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Report on the second phase of the OECD project Environmentally Sustainable Transport (EST)

Case study: The greater Oslo area

Farideh Ramjerdi

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Norwegian Centre for Transport Research

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Forfatter: *Farideh Ramjerdi*

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Sammendrag:
Fire scenarier for utviklingen av lokaltrafikken i Oslo-regionen er konstruert. Det ene er et trend-scenario, de øvrige oppfyller kriteriene for bærekraftig transport i OECDs EST-prosjekt. Det viser seg at å oppnå bærekraftighet med enten transportpolitiske eller teknologiske virkemidler alene, er umulig, mens scenariet som kombinerer disse virkemidlene og kraftige virkemidler for arealbruk og regionalisering av produksjonen, mer sannsynlig kan la seg gjennomføre.

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Summary:
Four scenarios for the development of local transport in the Greater Oslo area have been constructed. One is a "business as usual" scenario, while the others meet the criteria of Environmentally Sustainable Transport (EST) in OECD's EST project. It turns out that it is impossible to achieve sustainability by transport policy or by technological change used in isolation. Combining them, however, and adding strong measures to influence land use and the regionalization of production, probably a feasible scenario for the attainment of EST can be had.

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Rapporten kan bestilles fra:
Transportøkonomisk institutt, biblioteket,
Postboks 6110 Etterstad, 0602 Oslo
Telefon 22 57 38 00 - Telefax 22 57 02 90
Pris kr 100,-

The report can be ordered from:
Institute of Transport Economics, the library,
PO Box 6110 Etterstad, N-0602 Oslo, Norway
Telephone +47 22 57 38 00 Telefax +47 22 57 02 90
Price NOK 100.-

Preface

This report summarises the transport scenarios for the Greater Oslo Area, the Norwegian case study in the second phase of the OECD project "Environmentally Sustainable Transport", EST. The Norwegian Ministry of Environment has invited the Institute of Transport Economics to prepare this work.

Eli Marie Åsen at the Ministry of Environment has co-ordinated activities in connection with this project between the Ministry of Environment and the Norwegian Pollution Control Authority. The Norwegian Pollution Control Authority had the responsibility of the characterisation of some of the transport scenarios for the greater Oslo Area.

Lars Rand and Trond Jensen at the Institute of Transport Economics have contributed to this work. Laila Aastorp Andersen and Unni Wettergreen have provided the secretarial support. Farideh Ramjerdi has been the project leader and responsible for this report.

Oslo, December 1997
INSTITUTE OF TRANSPORT ECONOMICS

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Chief Research Officer

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Summary:

Report on the second phase of the OECD project Environmentally Sustainable Transport (EST)

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In 1995 the OECD initiated the project "Environmentally Sustainable Transport" (EST). The project consists of four phases. The first phase aimed at the characterisation of environmentally sustainable transport, in terms of development of different quantitative and other criteria for the transport sector.

The second phase of the project focuses on pilot projects conducted by some of the Member countries. The purpose of these pilot projects is (i) to develop four scenarios, business as usual (BAU), high-technology (EST1), capacity constraint (EST2) and optimum combination (EST3) scenarios; (ii) determination of the set of actions that might be required to achieve EST in each scenario, and; (iii) evaluation of economic, social and political implications of the proposed actions and the development of a preferred scenario.

Norway is one of the participating countries in the second phase of EST project and has proposed the greater Oslo area as its pilot project. This document describes the second phase of the project in the context of the Norwegian pilot project. It should be emphasised that this study does not reflect the official view of the Norwegian government nor of the local authorities of the Oslo region.

Methodology

The Norwegian case study is limited to the greater Oslo area that includes the two adjacent counties of Oslo and Akershus. The scope of the study is limited to passenger and freight transport within this area.

Year 2030 has been set as the target year for the attainment of EST. It is the year for which the EST scenarios are to be constructed and the BAU scenario to be projected. The reference year is 1990 for the quantitative criteria expressed as percentage change. It is also the year from which the BAU scenario is projected. The Implementation period for the instruments for the achievement of EST is 2000-2030. It is proposed that the milestone for implementation and its assessment should be 2010.

The report can be ordered from:
Institute of Transport Economics, PO Box 6110 Etterstad, N-0602 Oslo, Norway
Telephone: +47 22 57 38 00 Telefax: +47 22 57 02 90

The quantitative criteria should be expressed as reductions from 1990 in total emissions from transportation. Table 1 shows these criteria.

Table 1 Quantitative criteria for EST

Emission of pollutants	Reduction, in percent, from 1990 to 2030
CO_2	80
NO_x	90
VOCs	90

The specification of criteria for more local impacts such as those related to particulate matter and noise for the greater Oslo area will be carried out in the next phase of the study. The construction of criteria related to land use has presented substantial problems. The criterion for land use in this phase of the project is set to limit the use of land for transport purposes at the level (sanctioned) in 1996.

The Norwegian targets adopted in 1997 with respect to the emission of pollutants are different from those shown under Table 1. With respect to the emission of pollutants, the Norwegian government does not have sector specific targets.

The general methodology for the development of scenarios

Four alternative scenarios are constructed. The first scenario is Business as Usual (BAU). This scenario reflects the continuation of current trends in the transport sector. The other three scenarios are constructed so that they achieve the criteria set for Environmentally Sustainable Transportation (EST).

These scenarios are:

- A high-technology scenario, EST1, under which it is assumed that the EST criteria are met only by developments in transport technologies. Under this scenario it will be assumed that the demand for transport, passenger and freight will be similar to the BAU scenario.
- A capacity-constraint scenario, EST2, under which it is assumed that the EST criteria are met by different measures that affects the demand for passenger and freight transport. Under this scenario it will be assumed that the technological development would be similar to the BAU scenario.
- An optimum combination scenario, EST3, under which the EST criteria are met by combinations of measures that affects the demand for transport as well as development in transport technologies.

The relationship of the three EST scenarios to the BAU scenario has been suggested as follows[1].

[1] Notes on the meeting held in Oslo, Norway on 28-30 May 1996, Task Force on Transport, Environmentally Sustainable Transport,

	EST1 High-Technology	EST2 Capacity-Constraint	EST3 Optimum Combination
Technological developments	>> BAU	≈BAU	> BAU
Transport activity *	≈BAU	<< BAU	< BAU

* Transport distance and volume of passenger and freight

The above matrix suggests that EST1 involves similar levels of transport activity to that of the BAU scenario. The EST criteria in this scenario are to be met through the introduction of different technologies connected to vehicles, fuels and infrastructure.

The technological development under the EST2 scenario is, however, similar to that of the BAU scenario. In this scenario the EST criteria are met through reduction in transport activity (volume and distance), shifts to less pollutant transport modes, management of traffic within each transport mode and policies related to the provision of transport infrastructure.

The EST3 scenario will include both factors; those related to technology and those related to mobility management.

The specification of the EST scenarios followed a procedure whereby first the objectives to be aimed at in each scenario were specified. Potential policy instruments were then surveyed, and the the result of adopting a set of policies was assessed, if possible by the use of transport models. Often, the results suggested that changes in the tested policies or even the objectives themselves were neccesary to achieve EST. The process then continues until the EST criteria are met.

The BAU scenario

The BAU scenario reflects the continuation of the present trends in socio-economic and demographic factors as well as technological developments, legislation and other factors that will influence the demand for transport at a national level.

Projections of socio-economic and demographic developments are calculated by the Central Bureau of Statistics using the multi-sectoral growth model (MSG) and other models. Annual growth in population is assumed to be according to the SSB's model Mozart-1 up to year 2025. From 2025 up to 2030 the annual growth in population is assumed to be the same as in the period of 2020 to 2025. The Institute of Transport Economics has produced scenarios of technological development in the transport sector. Also, it is assumed that the changes in infrastructure will be according to the approved plans up to year 2000.

The forecasts of the transport volume in the BAU scenario is based on two model systems, one for passenger transport, RETRO (Rand 1997), and another for freight transport, GODMOD (Jensen 1994).

Under the BAU scenario car ownership will increase by 53 percent between 1990 and 2030. The distribution of trips by mode will shift towards car compared with the base year, 1990. The increase in number of trips by car is not as large as the increase in car ownership, 34 percent compared with 53 percent. Car occupancy will decrease from the present value of about 1.6 to 1.3. The number of trips by walk and cycle will decrease slightly from 1990 to 2030. We have assumed the occupancy rate for public transportation modes to stay at the level in 1990. The average trip length by car will increase. The increase is not as large as we had expected. This could be due to relatively conservative assumptions regarding the development of land use under the BAU scenario.

Table 2 shows a summary of the development of demand and the emissions from passenger transport within the greater Oslo area under the BAU scenario.

Table 2 Prediction of the development in travel and emissions in the passenger transport sector under the BAU scenario (1990=100)

Year	1990	2010	2030
		Car ownership	
No. of private cars	100	131	153
		Trips	
Total	100	117	122
Car	100	127	134
Public Transport	100	101	101
Walk/Cycle	100	97	97
		Vehicle-kilometres	
Total vehicle km.	100	120	125
Car	100	129	135
Public Transport	100	104	105
Walk/Cycle	100	100	101
		Fuel use/CO_2 emissions	
Total	100	111	110
Private car	100	112	111
Public transport	100	99	96
		NO_X emissions	
Total	100	53	26
Private car	100	50	22
Public transport	100	83	79
		VOCs emissions	
Total	100	52	25
Private car	100	50	22
Public transport	100	83	79

Table 3 shows the shifts in mode share between 1990 and 2030. This table also shows that the distribution of trips by mode will shift towards car compared with the base year, 1990.

Table 3 Shifts in mode share under BAU scenario

Mode share	1990	2010	2030
Car	0.59	0.64	0.69
Public transport	0.18	0.17	0.16
Walk/cycle	0.23	0.19	0.15
Total	1.00	1.00	1.00

The calculation of the BAU scenario shows that the emissions of NO_x and VOCs are reduced by about 75 percent. However, the situation for the emissions of CO_2 is very different. The emissions of CO_2 will increase by 10 percent compared with 1990 level. This calculation suggests that the BAU scenario does not meet the criteria for EST, especially with respect to the emissions of CO_2. It is relatively safe to assume that any scenario that meets the EST criterion with respect to CO_2 will meet other EST criteria.

Under the BAU the volume of *freight* transport expressed in tonne-kilometres or vehicle kilometres will increase by over 150 percent compared to 1990. The increase in freight transport volume is larger than expected, however, it is in line with the past trend.

The calculation of the BAU scenario shows that the emissions of CO_2, NO_x and VOCs will increase compared with 1990 levels. The comparison of the emission in the passenger transport with those in the freight transport suggests that the achievement of the EST criteria in the freight transport sectors poses much more problem. The reason for this is twofold. One is connected to the differences in expected technological developments in the two sectors and the other is connected to the differences in the expected growth in volumes in the two sectors.

The High-Technology (EST1) scenario

The EST criteria in the EST1 scenario are met through the introduction of different technologies connected to vehicles, fuels and information technology (telematics). For instance, we have assumed that the passenger car fleet will be composed of mainly electrical cars (about 40 percent) and very fuel efficient hybrid cars, e.g., which run on electricity and fossil fuel (about 60 percent). There will have to be strict regulations that limit the use of hybrid cars in urban area to the alternative fuel. A number of other strong assumptions have been made. The selection of technologies in the passenger and freight transport sector have been made such that in total, the transport sector will meet the EST criteria.

It is assumed that the introduction of the new technologies will not affect the prices of different modes of transport for the users. This is a strong but necessary assumption to attain similar demands for transport under the EST1 to that of BAU scenario.

The costs of developing and implementing the technologies necessary to attain EST in this scenario may be very high. The implicit assumption in the EST1 scenario is that the users are facing the same costs (generalised cost) as in the

BAU scenario. The implication is that the new technologies have to be highly subsidised. The level of subsidies could be beyond what might be publicly acceptable or even rational.

There are three main categories of policy instruments that could bring about the necessary reductions in emissions for meeting the EST criteria set for passenger and freight transport. These are:

- Economic policies such as differential taxation/ subsidies of fuel and vehicles
- Regulatory policies such as setting standards and targets
- Transport logistics and planning such as the use of telematics/information technology

Table 4 shows a summary of the methods for the attainment of EST criteria in the EST1 scenario. This table also shows the benefits and costs of the implementation of the policy instruments. The evaluation of costs and benefits at this stage of the work is rather crude and should be considered as preliminary. The environmental benefits from the attainment of the EST criteria are not included among the benefits in this table.

Table 4 A summary of the methods of application of the adaptations to the BAU scenario under EST1 scenario

Policy instruments	Policy objectives	Target group	Benefits	Costs
Economic policies	• Reduce emissions at source	Public sector	≈ ?	+++?
	• Improve efficiency of vehicle fleet	Users	+?	+?
		Administration & operation	≈	+
Regulatory policies	• Reduce emissions at source	Public sector	≈	≈
	• Improve efficiency of vehicle fleet	Users	+?	+?
		Administration & operation	≈	+
Logistics and planning	• Reduce emission at source	Public sector		++
	• Reduce absolute level of vehicle-km in passenger transport and road freight	Users	+	+
		Administration & operation	≈	+

Notes:

≈ No significant change in benefits or costs
\+ Small benefits or costs
++ Moderate benefits or costs
+++ Large benefits or costs
? Not clear

The Capacity-Constraint (EST2) scenario

Under the capacity-constraint scenario, EST2, the EST criteria are met through the reduction in transport activity (volume and distance), shifts to less pollutant transport modes, management of traffic within each transport mode and policies related to the provision of transport infrastructure.

It is assumed that economic growth, demographic factors and employment under the EST2 scenario will be the same as under the BAU scenario.

We suggest that the assumption about economic growth under the EST2 scenario will make this scenario impossible to implement. Under the EST2 scenario the volumes of transport, in particular freight transport, have to be reduced to a level where the assumption of no change in economic growth from the BAU scenario will not hold. In fact, the economy will experience a negative growth.

To meet the EST criteria in *passenger* transport under the EST2 scenario, travel pattern and behaviour must change drastically. There have to be major shifts in transport modes, to the advantage of public transport and walking and cycling. This implies drastic shifts in *the geographical pattern of activities*. These will have to be supported by integrated land use and transport policies. Car ownership will decrease drastically due to significant increases in costs of ownership and operation.

The situation is, however, different for freight transport. There is not too much scope to gain from modal shift in urban freight transport. To meet the EST criteria in 2030, the volume of freight transported in the greater Oslo area has to be reduced by 75 percent compared to the BAU scenario. Such reduction will have significant consequence for the economy and employment as perceived under the BAU scenario.

Table 5 shows a summary of the methods for the attainment of EST criteria in the EST2 scenario. This table also shows the benefits and costs of the implementation of the policy instruments as a package. The evaluation of costs and benefits at this stage of the work is rather crude and should be considered as preliminary. The environmental benefits from the attainment of the EST criteria are not included among the benefits in this table.

Table 5 A summary of the methods of application of the adaptations to the BAU scenario under the EST2 scenario

Policy instruments	Policy objectives	Target group	Benefits	Costs
Planing policies	• Reduce the number of trips • Reduce trip length • Reduce car use and freight transport • Change modal split	Public sector	≈ ?	+++?
		Users	++?	≈
		Administration/ operation	≈	+
Transport investment and development policies	• Reduce car travel • Change modal split • Increase utilisation, freight • Improve efficiency of vehicle fleet	Public sector	≈	+++?
		Users	+++?	+
		Administration/ operation	≈	+
Economic policies	• Reduce the number of trips • Reduce car use and road freight • Increase utilisation • Change modal split • Improve efficiency of the vehicle fleet • Reduce emission at source	Public sector	++?	+?
		Users	+?	+++?
		Administration/ operation	≈	+
Transport demand management	• Reduce car use • Change modal split • Increase utilisation	Public sector	≈	≈
		Users	+?	++?
		Administration/ operation	≈	+
Regulatory policies	• Reduce car use • Improve efficiency of vehicle fleet	Public sector	≈	≈
		Users	+?	++?
		Administration/ operation	≈	+
Education	• change travel behaviour and pattern	Public sector	≈	≈
		Users	+	≈
		Administration/ operation	≈	+

Notes:
≈ No significant change in benefits or costs
\+ Small benefits or costs
++ Moderate benefits or costs
+++ Large benefits or costs
? Not clear

The Optimum Combination (EST3) scenario

The optimum combination scenario is an efficient scenario in which the EST criteria are met by a cost-efficient and politically and socially acceptable package of policy instruments. The calculation of the EST1 and EST2 scenarios has helped in the formulation of the policy objectives and the selection of policy instruments under the EST3 scenario.

It was suggested that the EST1 scenario is a very unlikely scenario. This was mainly because technologies that could help the attainment of the EST criteria under this scenario do not seem to be available or are very costly to develop. We also suggested that EST2 scenario will be a very unlikely scenario. The main reason was that economic growth will be negative.

Land use policies under the EST3 scenario are similar to that under the EST2 scenario. Furthermore, under the EST3 scenario, planning policies that promote the *regionalisation* of consumption and production needs to be included. These policies have the following main components.

- Urban containment policies and enhancement of the role of the central city.
- Development of higher density, multi-functional community centres, with rail connection to the Oslo city. The facilities at these centres include work places, child care centres, shops, different services for recreation and "work stations" for telecommunication. These "work stations" can accommodate around 25 percent of the employment in a community.
- Promotion of policies that advance regionalisation of production and consumption at an optimal level. This policy has to be addressed at a national and international level. Hence it would be difficult to spell the policies that are relevant to the Oslo region in detail. These policies should be developed in the next phase of the study.

There will have to be some additional infrastructure improvements to support this land use/regionalisation plan.

To meet the EST criteria in *passenger transport* under the EST3 scenario, travel pattern and behaviour must change drastically. There have to be major shifts in transport modes, to the advantage of public transport and walking and cycling. However, car travel will not be as restrained as in the EST2 scenario. Neither is the decrease in car ownership as drastic as in the EST2 scenario. The decrease in car ownership is connected with significant increases in costs of ownership and operation of private car.

For *freight transport*, we have assumed that the structural changes in the pattern of consumption and production through regionalisation of consumption and production and optimisation of logistics will bring the volume, in terms of vehicle kilometres, in 2030 down to the 1990's level.

Since there will be some changes in travel behaviour and pattern under the EST3 scenario, the demand on *technologies* will not be as strained as in the EST1 scenario.

The calculation of the socio-economic effects of the EST3 scenario is not within the scope of the EST project, at least at this phase of the project. We assume that economic growth, demographic factors and employment under the EST3 scenario will be the same as those under the BAU scenario. However, it is very likely that the attainment of EST in the transport sector will be accompanied by some reduction in the economic growth in general, a cost that has to be evaluated socially and politically.

Table 6 shows a summary of the methods for the attainment of the EST criteria in the EST3 scenario. This table also shows the benefits and costs of the implementation of the policy instruments. As it has been mentioned earlier, the evaluation of costs and benefits at this stage of the work are rather crude and should be considered as preliminary assessments. The environmental benefits from the attainment of the EST criteria are not included among the benefits in this table.

Table 6 A summary of the methods of application of the adaptations to the BAU scenario under the EST3 scenario

Policy instruments	Policy objectives	Target group	Benefits	Costs
Planing policies	• Reduce the number of trips • Reduce trip length • Reduce car use and freight transport • Change modal split • Promote regionalisation	Public sector Users Administration/ operation	≈? ++ ≈	++ ? ? +
Investment policies	• Reduce car travel • Change modal split • Increase utilisation, freight • Improve efficiency of vehicle fleet	Public sector Users Administration/ operation	≈ ++? ≈	++? ++ +
Economic policies	• Reduce the number of trips • Reduce car use and road freight • Increase utilisation • Change modal split • Improve efficiency of the vehicle fleet • Reduce emission at source	Public sector Users Administration/ operation	+? +? ≈	+? ++? +
Transport demand management	• Reduce car use • Change modal split • Increase utilisation	Public sector Users Administration/ operation	≈ +? ≈	≈ ++? +
Regulatory policies	• Reduce car use • Reduce emissions at source • Improve efficiency of vehicle fleet • Promote regionalisation	Public sector Users Administration/ operation	≈ +? ≈	≈ ++? +
Education	• Change travel behaviour and pattern • Promote regionalisation	Public sector Users Administration/ operation	≈ + ≈	≈ ≈ +

Notes:
≈ No significant change in benefits or costs
\+ Small benefits or costs
++ Moderate benefits or costs
+++ Large benefits or costs
? Not clear

The comparison of the preliminary evaluations of EST1, EST2 and EST3, suggests that EST3 is less costly than the others. It is also more plausible.

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Sammendrag:

Rapport fra andre fase i OECDs prosjekt for bærekraftig transport (EST)

Oslo-regionen som case

OECD startet i 1995 et prosjekt om bærekraftig transport, EST-prosjektet. EST står for "Environmentally Sustainable Transport". Prosjektet har fire faser. Første fase definerte bærekraftig transport, og utviklet kvantitative og andre kriterier for bærekraftighet i transportsektoren.

Hovedinnholdet i andre fase av prosjektet er en serie av prøveprosjekter som gjennomføres av noen av medlemslandene. Hensikten med prøveprosjektene er (a) å utvikle fire scenarier, trendscenariet (kalt BAU, "Business As Usual"), høyteknologi-scenariet (EST 1), reisebegrensningsscenariet (EST 2) og kombinasjonsscenariet (EST 3); (b) å finne de virkemidlene som trengs for å oppnå EST i hvert av scenariene; og (c) å oppsummere de økonomiske, sosiale og politiske følgene av hvert av scenariene, og dermed utvikle et anbefalt scenario.

Norge deltar i andre fase av EST-prosjektet, og har fremmet Oslo-regionen som sitt prøveprosjekt. Denne rapporten omhandler dette prøveprosjektet. Rapporten er ikke uttrykk for den norske regjeringens syn, og heller ikke for synet til lokale myndigheter i Oslo-regionen.

Metoden

Studieområdet er Oslo-regionen, som består av de to fylkene Oslo og Akershus. Studien begrenser seg til å se på passasjer- og godstrafikk internt i dette området.

Vi har gått ut fra at EST-kriteriene skal være oppfylt i år 2030. Trendscenariet er en framskriving til dette året, og EST-scenariene gjelder også dette året. De kvantitative kriteriene er uttrykt som påkrevd prosentvis endring i forhold til basisåret 1990. Framskrivningene i trendscenariet bygger også på 1990 som basisår. Virkemidlene for å oppnå EST settes ut i livet i perioden 2000-2030, med år 2010 som en milepæl på vegen.

De kvantitative EST-kriteriene er gjengitt i tabell 1.

Rapporten kan bestilles fra:
Transportøkonomisk institutt, Postboks 6110 Etterstad, 0602 Oslo
Telefon: 22 57 38 00 Telefax: 22 57 02 90

Tabell 1 Kvantitative EST-kriterier

Utslipp	Prosentvis reduksjon fra 1990 til 2030
CO_2	80
NO_x	90
VOC	90

I neste fase av prosjektet vil det også bli satt kriterier for lokale utslipp i Oslo-regionen, som partikler og støy. Det har budt på problemer å formulere kriterier for arealbruk. I denne fasen av prosjektet har vi antatt at arealbruken til transportformål bør holdes på det nivået som planene pr. 1996 vil innebære.

Norske målsetninger med hensyn til forurensende utslipp vedtatt pr. 1997 avviker fra målsettingene i tabell 1. Norske myndigheter har ikke formulert sektorspesifikke mål for forurensende utslipp.

Allment om utviklingen av scenarier

Det er laget fire alternative scenarier. Det første er trendscenariet (BAU). Det forlenger nåværende tendenser i transportsektoren. De andre tre er laget slik at de vil oppfylle EST-kriteriene i år 2030. Disse tre er:

- Høyteknologi-scenariet (EST 1). I det scenariet skal EST-kriteriene oppfylles gjennom utviklingen i transport-teknologien aleine. Etterspørselen etter transport, både passasjer- og godstransport, antas å være den samme som i BAU.
- Reisebegrensningsscenariet (EST 2). I det scenariet skal EST-kriteriene oppfylles ved hjelp av tiltak som påvirker etterspørselen etter passasjer- og godstransport. Den teknologiske utviklingen vil være den samme som i BAU.
- Kombinasjonsscenariet (EST 3). Her er EST-kriteriene oppfylt gjennom en kombinasjon av virkemidler som påvirker etterspørselen og virkemidler som påvirker transport-teknologien.

Forholdet mellom de tre EST-scenariene og BAU-scenariet kan illustreres slik[1]:

	EST1 Høy-teknologi	EST2 Reise-begrensning	EST3 Kombinasjon
Teknologisk utvikling	>> BAU	≈ BAU	> BAU
Transportaktivitet *	≈ BAU	<< BAU	< BAU

* Tonn eller transportavstand for gods, passasjerer eller turlengde for passasjertransporten.

Denne matrisen antyder at EST 1 innebærer et tilsvarende aktivitetsnivå i transporten som BAU. EST-kriteriene i dette scenariet skal oppfylles ved å forbedre

[1] Notatet til Oslomøtet i EST-prosjektet, 28-30. mai 1996.

kjøretøyteknologien , drivstoffteknologien og infrastrukturen. EST 2 har på sin side en tilsvarende teknologiutvikling som BAU, men skal oppfylle EST-kriteriene ved reduksjon i transportaktiviteten (i volum eller kjørelengder), overføring av trafikken til mindre forurensende transportformer, trafikkregulering innen hver transportform, samt infrastrukturtiltak. EST 3 omfatter begge typer tiltak, både teknologitiltak og mobilitetsstyring.

EST-scenariene blei utarbeidet etter en prosedyre der en først spesifiserte målene som skulle oppnås i hvert scenario. Deretter skaffet man seg en oversikt over hvilke tiltak som var aktuelle for å nå dem, og beregnet virkningene av å anvende et sett av tiltak. Til disse beregningene blei det om mulig brukt transportmodeller. Ofte viste beregningene at det var nødvendig å endre virkemiddel-pakka for å oppnå EST. Prosessen fortsetter slik til EST-kriteriene er oppfylt.

BAU-scenariet

BAU-scenariet (trendscenariet) innebærer at sosioøkonomiske og demografiske faktorer utvikler seg ifølge offentlige prognoser. Til disse prognosene er SSBs MSG-modell og Mozart-1 modell brukt opp til år 2025, mens økningen i folketallet fra 2025 til 2030 er antatt å være den samme som i 2020 til 2025. Teknologiske faktorer, avgifter, regulering og andre faktorer som påvirker etterspørselen etter transport på nasjonalt nivå, utvikler seg også ifølge tilgjengelige prognoser. TØI har laget scenarier for den tekniske utviklingen i transportsektoren. Utbygging av infrastrukturen er antatt å følge planene som er vedtatt for perioden fram til og med år 2000.

Prognosene for reiseomfanget i BAU-scenariet er basert på RETRO, den regionale transportmodellen for Oslo-regionen (Rand 1997). Prognosene for godstransport bygger på anvendelse av GODMOD-modellen (Jensen 1994).

I BAU-scenariet vil bilholdet øke med 53% mellom 1990 og 2030. Fordelingen mellom transportformene vil endres i retning av mer privatbil enn i 1990. Økningen i antall reiser med bil er mindre enn økningen i bilholdet, nemlig 34% mot 53%. Gjennomsnittlig antall reisende i hver bil går ned fra 1,6 til 1,3. Reiser til fots og med sykkel reduseres noe fra 1990 til 2030. Vi har antatt at beleggs-prosenten i kollektivtrafikken er konstant. Gjennomsnittlig turlengde med bil vil øke. Denne økningen er mindre enn vi hadde ventet. Det kan skyldes de relativt konservative antakelsene vi har gjort om arealbruksmønsteret i BAU-scenariet.

Tabell 2 sammenfatter utviklingen i transportetterspørselen og utslippene fra passasjertransporten i Oslo-regionen i BAU-scenariet.

Tabell 2 Predikert utvikling i reiseetterspørselen og utslippene fra passasjertransport i BAU-scenariet (1990=100)

År	1990	2010	2030
		Bilhold	
Antall privatbiler	100	131	153
		Reiser	
Totalt	100	117	122
Bil	100	127	134
Kollektivtransport	100	101	101
Gang og sykkel	100	97	97
		Kjøretøykilometer	
Kjøretøykilometer totalt	100	120	125
Bil	100	129	135
Kollektivtransport	100	104	105
Gang og sykkel	100	100	101
		Drivstoff-forbruk/CO_2-utslipp	
Totalt	100	111	110
Privatbil	100	112	111
Kollektivtransport	100	99	96
		NO_X -utslipp	
Totalt	100	53	26
Privatbil	100	50	22
Kollektivtransport	100	83	79
		VOC-utslipp	
Totalt	100	52	25
Privatbil	100	50	22
Kollektivtransport	100	83	79

Tabell 3 viser endringen i reisemiddelfordelingen mellom 1990 og 2030. Tabellen viser også reisemiddelfordelingen går mot mer bilbruk sammenliknet med basisåret 1990.

Tabell 3 Reisemiddelfordelingen i BAU-scenariet. Andel reiser av totalt antall reiser.

Andel	1990	2010	2030
Bil	0.59	0.64	0.69
Kollektivtransport	0.18	0.17	0.16
Gang og sykkel	0.23	0.19	0.15
Totalt	1.00	1.00	1.00

Beregningene av BAU-scenariet viser at utslippene av NO_x og VOC reduseres med omkring 75%. For CO_2 er imidlertid situasjonen svært annerledes. CO_2-utslippene vil øke med 10% i forhold til 1990-nivået. Beregningene tyder på at BAU-scenariet ikke oppfyller EST-kriteriene, spesielt når det gjelder CO_2. En kan ganske trygt gå ut fra at et scenario som oppfyller EST-kriteriet for CO_2, også vil oppfylle de andre kriteriene.

I BAU-scenariet vil volumet av godstransport, uttrykt i tonnkilometer eller kjøretøykilometer, øke med over 150% fra 1990-nivået. Økningen er større enn vi ventet, men i tråd med trenden til nå. Utslippene av CO_2, NO_x og VOC fra godstransport vil øke i forhold til 1990. Sammenlikner vi utslippene i passasjertransporten og godstransporten, så ser det ut til at det vil by på langt større problemer å oppfylle EST-kriteriene i godstransporten. Det er to grunner til det. Den ene angår forskjellen i den forventede teknologiske utviklingen i de to sektorene, og den andre angår forskjellen i forventet veksttakt i sektorene.

Høyteknologi-scenariet (EST 1)

I EST 1-scenariet oppfylles EST-kriteriene ved innføring av ny teknologi i kjøretøyene, ny drivstoff-teknologi og ny informasjonsteknologi (telematikk). Vi har for eksempel antatt at passasjerbilflåten hovedsakelig vil bestå av elektriske biler (40%) og meget drivstoff-effektive hybridbiler, dvs. biler som både kan gå på elektrisitet og fossilt drivstoff (omtrent 60%). Det må være påbud om at hybridbilene skal bruke det alternative drivstoffet ved kjøring i byområder. En rekke andre strenge forutsetninger er gjort. Valget av teknologi i passasjer- og godstransport er gjort slik at i sum oppfyller transportsektoren EST-kriteriene.

Vi må forutsette at innføringen av ny teknologi ikke vil påvirke de prisene som brukerne står overfor i noen av transportformene. Dette er en streng, men nødvendig forutsetning for at etterspørselen skal være omtrent den samme i EST 1 som i BAU-scenariet.

Kostnadene ved å utvikle og innføre de tekniske løsningene som er nødvendige for å oppnå EST-kriteriene i dette scenariet, kan være svært høye. Den implisitte antakelsen i EST 1-scenariet er at brukerne står overfor samme (generaliserte) reisekostnader som i BAU-scenariet. Det følger av dette at de nye tekniske løsningene må være sterkt subsidiert. Subsidienivået kan overstige det som opinionen er villig til å godta, eller til og med bli uforsvarlig høyt.

Det finnes tre hovedkategorier av tiltak for å oppnå de nødvendige utslippsreduksjonene i dette scenariet:

- Økonomiske virkemidler, som differensierte avgifter og subsidier på drivstoff og kjøretøyer,
- Reguleringsbestemmelser som fastsetting av standarder og mål,
- Bedre logistisk styring og styring av transportsystemet, bl.a. ved bruk av telematikk og informasjonsteknologi.

Tabell 4 sammenfatter metodene for å oppnå EST-kriteriene i EST 1-scenariet. Tabellen angir også kostnader og nytte av å gjennomføre tiltakene. Dette er gjort på en grov måte i denne fasen av prosjektet, og må betraktes som foreløpige antydninger. Miljøgevinstene ved å oppnå EST-kriteriene er ikke tatt med i tabellen.

Tabell 4 EST 1. Virkemidler, delmål og kostnader og nytte av tiltakene for ulike målgrupper.

Virkemidler	Delmål	Målgruppe	Nytte	Kostnad
Økonomisk politikk	• Utslippsreduksjon ved kilden	Offentlig sektor	≈?	+++?
		Brukere	+?	+?
	• Effektivisere kjøretøyflåten	Adm. & drift	≈	+
Regulering	• Utslippsreduksjon ved kilden	Offentlig sektor	≈	≈
		Brukere	+?	+?
	• Effektivisere kjøretøyflåten	Adm. & drift	≈	+
Logistikk og planlegging	• Utslippsreduksjon ved kilden	Offentlig sektor		++
		Brukere	+	+
	• Redusere antall kjøretøy-km i passasjer-transport og godstransport på veg	Adm. & drift	≈	+

Merknader:

≈ Ingen vesentlig endring i nytte eller kostnad
\+ Små gevinster eller kostnader
++ Moderate gevinster eller kostnader
+++ Store gevinster eller kostnader
? Usikkert

Reisebegrensningsscenariet (EST 2)

I reisebegrensningsscenariet (EST 2) blir Est-kriteriene oppfylt gjennom reduksjoner i transportaktiviteten (volum og distanse), overføring til mindre forurensende transportformer, trafikkstyring innen hver transportform og politikk for forbedring og bedre bruk av infrastrukturen.

Økonomisk vekst, demografisk utvikling og sysselsetting i EST 2 er forutsetningsvis den samme som i BAU-scenariet. Imidlertid vil det nok i virkeligheten være slik at denne forutsetningen ikke lar seg opprettholde når en forsøker å sette EST 2-scenariet ut i livet. I EST 2 må jo transportvolumene, ikke minst for godstrafikken, reduseres til et nivå som er uforenlig med forutsetningen om lik økonomiske veksttakt i EST 2 som i BAU. Faktisk vil vi komme til å få negativ økonomisk vekst i EST 2.

For å oppfylle EST-kriteriene i *passasjertransporten* i EST 2, må reisemønster og reiseatferd endres drastisk. Vi må ha store endringer i reisemiddelfordelingen til fordel for kollektivtransport, gang og sykkel. Dette forutsetter drastiske endringer i det *geografiske aktivitetsmønsteret*. Integrert arealbruks- og transportpolitikk må tas i bruk for dette formålet. Bilholdet vil synke drastisk på grunn av økte bilholdskostnader og bilbrukskostnader.

For godstransporten er situasjonen annerledes. Det finnes ikke store muligheter for gevinster ved overføring til andre transportformer i godstransporten i byområder. For å oppfylle EST-kriteriene i år 2030 må godstransporten i Oslo-regionen reduseres med 75% i forhold til BAU-scenariet. En slik reduksjon må ha en merkbar innvirkning på økonomi og sysselsetting i forhold til BAU-scenariet.

Tabell 5 sammenfatter metodene for å oppnå EST-kriteriene i EST 2-scenariet. Tabellen angir også kostnader og nytte av å gjennomføre tiltakene. Dette er gjort på en grov måte i denne fasen av prosjektet, og må betraktes som foreløpige antydninger. Miljøgevinstene ved å oppnå EST-kriteriene er ikke tatt med i tabellen.

Tabell 5 EST 2. Virkemidler, delmål og kostnader og nytte av tiltakene for ulike målgrupper.

Virkemidler	Delmål	Målgruppe	Nytte	Kostnad
Planlegging	• Reduser antall reiser • Reduser reiselengde • Reduser bilbruk og godstransport • Endre reisemiddelfordeling	Offentlig sektor Brukere Adm. & drift	≈? ++? ≈	+++? ≈ +
Investering og utvikling	• Reduser bilbruk • Endre reisemiddelfordeling • Øk kapasitetsutnyttelse, gods • Øk kjøretøyflåtens effektivitet	Offentlig sektor Brukere Adm. & drift	≈ +++? ≈	+++? + +
Økonomisk politikk	• Reduser antall reiser • Reduser bilbruk og godstransport på veg • Øk kapasitetsutnyttelsen • Endre reisemiddelfordeling • Øk kjøretøyflåtens effektivitet • Reduser utslipp ved kilden	Offentlig sektor Brukere Adm. & drift	++? +? ≈	+? +++? +
Etterspørsels-demping	• Reduser bilbruk • Endre reisemiddelfordeling • Øk kapasitetsutnyttelsen	Offentlig sektor Brukere Adm. & drift	≈ +? ≈	≈ ++? +
Regulering	• Reduser bilbruk • Øk kjøretøyflåtens effektivitet	Offentlig sektor Brukere Adm. & drift	≈ +? ≈	≈ ++? +
Opplysning	• endre reiseatferd og reisemønster	Offentlig sektor Brukere Adm. & drift	≈ + ≈	≈ ≈ +

Merknader:

≈	Ingen vesentlig endring i nytte eller kostnad
+	Små gevinster eller kostnader
++	Moderate gevinster eller kostnader
+++	Store gevinster eller kostnader
?	Usikkert

Kombinasjonsscenariet (EST 3)

I kombinasjonsscenariet skal EST-kriteriene oppfylles med en tiltakspakke som både er kostnadseffektiv og akseptabel fra et politisk og samfunnsmessig synspunkt. Beregningene av EST 1 og EST 2 har gitt nøkler til hvordan målsetningene skal formuleres og valget av virkemidler skal gjøres i EST 3.

Vi har bemerket tidligere at EST 1-scenariet er lite realistisk, hovedsakelig fordi de tekniske løsningene som skulle bidra til å oppfylle EST-kriteriene i dette scenariet, enten ikke vil finnes eller koster svært mye å utvikle. Også EST 2-scenariet er lite realistisk, hovedsakelig fordi den økonomiske veksten vil være negativ.

Arealbrukspolitikken i EST 3 må være ganske lik arealbrukspolitikken i EST 2. Vi trenger også i EST 3 planlegging og tiltak som kan fremme en *regionalisering* av produksjon og forbruk. Politikken på disse områdene vil ha følgende elementer:

- Tiltak mot byspredning og for å tilføre sentrum økt virksomhet,
- Lokalsentre med høy tetthet og mange funksjoner, knyttet til sentrum med skinnegående forbindelser. Tilbudet i disse lokalsentrene omfatter arbeidsplasser, barnehager, butikker, fritidstilbud og "arbeidsstasjoner" med telekommunikasjon. Disse "arbeidsstasjonene" må kunne utgjøre arbeidsplassen for 25% av de yrkesaktive i bydelen.
- Tiltak for økt regionalisering av forbruk og produksjon. Disse må utformes på nasjonalt og internasjonalt nivå, og det er derfor ikke mulig å gå i detalj om hvordan de vil slå ut i Oslo-regionen. Slike tiltak bør spesifiseres i neste fase av prosjektet.

For å virkeliggjøre en slik plan for arealbruk og regionalisering vil det trengs infrastrukturforbedringer ut over BAU-nivå.

For å oppfylle EST-kriteriene i *passasjertransport* i EST 3, må reisemønster og reiseatferd legges drastisk om. Det trengs store endringer i reisemiddelfordelingen i retning kollektivtrafikk, gang og sykkel. Fullt så store begrensninger på bilbruken som i EST 2 vil det likevel ikke være. Heller ikke bilholdet vil måtte gå så drastisk ned. Den nødvendige nedgangen vil skyldes betydelige kostnadsøkninger knyttet til bilhold og bruk av bil.

De strukturelle endringene i forbruks- og produksjonsmønsteret som følger av regionaliseringen av produksjon og forbruk og forbedret logistikk, vil redusere godstransporten i år 2030, målt i kjøretøykilometer, til nivået fra 1990.

Siden det vil være omfattende endringer i reisemønster og reiseatferd i EST 3, vil kravene til nye tekniske løsninger ikke være så overveldende som i EST 1-scenariet.

Det ligger utenfor ramma for EST-prosjektet å beregne de sosio-økonomiske virkningene av EST 3. I det minste lar dette seg ikke gjøre i fase 2 av prosjektet. Vi antar at økonomisk vekst, demografisk utvikling og sysselsetting vil være som i BAU-scenariet. Likevel er det meget sannsynlig at å oppnå EST-kriteriene i transportsektoren vil innebære en viss reduksjon i den økonomiske veksten. Dette vil ha både politiske og sosiale konsekvenser.

Tabell 6 sammenfatter metodene for å oppnå EST-kriteriene i EST 3-scenariet. Tabellen angir også kostnader og nytte av å gjennomføre tiltakene. Som nenvt før, er dette gjort på en grov måte i denne fasen av prosjektet, og må betraktes som foreløpige antydninger. Miljøgevinstene ved å oppnå EST-kriteriene er ikke tatt med i tabellen.

Tabell 6 EST 3. Virkemidler, delmål og kostnader og nytte av tiltakene for ulike målgrupper.

Virkemidler	Delmål	Målgrupper	Nytte	Kostnad
Planlegging	• Reduser antall reiser • Reduser reiselengde • Reduser bilbruk og godstransport • Endre reisemiddelfordelingen • Regionalisering	Offentlig sektor Brukere Adm. og drift	≈ ? ++ ≈	++ ? ? +
Investment policies	• Reduser bilbruk • Endre reisemiddelfordelingen • Increase utilisation, freight • Improve efficiency of vehicle fleet	Offentlig sektor Brukere Adm. og drift	≈ ++? ≈	++? ++ +
Economic policies	• Reduce the number of trips • Reduce car use and road freight • Increase utilisation • Endre reisemiddelfordelingen • Improve efficiency of the vehicle fleet • Reduce emission at source	Offentlig sektor Brukere Adm. og drift	+? +? ≈	+? ++? +
Transport demand management	• Reduce car use • Endre reisemiddelfordelingen • Increase utilisation	Offentlig sektor Brukere Adm. og drift	≈ +? ≈	≈ ++? +
Regulatory policies	• Reduce car use • Reduce emissions at source • Improve efficiency of vehicle fleet • Regionalisering	Offentlig sektor Brukere Adm. og drift	≈ +? ≈	≈ ++? +
Education	• Change travel behaviour and pattern • Regionalisering	Offentlig sektor Brukere Adm. og drift	≈ + ≈	≈ ≈ +

Merknader:

≈	Ingen vesentlig endring i nytte eller kostnad
+	Små gevinster eller kostnader
++	Moderate gevinster eller kostnader
+++	Store gevinster eller kostnader
?	Usikkert

Sammenlikning mellom de foreløpige anslagene på kostnader og nytte i EST 1, EST 2 og EST 3 tyder på at EST 3 koster mindre enn de andre. Det er også et mer realistisk scenario enn de øvrige.

1 Introduction

In 1995 the OECD initiated the project "Environmentally Sustainable Transport" (EST). The project is perceived to comprise four phases. The first phase aims at the characterisation of environmentally sustainable transport, in terms of development of different quantitative and other criteria for the transport sector.

The second phase of the project focuses on pilot projects conducted by some of the Member countries. The purpose of these pilot projects is (i) to develop four scenarios, business as usual (BAU), high-technology (EST1), capacity constraint (EST2) and optimum combination (EST3) scenarios. EST1, EST2 and EST3 should be consistent with the characterisation of EST; (ii) determination of the set of actions that might be required to achieve EST in each scenario, and; (iii) evaluation of economic, social and political implications of the proposed actions and the development of a preferred scenario.

In the third phase of the project, an exercise similar to the second phase will be conducted with the necessary methodological refinements. In the fourth phase of the project, the characterisation of EST will be re-evaluated and guidelines for policies and instruments for the achievement of EST will be established.

Norway is one of the participating countries in the second phase of the EST project and has proposed the greater Oslo area as its pilot project. This document describes the second phase of the project in the context of the Norwegian pilot project. It should be emphasised that this study does not reflect the official view of the Norwegian government nor of the local authorities of the Oslo region.

Chapter 2 gives an overview of the methodologies adopted in this project. This chapter gives an overview of the scope of the study, critical years adopted for the evaluation of alternative scenarios, and a brief description of the methodologies used for the development of scenarios. Chapter 3 describes the business as usual scenario, chapter 4 the high-technology scenario, chapter 5 the capacity constraint scenario and chapter 6 the optimum combination scenario. In chapter 7 some of the main conclusions of the study are described.

2 Methodology

The Norwegian case study will be limited to the greater Oslo area that includes the two adjacent counties of Oslo and Akershus. The total land area of these two counties amounts to 5014 km^2. Oslo county has a land area of about 426 km^2 with a population density of about 1100 inhabitants per km^2. Akershus county has a land area of about 4587 with a population density of about 92 inhabitants per km^2. The total population of the greater Oslo area in 1990 was about 880 000 (the population in Oslo was about 462 000 and in Akershus about 418 000). The population growth in the greater Oslo region has been somewhat higher than in the rest of the country. The greater Oslo region has experienced a population growth of about 1 percent per year since 1985 while the annual growth rate in the rest of the country has been about 0.5-0.6 percent. For further information about the greater Oslo area see Appendix I.

2.1 Scope of the study

The scope of the study will be limited to passenger and freight transport within the geographical extent of the study. Initially it was proposed to have the scope extended to include long distance passenger and freight transport to and from Oslo. We propose that long distance travel should be analysed in the context of a national study. The main reason for this exclusion is that policies related to long distance travel would be sub-optimal if they are evaluated only within to the greater Oslo region. These policies include structural changes in the production and consumption pattern and optimisation of logistics that has to be addressed nationally rather than in relation to the greater Oslo area.

2.2 Critical years

Year 2030 has been set as the target year for the attainment of EST. It is the year for which the EST scenarios are to be constructed and the BAU scenario to be projected. The reference year is 1990 for the quantitative criteria expressed as percentage changes. It is also the year from which the BAU scenario is projected. The implementation period for the instruments for the achievement of EST is 2000-2030. It is proposed that the milestone for implementation and its assessment should be 2010.

2.3 The Criteria for EST

The quantitative criteria should be expressed as reductions from 1990 in total emissions from transportation. Table 1 shows these criteria.

Table 2.1 Quantitative criteria for EST

Emission of pollutants	Reduction, in percent, from 1990 to 2030
CO_2	80
NO_X	90
VOCs	90

The specification of criteria for more local impacts, such as those related to particulate matter and noise, for the greater Oslo area will be carried out in the next phase of the study. One alternative is to use WHO criteria where appropriate.

The construction of criteria related to land use has presented substantial problems. However, for this phase of the study the criteria connected with land use are constructed in a crude manner. This issue will be addressed more accurately in the next phase of the project. The criterion for land use in this phase of the project is set to limit the use of land for transport purposes at the level (sanctioned) in 1996.

The Norwegian targets adopted in 1997 with respect to the emission of pollutants are different from those shown under Table 2.1. With respect to the emission of pollutants, the Norwegian government does not have a sector specific targets. The targets shown in Table 2.2 are overall targets, for all the different sectors of the economy. The underlying principle is that with cost-effective instruments including taxation of emissions of the pollutants, the different sectors will respond differently in meeting the overall targets set for the whole economy.

Table 2.2 Some Norwegian targets

Emission of pollutants	Target
CO_2	To stabilise by 2000 to the 1989 levels
NO_X	To reduce by a magnitude of 30% between 1986 and 1998
VOCs	To reduce by a magnitude of 30% between 1989 and 1999[1]

2.4 The general methodology for the development of scenarios

Four alternative scenarios will be constructed. The first scenario is the Business as Usual scenario (BAU), which is projected from the base-year 1990. This scenario reflects the continuation of the current trends in the transport sector. The other

[1] This reduction applies to the mainland and the economic zone South of 62 degrees.

three scenarios are constructed so that they achieve the criteria set for Environmentally Sustainable Transportation (EST).

These scenarios are:

- A high-technology scenario, EST1, under which it is assumed that the EST criteria are met only by developments in transport technologies. Under this scenario it will be assumed that the demand for transport, passenger and freight, will be similar to the BAU scenario.
- A capacity-constraint scenario, EST2, under which it is assumed that the EST criteria are met by different measures that affects the demand for passenger and freight transport. Under this scenario it will be assumed that the technological development would be similar to the BAU scenario.
- An optimum combination scenario, EST3, under which the EST criteria are met by combinations of measures that affects the demand for transport as well as development in transport technologies.

In an earlier report (Ergoplan AS, 1996) an approach for the construction of the scenarios has been described[2]. The methodology for the construction of scenarios in this report deviates from the approach reported by Ergoplan. the deviations have been necessary to allow for the fulfilment of the EST scenarios as defined by OECD Task Force on Transport, Environmentally Sustainable Transport consistently.

In summary the relationship of the three EST scenarios to the BAU scenario has been suggested as follow[3].

	EST1 High-Technology	EST2 Capacity-Constraint	EST3 Optimum Combination
Technological developments	>> BAU	≈ BAU	> BAU
Transport activity *	≈ BAU	<< BAU	< BAU

* Transport distance and volume of passenger and freight

The above matrix suggests that EST1 involves similar levels of transport activity to that of the BAU scenario. The EST criteria in this scenario are to be met through the introduction of different technologies connected to vehicles, fuels and infrastructure.

The technological development under the EST2 scenario is, however, similar to that of the BAU scenario. In this scenario the EST criteria are met through reduction in transport activity (volume and distance), shifts to less pollutant transport modes, management of traffic within each transport mode and policies related to the provision of transport infrastructure.

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[2] The report by Ergoplan AS is on the characterisation of EST1 and EST2 scenarios. This work was commissioned by the Norwegian Pollution Control Authority.

[3] Notes on the meeting held in Oslo, Norway on 28-30 May 1996, Task Force on Transport, Environmentally Sustainable Transport,

The EST3 scenario will include both factors; those related to technology and those related to mobility management.

We will show later that the instruments that can promote high-technology such as pricing and regulation will affect mobility and, vice versa, some of the instruments that can be used for mobility management such as pricing will promote high-technology.

3 The BAU Scenario

The BAU scenario reflects the continuation of the present trends in socio-economic and demographic factors as well as technological developments, legislation and other factors that will influence the demand for transport at a national level.

In the Norwegian case study (the greater Oslo area) we would need to rely on more disaggregate predictions of these trends. Hence we will rely on the projections of socio-economic and demographic developments that are calculated by the Central Bureau of Statistics using the multi-sectoral growth model (MSG) and other models and likely changes in transport infrastructure. Table 3.1 shows a summary of the projected socio-economic trends under BAU scenario for Norway.

Table 3.1 Expected economic development under the BAU scenario, MSG calculation (1991=100)

Variable/Year	1991	2001	2010	2030
Real disposable household income	100.00	129.58	160.10	208.52
Employment, men	100.00	110.00	115.00	116.00
Employment, women	100.00	110.00	119.00	119.00
Purchase of own transport means, price index	100.00	105.01	98.40	91.76
Running outlay (all costs, except purchase cost) for own transport means, price index	100.00	106,62	105.80	106.29
Public transportation, price index	100.00	101.29	101.62	101.62
Gasoline, price index	100.00	107.33	104.26	105.09

Source: MSG runs for white paper, 1995

3.1 Demographic assumptions

Annual growth in population is assumed to be according to the Mozart-1 model of the Central Bureau of Statistics up to year 2025. From 2025 up to 2030 the annual growth in population is assumed to be the same as in the period of 2020 to 2025.

The population growth will decrease from an annual growth rate of about 0.4 percent over the period of 1990 to 2000 to about 0.25 percent after year 2000. The composition of the population will change in the greater Oslo region. The percentage of the population between age 20 and 64 will stay almost constant in the Oslo county, about 65 percent throughout the horizon of the study. However in the Akershus county, the percentage of the population between age 20 and 64 will steadily decrease from 77 to 72. Table 2 in Appendix II shows the assumptions regarding population growth in the greater Oslo area.

3.2 Labour force

The growth of the labour-force is slightly higher than the population growth until 2000 and lower than the population growth after year 2000. The growth in women's participation in labour force is assumed to be greater than men's, following the trends given in Table 3.1. Table 1 in appendix II shows expected annual growth in population and employment for this scenario.

3.3 Economic growth

Real disposable household income continues to increase at around 2 percent per year throughout the horizon of the study. Table 1 in appendix II shows the expected annual growth in real disposable income for the BAU scenario.

3.4 Technological development

The Institute of Transport Economics has produced scenarios of technological development in the transport sector. The calculation of the development in fuel efficient technologies have been based on the past trends as well as the future potentials for each mode of transport such as private car, bus, and rail. It has been assumed that these developments will be independent of the Norwegian market. Calculation of the technological developments in transport in Norway has been based on the price of fuel and the growth in passenger transport market in Norway as well as the international developments in technologies.

Table 3.2 Emissions for passenger travel, Grams per passenger km, short distance travel under the BAU scenario (1990 =100)

Mode/Year	1990	2010	2030
Car			
CO_2	100 (146.2)	86.3	82.2
NO_x	100 (1.3)	38.5	15.4
VOCs	100 (1.0)	39.0	15.5
Bus			
CO_2	100 (36.0)	88.9	81.8
NO_x	100 (0.8)	62.5	50.0
VOCs	100 (0.5)	62.5	50.0
Rail/ Light Rail			
CO_2	100 (18.0)	100.0	100.0
NO_x	100 (0.1)	100.0	100.0
VOCs	100 (0.1)	100.0	100.0

The technological development under the BAU scenario is consistent with the proposal from the Federal Environmental Agency, Germany, given some differences particular to Norway, such as differences in the car fleet [4].

We assume that under BAU there will be some development in technologies that will affect fuel efficiency and the emissions of pollutants from vehicles. Tables 3.2 and 3.3 show the assumptions regarding technological developments under the BAU scenario. For more information regarding assumptions and the calculation of the emission factors under the BAU scenario, see Thune-Larsen (1991, 1995).

Table 3.3 Emissions for freight travel, Grams per vehicle-km, short distance travel under the BAU scenario (1990 =100)

Mode/Year	1990	2010	2030
Light/Medium duty vehicles			
CO_2	100 (650)	92	84
NO_x	100 (8.2)	75	55
VOCs	100 (7.9)	80	60

In appendix II, Table 2 shows the expected development in fuel efficiency and Table 3 shows the projection of prices for transport in the BAU scenario. This is calculated based on the projection of price of fuel as well as the projection of the development of fuel efficiency.

3.5 Changes in the transport infrastructure

It is assumed that the changes in infrastructure will be according to the approved plans up to year 2000. Table 4 in appendix II shows a summary of the expected change in the transport infrastructure in the greater Oslo region.

In the context of this project, the assumption regarding changes in infrastructure is probably conservative. The assumption is probably more relevant for the evaluation of the expansion of the capacity of transport infrastructure. Most likely under the BAU scenario, in the context of this project, there will be additional transport infrastructure, in particular road projects, planned and executed during the horizon of the study.

3.6 Changes in land use

It is assumed that under the BAU scenario the present trend in decentralisation in work and house locations will continue. In connection with the opening of the new airport for the Oslo region, Gardermoen airport in Akershus, the following assumptions are made. There will be about 7000 new housing units and a corresponding number of work places at the location of the present airport,

[4] A proposal concerning emission reduction rates in the BAU scenario, submitted by Norbert Gorißen, Federal Environmental Agency, Berlin, Germany on 5 June 1996.

Fornebu. It is furthermore assumed that the present work places at Fornebu airport will be relocated to Gardermoen airport.

3.7 The method of projection of BAU

The forecasts of the transport volume in the BAU scenario will be based on two model systems, one for passenger transport, RETRO, and another for freight transport, GODMOD.

GODMOD is a general equilibrium model in which the transport sector, specially the freight transport sector, is described in detail. GODMOD has been applied at the national level. With some modifications, the model will be used for the greater Oslo area. It is assumed that only road transport is used for freight transport within the greater Oslo region. The present version of the model does not differentiate between the types of vehicles used for road traffic. It will be assumed that for freight transport within the Oslo region medium and light duty vehicles are used. Furthermore this model does not allow for the categorisation of freight according to the requested specification. The categorisation of freight transport by travel distance in this model is as refined to suit an urban situation. For a description of this model system see Jensen (1994).

Disaggregate or behavioural travel demand modelling is used in RETRO. The behavioural modelling is based on economic theory of demand. The input to RETRO or a scenario is a consistent set of exogenous factors and transport specific policies. Examples of the exogenous factors are income, employment, demographics and land use pattern. The outputs from RETRO are the predictions of car ownership, travels by different modes and for different travel purposes. The disaggregate nature of the models allows a more detailed breakdown of the results by mode and purpose of travel, household income level, age and sex of traveller, and other socio-economic characteristics. For a description of this model system see Rand (1997). Table 5 in Appendix II shows some of the long term elasticites that are derived from this model system.

3.8 Base year situation

The number of cars per 1000 population in the greater Oslo area is about 385 (about 357 in Oslo and 417 in Akershus). The distribution of trips by mode of transport is 59 percent by car, 18 percent by public transport, and 24 percent by walking and cycling in the greater Oslo area[5]. Table 3.4 shows the distribution of trips by mode and purpose. This table shows that the relative distribution of travel purpose is 30 percent work, 23 percent shopping and 24 percent recreation, i.e., less than one third of the total trips is connected to commuting.

[5] Based on the Oslo Travel Study of 1990/1991. The respondents in this study were between 13 to 74 years of age.

Table 3.5 shows the relative distribution of trips by travel distance and purpose. This table indicates that the average distance of trips is longest for travel purpose work, social visit and recreation.

Table 3.4 Distribution of trips by travel mode and purpose[5].

Travel Purpose	Mode					
	Car	Car driver	Car passenger	Public transport	Walk/ cycle	Total
Work	0.19	0.18	0.01	0.07	0.04	0.30
Education	0.01	0.00	0.00	0.02	0.01	0.04
Business	0.05	0.05	0.00	0.01	0.01	0.07
Accompany others	0.06	0.06	0.00	0.00	0.01	0.08
Shopping	0.13	0.11	0.02	0.03	0.07	0.23
Social visit	0.07	0.05	0.02	0.02	0.03	0.11
Recreation, others	0.08	0.06	0.02	0.02	0.07	0.26
Total	0.59	0.50	0.09	0.18	0.24	1.00

Table 3.5 Distribution of trips by travel distance and purpose, percentage.

Travel purpose	trip distance, kilometres				
	0-2	2-10	10-25	25+	total
Work	16	40	33	11	100
Education	34	32	22	12	100
Business	65	17	13	5	100
Accompany others	40	37	18	5	100
Shopping	45	40	11	4	100
Social visit	28	44	21	7	100
Recreation	38	44	14	4	100
Total	41	41	13	6	100

Available data does not easily lend itself to calculate the modal split of freight transport within the greater Oslo region. The freight within the greater Oslo region is transported by road and distributed among light and medium duty vehicles (vans and lorries).

3.9 Calculation of the BAU scenario

Table 3.6 shows a summary of the development of demand and the emissions from passenger transport within the greater Oslo area under the BAU scenario.

Under the BAU scenario car ownership will increase by 53 percent between 1990 and 2030. The distribution of trips by mode will shift towards car compared with the base year, 1990. The increase in the number of trips by car is not as large as the increase in car ownership, 34 percent compared with 53 percent. Car occupancy will decrease from the present value of about 1.6 to 1.3. The number of trips by walking and cycling will decrease slightly from 1990 to 2030. We have assumed the occupancy rate for public transportation modes to stay at the level in 1990. The average trip length by car will increase. The increase is not as large as we had expected. This could be due to relatively conservative assumptions regarding the development of land use under the BAU scenario.

Table 3.6 Prediction of the development in travel and emissions in the passenger transport sector under the BAU scenario (1990=100)

Year	1990	2010	2030
		Car ownership	
No. of private cars	100	131	153
		Trips	
Total	100	117	122
Car	100	127	134
Public Transport	100	101	101
Walk/Cycle	100	97	97
		Vehicle-kilometres	
Total vehicle km.	100	120	125
Car	100	129	135
Public Transport	100	104	105
Walk/Cycle	100	100	101
		Fuel use/CO_2 emissions	
Total	100	111	110
Private car	100	112	111
Public transport	100	99	96
		NO_X emissions	
Total	100	53	26
Private car	100	50	22
Public transport	100	83	79
		VOCs emissions	
Total	100	52	25
Private car	100	50	22
Public transport	100	83	79

Table 3.7 shows the shifts in mode share between 1990 and 2030. This table also shows that the distribution of trips by mode will shift towards car compared with the base year, 1990.

Table 3.7 Shifts in mode share under BAU scenario

Mode share	1990	2010	2030
Car	0.59	0.64	0.69
Public transport	0.18	0.17	0.16
Walk/cycle	0.23	0.19	0.15
Total	1.00	1.00	1.00

The calculation of the BAU scenario shows that the emissions of NO_x and VOCs are reduced by about 75 percent. However, the situation for the emissions of CO_2 is very different. The emissions of CO_2 will increase by 10 percent compared with 1990 level. This calculation suggests that the BAU scenario does not meet the criteria for EST, especially with respect to the emissions of CO_2. It is relatively safe to assume that any scenario that meets the EST criterion with respect to CO_2 will meet other EST criteria.

Table 3.8 shows a summary of the development of demand for freight and the emissions from freight transport within the greater Oslo area under the BAU scenario.

Under the BAU, the volume of freight transport expressed in tonne-kilometres or vehicle kilometres will increase by over 150 percent compared to 1990. The increase in freight transport volume is larger than expected, however, it is in line with the past trend.

The calculation of freight transport in the BAU scenario shows that the emissions of CO_2, NO_x and VOCs will increase compared with 1990 levels. The comparison of the emission in the passenger transport with those in the freight transport suggests that the achievement of the EST criteria in the freight transport sectors poses much more problems. The reason for this is twofold. One is connected to the differences in expected technological developments in the two sectors and the other is connected to the differences in the expected growth in volumes in the two sectors.

Table 3.9 shows a summary of the development of emissions in freight and passenger transport within the greater Oslo area under the BAU scenario. Under the BAU scenario, the total emissions of NO_x and VOCs will be reduced by about 50 percent of the 1990 levels, while the emissions of CO_2 will increase by around 30 percent of the 1990 level.

Table 3.8 Prediction of the development in travel and emissions in the freight transport sector under the BAU scenario (1990=100)

	1990	2010	2030
Tonne-kilometres	100	166	252
Vehicle Kilometres	100	171	253
Fuel use/CO_2 emissions	100	159	243
NO_x emissions	100	119	134
VOCs emissions	100	123	138

Table 3.9 Prediction of emissions in passenger and freight transport sector under the BAU scenario (1990=100)

	1990	2010	2030
Fuel use/CO_2 emissions	100	119	132
NO_x emissions	100	66	48
VOCs emissions	100	70	51

4 High-Technology (EST1) scenario

The EST criteria in the EST1 scenario are met through the introduction of various technologies connected to vehicles, fuels and information technology (telematics), mainly related to road transport telematics. For a description of some of these technologies, see Giannopoulos (1993), Svindén (1993) and Nijkamp (1996).

It is assumed that the projections of socio-economic and demographic factors and land use pattern under the EST1 scenario are the same as those under the BAU scenario.

The high-technology scenario can develop in many alternative directions. The two extreme directions of this scenario are one in which the public transport mode is the dominant mode of transport, and the other is the one in which the private car dominates. We have assumed that the modal split in this scenario will develop in the same manner as in the BAU scenario.

It is furthermore assumed that the introduction of the new technologies will not affect the price of different modes of transport for the users. This is a necessary assumption to attain similar demands for transport under the EST1 to that of BAU scenario.

Implicit in this assumption are different levels of taxation and subsidies from those in the BAU scenario. This is a very strong assumption, even an unrealistic one. One main problem with this assumption is the expected costs of the new technologies for the attainment of the EST criteria in the transport sector. It is rational to speculate that the marginal cost of improvements in technologies for the attainment of the EST criteria will increase, as demonstrated in Figure 4.1.

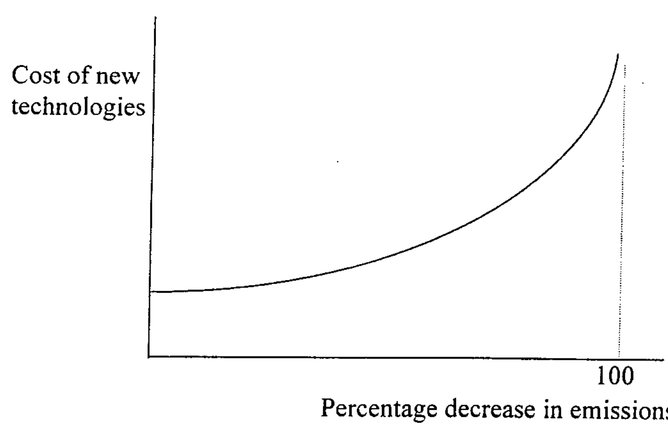

Figure 4.1 Relationship between cost of technologies and reductions in emissions

Consequently it is reasonable to assume that the required level of taxation and subsidies, to simulate similar volumes in passenger and freight transport as those in the BAU scenario, will be too large not to effect the economy in general.

The calculation of the EST1 scenario based on the above assumptions is an exercise that helps the construction of the optimal scenario, EST3.

4.1 Selection of technologies under the EST1 scenario

The adaptations to the BAU scenario to attain EST criteria are through technologies that reduces emissions at the source. These technologies consist of those connected with the vehicles themselves and those connected with the operation of the vehicles to minimise emissions.

Tables 4.1 and 4.2 show the assumptions regarding the emissions for passenger transport and freight transport under the EST1 scenario. The package of technologies in this scenario includes those related to vehicle, fuels and telematics. The calculation of the BAU scenario suggests that the attainment of the EST criteria in passenger transport sector is relatively simpler than in the freight transport sector. The selection of technologies in the passenger and freight transport sector will be such that in total the transport sector will meet the EST criteria under the EST1 scenario.

Passenger transport

The passenger car fleet will be composed of mainly electrical cars (about 40 percent) and very fuel efficient hybrid cars, e.g., which run on electricity and fossil fuel (about 60 percent). The main reason behind the assumption regarding the composition of the car fleet is the following. The majority of households will choose a hybrid car as the main car. This car type fulfils the multi purpose function of a present car (for their daily use as well as long distance travel). An electrical car will mainly be chosen as the second car in the multi-car households. There will be strict regulations that limit the use of hybrid cars in urban area to the alternative fuel than fossil fuel. The average emissions of CO_2 per vehicle kilometre from the new car fleet will be down by 90 percent from the 1990 level.

There will be widespread use of information technology both by the travellers and traffic managers in 2030. The improvements due to the use of telematics in 2030 will optimise routing, remove much of the stop-go from urban driving and minimise search time for parking. There will be further contribution to reducing fuel consumption and emissions by the widespread use of telematics. It is assumed that the use of telematics will reduce the emissions of CO_2 per vehicle kilometre by 45 percent during the peak periods and by 35 percent during off-peak periods. Altogether, the alternative technologies with respect to vehicles and infrastructure will reduce the emissions of CO_2 per vehicle kilometre by about 94 percent of the level in 1990. The emissions of NO_x and VOCs per vehicle kilometre will be down by 97 percent from the levels in 1990.

The projection of the development of technologies for bus is similar to those for car. However, the improvements in fuel efficiency for bus will not be as high as for passenger car. It would be possible, however, to use smaller vehicles for off-peak periods. The gains from this policy would be twofold. The average emissions of CO_2 per vehicle kilometre from the new bus fleet composition will be lower, and the vehicle occupancy rate will increase. It is assumed that the average emissions of CO_2 per vehicle kilometre from the new fleet will be reduced by 80 percent from the level in 1990. In total, the emissions of CO_2 per passenger kilometre, due to improved technologies, changes in the composition of bus fleet and higher occupancy rate, will decrease by about 90 percent from the level in 1990.

The use of telematics, both by travellers and by the managers, will contribute to further reduction of the emissions of CO_2 per passenger kilometre. Altogether, the emissions of CO_2 per passenger kilometre by bus will decrease by about 95 percent of the level in 1990. The emissions of NO_x and VOCs per passenger kilometre will be reduced by 97 percent of the levels in 1990.

There will be some room for improvements in technologies connected with light rail and rail. We have assumed that altogether, from improvements in technologies and increase in utilisation, the emissions of CO_2 per passenger kilometre by light rail and rail will decrease by about 10 percent of the level in 1990. The emissions of NO_x and VOCs per passenger kilometre will also be reduced by 10 percent of the levels in 1990.

Table 4.1 Emissions for passenger travel, Grams per passenger km, short distance travel under EST1 scenario (1990 =100)

Mode/Year	1990	2010	2030
Car			
CO_2	100 (146.2)	50.0	6.0
NO_x	100 (1.3)	25.0	3.0
VOCs	100 (1.0)	25.0	3.0
Bus			
CO_2	100 (36.0)	60.0	5.0
NO_x	100 (0.8)	40.0	3.0
VOCs	100 (0.5)	40.0	3.0
Rail/ Light Rail			
CO_2	100 (18.0)	75.0	10.0
NO_x	100 (0.1)	75.0	10.0
VOCs	100 (0.1)	75.0	10.0

Freight transport

We have assumed that all intraurban freights are transported by light and medium duty vehicles. As in the case of passenger transport, the improvements of technologies are related to technologies related to vehicles, fuel and the use of telematics. The urban freight transport will be restrained to lighter vehicles.

Table 4.2 Emissions for freight travel, Grams per tonne-km, short distance travel under EST1 scenario (1990 =100)

Mode/Year	1990	2010	2030
Light/Medium duty vehicles			
CO_2	100 (650)	65	25
NO_x	100 (8.2)	30	5
VOCs	100 (7.9)	30	5

An increase in the load factor through increased use of information technology is assumed. The use of information technology will contribute to lower fuel consumption and emissions. We have assumed that altogether the emissions of CO_2 per tonne kilometre will decrease by about 75 percent of the level in 1990. The emissions of NO_x and VOCs per tonne kilometre will be reduced by 90 percent of the levels in 1990.

4.2 Calculation of the EST1 scenario

Table 4.3 shows a summary of the development of demand and the emissions for passenger transport within the greater Oslo area under the EST1 scenario.

The projections of car ownership and the demand for transport are assumed to be the same as those under the BAU scenario.

Table 4.3 suggests that the EST criteria in the passenger transport are met in the EST1 scenario. Furthermore, the level of emissions of CO_2, NO_x and VOCs from the passenger transport allows for these emissions to be higher in freight transport than those set by the EST criteria.

Table 4.3 Prediction of demand in travel and emissions in the passenger transport sector under EST1 scenario (1990=100)

Year	1990	2010	2030
		Car ownership	
No. Of private cars	100	131	153
		Trips	
Total	100	117	122
Car	100	127	134
Public Transport	100	101	101
Walk/Cycle	100	97	97
		Vehicle-kilometres	
Total vehicle km.	100	120	125
Car	100	129	135
Public Transport	100	104	105
Walk/Cycle	100	100	101
		Fuel use/CO_2 emissions	
Total	100	64	8
Private car	100	64	8
Public transport	100	70	18
		NO_x emissions	
Total	100	34	5
Private car	100	32	4
Public transport	100	57	16
		VOCs emissions	
Total	100	34	5
Private car	100	32	4
Public transport	100	57	16

Table 4.4 shows a summary of the development of demand and the emissions for freight transport within the greater Oslo area under the EST1 scenario. We have assumed that the development of the volume of freight transported within the greater Oslo area follow that of the BAU scenario. The development of vehicle-kilometres will also be similar to that of the BAU scenario. This results from the assumptions related to the use of lighter vehicles for freight transport and a simultaneous increase in load factors. This table suggests that the EST criteria are not met for the freight transport under the EST1 scenario.

Table 4.5 shows a summary of the development of emissions in freight and passenger transport sectors within the greater Oslo area under the EST1 scenario. Under the EST1 scenario, the total emissions of CO_2 will be reduced by about 81 percent of the 1990 levels, while the emissions NO_x and VOCs of will decrease by around 93 percent of the 1990 level.

Table 4.4 Development of demand and emissions for freight transport under EST1 scenario (1990=100)

	1990	2010	2030
Tonne-kilometres	100	166	252
Vehicle Kilometres	100	171	253
Fuel use/CO_2 emissions	100	112	72
NO_x emissions	100	48	15
VOCs emissions	100	48	15

Table 4.5 Prediction of emissions in passenger and freight transport sector under EST1 scenario(1990=100)

	1990	2010	2030
Fuel use/CO_2 emissions	100	72	19
NO_x emissions	100	37	7
VOCs emissions	100	37	7

4.3 Method of adaptation

It was suggested earlier that the EST1 scenario, under the assumption that the passenger and freight transport volumes would follow those in the BAU scenario, is not a realistic scenario. There are, however, three policy objectives that are proposed under the EST1 scenario. These are:

- reduce emissions at source
- improve efficiency of vehicle fleet
- reduce the absolute levels of vehicle-km in passenger and freight transport by increasing the level of utilisation

The implicit assumption in the EST1 scenario is that the users are facing the same costs (generalised cost) as in the BAU scenario. As suggested by Figure 1, the costs of technologies that could satisfy the EST criteria in the EST1 scenario are perceived to be too high at this stage. The implication is that these technologies have to be highly subsidised. The level of subsidies could be beyond what might be publicly acceptable or even rational. Nevertheless, the evaluation of this scenario provides insight for the construction of the optimal scenario, EST3. There are three main categories of policy instruments that could bring about the necessary reductions in emissions for meeting the EST criteria set for passenger and freight transport. These are:

- Economic policies such as differential taxation/ subsidies of fuel and vehicles
- Regulatory policies such as setting standards and targets
- Transport logistics and planning such as the use of telematics/information technology

Table 4.6 shows a summary of the methods of application of the adaptations to the BAU scenario for the attainment of EST criteria in the EST1 scenario. This table also shows the benefits and costs of the implementation of the policy instruments. The evaluation of costs and benefits, at this stage of the work are rather crude and should be considered as preliminary assessments. The environmental benefits from the attainment of the EST criteria are not included among the benefits in this table.

Table 4.6 A summary of the methods of application of the adaptations to the BAU scenario under EST1 scenario

Policy instruments	Policy objectives	Target group	Benefits	Costs
Economic policies	• Reduce emissions at source • Improve efficiency of vehicle fleet	Public sector	≈ ?	+++?
		Users	+?	+?
		Administration & operation	≈	+
Regulatory policies	• Reduce emissions at source • Improve efficiency of vehicle fleet	Public sector	≈	≈
		Users	+?	+?
		Administration & operation	≈	+
Logistics and planning	• Reduce emission at source • Reduce absolute level of vehicle-km in passenger transport and road freight	Public sector		++
		Users	+	+
		Administration & operation	≈	+

Notes:

≈ No significant change in benefits or costs
\+ Small benefits or costs
++ Moderate benefits or costs
+++ Large benefits or costs
? Not clear

5 Capacity-Constraint (EST2) scenario

Under the capacity-constraint scenario, EST2, the EST criteria are met through the reduction in transport activity (volume and distance), shifts to less pollutant transport modes, management of traffic within each transport mode and policies related to the provision of transport infrastructure.

It will be assumed that the projection of economic growth, demographic factors and employment under the EST2 scenario will be the same as those under the BAU scenario.

We suggest that the assumption about economic growth under the EST2 scenario will make this scenario impossible to implement. Under the EST2 scenario the volumes of transport, in particular freight transport, have to be reduced to a level where the assumption regarding the same economic growth as that of BAU scenario will not hold. In fact, the economy will experience a negative growth.

5.1 Technological development

It is also assumed that the technological development under the EST2 is similar to that of BAU scenario. In this scenario the EST criteria are met through reduction in transport activity (volume and distance), shifts to less pollutant transport modes, management of traffic within each transport mode and policies related to the provision of transport infrastructure. Table 3.1 shows a summary of the projected socio-economic trends that will be used for the calculation of the EST2 scenario.

Tables 5.1 and 5.2 show the assumptions regarding the developments of emissions under the EST2 scenario. The assumptions about the technological developments under the BAU scenario have been used in this scenario. The developments of emissions are, however, different under the EST2 scenario. The main due policy objectives that affect emissions are:

- improve efficiency of vehicle fleet
- reduce the absolute levels of vehicle-km by increase in utilisation
- reduction in level of emissions by traffic management and reduction of the "stop-go" due to reduction of road congestion

Table 5.1 Emissions for passenger travel, Grams per passenger km, short distance travel under the EST2 scenario (1990 =100)

Mode/Year	1990	2010	2030
Car			
CO_2	100 (146.2)	80	65
NO_x	100 (1.3)	35	12
VOCs	100 (1.0)	35	12
Bus			
CO_2	100 (36.0)	80	61
NO_x	100 (0.8)	50	38
VOCs	100 (0.5)	50	38
Rail/ Light Rail			
CO_2	100 (18.0)	95	80
NO_x	100 (0.1)	95	80
VOCs	100 (0.1)	95	80

Table 5.2 Emissions for freight travel, Grams per vehicle-km, short distance travel under the EST2 scenario (1990 =100)

Mode/Year	1990	2010	2030
Light/Medium duty vehicles			
CO_2	100 (650)	85	67
NO_x	100 (8.2)	69	44
VOCs	100 (7.9)	73	48

5.2 Changes in the transport infrastructure

It is assumed that the changes in infrastructure will follow according to the approved plans up to year 2000. Table 4 in appendix II shows a summary of the expected changes in the transport infrastructure in the greater Oslo region. These changes are the same as those under the BAU scenario.

There would be further changes in transport infrastructure to support the proposed land use plan under the EST2 scenario. These changes are mainly connected with the provision of necessary infrastructure for public transport, bicycles and pedestrians. These are:

- improved rail services to support "higher density and multi-functional development" near stations along public transport corridors
- provision of the necessary bicycle and pedestrian infrastructure to support "higher density and multi-functional developments"
- provision of parking facilities near stations at "higher density and multi-functional developments" to support park and ride.

- further development of the public transport infrastructure, with emphasis on light rail infrastructure where feasible, and improvements of the present transport infrastructure
- provision of the necessary infrastructure for road pricing
- provision of new freight terminal facilities that would support optimisation of logistics in freight transport.

5.3 Changes in land use

Land use policies can contribute to the attainment of the EST criteria through bringing proximity in the locations of activities and hence reducing travel distance and promoting more environmentally friendly modes of travel such as walking, bicycle and public transport.

Land use policies under the EST2 scenario consist of the following main components.

- Urban containment policies to reverse the present trend in decentralisation of work and housing locations and the enhancement of the role of the central city. The scope of this policy is rather limited. There are two determining factors. The first factor is related to the slow rates of development and redevelopment. The second factor is related to the available space for urban development. In 1990's, most of the areas for urban development were built out in greater Oslo area. It is assumed that by 2030 there will be 30000 more housing units located in the city centre. In addition there will be 7000 new housing units located in the location of the present airport. Corresponding assumptions about work places are made.

- Development of higher density, multi-functional community centres, with rail connection to the Oslo city. Among other facilities, such as work places, child care centres, shops and different services for recreation, at these community centres there will be "work stations" for telecommunication. These "work stations" can accommodate around 50 percent of the employment in a community.

5.4 The characterisation of the EST2 scenario

It will be assumed that accessibility to activities, defined as the total number of activities that a person undertakes outside the home location, will be maintained at the 1990 level under the BAU scenario. We have assumed that telecommunication will not have any significant impact on the number of work trips. For telecommunication, one will have to go to a "work station" that is located centrally in a commune and is accessible by foot, bicycle, or public transport. However, the number of trips per person will decrease compared to the level in 1990. This is because the multi-functional community centres and the city centre will allow for trip chaining.

To meet the EST criteria in passenger transport under the EST2 scenario, travel pattern and behaviour must change drastically. There have to be major shifts in transport modes, to the advantage of public transport and walking and cycling.

This implies drastic shifts in the geographical pattern of activities that have to be supported by integrated land use and transport policies. Car ownership will decrease drastically due to significant increases in costs of ownership and operation.

Different schemes, with respect to travel pattern and behaviour, were sketched that meet the assumptions connected to accessibility and the EST criteria in 2030. The most acceptable of travel pattern and behaviour that can be supported through integrated land use and transport policies is refined as the EST2 scenario.

The situation is, however, different for freight transport. There is not too much scope to gain from modal shift in urban passenger transport. It is assumed that the optimisation of logistics will reduce the emissions of CO_2 by 30 percent. To meet the EST criteria in 2030 the volume of freight transported in the greater Oslo area has to be reduced by 75 percent of that under the BAU scenario. Such a reduction will have significant consequences for the economy and employment as perceived under the BAU scenario.

In principle, this stage of the calculation worked as an iterative process. A likely sketch for passenger and freight transport was drafted and calculated. The results were used to modify the sketch.

5.5 Calculation of the EST2 scenario

Table 5.3 shows a summary of the development of demand and the emissions from passenger transport within the greater Oslo area under the EST2 scenario. This table suggests that the EST criteria in the passenger transport are met in the EST2 scenario.

Table 5.4 shows the shifts in mode share between 1990 and 2030 under the EST2 scenario. This table shows that the distribution of trips by mode will shift towards public transportation and walking/bicycle compared with the base year, 1990.

Table 5.5 shows a summary of the development of demand and the emissions for freight transport within the greater Oslo area under the EST2 scenario. We have assumed that within the greater Oslo area, the volume of freight transport, in terms of tonne-kilometres, will be reduced by 17 percent in 2010 and by 37 percent in 2030 from that of the BAU scenario. In the calculation of the development of vehicle-kilometres we have allowed for the possibilities of optimisation of logistics.

Table 5.3 Predictions of demand for travel and emissions in the passenger transport sector under the EST2 scenario (1990=100)

Year	1990	2010	2030
		Car ownership	
No. of private cars	100	80	40
		Trips	
Total	100	113	114
Car	100	76	33
Public Transport	100	181	303
Walk/Cycle	100	179	203
		Vehicle-kilometres	
Total vehicle km.	100	107	107
Car	100	74	32
Public Transport	100	159	267
Walk/Cycle	100	206	235
		Fuel use/CO_2 emissions	
Total	100	37	18
Private car	100	33	11
Public transport	100	139	187
		NO_x emissions	
Total	100	22	10
Private car	100	14	2
Public transport	100	120	107
		VOCs emissions	
Total	100	22	10
Private car	100	14	2
Public transport	100	120	107

Table 5.4 Shifts in mode share under the EST2 scenario

Mode share	1990	2010	2030
Car	0.59	0.40	0.18
Public transport	0.19	0.31	0.53
Walk/cycle	0.22	0.29	0.29
Total	1.00	1.00	1.00

Table 5.5 Development of demand and emissions for freight transport under the EST2 scenario (1990=100)

	1990	2010	2030
Tonne-kilometres	100	83	63
Vehicle kilometres	100	60	44
Fuel use/CO_2 emissions	100	51	34
NO_x emissions	100	38	19
VOCs emissions	100	38	19

Table 5.6 shows a summary of the development of emissions in freight and passenger transport within the greater Oslo area under the EST2 scenario. Under the EST2 scenario, the total emissions of CO_2 will be reduced to about 20 percent of the 1990 levels, while the emissions NOx and VOCs of will decrease to about 11 percent of the 1990 level.

Table 5.6 Prediction of emissions in passenger and freight transport sector under the EST2 scenario (1990=100)

	1990	2010	2030
Fuel use/CO_2 emissions	100	40	20
NO_x emissions	100	25	11
VOCs emissions	100	25	11

5.6 Method of adaptation

It was suggested earlier that the EST2 scenario, assuming that the employment and economy will follow that in the BAU scenario, is not a realistic scenario. The main policy objectives that are proposed under the EST2 scenario are, however, the following:

- reduce the number of trips and increase the possibilities of trip chaining
- reduce trip length
- reduce car use and road freight transport
- increase utilisation of motor vehicles, both in passenger and freight transport
- change the modal split to the advantage of less polluting modes
- improve the efficiency of the vehicle fleet through speed control, removing of congestion and the "stop-go"
- reduce emissions at source through a more efficient vehicle fleet

There are three main categories of policy instruments that could bring about the necessary changes in travel behaviour and pattern for meeting the EST criteria under EST2 scenario. These are:

1. Spatial and land use planning and regulatory measures on land use
    - strategic land use and transport planning with focus on urban containment and the promotion of growth along rail corridors
    - promotion of the growth of multi-functional, high density commune centres
    - relocation of an appropriate part of service employment in the commune centres
    - fiscal policies to relocate employment in the commune centres
    - redevelopment of the Oslo city centre
    - zoning regulations to promote higher densities, multi-functional land use
    - parking regulations

- promotion of facilities necessary for the optimisation of logistics in freight transport

2. Transport investment policies instruments influencing transport demand and supply
    - limitation of road investment
    - investment in rail
    - provision of parking facilities near stations on rail corridors
    - further development of the public transport infrastructure, with emphasis on light rail infrastructure where feasible, and improvements of the present public transport infrastructure by measures such as reserved lanes for bus, use of telematics for bus priorities
    - improvements in public transport planning and operation
    - investment in infrastructure for bicycles and pedestrians
    - investment in telematics for traffic control
    - provision of new freight terminal facilities that would support optimisation of logistics in freight transport
3. Economic policies
    - pricing policies related to fuel
    - road pricing
    - differential taxation of motor vehicles
    - parking pricing
4. Transport demand management
    - incentives for the use of less polluting modes of transport
    - promote car utilisation and park and ride
    - provide information services for passenger and freight transport
5. Regulatory policies
    - parking control
    - extending pedestrian areas, entry prohibitions and traffic calming measures
    - enforcing speed limits
6. Education to increase public awareness about the relationship between travel behaviour and environment

Table 5.7 shows a summary of the methods of application of the adaptations to the BAU scenario for the attainment of EST criteria in the EST2 scenario. This table also shows the benefits and costs of the implementation of the policy instruments as a package. The evaluation of costs and benefits at this stage of the work are rather crude and should be considered as preliminary assessments. The environmental benefits from the attainment of the EST criteria are not included among the benefits in this table.

The cost of planning and transport investment policies, in terms of the necessary investment costs are probably very high for the public sector. Other policy measures are probably not very costly for the public sector. The public sector could have some gains and losses from the economic policies, depending on the required level of taxes and subsidies.

The users' benefits from the various policy measures are likely to be higher than losses. The underlying assumption in this scenario is that the activity participation of the population will not decrease very much compared with the BAU scenario.

There will be some costs connected with the administration and operation of different policy instruments under the EST2 scenario.

Table 5.7 A summary of the methods of application of the adaptations to the BAU scenario under the EST2 scenario

Policy instruments	Policy objectives	Target group	Benefits	Costs
Planing policies	• Reduce the number of trips • Reduce trip length • Reduce car use and freight transport • Change modal split	Public sector	≈ ?	+++?
		Users	++?	≈
		Administration/ operation	≈	+
Transport investment and development policies	• Reduce car travel • Change modal split • Increase utilisation, freight • Improve efficiency of vehicle fleet	Public sector	≈	+++?
		Users	+++?	+
		Administration/ operation	≈	+
Economic policies	• Reduce the number of trips • Reduce car use and road freight • Increase utilisation • Change modal split • Improve efficiency of the vehicle fleet • Reduce emission at source	Public sector	++?	+?
		Users	+?	+++?
		Administration/ operation	≈	+
Transport demand management	• Reduce car use • Change modal split • Increase utilisation	Public sector	≈	≈
		Users	+?	++?
		Administration/ operation	≈	+
Regulatory policies	• Reduce car use • Improve efficiency of vehicle fleet	Public sector	≈	≈
		Users	+?	++?
		Administration/ operation	≈	+
Education	• change travel behaviour and pattern	Public sector	≈	≈
		Users	+	≈
		Administration/ operation	≈	+

Notes:
≈ No significant change in benefits or costs
\+ Small benefits or costs
++ Moderate benefits or costs
+++ Large benefits or costs
? Not clear

It is important to emphasis that none of the policy instruments are not efficient or sufficient in attaining the EST criteria independently.

It should be expected that the marginal intensity of the enforcement of a single policy instrument has to increase for the attainment of the EST criteria, as demonstrated in Figure 5.1. Consequently it should also be expected that the costs of the implementation of a single policy instrument will exhibit the same property.

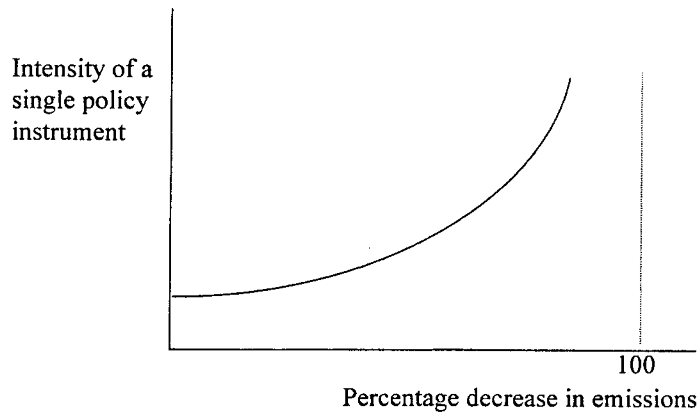

Figure 5.1 Relationship between the intensity of a policy instrument and reductions of emissions

6 Optimum combination (EST3) scenario

The optimum combination scenario is an efficient scenario in which the EST criteria are met through formulation of policy objectives and cost-efficient and politically and socially acceptable package of policy instruments. The calculation of the EST1 and EST2 scenarios has been beneficial in the formulation of the policy objectives and the selection of policy instruments under the EST3 scenario.

It was suggested that the EST1 scenario is a very unlikely scenario. This was mainly due to the outlook, at least at present, of the availability and costs of technologies that could help the attainment of the EST criteria under this scenario.

We also suggested that the EST2 scenario will be a very unlikely scenario. The main reason was that the economic growth under the EST2 scenario will be negative. It is assumed that the structural pattern of production and consumption under the EST2 scenario is the same as that under the BAU scenario.

Furthermore, calculations of EST1 and EST2 scenarios suggest that freight transport poses more problems for the attainment of the EST criteria than passenger transport. Consequently in the construction of the optimum scenario, EST3, freight transport should receive more attention.

The policy objectives under the EST3 scenario will be the following.

- reduce the absolute number of tonne kilometres in freight transport
- reduce the number of trips and increase the possibilities of trip chaining
- reduce trip length
- reduce car use and road freight transport
- increase utilisation of motor vehicles, both in passenger and freight transport
- changes the modal split to the advantage of less polluting modes
- reduction of emissions at source.
- improve efficiency of vehicle fleet.

The reduction of the absolute number of tonne kilometres in freight transport, to the extent that would support the attainment of the EST criteria, requires structural changes in the pattern of production and consumption. This requires a policy of regionalisation of consumption and production at an optimal level.

The consequences of this policy for the economic development and employment in the greater Oslo region are not very clear. The economic growth, the growth in labour force and in particular, the growth in different branches of the economy can be different from that of the BAU scenario. It is very likely that the shifts from the present pattern of consumption and production to a new and sustainable pattern will cause a dampening of the economic growth in the beginning.

The calculation of the socio-economic scenario under the EST3 scenario is not within the scope of the EST project, at least in this phase of the project. We assume that the projection of economic growth, demographic factors and employment under the EST3 scenario will be the same as that in the BAU scenario. However, it is very likely that the attainment of EST in the transport sector will be accompanied by some reduction in the economic growth in general, a cost that has to be evaluated socially and politically.

6.1 Technological development

The adaptations to the BAU scenario to attain the EST criteria are through technologies that reduces emissions at the source as well as technologies that are connected with the operation and utilisation of the vehicles. Since there will be some changes in travel behaviour and pattern under the EST3 scenario, the demand on technologies will not be as strained as in the EST1 scenario.

Tables 6.1 and 6.2 show the assumptions regarding technological development under the EST3 scenario. These assumptions reflect some rough calculations to include the trade-offs between the possibilities in technological developments and changes in travel pattern and behaviour.

Table 6.1 Emissions for passenger travel, Grams per passenger km, short distance travel under the EST3 scenario (1990 =100)

Mode/Year	1990	2010	2030
Car			
CO_2	100 (146.2)	65	25
NO_x	100 (1.3)	30	5
VOCs	100 (1.0)	30	5
Bus			
CO_2	100 (36.0)	65	30
NO_x	100 (0.8)	35	10
VOCs	100 (0.5)	35	10
Rail/ Light Rail			
CO_2	100 (18.0)	85	60
NO_x	100 (0.1)	65	40
VOCs	100 (0.1)	65	40

Table 6.2 Emissions for freight travel, Grams per vehicle-km, short distance travel under the EST3 scenario (1990 =100)

Mode/Year	1990	2010	2030
Light/Medium duty vehicles			
CO_2	100 (650)	75	45
NO_x	100 (8.2)	50	10
VOCs	100 (7.9)	50	10

6.2 Changes in the transport infrastructure

The assumption regarding the transport infrastructure under the EST3 is quite similar to that of the BAU scenario. The changes in infrastructure will follow according to the approved plans up to year 2000. Table 4 in appendix II shows a list of the approved transport infrastructure projects in the greater Oslo region.

The proposed additional infrastructure projects support a similar land use plan as that proposed under the EST2 scenario. These infrastructure projects are mainly connected with public transport, bicycles and pedestrians and with the efficiency improvements in freight transport. Following is a summary of these projects.

- improved rail services to support "higher density and multi-functional development" near stations along public transport corridors
- provision of the necessary bicycle and pedestrian infrastructure to support "higher density and multi-functional developments"
- provision of parking facilities near stations at "higher density and multi-functional developments" to support park and ride
- further development of the public transport infrastructure, with emphasis on light rail infrastructure where feasible, and improvements of the present transport infrastructure
- provision of the necessary infrastructure for road pricing
- provision of new freight terminal facilities that would support optimisation of logistics in freight transport

6.3 Changes in land use

It was mentioned earlier that land use policies, when integrated with appropriate transport policies, contribute to the attainment of the EST criteria through the following mechanisms

- bringing proximity to the locations of activities and hence reducing travel distance and the need to travel and increasing the possibilities of trip chaining
- promoting more environmentally friendly modes of travel such as walking, bicycle and public transport

Land use policies under the EST3 scenario are similar to that under the EST2 scenario. Furthermore, under the EST3 scenario, planning policies that promote the regionalisation of consumption and production needs to be included. These policies have the following main components.

- Urban containment policies and enhancement of the role of the central city. As mentioned earlier, the scope of this policy is rather limited. The two limiting factors were the slow rates of development and redevelopment and the available space for urban development. We will assume that by 2030 there will be 30000 more housing units located in the city centre and 7000 new housing units in the location of the present airport. Corresponding assumptions about work places are made. These are exactly the same assumptions as those under the EST2 scenario.

- Development of higher density, multi-functional community centres, with rail connection to the Oslo city. The facilities at these centres include work places, child care centres, shops, different services for recreation and "work stations" for telecommunication. These "work stations" can accommodate around 25 percent of the employment in a community.

- Promotion of policies that advance the regionalisation of production and consumption at an optimal level. This policy has to be addressed at a national and international level. Hence it would be difficult to spell out the policies that are relevant to the Oslo region in detail. These policies should be developed in the next phase of the study.

6.4 The characterisation of the EST3

It will be assumed that accessibility to activities, as defined earlier under section 5.4, will be maintained at the 1990 level. However, a slightly higher level of accessibility is achieved under the EST3 scenario than under the EST2 scenario. The role of telecommunication will not be as significant as that under the EST2 scenario.

To meet the EST criteria in passenger transport under the EST3 scenario, travel pattern and behaviour must change drastically. There have to be major shifts in transport modes, to the advantage of public transport and walking and cycling. However, car travel will not be as restrained as in the EST2 scenario. The shifts in transport mode have to be supported by significant shifts in the geographical pattern of activities that emerge from integrated land use and transport policies. The decrease in car ownership is not as drastic as in the EST2 scenario but is, however, significant. The decrease in car ownership is connected with significant increases in costs of ownership and operation of private car.

Different schemes, with respect to technological developments, travel pattern and behaviour, were sketched that meet the assumptions with respect to accessibility and the EST criteria in 2030. The most favourable combination of technological developments and travel pattern and behaviour, compatible with reasonable assumptions connected to land use and transport is refined as the EST3 scenario.

For freight transport, we have assumed that the structural changes in the pattern of consumption and production, through regionalisation of consumption and production and optimisation of logistics, will bring the volume, in terms of vehicle kilometres, in 2030 down to the 1990's level.

As explained under section 5.4, this stage of the calculation was an iterative process. A likely sketch for passenger and freight transport along with assumptions about technologies was drafted and calculated. The results were used to modify the sketch.

6.5 Calculation of the EST3 scenario

Table 6.3 shows a summary of the development of demand for travel and the emissions for passenger transport within the greater Oslo area under the EST3 scenario. This table shows that the EST criteria in the passenger transport are met in the EST3 scenario. Furthermore, the level of emissions of CO_2, NO_x and VOCs from the passenger transport allows for these emissions in the freight transport to be higher than those set by the EST criteria.

Table 6.3 Predictions of demand for travel and emissions in the passenger transport sector under the EST3 scenario (1990=100)

	1990	2010	2030
		Car ownership	
No. of private cars	100	109	99
		Trips	
Total	100	113	116
Car	100	107	78
Public Transport	100	124	225
Walk/Cycle	100	118	124
		Vehicle-kilometres	
Total vehicle km.	100	108	112
Car	100	100	70
Public Transport	100	125	220
Walk/Cycle	100	120	131
		Fuel use/CO_2 emissions	
Total	100	43	15
Private car	100	40	7
Public transport	100	113	207
		NO_x emissions	
Total	100	27	9
Private car	100	23	2
Public transport	100	75	108
		VOCs emissions	
Total	100	27	9
Private car	100	23	2
Public transport	100	75	108

Table 6.4 shows the shifts in mode share between 1990 and 2030. This table also shows that the distribution of trips by mode will shift towards public transportation and walking/bicycle compared with the base year, 1990.

Table 6.4 Shifts in mode share under the EST3 scenario

Mode share	1990	2010	2030
Car	0.59	0.56	0.42
Public transport	0.19	0.22	0.40
Walk/cycle	0.22	0.22	0.18
Total	1.00	1.00	1.00

The average trip distance of trips by car will be reduced from 14.6 kilometres under the BAU scenario to 13.0 kilometres under the EST3 scenario in 2030. The average trip distance of trips by public transport will be also reduced from 16.5 kilometres under the BAU scenario to 15.5 kilometres under the EST3 scenario in 2030.

Table 6.5 shows the distribution of trips by mode and purpose under the EST3 scenario in 2030.

Table 6.5 Distribution of trips by travel mode and purpose in 2030 under the EST3 scenario

	Mode			
Travel Purpose	Car	Public transport	Walk/cycle	Total
Work/education	0.11	0.14	0.10	0.35
Business	0.05	0.01	0.01	0.07
Shopping & service	0.14	0.13	0.04	0.31
Recreation, others	0.12	0.12	0.03	0.27
Total under EST3	0.42	0.40	0.18	1.00
Total under BAU	0.71	0.18	0.11	1.00

Table 6.6 shows a summary of the development of demand and the emissions for freight transport within the greater Oslo area under the EST3 scenario. It is assumed that the optimisation of logistics will reduce the emissions of CO_2 by 30 percent. The regionalisatoin of consumption and production reduces the freight volumes by 35 percent in terms of tonne-kilometres and by around 43 percent in terms of the 1990's levels. It is difficult to assert the validity of our assumptions in this phase of the study. The EST criteria in freight transport will not be met because of the CO_2 emissions. The emissions of CO_2 will only be reduced to 51 percent of the 1990 level.

Table 6.6 Development of demand and emissions for freight transport under the EST3 scenario (1990=100)

	1990	2010	2030
Tonne-kilometres	100	109	115
Vehicle Kilometres	100	110	100
Fuel use/CO_2 emissions	100	86	51
NO_x emissions	100	53	10
VOCs emissions	100	53	10

Table 6.7 shows a summary of the development of emissions in passenger and freight transport within the greater Oslo area under the EST3 scenario. Under the EST3 scenario, the total emissions of CO_2 will be reduced to about 21 percent of the 1990 levels, while the emissions NO_X and VOCs will be reduced to around 9 percent of the 1990 level.

Table 6.7 Prediction of emissions in passenger and freight transport sector unde the EST3 scenario (1990=100)

	1990	2010	2030
Fuel use/CO_2 emissions	100	50	21
NO_x emissions	100	32	9
VOCs emissions	100	32	9

6.6 Method of adaptation

The main policy objectives under the EST3 scenario were stated earlier. The policy instruments under this scenario are similar to those under the EST2 scenario with two additional categories of instruments. One category of policy instruments is connected to the promotion of the regionalisation of production and consumption. Another category is the additional policy instruments, such as regulatory measures by setting standards and targets connected with vehicle and fuel technologies that reduce emissions.

The main policy instruments under the EST3 scenario are the following:

1. Spatial and land use planning and regulatory measures on land use
    - planning policies for the regionalisation of consumption and production
    - strategic land use and transport planning with focus on urban containment and the promotion of growth along rail corridors
    - promotion the growth of multi-functional, high density commune centres
    - relocation of appropriate part of service employment in the commune centres
    - fiscal policies to relocate employment in the commune centres
    - fiscal policies to promote regionalisation of consumption and production
    - redevelopment of the Oslo city centre
    - zoning regulations to promote higher densities, multi-functional land use
    - parking regulations
    - promotion of facilities necessary for the optimisation of logistics in freight transport
2. Investment policies
    - limitation of road investment
    - investment in rail
    - provision of parking facilities near stations on rail corridors
    - further development of the public transport infrastructure, with emphasis on light rail infrastructure where feasible, and improvements

of the present public transport infrastructure by measures such as reserved lanes for bus, use of telematics for bus priorities
- investment in infrastructure for bicycles and pedestrians
- investment in telematics for traffic control
- provision of new freight terminal facilities that would support optimisation of logistics in freight transport

3. Economic policies
    - economic policies to promote regionalisation of consumption and production
    - pricing policies related to fuel
    - road pricing
    - differential taxation of motor vehicles
    - parking pricing
4. Transport demand management
    - incentives for the use of less polluting modes of transport
    - promote car utilisation and park and ride
    - provide information services for passenger and freight transport
5. Regulatory policies
    - regulatory policies regarding vehicle and fuel type
    - regulatory policies for the promotion of the regionalisation of consumption and production
    - parking control
    - extending pedestrian areas, entry prohibitions and traffic calming measures
    - enforcing speed limits
6. Education to increase public awareness about the relationship between travel behaviour and environment

Table 6.8 shows a summary of the methods of application of the adaptations to the BAU scenario for the attainment of the EST criteria in the EST3 scenario. This table also shows the benefits and costs of the implementation of the policy instruments. As it has been mentioned earlier, the evaluation of costs and benefits at this stage of the work are rather crude and should be considered as preliminary assessments. The environmental benefits from the attainment of the EST criteria are not included among the benefits in this table. The comparison of the preliminary evaluations of EST1, EST2 and EST3, suggests that EST3 is less costly than the others.

The cost of planning and transport investment policies, in terms of the necessary investment costs, are probably high for the public sector, but not as high as in the EST2 scenario. Other policy measures are probably not very costly for the public sector. The public sector could have some gains and losses from the economic policies. This would again depend on the level of required taxes and subsidies.

The users' benefits from different policy measure are likely to be higher than the losses. The underlying assumption in this scenario, as in the EST2 scenario, is that the activity participation of the population will not decrease very much compared with the BAU scenario.

There will be some costs connected with the administration and operation of different policy instruments under the EST2 scenario.

Table 6.8 A summary of the methods of application of the adaptations to the BAU scenario under the EST3 scenario

Policy instruments	Policy objectives	Target group	Benefits	Costs
Planing policies	• Reduce the number of trips • Reduce trip length • Reduce car use and freight transport • Change modal split • Promote regionalisation	Public sector Users Administration/ operation	≈ ? ++ ≈	++ ? ? +
Investment policies	• Reduce car travel • Change modal split • Increase utilisation, freight • Improve efficiency of vehicle fleet	Public sector Users Administration/ operation	≈ ++? ≈	++? ++ +
Economic policies	• Reduce the number of trips • Reduce car use and road freight • Increase utilisation • Change modal split • Improve efficiency of the vehicle fleet • Reduce emission at source	Public sector Users Administration/ operation	+? +? ≈	+? ++? +
Transport demand management	• Reduce car use • Change modal split • Increase utilisation	Public sector Users Administration/ operation	≈ +? ≈	≈ ++? +
Regulatory policies	• Reduce car use • Reduce emissions at source • Improve efficiency of vehicle fleet • Promote regionalisation	Public sector Users Administration/ operation	≈ +? ≈	≈ ++? +
Education	• Change travel behaviour and pattern • Promote regionalisation	Public sector Users Administration/ operation	≈ + ≈	≈ ≈ +

Notes:
≈ No significant change in benefits or costs
\+ Small benefits or costs
++ Moderate benefits or costs
+++ Large benefits or costs
? Not clear

7 Key features of the EST scenarios

In this phase of the project, the EST criteria were limited to CO_2, NO_x and VOC's. Other EST criteria such as those connected with noise and particulate matters will be addressed in the next phase of the project. The criterion connected with land use was provisionally set to that sanctioned in 1996 for land use for transport related purposes. This criterion will be addressed again in the next phase of the project. In the following the key features of the BAU scenario and the EST scenarios are described.

7.1 BAU scenario

The calculation of the BAU scenario suggests the following developments in the transport sector.

- Decentralisation of work and house locations will continue. Private car ownership in 2030 will increase by 53 percent compared with 1990. Number of trips in 2030 will increase by 22 percent compared with 1990. There will be shifts in transport mode in the passenger transport, towards car use, at the expense of public transportation and slow modes (walking/ cycle) compared with 1990.
- The volume of freight transport in 2030, in tonne-kilometres, will increase by 152 percent compared with 1990. Even though in 1990 passenger transport contributes to about 84 percent of the total emissions of CO_2 from the total transport activities, the share will decrease to 70 percent in 2030. The pictures for NO_x and VOC's are slightly different. Passenger transport contribution to the total emissions of NO_x and VOC's from the total transport activities in 1990 is about 80 percent compared with 42 percent in 2030. These figures suggest that the increase in the volume of freight transport is relatively larger than passenger transport. Freight transport will most likely be more problematic than passenger transport with respect to the environment, given the present outlooks of the potential technological developments.
- The total emissions of CO_2 from the transport sector will increase by 32 percent in 2030 compared with 1990. The total emissions of NO_x and VOC's from transport will decrease by about 50 percent in 2030 compared with 1990. The implication is that the key criterion among the EST criteria used in this phase of the study will be that connected with the emissions of CO_2.

7.2 EST1 scenario

Under the EST1 scenario, it is assumed that the volumes of transport, passenger or freight, will be similar to those under the BAU scenario. The EST criteria under this scenario are achieved fully through technological development. The demands on different transport technologies are determined with the characterisation of the EST1.

The underlying assumptions of the EST1 scenario are not reasonable. A set of generalised costs of transport will be associated with the technologies under EST1 that are probably very different from that in the BAU scenario and that would affect the demand for transport. As it was discussed earlier, the calculation of this scenario should be viewed as merely a helpful exercise for the constructions and characterisation of the optimum-combination scenario, EST3.

The characterisation of the EST1 scenario shows that the demand on technologies will be very high in order to meet the EST criteria. The cost of the implementation of this scenario, due to the very high demands on technologies, is perceived to be very high today. The use of fossil fuel in transport will have to be restricted.

- In the passenger transport sector, hybrid and electric vehicles will replace the present fleet. However, the use of passenger vehicles will be restricted to electric power in the greater Oslo area with few exceptions. There will be parallel technological improvements in public transport. Hybrid and electrical buses will replace the present fleet. There will be some improvements in technologies connected with light rail and rail.
- Intraurban freight transport will be restricted mainly to vans and some medium duty vehicle. The technological developments in the freight transport sector will be similar to those of the passenger transport sector. Electric and hybrid vans and lorries that run on fuel cells will emerge to replace the present fleet.
- In both passenger and freight transport, the technologies connected with vehicles and fuels will be accompanied by wide spread use of information technologies that produce further efficiencies and improve utilisation.
- In the characterisation of the EST1 scenario, it has been recognized that the scope of technological development in freight transport will be more limited than in passenger transport. The reductions in the emissions of CO_2, NO_x, and VOC's in passenger transport will compensate for smaller reductions of these emissions in freight transport and to attain the EST criteria.

7.3 EST2 scenario

Under the EST2 scenario, it is assumed that technological developments in transport are the same as those under the BAU scenario. The EST criteria under this scenario are achieved fully through demand management such as the reduction in transport activities (volume and distance) and shifts to less pollutant transport modes. The extent of these reductions and shifts are determined through the characterisation of the EST2.

The characterisation of the EST2 scenario suggests a drastic reduction in transport activities, in both passenger and freight transport sectors. Such reductions will have significant impacts on the economy and employment as perceived under the BAU scenario. Furthermore, the cost of the implementation of this scenario could be quite high due to large investments in transport and other infrastructures. Nevertheless, the calculation of this scenario, as EST1, should be regarded as a beneficial exercise for the constructions and characterisation of the optimum-combination scenario, EST3.

The calculation of the EST2 scenario suggests the following developments.

- In passenger transport, travel pattern and behaviour must change drastically. There will be major shifts in transport modes, to the advantage of public transport, walking and cycling. Car ownership and use will decrease drastically due to significant increases in costs of ownership and operation. In 2030, under the BAU scenario, car mode share is about 69 percent compared with 18 percent under the EST2 scenario. The level of participation in activities outside home is maintained at a slightly lower level than in 1990. However, the number of trips per person will decrease through trip-chaining. This implies drastic shifts in the geographical pattern of activities that have to be supported by integrated land use and transport policies. Some main features of land-use under the EST2 scenario are the reversal of the urban sprawl trends, local multi-functional community centres with connection to the Oslo city centre by rail, and more dense redevelopment of the Oslo city centre.
- The scope of modal shifts in freight transport is limited and hence the EST criteria have to be met mainly through significant reductions in transport volumes and some through the optimisation of logistics. In 2030, under the BAU scenario, tonne-kilometres will increase by 152 percent from 1990, compared with a reduction of 37 percent under the EST2 scenario. It is not possible to assert at this stage if such reductions in freight transport volumes can be accommodated without significant implications for the economy.
- There will be large investments in transport and other infrastructures connected to both passenger and freight transport under the EST2 scenario.
- It has been recognised that the scope for the reduction of freight transport volumes is less than in passenger transport. Consequently the EST2 scenario is characterised in such manner that the EST criteria are attained in total for passenger and freight transport.

7.4 EST3 scenario

Under the EST3 scenario, it is assumed that the attainment of the EST criteria will be through a consistent and efficient combination of improved technologies and demand management. The demand on technologies and the extent of the demand management are determined through the characterisation of the EST3.

The characterisation of the EST3 scenario suggests that the demand on technologies will not be as strict as under the EST1 scenario. Meanwhile the reductions in transport activities, in both the passenger and freight transport sectors, are not as drastic as those under the EST2 scenario. Nevertheless, the reductions in passenger and freight transport volumes will probably have some impacts on the economy and employment as perceived under the BAU scenario. The possible implications for the economy should be considered as a cost that society should evaluate among other costs and benefits for the attainment of the EST criteria.

The calculation of the EST3 scenario suggests the following developments.

- In passenger transport, travel pattern and behaviour change, yet not as drastically as that under the EST2 scenario. There will be shifts in transport modes, to the advantage of public transport, walking and cycling. Car ownership and use will decrease significantly due to increases in costs of ownership and operation. In 2030, under the BAU scenario, car mode share is about 69 percent compared with 18 percent under the EST2 scenario and 42 percent under the EST3 scenario. The level of participation in activities outside home is maintained at the 1990 level, however, the number of trips per person decrease through trip-chaining. There would be major shifts in the geographical pattern of activities that again have to be supported by integrated land use and transport policies. The main features of land-use under the EST3 scenario are similar to those under the EST2 scenario. These are the reversal of the urban sprawl trend, local multi-functional community centres with connection to the Oslo city centre by rail, and more dense redevelopment of the Oslo city centre. The main difference between the EST2 and EST3 scenarios in this respect is the intensity, and consequently the costs associated with the necessary measures.

- In freight transport the EST criteria have to be met mainly through reduction in transport volumes, and partly through the optimisation of logistics. In 2030, under the BAU scenario, the volume of freight, in terms of tonne-kilometres, increases by 152 percent from 1990, compared with a 37 percent decrease under the EST1 scenario and a 15 percent increase under the EST3 scenario. The decrease in freight transport volumes under the EST3 scenario is not as drastic as that of the EST2 scenario. Yet the reduction is significant enough to call for major policy changes with respect to freight transport. The regionalisation of consumption and production is a likely policy objective that can materialise the characterisation of the freight transport sector for the attainment of the EST criteria. It is not possible to assert at this stage if such a policy can be accommodated without any implications for the economy and employment.

- There will be some investments in transport and other infrastructure connected to both passenger and freight transport under the EST3 scenario, though not as much as those under the EST2 scenario.

- It has been recognised that the scope for technological development and the reduction of freight transport volumes is less than in passenger transport. Consequently the EST3 scenario is characterised in such a manner that the EST criteria are attained in total for passenger and freight transport.

8 Conclusions

Our evaluation of the BAU scenario suggests that the key quantitative criteria for EST will be the one regarding CO_2. It also suggests that it would be more problematic to attain the EST criteria in the freight transport sector than in the passenger transport sector.

Our evaluation suggests that the EST1 scenario is unlikely. The demands on technologies related to vehicles and fuels for the attainment of the EST criteria, are very high under this scenario. The costs of these technologies are perceived to be too high at present. The requirements on technologies in this scenario can not be realised without internationally co-ordinated actions.

The EST2 scenario is also unlikely. The assumption about the economic development under this scenario and the required decrease in demand for travel and freight transport are most likely not consistent. Especially, the required decrease in the volume of freight transport makes it implausible for the economy to develop as in the BAU scenario.

Under the EST3 scenario, the demands on technological developments are not as severe as under the EST1 scenario. The EST criteria in the passenger transport sector are realised by these technologies and necessary changes in travel pattern and behaviour. The realization of the EST criteria in the freight transport sector is more difficult. This will not be possible without significant changes in the pattern of consumption and production. The regionalisation of consumption and production is a likely policy objective to bring about the necessary changes. The scope of this policy objective should be calculated at a national level. Based on assumptions about the scope of this policy in the greater Oslo region, the passenger and freight transport sectors together will meet the EST criteria.

It is very likely that the economic development under the EST3 scenario will be different from that under the BAU scenario. The attainment of the EST criteria might result in deviation from the anticipated growth under the BAU scenario, in addition to other economic costs and benefits, that should be evaluated socially and politically.

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Appendix I The greater Oslo Area

Oslo was founded in 1050. During the last part of the 1800s, the population grew from 50000 to 250 000. There were several expansions of the city boundaries during 1800s. From 1910 onwards, the development of new suburbs in Aker with single family dwelling following subway tramlines started. In 1948 the municipalities of Oslo and Aker were joined. The local government bought large agricultural areas in Aker and "satellite cities" were developed. In the second part of 1980's, extensive building activities took place in Oslo. From 1985 to 1990 two large central urban development projects in Oslo, Aker Brygge and Vaterland were developed and built. In the 1990s, the last of the areas for urban development were built out. The alternatives for future development are:

- expand the developed zone
- build more densely in already built out areas
- find regional solutions in co-operation with the neighbouring municipalities.

The residential density in Oslo is 1.9 persons per dwelling. The occupancy rate is 0.6 persons per room. The average size of dwelling is 3.1 rooms and 83 sq.m.

There have been major changes in the economic, demographic and social trends in the greater Oslo area that have led to the present land-use and travel pattern. Following is a summary of these.

- There has been an increase in wealth due to increase in productivity and the expansion of the labour force, mainly due to the increase in women's participation in the labour force.
- Car ownership has increased due to the increase in purchasing power. There have been moderate changes in the costs of running a car compared with considerable increases in public transport costs in real terms.
- There has been a steady decrease in the household size with important implications for land-use and travel patterns.
- The economic affluence has brought more leisure time that has in turn changed lifestyles. This has resulted in the increase in travel to other activities compared to travel to work. Leisure trips now dominate trips for other purposes and these trips are often made by car.
- There has been a trend in decentralisation of workplaces. Workplaces are relocating from the central parts of Oslo to the suburbs and to Akershus. New shopping centres are established in the suburbs and in Akershus.
- The emerged travel patterns and land-use have reinforced each other, resulting in increases in car use and to a dispersal of population, employment and commercial activities. The emerged land-use pattern requires longer journeys often with no alternative than to use a car.

The evolved land-use and travel patterns have imposed high costs on resources, energy and the environment, mostly externalised. Among these are costs related to congestion, noise nuisance, community severance and landscape loss, and health and environmental damage due to air pollution. The environmental implications of these trends are alarming because predicted traffic growth is likely to outstrip measures to improve the energy efficiency and environmental performance of vehicles unless other policy measures are introduced.

Appendix II Some description of the BAU scenario

Table 1 Expected annual growth in population, employment and private consumption volume under the reference scenario

Variable/Year	1991-2000	2000-2025	2025-2030
Population	0.408	0.245	0.245
Employment	0.408	0.248	0.248
Private consumption volume			
total	2.199	2.197	2.197
per capita	1.785	1.923	1.923

Table 2 Expected development in fuel efficiency (grams/passenger km.)

Variable/Year	1991	2010	2030
Car, average	13.78	12.15	11.81
Car, short distance travel	14.22	12.57	12.22
Public trans., short distance travel	26.81	23.53	22.38

Source: TØI notat 991/91

Table 3 Expected development in travel cost per km (1991=100)

Variable/Year	1991	2010	2030
Car, average	100	96.67	95.57
Car, short distance travel	100	96.82	95.73
Public trans., short distance travel	100	99.43	98.98

Table 4 Expected change in the transport infrastructure in the Oslo region

National road projects in Oslo and Akershus up to 96-budget
Bicycle network up to 96-budget (about half of the total plan of 450 mill.)
Improvements in underground system according to the public transit company
Extension of up to Mortensrud
Street car through Akerbrygge
Gardermoen airport. Fornebu; no special plan
Gardermoen rail line
Different measures for the improvements in bus and street car services
No change in Gardermo rail line (no tunnel under the Old city)

Table 5 Long term elasticities for short distance passenger travel

	Car				Public Transport (PT)			
	Travel Time		Travel Cost		Travel Time		Travel Cost	
	peak	off peak	peak	off peak	peak	off peak	Peak	off peak
	Trips							
Total	0.00	-0.06	0.00	-0.05	-0.02	0.00	-0.02	0.00
Car	-0.28	-0.12	-0.16	-0.09	0.14	0.03	0.14	0.03
PT	0.40	0.12	0.22	0.08	-0.43	-0.25	-0.46	-0.24
Walk/cycle	0.29	0.10	0.16	0.06	0.27	0.33	0.28	0.30
	Person kilometre							
Car	-0.65	-0.33	-0.39	-0.28	0.16	0.03	0.17	0.03
PT	0.47	0.13	0.28	0.10	-0.57	-0.33	-0.65	-0.36
Walk/cycle	0.41	0.09	0.28	0.07	0.48	0.51	0.51	0.50
	Travel time use							
Car	-0.72	-0.31	-0.38	-0.25	0.15	0.03	0.17	0.03
PT	0.73	0.10	0.18	0.07	-0.34	-0.21	-0.11	-0.01
Walk/cycle	0.41	0.09	0.28	0.07	0.48	0.51	0.51	0.50
	Travel cost							
Car	-0.65	-0.33	-0.39	-0.28	0.16	0.03	0.17	0.03
PT	0.44	0.12	0.26	0.09	-0.51	-0.30	-0.55	-0.29
Walk/cycle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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