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ENVIRONMENTALLY SUSTAINABLE TRANSPORT (EST)
PHASE 3: POLICY INSTRUMENTS FOR ACHIEVING EST

Volume 2
Case Study: provided by Sweden

This document is part of the report on Phase 3 of the four-phase project on Environmentally Sustainable Transport (EST) [ENV/EPOC/PPC/T(99)6/FINAL]. The report on Phase 3 comes in two volumes: i) the synthesis report of the case studies with the different policy packages, and ii) as an annex volume, the compilation of the seven studies prepared by the participating countries. Phase 3 concerned the identification of policy instruments and measures for achieving EST. It is based on individual case studies carried out by ten countries.

Mr Peter Wiederkehr, ENV/NP: Tel. +33-1 45 24 78 92; Fax: +33-1 45 24 78 76;
Email: Peter.Wiederkehr@oecd.org

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FOREWORD

This document is part of the report on Phase 3 of the four-phase project on Environmentally Sustainable Transport (EST) [ENV/EPOC/PPC/T(99)6/FINAL]. The report on Phase 3 comes in two volumes: i) the synthesis report of the case studies with the different policy packages, and ii) as an annex volume, the compilation of the seven studies prepared by the participating countries. Phase 3 concerned the identification of policy instruments and measures for achieving EST. It is based on individual case studies carried out by ten countries. These studies form the annex to the report on Phase 3 of the EST project, and are as follows:

ANNEX 1: **Alpine Region** - *EST Synthesis report* (Austria, France, Italy and Switzerland) [ENV/EPOC/PPC/T(99)6/FINAL/ANN1]

ANNEX 2: **Canada** - *Environmentally Sustainable Transportation Study - Québec Windsor Corridor* [ENV/EPOC/PPC/T(99)6/FINAL/ANN2]

ANNEX 3: **Germany** - *Environmentally Sustainable Transportation Study* [ENV/EPOC/PPC/T(99)6/FINAL/ANN3]

ANNEX 4: **Japan** - *A Meso-Scale Estimation of Future CO_2 Emissions in Transport* [ENV/EPOC/PPC/T(99)6/FINAL/ANN4]

ANNEX 5: **The Netherlands** - *Environmentally Sustainable Transportation: Implementation and Impacts for the Netherlands for 2030* [ENV/EPOC/PPC/T(99)6/FINAL/ANN5]

ANNEX 6: **Norway** - *Environmentally Sustainable Transport - Case Study: The Greater Oslo area* [ENV/EPOC/PPC/T(99)6/FINAL/ANN6]

ANNEX 7: **Sweden** - *An Environmentally Sustainable Transport System in Sweden* [ENV/EPOC/PPC/T(99)6/FINAL/ANN7]

The overall purposes of the OECD EST project are to characterise EST and to establish guidelines for the development of policies that would result in the achievement of EST. The basic techniques used are scenario construction and backcasting.

- **Phase 1**, of the EST project—completed in 1996—involved a review of relevant activities of Member countries as well as the development of the definition of and criteria for EST.

- **Phase 2**, carried out in 1997 and 1998, has been the scenario-development phase. It has mainly comprised construction by participating Member countries of a business-as-usual (BAU) scenario and three scenarios for 2030 consistent with the EST criteria. It has also involved some preliminary consideration of the backcasting and other analyses to be undertaken during Phase 3.

- **Phase 3**, carried out in 1999 comprised the core of the backcasting exercise. It mostly consisted of the identification of packages of policy instruments and measures whose implementation would result in achieving the EST3 scenarios constructed during Phase 2. Phase 3 involved also refinement of the EST3 scenario and assessment of the social and economic implications of the BAU and EST3 scenarios.

- **Phase 4**, conducted during 2000 comprised refinement of the definition and the criteria for achieving EST and the development of guidelines for policies for moving towards EST.

The work has been carried out by six teams of experts from nine countries, each with a separate geographical focus to describe how this environmentally desirable objective may be achieved. The six case studies include Sweden, the Netherlands, Germany, the Quebec-Windsor corridor in Canada, the Greater Oslo region and the Alpine region comprising parts of Austria, France, Italy and Switzerland. Related studies have been undertaken by Japan and for the Central and Eastern European region within the context of the Central European Initiative of Environment Ministers (CEI). The case study on EST for Japan is also included in the Annex, while the EST study for the CEI has been published separately.

The reports and expert papers of all Phases of the project are also available on OECD's Internet site (http://www.OECD.org/env/ccst/est).

PART ONE

KFB

An Environmentally Sustainable Transport System in Sweden

A scenario study

Peter Brokking, Lars Emmelin, Mats-G Engström, Jan-Evert Nilsson,
Gunnar Eriksson, Olle Wikberg

KFB-Rapport 1997:3

ABSTRACT

This is a short version of a scenario study concerning the possibilities to reach an Environmentally Sustainable Transport system in Sweden in a perspective of 30 years. The aim of the scenario study has been to describe one of several possible paths from today's transport system to an environmentally adopted one. However, this does not imply that the task is to predict how such a transformation can be accomplished. The aim is rather to illustrate what such transformation. Require in the form of political decisions. The transformation of the transport system in to an environmentally adopted one, is primarily treated as a political problem, and a political perspective has accordingly been chosen for the study.

In this English version of the scenario, the carbon dioxide problem is used to illuminate the many conflicts in goals and other problem that will attend an environmental adoption of the Swedish transport system, and to highlight the analytical points of departure for the scenario study.

The analysis shows that it is possible to reach the national environmental goals that characterize, with given definitions, an environmentally sustainable transport system. However, this implies many severe political decisions over a long period of time, which in turn implies a long-term national consensus about the importance to reach the overall goal. Other results the scenario points out, is the risk that a policy focused on one sector leads to "solving" a problem by moving it outside systems limitations, and the limitations on a national environmental policy. Being able to count on assistance from other countries through an environmental adoption of the transport system in the European Union or globally, would drastically facilitate the environmental adoption of the Swedish transport system, through, among other things, a more rapid technological development. This indicates the necessity of promoting issues involving transportation and the environment in international forums.

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PREFACE

Within a larger cooperative project between Swedish authorities and the Swedish automotive and petroleum industries regarding long-term strategies for an Environmentally Sustainable Transport system (the EST-project), Nordplan, the Nordic School of Planning, was assigned to implement a scenario study. The scenario study was carried out by a research team consisting of professor Lars Emmelin, professor Mats-G Engstr6m, professor Jan-Evert Nilsson (project-leaders) and M Techn Peter Brokking, Lic Techn Gunnar Eriksson and B Sc Olle Wikberg. The scenario, which was published in Swedish in August 1996, consists of about 360 pages in two volumes.

The work with the scenario has been followed by a reference group of representatives from the interested parties involved in the EST-cooperation. This version, which was funded by the Swedish Environmental Protection Agency and the Swedish Transport and Communication Research Board, has not been discussed by the interested parties.

Stockholm in January 1997.

AN ENVIRONMENTALLY SUSTAINABLE TRANSPORT SYSTEM IN SWEDEN

1. Introduction

The purpose of the study has been to use the scenario format to describe one of several possible paths from today's transport system to an environmentally sustainable one. However, presenting this description as a scenario does not imply that the task is to predict how such a transformation of the transport system can be accomplished. The aim is rather to provide an illustration of what such a transformation can be expected to require in the form of political decision that making.

In this short version the purpose is to highlight the analytical points of departure for the scenario study, and to point out the conflicts in goals and other problems that attend an environmental adaptation of the transport system. This is done by exemplifying how the carbon dioxide problem has been handled within the framework of the scenario study. The description of the goals for an environmentally sustainable transport system presented in section 3, and the account in Appendix 1 of the policy instruments introduced in the scenario, provide an indication of what environmental problems other than carbon dioxide characterize the Swedish transport system and how these problems are treated in the scenario.

2. Conditions and assumptions

2.1 Possible perspectives

The scenario is intended to give a concrete description of the demands that must be fulfilled in order to bring about an environmentally sustainable transport system. How this description is shaped, is determined by the perspective established.

One possibility is to regard the transformation of the transport system from a *technical perspective.* That is probably the perspective most frequently encountered when the task is to prefigure future developments in the transport field. Such a scenario would provide answers concerning the technical solutions that can contribute to achieving an environmentally sustainable transport system. A scenario based on a technical perspective normally also includes a socioeconomic estimate of costs.

Another possibility is to establish an *idealistic perspective.* In this case, interest is focused on the changes in the population's values and behaviour required to realize the desired transport system. From such a perspective, the scenari o will revolve around questions concerning how people's lives will be affected along the way to the environmentally sustainable society.

A third possibility is to adapt a *political perspective.* The focus is on what types of political decisions are required and can be expected to win legitimacy, thereby contributing to the transformation of the transport system. Such a perspective calls attention to the goal conflicts that arise in connection with such a transformation.

The choice of perspective is determined by how the problem is regarded, among other things. Is the transformation primarily viewed as a technical problem, 'a problem of values and behaviour or as a political problem? The environmental adaptation of the transport system embraces all of these problems. However, a consistent analysis presumes a certain amount of simplification.

The task here has been to indicate one possible path from today's transport system to a future situation *that fulfils certain nationally established environmental goals.* Hence the study's point of departure is that societal development can be steered in a desirable direction. Implicitly, this involves a belief in the possibility of influencing societal development in the desired manner through political decisions. The point of departure presumes the establishment of a political perspective in which attention is directed to conceivable measures for achieving the goal aimed at, as well as to the goal conflicts that arise in conjunction with these measures.

In the present study, the transformation of today's transport system into an environmentally sustainable one is treated primarily as a political problem, and a political perspective has accordingly been chosen.

2.2 Two systems limitations

The subject of this study - the Swedish transport system - must be delimited both geographically and functionally.

The geographical demarcation is determined by the perspective chosen. The transport system studied is located on Swedish territory, an area that falls under Swedish jurisdiction. Decisions made by Swedish political bodies have an extent that mainly corresponds to Sweden's territory. In theory, at least, it is possible for Swedish authorities to determine the requirements that must be met by the transport system within that territory, and perhaps the way in which that is to be done.

The assumption for the scenario is that environmental adaptation of the Swedish transport system will be carried out regardless of what happens in other countries. Hence we are dealing with a scenario for the environmental adaptation of the transport system in a country of just under 9 million inhabitants, which contributes to magnifying certain conflicts in goals. A similar environmental adaptation of the transport sector in the EU or among the world's industrial countries would appreciably facilitate the corresponding adaptation in Sweden.

There is a lack of self-evident analytical criteria for setting the functional systems boundaries. The choice is therefore pragmatic. In this study, all production of transportation has been included in the transport sector. This delimitation means that the manufacture of vehicles, propellants, spare parts, etc. has been omitted.

The risk attending distinct systems boundaries is that problems may be exported. Improvements in the transport sector may be counterbalanced by deterioration in other sectors of society. This is dealt with in the scenario by commenting on such effects.

2.3 Three constants

Three factors are presumed to be constant during the periods of time studied and deserve special comment.

First, it is assumed that the characteristics of human beings and the motivations for their actions will remain constant. Self-interest is expected to play a determining role in the way people act, and material conditions are assumed to exercise great influence on their decisions. This supposition implies that

environmental adaptation will not be facilitated by people spontaneously changing their behaviour on the basis of increasing awareness of environmental problems.

Second, it is assumed that Sweden will maintain its present parliamentary political system, a system in which governing power is held by the party or parties that have the support of a majority in Parliament. The strength of the various parties in Parliament is determined in general elections. This system results in limiting freedom of political action to what is politically legitimate. The questions of what instruments can be used and what measures can be taken are thus not determined necessarily on the basis of how effective they are for achieving the goal, but rather by what legitimacy they have. Political legitimacy, in turn, is influenced by what goal conflicts arise from a given decision.

Third, it is assumed that Sweden will remain a member of the European Union, which implies that the freedom of national political action is delimited in the ways defined by the Rome and Maastrich treaties.

2.4 Three phases in a change over to an environmentally sustainable transport system

A successful transition to an environmentally sustainable transport system presumes a gradual upgrading of the ambition to make the society as a whole sustainable. If environmental sustainability does not achieve the status of a prime national political goal, the prerequisites for realizing a transport system that fulfils the requirements of the given goal will be lacking. This study assumes such an upgrading of environmental concern.

The scenario presumes that the transformation of the transport system can be described as a process characterized by three phases.

The acceptance phase, which is assumed to continue until 2005, is characterized by consideration of the environment being accepted as a restriction in connection with the design of transport policy. Hence during this phase, environmental considerations do not have such a status that they are superior to other considerations, which in turn establishes a restriction on the types of instruments that can be used. In order to achieve the requisite political legitimacy, it is assumed that environmental efforts must often be legitimized with argument; from other policy areas.

The adjustment phase comprises the time period 2006-2015. It is distinguished by the upgrading of environmental objectives. In this phase, environmental policy is given such priority that the environment becomes superior to other political goals within certain areas, such as traffic, energy, agricultural and regional policies.

The implementation phase, comprising the period 2016-2026, is characterized by environmental consideration acquiring such priority that it achieves precedence over other political goals. During this phase, environmental sustainability is developed into an idea embraced by all political parties and affecting all political fields. Political disagreement is no longer about the goal, but rather about the means that can be employed to realize environmental sustainability.

A parallel can be drawn between the upgrading of the environmental priority envisaged here and the developments within the European community over the past few decades. National protectionism has gradually transformed into something suggesting unbounded free trade. Today free trade has high priority and can be viewed as providing the dimensions for other political objectives, for example regarding environmental policy.

3. Organization of the study

The scenario study can roughly be said to be divided into 5 blocks.

1. An operationalization of the given goals for an environmentally sustainable transport system.

2. A description of today's Swedish transport system in the terms with which the goal is stated.

3. An identification of the need for action to close the gap between the goals established for the transport system and that system's development by 2026.

4. The development of qualitative systems models to be used for identifying instruments that can contribute to closing the ascertained gap between the transport system's independent development and the goals established for it.

5. Scenario narrative. A discourse on developments over time from today's transport system towards an environmentally sustainable transport system.

All of these blocks except the fourth one will be treated to some extent in this short version. As mentioned previously, this will be done by focusing on the problem of carbon dioxide. Appendix 1 contains an account of all of the instruments introduced in the scenario. This account can be viewed as a summary of what goes on in the various phases. Appendix 2 contains an account of how gasoline prices and operating costs for passenger cars evolve according to the scenario.

3.1 Goal description

In cooperation with the principals, the content of the concept "an environmentally sustainable transport system" has been operationalized into four types of goals - for emission, for ambient air quality and noise, for conservation of nature and cultural heritage and for responsible management of natural resources. These four goals of the scenario study are summarized in Table 1.

The goals for the transport sector are derived from the environmental goals for society as a whole. This means that the reductions applicable to society as a whole also apply to the transport sector.

Table 1. Goals for the Swedish transport sector

Goals for emissions
By 2026 the emission of carbon dioxide by the transport sector should amount to 70% of the 1990 emission level. By 2026 the transport sector's emission of other greenhouse gases affecting the climate will amount to 60-80% of the 1990 emission level. By 2026 the transport sector's emission of sulphur should amount to 10% of the 1980 emission level. By 2026 the transport sector's emission of nitrogen oxides should amount to 20% of the 1980 emission level. By 2026 the transport sector's emission of volatile organic compounds (VOC) should amount to 15% of the 1988 emission level. The transport sector's emission of carcinogenous substances in urban areas (polycyclic aromated hydrocarbons in vapor and particle phases, benzopyrene, formaldehyde, acetaidehyde, propylene and butadiene) should be reduced by 50% by 2005. The transport sector's emission of lead, mercury and cadmium should cease in the long run.
Ambient air quality and noise
The Swedish Environmental Protection Agency's prescribed values for air quality in urban areas may not be exceeded during the period 2000-2026. (This applies to carbon monoxide, nitrogen dioxide, sulphur dioxide, soot and particles). By 2026, noise levels must be lower than the long-term standards laid down by the Environmental Protection Agency.
Conservation of nature and cultural heritage
By 2026, the transport sector must be adapted to the goals established for biological diversity and for cultural and natural environments. As regards natural environments, the emphasis is on areas important for recreational facilities in the vicinity of urban areas.
Responsible management of natural resources
By 2026 the transport sector will be adapted to long4erm economizing with natural resources in its use of materials, and generally conform to the technical system's circularity principle for energy and materials. One specified goal is to achieve virtually complete recycling of vehicles by 2026.

3.2 Today's transport system and its carbon dioxide emissions

Estimates of the carbon dioxide emissions from various modes of transport in Sweden in 1995 are presented in Table 2. Road traffic accounts for ca. 80% of the carbon dioxide emissions from the Swedish transport sector. The emissions from ships and planes are also significant, whereas those from trains are marginal. In the main, the Swedish railways are electrified, and ca. 95% of the country's electricity is generated by "emission free" hydro and nuclear power.

Table 2

Emissions of carbon dioxide by the Swedish transport sector in 1995 (in thousands of tons)

	Carbon dioxide
Road traffic	17 200
Ships	2 700
Planes	1 700
Trains	10
Total	21 600

3.3 Instruments required to reach the carbon dioxide goal

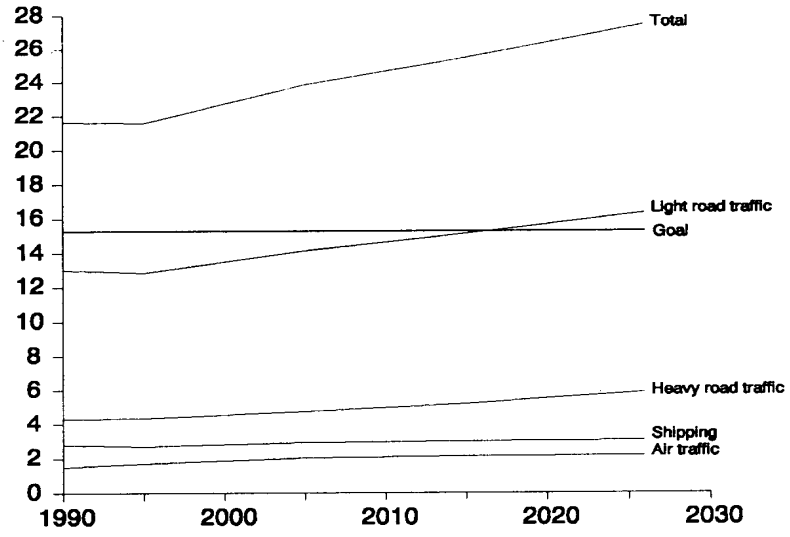
Identifying the policy instruments necessary to bring carbon dioxide emissions down to the level prescribed by the goal description requires a feasible representation of the Swedish transport system's independent development up to 2026. To achieve this, we have employed one of the master scenarios, the so-called basic package, provided by the principals.

The basic package assumes an increase in traffic on the level of the past three decades. It is similarly assumed that there will be improvements in the energy efficiency of cars, planes, trains and ships. No such improvements are anticipated for heavy road traffic, however. The basic package also contains a number of other improvements, e.g. vehicle requirements equivalent to EU 2000 for light vehicles and EURO III for heavy vehicles. It is similarly assumed that minor improvements in the emission characteristics of planes and ships will occur spontaneously. The basic package also includes a number of infrastructure investments, e.g. in the form of noise protection along the national highway network.

The basic package can be regarded as conservative with regard to the potential of technical developments in the future. Improvements in energy efficiency are expected to be counterbalanced by increases in performance. But inasmuch as the purpose of the scenario study is to identify conflicting goals and other problems associated with environmental adaptation of the transport system, a conservative master scenario seems to be a good point of departure.

The basic package indicates the emission of carbon dioxide over time up to 2026, allowing for a certain technical development and assuming that no further political measures are taken to reduce that emission; see Figure 1.

Figure 1. Development of carbon dioxide emissions from 1990 to 2026 according to the basic package, related to current goal in millions of tons



According to the basic package, *carbon dioxide emission* increases for all modes of transport. The relative changes are basically the same for all subsectors. The increase in traffic is consistently greater than the reductions of the specific energy consumption. The established goal appears to be remote. In 2026, the

transport sector's emission of carbon dioxide exceeds the goal by more than 80%. Light road traffic is the dominant reason, while heavy road traffic, shipping and air traffic account for lesser contributions.

4. Scenario narrative

The scenario takes the form of an historical narrative written from the perspective of the final year of the study, 2026. It describes one feasible future development as though it were an historical fact.

Work on the scenario has shown that the subgoals that cause the greatest goal conflicts, and that are consequently among the most difficult to realize, are those for carbon dioxide emission and noise.

In this short version of the scenario, carbon dioxide is used as an example to present the analytical points of departure of the scenario study and to

indicate which goal conflicts can arise during an environmental adaptation of the transport sector - and how they may possibly be dealt with.

4.1 On choosing policy instruments

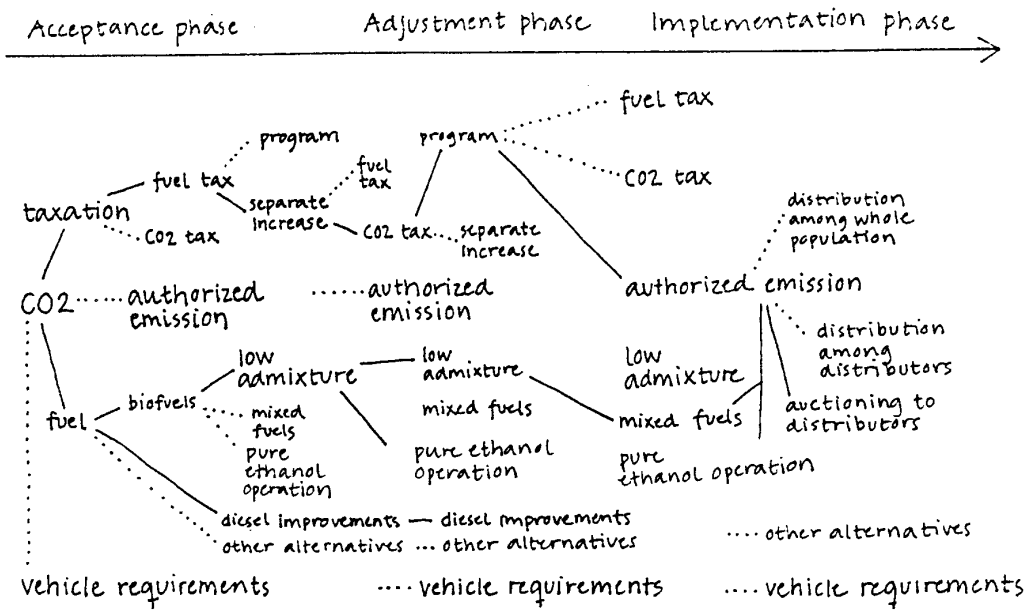
The emission of carbon dioxide is determined by the amount of fossil fuels combusted.

The first stage in managing the carbon dioxide problem has been to use a qualitative systems model to identify the factors that influence the transport sector's use of fossil fuels.

Then, on the basis of this analysis, a number of policy instruments have been formulated which, considering the political perspective and the stated conditions, have been deemed able to win political legitimacy during the scenario period. Figure 2 summarizes the scenario in terms of the instruments introduced during the acceptance phase, the adjustment phase and the implementation phase to reach the carbon dioxide goal. The solid lines in the figure indicate the "paths" that have been chosen, while the dashed lines show alternative paths that have been considered but which, for various reasons, have been rejected.

Implementability and political legitimacy have determined the choice on the basis of a number of technically conceivable alternatives. Thus it is not self-evident that the most attractive alternatives in a technical or economic sense are those that have been chosen at all times.

Figure 2. Strategic choice of policy instruments on the path to a solution of the carbon dioxide problem in the transport sector



4.2 The Acceptance Phase, 1996-2005

The outstanding characteristic of the acceptance phase is the need for "helpful arguments" and compensatory measures to ascribe political legitimacy to the instruments implemented to achieve the goal for carbon dioxide emissions.

Relatively early in the acceptance phase, the fuel tax is raised by $0.30 including VAT, see Figure 2 above.[1]) Among other things, this decision is expected to demonstrate a certain legitimacy through reference to its favourable environmental impact. The effects on carbon dioxide emission, however, are not a sufficiently adequate reason for being able to push through this tax rise, even though it can be argued that already in the acceptance phase, environmental awareness in Sweden is comparatively great. The carbon dioxide problem is a global problem which Sweden can only marginally affect. Many Swedes question whether Sweden alone should adopt measures for reducing carbon dioxide emission as long as other countries indicate no sign of doing so.

Despite a significant revival of the Swedish economy during the mid-1990s, there is still a great need to strengthen the nation's finances. The upswing that has occurred has had its price. During the first half of the 90s, there have been major retrenchments in the Swedish welfare system. Swedes have paid a high price to reduce the deficit in the government's finances. Not least in the strong Swedish labour movement, there is a strong opinion propagating for a restoration of the compensation levels in unemployment, sickness and parental insurances.

Historically, fuels have been heavily taxed in Sweden. In 1995, the state's income from fuel taxes was ca. $4.5 thousand million, which is the equivalent of ca. 10% of total state revenues. This is in line with an international pattern in which countries who have no petroleum industry put high taxes on petroleum

[1] 1 US $ = 6,6 SEK.

products. Fuel taxes have long been an accepted source of income for the Swedish government. Tax increases during this acceptance phase thus follow a traditional pattern, and gain additional legitimacy through their positive effect on national finances.

The ongoing budget rationalizations and the strong opinion against additional social welfare cutbacks can in this respect - aside from the potential for carbon dioxide reductions - be seen as a “helpful argument” for tax increases.

The reason that it is fuel taxes and not taxes on carbon dioxide that are increased can be explained thus: the foremost argument for tax increases in Swedish political rhetoric is not the carbon dioxide problem but the opportunity to improve the nation's finances.

One alternative to a large one-off increase might have been to raise taxes, for example over a 5-year period, by $0.06 per year. Such a procedure has been tried in other countries and was also proposed in a national study of Swedish climate policy in the mid-90s. The advantage of such an approach is that it makes it easier for people to gradually adjust themselves to a higher price for fuel. However, a programme for tax increases means that the politicians are under constant pressure, and there is an obvious risk that the programme will be weakened or completely stopped.

The Swedish business sector maintains that taxes weaken its ability to compete. Special prominence is given to what usually goes under the appellation “the Swedish distance handicap”. The great geographical distances within the country and to the main continental markets are described as a handicap for Swedish industry. Representatives of the Swedish automotive industry are among the most critical voices. They call attention not only to the distance handicap, however, but also to the government's consideration of the atmosphere which, they say, exacts a price in more traffic injuries and fatalities. Their reasoning is that since people can be expected to adapt to the new gasoline price levels by acquiring smaller and more fuel-efficient vehicles. The Swedish auto makers Volvo and Saab are by tradition oriented toward manufacturing larger cars with improved safety. Increases in the price of gasoline steer demand in the direction of other makes of cars that offer lower fuel consumption, but also inferior safety.

Residents of rural districts are another segment of Swedish society that strongly criticizes the proposed tax rises. They maintain that the great geographical distances in rural areas and the lack of local services and functional public transportation make them much more dependent on private cars than people living in the country's more densely populated areas. There is also sympathy for the viewpoints expressed by rural dwellers within the parties aligned behind tax increases.

The government's reading of the situation leads it to the conclusion that the decision to raise fuel taxes must be given a social profile, and that the business sector must receive some kind of compensation.

Therefore, residents of EU Goal 6 areas, i.e. people living in the highest priority areas designated by the EU for regional development policy assistance in Sweden, are compensated through improved opportunities for deductions for business travel. The vehicle tax is abolished entirely. This favours both car owners and the auto industry. The government also decides on a time-limited scrapping programme to get rid of a large number of the cars without catalytic converters still on the road. For one year following the introduction of the tax rise, a premium of $1,500 will be paid to those who turn in cars without catalytic converter to the junkyard. Since catalytic converters became mandatory for models produced in 1989 and after, this means that the cars for which the scrapping incentive is intended are well over 10 years old. The scrapping programme is motivated by its modernizing effect on the vehicular population of Sweden, but should also be seen as a measure for conciliating the Swedish auto industry. Industrial estimates suggest a significant increase in the demand for new cars as a result of the programme.

The business sector's criticism of the tax increase is somewhat unfair, since the way it is constructed includes certain elements of subsidy to the business sector. The tax is based on litres of fuel, despite the

fact that diesel oil creates 11 % more carbon dioxide emission than gasoline. This provides an advantage for business as compared to the private citizen. Furthermore, the VAT of 25% is included in the tax rise; businesses can deduct this, whereas it must be paid in full by private persons.

Initially, the new fuel tax lowers the demand for fuel, but after a while this proves to have been only a brief dent in the demand curve. A temporary weakening of demand turns out to be followed by a continuing increase from a lower level. The government, which is firmly decided to try to reduce the emission of carbon dioxide, realizes that additional measures must be taken. Yet it is hesitant to raise the tax level further, primarily because an additional tax rise poses the risk of undermining Swedish prosperity.

Hence the possibility of investing in *biofuels* once again becomes topical. The introduction of biofuels has previously been discussed at regular intervals in Sweden. Historically, however, it has not been the carbon dioxide potential of biofuels that has been given prominence, but rather the possibilities of improving air quality in urban areas and reducing the country's dependence on petroleum imports.

Initially the discussion centered on the possibility of changing the fuel tax into a pure carbon dioxide tax that would make biobased fuels economically attractive. That proposal proves to have much going for it. Carbon dioxide emission would decrease, domestic production of biofuels would begin, employment figures would improve, etc. There is, however, one big and important loser - the Ministry of Finance. A large scale conversion to biobased fuel would result in major reductions in income for the state. The government gets help from the EU to circumvent the problem. The Finance Ministry refers to the fact that EU regulations demand uniform taxation for all types of fuel for road traffic, and thus biofuels cannot be taxed less than gasoline and diesel oil. Biofuel used in Otto cycle engines must be taxed as gasoline, and if used in diesel engines it must be taxed as diesel oil.

After a time, a new proposal is presented: low-level admixture of biofuel in gasoline. The way the proposal is designed, the government will first try to reach an agreement with the petroleum companies on a voluntary commitment to mix increasing amounts of biofuel in all gasoline sold up to the equivalent of 5% (in terms of energy) by the year 2005. Here'we see obvious parallels with the agreement reached in 1994 with the petroleum companies on the Swedish market with regard to the environmental classification of fuels. If this fails, a Parliamentary decision will decree that the right to sell gasoline in Sweden involves a commitment to admix a prescribed amount of biofuel. The government realizes that such a decision can be viewed by the EU Commission as a barrier of trade and that the matter may very likely land in the EU Court of Justice. Following an analysis, however, the government is prepared to drive the issue further. Among other things, the analysis has shown that an individual member country has the possibility of introducing environmental regulations that may, to a certain degree, conflict with the principles of the internal EU market if prospective environmental gains can be shown to outweigh the negative effects on the internal functioning of the market. It is further pointed out that the possibilities to initiate national environmental policy measures are greatest in areas in which relevant EU legislation is lacking.

The thinking presented by the Cabinet Office and the Ministries creates unrest among the petroleum companies, but since the business are striving to improve it's environmental image, and since the long-term analyses of several petroleum companies indicate that it is not a question of *if*, but rather *when*, biofuels begin to compete with the fossil alternatives on the global scene, the protests are feeble. Nor are there any particularly loud protests from the members of the population at large. Low-level admixture of biofuel does not require any major alterations in either vehicles or filling stations. Nor are driving attributes noticeably affected. Inasmuch as biofuel, in this case ethanol, which is the engine alcohol analyzed in the study, is more expensive to produce than gasoline, the price of fuel at the pump will rise. However, the admixture grade of 5% by 2005 will not result in a greater increase than ca. $0.02 per litre.

Nevertheless, the carbon dioxide problem is still not sufficient to give lowlevel admixture with the required legitimacy. The Swedish public still entertains doubts as to whether carbon dioxide emission really is a problem. There is also a supposition that the environmental problems caused by traffic can generally best

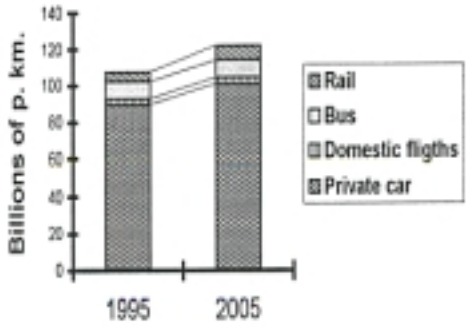
be solved through technological developments. But this is a false premise, apart from whatever technical development may imply in terms of improved energy efficiency in vehicles. There is no possibility of eliminating carbon dioxide emission at the exhaust pipe.

As has appeared earlier, however, there are several other weighty arguments that can be made for the carbon dioxide potential of biofuels. The agrobusiness complex, which has traditionally enjoyed a strong position in Swedish politics, wholeheartedly supports the government's thinking. These interests perceive marketing possibilities for the surplus of Swedish grains. Large areas currently lying fallow can also be made use of for further production of grains of industrial quality. Because this initiative is not linked to any form of subsidy and is furthermore designed as a long-term programme that vouches for a guaranteed demand, we now have the long-term prerequisites previously lacking for starting up a more ambitious production of automotive biofuel in Sweden.

There are also obvious advantages from the perspectives of regional and employment policies. Even from a short-term energy policy perspective there are advantages since the poisonous debate about the phase-out of nuclear power has put the focus on alternative energy resources. Based on a referendum in 1980, the Swedish Parliament decided that nuclear power should be phased out by the year 2010. In recent years, several political parties, supported by industry as a whole and especially by the Swedish steel and forestry industries, have begun to question the wisdom of carrying out the results of the referendum, for economic reasons. At present there are indications that the phase out will not be carried through according to the original plan.

At the end of the acceptance phase, transportation by private car has increased by about **10%** as compared to 1995. Air travel has increased by a little over 25%, and rail travel by something more than 40%. On the other hand, bus travel has remained basically unchanged (figure 3).

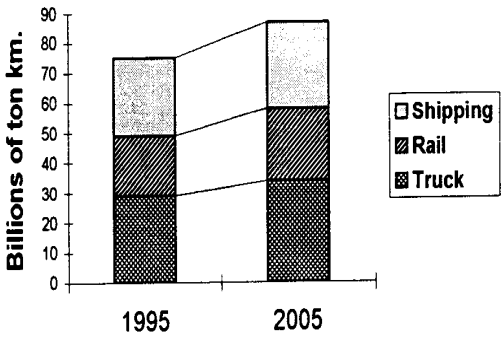
Figure 3. Passenger transportation in 1995 and 2005



Truck transports go up by a little under 18% during the period 1995-2005. Traffic involving other modes of transport also increases during the acceptance phase - shipping by over 10% and rail freight by ca. 20% (figure 4).

By 2005, carbon dioxide emission has stabilized. The emission nevertheless exceeds the goals established for 2026 (see also figure 9).

Figure 4. Freight transportation in 1995 and 2005



4.3 The Adjustment Phase, 2006-2015

There is increased legitimacy in the adjustment phase for pursuing an active environmental policy. As compared with the situation that prevailed during the acceptance phase, the need for "helpful arguments" and compensatory measures to arrive at decisions contributing to a reduction of carbon dioxide emission has diminished.

In political circles, it is pointed out that the measures taken during the previous decade to reach the carbon dioxide emission goal have by no means had the negative effect on the Swedish business sector anticipated

by its advocates. Yes, employment in the industrial sector has indeed gone down. But that is to be explained by a natural structural transformation, and not by the environmental adaptation of the transport system.

The results achieved thus far, combined with the minor impact on the competitive capability of the business sector, add up to a strong political resolution to move forward. Many political parties appeal to Sweden to begin to assume the role of international exemplar in environmental issues. With few exceptions in the political establishment, the tendency is a shift in emphasis - from having previously discussed the goal, we now arrive at a position where we discuss the means to be employed to bring about the realization of the goal.

In the adjustment phase, there are possibilities to make use of a climate policy that is more active and has a more direct effect. The major explanation of the new situation, of course, lies in the fact that the individual person's awareness of the importance of environmental issues for long-term survival has increased. At this point in time, most people realise what the effects of carbon dioxide emissions may ultimately have.

The effect of the fuel tax rise in the acceptance phase was limited to a reduction of the rate of increase in demand for fuel. Although there was broad political agreement about the importance of reducing carbon dioxide emission, opinions as to how that could be achieved were divided.

The business sector emphasizes that rather than increasing the cost of driving a car, we should rely on technological developments that can result in the average reduction of the consumption of fuels. One obvious weakness in the argumentation of the business sector, however, is that something like 98-99% of the research that can generate new technological solutions takes place abroad. That suggests that the rate of Swedish environmental adaptation - if this approach is elected - will be dictated from abroad.

Most Swedish political parties would like to have a more robust approach, so that Sweden, even in the future, can sustain its ambition to be a leading country in the environmental field. A tax increase to reduce the use of fossil fuels and consequently the emission of carbon dioxide is regarded by most parties as the most reliable solution. And this kind of solution is also propitious from the viewpoint of national finances. The government decides to increase the carbon dioxide tax. This seems to be quite in order, since the carbon dioxide problem at this point - as compared to the situation in the acceptance phase - has acquired such legitimacy that it no longer needs to be supported by "helpful arguments". Tax increases on fuels in the acceptance phase were justified more by the need for additions to state finances than by their environmental potential.

The government's decision implies annual rises in the fuel tax during a ten year period up to 2015. Tentative estimates indicate that the tax needs to be raised on an order of $0.60 (including VAT) per litre of gasoline, which entails an annual increase of $0.06 to achieve the desired reduction in carbon dioxide emission. For diesel oil, the annual increase is ca. $0.61 because of its higher carbon content. The government stipulates clear reservations that the actual tax increases may prove to deviate from these figures if the effectiveness of the increases deviates from what has been estimated. This could be the case if, for example, developments in Swedish household incomes deviate from those prognosticated, if the global market price for petroleum is different from what has been assumed, if the exchange rate of.the Swedish krona develops in unforeseen fashion, or if the fuel consumption per mile of automobiles changes faster than what has been presumed.

It is the increased legitimacy of climate policy that makes it possible this time to employ a programme for tax rises. Their great advantage is the possibility for individuals and companies to adapt themselves over an extended period of time. A programme for gradual tax rises ranging over several years provides clear insight into what the situation is going to be during the years to come. The rules of the game for the players on the market are explained. Companies that deem it necessary can restructure their production systems to reduce transport costs. Families have the possibility to move to different dwellings, and people

have the opportunity to change jobs or work methods to adjust themselves to the new cost conditions. Readjustment expenses are lower than would be the case if the increases were implemented all at once.

To cushion the automotive industry's protests against the carbon dioxide programme, a decision is made to reintroduce the vehicle taxes that were done away with in the acceptance phase. The new system for vehicle taxation, however, has an entirely different function than the old one. Tax is levied only on vehicles more than 8 years old. It is intensely progressive, making it almost prohibitive for vehicles more than 12 years old. The vehicle tax can be seen as a rolling scrapping programme and guarantees a high rate of turnover in the Swedish passenger car pool, which the Swedish auto industry views as positive.

Many economists are critical of the programme, maintaining that state revenues from fuel taxes will in the long run attain such proportions that the government will become dependent on them; for financial reasons, it will be compelled to resist the introduction of such new environmental technology that will reduce gasoline consumption. The tax course entered upon runs the risk of Sweden's lagging behind in the event of a changeover to new technical solutions in the passenger car area. One rhetorical question posed in the debate is what the government plans to tax in order to maintain its revenue levels when the electric car achieves its expected breakthrough.

The introduction of biofuel in the form of low-level admixture of ethanol to gasoline during the acceptance phase has been successful. Therefore it is decided that the admixture of ethanol in gasoline will be enlarged to 10% (in terms of energy) by the year 2010. This decision also includes the admixture of 10% ethanol in diesel oil by the year 2015. The decision is accepted with no audible counterproposals.

At this point, the pressure on the government is rather coming from the agroindustry complex and from segments of the environmental movement to use a general tax relief for biofuels as an incentive for a large-scale and spontaneous introduction of biofuels. The government objects by pointing out that the EU's mineral oil directive prevents an individual country from levying a smaller tax, or no tax at all, on biofuels. The Finance Ministry is also well aware that a general tax relief for biofuels would result in a major reduction in government revenues. Were 10% of current fuel consumption replaced by untaxed biofuels, government revenues would drop by over $450 million - a sum equivalent to ca. 12% of the Swedish government's outlays for communications objectives.

To mollify the critics accusing the government of not doing anything to facilitate a large-scale introduction of biofuel, the decision is made to launch two different R&D projects. One implies that 75% of inner-city bus traffic will employ dedicated alcohol vehicles fueled by pure ethanol by the year 2015. The other involves making the vehicle fleets of governmental departments and authorities consist of pure ethanol vehicles by the year 2015. The government utilizes EU legislation, referring to the fact that what is involved is pilot project undertakings and that it may therefore grant tax exemptions for the R&D projects.

The R&D projects are motivated by the fact that the percentage of air pollutants in urban areas will be further reduced, and that they also pave the way for spontaneous introduction as soon as the production costs of biofuels have gone down to the levels of fossil alternatives.

This decision also gives the government the opportunity to counter proponents of tax relief by pointing out that it is doing what is possible within the framework of EU regulations, and that subsidization will gradually increase in step with the progress of the R&D projects.

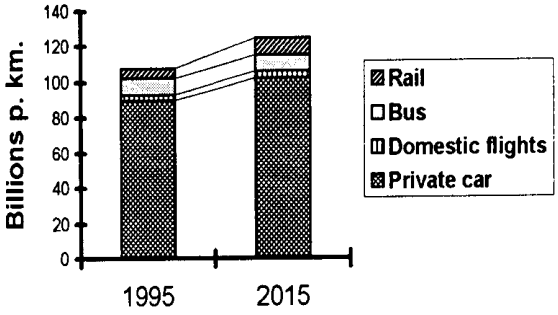
By 2015, travel by private car has increased by a good 13% as compared with 1995. Air travel has gone up by 40%, rail travel by 66% (figure 5). Freight transport is distinguished by a 24% increase in truck traffic. Maritime shipping goes up by 23% and rail transports by 35% (figure 6).

As a result of the new system of vehicle taxation introduced during the adjustment phase, there is increased turnover in the passenger car sector. In 2015 it is affirmed that there are now more than 4.3 million cars in

Sweden as compared with just over 3 million in 1995. Sales of new cars are at about 480,000 per year. The previous record year for Swedish car sales was 1988, when 340,000 vehicles were sold.

By the year 2015, carbon dioxide emission has diminished appreciably. It now appears that the carbon dioxide goal is within reach. Compared to the situation in 1990, carbon dioxide emission has gone down by ca. 15%. But there is still ca. 15 per cent units left before the goal is reached (see also figure 9).

Figure 5. Passenger transportation in 1995 and 2015

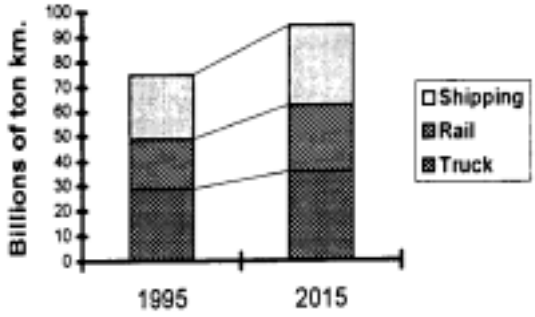


4.4 The Implementation Phase, 2016-2026

In this phase, environmental policy has acquired the status of a primary goal. Environmental policy is regarded as at least as important as all the other policy areas. At this stage, there is legitimacy for quantitatively limiting the emission of carbon dioxide in the transport sector.

At the beginning of the implementation phase it is determined that the various efforts made to reduce carbon dioxide emission from the transport sector have had appreciable effects both on the transport system and on public attitudes concerning the influence of politics on the real world.

Figure 6. Freight transportation in 1995 and 2015



In political circles there is growing conviction that it is indeed possible to create an environmentally sustainable society, which in turn presumes an environmentally sustainable transport system. At the same time, it is obvious that much remains to be done with regard to carbon dioxide emission.

The environmental movement and the scientists closely associated with it believe that firmer positions by the politicians are required to achieve the carbon dioxide goal. That goal demands a high priority in policy formulations. In some political parties, there is complete agreement with the environmental movement, whereas others may agree in principle but question the advisability of giving priority to this goal above others. Should the carbon dioxide goal really be achieved regardless of other social consequences to which it may give rise?

A group of experts is appointed to illustrate the extant possibilities and alternatives for assuring the achievement of the carbon dioxide goals by 2026. In their presentation, they recommend to the government a system involving emission rights for carbon dioxide. The system makes it possible to put in place the quantitative restriction for carbon dioxide emission that the government has wanted, while at the same time allowing the allocation of such emissions on the basis of conditions adjusted to the market.

The government accepts the proposals of the expert group and wins a majority in the Parliament for a system involving carbon dioxide emission rights.

Academic economists maintain that the decision to introduce a system of carbon dioxide rights exclusively in the transport sector will result in expensive, misplaced allocations as far as society is concerned. Very expensive measures must be taken within one sector, while in other sectors no further instruments are introduced to reduce carbon dioxide emission, even though the costs for such measures in these other sectors might be lower than those within the transport sector. According to these economists, this is the springboard to a system of emission rights never before allotted to one individual sector.

Other economists, engaged in practical affairs, maintain that this latter postulation is wrong. A system involving emission rights has long been applied - limited, for example, to the industrial sector - in the U.S.A. Preliminary plans for gasoline rationing have been drawn up on other occasions in Sweden, most recently during the oil crisis of 1973/74; they can be compared to the system presently introduced. By way of conclusion, the more practically oriented economists point out that it is certainly true that a system comprising all sectors of society would be preferable. However, this fact by no means prevents introducing a system that applies exclusively to the transport sector. A system that later can be extended to other sectors.

However, two problems remain for the government to solve: to whom, and how, should the rights be allocated? In terms of “to whom” the expert evaluation indicated four alternatives: allocation to everybody in Sweden; allocation to all owners of vehicles; allocation to petroleum companies; auctioning off the rights to petroleum companies. Having consulted the experts who carried out the investigation, the government decides to adopt the fourth alternative: to auction off the carbon dioxide emission rights to the petroleum companies. The government's position was influenced by, among other things, the risks of criminalization, legal implications, possible negative effects on competition, and the great administrative costs that might be associated with other alternatives. The modes of transportation encompassed by the system are road traffic, maritime shipping and aviation. How the rights are to be distributed among different modes of transportation will be decided by the Parliament. That way, the politicians can assure that no one mode of transport will be favoured at the cost of others.

The introduction of the system involving emission rights changes the prerequisites for admixture of engine alcohols in gasoline and diesel oil. The price for emission rights the distributors are obliged to pay is passed on to the customers. If the price of emission rights goes up to the point where they exceed the price differential between petroleum-based fuels and the biobased alternative, the gasoline companies will be stimulated to increase the admixture of engine alcohols.

Thus a direct connection is created between the demand for emission rights and the admixture of engine alcohols. By gradually reducing the supply of emission rights, the government can bring about a desired reduction of carbon dioxide emissions from road traffic. Many politicians therefore believe that the emission rights system means that the carbon dioxide . problem has finally been solved. The politicians have finally gained access to a valve that they can open or close to the extent required for reaching the carbon dioxide goal.

Other actors do not share these politicians' satisfaction with the state of things. The business sector criticizes the politicians for not considering the consequences of their adjustments to the supply of emission rights. A reduction in the supply that leads to reduced emissions simultaneously exacts a price in the form of increased transport costs - for the business sector, among others.

Thus the carbon dioxide goal will be achieved at the price of weakening the competitive ability of Swedish companies. Weakened international competitiveness leads to lower growth and higher unemployment. The business sector insists that the population is paying a high price for the politicians to play with the “emission valve” in the form of diminished welfare.

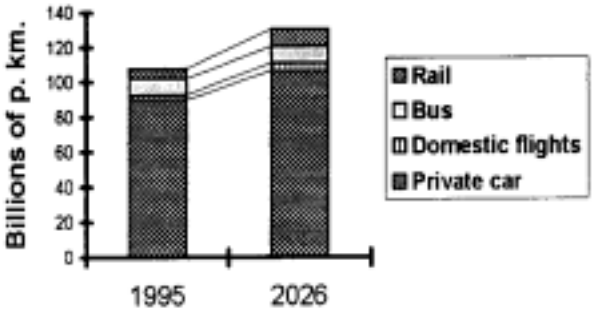
Business feels itself pressured from two directions. It is not only transport costs that have increased much more in Sweden than in other countries. Sweden's decision to phase out nuclear power has simultaneously

meant that energy costs for the business community here, as compared with the situation in competing countries, have also soared, albeit from a previous level that had been quite favourable.

Energy experts, however, think that the situation for industry will improve after nuclear power has been completely phased out. Then the substitution of bioenergy for nuclear energy will be completed, which will mean a tapering off of the dramatic growth in demand for biofuels, with a subsequent normalization of costs for that source of power.

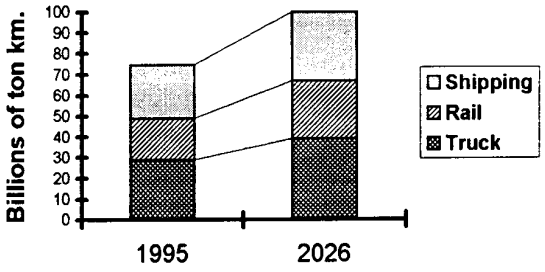
Transportation by passenger car increases by nearly 20% during the period covered by the scenario, i.e. from 1995 to 2026. The corresponding increase for air and rail travel is 50% and 75% respectively. There is only a marginal increase in bus travel (figure 7).

Figure 7. Passenger transportation in 1995 and 2026



With regard to truck transports, they increase by nearly 35%. The figures for shipping and rail freight are 27% and 40% respectively (figure 8).

Figure 8. Freight transportation in 1995 and 2026

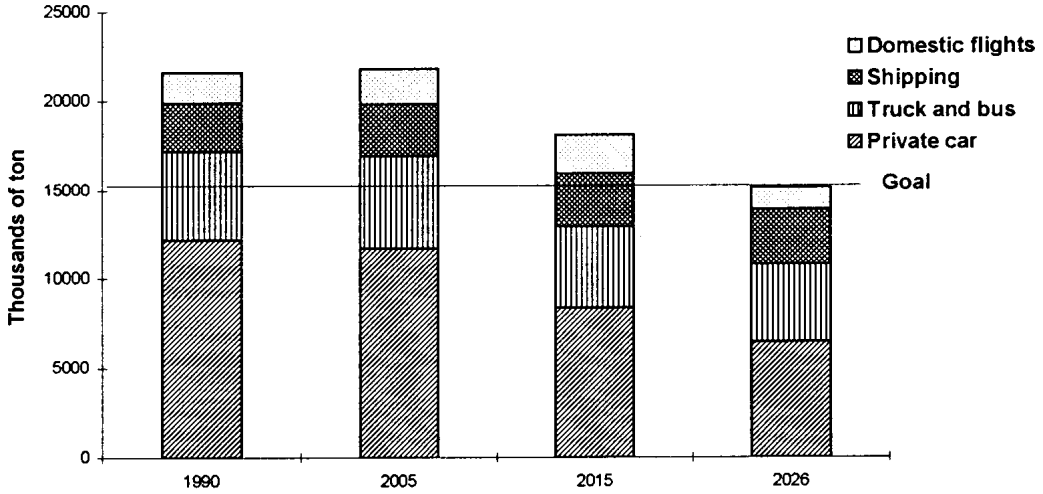


As a result of the scrapping programme introduced during the adjustment phase, sales of new cars remain high. According to the scenario, 510,000 passenger cars are purchased in 2026. The total number of automobiles in Sweden is ca. 4.6 million.

The carbon dioxide goal has now been reached. The system of emission rights for carbon dioxide has meant that the volume of traffic has been kept within bounds and that the use of engine alcohols has increased. Over 20% of the energy used in the road traffic sector comes from engine alcohols.

Figure 9 shows the development of the carbon dioxide emission according to the scenario.

Figure 9. Carbon dioxide emission levels 1990, 1995 and emission levels according to the scenario 2005, 2015 and 2026
(thousands of tons)



5. Insights

The scenario approach, illustrated here by a description of the road to the carbon dioxide goal, results in a number of general insights with regard to the possibilities of achieving an environmentally sustainable transport system.

First, such a transport system will never be brought about in the manner described in the scenario. Politics does not function in the way assumed in the analysis. Operationalizable long-term goals which politicians commit themselves to realize are normally not defined in the world of politics. Rather, political goals are formulated and reformulated in a process involving interplay with the incentives that are employed. Consequently, the question of when an environmentally sustainable transport system is achieved becomes a question of when the politicians think it has been realized, and not a question of when certain goals defined in advance have been achieved.

Second, the analysis illustrates the risk that a policy focused on one sector leads to "solving" a problem by moving it outside of systems limitations, to other sectors of society and even to other countries. There is an obvious risk that carbon dioxide emission from traffic will be reduced by transferring it to the industrial., agricultural and energy sectors. In corresponding fashion, a reorganization of Swedish energy policy can result in making it more difficult to reduce carbon dioxide emission in the transport sector.

Third, the scenario points out the importance of national consensus for the possibilities of transforming society through political means. Achieving the carbon dioxide goal requires a great many political decisions that are made over a long period of time. If this is to happen, there will have to be great political unity about the course to be adopted to guarantee that the reduction of carbon dioxide emissions will continue regardless of which constellation constitutes the political majority.

Fourth, the scenario elucidates the limitations on a national environmental policy. Being able to count on assistance from other countries through an equivalent environmental adaptation, in the European Union or globally, would drastically facilitate the environmental adaptation of the Swedish transport system. This in

turn indicates the absolute necessity of promoting issues involving transportation and the environment in international forums.

Finally, it is worth stressing that analyses are by nature conservative in the sense of being anchored in the reality from which they proceed. Describing a path towards the solution of the carbon dioxide problem in the Swedish transport sector, for example, reveals a path marked by the knowledge and suppositions about society that have resulted from developments thus far. In this respect, the future will provide new openings not considered in the scenario.

Similarly, changes in the valuations of the Swedish population and the ability to reformulate central conflicts can contribute to changing the outlook on conflicting goals. Such changes can contribute both to creating new approaches and to eliminating some that currently exist.

APPENDIX 1

This appendix summarizes the instruments introduced in the acceptance, adjustment and the implementation phases, according to the overall scenario. Thus, it includes all instruments bearing on the goals that characterize an Environmentally Sustainable Transport system.

Instruments introduced during the Acceptance Phase

- In the effort to limit carbon dioxide emission, it is decided to **raise the fuel tax by $0.30 per litre of gasoline.** As a compensatory measure, **the vehicle tax is abolished.**

- In connection with the fuel tax rise, it is decided to introduce **a time-limited scrapping programme for passenger cars without catalytic converter.** $1,500 will be paid for up to one year after the introduction of the fuel tax rise to car owners who turn in their car without catalytic converter for scrapping.

- In order to eventually not only slow down the increase of carbon dioxide emissions but also to achieve a permanent reduction, the government decides **on low-level admixture of biobased engine alcohols in all gasoline sold in Sweden.**

- With the Norwegian capital Oslo as a model, the decision is made to introduce **local traffic tariffs in Sweden's three largest cities.** Motorists are forced to pay a fixed fee every time they cross the tariff lines that enclose the central areas of these cities.

- In maritime shipping, **bilateral agreements** are signed with the neighboring countries Finland, Denmark, Germany and Poland that **sulphur content may not exceed 0.5%** in the oil used in ferry traffic between them and Sweden. The agreement also means that **ships used for ferry traffic must be equipped with catalytic converters.** In addition, the agreement is supplemented with an **operating fee** for ships that do not fulfil the requirement but sail in Swedish territorial waters.

- To bring about an adaptation towards the best airplanes in terms of noise, **an increased noise differentiation of landing fees** is adopted. When the noisier so called Chapter 2 aircraft are phased out in 2002, continued reduction of noise levels is assured by a decision that **landing fees** YAII **be dfferentiated between that half of Chapter 3 aircraft using Swedish airports that are quietest and the half that is noisiest.**

- To reduce the risk that the number of people exposed to noise rises as a result of too short a time perspective in the planning of new construction, it is decided that **agreements on the planning of new buildings in the vicinity of airports vall be drawn up between the airport administration and the affect communities.** The purpose is to guarantee the

possibilities of expanding aviation facilities without having to increase the number of people exposed to noise.

- To obtain a better overall view of both traffic and infrastructure, to achieve a more effective use of resources, and to better safeguard the interests of natural and cultural environments, **an organizational change in infrastructure planning in some selected regions** is carried out. This change is intended to increase regional and political influence on the planning of the infrastructure.

Instruments introduced during the Adjustment Phase

- A decision is made to **increase the admixture of biofuels in gasoline.** In addition, from now on there will be **admixture in diesel fuel as well.** To prepare the way for a possible future spontaneous introduction of biofuels, among other things, **a certain percentage of pure ethanol vehicles is required** in the automobile fleets of government departments and authorities, and **a certain amount of pure ethanol operation in urban bus traffic is also stipulated.**

- An increase in the carbon dioxide tax is introduced. It occurs in the form of a programme that stipulates an annual increase in the carbon dioxide tax on gasoline by ca. $0.06 per litre from 2005 to 2015. The carbon dioxide tax on diesel oil is raised by ca. $0.07 per litre annually. This programme is partially goal-governed.

- At this point in time, the principal problem in urban areas is defined as noise. The decision is made that **traffic tariffs in the environmental zones can be scaled according to the noise problems that exist.** The tariff can thus vary both in time and in different zones. **Passenger cars are included in the environmental zone system and the size of the fee is related to each car's environmental performance.** Vehicles not fulfilling the basic environmental demands are excluded from the zones. Also introduced is **a system of automatic emission monitoring.** Equipment is installed at the entrances to the environmental zones that measures the amount and composition of emissions from entering vehicles.

- A decision is made on **a programme for scrapping.** This is done by **reintroducing the vehicle tax.** A progressive vehicle tax applies for vehicles more than 8 years old. For vehicles more than 12 years old, the decision implies a vehicle tax that is almost prohibitive. Vehicles more than 8 years old are not allowed into the environmental zones.

- Avoluntary agreement between the auto industry and the government signifies that all cars beginning with the 2005 models must be equipped with **preheaters for the catalytic converter** so that the cold-start emission will be reduced by 50% as compared with conventional operation.

- In order to further limit the environmental impact of maritime shipping, the bilateral agreements are expanded to include all ships operating in Swedish territorial waters. In addition, with regard to ferry traffic, stricter limits are set on the sulphur content of fuels.

- On the European level, a decision is made to **increase the emission requirements for heavy vehicles.** The permitted emission of regulated air pollutants is reduced to what is stated as possible EURO IV requirements.

- To accelerate scrapping of two-cycle engines in pleasure boats, and hence bring down hydrocarbon emissions, **people who scrap their twocycle engines are given a scrapping premium over a period of 6 years.** At the same time, it is decided that **two-cycle engines may only be used for another 10 years.**

- Regarding the problem of noise pollution caused by aircraft, there is in this phase no alternative other than to **relocate the noisiest airports.**

- To strengthen conservation interests, there is **a revision of the planning and building law.** This means that the landscape is divided into three categories according to the strength of the conservation interests. In addition, the government's regional organs, the county councils, are given a stronger role as custodians of environmental interests in planning infrastructure.

Instruments introduced during the Implementation Phase

- In order to achieve a significant quantitative reduction in the emission of carbon dioxide, **a decision is reached on a system of emission rights.** The rights to emit carbon dioxide are auctioned off to the distributors of fossil fuels. The decision includes road, maritime and air transports. How the rights are to be distributed among the different modes of transport is decided by Parliament.

- Public sector purchase of transport services is bound to observe a **requirement for pure ethanol operation.**

- The steadily growing number of diesel-powered vehicles has in and of itself made it easier to adjust to the carbon dioxide goal. However, the emission of nitric oxides proves to have reached alarming levels. Therefore, **vehicle taxation is changed so that it is no longer favourable to purchase new diesel vehicles.**

- The enhanced demands on sulphur emission which previously applied only to ferry traffic, are extended to include all ships trafficking Swedish waters. Simultaneously, the prescribed values for nitric oxide emissions by ships are additionally tightened.

- Noise continues to be the principal problem in urban areas. **Strict noise requirements are introduced for vehicles used within the environmental zones.** During a 5-year transition period, however, the use of vehicles that do not fulfil the noise requirements is permitted. But these vehicles are required to pay a **drastically increased fee for permission to enter the environmental zones.**

- In order to further reduce the emission of air pollutants, traffic supervision by automatic emission monitoring, previously used only when entering environmental zones, is amplified. **A decision is made to introduce an equivalent system throughout the country.**

- To cope with the problem of air traffic noise the only remaining solution is to reduce the number of flights. At every airport, the numbers of takeoffs and landings that can be permitted without exceeding the guidelines for aviation noise are estimated. **Takeoff and landing rights are sold to the airlines that make the highest bids.**

- In order to better safeguard conservation interests, **the number of landscape categories in the planning and building law is reduced from three to two.** In concrete terms, this means that a reverse burden of proof applies to an expansion of the infrastructure: the responsible authority must be able to prove that a planned expansion will not impact on either natural or cultural environments to an unacceptable extent.

APPENDIX 2

Gasoline prices and operating costs in the year 2026 according to the scenario

The gradual increase in the price of gasoline depends partly on the tax rises that were carried out, and partly on the effect on prices, as indicated in the scenario, of the introduction of biofuels. In other words, it is only the price increase constituted by the scenario's policy instruments that is reflected in the following table. If, for example, the global market price of oil should go up, the price at the pump would also increase further.

Table 1 indicates the scenario's effects on the price of gasoline vis-6-vis the real development of gasoline prices. The cost of driving a new car 10 kilometres in 2026, as compared with that in 1995, goes up by ca. $0.12. Considering the average car in the entire population, in terms of fuel consumption and age, the cost increase is ca. $0.18.

Table 1. Developments in gasoline prices, vehicle energy efficiency and the cost of gasoline for driving 10 kilometers in a new car compared to an average car according to the scenario (1995 US $)

Year	Gas price / litre US $	Gas consumption litre/l 0 km		Gas cost / l 0 km US $	
		New car	Average car	New car	Average car
1995	1,17	0,82	0,92	0,96	1,08
2005	1,47	0,60	0,81	0,89	1,20
2015	2,10	0,50	0,69	1,05	1,45
2026	2,52	0,43	0,50	1,08	1,26

The effects of the dramatically increasing gasoline prices are gradually alleviated by the steadily increasing energy efficiency in the Swedish vehicle pool. In this improved energy efficiency there is a great technological potential, e.g. the commitment of the European automotive industry to reduce vehicular fuel consumption by an average of 15% by the year 2005. Thereafter the average fuel consumption is expected to go down by another 5% by 2026. In addition to that ascribed to technological developments, the reduction of average fuel consumption in the vehicle pool can be attributed to the trend towards increasingly energy-efficient vehicles in Sweden.

TFK Transport Research Institute
98-12-16/ Bo Östlund

PART TWO

Project on Environmentally Sustainable Transport (EST)

ECONOMIC IMPACT ASSESSMENT OF THE SWEDISH EST3 SCENARIO

Bo Östlund

The study has been performed by order of the Swedish Environmental Protection Agency.

PREFACE

This analysis was performed for the Swedish Environmental Protection Agency (Naturvårdsverket) during a couple of months in the autumn of 1998. The work has mainly been based on a former scenario study of an environmentally sustainable transport system in Sweden conducted by Nordplan and carried out by professor Lars Emmelin, professor Mats-G Engström, professor Jan-Evert Nilsson, M Techn Peter Brokking, Lic Techn Gunnar Eriksson and B Sc Olle Wikberg.

The economic analysis has been conducted with methodological help from professor Chuang-Zhong Li and Richard Johnsson at the University of Dalarna. Stefan Andersson has been responsible for the project at the Swedish Environmental Protection Agency and a stimulating discussion partner during the work.

Borlänge in December 1998.

Bo Östlund

Introduction

In 1995 the OECD started the project ”Environmentally Sustainable Transport” (EST). The aims of the project are to “characterise EST and to establish guidelines for the development of policies that would result in the achievement of EST” [OECD 1998a]. Participating countries are Germany, The Netherlands, Canada, France, Switzerland, Austria, Norway and Sweden.

The Swedish contribution to OECD’s EST- project has, since the start, been based on the work done in the Swedish EST-study (the MaTs-cooperation in Swedish). The Swedish EST-study was a joint project between Swedish authorities and the Swedish automotive and petroleum industries regarding long-term strategies for an environmentally sustainable transport system [Naturvårdsverket 1996].

This study is a part of phase 3 of the OECD project, which comprises the identification of packages of policy measures whose implementation would result in the attainment of EST. Phase 3 also includes an examination of the economic and social implications of attaining an EST. In the Swedish EST-study that issue was partly dealt with in a scenario study carried out by a research group at NORDPLAN, the Nordic School of Planning. The purpose of the scenario study was to use the scenario format to describe one of several possible paths from today’s transport system to an environmentally sustainable one [Brokking et al 1997, Naturvårdsverket and KFB 1996]. However, the study of NORDPLAN didn’t consider the economic implications in detail.

This report contains an economic impact assessment. The basis is the qualitative and quantitative descriptions of the EST-scenario (EST3) carried out by NORDPLAN [Brokking et al 1997, Naturvårdsverket and KFB 1996]. The projection year of the study was 2026 (30 years ahead). In this study the results are used for the actual projection year 2030. Further quantification’s are taken from the SAMPLAN study and directly from the planning instruments (e.g. transport models) used in that study.

SAMPLAN is a joint planning organisation representing the Swedish Institute for Communication Analysis (SIKA), the National Rail Administration (Banverket), the National Road Administration (Vägverket), the Board of Civil Aviation (Luftfartsverket), the Board of Shipping and Navigation (Sjöfartsverket) and the Transport and Communications Research Board (KFB). SAMPLAN was conducting quantitative studies of several scenarios mainly concerning different allocation of infrastructure investments parallel to and in co-operation with the Swedish EST-study [Algers, Swahn, Widlert, Östlund, 1995]. The results from these studies as well as the results from the EST-study were reported to the parliamentary commission on Transport and Communications, “KomKom”, as a basis for the 1998 Transport Policy Bill.

It is obvious that it is impossible to make relevant fore-casts for 2026 or 2030. The results must therefore not be taken as fore-casts but as an attempt to elucidate some consequences of one of many possible packages of policy measures to reach an EST situation.

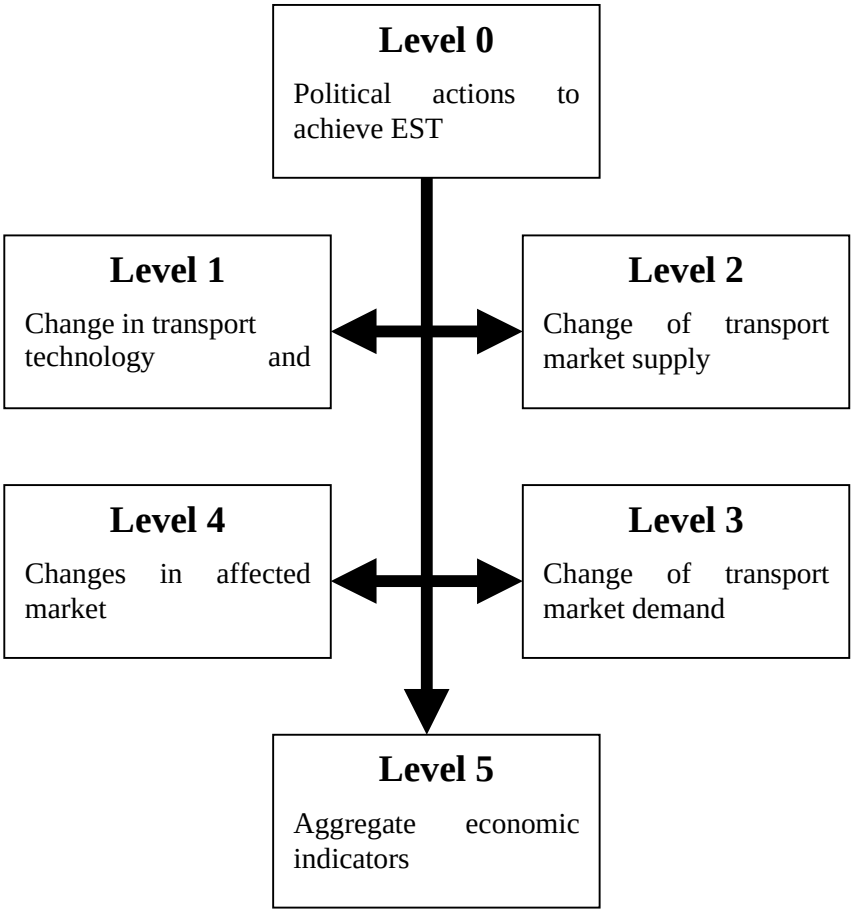
1. Methodology

From discussions on methodologies of economic assessment of the EST scenarios the OECD concluded that traditional cost-benefit analysis was not favourable for assessing the economic consequences of the scenarios because this methodology presuppose that the changes to be assessed are marginal and do not generate major repercussions outside the transport sector. The EST scenarios however describe major changes in technology and behaviour such that a system dynamics modelling approach (SDM) appeared more suitable. Preparing the data and functional input for a SDM was however considered too time-consuming as it would require considerable additional data and could lead to problems with handling

the complex structure. Therefore a simplified cybernetic model (SCM) was choosen as the preferred solution.

An SCM can be described as a method of generating rankings by means of an expert questioning and evaluating the results through active/passive influence indicators or positive/negative feedback analysis [Rothengatter 1997]. The University of Karlsruhe has developed a variant of an SCM, which enables a comparison of the economic impacts of the EST3 scenario with the business-as-usual scenario. The methodology is called the Impact Path Analysis (IPA) and is described in " Economic Assesment of EST Scenarios. Methods and Approach." [Rothengatter 1997].

In this paper the "Mainstream assessment", in which the assumed policy actions are assessed with respect to their impacts on different levels of economic activity, is described for the Swedish EST-scenario. In order to reduce the complexity of the study, only one environmental target – the CO_2-target (-30% for the period 1990-2026) and the policy instruments it requires – has been chosen as a basis for the evaluations.



2. Change in transport technology and behaviour – Level 1

As a first step in the analysis we have used the "balance-of-efforts" method provided by OECD [Gilbert 1998] to estimate the contribution of activity changes, technological changes, efficiency changes and modal shifts to reach the CO_2 criterion.

In the NORDPLAN study, mode shifts are mentioned as a probable effect of the price-increase for the road traffic and of the regulations for the air traffic. In the numerical data given in the report however no such effects are taken into account. Based on elasticities from the national transport modelling system the analysis has been completed with estimates on mode shift effects.

In the NORDPLAN scenario the measures are focused on technology measures in the road traffic. Technology alone contributes to 55% of the total CO_2 reduction of emissions. Most of that – 52% - are due to measures in the road sector. The effects of lower activity, that is reduction of passenger and tonne kilometres, accounts for 29% of the total CO_2 reduction out of which 24% in the road sector. Higher occupancy and higher load factor stands for 9% and mode shifts for 7% of the reduction of emissions.

The road sector alone accounts for 88% of the reduction of emissions.

The results are shown in the following Table (Table 2.1).

Table 2.1. Contributions of modes and measures to CO_2 reduction in 2026

	Car	**Bus**	**Air**	**Lorry**	**Shipping**	**Rail**	**Total**	**%**
CO_2 changes (in Ktonnes) through:								
Activity alone	-4 452	-122	-694	-214	-129	-2	-5 613	29%
Technology alone	-8 330	-150	-355	-1 920		-1	-10 756	55%
Occupancy/loading alone	-725	0	-818	-295		-1	-1 839	9%
Mode shift alone	-604	82	-292	-779	129	6	-1 458	7%
Sums of reductions	-14 111	-190	-2 159	-3 208	0	2	-19 666	100%
Mode shares of reductions	72%	1%	11%	16%	0%	0%	100%	

The second step of the evaluation level 1 is to estimate the contribution of different policy instruments to the assumed changes in technology and behaviour. The following quantification's are mainly deduced from the NORDPLAN study and the results from the national travel demand study [SAMPLAN 1996].) Appendix 1 summarises the instruments introduced in the scenario.

Cars

In order to achieve a significant quantitative reduction in the emissions of carbon dioxide, a decision is supposed to be reached on a system of emission rights. For road vehicles this is assumed to increase the fuel price by 118% for gasoline and 195% for diesel. The cost increase is assumed to increase the energy efficiency of cars in general but mainly to make citizens choose smaller cars with a lower fuel consumption. This stands for 65% of the technological change in CO_2 reduction. The other 35% are due to the fact that the fuel price has reached a level, where the price differential between petroleum-based fuels and the biobased alternative makes it worth-while for the gasoline companies to increase the admixture of engine alcohol's. In 2026 over 20% of the energy used in the road traffic sector comes from engine alcohol's. Both of these effects are in table 2.2 classified as measures in the field of conventional vehicle technology and accounts for a major share (77%) of the contribution of technology changes. Impacts of the assumed environmental zoning systems are locally important but do not contribute much to the reduction of CO_2 reduction on the national level.

The other main effect of the pricing policy is behavioural changes. They consists of lower rate of car ownership, a decrease in car-use and a higher car occupancy as a consequence of the increase of fuel costs. These effects stands for 31%, 56% and 13% respectively of the behavioural changes induced by the pricing policy.

The lower rate of car ownership is caused by higher fuel costs and higher car taxation. The latter is the most important factor roughly calculated to stand for 83% of the decrease in car ownership.

Lorries

The assumed technological changes of lorries – mainly increased energy efficiency – are to 90% an effect of pricing policies. The remaining 10% are assumed to be an effect of restrictions for public owned vehicles (i.e. pure ethanol operation) and access restrictions for conventional vehicles in the environmental zones.

The assumed reduction of lorries used is the result of pricing policy and management efficiency gains. The efficiency gains are caused by the pricing policy and are for that reason not separated.

Air traffic

The reduction in air transports is an effect of the regulations (for noise protection) of the number of takeoff and landings. Takeoff and landing rights are sold to the airlines that makes the highest bids. Accordingly the effect could be seen as an effect of variable pricing.

The cost increase is assumed to result in

- the use of more energy-efficient aeroplanes (16%);
- a higher occupancy (38%);
- a decrease in passenger-kilometres (32%); and
- a mode shift to rail (14%).

The following two tables gives the result of the distribution of effects on the different policy instruments.

Table 2.2. Contribution of changes in transportation technology

Policy instrument	Conventional. vehicle technology	Innovative vehicle technology	Efficiency rail transport	Efficiency aviation	Total
%					
Variable pricing policy	93	0	0	3	96
Fixed pricing policy	0	0	0	0	0
Standards behaviour	4	0	0	0	4
Management efficiency gain	0	0	0	0	0
Land use	0	0	0	0	0
Investments alt. modes	0	0	0	0	0
Education etc	0	0	0	0	0
% of target achievement	97	0	0	3	100

Table 2.3. Contribution of changes in transportation behaviour

Policy instrument	Reduced motorization	Reduced car travel distance	Reduced air travel distance	Higher loading factor	Total
%					
Variable pricing policy	15	36	11	21	83
Fixed pricing policy	17	0	0	0	17
Standards behaviour	0	0	0	0	0
Management efficiency gain	0	0	0	0	0
Land use	0	0	0	0	0
Investments alt. modes	0	0	0	0	0
Education etc	0	0	0	0	0
% of target achievement	32	36	11	21	100

3. Change of transport market supply – Level 2

Level 2 of the analysis is dealing with the supply side of the transport system. The supply side is characterised by the generalised costs of the different modes. Generalised costs consists of all costs associated with a trip which influence the tripmakers behaviour. That is operating costs or ticket cost, time costs according to the tripmakers valuation, internalized costs of externalities (included in operating costs) and costs of inconvenience. In the Swedish scenarios the differences between BAU and EST are internalised in the operating costs.

The generalised cost changes are calculated based on the generalised costs in the national transport model system. The inconvenience costs as shown in the mode specific parameters in the model are for practical reasons excluded.

As could be seen in table 3.1 most of the changes of the supply side are caused by variable pricing policies.

Table 3.1. Change in generalised costs per kilometre (%)

Policy instrument	Cars	Lorries	Rail passenger	Rail freight	Shipping	Air transport
%						
Variable pricing policy	35	18	0	0	0	25
Fixed pricing policy	0	0	0	0	0	0
Standards behaviour	1	2	0	0	0	0
Management efficiency gain	0	-5	0	0	0	0
Land use	0	0	0	0	0	0
Investments alt. modes	0	0	0	0	0	0
Education etc	0	0	0	0	0	0
Total	36	15	0	0	0	25

Cars

The fuel price for private cars is assumed to increase with 118% in comparison with BAU. With a value-of time of approximately 55 SEK/h in the price-level of 1997 and an assumed decrease in fuel consumption of 35% the decrease in generalised costs amounts to 35%.

Lorries

The fuel price is assumed to rise with 195% in comparison with BAU. According to a study of the cost composition for road transport companies [SPK 1991] the fuel costs amounts to 11% of the total transport costs. The vehicles are assumed to increase their fuel efficiency with 10%. This summarises to an increase of the generalised costs for road transport to 18% in comparison with the BAU. The restrictions for public

owned vehicles and environmental zone restrictions have a small impact on the generalised costs averaged on a national level. Management efficiency gains (e.g. more effective use of vehicles) will marginally reduce the generalised costs.

Air transport

In the Swedish EST-study the reduction in air transports is an effect of the regulations (for noise protection) of the number of takeoffs and landings. Takeoff and landing rights are sold to the airlines that makes the highest bids. Thus the effects of the regulation are classified as an impact of a pricing policy. The decrease in number of take-off and landings is assumed to reach about 50% and the number of trips with 33%. No explicit assumptions are made regarding the corresponding price increase.

The price increase could be deducted if the price elasticity is known. Price elasticities for air transport differs very much between different surveys. [See for example Oum, Waters and Young, 1992]. The Swedish national transport forecasting system gives a price elasticity for air transport of –0.96. This seems to be a reasonable average of the different results known from the literature.

A 33 % decrease of air travel and an elasticity of –0.96 gives a corresponding price increase of 32%. The price is the major part of the generalised costs for air trips. The increase in generalised costs is estimated to 25%.

4. Change of transport market demand – Level 3

In evaluation level 3 the changes of transport demand are compiled and allocated to the different policy instruments. In comparison with earlier reported data some changes have been introduced. Cross-elasticity effects are in the basic report of the NORDPLAN analysis mentioned in qualitative terms but were not quantified. At this stage we have completed the analysis based on elasticities from the Swedish national travel demand forecasting system. Some details are given in the text below.

Table 4.1. Impact on transport demand (% change of passenger-km or tonne-km)

Policy instrument	Light rail buses	Railway passengers	Cars	Railway freight	Shipping	Lorries	Air transport
%							
Variable pricing policy	-5	20	-25	12	0	-16	-33
Fixed pricing policy	0	2	-3	0	0	0	0
Standards behaviour	-1	0	-1	0	0	0	0
Management efficiency gain	0	0	0	0	0	0	0
Land use	0	0	0	0	0	0	0
Education etc	0	0	0	0	0	0	0
Total	-6	22	-29	12	0	-16	-33

Cars

The travel demand changes due to pricing policies are calculated with the fuel-cost elasticity –0.32 according to a recent Stated Preference study on value-of-time [SAMPLAN 1995]. The found elasticity seems to be reasonable in comparison with international experiences [See for example Goodwin 1992].

Buses and light rail

The price elasticity for buses is found to be –0.25 according to the national model system [Kjellman 1991]. With an assumed fuel price share of 10% of the total operating costs for buses and an increase of 194% of fuel price (diesel) the decrease of travel demand for buses is 8%. The category buses and light rail consists to 80% of bus-traffic [TPR 1990].

Railway passengers

In the value-of-time study [Algers 1995] the car-fuel price cross-elasticity 0.18 was found for rail.

Air transport

In the EST3-scenario for Sweden the number of take-off and landings are assumed to decrease with 50% compared with the BAU-scenario. This will be achieved with an auction system. The airlines are assumed to compensate by using bigger planes and to increase the fares. The fares are assumed to increase with 32% resulting in a decrease of air travel with 33% (elasticity –0.96 according to a test run with the national travel demand modelling system).

Lorries

The elasticities for truck freight varies according to many sources [for example Oum et al 1992] around 1. The fuel costs contribute to about 10% to the operating costs which means that the fuel price elasticity could be estimated to 0.1. With a fuel price increase of 195% this means a decrease of tonnes-kilometres by about 16%.

Rail freight

Lacking cross-elasticities for rail freight as a function of operating costs for road freight it is assumed that 50% of the decrease of road freight will be transferred to rail and the rest will result in more effective logistic schemes, rationalisation of material handling and lower production levels.

5. Changes in affected markets – Level 4

5.1 Economic importance of transport-related sectors

The economic importance of the markets which are influenced by the scenario changes are described by gross production value, value-added and final demand. The basic data are taken from the National accounts for Sweden 1991 [SCB 1997]. IO-tables with a suitable disaggregation could not be made available which means that the calculations in some parts are rather rough. Considering the time-perspective and the

possible accuracy of input data this was considered as a minor problem. Economic data are given in billion SEK in 1991 prices.

The yearly economic growth factors are taken from the official economic long term planning in Sweden. Gross production values and value-added for BAU are given in table 5.1. The economic sectors are defined according to the SNI92 nomenclature based on NACE rev. 1.

Table 5.1. Gross production value and value-added in directly affected sectors for the BAU-scenario 2026/2030. (Billion SEK)

SNI-code	Economic sector	Production value	Value-added
60.1	Railway companies	18	6
60 others	Other land transport companies	103	48
61	Shipping companies	46	14
62	Air transport companies	27	12
63	Service companies supporting transport	39	22
34-35	Industry for transport equipment	158	49
50.2	Car trade and repair	32	19
50-52	Wholesale and retail	325	215

5.2 Changes in value-added in transport-related sectors

The assumed changes in the NORDPLAN study are described below and quantified for the affected economic sectors.

5.2.1 Passenger transport

Road vehicle manufacturers (economic sector 34-35).

The programme for scrapping through progressive vehicle taxes – higher taxes for older vehicles – makes the average lifetime for cars to go down from around 16 years today to 9 years. This increases the sale of new cars from an average of 220 000 during the last ten years [SIKA 1998] to 510 000 in 2026. In BAU the number of cars are assumed to be about 10% higher than in EST3 [SAMPLAN 1996] but with the average lifetime of today the yearly sale increases slower to about 310 000 in 2026. The car sale is thus 65% higher in EST3 than in BAU.

With the assumptions of:

- no changes of the markets outside Sweden;
- today's market-shares for Swedish-built cars; and
- a domestic sale share of approximately 25% of cars manufactured in Sweden [Volvo 1998; SAAB 1998].

this means an increase of value-added by 15% for the car manufacturers in Sweden. The assumption of no changes of the markets outside Sweden (business-as-usual in the rest of the

world) also means that there exists a market for used cars outside Sweden and the influence of the scrapping program on the citizens total consumption budget can be neglected.

Car trade (50.2).
The value-added is assumed to increase as much as the domestic car sales, that is 65%.

Car repair (50.2).
The change in value-added for car repairs is assumed to follow the car-use changes. The change in passenger kilometres of –29% is followed by slightly higher car occupancy in the EST3 scenario which means that the car use and the value-added for car repairs goes down with 30%. Including heavy freight vehicles the decrease will be slightly less. Including car trade the sector car trade and repair is assumed to get no change.

Railway industry (60.1).
Changes in value-added for railways and related industries are assumed to be proportional to the changes of passenger kilometres. The railways are assumed to increase its traffic work with 18% for passenger traffic in comparison with the BAU-scenario.

Tourist industry (63).
Higher costs for air travel reduces the charter traffic from Sweden. The number of foreign tourists to Sweden will also be reduced. As Sweden has a negative "tourism balance" this is more than compensated by more domestic tourism. The tourist industry is assumed to increase its value-added with 15%.

Aviation industry (62).
In the Swedish EST3 scenario the rest of the world is supposed to follow BAU. As the airplane manufacturing industry is only partly dependent on Swedish civil aviation and as the competition with other modes primarily influences regional short distance connections, it is assumed that the value-added decrease is less than proportional to the change in passenger kilometres. The value-added for the aviation industry is assumed to be 20% lower in the EST3 scenario than in BAU.

Freight transport

Road transport vehicles industry (34-35).
The change in value-added for the road transport vehicles industry is assumed to be proportional to the changes in tonne kilometres for the parts of the industry that are dependent only of the Swedish market. With the assumption of no change outside Sweden and a domestic sale share of about 10% of the Swedish production this means a decrease of value-added by 1% for the vehicle manufactured in Sweden. The weighted average for car manufacturers in Sweden is assumed to be an increase of approximately 10%.

Road freight (60 others).
The change in value-added is assumed to be proportional to the change of tonne-kilometres, i.e. –16%.

Rail freight (60.1).
The change in value-added is assumed to be proportional to the change of tonne-kilometres, that is 12%.
The weighted average for railways is approximately 16%.

Water-borne freight (61).
The changes in tonne-kilometres and in value-added are assumed to be neglectable.

Forwarding agencies (63).
The higher efficiency in the freight sector is assumed to be created through more efficient forwarding agencies. The market for service companies supporting freight transport - "transport brokers" – is assumed to increase with 15%.

Retail trade and wholesale business (50-52)

The Swedish EST3-scenario is heavily dependent on fuel price increases. The total expenditures for fuel will, with respect to changes in fuel consumption per km, increase with approximately 11%. The consumption budget and the value-added in retail trade and wholesale business can thus be assumed to decrease with about 1%.

Production of biofuels

In 2026 more than 20% of the energy used in the road traffic comes from engine alcohols. The alcohols are to a great extent (1 million m^3) produced in Sweden. The production is assumed to employ 7000 persons, the production value to be about 2 billion SEK and the value added approximately 1.2 (relation value-added/production value assumed to equal to agriculture and forestry).

Table 5.2. Changes in value-added in directly affected sectors for the BAU- and EST3-scenario
(Billion SEK)

SNI-code	Economic sector	Value-added BAU	Value-added EST3
60.1	Railway companies	6	7
60 others	Other land transport companies	48	40
61	Shipping companies	14	14
62	Air transport companies	12	9
63	Service companies supporting transport	22	25
34-35	Industry for transport equipment	49	53
50.2	Garages for motor vehicles	19	19
50-52	Wholesale and retail	215	213
nn	Production of biofuels	0	1.2

The changes in final demand are because of lacking IO-tables with a suitable disaggregation for the transport sector roughly estimated to be proportional to the changes in value-added. The results are given in Table 5.3.

Table 5.3. Estimated macro-economic impacts of EST3 in directly affected sectors in comparison with BAU. (Billion SEK)

	34-35	50.2+60o+nn	60.1	62	63	50-52	61	
	Vehicle manufact.	**Second. car business**	**Railway industry**	**Airline industry**	**Touristic industry**	**Retail business**	**Shipping companies**	**Total**
Gross Prod. Value BAU	158	135	18	27	39	325	46	748
Final Demand BAU	136	116	15	23	34	293	40	657
Change in value-added compared to BAU (%)	10	-11	16	-15	15	-1	0	
Change in Final Demand compared to BAU	14	-13	2	-3	5	-3	0	2

6. Aggregate economic indicators – Level 5

On the level 5 of the Impact Path Analysis the results from level 4 are extrapolated by including multiplier effects to calculate the changes of the gross production value for the affected economic sectors. The calculations are based on the assumption that the economy is underemployed to such a degree that multiplier effects may occur.

The total change of the national income can be derived from the final demand using a multiplier formula from national econometric analysis. The multiplier can vary between 1.2 and 1.6 depending of the level of unemployment [OECD, Rothengatter, 1998b]. For Sweden we have used a multiplier of 1.3.

The changes in production values for the different sectors are calculated using multipliers for the direct and indirect effects. Including the indirect effects means that the influences of changes in the transport sector on other sectors of the economy are considered. The multipliers are derived from Rothengatter [1998b].

Table 6.1. Multipliers for direct and indirect effects of changes of the economic activity in the transportation sector

	Vehicle manufact.	**Second. car business**	**Railway industry**	**Airline industry**	**Touristic industry**	**Retail business**
GPV,direct	1.33	2.08	1.74	1.88	1.63	1.10
GPV, direct + indirect	2.50	2.75	2.18	2.20	2.18	1.61

The results are displayed in the first three rows of Table 6.4.

The employment for BAU is based on data for 1995 [SCB 1997]. The employment growth is extrapolated from a forecast for 2010 conducted for the SAMPLAN-study [Lundkvist *et al*. 1995].

Table 6.3. Employment in transport related sectors for 1995 and the BAU-scenario for 2026/2030

SNI-code	Economic sector	1995	BAU 2026/2030
60.1	Railway companies	18 800	18 400
60 others	Other land transport companies	98 900	96 900
61	Shipping companies	18 100	17 700
62	Air transport companies	21 200	20 800
63	Service companies supporting transport	59 000	57 800
34-35	Industry for transport equipment	91 800	81 700
50.2	Garages for motor vehicles	27 100	26 600
50-52	Wholesale and retail	482 700	444 100
	Total transport, wholesale and retail	817 600	764 000
	Total employment	4 079 000	4 925 000

The labour productivity is calculated from the gross production value and the employment for each sector. The employment change is finally derived from the changes in production values and labour productivity.

Table 6.4. Change in macroeconomic indicators from BAU to EST3
(Billion SEK and thousand employees)

	Vehicle manufact	Second. car business	Railway industry	Airline industry	Touristic industry	Retail business	Total
Tot. Ch. Nat. Income	18,5	-17,2	2,6	-4,0	6,6	-4,0	2,6
Ch. GPV dir.	24,6	-35,7	3,5	-5,6	8,2	-3,3	-8,4
Ch. GPV dir+ind.	46,2	-47,2	5,8	-8,7	14,4	-6,4	4,1
Employment BAU	81.7	123.5	18.4	20.8	57.8	444.1	746.3
Labour Productivity (MSEK)	1,93	1,09	0,98	1,30	0,67	0,73	
Ch. Employment	23,9	-43,2	5,9	-6,7	21,3	-8,7	-7,5

The results show that the changes assumed in the Swedish EST3-scenario have a minor effect on employment. The total loss of employment is 7 500 corresponding to –0.15% of the total employment in Sweden. The overall effects on the economy are also very small. The change of national income is approximately +0.2%.

This is the result of a static analysis and does not take into account any dynamic changes of the production technology induced by the environmental policy of state. According to [Rothengatter 1997] this can have a number of positive side effects: Technical progress can be fostered to save resources or the income from ecological taxation can partly be used to reduce labour costs (“green taxation” or “skatteväxling”)

7. Discussion / Conclusions

The analysis of major changes of a distant future situation is an almost overwhelming challenge. The uncertainties in forecasting over such a long period of time is of course very large. The results should therefore not be interpreted as traditional forecasting but as an example of what could be the consequences of a certain package of policy measures leading in the direction of a sustainable transport system. The long time period means of course that there are many opportunities to make changes in the evaluation of consequences and of the chosen policies.

With all uncertainties in mind some conclusions of the analysis of the Swedish EST-scenario can be drawn:

- The influence on employment must not necessarily be large.
- The analysis shows a small decrease, 0.15% of the employment of the assumed measures.
- The impact on the total economy seems to be very modest with a change in national income of less than one percent.
- The EST scenario has an important impact on road and air traffic, which decreases with approximately one third. The environmentally more friendly modes will instead increase. The railways will for example increase with 10% in freight transport and 20% in passenger transport.

It should be noted that the economic analysis is made on the level of national accounts and national employment. On that total level the impacts are very small but the changes are not evenly spread among the different sub-sectors. The economy would be subject to important changes with major consequences for the employment in industry related to air and road traffic.

The analysis has not explicitly treated welfare consequences. The assumed measures has an influence on accessibility and of the distribution of costs and benefits over regions and different socio-economic groups, that must not be neglected.

By assessing the analysis some points should be noted and further discussed:

- The Swedish base-scenario assumes that there will be improvements in the energy efficiency and other improvements of cars, air-planes, trains and ships. The base-scenario also includes a significant number of infrastructure investments not least in the rail sector. “Business As Usual” in the Swedish study accordingly means future improvements in – at least - the pace of today. The changes necessary to reach EST3 must accordingly be added to the not neglectable changes in the BAU.
- The measures proposed by the NORDPLAN study are to a great extent concentrated upon the price instrument. Through that both the technological development and the behaviour of the individuals are influenced. NORDPLAN has consciously chosen a perspective where the transformation of the transportation system is treated as a political problem. The possibilities that the population’s values – life style – could be changed with different measures is accordingly not focused. It is also a pronounced starting-point that no technological “revolutions will occur. The measures are based on a modest development of known technology.

- The "educational" side concerns mainly to create acceptance for the internalisation of external costs. Brokking et al states that "a successful transition to an environmentally sustainable transport system presumes a gradual upgrading of the ambition to make the society as a whole sustainable. If environmental sustainability does not achieve the status of a prime national goal, the prerequisites for realising a transport system that fulfils the … given goal will be lacking." The authors has therefore described the scenario as a transformation in three phases: the acceptance phase, the adjustment phase and the implementation phase. This process concerns the transition of the society as a whole to new priorities. The transition concerns though primarily to make people accept the use of price instruments to achieve the environmental goals.

- The results from the Swedish study cannot easily be generalised to a global level because of the assumption that the rest of the world is developing according to BAU.

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APPENDIX 1

This appendix summarises the instruments introduced in the acceptance, adjustment and the implementation phases, according to the overall scenario. Thus, it includes all instruments bearing on the goals that characterise an Environmentally Sustainable Transport system.

Instruments introduced during the Acceptance Phase:

- In the effort to limit carbon dioxide emission, it is decided to **raise the fuel tax by $0.30 per litre of gasoline**. As a compensatory measure, **the vehicle tax is abolished**.

- In connection with the fuel tax rise, it is decided to introduce **a time-limited scrapping programme for passenger cars without catalytic converter.** $1,500 will be paid for up to one year after the introduction of the fuel tax rise to car owners who turn in their car without catalytic converter for scrapping.

- In order to eventually not only slow down the increase of carbon dioxide emissions but also to achieve a permanent reduction, the government decides on **low-level admixture of bio-based engine alcohol in all gasoline sold in Sweden**.

- With the Norwegian capital Oslo as a model, the decision is made to introduce **local traffic tariffs in Sweden's three largest cities**. Motorists are forced to pay a fixed fee every time they cross the tariff lines that enclose the central areas of these cities.

- In maritime shipping, **bilateral agreements** are signed with the neighbouring countries Finland, Denmark, Germany and Poland that **sulphur content may not exceed 0.5%** in the oil used in ferry traffic between them and Sweden. The agreement also means that **ships used for ferry traffic must be equipped with catalytic converters**. In addition, the agreement is supplemented with an **operating fee** for ships that do not fulfil the requirement but sail in Swedish territorial waters.

- To bring about an adaptation towards the best airplanes in terms of noise, **an increased noise differentiation of landing fees is adopted**. When the noisier so called Chapter 2 aircraft are phased out in 2002, continued reduction of noise levels is assured by a decision that **landing fees will be differentiated between that half of Chapter 3 aircraft using Swedish airports that are quietest and the half that is noisiest**.

- To reduce the risk that the number of people exposed to noise rises as a result of too short a time perspective in the planning of new construction, it is decided that **agreements on the planning of new buildings in the vicinity of airports will be drawn up between the airport administration and the affect communities**. The purpose is to guarantee the

possibilities of expanding aviation facilities without having to increase the number of people exposed to noise.

- To obtain a better overall view of both traffic and infrastructure, to achieve a more effective use of resources, and to better safeguard the interests of natural and cultural environments, **an organisational change in infrastructure planning in some selected regions** is carried out. This change is intended to increase regional and political influence on the planning of the infrastructure.

Instruments introduced during the Adjustment Phase:

- A decision is made to **increase the admixture of bio-fuels in gasoline.** In addition, from now on there will be **admixture in diesel fuel as well.** To prepare the way for a possible future spontaneous introduction of bio-fuels, among other things, **a certain percentage of pure ethanol vehicles is required** in the automobile fleets of government departments and authorities, and **a certain amount of pure ethanol operation in urban bus traffic is also stipulated.**

- An increase in the carbon dioxide tax is introduced. It occurs in the form of a programme that stipulates an annual increase in the carbon dioxide tax on gasoline by ca. $0.06 per litre from 2005 to 2015. The carbon dioxide tax on diesel oil is raised by ca. $0.07 per litre annually. This programme is partially goal-governed.

- At this point in time, the principal problem in urban areas is defined as noise. The decision is made that **traffic tariffs in the environmental zones can be scaled according to the noise problems that exist.** The tariff can thus vary both in time and in different zones. **Passenger cars are included in the environmental zone system and the size of the fee is related to each car's environmental performance.** Vehicles not fulfilling the basic environmental demands are excluded from the zones. Also introduced is **a system of automatic emission monitoring.** Equipment is installed at the entrances to the environmental zones that measures the amount and composition of emissions from entering vehicles.

- A decision is made on **a programme for scrapping.** This is done by **reintroducing the vehicle tax.** A progressive vehicle tax applies for vehicles more than 8 years old. For vehicles more than 12 years old, the decision implies a vehicle tax that is almost prohibitive. Vehicles more than 8 years old are not allowed into the environmental zones.

- A voluntary agreement between the auto industry and the government signifies that all cars beginning with the 2005 models must be equipped with **pre-heaters for the catalytic converter** so that the cold-start emission will be reduced by 50% as compared with conventional operation.

- In order to further limit the environmental impact of maritime shipping, **the bilateral agreements are expanded to include all ships operating in Swedish territorial waters.** In addition, with regard to ferry traffic, stricter limits are set on the sulphur content of fuels.

- On the European level, a decision is made to **increase the emission requirements for heavy vehicles.** The permitted emission of regulated air pollutants is reduced to what is stated as possible EURO IV requirements.

- To accelerate scrapping of two-stroke engines in pleasure boats, and hence bring down hydrocarbon emissions, **people who scrap their two-stroke engines are given a scrapping premium over a period of 5 years.** At the same time, it is decided that **two-stroke engines may only be used for another 10 years.**

- Regarding the problem of noise pollution caused by aircraft, there is in this phase no alternative other than to **relocate the noisiest airports.**

- To strengthen conservation interests, there is **a revision of the planning and building law.** This means that the landscape is divided into three categories according to the strength of the conservation interests. In addition, the government's regional organs, the county councils, are given a stronger role as custodians of environmental interests in planning infrastructure.

Instruments introduced during the Implementation Phase:

- In order to achieve a significant quantitative reduction in the emission of carbon dioxide, **a decision is reached on a system of emission rights.** The rights to emit carbon dioxide are auctioned off to the distributors of fossil fuels. The decision includes road, maritime and air transports. How the rights are to be distributed among the different modes of transport is decided by Parliament.

- Public sector purchase of transport services is bound to observe a **requirement for pure ethanol operation**.

- The steadily growing number of diesel-powered vehicles has in and of itself made it easier to adjust to the carbon dioxide goal. However, the emission of nitric oxides proves to have reached alarming levels. Therefore, **vehicle taxation is changed so that it is no longer favourable to purchase new diesel vehicles**.

- The enhanced demands on sulphur emission which previously applied only to ferry traffic, are extended to include all ships trafficking Swedish waters. Simultaneously, the prescribed values for nitric oxide emissions by ships are additionally tightened.

- Noise continues to be the principal problem in urban areas. **Strict noise requirements are introduced for vehicles used within the environmental zones.** During a 5-year transition period, however, the use of vehicles that do not fulfil the noise requirements is permitted. But these vehicles are required to pay **a drastically increased fee for permission to enter the environmental zones**.

- In order to further reduce the emission of air pollutants, traffic supervision by automatic emission monitoring, previously used only when entering environmental zones, is amplified. **A decision is made to introduce an equivalent system throughout the country**.

- To cope with the problem of air traffic noise the only remaining solution is to reduce the number of flights. At every airport, the numbers of takeoffs and landings that can be permitted without exceeding the guidelines for aviation noise are estimated. **Takeoff and landing rights are sold to the airlines that make the highest bids**.

- In order to better safeguard conservation interests, **the number of landscape categories in the planning and building law is reduced from three to two**. In concrete terms, this means

that a reverse burden of proof applies to an expansion of the infrastructure: the responsible authority must be able to prove that a planned expansion will not impact on either natural or cultural environments to an unacceptable extent.