biofuels increases.

A government study estimates that 27 per cent of land currently under cultivation may need to be used if the target of 10 per cent renewable energy in the transport sector is to be achieved using only domestically-produced ethano.¹⁷¹ However, this calculation does not take into account possible improvements in production methods or the possibility that second-generation biofuels could be sold commercially on the market in future. It may also be noted that not all cultivation land in Sweden is currently being used and that it may be possible to increase the intensity of cultivation.¹⁷² Despite this, the possibilities of increasing domestic production are limited. Swedish conditions, for example, are not suitable for producing biodiesel from agricultural raw materials.¹⁷³

8.2.2 *Sustainability criteria only apply to biofuels*

Imports of biofuels are expected to increase to enable Swedish consumption of biofuels to increase. The issue of the climate benefit of Swedish biofuel consumption is thus also associated with international production.

As described in Chapter 7, the EU is beginning to impose requirements that biofuels must meet specific sustainability criteria in order to receive support such as tax exemptions. These include a requirement that their use must lead to a certain percentage reduction of greenhouse gas emissions compared to

¹⁷¹ SOU 2007:36, *Bioenergi från jordbruket – en växande resurs* [SOU 2007:36, *Bioenergy from agriculture – a growing resource*], page 29.

¹⁷² Börjesson, P. et al. (2010), *Livscykelanalys av svenska biodrivmedel* [Life-cycle analysis of Swedish biofuels].

¹⁷³ See SOU 2007:36, page 37.

fossil fuels. The sustainability criteria do not only apply within the EU but also apply to imported biofuels.¹⁷⁴ One important aspect is therefore how the sustainability criteria are implemented in third countries.

One problem with the sustainability criteria is that they only apply to biofuels. There is therefore a risk of the criteria leading to emissions moving to unregulated sectors and countries if the production of biofuels increases.

Agricultural products other than biofuels are also currently not covered by regulations equivalent to the sustainability criteria. In order to effectively reduce the negative impact that the sustainability criteria are intended to manage, it is important that the same attention should also be paid to other forms of agricultural products.

8.2.3 *Various concepts of indirect land use effects*

In addition to the fact that direct land use in the production of biofuels is expected to increase, research continues on the effects that indirectly affect land use. One example of an indirect land use effect is when planting maize on land where soya beans were previously cultivated leads to increased imports of soya beans. This may then result in increased cultivation of soya in tropical areas such as Brazil. Increased soya cultivation has been a major cause of deforestation in the Amazon. This would have adverse consequences for the climate because the rain forest is a major carbon sink which binds carbon dioxide.

There is no disagreement as to whether indirect land use effects exist. There is, however, disagreement as to their extent. In recent years, a few studies have been published in which the authors attempt to estimate the indirect land use change effects from biofuel production.¹⁷⁵ According to these studies, if indirect land use effects are taken into account emissions from biofuels would increase considerably, sometimes to the point where emissions are higher than for the fossil alternative.¹⁷⁶ However, these studies have been the subject of a great deal of criticism. The critics state, among other things, that they fail to take

¹⁷⁴ See Article 19, paragraph 3 of Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (the Renewables Directive) and Article 7d, paragraph 3 of Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of gasoline, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC (the Fuel Quality Directive).

¹⁷⁵ Searchinger, T. et al. (2008), Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land Use Change, and Wibe, S. (2010), *Etanolens koldioxideffekter – En översikt av forskningsläget* [The carbon dioxide effects of ethanol – An overview of current research].

¹⁷⁶ Global economic equilibrium models are used to estimate the extent of the indirect land use effects.

sufficient account of factors such as the availability of unused cultivation land, productivity developments in the agricultural sector and positive effects due to the fact that by-products are able to replace other cultivation of feed crops.¹⁷⁷ A recently-published report from the Swedish Environmental Protection Agency also noted that there is insufficient data and empirical evidence to allow any safe conclusions to be drawn with regard to indirect land use effects.¹⁷⁸

8.2.4 *The question of land use becomes more relevant if international production increases*

The risks of increased emissions as a consequence of indirect and direct land use effects become more relevant if the use of biofuels increases. According to some studies, the risks are minimised by a well-balanced rate of expansion and adjusted production volumes which are limited according to the current available raw material base.¹⁷⁹

The definition of “a well-balanced rate of expansion” is open to discussion. For example, the UK parliament has decided to reduce the rate of gradual increase in the compulsory biofuel quota introduced in 2008 and to allow growth to level off in 2013. If the UK government considers that the risks involved in expanding production have been managed properly, it intends to increase the quota from 2016 onwards to achieve the 10 per cent target by 2020.¹⁸⁰

Indirect land use effects as a result of production and use of biofuels are not currently included in the EU sustainability criteria. In accordance with the Renewables Directive and the Fuel Quality Directive, the Commission issued a report on indirect land use effects associated with the use of biofuels in December 2010.¹⁸¹ In that report, the Commission notes that indirect land use effects can contribute to lower reductions in the emissions brought about by biofuels, but there are uncertainties as to how the effects are to be measured.

¹⁷⁷ See, for example, Wang, M. and Haq, Z. (2008), Letter to Science and Börjesson, P. Nilsson, L. and Berndes, G. (2010), *Fel om etanolens klimatpåverkan [Errors concerning the climate impact of ethanol]*, debate article in *Sydsvenskan* on 26 January 2010.

¹⁷⁸ Naturvårdsverket [The Swedish Environmental Protection Agency] (2010b), *Is it possible to avoid bad impacts by using good fuel ethanol?*

¹⁷⁹ See, for example Börjesson, P. et al. (2010) *Livscykelanalys av svenska biodrivmedel [Life-cycle analysis of Swedish biofuels]*, page 18, Naturvårdsverket [The Swedish Environmental Protection Agency] (2010b), *Is it possible to avoid bad impacts by using good fuel ethanol?*, page 47 and Naturvårdsverket (2004), *Skattebefrielse för biodrivmedel – leder den rätt? [the Swedish Environmental Protection Agency (2004), A tax exemption for biofuels – is it leading in the right direction?]*, page 8.

¹⁸⁰ The Renewable Fuels Agency (2008), The Gallenger Review of the indirect effects of biofuels production. See also the Department for Transport (2009), Explanatory Memorandum to the Renewable Transport Fuel Obligations (Amendment) Order 2009.

¹⁸¹ Article 19, paragraph 6 of the Renewables Directive and Article 7b, paragraph 6 of the Fuel Quality Directive.

The Commission will present an assessment by July 2011 of whether indirect land use effects should be incorporated into the sustainability criteria.¹⁸²

8.3 Research takes time

8.3.1 *Research is important for that reason*

The reason for the tax exemption was to provide conditions in which more environmentally-friendly biofuels can be developed.¹⁸³ There is great confidence that research will lead to more advanced technologies for producing biofuels, i.e. for the development of second-generation biofuels. The government has been funding research for a long time, granting a total of around 3.9 billion since 1975. See Chart 8.1 below. Thus, research grants can be considered to be a key instrument for the government to make technological development possible and enable more advanced biofuels to come into commercial use.¹⁸⁴

Improvement in the technologies is also stressed in various contexts as a prerequisite for biofuels to be a sustainable alternative fuel in the transport sector.¹⁸⁵ As described above, it is likely that larger areas of land than are currently used will be required if the use of biofuels increases in future. However, if new technologies contribute to more efficient production or to enable new raw materials to be used, then the acreage used for production could be lower.

8.3.2 *Investments in research, then and now*

State funding of research on biofuels has existed since 1975. Parallel to research funding, subsidies for commercialisation have also existed since 1980. The SNAO has carried out a survey of the research funding granted to date. Subsidies for commercialisation are also included in the survey from 1998

¹⁸² The European Commission (2010), Report from the Commission on indirect land use changes for biofuels and biofluids.

¹⁸³ See prop. 1994/95:54, bet. 1994/95:SkU4, rskr. 1994/95:152 [Government Bill 1994/95:54, Committee Report. 1994/95:SkU4, Riksdag Communication 1994/95:152].

¹⁸⁴ See, for example beslut 1975 (prop. 1975:30, *om energihushållning m.m.*, bil. 1, bet. NU 30, rskr. 202) [the 1975 decision (Government Bill 1975:30, *on energy economy, etc.*, appendix 1, Committee Report NU 30, Riksdag Communication 202)] and beslut 1978 (prop. 1977/78:110, *om energiforskning m.m.* bet. NU 68, rskr. 341) [the 1978 decision (Government Bill 1977/78:110, *on energy research, etc.*, Committee Report NU 68, Riksdag Communication 341)], beslut 1981 (prop. 1980/81:90, *om riktlinjer för energipolitiken*, bil. 1, bet. NU 60, rskr. 381) [1981 decision (Government Bill 1980/81:90, *on energy policy guidelines*, appendix 1, Committee Report NU 60, Riksdag Communication 381)].

¹⁸⁵ See, for example, trafikutskottets forskningsöversikt 2007/08:RFR14, *Förnybara drivmedels roll för att minska transportsektorns klimatpåverkan* [the transport committee's review of the research 2007/08: RFR14, *The role of renewable fuel in reducing the transport sector's impact on the climate*], page 62.

onwards.¹⁸⁶ From 1998 to 2010, subsidies for research and commercialisation were combined and it has not been possible to separate them.

The survey shows that research funding in the period from 1975 to 1989 was granted within the framework of various energy research programmes. The reasons for the funding have varied over time. It was only from 1992 onwards that research funding came to be linked to alternative fuels in order to reduce the greenhouse gases in the atmosphere.¹⁸⁷ Prior to that, the aim was to safeguard the energy supply by investing in alternative fuels that would replace oil in the long term and thereby reduce dependence on oil.¹⁸⁸ During the 1970s and 1980s, the central government expressed a wish for research to primarily relate to domestic production of biofuels.¹⁸⁹ The State government signalled for the first time in 1987 that funding of research for biofuels should primarily relate to research to develop second-generation biofuels such as cellulose-based biofuels.¹⁹⁰ In 1998, the central government clearly aimed the funding at second generation fuels through the “Ethanol production from forest raw material” programme.¹⁹¹

From 1975 to 1998 it was possible to interpret central government research funding in advance. This was because the State government, through partial research programmes such as for biofuels, announced how large the initiatives would be at least three years in advance. From 1999 onwards, these assessments and prioritisations were made by the Swedish Energy Agency within the framework of the general research subsidy. Therefore, since 1998 it has not been possible to see in advance the size of the amount allocated by the Swedish Energy Authority to research and development of biofuels. It is possible to go back in time through the Swedish Energy Agency’s annual reports to obtain information on the scale of the funding for transport research, but it is not possible to discern how much of that funding went on research

¹⁸⁶ The supporting data is based primarily on the government’s research and energy bills.

¹⁸⁷ Prop. 1992/93:179 *om åtgärder mot klimatpåverkan m.m.* [Government Bill 1992/93:179, *on measures to counteract the impact on the climate, etc.*].

¹⁸⁸ Prop. 1975:30 [Government Bill 1975:30], prop. 1977/78:110 [Government Bill 1977/78:110], prop. 1980/81:90 [Government Bill 1980/81:90], prop. 1983/84:107, *om forskning* [Government Bill 1983/84:107, *on research*], prop. 1986/87:80, *om forskning* [Government Bill 1986/87:80, *on research*] and prop. 1989/90:90, *om forskning* [Government Bill 1989/90:90, *on research*].

¹⁸⁹ *Ibid.* Prop. 1975:30 [Government Bill 1975:30], prop. 1977/78:110 [Government Bill 1977/78:110], prop. 1980/81:90 [Government Bill 1980/81:90], prop. 1983/84:107 [Government Bill 1983/84:107], prop. 1986/87:80 [Government Bill 1986/87:80] and prop. 1989/90:90 [Government Bill 1989/90:90].

¹⁹⁰ Prop. 1986/87:80 [Government Bill 1986/87:80].

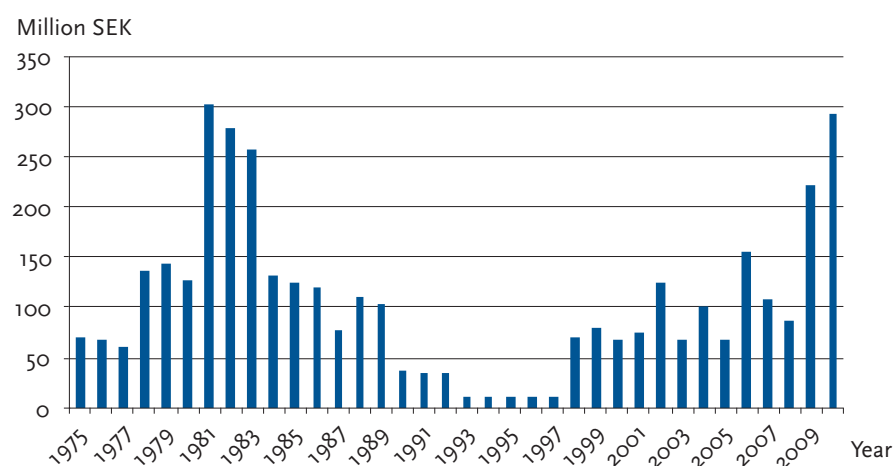
¹⁹¹ Prop. 1996/97:84, *En uthållig energiförsörjning* [Government Bill 1996/97:84, *A sustainable energy supply*].

into biofuels.¹⁹² Supporting data for the SNAO survey of the period from 1998 to 2010 therefore comes directly from Swedish Energy Agency administrators.¹⁹³

The advantage of a system whereby the authority assesses how the different parts of energy research should be prioritised from year to year is that it is flexible. It allows investments to be better adapted to suit the need for research funding at different times. However, it also means that the allocation of research funds becomes less transparent.

Chart 8.1 below shows the total funding over time on research into biofuels.

Chart 8.1. Funding for R&D of biofuels 1975–2010, million SEK



Source: Data compiled by the SNAO. The amount relates to research funding during the period converted to fixed prices (2010) on the basis of the KPI [Consumer Price Index]. Funding for commercialisation is included from 1998–2010.

The survey shows that total funding since 1975 amounts to approximately SEK 3.9 billion.¹⁹⁴ However, the funding has varied greatly over time. On average, research funding amounts to SEK 108 million per year during the period. If that funding is compared to the current cost of the tax exemption in terms of lost tax revenues of approximately SEK 2 billion per year, research funding has been modest.

¹⁹² Prop. 2005/06:127, *Forskning och ny teknik för framtidens energisystem*, bilaga 4, bet. 2005/06:NU19, rskr. 2005/06:347 [Government Bill 2005/06:127, *Research and new technologies for future energy systems*, appendix 4, Committee Report 2005/06:NU19, Riksdag Communication 2005/06:347].

¹⁹³ Statens energimyndighet [Swedish Energy Agency], Excel files via e-mail, 28/06/2010.

¹⁹⁴ The supporting data for research funding for 1998 to 2010 comes from data from Energimyndigheten [the Swedish Energy Agency] and not, as in previous years, from government bills. This is because from 1998 onwards it has not been possible to discern the size of the investment from government documents.

The chart shows that funding in 2010 amounts to 300 million SEK, which is almost as much as in the record year of 1981. According to the Swedish Energy Agency, research in recent years has been focused on commercialising the results of research on second generation biofuels. This research work is more expensive than before. The Swedish Energy Agency has therefore requested more funding from the State government and the government has agreed to provide it. This explains the increase in research funding in recent year.¹⁹⁵ Through the *klimatmiljarden* [climate billion], for example, the State government invested SEK 120 million during the period from 2008 to 2010 in research into second generation biofuels.¹⁹⁶ The State government increased the funding by an additional SEK 875 million over a three-year period in the 2009 Budget Bill.¹⁹⁷

8.3.3 *The results of the research*

The biofuels on the market today are mainly produced using technologies that have been known for a long time, despite the research funding granted since 1975 (albeit initially on a limited scale). The Swedish Energy Agency's current funding goes on research and development aimed at developing production technologies that allow sustainable production of fuels that is cost-effective and able to operate on commercial markets in future.¹⁹⁸ Whether current investments will produce the desired results can only be evaluated after 2015–2016.¹⁹⁹ This shows that it takes time for research and development to produce results. In the Swedish Energy Agency's monitoring of the tax exemption for biofuels, the Agency has previously stated that the tax exemption has gone on biofuels produced using technologies that are already known and that have little development potential.²⁰⁰ The SNAO therefore takes the view that there is reason to be cautious when issuing forecasts as to when second generation biofuels will be available on the market.

¹⁹⁵ Notes from a telephone conversation with Energimyndigheten [the Swedish Energy Agency] on 20/10/2010.

¹⁹⁶ Prop. 2007/08:1, UO 21 [Government Bill 2007/08:1, UO 21], page 74, bet. 2007/08:NU3, rskr. 2007/08:100 [Committee Report 2007/08:NU3, Riksdag Communication 2007/08:100].

¹⁹⁷ Prop. 2008/09:1, UO 21, Budgetpropositionen för 2009 [Government Bill 2008/09:1, UO 21, 2009 Budget Bill], page 48, bet. 2008/09:NU2, rskr. 2008/09:139 [Committee Report 2008/09:NU2, Riksdag Communication 2008/09:139].

¹⁹⁸ Statens energimyndighet [Swedish Energy Agency], website 22/10/2010, <http://www.energimyndigheten.se/sv/Forskning/Transportforskning1/Alternativa-drivmedel/>.

¹⁹⁹ Statens energimyndighet [Swedish Energy Agency], telephone calls, 20/10/2010.

²⁰⁰ See section 3.5.1.

8.4 Possible to promote further reductions in emissions at national level

The EU Renewables Directive includes sustainability criteria for biofuels and other bioliquids. The sustainability criteria contain requirements to be met by biofuels in order for a tax exemption to be permitted and in order for biofuels to count towards the 10 per cent target.²⁰¹

Initially, the EU establishes a requirement that greenhouse gas emissions should be at least 35 per cent lower than the corresponding use of fossil fuels. Biofuels produced in existing facilities are exempt from the requirement for a 35 per cent reductions in emissions by 2013. However, the requirement for reductions in emissions will be gradually raised to 60 per cent for biofuels produced in new facilities starting up in 2017 or later.²⁰² A control system to guarantee compliance with the provisions is expected to be in place from January 2011 onwards. The Swedish Energy Agency will be the supervisory authority.²⁰³

At present it is not possible to express a view as to whether the requirements in the sustainability criteria will affect emissions from the use of biofuels. If we look at the size of the reduction in emissions to which biofuels have given rise in Sweden to date, compared to that of fossil fuels, they have exceeded the minimum requirements imposed by the EU. For that reason, the sustainability criteria are unlikely to affect emissions from Swedish production and consumption of biofuels. Thus, it is probable that they will also not contribute to the tax exemption becoming more cost-effective.²⁰⁴

Given that the EU sustainability criteria are modest by Swedish standards, there is reason to analyse the possibility of introducing national requirements at a higher level.

When the Riksdag made a decision on the sustainability criteria, the Committee on Environment and Agriculture stated that the Renewables Directive was not designed as a minimum directive as far as the criteria were concerned.²⁰⁵ At the same time, Member States may not exclude biofuels that

²⁰¹ Articles 17–21 of the Renewables Directive. The sustainability criteria have been implemented in Swedish law. See prop. 2009/10:164, bet. 2009/10:MJU26, rskr, 2009/10:299, *lag (2010:598) om hållbarhetskriterier för biodrivmedel och flytande biobränslen* [Government Bill 2009/10:164, Committee Report. 2009/10:MJU26, Riksdag Communication 2009/10:299, *Act (2010:598) on sustainability criteria for biofuels and bioliquids*].

²⁰² Article 17 of the Renewables Directive.

²⁰³ Prop. 2009/10:164, *Hållbarhetskriterier för biodrivmedel och flytande biobränslen* [Government Bill 2009/10:164, *Sustainability criteria for biofuels and bioliquids*], page 34.

²⁰⁴ Interview, Statens energimyndighet [Swedish Energy Agency], 24/06/2010.

²⁰⁵ Bet. 2009/10:MJU26, *Hållbarhetskriterier för biodrivmedel och flytande biobränslen m.m.* [Committee Report 2009/10:MJU26, *Sustainability criteria for biofuels and bioliquids, etc.*], page 10.

meet the sustainability criteria from support or from being counted towards the targets in the directive.²⁰⁶ However, the directive provides various ways to favour biofuels that provide benefits in addition to the criteria. For example, those biofuels count double towards the renewables target.²⁰⁷

The preamble of the directive also states that the Member States may promote the use of biofuels that result in additional benefits in their support systems. This applies particularly if these biofuels have higher production costs.²⁰⁸ It should thus be possible at national level to promote further reductions in emissions by providing additional aid for biofuels that are more climate-friendly, particularly if the production cost of a more climate-friendly biofuel is higher than the less climate-friendly alternative. One problem with such a solution is that it involves more administration because the support – the tax exemption in this case – then needs to be differentiated according to the size of the reductions in emissions brought about by different biofuels.

8.5 Is an alternative model to the tax exemption needed?

8.5.1 *The EU target of 10 per cent renewable energy in the transport sector by 2020 is binding*

It was decided at the spring summit of the European Council in 2007 that the target of 10 per cent renewable energy in the transport sector by 2020 would be binding.²⁰⁹ In the budget bills for 2009 and 2008, the State government stated that a binding target means uncertainty as to whether the tax exemption for biofuels can be retained at all.²¹⁰ The Energy Tax Directive contains a provision stating that Member States may not grant tax exemptions to biofuels to achieve binding targets.²¹¹

According to the Commission's legal services, the target of 10 per cent renewable energy in the transport sector is binding within the meaning of the Energy Tax Directive.²¹² This is because the target will be extremely difficult to

²⁰⁶ See Article 17.8 of the Renewables Directive, which states that, for the purposes referred to in the sustainability criteria, Member States shall not refuse to take into account, on other sustainability grounds, biofuels and bioliquids obtained in compliance with the Articles on the sustainability criteria.

²⁰⁷ Article 21 of the Renewables Directive.

²⁰⁸ Sections 89 and 95 of the preamble to the Renewables Directive.

²⁰⁹ See, for example, section 13 of the preamble to the Renewables Directive.

²¹⁰ Prop. 2008/09:1 [Government Bill 2008/09:1], section 6.2.5.4 and prop. 2007/08:1 [Government Bill 2007/08:1], section 5.6.13.

²¹¹ Article 16.6, of Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity (the Energy Tax Directive).

²¹² Commission of the European communities (2008), SEC(2008) 85, VOL. II, page 158–159.

achieve without biofuels.²¹³ The Commission's assessment means that Member States must stop granting tax exemptions for biofuels from the moment the 10 per cent target is met, i.e. 2020. There are many indications, therefore, that Sweden will be forced to stop granting tax exemptions for both low-level blends and high-level blends of biofuels from 2020.

However, discussions are ongoing with regard to a revision of the Energy Tax Directive that may lead to an amendment of the condition.²¹⁴ An amendment of the directive would mean that Member States could support biofuels through tax exemptions even after 2020. However, such a process may take a long time and it is unclear what the result would be. It may also be noted that there is as yet no equivalent to Sweden's investment in high-level blended ethanol in other EU countries, although there are indications that it is on the way.²¹⁵

8.5.2 *Compulsory quotas as an alternative to the tax exemption*

The tax exemption for biofuels is an operating subsidy that aims to make biofuels competitive in relation to fossil alternatives. The tax exemption is intended to give consumers incentives for using biofuels as an alternative to fossil fuels.

The State government stated in the 2010 Budget Bill that the general tax exemption should apply only until the end of 2013, when the State aid approval for the current Swedish tax strategy expires. The state government argued that, instead, a system with a so-called quota obligation could in the long term be an option to promote the use of biofuels and help achieve the target of 10 per cent renewable energy in the transport sector. The State government therefore gave the Swedish Energy Agency the task of analysing the conditions for and consequences of a compulsory quota system.²¹⁶

A compulsory quota is a legal instrument whereby gasoline companies are obliged to sell a certain percentage of biofuels. The Swedish Energy Agency has investigated a range of alternative solutions based on the task assigned by the State government.²¹⁷ In its report, the Swedish Energy Agency proposes that suppliers should be obliged to supply a certain percentage (a quota) of biofuels.

²¹³ However, the Commission's legal services consider that the target is not binding in relation to the rules on State aid.

²¹⁴ Statens energimyndighet (2009a), *Kvotpliktssystem för biodrivmedel* [Swedish Energy Agency (2009a), *Compulsory quota system for biofuels*], page 90.

²¹⁵ See 2009/10:RFR7, *Pumplagen – Uppföljning av lagen om skyldighet att tillhandahålla förnybara drivmedel* [2009/10:RFR7, *The Pump Act – monitoring of the Act on the obligation to supply renewable fuel*]. See also Chapter 6 of this report.

²¹⁶ Prop. 2009/10:1 [Government Bill 2009/10:1] and prop. 2008/09:162 [Government Bill 2008/09:162], page 86.

²¹⁷ Statens energimyndighet (2009a), *Kvotpliktssystem för biodrivmedel* [The Swedish Energy Agency (2009a), *Compulsory quota system for biofuels*].

The compulsory quotas will apply to gasoline and diesel and the level will be set in relation to the blending levels in the Fuel Quality Directive.

The Ministry of Finance takes the view that the Swedish Energy Agency's proposals are not likely to be implemented in their present form. This is because the Ministry of Finance considers that it is very difficult to use a tax exemption along with a binding compulsory quota because it then becomes difficult to defend the argument that the tax exemption is required from a State aid perspective.²¹⁸

The SNAO has also obtained similar information in contact with experts in EU law.²¹⁹ A binding compulsory quota makes it obligatory for companies to supply a certain percentage of biofuels and a tax exemption will therefore not affect the companies' behaviour. In terms of the rules on State aid, a tax exemption is therefore not regarded as necessary or proportionate.

However, from the point of view of EU law it should be possible to supplement a compulsory quota in the form of, for example, obligatory low-level blending with a tax exemption for high-level blending. In such a case, the use of high-level blended biofuels does not help achieve any compulsory quota. However, such a solution involves a series of administrative challenges since the tax will differentiate between biofuels used for low-level blending and biofuels used for high-level blending.

²¹⁸ Interview. Finansdepartementets skatteavdelning [The Ministry of Finance tax department], 02/06/2010.

²¹⁹ See the statement by Ulf Bernitz, Professor of European Integration Law at Stockholm University, 12/01/2011.

9 Conclusions and recommendations

The aim of this audit was to examine to what extent and at what cost the tax exemption for biofuels helps achieve the Riksdag's climate objectives. The tax exemption is an expensive, blunt way to reduce greenhouse gas emissions. The cost of the tax exemption has also increased substantially in recent years, while it also gives rise to a number of counter-productive effects. The State government's decisions on tax exemptions have been short-term and unpredictable and have not brought about the conditions for the intended technological development. Neither has the State government monitored and commented on the overall scope of the tax exemption or its effects in recent years. The fact that the tax exemption is intended to achieve several objectives contributes to a lack of transparency.

9.1 The tax exemption for biofuels helps achieve the Riksdag's climate objectives – but not at a reasonable cost

The tax exemption has mainly contributed to an increase in low-level blending ...

The State government has been empowered to adopt decisions on tax relief or tax exemptions for biofuels in response to applications from individual suppliers or companies since 1995. The tax exemption is the single most important instrument for increasing the use of biofuels, particularly biofuels for low-level blending.

There is a significant correlation between the State government's decisions on tax exemptions for biofuels and how the use of biofuels has developed. The use of biofuels began to increase from around 2002 when the State government began to grant full exemptions for all biofuels. Virtually all gasoline and diesel now contain up to 5 per cent biofuels by volume. The tax exemption has been crucial for this development. In the 2011 Budget Bill, the State government also

proposes a possibility of obtaining tax exemptions for higher low-level blending levels than previously.²²⁰

... but has not been sufficient to sustain consumption of E85

Biofuels can also be used as high-level blended fuel. For example E85, which consists of 85 per cent ethanol and 15 per cent gasoline, is used in Sweden. A tax exemption is not sufficient on its own to establish a market for high-level blended biofuels because investment in vehicles and infrastructure is also required.

Sweden is virtually the only EU State that has created a market for E85. The number of cars that are able to run on renewable fuels has risen sharply in recent years. The same applies to the number of fuel stations offering biofuels for sale.

According to the SNAO questionnaire for ethanol and gas car owners, the desire to reduce the impact on the climate and economic factors such as different green car subsidies and the expectation of higher gasoline prices are important factors when choosing a green car. The survey also shows that most ethanol-powered car owners vary between E85 and gasoline. The price is important for the choice of fuel, while the distance to a fuel station is less important.

Up to 2008 there was a strong correlation between the increased consumption of E85, the number of ethanol-powered cars and the number of E85 fuel stations. However, this correlation ceased to exist after 2008. Despite the fact that the number of fuel stations for E85 and the number of ethanol-powered cars continued to rise, albeit at a slightly slower rate, consumption of E85 has fallen. This can largely be explained by the fact that many ethanol-powered car owners have refuelled with gasoline instead of E85 as a result of lower gasoline prices and higher E85 prices. Although the tax exemption is a full exemption, it has not been sufficient to maintain consumption of E85 when the price of gasoline has fallen.

The use of biofuels means a reduction in greenhouse gas emissions

Estimates of emissions from biofuels are to a large extent dependent on the assumptions made, the method for calculating the various stages and where the borderline for which stages are to be included is drawn. Different studies will therefore yield different results.

²²⁰ Prop. 2010/11:1 [Government Bill 2010/11:1], section 6.6.2.

Within the framework of the audit, the SNAO has calculated the size of the reduction in emissions that Swedish use of biofuels could bring about in relation to the fossil fuel alternatives. The calculations are carried out from a life-cycle perspective, among other things. The calculations use the same values for emissions as in the Swedish National Transport Administration index of new cars' impact on the climate and in the EU sustainability criteria. Furthermore, emissions have also been calculated based on an assumption that biofuels are completely carbon dioxide-neutral, and an assumption that biofuels will reduce emissions by at least 35 per cent from a life-cycle perspective compared to fossil fuels. This figure is the limit for whether a biofuel can be regarded as sustainable in accordance with the EU sustainability criteria. Overall, the SNAO has therefore estimated that the use of biofuels may have led to reduced emissions of approximately 0.4 to 1.1 million tonnes of carbon dioxide equivalents a year in the 2007–2009 period. The reduced emissions represent approximately 1 per cent of Sweden's total emissions of greenhouse gases, or 5 per cent of emissions in the transport sector.

The tax exemption is a relatively expensive way of reducing greenhouse gas emissions

The tax exemption has been a prerequisite for the increased use of biofuels. Thus, the tax exemption has also been a prerequisite for reductions in emissions that can be linked to the use of biofuels.

The loss of tax revenues arising as a result of the tax exemption has increased steadily since 2000 and currently amounts to around SEK 2 billion a year. The amounts vary depending on whether the figures are based on budgeted amounts or volumes of biofuels sold.

On the basis of the total cost of the tax exemption, the reduction in emissions brought about by the use of biofuels means a cost to the State government of around SEK 3 per kg of carbon dioxide reduction. Therefore, compared to the carbon dioxide tax of SEK 1.05 per kg of carbon dioxide for example, a full tax exemption for biofuels is a relatively expensive means of reducing greenhouse gas emissions.²²¹ In order for a full tax exemption for biofuels to result in a cost for the measure in line with that of the carbon dioxide tax, biofuels would need to result in reductions in emissions of well over 100 per cent from a life-cycle perspective.

²²¹ Alternative bases for comparison include average CO₂ tax of SEK 0,55 per kg of CO₂ and the EU Commission estimate of the cost of achieving the EU emissions and biofuels targets through cost-effective measures of SEK 0,40 per kg of CO₂.

9.2 The State government's management of the tax exemption has not been conducive to sustainability and predictability

The tax exemption has not resulted in long-term, predictable conditions for all companies

In order to provide long-term, predictable conditions for biofuels, the State government has devised a set of principles to form the basis of decisions on tax relief. At the same time, the government's reasons for adopting decisions on tax relief have varied over the years, which has led to a situation whereby different companies are treated differently. Despite the intention to provide biofuels with long-term, predictable conditions, the government's decisions on tax relief for biofuels have in most cases related to relative short periods – one to two years. However, several companies have applied for tax exemptions for longer periods than that.

Unequal treatment and short decision periods are problematic for several reasons. Different conditions from one company to another are bad from the point of view of competition and do not guarantee technical neutrality between biofuels. The fact that conditions change over time and decisions on tax exemptions only apply for a short period of time also limits companies' ability to predict the rules of the game in the market. This has implications for companies' willingness to invest in costly technologies that can only pay dividends in the long term. According to a study recently published²²² by Price Waterhouse Coopers, many companies perceive existing environmental taxes and regulations as ineffective, inconsistent and unclear. Companies are therefore calling for stable, well-designed guidelines and policy instruments that contribute to fair competition and long-term planning conditions.

The tax exemption has so far not had any major impact in terms of driving technology forward

When the tax exemption for biofuels was introduced, it was intended that it would be used for pilot projects aimed at developing more environmentally-friendly fuels. However, most of the government's decisions on tax relief relate to general tax exemptions rather than pilot projects. Tax exemptions for pilot projects have therefore lost their practical significance. This also means that the government does not impose requirements for technological development or "technological" news value when adopting decisions on tax exemptions. Instead, all biofuels are granted tax exemptions on application, regardless of technology.

²²² Pricewaterhouse Coopers (2010), Appetite for change – Global business perspectives on tax and regulation for a low carbon economy.

In the monitoring of the tax exemption by the Swedish Energy Agency, the Agency has been unable to discern any development towards new technologies or technologies other than those that have already been known for a long time. The Agency also considers that biofuels for low-level blending probably have a smaller impact in terms of driving technology forward. Low-level blending is an effective way of quickly getting large volumes of biofuels on to the market, but it does not contribute to the development of new fuels. Above all, it favours existing technologies that are able to consolidate their unique position in the market. There is thus a risk that the tax exemption contributes to settling for technologies that are neither long-term nor able to serve as a bridge to long-term solutions.

The government continues to adopt decisions on tax exemptions in special cases – it is not clear what special cases this refers to

The Riksdag has now decided, in response to a proposal by the government, that from the start of 2011 the government will be empowered to adopt decisions on tax relief for biofuels in special cases without any need for such tax relief to relate to pilot projects. This change means that the legislation will now reflect how decisions on biofuels have been designed for several years. This is positive from the point of view of transparency. At the same time, it is not clear in which special cases the government can decide to grant tax relief for biofuels. Neither has the government released information on what will happen to the tax exemption after 2013, when Sweden's State aid approval expires.

9.3 The tax exemption for biofuels gives rise to a number of effects that are counter-productive to its aims

Tax exemptions for low-level blending can lead to higher gasoline and diesel consumption

The exemption is intended to level out production costs between different biofuels. When a tax exemption for biofuels for low-level blending in gasoline or diesel expires, it also affects the price and consumption of these fuels. However, the extent to which it affects the consumption of gasoline or diesel is an empirical question. Within the framework of the audit, the SNAO presents some simple numerical examples that show that the tax exemption helps lower prices for gasoline and diesel, all other things being equal, but that the impact on gasoline and diesel consumption will be relatively small. At current prices, taxes and low-level blending levels, the tax exemption may lead to an increase in gasoline consumption of around 0.5 to 2 per cent, depending on how price-sensitive consumption is assumed to be. The impact of the tax exemption on

diesel consumption will be smaller because diesel is less price-sensitive than gasoline.

However, even small changes in the consumption of gasoline or diesel lead to higher greenhouse gas emissions. The increase presented in the SNAO numerical examples is sufficiently large to counteract up to one quarter of the reduction in emissions brought about by total low-level blending of biofuels.

Taxpayers subsidise car owners – which is not compatible with the polluter pays principle

The tax exemption for biofuels is financed jointly by all taxpayers. That means that, in this case, the taxpayers subsidise the car owners. The tax exemption is therefore not compatible with the principle of polluter pays. This is especially true if the tax exemption means that the prices of gasoline and diesel are lower than they would otherwise have been.²²³

Ethanol-powered cars cause higher emissions when running on gasoline than gasoline cars

The number of ethanol-powered cars has risen quite sharply in recent years. Although the number of ethanol-powered cars has risen, it is not certain that the climate benefits have increased to the same extent, it simply depends on what fuel the cars are refuelled with and the cars' fuel consumption. As previously noted, low gasoline prices in recent years have led many ethanol-powered car owners to refuel with gasoline instead of E85. However, the average fuel consumption of new ethanol-powered cars is higher than that of gasoline cars. When ethanol-powered cars are run on gasoline, their emissions are therefore higher than those of gasoline cars running on gasoline. If the tax exemption for low-level blending also contributes to lower gasoline prices then this is a further counter-productive effect because the refuelling rate for E85 largely follows the price of gasoline.

The customs tariff means more expensive biofuels and reduced climate benefit

The EU does not allow the tax exemption to lead to a situation whereby biofuels are over-compensated relative to the fossil fuels they replace. This is a problem because it is difficult to differentiate the tax exemption granted to biofuels with different production costs.

²²³ The Polluters Pay Principle (PPP) means that preventive or remedial measures must always be paid for by those who cause or risk causing environmental disruption. 2 kap. 3 § miljöbalken (1998:808) [Chapter 2, section 3 of the Swedish Environmental Code (1998:808)].

To solve the problem of over-compensation, the government has introduced a customs tariff for ethanol used for low-level blending. The customs tariff means that an exemption will only be allowed for low-level blended ethanol if the ethanol has been imported at the highest possible customs rate. The customs tariff also means that ethanol produced with high production costs domestically or within the EU becomes more competitive relative to imported ethanol with low production costs. This therefore makes the use of ethanol for low-level blending more expensive than necessary. This increased cost is not matched by greater climate benefits. Instead, the customs tariff favours ethanol that brings about lower reductions in emissions at the expense of ethanol that may lead to larger reductions in emissions.

Calculations of over-compensation do not favour biofuels with lower production costs

The calculations of whether or not the tax exemption has resulted in over-compensation do not determine how the tax exemption is structured, for example whether or not the customs tariff should be retained. However, the principle used to calculate whether the tax exemption for biofuels leads to over-compensation does not favour imported ethanol with a lower production cost. The calculation principle itself therefore makes it more difficult to remove the customs tariff, which is something that the government has announced.

9.4 The government's monitoring of and reporting on the tax exemption has been defective and inadequate

The Riksdag has called for clearer presentation and analysis of the results of various measures in the climate area. The Riksdag has also stated that the government should investigate and report back with concrete proposals for policy instruments to create stable rules for production and development of biofuels, regardless of the position with regard to State finances.

The government has not presented any comprehensive strategy for how investment in biofuels should best be designed. However, the tax exemption for biofuels has been identified as the most important policy instrument for promoting the use of biofuels. Neither has the government monitored and commented on the full scope of the tax exemption and its effects in any fiscal bill in recent years. Neither has the government, either in bills or other documentation, described how decisions concerning tax exemptions have changed over time and what effects this has had, for example that some companies have been favoured at the expense of others.

However, the government previously presented the principles on which it intended to base decisions on tax exemptions. However, it is only in recent years that the government has obeyed those principles in its decisions on tax relief.

The customs tariff that the government has introduced to address the question of over-compensation entails additional support for domestically produced biofuels. For that reason it is of interest also to follow up the issue of over-compensation and the effects of the customs tariff in other contexts, besides reporting to the EU. The government has not presented any considerations regarding the effects of the customs tariff on domestic production weighed against access to cheaper imported, more climate-friendly ethanol.

9.5 The tax exemption is not structured so as to be sustainable in the long term

Difficult to produce new and more advanced biofuels

It will be difficult to meet the demand generated by increased use of biofuels with just Swedish production based on the technologies that are commercially viable today. It will therefore be necessary to import biofuels or develop new biofuels.

Over the years, there has been great confidence that investment in research will bring about development towards more advanced biofuels, particularly biofuels produced from cellulose or forest raw material. The government has invested nearly SEK 4 billion on subsidies for research into biofuels since 1975, though the amount has varied from year to year. However, it is difficult to obtain an overall picture of the results of these investments. The biofuels currently on the market are produced mainly using technologies that have been known for a long time.

EU sustainability criteria apply only to biofuels

EU sustainability criteria impose, among other things, requirements as to the extent to which a biofuel must reduce emissions compared to a fossil fuel in order to be eligible for support. Sustainability criteria also apply to imports of biofuels and therefore the way in which the criteria are implemented in third countries becomes an important aspect.

One problem with sustainability criteria is that they only apply to biofuels. Other agricultural products, for example, are not covered by equivalent conditions. There is therefore a risk that the sustainability criteria will lead to emissions moving to unregulated products, sectors and countries.

Sweden has the ability to promote further reductions in emissions

The requirements concerning reductions in emissions imposed by the EU in order for biofuels to be considered sustainable are gradually increasing, though they are relatively modest in relation to Swedish production and consumption. Thus, it is uncertain whether the requirements will contribute to the development of new biofuels or to making the tax exemption more cost-effective in relation to the climate objectives. However, it should, in the SNAO's view, be possible to promote further reductions in emissions nationally by differentiating the tax exemption according to the extent of the reductions in emissions brought about by different biofuels. This is particularly true if production costs are higher for the biofuel that generates lower emissions. At the same time, one-sided requirements for biofuels can lead to emissions moving to other products or sectors instead. In order for emissions to be reduced at as low a cost as possible, it is therefore important not to direct measures towards any specific type of production.

It is not likely that the tax exemption can be retained after 2020

If the use of biofuels increases, a continued tax exemption for biofuels will mean that the loss of tax revenues will continue to rise. This may make it less likely that the tax exemption can be maintained in the long term. The fact that the target of 10 per cent renewable energy in the transport sector by 2020 is binding also means that the tax exemption cannot be retained after 2020 under current EU rules. The tax exemption for biofuels in existence today is therefore not sustainable in the long term.

9.6 Recommendations

The SNAO has found no evidence that the tax exemption for biofuels contributes to the achievement of the Riksdag's climate objectives at a reasonable cost to society. Neither has the tax exemption stimulated the development of new and more advanced biofuels. If the tax exemption contributes to settling for technologies that are not viable in the long-term or that cannot serve as a bridge to long-term solutions, this also entails a financial risk for individual consumers who wish to make environmentally-aware choices. In view of this, it is questionable whether it is effective for the government to continue to grant full tax exemptions for biofuels – at any rate in the form in which the tax exemption has been managed, designed and monitored up to now.

In the 2011 Budget Bill, the government announced an extended tax exemption for low-level blending of biofuels from 1 January 2011. The Riksdag has also decided, in response to a proposal by the government, that the government

will be empowered to continue to grant tax relief for biofuels in special cases. In view of this, the SNAO puts forward the following recommendations to the government:

- In order to achieve greater transparency, the government should improve its reporting and monitoring of the tax exemption for biofuels. This is especially true in the light of the increased loss of tax revenues, the fact that the tax exemption must currently achieve several different goals and objectives and that a tax exemption for biofuels is a relatively expensive way of achieving the Riksdag's climate objectives.
- The government should report more clearly on how the tax exemption, in combination with the customs tariff, affects Swedish production, imports and use of biofuels and what effects it entails.
- It is important that decisions on tax exemptions should apply for longer periods and that they should not favour certain companies or biofuels over others. The government should clearly specify the circumstances in which tax relief can be granted to avoid a situation whereby different companies and biofuels are treated differently.
- Sweden's State aid for the tax exemption expires in 2013, though it is not likely that the tax exemption can be retained after 2020 for EU legal reasons. In order to give companies and consumers a reasonable chance to plan ahead, the government needs to make clear in the short term how the tax exemption is to be managed from now on. In the longer term, the government needs to analyse which measures best achieve the climate objectives.

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Appendix 1 SNAO questionnaire to green car owners

Population and sample

The population of this study consists of all ethanol and gas car owners. In order to take a sample from the population, a sampling frame is created, which delimits, identifies, and allows links to objects in the population. The sampling frame was created from the vehicle register and consists of all registered owners of an ethanol or gas car at 31 December 2009 aged 18 or over. A stratified simple random sample of 2,500 vehicle owners was extracted from the sampling frame. The stratification was carried out per fuel and region.²²⁴ A stratified simple random sample means that all objects within each stratum have an equal probability of being included in the sample.

Implementation of the survey

The survey was conducted by Statistics Sweden in September 2010. Statistics Sweden conducted the survey with the aid of postal and on-line questionnaires.

Analysis of results

A total of 1,759 people responded to the survey, which is 72.4 per cent of the sample. See Table 1.

²²⁴ The regional breakdown is based on the classification of municipalities carried out by *Sveriges Kommuner och Landsting* [the Swedish Association of Local Authorities and Regions] in 2001. This divides Sweden into 9 different groups of municipalities according to such measures as population, commuting patterns, structure of industry, etc. This study defines municipality groups 1–3 as “large municipalities”, whereas municipality groups 4–9 are defined as “medium-sized or small municipalities.”

Table 1. Response rate and non-response rate

Ethanol-powered cars	Population	Sample (of which over-coverage)	Respondents (number)	Respondents (proportion)	Non-response rate
Large municipality	63,714	660 (19)	461	71.92	28.08
Medium-sized or small municipality	36,164	655 (24)	448	71.00	29.00

Gas cars	Population	Sample (of which over-coverage)	Respondents (number)	Respondents (proportion)	Non-response rate
Large municipality	4,784	625 (13)	435	71.08	28.92
Medium-sized or small municipality	1,543	560 (13)	415	75.87	24.13
Total	106,205	2,500 (69)	1,759	72.36	27.64

Non-response can be said to consist of object non-response, which means that the questionnaire was not answered at all, and partial non-response, which means that some questions in the questionnaire were not answered. The non-response in Table 1 consists of object non-response.

Weights have been developed to enable the results to be extrapolated to population level. Extrapolating with weights means that the results can be presented for the whole population and not just for the respondents. The weights compensate for object non-response but not for partial non-response. Thus, each table may contain different numerical data.

The partial non-response rate in this survey ranges from 0.8 to 13.4 per cent. The questions with a higher partial non-response rate concern all questions concerning company cars or company car taxation.

Tables of results

Table 2. Proportion of vehicle owners who have an ethanol or gas car privately or as a company car

Ethanol-powered car	Private	Company car	Uncertain
Large municipality	98%	1%	1%
Medium-sized or small municipality	98%	2%	0%

Gas cars	Private	Company car	Uncertain
Large municipality	90%	9%	1%
Medium-sized or small municipality	96%	3%	0%

Number of responses: 1,661

Table 3. Reasons for choosing an ethanol or gas car (results per stratum)

Ethanol-powered car owners large municipality	Very important	Fairly important	Not important/not relevant	<i>Total number of responses</i>
Climate reasons	59%	36%	5%	438
Green car rebate/lower vehicle tax	31%	34%	36%	417
Lower taxation of benefits	7%	11%	82%	405
Expectation of higher fossil fuel prices	25%	35%	40%	413
Avoiding congestion charges	22%	14%	64%	418
Cheaper parking	20%	23%	57%	413
Good impression on others	8%	22%	70%	413
Employer's company car policy	2%	2%	96%	397

Cont.

Ethanol-powered car owners large municipality	Very important	Fairly important	Not important/ not relevant	<i>Total number of responses</i>
Climate reasons	49%	42%	10%	427
Green car rebate/lower vehicle tax	32%	35%	34%	401
Lower taxation of benefits	8%	12%	80%	384
Expectation of higher fossil fuel prices	26%	40%	34%	403
Avoiding congestion charges	6%	11%	83%	397
Cheaper parking	8%	13%	78%	398
Good impression on others	4%	24%	72%	399
Employer's company car policy	2%	2%	95%	378

Gas car owners large municipality	Very important	Fairly important	Not important/ not relevant	<i>Total number of responses</i>
Climate reasons	76%	20%	4%	428
Green car rebate/lower vehicle tax	18%	30%	52%	414
Lower taxation of benefits	13%	11%	76%	406
Expectation of higher fossil fuel prices	18%	38%	44%	411
Avoiding congestion charges	14%	15%	70%	415
Cheaper parking	21%	32%	46%	412
Expectation of lower running costs	51%	28%	22%	419
Good impression on others	20%	29%	51%	414
Employer's company car policy	11%	4%	85%	400

Cont.

Gas car owners medium-sized or small municipality	Very important	Fairly important	Not important/ not relevant	Total number of responses
Climate reasons	80%	18%	3%	404
Green car rebate/lower vehicle tax	18%	28%	54%	391
Lower taxation of benefits	9%	10%	81%	388
Expectation of higher fossil fuel prices	23%	41%	36%	390
Avoiding congestion charges	6%	11%	82%	390
Cheaper parking	9%	27%	64%	394
Expectation of lower running costs	48%	31%	21%	396
Good impression on others	14%	37%	49%	391
Employer's company car policy	4%	4%	92%	375

Table 4. Which fuel do you usually refuel your car with? Result per stratum

Ethanol-powered car owners	Always E85	Usually E85	Usually gasoline	Always gasoline
Large municipality	22%	47%	22%	9%
Medium-sized or small municipality	16%	46%	24%	14%

Gas car owner	Always vehicle gas	Usually vehicle gas	Usually gasoline	Always gasoline
Large municipality	59%	33%	5%	0%
Medium-sized or small municipality	53%	34%	10%	2%

Number of responses: 1,738

Table 5. Reasons for choosing to refuel with E85 or vehicle gas, not including price. (result per stratum)

Ethanol-powered car owners large municipalities	Very important	Fairly important	Not important/ not relevant	<i>Total number of responses</i>
Climate reasons	62%	32%	6%	447
How often you have to refuel	19%	38%	43%	432
Logical to refuel with E85 when you have an ethanol-powered car	49%	30%	20%	435
Time of year – refuel less with E85 in winter/at sub-zero temperatures	28%	32%	40%	433
Employer’s company car policy	1%	2%	97%	418
Distance to a fuel station that sells E85	11%	26%	63%	430

Ethanol-powered car owners medium-sized or small municipality	Very important	Fairly important	Not important/ not relevant	<i>Total number of responses</i>
Climate reasons	53%	39%	8%	422
How often you have to refuel	17%	38%	45%	399
Logical to refuel with E85 when you have an ethanol-powered car	44%	37%	19%	414
Time of year – refuel less with E85 in winter/at sub-zero temperatures	33%	30%	37%	413
Employer’s company car policy	2%	0%	98%	388
Distance to a fuel station that sells E85	21%	26%	54%	408

Cont.

Gas car owners large municipality	Very important	Fairly important	Not important/ not relevant	<i>Total number of responses</i>
Climate reasons	81%	17%	2%	426
How often you have to refuel	32%	37%	31%	419
Logical to refuel with vehicle gas when you have a gas car	78%	13%	9%	421
Recommendations from a car dealer or repair shop	3%	6%	91%	415
Employer's company car policy	8%	3%	89%	413
Distance to a fuel station that sells vehicle gas	42%	37%	20%	411

Gas car owners medium-sized or small municipality	Very important	Fairly important	Not important/ not relevant	<i>Total number of responses</i>
Climate reasons	82%	16%	2%	407
How often you have to refuel	31%	38%	31%	400
Logical to refuel with vehicle gas when you have a gas car	77%	10%	12%	401
Recommendations from a car dealer or repair shop	2%	4%	94%	399
Employer's company car policy	3%	2%	94%	395
Distance to a fuel station that sells vehicle gas	51%	33%	16%	396

Table 6. Have you received recommendations from a car manufacturer or a repair shop to refuel with gasoline occasionally? (Results only for ethanol-powered car owner owners)

Ethanol-powered car owners	Yes	No	Don't know
Large municipality	33%	61%	6%
Medium-sized or small municipality	29%	65%	6%

Number of responses: 894

Table 7. Have these recommendations influenced how often you refuel with E85? (Results only for ethanol-powered car owner owners)

Ethanol-powered car owners	No	Yes, I refuel with E85 less	Yes, I just refuel with gasoline	Don't know
Large municipality	61%	28%	9%	2%
Medium-sized or small municipality	67%	25%	5%	2%

Number of responses: 359

Table 8. How many kilometres is it between your home and the nearest fuel station with E85 or vehicle gas? Result per stratum

Ethanol-powered car owners	0-5	6-10	11-15	16-20	21-30	31-40	> 40
Large municipality	83%	10%	4%	1%	0%	0%	1%
Medium-sized or small municipality	62%	16%	13%	8%	5%	3%	1%

Gas car owner	0-5	6-10	11-15	16-20	21-30	31-40	> 40
Large municipality	51%	24%	9%	7%	7%	1%	1%
Medium-sized or small municipality	29%	14%	11%	9%	13%	11%	11%

Number of responses: 1,609

Table 9. Have any of the following made you decide not to refuel with vehicle gas? (results only for gas car owner)

Gas car owners large municipality	No	To some extent	To a great extent	Don't know	<i>Total number of responses</i>
Lack of fuel stations that sell vehicle gas	16%	33%	50%	1%	429
Fuel station run out of vehicle gas	39%	28%	32%	1%	425
Malfunctioning or broken pumps	39%	35%	26%	0%	422

Gas car owners medium-sized or small municipality	No	To some extent	To a great extent	Don't know	<i>Total number of responses</i>
Lack of fuel stations that sell vehicle gas	13%	37%	49%	0%	411
Fuel station run out of vehicle gas	45%	36%	18%	1%	404
Malfunctioning or broken pumps	48%	35%	16%	1%	405

Table 10. What do you think of the prices of E85 and vehicle gas? Result per stratum

Ethanol-powered car owners	Much too high	Slightly too high	Fine	Slightly too low	Much too low	Not important at all
Large municipality	40%	44%	13%	0%	0%	3%
Medium-sized or small municipality	40%	44%	10%	0%	0%	6%

Gas car owners	Much too high	Slightly too high	Fine	Slightly too low	Much too low	Not important at all
Large municipality	32%	49%	16%	0%	0%	2%
Medium-sized or small municipality	29%	48%	21%	0%	0%	3%

Total number of responses 1,732

Table 11. How important is the price difference between E85 and gasoline and vehicle gas and gasoline for your choice of fuel? Result per stratum

Ethanol-powered car owners	Not important at all	Not very important	Fairly important	Very important	Don't know
Large municipality	14%	11%	33%	42%	1%
Medium-sized or small municipality	13%	9%	29%	46%	3%

Gas car owners	Not important at all	Not very important	Fairly important	Very important	Don't know
Large municipality	13%	19%	31%	37%	0%
Medium-sized or small municipality	12%	16%	31%	39%	1%

Total number of responses 1,736

Table 12. At what price difference between E85 and gasoline do you choose to refuel with gasoline? (results only for ethanol-powered car owners). In the past year a litre of gasoline has on average cost 30% more than a litre of E85. However, gasoline has a higher energy content. When the price difference between gasoline and E85 falls, many people choose to refuel with gasoline instead of E85

Ethanol-powered car owners	< 20%	21–40%	41–60%	> 60%	Don't know
Large municipality	29%	30%	9%	1%	30%
Medium-sized or small municipality	27%	36%	7%	1%	29%

Number of responses: 782

Table 13. The prices of vehicle gas vary from one part of Sweden to another. How does the difference in price between vehicle gas and gasoline affect your choice of fuel? (results only for gas car owners) *In the question, one Nm³ of vehicle gas is compared with one litre of gasoline*

Gas car owners	Refuel with vehicle gas				Refuel with gasoline	Don't know
	Regardless of the price of gasoline	gasoline more expensive	Cost the same	Gasoline cheaper		
Large municipality	69%	21%	6%	1%	1%	2%
Medium-sized or small municipality	67%	22%	6%	0%	2%	3%

Number of responses: 840

Table 14. The media have recently reported on running and engine problems with ethanol-powered cars that run on E85. Have you had any of those problems with your ethanol-powered car? (results only for ethanol-powered car owners)

Ethanol-powered car owners	Yes	No	Don't know
Large municipality	16%	78%	5%
Medium-sized or small municipality	13%	81%	6%

Number of responses: 890

Table 15. Have these problems meant that you have used your ethanol-powered car less than if the problems had not occurred? (results only for ethanol-powered car owners)

Ethanol-powered car owners	No	Yes, less or slightly less	Yes, a lot less	Don't know
Large municipality	68%	17%	5%	10%
Medium-sized or small municipality	63%	12%	7%	18%

Number of responses: 226

Table 16. Have these problems affected how much you refuel with E85? (results only for ethanol-powered car owners)

Ethanol-powered car owners	No	Yes, I refuel with E85 less	Yes, a larger proportion of E85	Don't know
Large municipality	24%	64%	3%	9%
Medium-sized or small municipality	36%	47%	2%	15%

Number of responses: 229

Table 17. If you changed car today, what kind of car would you choose? More than one answer may be given. Result per stratum

	Ethanol-powered car owners		Gas car owners	
	Large municipality	Medium-sized or small municipality	Large municipality	Medium-sized or small municipality
Ethanol-powered car	24%	30%	2%	2%
Gas car	8%	6%	48%	55%
Diesel car	27%	28%	21%	19%
Gasoline car	7%	7%	4%	3%
Electric car/electric hybrid	16%	13%	18%	15%
Other	3%	2%	4%	4%
Don't know	15%	14%	3%	2%
Total number of responses	720	642	647	599

One open question was included in the questionnaire, but is not reported in this table appendix:

If you have anything further that you wish to add, you are welcome to write it here.

Appendix 2 Reductions in emissions from Swedish use of biofuels from a life-cycle perspective

The table below shows a summary of the extent of the reductions in emissions that biofuels may be assumed to bring about from a life-cycle perspective. The calculation of reductions in emissions is based on the supporting data and emissions values used in the Swedish Environmental Protection Agency and Swedish National Transport Administration index of new cars' impact on the climate from 2007 to 2009.²²⁵

²²⁵ Naturvårdsverket (2008), *Index över nya bilars klimatpåverkan 2007 i riket, länen och kommunerna* [The Swedish Environmental Protection Agency (2008), *The index of new vehicles' impact on the climate in 2007, nationally, in the counties and in the municipalities*], Naturvårdsverket (2008), *Index över nya bilars klimatpåverkan 2008 i riket, länen och kommunerna* [the Swedish Environmental Protection Agency (2008), *The index of new vehicles' impact on the climate in 2008 nationally, in the counties and in the municipalities*] and Trafikverket (2009), *Index över nya bilars klimatpåverkan 2009 i riket, länen och kommunerna* [the Swedish National Transport Administration (2009), *The index of new vehicles' impact on the climate in 2009, nationally, in the counties and in the municipalities*].

Table 1. Average reductions in emissions from ethanol for E85 and low-level blending and biodiesel, 2007–2009

Ethanol for E85	2007		2008		2009	
	Percent- age of total	Emis- sions kg per litre	Percent- age of total	Emis- sions kg per litre	Percent- age of total	Emis- sions kg per litre
Swedish (sulfite)	10%	0.2	5%	0.2	–	–
European	–	–	–	–	12%	0.83
Brazilian	90%	0.2	95%	0.2	88%	0.51
Average		0.2		0.2		0.55
Reduction com- pared to gasoline		89%		89%		69%

Ethanol for low-level blending	2007		2008		2009	
	Percent- age of total	Emis- sions kg per litre	Percent- age of total	Emis- sions kg per litre	Percent- age of total	Emis- sions kg per litre
Swedish (wheat)	20%	0.5	20%	0.5	58 %	0.55
European	25%	1.24	25%	1.24	42 %	0.83
Brazilian	55%	0.2	55%	0.2	–	–
Average		0.52		0.52		0.67
Reduction com- pared to gasoline		71%		71%		63%

Biodiesel	2007		2008		2009	
	Percent- age of total	Emis- sions kg per litre	Percent- age of total	Emis- sions kg per litre	Percent- age of total	Emis- sions kg per litre
Average		1.52		1.52		1.52
Reduction com- pared to diesel		47%		47%		47%

Source: The SNAO's compilation based on data from the Swedish Environmental Protection Agency and the Swedish National Transport Administration.

For more information about the Swedish National Audit Office, please return to our website: www.riksrevisionen.se

Riksrevisionen [The Swedish National Audit Office] has audited the tax exemption for biofuels. The aim of the audit was to examine to what extent and at what cost the tax exemption for biofuels helps achieve the Riksdag's climate objectives.

The audit shows that the tax exemption is an expensive and blunt way of reducing greenhouse gas emissions. The government's decisions on tax exemptions have been short-term and unpredictable and have not brought about the conditions for the intended technological development. Neither has the government monitored and commented on the overall scope or effects of the tax exemption. The fact that the tax exemption is intended to achieve several objectives contributes to a lack of transparency.

The Swedish National Audit Office recommends that the government improve its reporting and monitoring of the tax exemption. In order to give companies and consumers a reasonable chance to plan ahead, the government needs to clarify how the tax exemption is to be managed in future. In the longer term, an analysis of which resources are most suitable for achieving the climate objectives is needed.

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