

## **GROWTH SCENARIOS AND CORRESPONDING EMISSIONS FOR THE TRANSPORT OF GOODS BY TRUCK AND TRAIN IN EUROPE**

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### **SUMMARY**

Two socio-economic scenarios are constructed to show the economic development trends in the 12 EEC countries plus Switzerland until the year 2010. These scenarios are the background for future growth of goods transport, where a policy shift with regard to road transport is also being simulated. In combination with different emission abatement policies in the two scenarios, the contribution of the policy changes assumed in scenario 1 becomes clearly visible.

### **1. SOME DEFINING REMARKS**

Some definitions have to be made at the beginning. The "fashionable" word scenario needs such definition first, because it is used today in quite a number of contexts. The concept is actually theatrical in origin, describing the scenic setting of a stage play - its infrastructure, so to speak. In the theatre - as indeed in reality - this can only be modified over a longer period of time; scenarios therefore always describe longer-term developments.

Herman Kahn, the American futurologist who died some years ago, defined scenarios as follows: "Scenarios describe hypothetical sequences of events constructed for the purpose of focusing attention on causal processes and working toward decisions." This definition implies, on the one hand, that scenarios must be conceived multi-dimensionally, i.e. political, social, technological, ecological, demographic and economic factors must be taken into account. On the other hand, they remain hypotheses in the sense that conceivable lines of future development are the reflection of various social and political values and objectives, whose long-term shape cannot be predicted conclusively. A third feature of useful scenarios is the inherent consistency of the development picture they provide; after all, scenarios are not intended merely to paint attractive pictures, they are supposed to assist in decision-making. However, allowance must be made for the fact already mentioned above, namely that there are in principle a large number of conceivable routes into the future, so that on a longer-term view only a few of the possibilities for future development (of the world, a country, or parts of it ...) can be outlined.

Secondly, our analyses comprise the 12 EC countries plus Switzerland. We would have liked to include a larger number of countries. The main problem here is however the availability of comparable statistics. Within the EC the Statistical Office has prepared such a data base which serves our purposes well. The data for Switzerland could be adapted to the underlying definitions. Other statistical sources, mainly OECD/ECMT, proved to show quite important differences when compared with the EC-data, which could not be cleared up satisfactorily.

Finally, our analyses are dealing mainly with goods transport by rail and truck. Data on barge transport arrived too late to be included in our calculations. With goods transports by plane the question arises which routes would have to be included, leading again to severe statistical problems. To be sure: train and truck together represent by far the largest transport flows. A change of shares in goods transport between these will have by far the largest effect on emissions.

## 2. TWO DIFFERENT SCENARIOS

While forecasters are largely in agreement about the economic trend in the year to come, opinions diverge on the question of economic development beyond that, i.e. in the longer term. Some expect the economic situation to improve again with time, while others predict a further deterioration. One could, of course, take the standpoint that there have always been pessimists and optimists, so the "truth" should turn out to be somewhere between the two extremes. In this case this approach is not valid. The differences of opinion we have referred to are not simply a matter of viewing the development outlook for the global economy through spectacles of different hues. The widely diverging views of development prospects are based much more on two fundamentally different - but equally possible - economic and political approaches. One reading is based on the idea that the forecast slackening of growth throughout the world is not the result of the economic cycle, but rather a reflection of errors made at all important decision-making levels in business and politics. The slowdown - according to this version - represents the foretaste of an impending development crisis which will break out sooner or later as the inevitable consequence of an increasing build-up of unresolved structural problems, since the will to solve these problems is largely absent. This would need a much greater degree of international cooperation, a more consistent economic policy, more deliberate government encouragement of structural change, a greater appreciation on the part of sectional interests in business and politics that in a national economy no more can be distributed than is produced, the willingness of employees in all positions and functions to accept a higher degree of job mobility, and finally an increase in corporate innovation. Since these conditions do not exist to a sufficient extent at present, only a genuine crisis situation can induce the insight, the good sense and also the will of people involved in the economy vigorously to seek a solution to the urgent existential structural problems by a change in their attitude, rather than merely postponing the action that needs to be taken.

Diametrically opposed to this is the view that the slackening in economic growth which is generally foreseen for one of the next years is of a temporary nature. A kind of "breathing space" before a renewed "take-off", especially by the western European economies, which have very noticeably lost momentum since the break in the trend which occurred in the 'seventies.

These two views obviously differ in their assessment of the process of structural adjustment to which all national economies are subject due to the fundamentally different and continually changing basic conditions in the global economy. There can be no disputing the fact that this process of adjustment has been too little encouraged in almost all western European countries. On the contrary, in many cases it has been hampered, not to say prevented. On the one hand by defensive corporate strategies designed to protect existing production structures, which have also been largely supported by the trade

unions; on the other by government policies which attempted to maintain structures which were no longer internationally competitive by means of extremely costly supportive intervention. The situation on the western European labour market, where millions are unemployed for structural reasons, indicate that the national economies in this region still have a backlog of adjustment to cope with. This adjustment backlog is related to all three of the basic directions of development mentioned above, i.e. global markets, European integration, and the inevitable adjustment to the overall conditions prevailing on "spaceship Earth".

Viewed from this standpoint, two different development scenarios - as outlined in figure 1 - can be derived for the future of our national economies. Which of these actually materializes will depend upon our response at all relevant decision-making levels in business and politics, and especially on our attitude to structural change in the economy and the processes of adjustment this requires.

1. One scenario leads to healthy further development of our national economies on qualitatively strengthened structures adjusted to the fundamental changes in the world's economic and ecological environments. However, this development path presupposes passing through a "lean period" during the next 3 to 5 years, since coping with structural change involves the kind of adjustment difficulties and problems we have described in the short term.
2. The other scenario - which is characterized by defensive action by employers and employees, as well as massive government intervention to maintain the status quo - will lead to an existential structural crisis in the long term. On the other hand, in the short term, action of this kind can enjoy a certain degree of success, which is why there is a danger, in the final analysis, of taking the wrong path - both in business and in politics.

### 3. SOME BASIC TRENDS

As already mentioned, scenarios must start out at the global level in order to take into account the impulses directed at our countries. It also has to be borne in mind that the current situation of the European industrial countries cannot be viewed only in rosy tones. A number of problems have to be faced and the rather frantic rounds of summit diplomacy has done little towards finding a solution to date. In the medium term three areas are apparent which - depending upon the emphasis placed on them - will affect the environment of our economy to varying digress in future:

- On the one hand it must be noted that the emerging global economy and the growing importance of the development process mean that the third world is an increasingly significant factor in all spheres of economic activity on both the economic and the political plane of the world economy as such; the narrowly national view has declined markedly in importance. However, it is impossible to predict the pace and direction of this process.
- The integration process taking place within the EEC is also working basically in the same direction. The discussions now under way regarding the enlarged European house including with different intensity some countries of the comecon past, will finally have strong quantitative effects and show also qualitative impact on the economic development in all European countries. Since nobody actually can foretell what will happen on the political stages we

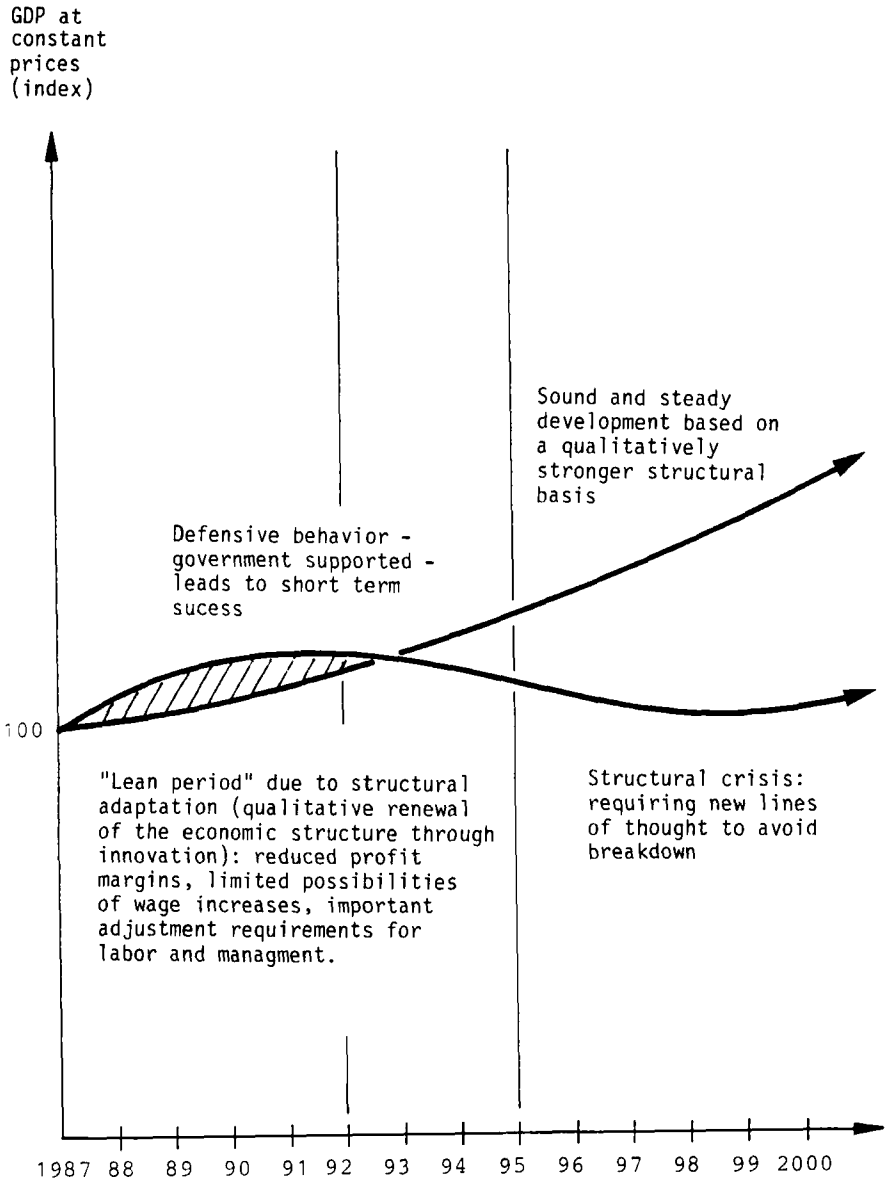


Fig. 1. Two possible development scenarios for the nineties

can only reflect differing decisions in our scenarios. In principle, therefore, there are still four conceivable routes open to Europe on the basis of a differing combination of the degree of liberalization both within the single market itself and in its relations with non-EEC countries. Although GATT agreements restrict the freedom of action of the individual countries and of the European Commission - especially as regards the international exchange of merchandise - a large number of hitherto bilateral arrangements are also in force in this area, and the international exchange of services is not yet even included. In schematic form, these possibilities can be characterized as shown in figure 2.

		Relations of EC to other countries	
		Liberal	Restrictions
Relations between EC countries	Liberal	Start as planned "Adjusting" I	Seclusion "Fortress Europe" III
	Restrictions	Retardation "Rougher going" II	Trade wars "Hostile Fortresses" IV

Fig. 2. Possible routes for the EC

- Thirdly, it must also be emphasized that the social and political foundation on which economic development has been able to unfold securely over a long period has lost some of its stability. Not least under the ecological threat of climatic changes and an increasingly hostile attitude to technology, there has been a marked shift in the socio-political environment! Economic and political attitudes reflect these changing social values, but follow them only with more or less of a time lag. Value systems have thus become less stable: values are in the process of changing, but there is little or no sign of the re-thinking process that must take place if people are to act in everyday life as required by changing moral concepts. On the contrary, broad sections of the population, despite loud protestations in favour of a "better environment" and a more economical use of resources, continue to indulge in a hedonistic philosophy directed towards consumption with a so far undiminished and indeed rather increased fervour. The illustration shows that, during the past ten years, consumption has tended to increase at a higher rate than the long-

term trend. The demand for individual freedom - in spite of many appeals and demonstrably harmful effects - continues unabated and, taken together with the increasing preference for the private car, for example, makes it safe to deduce that the protection of the environment is something that is preferably left to "the other fellow". The assertions heard from time to time that these ideas are receiving more attention today is still in flagrant contradiction to reality.

#### 4. THE UNDERLYING SCENARIOS

For our analyses of future trends in goods transports in Europe two scenarios have been developed. These differ primarily in the readiness and the will to pursue vigorously a solution to the existing ecological, social and economic problems.

##### 4.1 Scenario 1: structural problems and adjustment

Scenario 1 assumes that appreciation of the global development problems and recognition that these cause structural problems in the western economies will result in social and political reactions, and that there will be a gradual change in the socio-economic environment which will occur initially on the social and political plane. The stalemate often encountered on the political plane in dealing with problems can be broken, even allowing for the inevitable need for adjustment. A development of this kind assumes in particular that the selfish prosperity which is becoming more widespread in the industrial countries will again take second place to common interest, and that a sense of responsibility extending beyond the sphere of purely personal self-interest will prevail.

In this kind of social environment a process of qualitative renewal of structures gets underway in the old industrial countries, which succeeds at least in mitigating, if not resolving, the socio-economic and ecological problems. The subsequent progress of development then corresponds to the theoretical visions of harmonious economic growth which - supported by broad sections of society - permits governments to implement a consistent, longer-term policy within a system of clearly defined objectives while adhering strictly to the principles of free enterprise. The selective employment of new technologies and the further development of industrial production in the direction of the service economy promotes the transition to processes which are economical with resources, consume less energy and are more environmentally compatible.

The dismantling of arrangements not based on free market principles and designed to preserve positions of power encourages a wave of investment in the infrastructure, which through improvements in systems of supply and automated remote control also permits adjustment in settlement structures and helps to reduce interpersonal barriers through more decentralized structures. Economic development also enables the necessary capital to be made available. A further increase in the division of labor, intensified by the process of integration in Europe (incl. eastern countries), leads to strong growth in traffic demand. Emission abatement policies are enforced throughout Europe, railways claim a larger share of goods traffic. Toward the end of the time span under consideration a slight reduction of goods transports and ton kilometers is achieved.

#### 4.2 Scenario 2: muddling through

In contrast to scenario 1, it is assumed in this scenario that, during the period under study, the western democracies do not summon up the strength to regenerate themselves and to resolve the existing and steadily worsening problems. Small-minded nationalism takes hold, slowing down European integration to a mere crawl. Short-term measures are implemented under political pressure, without reference to their damaging long-term consequences. For example, working hours are reduced across the board in order to contain unemployment, thus impairing still further the competitive position of these countries in the global economic context. Environmental protection and peace movements attempt to force through their demands without compromise, which can result in the political and economic process being brought to a standstill. Missing political will and coherence, the lack of clear cut investment strategies, reduced competitiveness as a consequence of insufficient means and lacking will to perform are the characteristics of this scenario, thus slowing down economic development as well as the possibility to introduce effective policies to reduce ecological problems.

Slower economic development than in scenario 1 also reduces growth of traffic demand, deferred structural adjustment, however, leads to a continuation of transport growth after 2005, thus reaching approx. the same levels as in the more dynamic scenario 1, which is characterized by a much higher degree in efficiency with regard to production processes, logistics or use of resources

### 5. SOME QUANTITATIVE RESULTS

#### 5.1 Development of goods transports

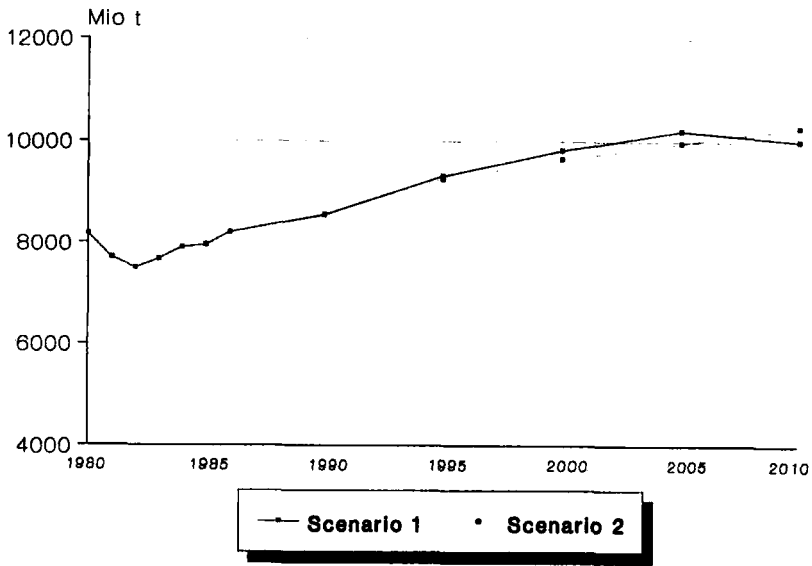
The calculations are based on a simple model of regression analyses. Analyses (whenever possible) have been made on a gliding time scale in order to introduce parameter changes according to the different economic development of the two scenarios as well as to reflect structural change. Calculations are made on the level of the different countries as well as for the EC as a whole, in order to double-check the shares of the different countries. Break down into rail and road transport is based on regression techniques in Scenario 2, thereby continuing past trends, whereas in Scenario 1 deviating policies as well as infrastructural developments are simulated based on a shift-and-share method<sup>1</sup>. We have chosen this direct approach because with this analyses we only try to show rather rough tendencies as well on the level of goods transports as with respect to the effectiveness of emission abatement policies. This is also why we deem the analyses of train and truck flows as representative for the problems posed in this field.

Results of these calculations are best reflected in graphical form. The following figures contain the relevant information, comparing the results of the two scenarios. The policy shift comes to show very clearly when regarding goods transports by train. In scenario 1 volume of goods transports by train is about one third higher than in scenario 2 in the year 2010, whereas ton kilometers are even expected to be nearly 50 % higher. While this can be regarded as a massive change from the viewpoint of train transports,

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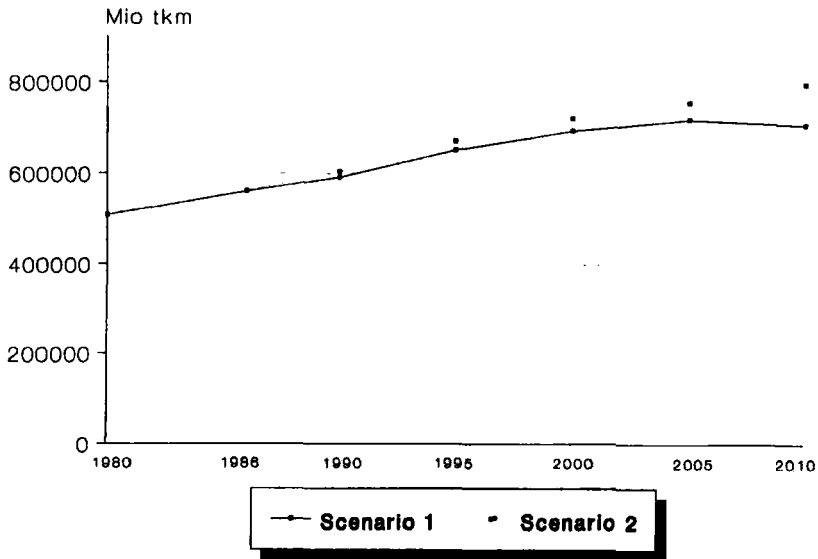
<sup>1</sup> For Switzerland a more detailed approach was used as outlined in: Graf, H.G.: Perspektiven des Schweizerischen Verkehrswesens, Teil 4 Güterverkehr-Perspektiven 1985-2010, St. Gallen 1988

### Goods traffic EC + CH road



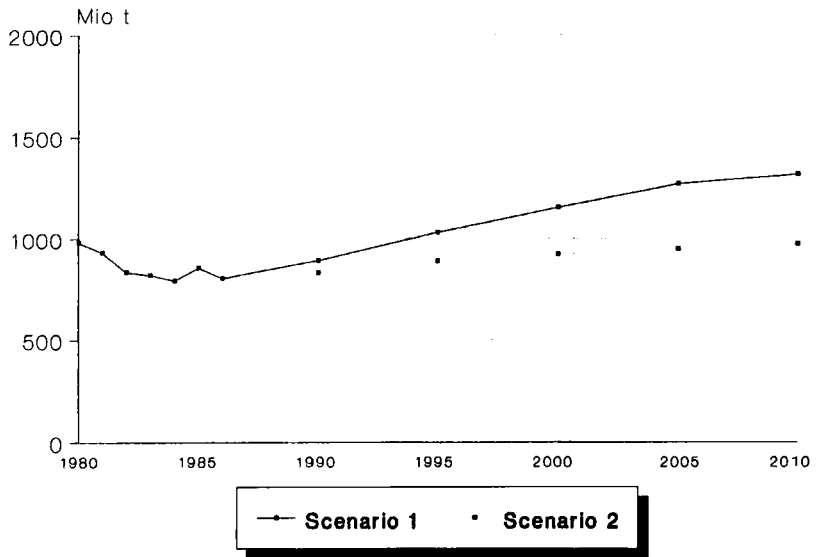
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### Goods traffic EC + CH road



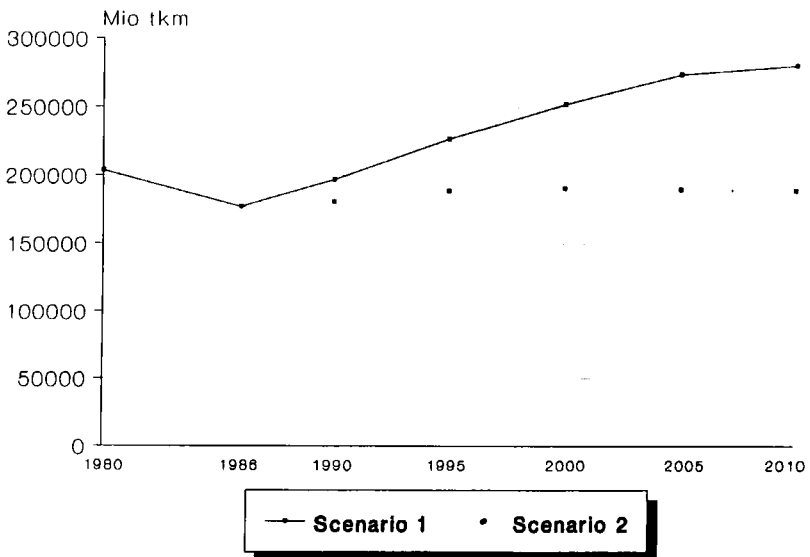
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## Goods traffic EC + CH rail



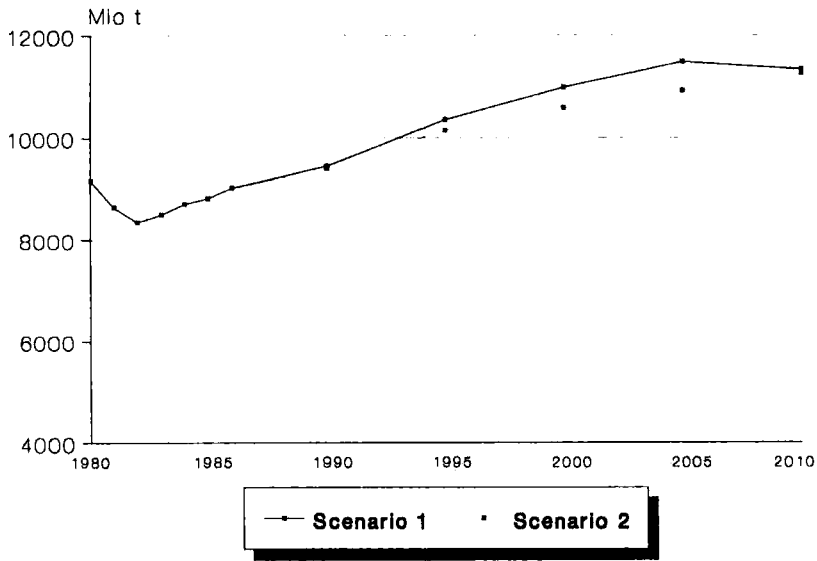
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## Goods traffic EC + CH rail



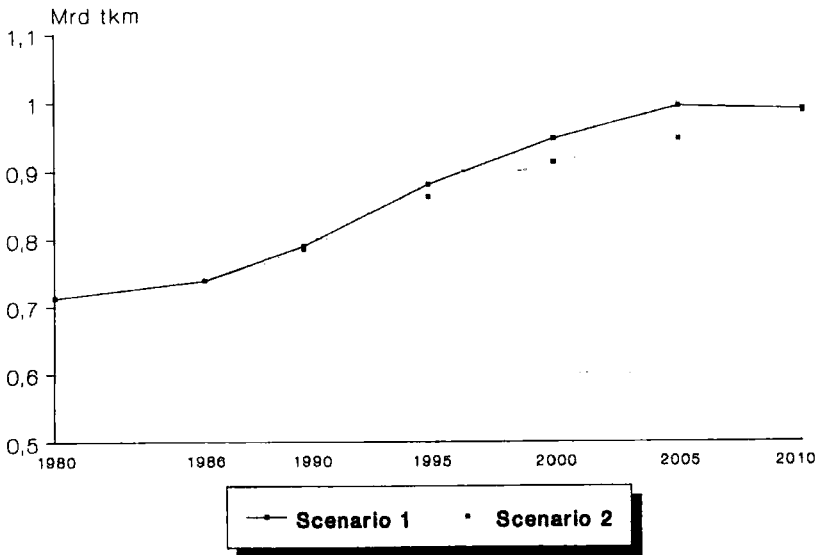
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### Goods traffic EC + CH rail and road



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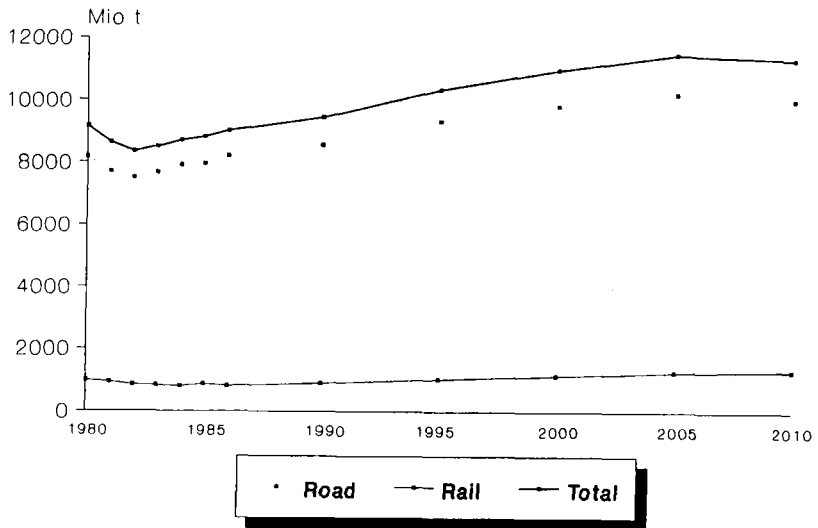
### Goods traffic EC + CH rail and road



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## Goods traffic EC + CH

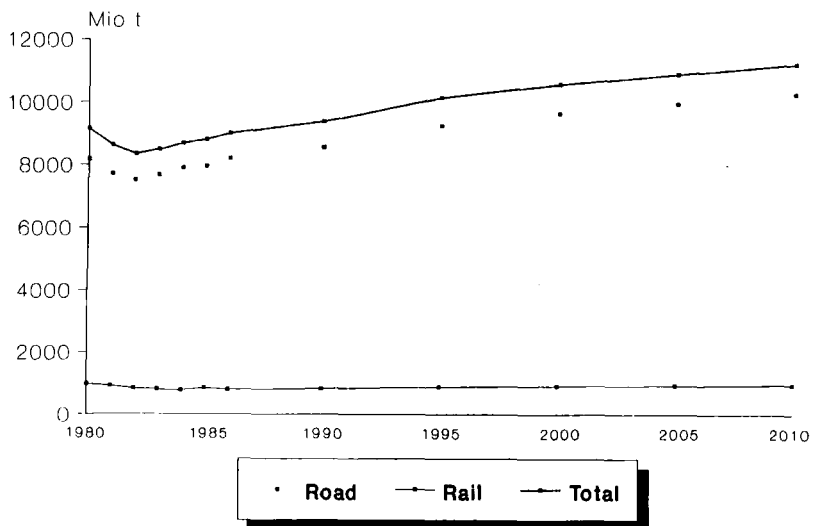
Scenario 1



(c) SGZZ/bwv

## Goods traffic EC + CH

Scenario 2



(c) SGZZ/bwv

for transports by truck the difference seems only minor (3 % in 2010). In combination, however, with different emission abatement policies in the two scenarios the contribution to an improvement of the environment becomes more visible.

## 5.2 Corresponding emissions

Calculations of the emissions corresponding to the projected development of goods transport as presented above are based on emission factors as supplied by Mr. Rijkeboer from TNO in Delft for road transport. Emission factors used for inland waterway vessels and diesel freight trains draws on work being carried out by P. Bouman and others at the Technische Universiteit Delft. These again have been derived from a CBS publication<sup>2</sup> which analyses these factors by different types of vehicles for good transports, different fuels and several types of traffic flows. These factors partially are further broken down by weight and age of the trucks.

In order to link these two sets of figures, it is therefore necessary to have functions which distribute the total freight volumes between categories of vehicle and categories of road type. Distribution functions have been estimated by Mr. Pearse using data from a number of different sources. Some additional remarks are deemed necessary:

- As far as rail is concerned, an apportionment was made for each country between diesel and electric traction on the basis of figures from EUROSTAT for the base year. A certain amount of further electrification in the future was assumed.
- For electric traction, emissions arising indirectly in generating the necessary electricity were attributed to the transport of freight by this relevant substance per KWh generated in the given country for the given year. This was obtained from the study Energy 2010 over the period of interest. Arguably this should be done using emissions in respect of the fuel used in respect of marginal demand, but this is not very practical.
- The emission factors for road vehicles supplied allow for the expected tightening of the NO<sub>x</sub> standard for diesel engined vehicles in 1992/93 and 1995/96, and can therefore be regarded as allowing for a minimum NO<sub>x</sub> reduction. These factors were therefore used in estimating emissions under scenario 2. In scenario 1, a further reduction was allowed for, corresponding to the maximum reduction which is thought to be feasible with existing engine design. Scenario 1 has also been evaluated using lower NO<sub>x</sub> emission factors, the values of which are rather speculative, and assume further reduction technology, e.g. catalytic reduction ("Scenario 1 with further NO<sub>x</sub> abatement"). Scenario 1 also assumes that more efficient locomotives will be introduced for rail freight.

Given the set of data and assumptions the following six cases of emission estimates have been made for each country of the EEC and for Switzerland:

- year 1986;
- year 2000, scenario 1;
- year 2000, scenario 2;

<sup>2</sup> Luchtverontreiniging emissies door wegverkeer 1978 - 1984, Centraal Bureau voor Statistiek

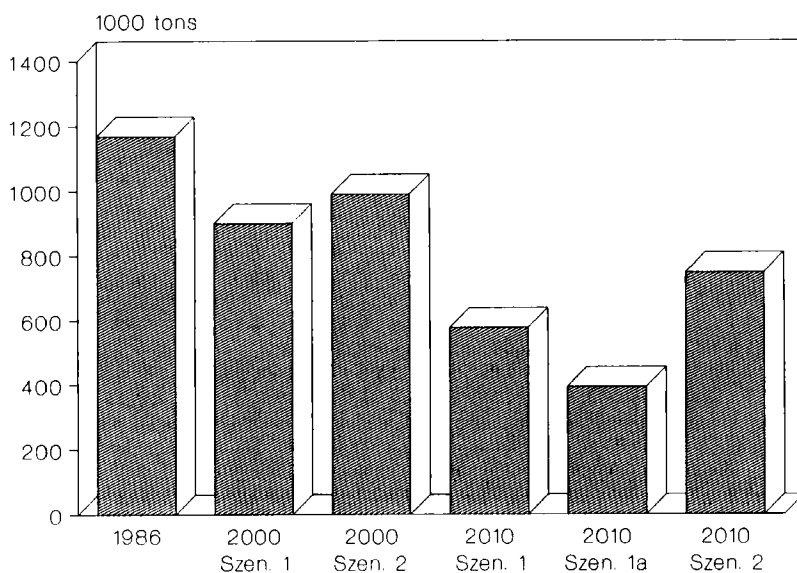
- year 2010, scenario 1;
- year 2010, scenario 1, with further NO<sub>x</sub> abatement;
- year 2010, scenario 2.

The substances looked at are NO<sub>x</sub> (as NO<sub>2</sub>), hydrocarbons (including other volatile and gaseous organic substances), carbon dioxide, and particulates.

The results for the total of the region under analysis are presented for these six cases in the figures below. Scenario 1 leads to lower emissions than scenario 2. This is due to the fact that in scenario 1 emission abatement policies are assumed to be more effective as well as that rail will have a larger role in freight transportation in the future, also as a result of political measures intended to lead to a change in this distribution.

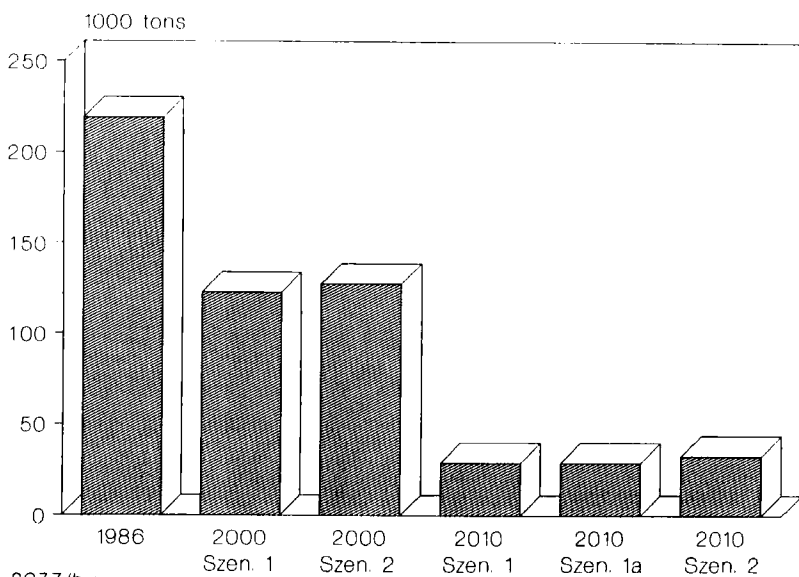
This, finally, is the point where barge transport has to be dealt with. It has not been included in the calculations because the statistical situation in this field is confusing: comparing EUROSTAT and ECMT statistics the latter figures are approx. 20 % higher, although both statistics are not complete. When looking at the data available total volumes transported by inland waterway appear to have remained stagnant since a number of years. As emission factors per ton-kilometer for transport by barge are generally an order of magnitude lower than in respect of road transport a shift of some parts of road transport to barge transport would result in a further decline of emissions of the transport sector as a whole. How large this shift of transports from road to barge might be is partly a political question, would have to be analyzed secondly with a high degree of detail with regard to the aptitude of different goods for barge transport, e.g. given the trend to just-in-time production and transport cycles.

## NOx Emissions



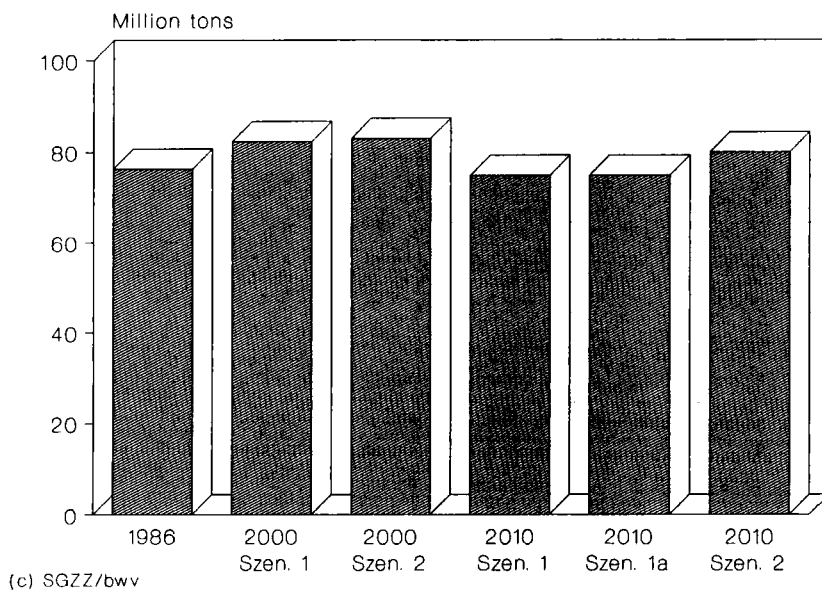
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## CxHy Emissions



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## CO2 Emissions



## Particulates

