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

Volume 2
Case Study: provided by Germany

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).

Umweltbundesamt

University of Karlsruhe (TH)
Institute for Economic Policy Research

OECD Project on Environmentally Sustainable Transport (EST) Phase 3

German Case-Study

Final Draft

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AUTHORS

Umweltbundesamt:

Hedwig Verron
Norbert Gorißen
Michael Jäcker-Cüppers
Paul Klippel
Reinhard Kolke

with assistance of:
Wulf Hülsmann
Andres Lorenz
Petra Röthke

IWW:

Werner Rothengatter
Burkhard Schade
Wolfgang Schade

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OECD PROJECT ON ENVIRONMENTALLY SUSTAINABLE TRANSPORT (EST) - PHASE 3 —GERMAN CASE STUDY—

1. Introduction

This report is part of a project on Environmentally Sustainable Transport (EST) started by the OECD in late 1994 in order to look into way and means to reduce the environmental impact of transportation significantly. Participating countries are Sweden, Norway, The Netherlands, Canada, France, Switzerland, Austria and Germany.

The aim of this project is:

- To identify key criteria for what might be sustainable transport.
- To construct a business-as-usual (BAU) scenario revealing how further unsustainable development in transport may look and three environmentally sustainable transport scenarios which demonstrate different paths towards achievement of the criteria, all of them taking 1990 as the reference year and 2030 as the year for which attainment of the EST criteria is to be achieved.
- To identify packages of policy instruments which enable attainment of the criteria in the EST scenarios.
- To assess these scenarios with respect to their technical, economic and political feasibility.

Phase 1 of the EST project was dedicated to review government programmes in OECD member countries regarding evidence and thinking on transport and environment, and to identify the criteria for EST. The criteria identified to be the most important for a description of EST were carbon dioxide (CO_2), nitrogen oxides (NO_X), volatile organic compounds (VOC), particulate matter (PM) emissions, noise from transport and land use for transport infrastructure (OECD 1996).

The criteria considered in the German case study are given below.

Table 1. **EST Criteria for the German Case Study**

Parameters	Criterion		Specification
CO_2	– 80 %	emission reduction of the transport sector in 2030 compared to 1990	all areas
NOx	– 90 %		
VOC	– 90 %		
PM	– 99 %		urban areas
Noise	<= 65 dB(A)		all areas
	<= 55 dB(A) daytime		residential areas
	<= 45 dB(A) night		
Land Use	criterion has to be developed		urban areas
	no extension of transport infrastructure		rural areas

In phase 2 of the EST project scenarios have been elaborated for every case study describing the year 2030:

The BAU scenario assumes that neither significant policy changes nor surprising technical development will take place in the transport sector. Only those structural changes and technical innovations are assumed that can be expected from today's point of view.

EST1 is the *high technology scenario* in which a purely technical approach is used. All transport activities remain the same as under BAU conditions; the EST criteria are assumed to be met through massive improvement in vehicle technology using alternative fuels and propulsion systems.

EST2 is the *mobility management scenario* where no technology changes are introduced compared to the BAU scenario but only a broad reduction in transport activity; all emission reductions achieved compared to BAU are a consequence of less kilometres driven and less ton or passenger kilometres.

EST3 is combining technical progress and transport reduction strategies to meet the EST criteria. It assumes that less technological progress takes place than in EST1, and that fewer policy changes concerning transport activity are made than in EST2.

Resulting from the backcasting approach the sustainability criteria are met in all EST scenarios.

A synthesis report on Phase 2 of the OECD EST project has been published in1999 (OECD 1999 a) including the individual case studies as an annex volume (OECD 1999 b).

This report now is describing phase 3 of the project dealing with the identification of policy instruments, which enable attainment of the defined EST criteria. The policy package is based on the EST3 scenario as elaborated in phase 2 of the project. Additionally the report contains an assessment of economic implications.

The EST3 scenario is mainly characterised by conventional, but highly efficient technology and nearly zero emissions (EZEV). Fuel consumption of passenger cars will be 2.5 l per 100 km. The EZEV standard will be reached with an internal combustion engine. CO_2 emission of high duty vehicles will be 40 % less compared to EURO 2 level. NO_x and PM levels will be reduced 80 % and 95 % respectively. Similar reduction rates will be achieved by vessels and diesel rail engines. Scheduled bus service will be achieved by half trolley buses and half gas buses. More than half of the electricity used for trolley buses, light rail and rail traffic will stem from renewable sources. Fuel efficiency by aviation will be raised by 55 %.

Technical measures with vehicles, tires and surfaces will result in noise reduction of 9 dB(A) for road traffic and 20 dB(A) for rail traffic.

In terms of transport activity, passenger travel in total will only slightly decrease as compared to 1990, and freight transport will even increase by almost 20 per cent.

Table 2. **Transport Activity**

Billion p-km, t-km	**1990**	**2030 BAU**	**2030 EST3**
Walking, Cycling	53.2	44.9	79.8
Light Rail/Buses	82.6	87	263.8
Railway Passenger	61.5	81	281.8
Cars, Motorcycles	721.9	1057.4	340.4
Airplane	100.3	529.7	41.1
Total Personal Travel	1019.5	1800.0	1006.9
Railway Freight	104.4	104.4	468
Inland Navigation	56	84.6	105
Ocean Ship	845	1501.8	792.3
Road freight	202.2	487.4	63.5
Total Freight	1207.6	2178.2	1428.9

Car traffic is supposed to be less than half the volume in 1990, while public transport grows significantly, by 270 per cent. Transport activity by aircraft is assumed to drop to roughly 40 per cent of the 1990 figure, which means that aviation has to be reduced to the highest degree of all transportation modes compared to BAU.

Figure 1: **Transport Activity - Personal Travel**

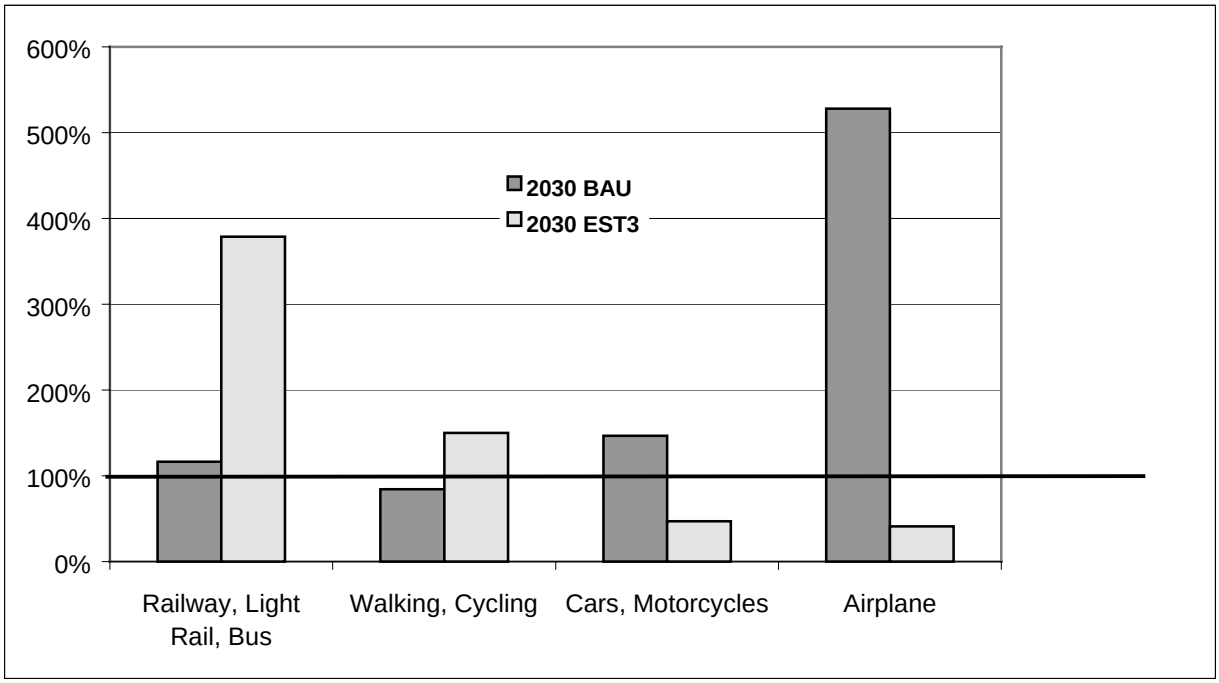
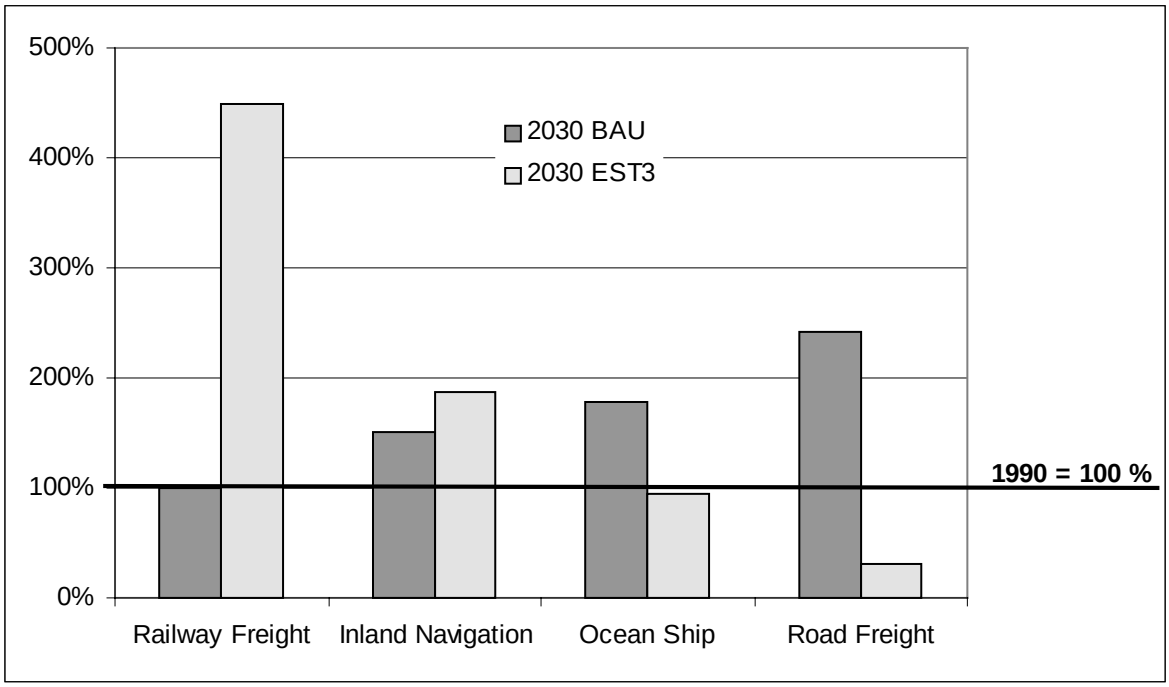


Figure 2: **Transport Activity - Freight**



Long distance freight traffic is assumed to shift mainly to railway and inland waterways. As a consequence, road freight drops down to 30 per cent of the base year's volume.

2. Methodology

Identification and assessment of the instruments necessary to promote EST3 has been accomplished in several steps:

A list of features was established, covering the relevant aspects of EST3. For each of the features a list of instruments is describing the necessary political actions.

In a brainstorming session experts from different sections of the Federal Environmental Agency discussed the impacts of the instruments, using the assessment scheme proposed by Karst Geurs and discussed at the EST Expert Meeting in July 1997.

As a result of the brainstorming, which revealed rather complex impact structures, a separate scheme has been developed, which is simpler in structure but allows to describe and comment the impacts in more detail. The assessment scheme has been filled in by the EST study team and sent again to the experts of the Federal Environmental Agency for comments.

In addition, the structure of impacts has been visualised as a flow chart for every instrument.

These are the features which have been found to be the most important:

- CO_2 emission regulation for all sorts of vehicles.
- Fuel tax rise.
- Road pricing for heavy duty vehicles.
- Traffic calming in towns.
- Improvement of public transport infrastructure and service.
- Improvement of railway infrastructure and service.
- Regional economics.
- Regional tourism.
- Land use.
- Energy supply.

The instruments are selected in order to achieve the CO_2 target, assuming the targets for NO_x , VOC and PM can partly be attained at the same time. This assumption does not hold for noise, so instruments aiming at noise reduction are dealt with separately. Aviation also is discussed in a section of its own, because the instruments considered are solely aiming at air traffic.

The main features and the affiliating instruments are described in the following text. The instrument package described below is demonstrating the main course of action necessary to achieve the targets of EST. There are other instruments not outlined in detail, as for example CO_2 standards for duty vehicles, trains and ships. These standards will be conceived similar to the CO_2 standards for passenger cars.

Exhaust regulation for NO_x and PM for all kind of vehicles will be necessary as well, consequently continuing existing policy.

Assessments of effects are partly based on empirical results or expert rating. Thus the assessments of traffic calming strategies in towns and of improvement of public transport have a good empirical basis. In most cases, however, assessment is based on the experiences of the study team and have not yet been discussed in the scientific community.

The instruments chosen have been discussed for some years already. Their effects are more or less well-known. Thus the strategy proposed is not leaving the spectrum of today's ideas. Nevertheless it might be very useful to think about visions and to analyse the applicability and effects of innovations. Why not use wind energy for ocean ships for example[1] or zeppelins for freight transport. Research is an important part of the EST strategy and attention should be paid even to unusual solutions.

3. CO_2 - reduction of ground transportation

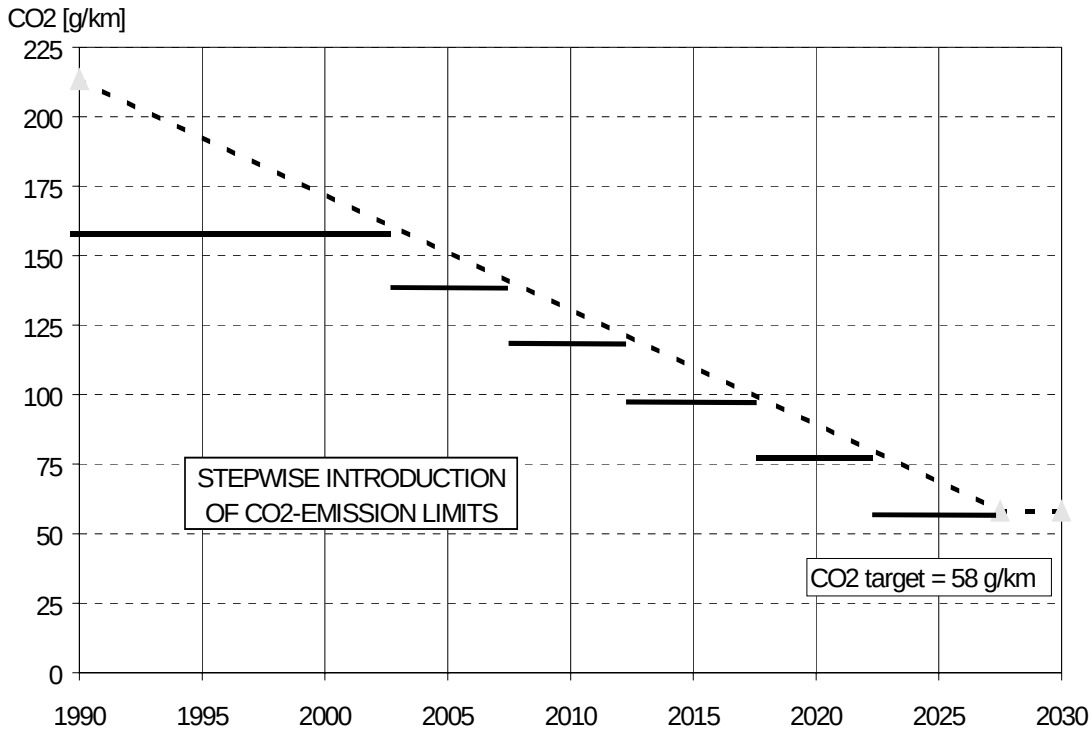
3.1 CO_2-standards for passenger cars

CO2 standards for passenger cars are taken as an example in order to demonstrate the principal strategy identifying steps of emission regulation. CO_2 standards for duty vehicles, trains and ships, as well as tightening standards for NO_x and PM have to be defined in a similar way.

The EST3 scenario assumes a passenger car fleet with an average fuel consumption of 2,5 l/100km. Only gasoline vehicles will be allowed. This target is only achievable, if binding CO_2-standards will be implemented. Therefore stepwise emission standards will be introduced, following the example of exhaust pollutants (see **Figure 3**). In the first steps these standards will be designed depending on the overall vehicle mass, to allow manufacturers to produce a variety of vehicle sizes, while maintaining the average fleet within the standards. With each step of strengthening the freedom to produce heavier vehicles with higher consumption will be tightened. At the end only vehicles which do not fail the standard, irrespective of their weight, are getting a certificate.

[1] Hansen, K.: Modern Windships, Copenhagen 1996

Figure 3. **Average Emissions and CO_2 -Limits for passenger cars**



A CO_2 standard like that should be accompanied by annual vehicle taxes, which are based on fuel consumption, to assure that the whole vehicle stock will be changed in the right direction. This means, that very high annual taxes for vehicles significantly above the standards avoid car users from keeping old cars with high consumption (exemptions may be considered for old-timers and other cars with very small mileage).

The introduction of the first step of these standards, with a broad deviation depending on the vehicle mass, will take place in 2002, tightening every 5 years. As an alternative to the mass dependency of the standards the CO_2-standards can be formulated depending on the horsepower or depending on passenger vehicle classes (sub-compact car, compact car, vans ...). In any case it has to be assured, that the average newly produced vehicle complies to the standards.

The measure will have a very significant effect: The overall fuel consumption and CO_2-emissions of passenger cars will decline by more than 75%.

Responsible actors for this measure are the European Commission and the national governments on the one side, on the other side the vehicle manufacturers. It is very important to involve and participate the public in the negotiations on this measure, since the manufacturers will try to avoid standards. However, the introduction of strict CO_2-standards will allow people to keep on driving cars to some extent.

3.2 Fuel tax

Fuel tax is considered one of the most important instruments influencing environmental impact of personal car transport. The effects, that will be achieved by rising fuel tax, are multifold:

- Demand for low consumption vehicles will increase, thus accelerating the process of replacing high consumption vehicles launched by emission regulation.

- The options of public transport, cycling and walking will become more attractive, provided public transport service and conditions for walking and cycling will be improved simultaneously.

- People will tend to avoid long driving distances, thus reducing transport activity. For example, driving to distant shopping centres supplying goods cheaply will no longer pay.

- As far as near by destinations will become more advantageous for people, urban sprawl will be reduced.

The concept of fuel tax increase has to consider several aspects:

- Fuel consumption of cars in EST3 will be about one fourth of today's fuel consumption. This means, that variable costs of driving are reduced almost about the same amount if prices remain constant. As a consequence fuel prices and costs of transport have to be dealt with separately.

- To achieve a substantial reduction of car transport activity, variable costs of driving have to rise considerably.

- The process of rising transport costs should begin smoothly.

- In order to compensate for declining fuel consumption fuel prices have to rise according to the CO_2 standards for passenger cars.

A fuel tax increase is proposed, which has two components (see **Figure 4**):

One component is following consumption reduction as given by emission regulation, thus keeping fuel costs per kilometre constant. It is only the second component, which is thought to rise transport costs.

It is proposed to raise fuel tax from today 0.56 to 5.37 (1.10 DM to 10.50 DM) by 2030, given in today's prices. This means a fuel price increase from 0.92 to 5.73 (1.80 DM to 11,20 DM), while fuel costs per kilometre will just double (see **Figure 5**).

Figure 4. **Two Component Fuel Tax**

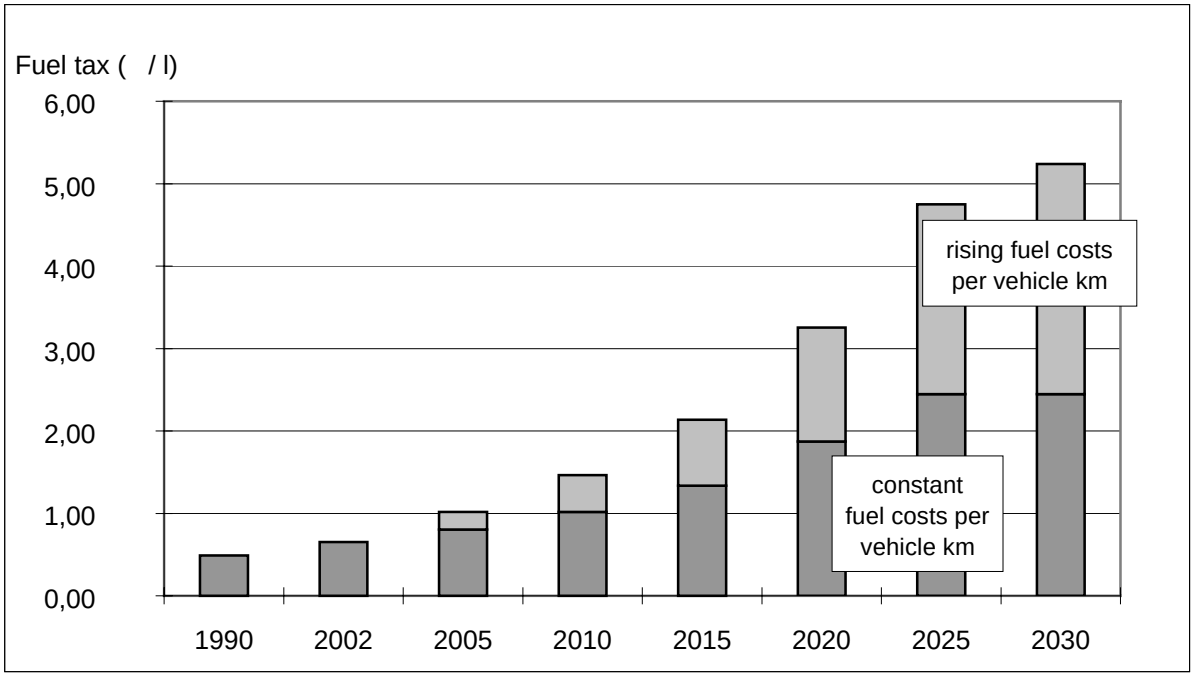
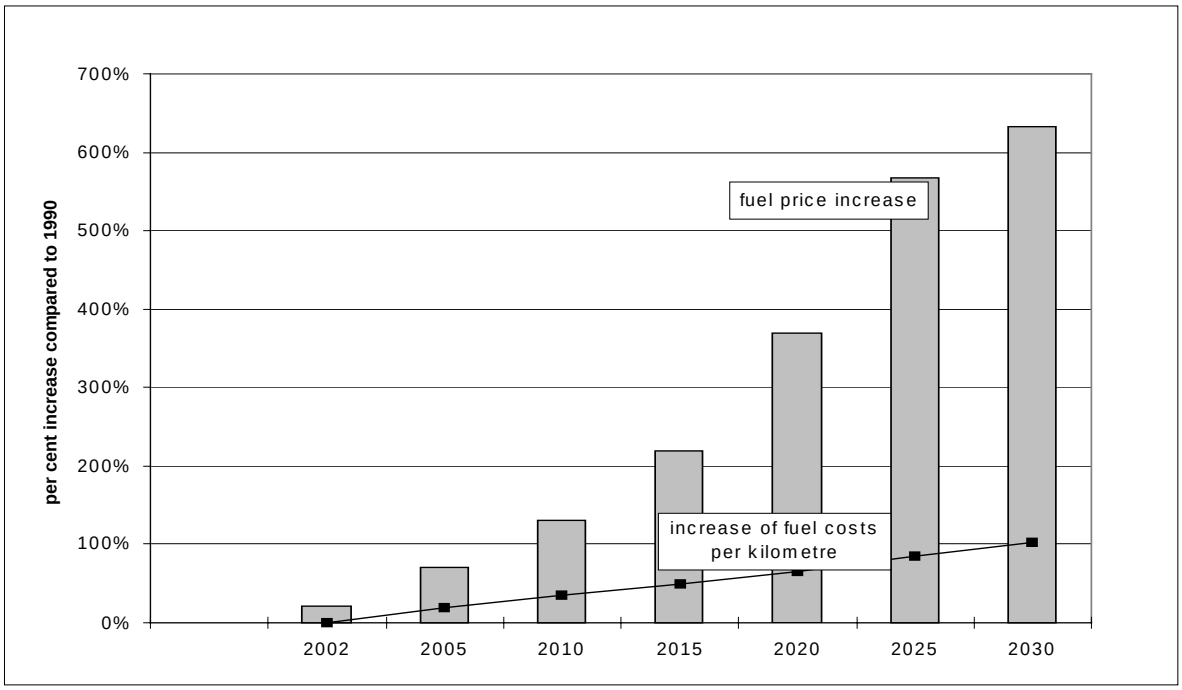


Figure 5. **Fuel price increase and increase of fuel costs per kilometre**



It is estimated, that this instrument will reduce car traffic by 50 per cent (based on a long term elasticity coefficient of $\varepsilon = -0{,}45$[2]).

3.3 Road pricing for HDV

Today HDV are paying only partly for their infrastructure and environmental costs. Together with the poor performance of freight railways in Europe and the lack of surveillance of social regulations this is a key factor for the increasing share road freight is covering from the whole freight transport market.

A road pricing system for HDV will be designed in a way to reflect the mileage of each individual vehicle and its environmental performance ($_{CO2}$, air pollutants and noise). Electronic devices (using GPS or equivalent) will be able to count the mileage and the fuel consumption, vehicles will be clustered according to their emission standards and their noise category. The charge may be higher for sensitive areas and lower for less sensitive areas. On a yearly basis vehicle operators have to pay the charge, which will be calculated from these components. In the year 2030 the charge level will be approximately 1.25 /km (2,50 DM/km) for high consumption and high emission vehicles and lower for low consumption and low emission vehicles. The charge level reflects the fuel tax, as assumed for passenger cars in 2030. Trucks will be exempted from fuel tax, to avoid _inkering (using cheaper fuel from neighbouring countries) from transit trucks. Domestic truck operators therefore will have the opportunity to get the fuel tax back. Although the charge level seems to be very high, it is not unrealistic, since Switzerland has agreed an a road user charge for trucks recently, which has a level of approximately half of that assumed here.

The charge will be introduced stepwise: A charge level of 0.25 /km (0,50 DM/km) will be introduced in 2002 (not reflecting fuel consumption or emission at this stage), in 2010 the level will rise up to 0.50 /km (1,00 DM/km), 2020 to 1.00 /km (2,00 DM/km). 2029 1.25 /km (2,50 DM/km) will be attained. By 2020 charges will be lower for low emission and low consumption vehicles.

The effects of the introduction will be twofold:

- Truck operators will try to avoid the charge by purchasing less polluting, less noisy and less consuming trucks earlier, than they would do anyway. This in consequence will stimulate the vehicle industry to develop and supply advanced vehicle technology as soon as possible (with positive effects on employment and in particular on research and development).

- The industry will try to avoid road shipping and/or improve load factors to the highest possible extent. This will result in higher shares for freight railways, provided a more efficient and liable rail system is realised.

Following the results of a study in behalf of the Federal Environmental Agency[3], which analyses strategies to influence long distance road freight traffic, it is estimated that this measure will lead to a 50% reduction of the road freight ton-kilometres of the BAU case, if the measure is accompanied with the necessary measures to improve the rail freight system. The share of rail freight will increase, but small parts of the road decrease will be shifted to inland waterways or will be reduced because of less transport intensive economic relations among the industry.

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[2] Storchmann, Karl-Heinz (1993): Abgaben auf den Pkw-Verkehr und ihre Wirkungen auf den Kraftstoffverbrauch im internationalen Vergleich. RWI-Mitteilungen Vol. 44, 345-374.

[3] DIW- Deutsches Institut für Wirtschaftsforschung: Verminderung der Luft- und Lärmbelastung im Güterfernverkehr 2010. Berichte 5/94. Umweltbundesamt, Berlin 1994.

Responsible for implementing this measure are the European Union (the relevant directive needs to be adapted in a way that allows the introduction of such a territory based charge) and the federal government. Affected actors are the trucking industry, the manufacturing industry, which contracts shippers, the vehicle industry, and the railway companies.

3.4 Road and rail infrastructure

In a sustainable transportation system infrastructure development plays a different role compared to today's situation. The infrastructure itself needs to be optimized in a way to avoid harmful effects on the natural resources and the destruction of the livability of urban areas. On the other hand the infrastructure has to serve as a provider for the sustainable transportation system and has to offer in particular better facilities for more environmentally transportation modes. This means, that the planning process has to take into account all transportation modes and the overall effects of the whole network, as it is proposed in the concept of strategic environmental assessment for plans and projects (SEA).

Planning the transportation infrastructure for a sustainable transportation system means to change the currently used decision-making process for developing the German federal infrastructure plan (Bundesverkehrswegeplan) in total. In a major research project such a new methodology was developed for the Umweltbundesamt[4]

The starting point of the procedure for a design of environmentally sustainable transport plans are environmental targets, as set e.g. in the EST-project, and other political targets (e.g. economical, social, financial targets). On the basis of the set of policy measures, single projects are evaluated in a cost-benefit analysis, applying so-called shadow prices. In the next step the overall effect of the new network (all transport modes) is assessed (including the induced traffic), whether it still meets the targets.

In the consequence of this approach, it can be estimated, that the infrastructure in an EST scenario will support the massive changes in the transport behavior of people and goods (modal shifts). Therefore more and efficient railways, public transport infrastructure is provided, while no more highways, despite of short bottleneck-links, will be constructed. Concerning roads, maintenance will remain, while a lot of highways may be cut back, to improve the natural resources, countryside and the urban environment.

Detailed studies have shown, that capacity of rail may be doubled for the short term by some rather simple measures (as for example harmonising speeds, use of double-deckers for wagons) requiring only punctual extension of infrastructure.[5] [6] For the long term, in order to absorb the shifts from road freight, extra tracks for freight will be necessary accompanying the existing rail network, which means doubling of the network for long distance freight rail. With road freight becoming much less attractive, there will be growing demand for new or reconstructed rail lines on regional level, branch lines for every bigger company have to become the rule . For long distance passenger transport, the rail network has to be expanded only on some relations, using modern information technologies and train coupling and sharing systems to rise capacities.

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[4] Rothengatter, W. et al.: Entwicklung eines Verfahrens zur Aufstellung umweltorientierter Fernverkehrskonzepte als Beitrag zur Bundesverkehrswegeplanung. Umweltbundesamt, Berlin 1998.

[5] HaCon Ingenieurgesellschaft und Universität Hannover: Kapazitätsreserven der Schieneninfrastruktur im Güterfernverkehr. Deutsches Verkehrsforum e..V., Umweltbundesamt, Bonn/ Berlin 1996.

[6] Entwicklung und analyse von Optionen zur Entlastung des Verkehrsnetzes und zur Verlagerung von Straßenverkehr auf umweltverträglichere Verkehrsträger. Deutscher Bundestag, Drucksache 13/11447, 28.09.1998.

3.5 Large-scale traffic calming strategies in towns ("Flächenhafte Verkehrsberuhigung")

Since the first idea came up in the early eighties, many towns have taken measures of large-scale traffic restraint, well known in Germany as „Flächenhafte Verkehrsberuhigung".[7] Traffic calming is an integrated strategy, which should comprise the following measures:

- Reduced traffic speeds for motor vehicles (30 km/h speed limit in cities and villages unless signs show otherwise).
- Reducing space for private cars, more space for pedestrians, cyclists, public transport, vegetation, more pleasant public spaces.
- Reduction in available parking space.
- Motor traffic bans, preferential schemes for low-emission vehicles (bus, train) and for HOV and car-sharing.
- mixing of particular land uses („short-distance town").

These measures should be taken in all towns, extended to the whole area of town and complemented by improvement of public transport service.

Responsibility is mainly up to local governments, while federal government has to regulate 30 km/h speed limitation. The strategy requires detailed planning and extensive public participation. Realisation may be completed by 2010, single measures like 30 km/h speed limits for example may be realised within a five years' period.

The effects of these measures are less traffic and lower speeds leading to noise reduction and reduction of traffic accidents. Residential quality is improving at the same time, thus complementing town redevelopment programs. Car traffic in towns is estimated to drop by about 8 per cent.[8]

3.6 Public transport service

Improvement of public transport service will compensate restrictions for car traffic. The aim is to maintain the 1990's level of travel activity. The main aspects are

- Improvement of service in space and time
  In order to guarantee access for everybody, public transport network is to be expanded and vehicle frequency has to be increased. In the long run, general access to public transport will only be possible if land use will change from low density to more compact structures. Nevertheless there recently have been many good examples improving rural rail service, following the reform of the German railway system. Experience in Switzerland shows that hourly bus service is possible and successful in rural areas. In low density areas and during

[7] Bundesministerium für Raumordnung, Bauwesen und Städtebau, Bundesministerium für Verkehr, Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit: Forschungsvorhaben Flächenhafte Verkehrsberuhigung - Folgerungen für die Praxis. Bonn 1992.

[8] Citair - Computergestütztes Instrument zur Prognose der Auswirkung verkehrlicher Maßnahmen zur Immissionsreduzierung, Version 1.0, Umweltbundesamt, Berlin 1998.

times when there is low demand, a flexible public transport service, with small buses or vans to be ordered by call, will complete an extensive railway or scheduled bus network.

- Priority lanes and priority at traffic lights for buses and light rail will accelerate public transport, restricting car traffic at the same time. The instrument is important in the beginning as long as streets are overcrowded with cars. It shows the benefits of public transport to car drivers and it is a symbol for a change of values.

- Information about connections, timetables and fares should be present in everyday life, tariffs should be easily understandable, and the purchase of tickets should be simple.

- Bus stops and stations should become pleasant places. Transfers between buses, street cars and trains should be more comfortable.

- A tight network of local service agencies for sustainable mobility will be set up. Their task will be information and advice as to the best transport possibilities for individual journeys including public transport, bicycle, ride sharing, car sharing and hired cars. They will act as travel agencies and organise door to door transport. They will make arrangements with railway companies hotel industry and event organisers in order to offer journey packages, combining long distance travel or visits of events with public transport at destination.

It is important, that improvement of public transport will start very early in the process of sustainable development, in order to raise public acceptance. An agreement of all actors (federal government, states governments, local governments, transport companies) will guarantee co-ordinated action. Local governments may give priority to public transport at traffic lights and establish bus lanes at once. The cities of the local agenda 21 network could give good examples and take the lead. Transport companies may be bound to improve information policy, if they claim public subsidies. The costs of both of these measures are low and probably will be exceeded by an increase of revenues. Local service agencies for sustainable mobility in the beginning should be supported by national program, later on they will pay their way.

Increasing frequency and expanding networks of public transport cannot be realised relying on the resources of transport companies alone. The measures should be introduced step by step, accompanied by restrictions of car traffic. In order to avoid inefficiency, public subsidies should follow least cost principles. With increasing number of users and rising revenues subsidies may be reduced in the long run.

The effects of these measures taken alone are rather low (2-3% concerning transport activity in town[9]). They gain importance in combination with traffic restraint strategies and increasing costs for car usage. As several examples form Swiss and German cities show, improvement of public transport might stop car traffic increase at least.

3.7 Railway service

Improvement of railway service in the first place is up to railway companies. As road transport will become more expensive, the share of rail traffic will increase and railway service will get more profitable. Establishing service & logistic agencies for freight transport might be extremely useful. As the service agencies for sustainable mobility do for personal transport, the service & logistic agencies will organise door to door freight transport. Their task will be to sell transport service for goods to companies and to purchase transport options from road freight and railway companies.

[9] Citair op.cit.

Governmental subsidies may be important in a starting phase, helping to improve the system of multimodal road-rail transport for example. Research and development is required improving and accelerating road-rail transfer, or improving collection and distribution of goods.

Federal regulations concerning safety of railway construction and operation should be reformed in order to allow for more flexible technical solutions. On the other hand, Federal Government has to control the success of deregulation, which started in 1994, in order to allow for competition in railway service. In particular free access to the tracks has to be ensured.

The European Commission should take the initiative to harmonise the regulations concerning railway operation in European countries. Institutions of the European Union may provide a forum for national railway companies to promote harmonisation of railway technology (as for example power systems or automatic coupling).

3.8 Regional economic structures

Exchange of goods will be organised in a less transport intensive way if the costs of transport will rise considerably. Nevertheless there is a need of public support in order to increase proximity of economic interrelations.

- Proximity of production and demand can be improved for some branches, especially for agriculture and for segments of trade . Support programs and supported experiments on national, states' or communal level may help to establish regional markets within a ten years period.

- Subsidies and programs on European and national or states' level to decrease inter-regional inequity in economic development are to be reviewed with respect of their traffic inducing or reducing quality. Subsidies should be bound to low traffic transport organisation. The procedure may be established and the checks done by 2007.

These instruments might lead to a reduction of road freight of about 5 %.[10] [11]

3.9 Local and regional tourist and recreational areas

Tourist air travel is thought to diminish. Thus, in order to make people aware of the attractions of their own country, marketing of regional tourism should be promoted by Federal Government, States' governments, local governments and tourist associations. This would be part of a campaign aiming at increasing acceptance of the idea of sustainable transport with the public. To avoid an increase of car traffic in tourist regions, tourist marketing has to be combined with the activities of the local service agencies for sustainable mobility. Subsidies may be lowered or dropped in subsequent periods.

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[10] Kindermann, Arndt: Ökologische Chancen und Perspektiven von Regionalproduktion und Regionalvermarktung. Naturschutzbund Deutschland e.V., Bonn 1997.

[11] Scherer, Roland et al.: Perspektiven der Regionalvermarktung für die verarbeitende endverbrauchernahe Industrie. EURES Institute for Regional Studies in Europe im Auftrag des Naturschutzbunds Deutschland e.V., Freiburg 1997.

Virgin nature areas are most attractive for tourism. Therefore, nature conservation areas have to be protected and developed by Federal Government and States' governments. Low traffic recreational areas near towns or cities have to be preserved by communal land use planning.

These measures should be seen as compensation for restrictions and rising prices in transport. They will help to increase acceptance of sustainable mobility and avoid or diminish dissatisfaction. Their effect can only be assessed in combination with the effects of fuel tax increase and air traffic restrictions.

3.10 Low traffic land use patterns

A change in land use development requires planning activities which minimize suburbanisation and focus on in-town sites[12] on the one hand, and influencing individual decisions on the other hand.

Land use planning is influenced by different sectoral and spatial interests. Low traffic land use planning requires better integration of settlement and transportation planning. Regional instruments and structures of co-operation have to be improved, reducing hamrful competition among adjacent communities, and thus allowing to prevent urban sprawl and location of new distinct industrial or commercial areas on the one hand, and to protect nature and landscape conservation areas on the other hand. Local and regional development plans have to design these low traffic land use patterns according to the environmental priciples of the Regional Planning Act and the Building Code.

Individual decisions will be influenced by charges and taxes. Charges on land use will minimise land consumption for buildings, leading to higher density. Taxation of parking opportunities will help to reduce parking places, reducing land consumption for parking in the same time. In addition, taxation of parking opportunities will diminish the advantages of commercial areas outside of settlements. These measures should be accompanied by a reform of States' construction regulations, which in the first place no longer should impose to set up parking opportunities with every new building, and secondly should allow for lower distances between buildings. In order to compensate the restrictions for new settlements, residential quality of towns should be improved by public redevelopment programs.

As land use patterns change very slowly, it is all the more important to start taking the instruments as soon as possible. Town redevelopment programs of the States (Länder) are under way already since the early eighties. They should not be reduced but better funded in the next ten years' period at least.

Within a five years period, charges on land use for newly purchased land and taxation of newly built parking opportunities may be introduced by federal government. Following Apel, Henckel et al.[13] we suggest a land use tax, which is consisting of two components:

- 1 per cent of the guide values for land prices.
- plus 2 DM for land provided for house building up to 4 DM for land provided for industrial use per square meter and year.

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[12] Apel, D., Lehmbrock, M. et al: Kompakt, mobil, urban : Stadtentwicklungskonzepte zur Verkehrsvermeidung im internationalen Vergleich. Deutsches Institut für Urbanistik (Difu) im Auftrag des Umweltbundesamtes, Berlin 1997.

[13] Apel, D., Henckel, D. et al.: Flächen sparen, Verkehr reduzieren. Möglichkeiten zur Steuerung der Siedlungs- und Verkehrsentwicklung. Berlin 1995.

For parking opportunities we suggest to begin with a tax of 100 DM per parking place and year, which is based on about the price residents are ready to pay for parking in residential parking areas. This measure should be increased for commercial and industrial parking areas at least, if there are no sufficient effects to be found. Both instruments might be extended to existing properties within a period of another ten years.

A requirement of low traffic land use planning is the improvement of regional instruments and structures of co-operation and planning. This expectedly will be difficult to undertake, as the constitutional rights of communal governments are concerned. A period of discussion and convincing should be allowed before starting with regulations. This will mean a period of implementation of about ten years.

The effect of these measures are assessed to be about 10-15 % concerning transport activity.[14]

3.11 Electricity Generation

One third of total person kilometres and one forth of freight kilometres travelled in the EST3 scenario for the year 2030 will be driven by electricity. Thus, with strategies for environmentally sustainable transport, efficient power generation has to be taken into account.

Future electricity generation will be affected by several developments which started at the end of the 20th century.

On one hand the deregulation of the European energy market (Energiewirtschaftsgesetz) will change the whole market of electricity production and supply, mainly into the direction of short term cheap electricity generation. In the short term, low cost electricity can be produced from old or formerly subsidized coal power plants in Germany as well as from old power plants in other West or East European countries. Also electricity from current nuclear power plants (excluding external costs of waste management, etc.) could be one of the low cost options for electricity in the short term. In the long term the cheapest production of electricity could be the production from natural gas power plants combined with low investment cost, e.g. gas and steam power plants, which can be operated at efficiencies higher than 57 % and reduce CO_2 in comparison to current power plants significantly.

On the other hand the deregulation of the European energy market will allow to buy electricity from "green" energy producers. They can get electricity from renewable resources in other countries, like waterpower from Norway, wind power from Germany or solar power from Southern Europe. Green energy from non fossil resources already today can be cheaper on a price basis than electricity from a typical energy mix in Germany. There are price examples of 0.1375 /kWh with a minimum of 50 % from renewable resources and a maximum of 50 % from natural gas cogeneration plants in comparison to 0.155 /kWh for electricity from the current electricity producer and supplier.

<u>But all of these options have to keep in mind</u>:
Non-fossil fuels can make a major contribution to climate protection and resource conservation only if energy is efficiently used, in other words if sizeable cuts in primary fuel inputs are achieved. In 1995, for instance, electricity generation from wind power rose by 60% over 1994 in Germany, but absolute electricity consumption grew by 15 times that amount, negating this success.

Additional strategies have to be followed to attain considerable improvements of efficiency and the use of non-fossil energy. Deregulation (Energiewirtschaftsgesetz) as well as a regulation for the minimum prices

[14] Enquete-Kommission "Schutz der Erdatmosphäre" Mobilität und Klima des Deutscher Bundestags: Wege zu einer klimaverträglichen Verkehrspolitik. Bonn 1994.

that have to be paid by electricity supply companies for electricity from non-fossil resources (Stromeinspeisungsgesetz), as well as an energy tax on CO_2 emissions from electricity generation will support the use and introduction of renewable energy and the cogeneration of electricity and heat. The German energy tax does focus on a reduction of the use of fossil energy and fuels in principle. But the energy tax (or ecological tax, as it is called in Germany) does not depend on the CO_2 emissions. Electricity from renewable resources has the same tax rate as electricity from coal.

Various overlaps may arise between the specific reduction potential in different areas. A CO_2 /energy tax, for example, would obviously have effects on many other activities. These strategies could support the

- increase of cheap low carbon natural gas use in small unit power generation with cogeneration and gas and steam turbines;

- increase of efficiency of power plants up to 70% (see Figure 4) by combining the current natural gas or coal steam turbine generation with gas turbines and which could be done with power plants as well;

- increase of efficiency of steam power plants by improvement of turbine geometry;

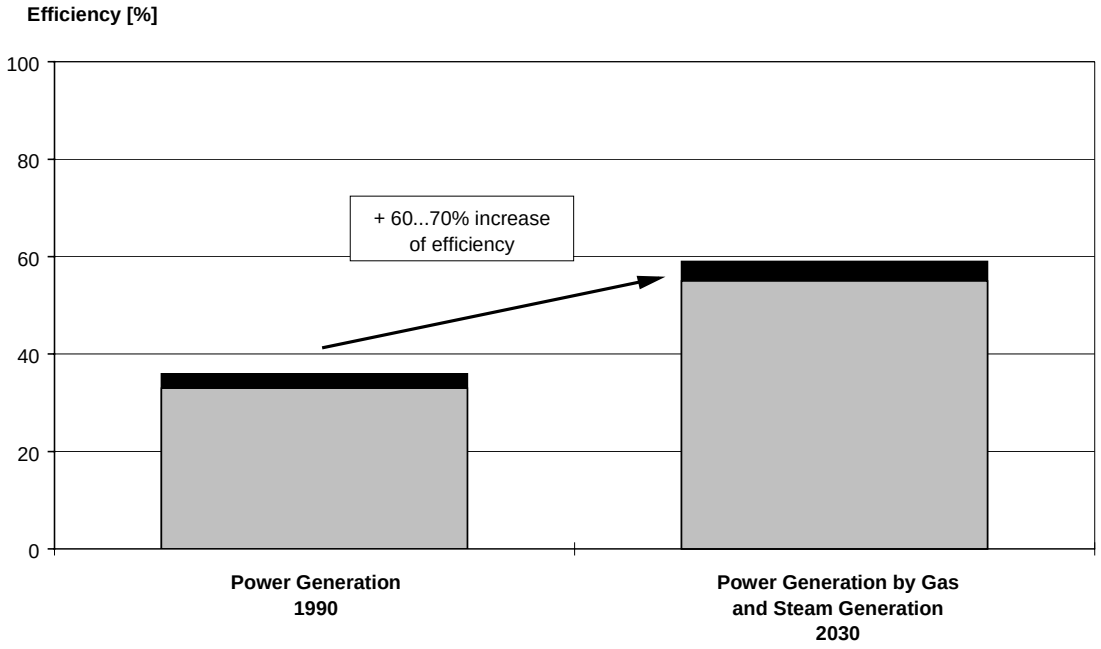
- additional construction of small power generator units on the basis of natural gas, producing heat and electricity (e.g. micro turbines, fuel cells, engines) that will allow the electricity production industry to extend its markets into the heat selling sector and beyond boundaries;

- growth of “green” electricity supply companies, which already buy “green energy” from other countries (e.g. Norway, Denmark, Southern Europe) for sale in Germany;

- reinvestment of partial profits of “green” electricity companies into new projects for CO_2-reductions and renewable energy use (as is already done by some companies which sell “green” electricity);

- investments by oil companies in offshore wind power generation projects;

Figure 6. **Efficiency increase for Fossil Power Generation**



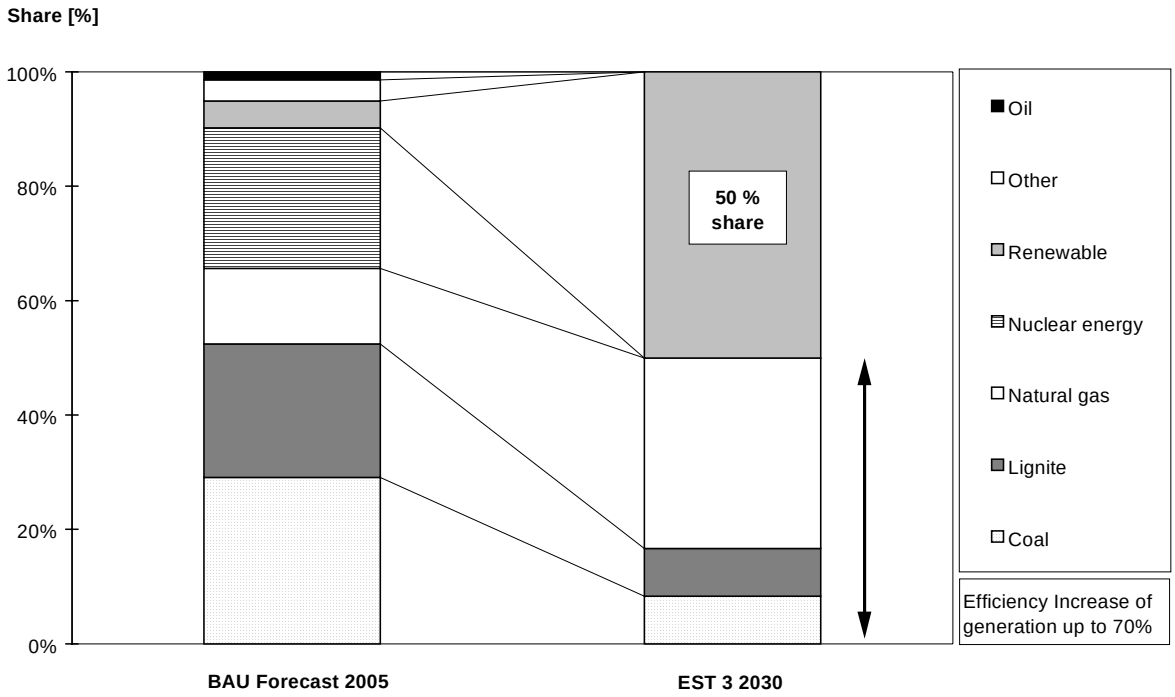
The outlined strategy will result in:

- an increase of the efficient use of fossil fuels;
- in a short term perspective with the import of renewable electricity from other countries;
- in a long term perspective with an additional construction of electricity generation facilities from non fossil resources (wind, biomass, solar, water, thermal heat); and
- in an additional construction of small cogeneration power plants like fuel cells, micro turbines and engines on a natural gas basis.

The overall result will be a new power generation structure with shares of renewable resources up to 50 %. The use of natural gas in conventional power plants already results in a specific CO_2 reduction by 45% compared to coal. The efficiency increases further by 70 %, if new developed technologies will be used. This results in a CO_2-reduction by new electricity power generation of more than 80%.

The time horizon will be until 2030. The first steps (energy tax, implementation programmes for non fossil power generation facilities and an efficiency revolution for fossil power plants) must be introduced immediately. The energy tax for different possibilities of electricity generation must be developed on a CO_2-basis.

Figure 7. **Development of the Share of Power Generation**



4. Reduction of noise emission

As EST criterion, the reduction of noise reception levels by road and rail transport to a maximum of 55 dB(A)/45 dB(A) by day/by night has been defined for the German case study (rating level outside the dwellings).

To reach the target, a reduction of the noise reception limits for new or substantially altered traffic lanes to the target values, and gradual introduction of the target levels to existing traffic lanes has to be applied as a central measure. With the legal implementation of this measure the residents affected are entitled to corresponding abatement measures, the accomplishment of the noise reduction targets however has to be supported by additional measures which are characterised by different levels of actions (see **Table 3**). The introduction of noise reception limits for existing traffic lanes may lead to the problem that in the case of insufficient contributions of the reduction of emissions and VKT or modal shift the targets can only be reached by additional secondary protection measures (as barriers, walls and sound proof windows) with increasing costs, social and physical separation and insufficient protection of the residential areas outside the houses.

Responsible for the introduction of noise reception limits and financial instruments are the German parliament and government, for product-related regulations (emissions etc.) the European Union and for the traffic regulations the local governments.

Table 3. **Noise Abatement Measures**

0. Central measure: Introduction of noise reception limits for existing traffic lanes into German environmental law	
A. Reduction of the noise emissions	
A1	noise regulation for all vehicle categories
A2	speed limit of 30 km/h inside towns
A3	traffic calming
A4	road pricing for heavy duty vehicles depending on emission technology and sensitivity of areas
A5	privileges for noise reduced vehicles
A6	emission based track pricing for railways
A7	low noise road and rail surfaces
B. Reduction of VKT and modal shift to more silent means of transport	
all measures which:	
B1	reduce the VKT,
B2	increase the costs or obstacles for individual motorised traffic
B3	and promote public transport.

4.1 Quantifying the measures

- **Reduction of noise reception limits**

  New or substantially altered traffic lanes:
  The reduction to the target limits should be accomplished as soon as possible (within this parliamentary term until 2002), in order to avoid the creation of new cases to be renovated later on. The contribution of this measure is small as there won't be very many new or substantially altered lanes. Careful traffic line planning, secondary noise abatement measures and the implementation of immediately efficient noise emission reductions (eg. low noise road surfaces and railway tracks) will allow for the fulfilment of the target.

  Existing traffic lanes (noise renovation)
  The reduction to the target values is only possible in the long term and in step with the successful realisation of other measures. The noise reception limits for existing traffic lanes should be lowered in linear steps with the first step, the introduction of limits at all, needing a longer period of preparation (e.g., in form of a national noise abatement program with a limit of 65/55 dB(A) from 2010 on and the linear reduction by 2030 to 55/45 dB(A)).

- **Reduction of the noise emission limits of vehicles (A1)**

  For railway vehicles today no limits exist. Necessary reduction levels are given in **Table 4**. The target limits can be realised for nearly the whole range of the railway lines. Locally additional measures will be necessary (e.g. secondary noise abatement measures).

Table 4. **Reduction of the noise emission limits for railway vehicles**

1. step by 2002 (2008 for old vehicles)	- 10 dB(A) - 5 dB(A)	freight wagons tread-braked powered vehicles and passenger wagons (new and old vehicles) for all other vehicles (with the exception of wagons like the those of the ICE) (new and old wagons)
2. step by 2007 (2013 for old vehicles)	additional -8 to -10 dB(A)	for all categories of vehicles by shielding measures

For Road vehicles the noise emission limits have to be reduced step by step so that the engine noise does no longer influence the total sound emissions significantly (see **Table 5**).

Table 5. **Noise emission limits for road vehicles**

	Year	**Limit (dB(A))**
cars	2002	71
	2007	68
	2012	65
	2017	62
trucks	2002	78
	2007	74
	2012	76
	2017	72

Simultaneously the noise emissions of tires and road surfaces must be reduced (see **Table 6**).

Table 6. **Reduction of the noise emissions for tires and road surfaces**

	Year	**Reduction (dB(A))**
tires	2002	- 3 dB(A)
	2007	- 6 dB(A)
surfaces (A7)		
outside towns	2002	- 5 dB(A)
inside towns	2002	- 3 dB(A)

The total reduction of the - critical - impairment inside towns due to the above mentioned measures will be about 9 dB(A) (with full effect from about 2027 on).

- **Traffic calming, speed limit of 30 km/h (A2, A3):**
  The road vehicles noise emissions can be reduced by additional 3 dB(A) (mainly the rolling noise) when the speed limit inside towns is reduced to 30 km/h and when steady driving is caused by traffic calming. Together with the emission reduction for vehicles, tires and surfaces this yields a reduction of noise levels inside towns by 12 dB(A)on average.

- **Reduction of VKT, change of modal split (B):**
  In EST3 VKT of cars in towns will drop to 25% and VKT of trucks to 40% of the 1990 values (see 1). This causes a reduction of the equivalent sound levels between 4 and 6 dB(A) on average with respect to the percentage of trucks.

4.2 Total effects

The combined measures for the reduction of noise emissions and VKT will reduce the noise levels along streets inside towns by 17 dB(A) on average by the year 2030. For most of the streets the target values of 55 dB(A)/45 dB(A) by day/by night thus can be realised. The cases with today levels above 72 dB(A) by day have to be subject to additional traffic restraints.

5. Reduction of environmental impacts by aviation

Aviation is the transport mode with the highest growth rates. Furthermore only little progress has been achieved to reduce the specific emissions by technical means. Since aviation may cause the biggest problems in meeting the EST criteria major changes in policy are necessary.

5.1 Emission standards for new aircrafts and retrofit programs

Tight standards for new aircraft engines (in a first step) will be implemented for NO_x (-50% within 10 years), CO_2 and other pollutants. In a second step (starting in the year 2010) a new certification methodology is introduced, which certifies aircraft-engine-combinations on the basis of the transportation offer (seat-kilometers or tonne-kilometers) including cruise level emissions. Only this methodology assures a reduction of emissions per kilometer. The correspondent NO_x emissions for new aircrafts will be 70% lower in 2030 and CO_2 emissions 50% lower compared to today's values with these standards. Additionally retrofit programs, supported by economic incentives, will assure that at least 50% of the aircraft stock operating in Germany will meet these requirements.

Existing standards for noise will be tightened as well. Retrofit programs allow older aircraft to operate and meet environmental requirements set around airports for a limited period.

5.2 Economic measures, operational measures

Due to the high growth rates of aviation and the regarding growth of emissions, measures have to be taken which reduce demand for air travel and / or give further incentives for cleaner aircrafts and mode shifts. In that context the introduction of taxes, which already have to be paid by other modes and sectors like the fuel tax and the value added tax (VAT), play an important role. Both taxes will be valid for domestic and international flights as well. The fuel tax will be introduced gradually following the scheme for road

transport, but on a lower level, as for road transport one component of fuel tax is compensating for reduced fuel consumption. This is only possible if the action is taken accordingly in all industrialized countries (e.g. all OECD or Annex B countries). In the consequence the ticket prices will go up considerably and growth of passenger kilometers will be limited. Airlines will also react in offering bigger, more efficient aircrafts with higher load factors, to allow more people to fly with less kilometers flown (reduced specific emission factors).

A second part of economic measures aims at giving more incentives for cleaner aircrafts. These emission related charges will be introduced within the next 10 years both for emission depending landing and en-route charges. They will increase landing charges and en-route charges for aircraft-engine-combinations with higher than average emissions in order to give incentives for the introduction of less polluting aircrafts and foster demand for better technology including the necessary research and development programs. These emission related charges will allow an earlier introduction of cleaner technology, as possible if only standards were applied.

The current air service management system suffers from a lot of inefficiencies which offset, to a limited extend, other mitigation measures. Therefore these measures should be used in combination with the other measures: free flight instead of controlled routes, reduced horizontal, vertical and longitudinal distances, improved landing and take-off schemes, improved air control systems. Up to 10% of the total CO_2 emissions could be saved with an optimized air transport management system.

5.3 Tradable permits for CO_2 emissions

The air travel reductions necessary for achieving the EST scenario even with the above described measures is tremendous: In 2030 not more than 40% of passenger-kilometers of 1990 are acceptable to achieve the criterion.

The Kyoto-Protocol defined a sample of flexible mechanisms to reduce greenhouse gas emissions, among which emissions trading is one of the most important. Emissions trading is one potential opportunity to reduce the remaining emissions above the EST scenario from other sectors.

A emissions trading system for the aviation sector would limit reductions to those which could be achieved with in the aviation sector itself. A cap would define the maximum allowable emissions remaining in the EST scenario. The overall target of such a system is to assure the attainment of the very critical CO_2 target for aviation and not to reduce the possibility of traveling. Airlines would have the possibility to trade emissions among each others. In the beginning a fair allocation system of permits have to be designed. A trading system could encourage further development and adoption of cleaner technologies within the industry, but would also limit the demand by increasing air tickets to prohibitive levels. If the industry were to meet these targets from within then a market clearing price would settle at a level which matched the technological or operational level required for aviation to reduce its marginal emissions.

As an alternative it could also be considered to allow for trading between different sectors (aviation would buy emission rights from other sectors, which are more able to reduce their emissions). This, however, is outside the scope of the EST study.

6. Implementation strategy

It is not reasonable to work out a detailed program quantifying every policy measure over the whole time period. Rather the process of implementation should be open for revision. Nevertheless it is important to reliably decide upon strategy and instruments over longer periods of time, thus everybody can anticipate

the changes, which will take place in the future. The intention of the definition of the measures, as given above, is 1. to give a starting point for discussion and 2. to demonstrate the necessary dimension of change from the best of our knowledge today.

To prevent early failure of the project it is important to plan the starting strategy very carefully. Thus in the process to achieve sustainability several phases should be foreseen, starting with a phase of acceptance. In the next phase first measures should be taken, followed by an evaluation of effects. In the ongoing process, the definition of measures should be adjusted to make sure that desired effects are realised and undesired effects prevented. Three phases are described below: Phase 1: Acceptance, Phase 2: Action, Phase 3: Evaluation and Adjustment.

6.1 Phase 1: Acceptance

The aim of the first phase is to make sure that the principles and targets of EST are broadly understood and accepted. There are mainly two fields of activity:

Public relation and discussion

The idea of EST has to be broadly published. It is important to make clear that EST is definitely necessary and to show the connections of EST with existing aims, ideas and efforts. EST has to be presented as a long termed process, showing the whole strategy at the beginning already.

- A national program towards sustainable development has to be elaborated.
- Easily understandable brochures and flyers have to be worked out and nicely designed in order to win the audience. Internet should be used to spread the information. Audio-visual methods could help to provide a vision of everyday life if EST has become reality.
- Discussion forums with opinion leaders or people responsible for action at different levels of society should be established or supported.
- There may be competitions arranged for different groups of society, as children, citizens, etc. in order to bring forth visions of low transport organisation of everyday life.
- Existing initiatives, which demonstrate ways towards sustainability, as Car Free Cities, Car Sharing, etc. should be supported publishing and realising their ideas.
- The process towards EST has to be presented as a step by step strategy.

Demonstration of benefits

The measures which are taken in this phase should be easily realised, have low costs and show that the sustainability strategy has positive effects for people:

- The general speed limit in town has to be lowered to 30 km/h in order to rise security for non-motorised traffic, and to reduce noise levels. Illegal parking on footpaths and cycling lanes should be controlled and pursued more consequently.

- Priority lanes for buses and priority at traffic lights for buses and street cars should be established in this phase. Information about connections, timetables and fares, the design of stops and stations, the modality of ticket purchase has to be improved.

- A network of local service agencies for sustainable mobility has to be established by national program. Policy towards sustainability could be combined with labour market policy, supporting the agencies for a limited time period.

- Service & logistic agencies organising door to door goods transport have to be established.

In addition, realisation of the instruments starting in phase 2 has to be prepared. Efforts should be taken to establish EST as part of education in several areas, for example education of town and regional planners. The ongoing revision of the Federal Transport Network Plan has to be adjusted to EST.

Who is supposed to act ?

The European Union

- preparation of exhaust and noise regulation for all modes starting in phase 2;

- prepare harmonisation of international railway technology and regulation.

The Federal Government

- national program towards sustainable development. The program should contain the targets and strategies the Federal Government has agreed on;

- public relations work. The EST topic should be part of the Federal public relations program;

- adjustment of the Federal Transport Network Plan;

- regulation of speed limits in towns. There is much support for this measure, as for example from the Association of German Cities and Towns ("Deutscher Städtetag“). The measure will cause almost no costs;

- Speed limits on motorways. This instrument is accepted with general public, but heavily attacked by important lobby groups;

- subsidy program for service agencies. To fully support 100 agencies with three jobs each for two years will cause costs of about 30 million Euro;

- support education for EST, establish chairs of low traffic land use planning;

- support research and development on the topic of new technologies for rail freight;

- reform regulations concerning railway construction and operation in order to provide interoperability and competition within the European rail system;

- continue step by step realisation of CO_2 / energy tax.

Local Governments

- Controlling of illegal parking;
- priority lanes, priority at traffic lights. Public transport will become more efficient. The measure will lessen the deficits of public transport covered by communities;
- enforce marketing for local tourism.

Transport companies

- improve information policy;
- improve design of stops and stations;
- improve the modality of ticket purchase;

All three measures may be profitable in the end as they rise comfort of use and attract new users.

- establish service & logistic agencies for freight transport;
- establish service agencies for sustainable mobility in personal transport.

6.2 Phase 2: Action

All measures necessary to achieve sustainability have to be prepared and realisation started in this phase, except tradable permits for aviation trips (**Table 7**). There are no other instruments left, which will start implementation later in time. The beginning of this phase may be the year 2002.

The European Union should

- start realisation of step by step exhaust and noise regulation;
- realise harmonisation of international railway technology and regulation;
- reform regional economic subsidies programmes;
- abolish tax exemptions for aviation;
- introduce en-route charges in aviation.

The Federal Government should

- start realisation of step by step rise of fuel tax and road pricing;
- reform vehicle tax;
- prepare and establish charges on land use and taxation of parking opportunities;

- together with local and regional authorities initiate and organise the improvement of regional instruments and structures on co-operation and planning;
- reform housing promotion by tax exemptions;
- reform regional economic subsidies programmes;
- support regional markets;
- improve nature conservation;
- reform supports of public transport;
- support multimodal rail-road transport;
- reform energy legislation;
- support energy saving technology;
- introduce emission depending landing charges.

The States (Länder) should

- improve nature conservation;
- support regional tourism;
- reform construction regulations;
- promote housing inside towns and town redevelopment;
- reform housing subsidies programs;
- improve instruments and structures of co-operation in order to facilitate low traffic land use planning;
- support city logistic projects.

The Local Governments should

- plan and realise large scale traffic calming strategies in towns;
- plan and start realisation of extension of public transport networks (road and rail);
- improve instruments and structures of co-operation in order to facilitate low traffic land use planning;
- realise low traffic land use planning;
- protect / establish low traffic recreational areas;

- support city logistic projects.

The transport companies should

- increase frequencies of vehicles in public transport;
- Establish hourly bus service in rural areas;
- improve railway service and logistics;
- improve multimodal rail-road transport;
- reinforce international co-operation to improve international rail transport;
- establish city logistic projects;
- optimise air transport management system.

6.3 Phase 3: Evaluation and adjustment

On every level of action the instruments continually have to be adjusted according to conditions and effects. Nevertheless the whole strategy has to be evaluated at least once during the implementation process. By the year 2015 all instruments may show first effects at least. This should be the right time to check the outcomes of the whole program on the environmental as well as the economic and social dimension. Depending on the results of this check the steps of the program not realised yet should be enforced or relaxed. Compensation strategies might be necessary in order to avoid economic or social friction.

Table 7. **Timetable Showing Implementation and Effects of Instruments**

	2000		2005		2010		2015		2020		2025		2030	
CO2 standards for vehicles	prep.	1. step		2. step		3. step		4. step		5. step		6. step		
Fuel Taxation	prep.	1. step		2. step		3. step		4. step		5. step		6. step		
Road Pricing for heavy duty vehicles	prep.	1. step			2. step				3. step				4. step	
Traffic Calming in Towns														
speed limit of 30 km/h inside towns		immidiate realisation, effects almost without delay												
parking management	prevent illegal p		start realisatio											
increase areas dedicated to pedest., cycl., PT		planning	start realisatio											
motor traffic bans		planning	start realisatio											
Public Transport														
priority for buses and street cars		immidiate realisation, effects almost without delay												
improving information systems	prep.	realisation												
increasing frequency, extending networks		planning		realisation 1. step					realisation 2. step					
service agencies for sustainable mobility	prep.	realisation												
Railway Service														
extension of rail infrastructure	planning			realisation 1. step				realisation 2. step						
improve rail-road intermodality		preparation		realisation 1. step			realisation 2. step							
internat. harmonisation of technol. and regul.		preparation		realisation 1. step			realisation 2. step							
introduce competition	prep.	start realisation												
improve service and logistics	prep.	realisation												
Regional Economics														
reform subsidy programmes		preparation		realisation										
support regional markets		preparation		realisation										
Regional Tourism														
provide support	start realisation													
improve nature conservation	prep.	start realisation												
Land Use														
charges on land use		prep.		start realisation										
planning for low traffic levels	realisation													
improve co-operation in regional planning institut.		prepar	realisation											
reform construction planning regulations	prep.		realisation											
tax parking opportunities		prep.	realisation											
reform housing subsidy programs		prep.	realisation											
promote town reconstruction and housing	realisation													
Energy Supply														
reform of energy legislation	prep.	realisation												
subsidize for energy saving technology	prep.	realisation												
CO2 / energy tax	1.step			2. step		3. step		4. step		5. step		6. step		
Noise Emission														
noise reception limits for traffic lanes	1. step			2. step										
noise regulations for rail vehicles	prep.	1. step		2. step										
noise regulations for road vehicles	prep.	1. step		2. step		3. step		4. step						
noise regulations for tires	prep.	2. step		2. step										
noise regulations for surfaces	prep.	realisation												
Aviation														
exhaust standards for NOx and CO2	prep.	1. step			2. step									
emission related charges	prep.	realisation												
taxation of kerosene	prep.	1. step		2. step		3. step		4. step		5. step		6. step		
optimise air transport management system	prep.	1. step			2. step			3. step			4. step			
tradable permits for CO2 emission							prep.		1. step		2. step			
			first effects of measure ...						effects fully realised					

7. Gaps and Barriers

7.1 Policy needs

Table 8 is showing the gap between existing policy trends and the needs following from the defined EST criteria and the EST3 scenario. It can be seen from this table, that in some cases existing trends in policy just have to be intensified or extended to similar areas, for example in the case of fuel tax or road pricing. In the fields of traffic calming and public transport there are good examples available, which have to become standard all over the country. New strategies have to be introduced in land use charging and aviation standards and charging. In the field of energy policy the trends are going in the wrong direction from the sustainable point of view. Research is needed especially in the field of regional economics.

Table 8. Policy needs

Instrument	Policy trend	Requirement
CO_2 standards for vehicles (passenger cars 58 g / km by 2025),	no standards defined, agreement with ACEA: 140 g CO_2 / km for passenger cars by 2008	change policy towards automobile industry, define standards for cars, trucks and rail vehicles
Fuel tax rise to 5 Euro / l by 2030	fuel tax rise up to 0,65 Euro for gasoline and 0,47 Euro for diesel by 2003	to be continued and intensified, alignment of diesel tax
Road pricing for heavy duty vehicles (1 Euro / km)	charges on low level probably introduced in 2002	to be continued and intensified
Traffic calming in towns	traffic calming areas exist in most towns, not many new investments, small car free housing areas planned in some towns, quality of infrastructure for pedestrians and cyclists differs very much	generally 30 km / h in towns, extension of traffic calming areas, alignment with best examples
Public transport: priority for PT vehicles	different from town to town	alignment with best examples
Public transport: improving information systems, service agencies for sustainable mobility	mobility centres in many towns, mobility service per internet	to be continued and extended
Public transport: increasing frequency, extending networks	regional rail service partly improved after reform of railway system	to be continued and extended to other regions, bus service to be included
Railways: extension of rail infrastructure	extensions of rail and road infrastructure	stop extension of road infrastructure

(*continued next page*)

(*Table 8 continued*)

Instrument	Policy trend	Requirement
Railways: improve rail-road intermodality, improvement of service and logistics	standstill	incentives needed
Railways: introduce competition	national course set by reform of railway system, discussion on EU level	remove barriers (i.e. excluding track prices)
Railways: international harmonisation of regulations and technology	discussion on EU level	regulations to be changed, technology to be introduced on national level
Regional economics	research	research to be continued, reform subsidy programs
Regional tourism	many local activities	to be continued
Land use: charges on land use, tax parking opportunities	no plans for charges	intensify discussion, charges to be introduced
Land use: planning for low traffic levels, improve co-operation in regional planning institutions	many local / regional activities	to be continued and extended
Land use: reform construction planning regulations, reform housing subsidy programs, promote town reconstruction and housing	reform activities in some States	to be continued and extended
Energy supply:	liberalisation of energy market is deteriorating conditions for regenerative energy generation	support energy saving technology, cogeneration, CO_2 tax
Noise reception limits for existing lanes	under discussion	limits to be introduced
Noise: regulations for rail vehicles, road surfaces and tires	standards will be introduced soon	to be continued
Noise: regulations for road vehicles	standstill	lower standards needed
Aviation: exhaust standards for NOx and CO_2	no standards planned	standards to be introduced
Aviation: emission related charges, abolish tax exemptions, tradable permits for CO_2 emission	under discussion	charges, taxes, permits to be introduced
Aviation: optimise air transport management system	will be realised	to be continued

7.2 Gaps in knowledge

Technology of low consumption and low emission road freight vehicles, rail vehicles, ships, public transport vehicles, aeroplanes has to be developed. This is the task of research and development programmes of the government and of vehicle industry. Emission standards have to be proposed in order to give an incentive.

Leisure travel is the main travel purpose of all transport activities. The term leisure travel encloses a wide spectrum of very different activities, which are not known very well. There is not much known about the possibilities of influencing people' s leisure travel behaviour. An ongoing research project of the Federal Environmental Agency is trying to find first answers to these questions.

The excessive increase in aviation is caused by long-haul holiday trips. Nothing is known about possibilities to find out satisfying alternative destinations people will accept.

There is not much known about the needs of everyday life an EST strategy could be based on. A research programme is needed, which empirically analyses the importance of transport in everyday life and finds out the conditions necessary for a broad acceptance of EST.

7.3 Barriers for implementing EST

In Germany's economy vehicle industry is playing an important role. Politics that is meant to influence vehicle markets will have to deal with very strong economic interests. The political influence of manufacturers and manufacturer associations is strong.

Trucking companies are struggling for their interests, preventing fiscal measures concerning trucking. Building contractors are fighting for road construction orders on local, regional or State's level. Local builders often have an important position in communal social life.

Apart from direct lobby influences, policy impairing car industry has to be afraid of serious friction in economic development and employment. The EST project therefore is providing information on the topic of economic implications of the EST strategy (see Chapter 8).

Politicians try to avoid big changes in politics, no matter which political level, because reactions of people are an element of uncertainty. The introduction of the green tax reform by the newly elected German government in 1998 is a good example. The government did not present this very good concept offensively. Thus the levels of the eco-charges are very low, many exemptions are made to please everybody, and normal people can hardly realise the concept being good.

The people who are responsible for transport planning and policy mainly belong to the class of society with highest car affinity. With communal planning authorities those sections dealing with pedestrian or bicycle transport in most cases have very low budgets and restricted rights. There is a lack of institutional support, success depending very much on the commitment of single persons.

Traffic growth is part of a vicious circle. City inhabitants decide to live outside the centres because road traffic is so much disturbing. By doing so transport needs are growing, former inhabitants changing into commuters to the city. Inhabitants staying behind become even more disturbed by traffic. The needs to move outside the city are growing.

For people who want to change their behaviour the threshold is rather high, because of the car oriented situation. Dwellings are increasingly sprawled, retailers concentrated outside towns, access often restricted

to cars. Car drivers who individually leave their car and change to bicycle or public transport cannot influence being disturbed by car traffic. Pedestrians and cyclists suffer from noise, lack of comfort and safety to move undisturbed. The frequency of public transport is low because most people are using cars. Information about timetables and fares are not obviously present everywhere, it needs an effort to collect the information.

Many people may not be totally satisfied with their car dependent life, but nevertheless they can not imagine doing better without the car. There are no visions or fascinating examples present. Living without a car while maintaining the level of mobility and comfort at the moment is rather an expensive enterprise. It is possible to buy a cheap, low consuming car, use it several years, spending almost no money for maintenance, then scrap it. Compared to this possibility, mobility with public transport is much more expensive, the more if there is not a single person but a family to be transported.

For mothers (or fathers) of small children car driving is often the only chance to reconcile their different tasks, as household, children's' care, and job. One reason is the pressure of time, public transport's average travel time being twice average car travel time. Second reason is the lack of comfort travelling with small children using the public transport system.

8. Impacts on economy

The assessment of the macroeconomic changes that are caused by EST policies is a very important factor. To assess these changes two different methods are used: the Impact Path Analysis (IPA) and the System Dynamics Model (SDM).

The IPA outlined the macroeconomic development between the business-as-usual (BAU) scenario and the EST scenario presupposing no major technological or structural change induced by environmental policy.

The SDM offers the opportunity to construct a feedback mechanism for the macroeconomic development, which includes also structural changes induced by second round that occur only in the long run. Secondary effects arise because transport is highly interrelated with other social systems. Thus e.g. environmental taxes for one mode causes a direct effect in form of decrease in demand for this mode but also secondary effects in form of technological changes within that mode, in other modes and maybe in other sectors of economy.

SDM is an effective tool to describe the development of social and economic systems because it can take up many feedback of economic and social interactions. After finishing the development of an SDM model, called ESCOT (Economic Assessment of Sustainability poliCies Of Transport), we are now in a position to compare the results of ESCOT and IPA.

Finally we develop an "EST-50%" Scenario and assess its results. Its aim is to look at the economic impacts if we weaken the ecological challenge and decrease the intensity of policy measures that change the transport behaviour of population or firms.

8.1 Description of the SDM ESCOT

8.1.1 Basics of System Dynamics

Based on the finding that socio-economic systems as well as a lot of other real world systems often behave counterintuitively, which means that measures that have a positive influence in the short run have a

negative outcome in the long run, Forrester[15] concluded that such systems are composed of several interacting feedback loops. To model the feedback loops Forrester developed three types of structure elements and composed them with a special scheme to sets of difference equations that describe the inter-relationships within the system dynamics model.

With this approach linear systems as well as non-linear systems can be modelled. Results are produced with computer simulations that calculate the system states step-by-step over the simulation period.

Summarising, the basics of system dynamics are:

- the mental problem solving process (e.g. evaluation of relevance of interrelationships);
- the information-feedback theory (e.g. constructing a model of several feedback loops);
- the decision theory (e.g. defining decision rules to move along the time path from one system state into another); and
- computer simulation.

Finally it has to be emphasised that system dynamics models are not used for point-to-point forecasts and assessments, but for forecast of the development of the model variables over time, such that the time path development of the variables can be used for assessment.

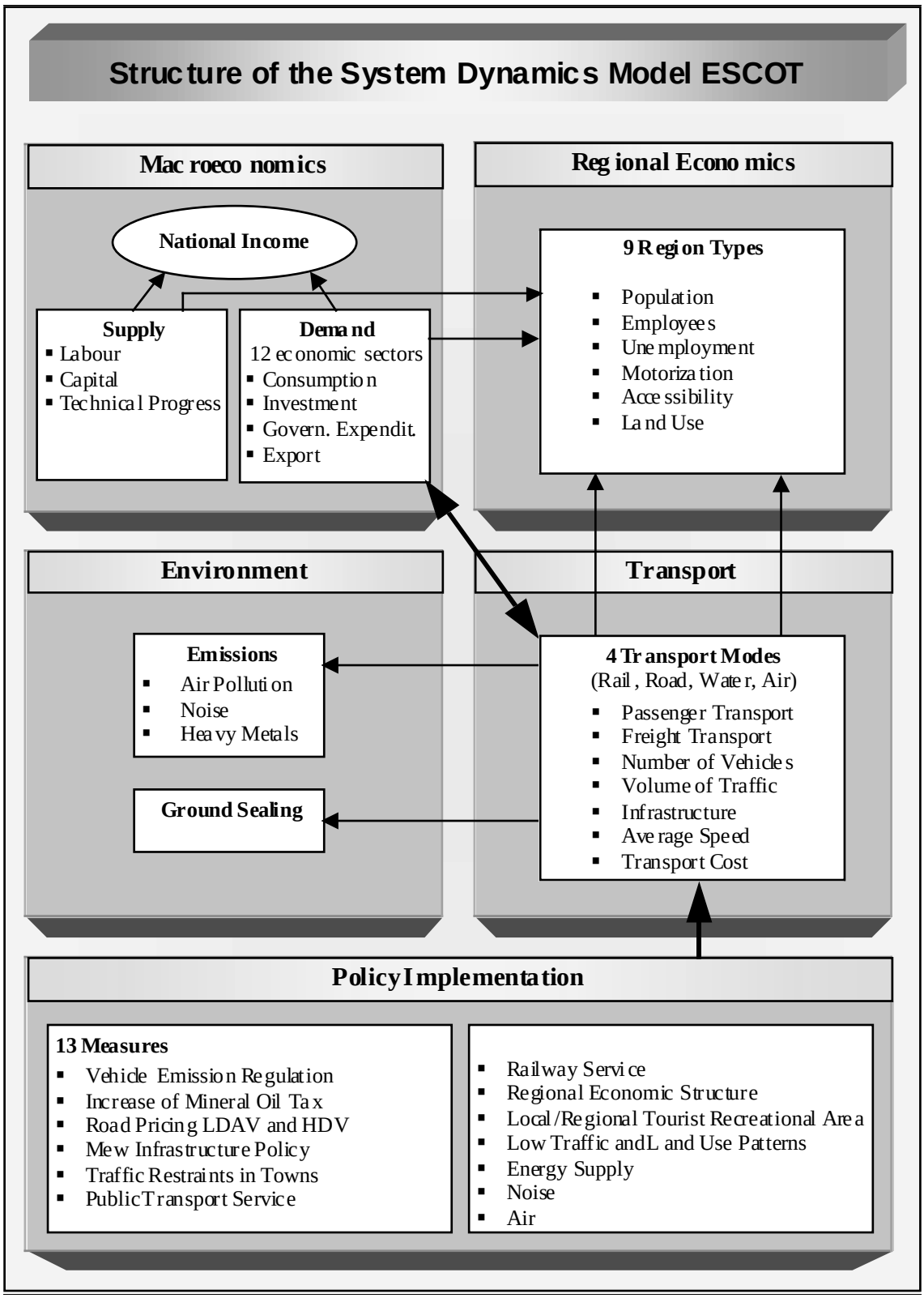
8.1.2 Structure of BAU/EST - ESCOT

The structure of the SDM that is developed to assess the scenarios is based on five different models representing four most important subsystems describing the impact areas and the policy sphere (Figure 8).

The **macroeconomic model** supplies information on the aggregate economic level (e.g. national income). The **regional economic model** is disaggregated into 12 different economic sectors. Furthermore 9 functional types of regions are defined (e.g. rural regions or highly agglomerated areas). This classification is also applied for the **transport model**. In addition this model distinguishes between different transport modes (road, rail, water, air) and different types of infrastructure links (e.g. high-speed links between agglomerations). The **environmental model** calculates data on emissions of transport activities and estimates their first round effects. The **policy model** drives the scenarios that influence the other model system. The most policy implementations intervene in the transport model such that this model usually is the steering area for simulating the impact mechanisms.

[15] Forrester, Jay W.: Grundzüge einer Systemtheorie, Wiesbaden 1972.

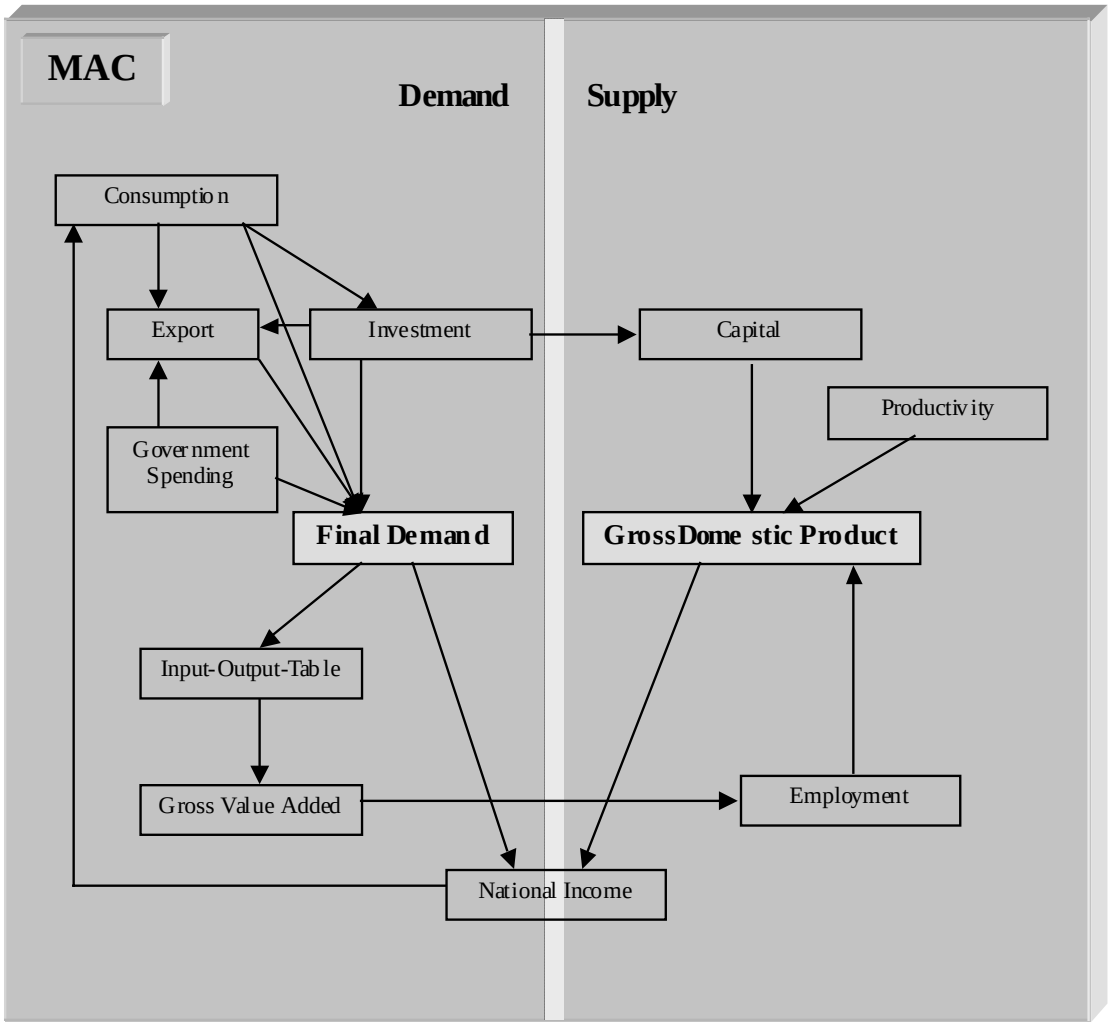
Figure 8. Structure of System Dynamics Model ESCOT with BAU/EST Policy Implementation



8.1.3 The macroeconomic model

Constructed as a Keynesian model the macroeconomic model is divided into two main parts: the demand and the supply side. Demand is split into four main demand sectors: consumption, investment, government expenditure and export. Each of the four demand sectors is disaggregated into 12 economic sectors (e.g. mineral oil industry).

Figure 9. Demand and Supply Side in ESCOT



The supply side is split into the production factors labour and capital. In addition technological progress is considered on the supply side to integrate the technical development within the economy.

Demand side

The main objective of the demand side is to calculate the final demand. The final demand is determined by the development of consumption, investment, government spending and export.

The variable **consumption** represents the consumption of the private households. For its calculation, we use the national income as one input. Additional inputs are the consumption spent in the transport sector like:

- mineral oil industry: the consumption of fuel for car travel;
- vehicle demand purchases: consumption of cars and motorcycles, repair;
- transport service: rail, bus and air travel.

The reason for this approach is that private households change their consumption patterns if transport prices increase. We consider that consumption in transport sectors causes impacts on consumption in non-transport sectors in a way that e.g. a decrease of consumption in transport sectors leads to a non-negligible increase of consumption in non-transport sectors. This does not mean that there will be a complete compensation because of complementarities between transport and other activities and incentive effects. For all calculations taxes and especially the mineral oil tax is taken into account.

The variable **investment** represents the investment of enterprises and government. The development of investment in one sector depends on the development of consumption in the same sector. Another influence on investments depends on the freight transport submodule. The transport models provide information about the traffic volume of road, rail and ship freight transport. These inputs are used as an indicator for investment in vehicles and buildings. Finally the investments made by the government in infrastructure for the road and rail mode is considered.

The variable **government** shows the expenditure of the government. We assume a yearly increase of 2%. In the system the variable **export** follows a similar development as consumption, investment and government for each sector. This means, that we add consumption, investment and government of one sector, derive the trend of this sum and link the export to this trend.

By adding consumption, investment, government and export of each sector we receive the **final demand** of each sector. Using the final demand concept we can calculate the following basic economic indicators:

- the national income;
- the gross value added; and
- an input-output-table for intersectoral flows of products and resources.

Supply side

The main objective of the supply side is to calculate the **gross domestic product,** which in terms of the calculation method can also be interpreted as the potential output of the economy. For the calculation of the gross domestic product an extended Cobb-Douglas function is used including labour, capital and productivity as inputs:

$$\text{Gross domestic product}(t) = c * e^{(\text{productivity} * t)} * \text{labour}(t)^{\alpha} * \text{capital}(t)^{\beta}$$

with c: constant

α, β: production elasticities

The variable **labour** stands for the yearly worked hours. It is based on the employment, which is derived by the gross value added and the specific employment per unit of gross value added for each sector. The sectors for transport vehicle production and transport services are separated into different modes. This enables us to consider the employment shift from one transport mode to another.

The variable **capital stock** depends on the private and public investment, and its depreciation. For the depreciation we assume a life cycle of 15 years. The increase of technical progress leads to a decrease of this life cycle. That reflects the fact that product cycles in recent years have always been shortened by the enormous technical development e.g. in the computer industry.

We treat the variable **productivity** by assuming an autonomous development of technical progress. This autonomous increase of productivity is the same for both scenarios. Besides this autonomous development of technical progress we have to take into consideration that the vehicle production sector in Germany is an important factor for the productivity. Therefore we implemented an indicator for the development of productivity caused by car, low duty vehicle, heavy duty vehicle and plane production. In EST the fostering of higher emission standards of transportation for all modes lead to more investigations, innovations and new technologies. Therefore we derive in EST an increase of this indicator and an increase of the rate of technical progress.

8.2 Results for the BAU/EST Scenarios

To get a clear understanding of the to be expected economic effects it is first necessary to look at the changes of transportation. The BAU scenario reflects the business-as-usual development. The EST scenario developed under the hypothesis that CO2 emissions to be reduced by 80% till the year 2030. We can see the difference between 1990, BAU 2030 and EST 2030 for passenger travel (Figure 10) and freight transport (Figure 11).

Figure 10. Passenger Travel

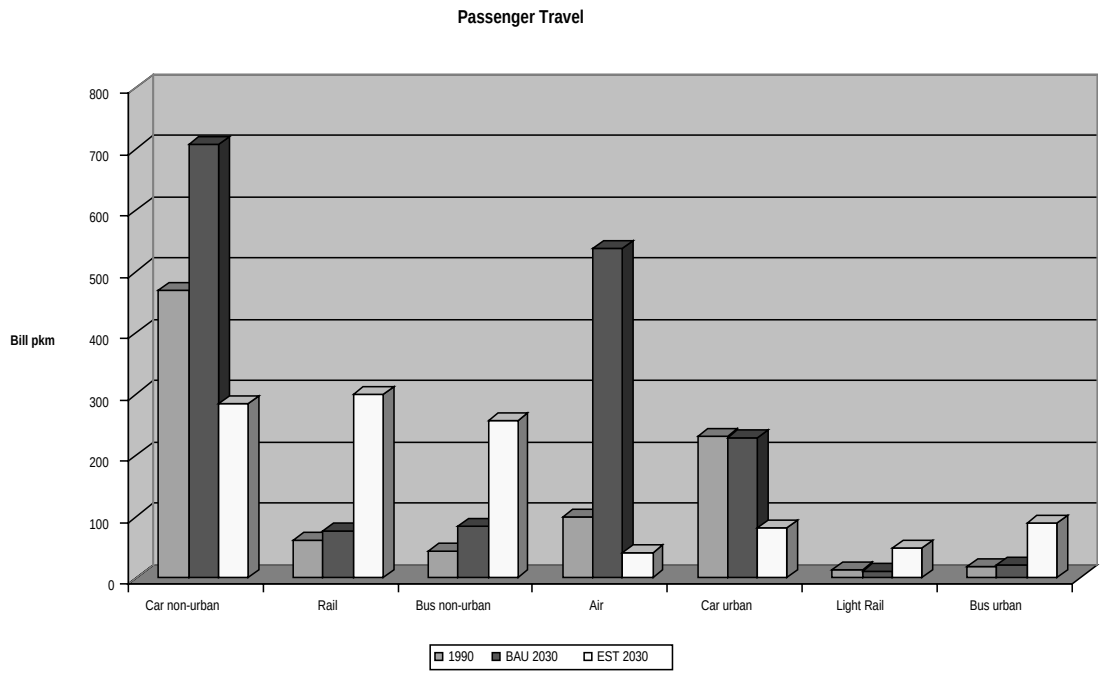
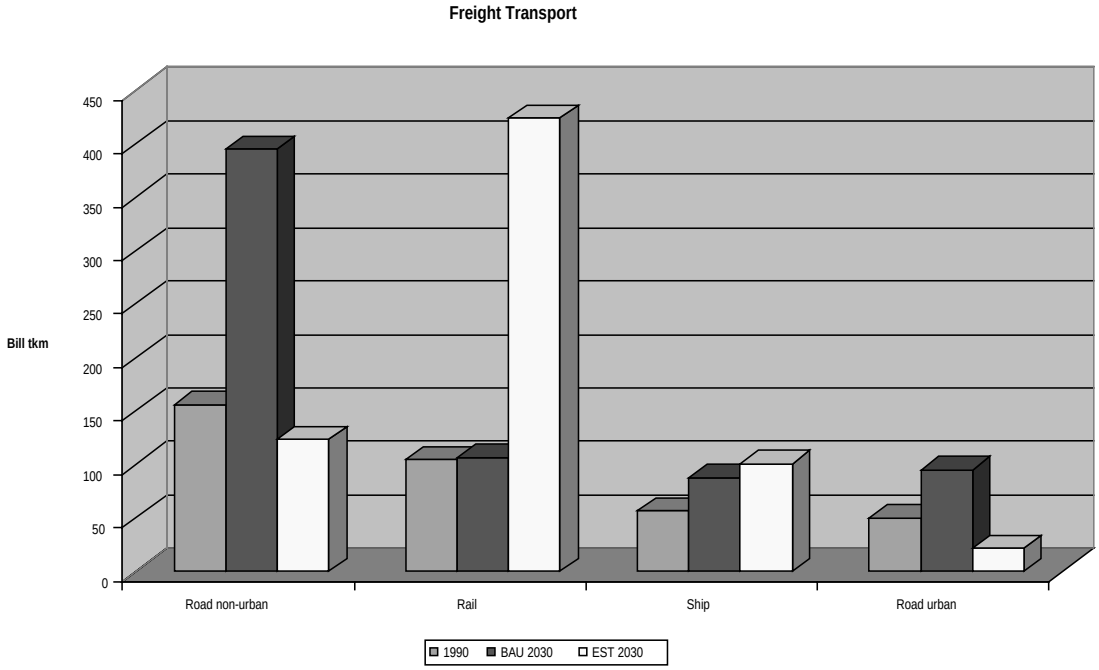


Figure 11. Development of Freight Transport



Looking at the totals the envisaged goal of a reduction of CO_2 emissions by 80% could not be reached completely. But with a reduction of more than 72% ESCOT is very close to this goal.

8.2.1 Demand side

The results of the simulation for the year 2030 with respect to consumption, investment, export and final demand in the different scenarios are listed in the following Table 9.

Table 9. Final Demand for BAU/EST Scenarios

Demand side: Sector (bill. DM; year 2030)	Consumption		Investment		Govern-ment	Export		Final Demand	
	BAU	EST	BAU	EST	BAU/EST	BAU	EST	BAU	EST
1 Agriculture	21	23	1	1	0	8	8	30	32
2 Energy, Water	80	82	0	0	0	6	6	86	88
3 Chemistry and Mineral Oil	99	88	1	1	0	155	138	256	227
4 Iron, Steel	0	0	11	11	0	45	45	56	57
5 Mechanical and automotive products	106	58	219	194	0	305	234	629	486
6 Electronics	61	64	77	78	0	129	133	267	275
7 Wood, Paper	116	122	13	14	0	72	75	202	210
8 Food	295	309	0	0	0	46	48	341	357
9 Construction	3	3	321	352	0	2	2	326	358
10 Traffic Services, Commerce	559	574	32	32	0	104	106	694	712
11 Private Services	793	832	25	25	0	37	39	855	896
12 Public Services	122	128	2	2	1212	2	2	1338	1344
Total	2256	2283	701	710	1212	910	836	5080	5041
Difference betw. BAU and EST		+1.1%		+1.3%	0%		-8.1%		-0.8%

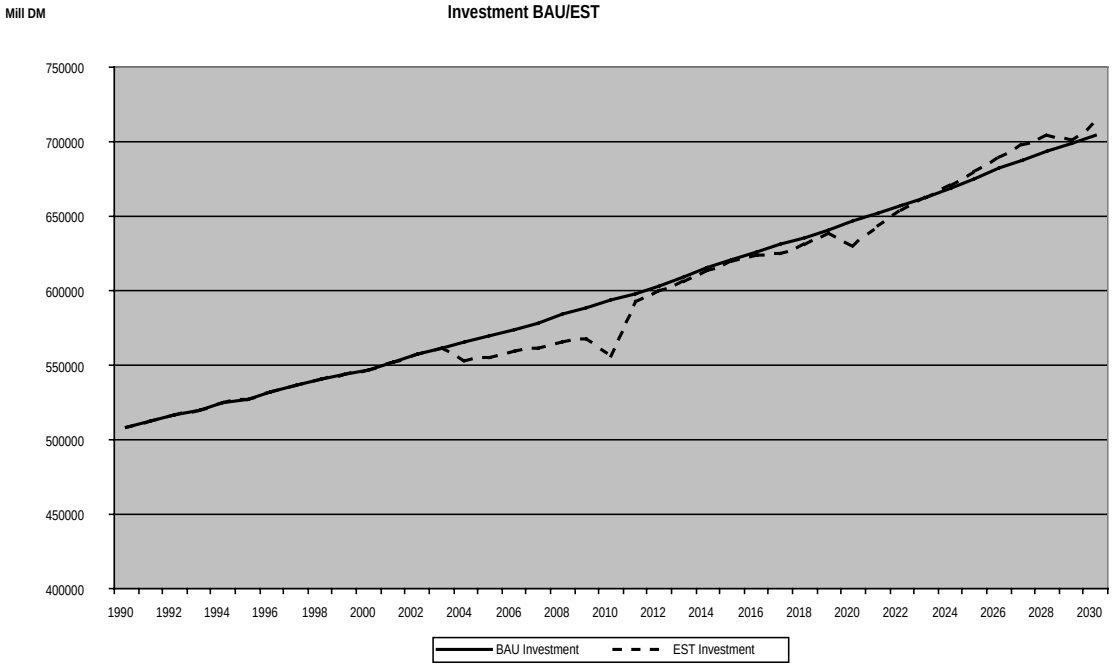
In most of the sectors we notice a small increase of **consumption**. The highest decrease is observed in sector 5 (includes vehicle production), a low decrease is in sector 3 (mineral oil). For **investment** overall changes are minor. The high decrease in sector 5 is offset by increase in sector 9, which is based on the investments in infrastructure for environmentally friendlier transportation.

For **exports** we estimate a sharp decrease in sector 5. The influence of the vehicle production on the export sector is evident.

The **final demand** side shows the entire effect on the different sectors. In total we notice that the negative effects on export are mostly offset by the development of consumption and investment. So, final demand differs only by about 0.8% between both scenarios.

If we look at the graph for **investment**, we can give one reason for the positive development of consumption and investment. The first ten years the investment in EST is lower because of the negative effects of reduced consumption, investments into rail infrastructure still being in its planning phase. From the year 2010 the fostering of investments in rail infrastructure and the expansion of the rail network begin. This effect balances out the negative effects of the decrease of consumption.

Figure 12. Development of Investment



8.2.2 Supply side

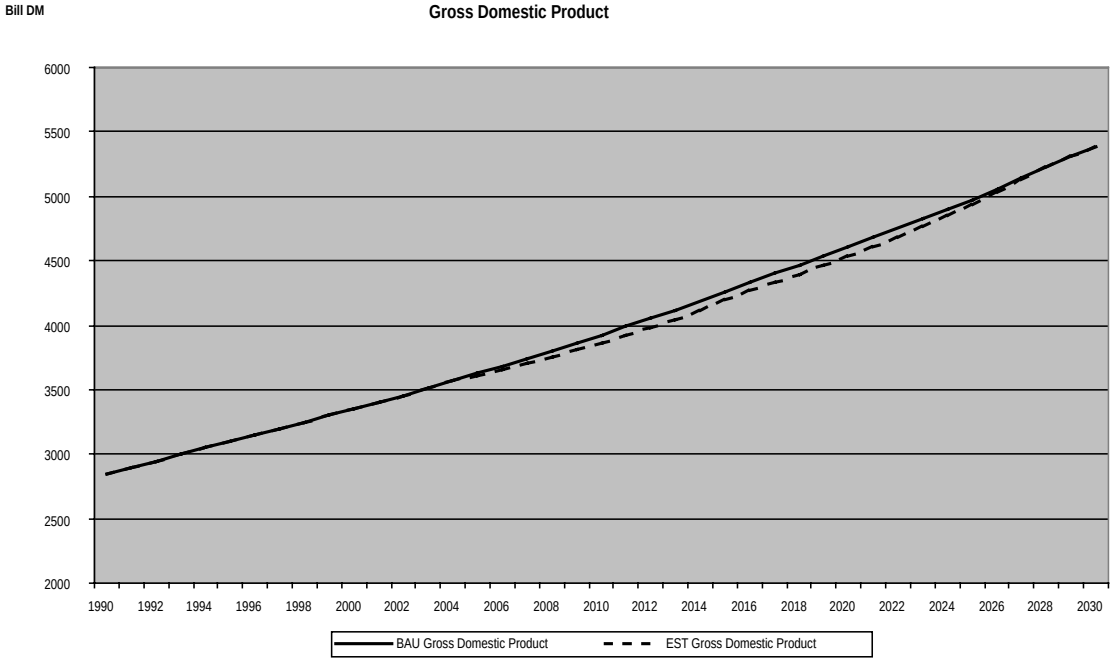
In EST **employmen**t reaches a slightly lower level than BAU. The simulation shows a minus of 335 000 jobs in the year 2030. **Capital stock** is also the same as in BAU. For capital stock the higher amount of investment balances out the abridged depreciation of capital in the vehicle production sectors.

Table 10. Supply for BAU/EST scenario

Supply side	1990	BAU 2030	EST 2030	Diff. EST to BAU	Diff. EST to BAU in %
Employment [Mill. Person]	34.921	32.206	31.871	-0.335	-1.0%
Capital stock [Bill. DM]	10.709	13.246	13.085	-0.161	-1.2%
Productivity [1/1000]	11.000	11.000	11.309	+0.309	+2.8%
Gross domestic product [Bill. DM]	2.844	5.379	5.382	+0.003	+0.1%

For **productivity** we estimate an increase of about 2.8%. This is caused by an increase of the rate of technical progress from 0.011 to 0.01130. This productivity is a major influence on the growth of gross domestic product. In the graph for **gross domestic product** we realise that gross domestic product of EST is lower at the beginning of the policy measures. Due to the increase of investments (public and private) gross domestic product of EST approaches the BAU value at the end of the simulation.

Figure 13. Development of Gross Domestic Product



8.2.3 Conclusions

The results of the analysis clearly show that the departure from car and road freight oriented transport policy is far from leading to an economic breakdown. The effects concerning economic indices are rather low, even though the measures proposed in the EST3 scenario designate distinct changes compared to today's transport policy. In the beginning of the EST period the growth of GDP is less than it is expected to be in BAU, but in the end of the period GDP in EST is slightly higher than BAU. Final demand on the other hand is slightly lower in EST compared to BAU. The impact on employment however is clearly negative. From the development of indices during the period analysed there is evidence, that the time period until 2030 might be too short to fully avoid negative impacts. Therefore impact modelling has been repeated with the CO_2 criterion relaxed to 50 %. With ESCOT this modification can be quite easily realised. Policy measures can be easily changed and the resulting scenario examined.

8.3 The EST-50% scenario

The time period analysed is the same, the CO_2 criterion being a reduction of 50 % compared to 1990. The policy measures are changed as follows:

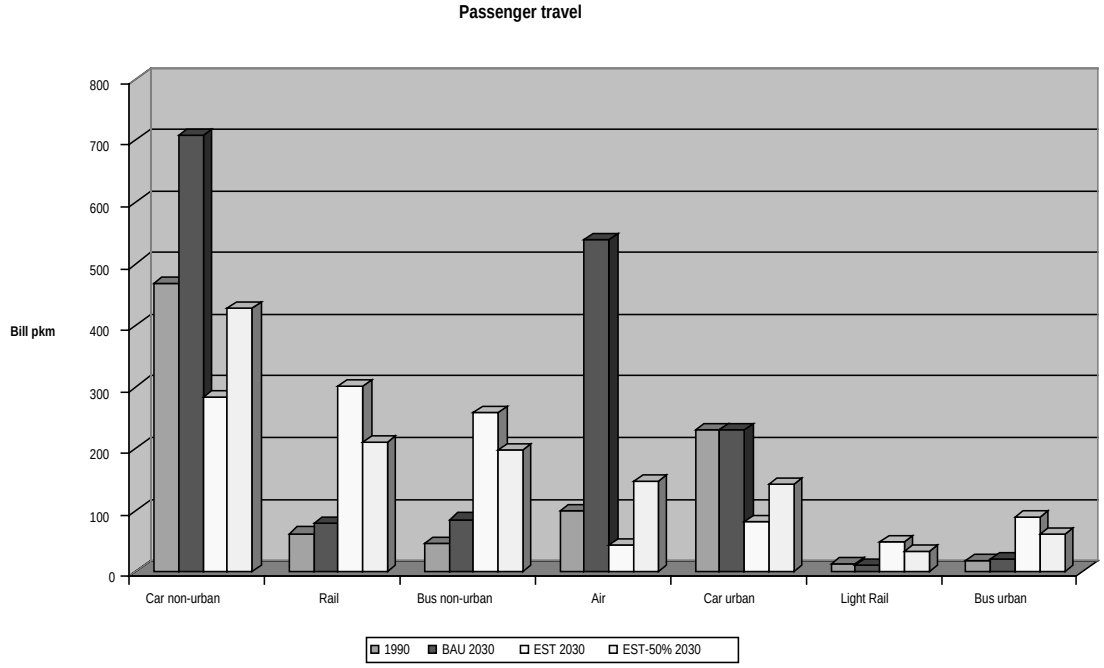
- Increase of fuel tax less than 50% of EST.
- Increase of road pricing only 50% of EST.
- Improvements in emission regulation about 70% of EST.
- Expansion of railway infrastructure about 70% of EST.

– Inner city, railway service, regional economic and land use measures same as in EST.

– Energy policy measures same as in EST.

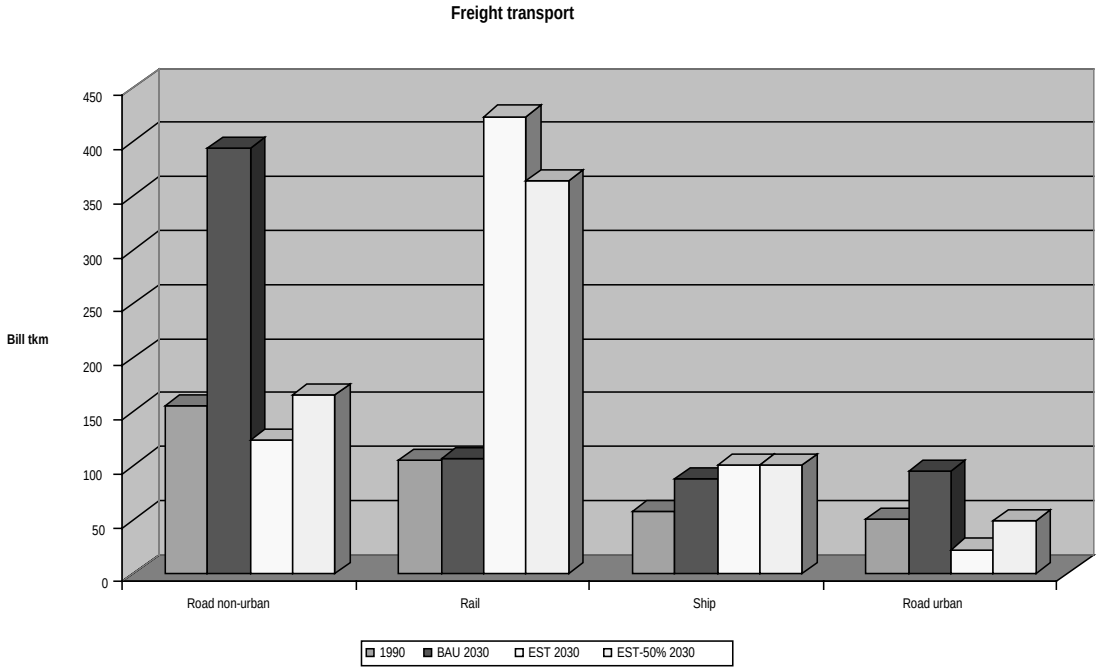
This leads to changes for passenger travel and freight transport compared with BAU and EST:

Figure 14. Comparison of passenger travel in 1990 and in 2030 for BAU, EST(EST-80%) and EST-50%



The changes for passenger travel and freight transport are much lower in EST-50% than in EST-80%. For EST-80% drastic changes for car travel and air transport are necessary. In EST-50% the amount of passenger-km for car travel and air transport can be held in 2030 on same level as in the year 1990. But the growth of passenger travel is absorbed by environmental more friendly modes.

Figure 15. Comparison of freight transport in 1990 and in 2030 for BAU, EST(EST-80%) and EST-50%



For freight transport we recognise the same characteristics. The amount of ton-km of road transport reaches for EST-50% in 2030 the same level as in 1990. The growth of freight transport is absorbed by rail and ship transport.

The changes for road and air of transport now are much less spectacular. This goes further with mode shift effect towards environmentally friendlier modes as in EST-80%. But it is important that the environmentally friendlier modes have to be attractive enough to absorb the growth of transport activity.

8.3.1 Demand side

The results of consumption, investment, export and final demand are listed in Table 11.

Table 11. Final demand for BAU/EST-50% scenario

Demand side: Sector (bill. DM; year 2030)	Consumption		Investment		Govern-ment	Export		Final Demand	
	BAU	EST-50%	BAU	EST-50%	BAU/ EST-50%	BAU	EST-50%	BAU	EST-50%
1 Agriculture	21	23	1	1	0	8	8	30	32
2 Energy, Water	80	82	0	0	0	6	6	86	88
3 Chemistry and Mineral Oil	99	90	1	1	0	155	140	256	232
4 Iron, Steel	0	0	11	12	0	45	46	56	57
5 Mechanical and automotive products	106	81	219	203	0	305	265	629	549
6 Electronics	61	65	77	79	0	129	133	267	276
7 Wood, Paper	116	122	13	14	0	72	75	202	211
8 Food	295	310	0	0	0	46	48	341	358
9 Construction	3	3	321	337	0	2	2	326	343
10 Traffic Services, Commerce	559	581	32	32	0	104	108	694	721
11 Private Services	793	834	25	25	0	37	39	855	898
12 Public Services	122	129	2	2	1212	2	2	1338	1344
Total	2256	2320	701	705	1212	910	873	5080	5109
Diff. betw. BAU and EST-50%		+2.8%		+0.5%	0%		-4.1%		0.6%

The structure of the changes between EST-50%/BAU on one hand and EST-80%/BAU on the other hand are similar. But significant differences in the magnitude of the changes occur. As for EST-80% we notice in most of the sectors a small increase of private **consumption**. Decreases of consumption are expected in sector 5 (includes vehicle production) and sector 3 (mineral oil). But these decreases are much smaller for EST-50%. With 2.8% the overall increase for consumption is much higher than the 1.1% increase for EST-80%. This effect depends on the similar technical policy measures and the moderate pricing policy measures compared to EST-80%.

Also for **investment** and **exports** changes in EST-50% are minor (e.g. the decrease in sector 5 and the increase in sector 9). The increase of investment is smaller (0.5%) than the increase of 1.3% for EST-80%. The negative effects for exports of automotive products can not be fully compensated by the increase of other sectors. We derive a total negative effect for exports of 4.1% compared to 8.1% for EST-80%.

The **final demand** side shows us the entire effect on the different sectors. In total we notice that the negative effects in the export sector can be overcompensated by the development of consumption and investment. So, final demand increases by about 0.6% above the level of BAU compared to a decrease of 0.8% for EST-80%.

Supply side

In EST-50% the **employment** reaches a higher level than in BAU at the end of the simulation period (of 335000 jobs at the year 2030). For **capital stock** there is a small decrease caused by the earlier depreciation by an increase of productivity. In total **gross domestic** goes up 1.2%.

Table 12. Supply for BAU/EST-50% scenario

Supply side	1990	BAU 2030	EST-50% 2030	Diff. EST-50% to BAU	Diff. EST -50% to BAU in %
Employment [Mill. Person]	34.921	32.206	32.541	+0.335	+1.0%
Capital stock [Bill. DM]	10.709	13.246	13.106	-0.140	-1.1%
Productivity [1/1000]	11.000	11.000	11.256	+0.256	+2.3%
Gross domestic product [Bill. DM]	2.844	5.379	5.441	+0.063	+1.2%

In general these positive results on the supply side depend on two main effects. One is the increase of **productivity**. The productivity increases in the EST-50% scenario by 2.3% (2.8% for EST-80%). This increase of productivity depends itself on the higher emission regulation that enforces research and development in the vehicle and the energy industries.

The other effect belongs to the influence of the demand side with its positive effects on consumption, investment and final demand.

So the EST-50% scenario shows that environmental policy can have positive impacts on the economy if it actively makes use of flexible market adjustments without overstressing them. To develop such environmental policies we have to take into consideration the weight between technical policy measures and pricing policy measures and of course the positive economic effects caused by higher productivity.

8.3.4 Comparison of EST-50% and BAU in the year 2015

The assessment of BAU/EST scenario contains not only the end time of analysis but also meantime points. Therefore we derived the results for EST-50% for the year 2015 (same for IPA EST-50%). At this time the total changes of transportation are nearly half realised compared to the goal at the year 2030.

Demand side

The results of consumption, investment, export and final demand are listed in the Table 13.

Table 13. Final demand for BAU/EST-50% scenario in the year 2015

Demand side: Sector (bill. DM; year 2015)	Consumption		Investment		Govern-ment	Export		Final Demand	
	BAU	EST-50%	BAU	EST-50%	BAU/ EST-50%	BAU	EST-50%	BAU	EST-50%
1 Agriculture	17	17	1	1	0	6	6	24	24
2 Energy, Water	62	62	0	0	0	5	5	66	67
3 Chemistry and Mineral Oil	83	73	1	1	0	130	115	214	190
4 Iron, Steel	0	0	10	10	0	40	40	50	50
5 Mechanical and automotive products	109	112	190	183	0	278	275	577	570
6 Electronics	48	49	68	69	0	108	109	224	226
7 Wood, Paper	88	90	12	12	0	56	56	156	158
8 Food	226	230	0	0	0	35	36	261	266
9 Construction	3	3	285	292	0	2	2	291	298
10 Traffic Services, Commerce	437	433	28	28	0	82	81	547	542
11 Private Services	609	621	22	22	0	29	29	660	672
12 Public Services	95	97	1	1	899	1	1	996	998
Total	1777	1789	618	619	899	771	756	4065	4062
Difference betw. BAU and EST		+0.6%		+0.1%	0%		-2.0%		-0.1%

In general lower effects on economic data are found for the year 2015 than for 2030. **Consumption** drops only in the sector 3 caused by the lower fuel consumption of vehicles. Also for **investment** the effect of the expansion of the railway network is rather small belonging to the fact that the beginning of the expansion is in 2010.

In this period of time the total effects on **exports** are minus 2.0% which is nearly half of the decrease of exports till 2030.

Altogether the changes of consumption, investment and export are nearly balanced out. **Final demand** decreases by 0.1%.

Supply side

In EST-50% the **employment** reaches a similar level as in BAU in the year 2015. A plus of 8000 jobs is obtained in the year 2015. For **capital stock** a decrease of 0.9% has been found caused by the earlier depreciation by increase of productivity. The effect on **gross domestic product** of minus 0.1% has the same magnitude as the decrease of final demand.

Table 14. Supply for BAU/EST-50% scenario

Supply side	1990	BAU 2015	EST-50% 2015	Diff. EST-50% to BAU	Diff. EST-50% to BAU in %
Employment [Mill. Person]	34.921	34.238	34.246	+0.008	+0.0%
Capital stock [Bill. DM]	10.709	12.335	12.218	-0.117	-0.9%
Productivity [1/1000]	11.000	11.000	11.125	+0.125	+1.1%
Gross domestic product [Bill. DM]	2.844	4.242	4.236	-0.006	-0.1%

The technology push leads to an increase of 1.1% of **productivity**. This balances out the negative effects of the pricing policy measures on demand.

In total the aggregate effects on the economic side are low but there are considerable sectoral shifts (e.g. sector 3 on final demand). In the EST-50% scenario the results for the year 2015 demonstrate that there is only a little risk for economic development. If consumers are willing to increase their demand for environmentally better alternatives, if the latter become more attractive and if industry discovers possibilities for speeding up technological change the overall results on economic performance can even be positive.

8.3.4 Comparison between ESCOT and IPA

The IPA method found out negative effects for all indicators of the demand side which increased over time.

Table 15. Comparison of final demand for IPA and ESCOT

Demand side [%]	IPA 2015	ESCOT EST-50% in 2015
Consumption	-0.6	+0.6
Investment	-0.9	+0.1
Export	-1.6	-2.0
Final Demand	-0.7	-0.1

In ESCOT the negative effects for consumption and investment were balanced out and for final demand were lower than calculated with IPA. This compensation is based on structural changes and dynamic developments that are not considered in the IPA. At the level 4 of IPA all data are calculated without taking into account that higher productivity may arise and change gross domestic product as well as the economic indicators on the demand side.

Only for exports ESCOT derives negative effects in the same magnitude as in IPA, which belongs to the fact that the vehicle production in Germany is an important factor for the export.

Table 16. Difference of employment for EST-50% to BAU in 2015 (calculated with IPA and ESCOT)

Supply side	IPA 2015	ESCOT EST-50% in 2015
Change of employment [Mill Persons]	+0.009	+0.008

For the employment the results are for both methods are similar. With IPA and with ESCOT we calculate nearly the same employment figures for EST-50% and BAU.

This means that IPA is sticking more the first round effects which are governed by negative influences of higher prices and restrictions on the demand side. ESCOT includes second round effects and the major feedback mechanisms which become effective in the long run. It assumes that the market forces can positively be stimulated by environmental policy, leading to an increase of productivity on the supply side. In the long run the productivity gain and the associated stimulation of production may more than offset the initial reductions of demand.

9. Conclusions

The work on phase 3 of the EST project has revealed that there are enormous efforts necessary to achieve the sustainability targets, and the time left is very short.

As far as passenger transportation is concerned the targets, except for the noise targets however, might be achieved with the instruments chosen. There are powerful measures available to reduce urban car traffic by two thirds compared to 1990 as proposed in the EST3 scenario. It seems possible, too, to cut non-urban car traffic by half, mainly by shifting journeys to public transport. Reducing air transport by 60 per cent compared to 1990, as proposed in the EST3 scenario, seems much more difficult however, as air travel has the highest growth rates of all transport modes. Tradable permits for CO_2 emission by aviation seem to be a possible solution to come closer this target.

As for freight transport the reduction of transport volume of HDV defined in the EST3 scenario (-75 % VKT compared to 1990) will probably mostly be achieved with the instruments available. This does not hold for LDV traffic however, which is supposed to drop to about 40 per cent of the 1990 VKT value. Thus there is revealed a need for innovation in the field of freight distribution.

Regarding noise, levels above 55 dB(A) will still remain on main roads in town. Research has to be enforced in order to improve noise abatement technology and to develop more powerful organisation and logistic concepts.

The results of the assessment of economic impacts clearly show that the departure from car and road freight oriented transport policy is far from leading to an economic breakdown. The effects concerning economic indices are rather low, even though the measures proposed in the EST3 scenario designate distinct changes compared to today's transport policy. The impact on employment however is clearly negative. Therefore it should be proposed to expand the time period for change in order to decrease the speed of change and give more room to compensating measures. To check for the results of this proposition, impact modelling has been repeated with the CO_2 criterion for the year 2030 relaxed to 50 %. The result is encouraging. Although export level is still lower than expected in BAU, this effect is fully

compensated by consumption, and the total of final demand is slightly positive. The growth of GDP is accelerated as well, and there are positive effects on employment to be expected. So the EST-50% scenario shows that environmental policy can have positive impacts on the economy if it actively makes use of flexible market adjustments without overstressing them. To develop such environmental policies we have to take into consideration the trade-off between technical policy measures and pricing policy measures and of course the positive economic effects caused by higher productivity of production activities.

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