Urban form, transportation and greenhouse gas emissions

Experiences in the Nordic countries

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Irmeli Harmaajärvi, Sirkka Heinonen & Pekka Lahti
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Nordic Council of Ministers

Store Strandstræde 18
DK-1255 Copenhagen K
Phone (+45) 3396 0200
Fax (+45) 3396 0202

Nordic Council

Store Strandstræde 18
DK-1255 Copenhagen K
Phone (+45) 3396 0400
Fax (+45) 3311 1870

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Nordic co-operation in the transport sector

The overall, general objective of co-operation is to foster a Nordic transport sector characterised by efficiency, competitiveness, safety, sustainability, and equality. In order to attain these objectives with the resources available, co-operation will be focussed on four areas:

Sustainable Mobility, The Baltic Sea, Intelligent Transport Systems and Transport Safety.

The Nordic Council of Ministers

was established in 1971. It submits proposals on co-operation between the governments of the five Nordic countries to the Nordic Council, implements the Council's recommendations and reports on results, while directing the work carried out in the targeted areas. The Prime Ministers of the five Nordic countries assume overall responsibility for the co-operation measures, which are co-ordinated by the ministers for co-operation and the Nordic Co-operation committee. The composition of the Council of Ministers varies, depending on the nature of the issue to be treated.

The Nordic Council

was formed in 1952 to promote co-operation between the parliaments and governments of Denmark, Iceland, Norway and Sweden. Finland joined in 1955. At the sessions held by the Council, representatives from the Faroe Islands and Greenland form part of the Danish delegation, while Åland is represented on the Finnish delegation. The Council consists of 87 elected members - all of whom are members of parliament. The Nordic Council takes initiatives, acts in a consultative capacity and monitors co-operation measures. The Council operates via its institutions: the Plenary Assembly, the Presidium and standing committees.

Abstract

The main objective of the project was to identify instruments to develop urban form and transportation systems in a sustainable way to decrease greenhouse gas emissions in the Nordic countries. Instruments can be found on different levels: national, regional and local. The main sectors are land use and transportation planning, land use and transportation policies, tax policy, co-operation, information dissemination, interaction, monitoring and early warning systems. Instruments concern for example control of urban development, supporting residential activities in city centres, control of location of shopping malls, preventing long commuting trips, reduction of transportation need and car dependency, promotion of walking, cycling and public transport and eco-managed telework.

Land Use, Planning and Building Acts, national objectives and other regulations guide and control planning. They have many objectives which are supposed to promote sustainable development. Planning systems include zoning and transportation system plans on different geographical levels: international, national, regional and local. Certain principles are in many countries regarded as good for sustainability, many of them based on research results. Integration or infill of the urban form is to be taken as the starting point on all land use planning levels. The possibilities for supplementary building in already built-up areas are examined. New areas are located in proximity to existing areas with good public transport facilities, especially rail services. Most important services are located within easy walking distance or accessible by public transport. Land use planning aims to keep distances between various activities as short as possible. Housing, work places and services, as well as local recreational areas, are situated close to one another. Large shopping units are located in city centres or areas with good public transport. More integrated land-use and transport planning is considered to be necessary.

The general objective of land use and transport planning is to maximize the modal share achieved by walking, cycling and public transport together. Public transport is promoted by a good and comprehensive standard of service, a rapid network, ease and comfort in use, as well as inexpensive fares. Walking and cycling are promoted with developing network of tracks and by making the surroundings attractive. Providing pedestrian precincts in central areas creates favorable conditions for comfortable urban living.

Car traffic can be reduced with help of economic instruments, e.g. pricing and fiscal instruments, by traffic pricing, parking policies, car sharing, company bicycles, transportation telematics, teleworking, telepresence, taxation politics, removing or restricting tax deductions for commuting and company cars, by applying polluter pays-principle to infrastructure, by real estate and fuel taxes and by applying determined land policy.

Taxes can be an effective way to affect people's choices of dwelling location and mode of travel. For example, removing or restricting tax deductions for commuting and company cars and, in the other hand, increasing tax deduction for public transport can lead to less transportation need and less use of private cars. Fuel taxes may promote less use of private cars. Municipalities can control land use and direct it to favorable areas also by real estate taxes.

Municipalities which are responsible for land use and transportation planning cannot always afford large public transport investments alone and additional state financing is often needed. Coordinated investment plans can help decisions. Road customs, congestion prices etc. can be used for financing in addition to their impact on use of private cars.

Traffic pricing can be an effective instrument to promote public transport and walking and bicycling instead of use of private cars. Road customs, congestion prices and parking prices have proved to be effective. Parking policies may be an important tool to control urban form. Restricting amount of parking places and adjusting the cost of parking is a good instrument to reduce use of cars especially in city centres.

Eco-managed telework can be one solution to reduce need for transport. A concept of the Eco-Managed Introduction of Telework from Finland is introduced. In the chosen Finnish case areas, possibilities were explored for linking residential areas with well developed ICT infrastructure to the eco-managed introduction of telework. Telework can also be integrated as part of a lifestyle based on sustainable development. The role of telework centres in reducing passenger car commuting was also analysed. Further, introduction of eco-managed telework can be included in environmental strategies of communities, corporations and institutions. Denmark was among the first European countries to start giving regulations on telework arrangements. One important factor to promote the development was the decision that a computer which employer gives to employee to use at home is not a taxable advantage. In Norway impacts of telework have been assessed in Oslo and Bergen. The analysis showed that telework has potential to reduce transport and emissions in both regions. The government has included several telework projects into its development programmes concerning labour markets and regional policy. In Sweden the government has proposed large state support to build a country wide broadband channel for households and rural areas. The cities of Stockholm and Linköping have carried out telework projects. In 2001 the government established an IT & Environmental Forum with the aim of promoting ict and sustainable development. One of its two working groups is concerned with virtual mobility.

Research results show that urban form has remarkable and long-term impacts on greenhouse gas emissions and that there are significant possibilities to reduce emissions by control of urban form and transportation. Most of the measures have also other positive impacts, e.g. on other emissions, costs and the quality of the environment.

Good ideas and knowledge of research results are however not enough to create sustainable urban form and transportation. There are many possible obstacles which would be necessary to address and try to solve. In land use planning the main obstacles or challenges may be lack of cooperation between municipalities which have an essential role in planning, lack of determined land policy of municipalities and lack of control of scattered development in rural areas. The possibility of the local authorities to regulate parking lots is limited by the fact that in many city centres the majority parking lots are private. The good governmental level targets and programmes that aim at better integration of environmental and other social aspects into land use planning and transport policy may not be internalised at the local level because some other aims and objectives may (such as commercial or other industrial employment etc.) exceed these aims of land use and transport planning. Taxes and traffic pricing are not very popular among people. The problem is that fiscal policy is often designed from budgetary point of view, not to achieve the best environmental or any other social policy goal. Eco-

managed telework requires combined efforts made by employers and employees, supported by regulations. Lack of coordination between transportation and land use planning in general and between national and local planning have been regarded as a major challenge in order to control development of urban form and transportation.

It is obvious that some of the instruments which could be relevant in reducing greenhouse gas emissions can fall between ministries and other administrative sectors. This fact suggests more intensive cooperation between different levels and branches of public sector. In addition to ministries of environment, transportation & communication, also ministries responsible for financing and social welfare issues should be taken along when defining research needs and assessment of alternative measures.

Planning alone cannot stop the urban sprawl. When considering and assessing different measures on national level, legislative and fiscal issues, citizen participation and other background forces should be taken under serious consideration. Better cooperation between researchers, politicians, civil servants and citizens is needed to find deeper understanding about economic, social and environmental long-term effects of decisions concerning urban development.

Continuing discussion and more focused research initiatives are needed. Common understanding and interpretation of problems in the Nordic countries can promote favourable national solutions and decisions.

Co-operation, interaction and dissemination of information are essential to contribute to sustainable urban form and transportation.

Sammandrag

Det nordiska projektet "Urban form, transport and greenhouse gas emissions" ("Samhällsstruktur, trafik och utsläpp av växthusgaser") har finansierats av Nordiska ministerrådet och Miljöministeriet i Finland och utförts av VTT, Statens Tekniska Forskningscentral i Finland. Projektet har letts av Nordiska ministerrådets temagrupp för Hållbar Mobilitet som också utgjorde en väsentlig del av samarbetsnätverket för projektet. Ytterligare experter medverkade i projektet vid en "workshop".

Nordiska länder har många gemensamma egenskaper vad gäller samhällsstruktur och trafik. Många problem har uppfattats på samma sätt och mycket av diskussionen handlar om samma saker. Samhällsstruktur och markanvändning har en stor inverkan på trafikvolym och färdstätt och därmed också på utsläpp av växthusgaser. Splittringen av samhällsstrukturen har varit en fortgående trend i alla nordiska länder i årtionden, och engagemang i den här processen anses viktigt.

Relativt hög förekomst av tätorter, väl fungerande och användbar kollektivtrafik samt gång- och cykelnätverk av hög kvalitet är exempel på instrument som anses vara bra för att reducera utsläpp av växthusgaser. Dessa instrument anses också befrämja andra miljö- och trafikpolitiska mål, speciellt luftkvalitet, trafiksäkerhet och en sund miljö.

Instrument för utveckling av samhällsstruktur och trafiksystem med avseende att minska utsläpp av växthusgaser finns i alla nivåer och sektorer av planläggning och beslutsfattande. Exempel på instrument är planering av markanvändning och trafik, stadsplanering, olika slags beskattning, finansiering av infrastruktur, trafiksprissättning och parkeringspolitik. Den nya ICT- teknologin kan ge nya sätt att erbjuda samma urbana tjänster som tidigare, men med mindre effekter på trafiken.

Enbart planering kan inte förhindra splittring av samhällsstrukturen. Samarbete mellan forskare, politiker, tjänstemän och medborgare behövs för att uppnå bättre förståelse för vittgående ekonomiska och sociala effekter samt miljöeffekter av de beslut som gäller samhällsstrukturens utvecklande.

Fortsatt diskussion och mer fokuserade forskningsinitiativ behövs. Förståelse för gemensamma problem i de nordiska länderna kan befrämja fördelaktiga nationella lösningar och beslut.

Preface

The Nordic project “Urban form, transportation and greenhouse gas emissions” was launched by the initiative of the Ministry of the Environment of Finland and the Ministry of Transportation and Communications Finland as an action after the National Climate Strategy of Finland. The project was commissioned by the Nordic Council of Ministers and the Ministry of the Environment of Finland.

The project was carried out by Senior Research Scientist Irmeli Harmaajärvi (project manager) and Chief Research Scientists Sirkka Heinonen and Pekka Lahti at VTT, the Technical Research Centre of Finland.

The project was guided by the theme group “Sustainable Mobility” of the Nordic Council of Ministers. The theme group also formed an essential part of the co-operation network of the project. The chair of the group was Stefan Andersson from Sweden and the members were Claes Pile from Sweden, Leena Silfverberg and Risto Saari from Finland, Ole A. Hagen and Trond Kråkenes from Norway, Peder Mandrup Knudsen and Lars Olsen Hasselager from Denmark and Johann Gudmunsson from Iceland. The adviser at the Nordic Council of Ministers was Helena Wallin.

The project had a workshop in December 2003 in Helsinki. Participants were Leena Silfverberg from the Uusimaa Regional Environment Centre, Aulis Tynkkynen from the Ministry of the Environment Finland, Risto Saari from the Ministry of Transport and Communications Finland, Ole A. Hagen from the Ministry of the Environment Norway, architect Mats Carlsson from Swedish National Road Administration, town planning chief Leo Kosonen from City of Kuopio and Irmeli Harmaajärvi and Sirkka Heinonen from VTT.

The authors are solely responsible for the content and the conclusions in the report.

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Introduction

Background of the project

One of the most important international targets to achieve ecologically sustainable development is combating the climate change, which means reducing greenhouse gas emissions.

Urban form has direct and indirect effects on greenhouse gas emissions. It affects via buildings and infrastructure, energy consumption, energy production systems, waste management, need for transportation, distances, accessibility, modal split, prerequisites for public transportation, walking and cycling etc.

In international literature most of the cases share a common understanding of sustainable urban form including the whole process of construction, maintenance and use of urban structures: minimizing the consumption of energy and other natural resources and causing as little harmful emissions and wastes as possible. On a city level the most important targets include: efficient energy supply system, reduction of transportation demand, development of prerequisites for pedestrian and bicycle traffic and public transportation, conservation of land as a natural element, locating new construction to built up areas meaning infill and increase of efficiency in demand for infrastructure and sufficient building density.

Urban sprawl has been a common and continuing trend in many countries. The same trend can be recognised in Nordic countries as well. Finland has especially low urban densities but less living space in dwellings than the others. Resources are used to cover long distances and heavy infrastructure instead.

Integrating urban form promotes economically, ecologically and socially sustainable development by reducing demand for transportation and energy consumption in buildings and other structures and thus decreasing greenhouse gas emissions as well as other emissions, which are harmful for human health and nature.

Objectives and tasks

The objective of the project is to identify instruments to develop urban form and transportation systems in a sustainable way to decrease greenhouse gas emissions. To achieve this goal a better understanding is needed about the urban form and its functions as well as their effects on greenhouse gas emissions. Instruments can be found on different levels: national, regional and local. The main sectors to be studied are land use and transportation planning, land use and transportation policies, tax policy, co-operation, information dissemination, interaction, monitoring and early warning systems. Instruments could concern, for example, control of urban development, supporting residential activities in city centres, control of location of shopping malls, preventing long commuting trips, reduction of transportation need and car dependency and promotion of walking, cycling and public transport.

In the Nordic countries there are different situations and experiences concerning urban development, transportation and greenhouse gas emissions. It would be fruitful to take advantage of the experiences from different Nordic countries.

The project has the following tasks:

1. Definition of links between technological change and changes in urban form, as well as their interaction between transportation and other factors which have impact on greenhouse gas emissions.
2. Trends in changes of urban form, transportation and greenhouse gas emissions, especially in the growing urban regions.
3. Identification of possible instruments to control development of urban form and transportation to decrease greenhouse gas emissions.

National, regional and local instruments:

- land use and transportation planning and policies
- tax policy
- co-operation, information dissemination, interaction
- monitoring and early warning systems.

Instruments could concern for example:

- control of urban development
- supporting residential activities in city centres
- control of location of shopping malls
- preventing long commuting trips
- reduction of transportation need and car dependency
- promotion of walking, cycling and public transport.

4. Experiences of instruments in different countries

Which instruments have been used or tested in different countries? What are the results or other experiences (positive or negative)?

5. How to learn from each other in the future?

1 Links between urban form and greenhouse gas emissions

Urban form can be generally defined as the entire built environment including buildings and networks in both urban and rural areas. Although the object of the project is to define impacts of urban form to greenhouse gas emissions, changes and development of urban form and transportation have also economic, other ecological as well as social impacts. Many of them affect to the same direction, i.e. at the same time can be gained positive impacts both on greenhouse gas emissions and other emissions, costs, use of natural resources, health and social welfare. Policies to control urban form have many other targets additional to climate change related.

Links between technological changes and changes in urban and regional forms have been identified for example in a Finnish study on urban form and greenhouse gas emissions (Harmaajärvi, Huhdanmäki & Lahti 2001). The general social change factors form the background of the future development of urban and regional forms. The factors are interlinked in many ways and form complex chains including factors related to technological change, productivity, gross national product, income and income distribution, social and economic structure, working culture, service and free time behaviour etc. The chains and modification processes are often cyclic or spiral composed of series of events strengthening one another. (Figure 1)

Figure 1. The circle of the changes in technology and changes in urban and regional forms (Harmaajärvi et al. 2001)

Changes in urban and regional forms affect greenhouse gas emissions directly via amount and location of structures, i.e. buildings, networks and other structures and transportation between functions, and in the other hand via other changes, e.g. changes linked with living standard, motorizing and amount of transport as well as their combined and multiplex effects. Multiplex and circuit effects appear for example in

modal split where motorizing increases share of cars, which promotes urban sprawl, which again promotes the use of cars.

Petter Naess investigates the relationship between energy and urban form according to Susan Owens (figure 2):

Figure 2. Model of the relationship between the energy system and spatial structure (Owens, S. 1986, Naess, P. 1996)

Relationship between urban form, transportation and ecological and economic impacts have also been studied in an assessment model EcoBalance which has been developed and applied in several case studies in Finland (e.g. Harmaajärvi 1995 and 2000a). (Figure 3)

EcoBalance Model

Figure 3. The structure of the EcoBalance model. The model estimates the total consumption of energy and other natural resources (building materials and fuels), production of emissions and wastes and costs caused directly and indirectly by residential areas and urban structures. EcoBalance model includes all urban structures: buildings, technical infrastructure and green areas. The model is divided into three submodels: production, operation and transportation models. (Harmaajärvi 1995)

2 Nordic studies on impacts of urban form and transport

Urban form and energy use for transport

Petter Naess has stated in his doctoral thesis “Urban form and Energy Use for Transport. A Nordic Experience” (Naess 1996) that urban form variables exert important influences on transportation energy use. According to the empirical findings of investigations the following urban form characteristics contribute to a low energy use of transport:

- A high population density for the town as a whole
- High density within local areas of the town
- A centralized pattern of residences within the urban area (i.e. higher population densities in inner areas than in outer areas of the town)
- A centralized location of workplaces within the urban area (except for functions directed towards the local community)
- A decentralized pattern of urban settlements at a regional scale
- A high population size of the individual town
- Low parking capacity at the workplace.

According to the study the variation in per capita energy use for transportation attributable to variation in urban form factors is considerable, in particular when comparing different areas within a town, but also when comparing towns with different urban form characteristics. Keeping constant other variables influencing energy use, the investigations of 22 Nordic towns indicate that the inhabitants in the town with the lowest population density (Halden, with 654 square meters of urban area per capita) use on average 25 per cent more energy for transportation than the inhabitants in the town with the highest population density (Copenhagen, with 305 square meters of urban area per capita). Similarly, a differential in energy use of 28 per cent is attributable to the difference in the degree of decentralized distribution of the population over the urban area between the towns with the most decentralized (Alta) and the most centralized pattern of residence (Randers). Imagining a town having both as low population density as Halden and as decentralized pattern of residences as Alta, per capita energy use could be expected to be 60 per cent higher than among the inhabitants of a town with the same population density as Copenhagen and the same degree of centralization as Randers. This differential equals 3 100 kilowatt hours per capita annually, or seven per cent of the total per capita inland energy use in Norway.

Naess states in his study also that in general, urban form characteristics favorable for the minimizing of transport energy requirements, also seem to be favorable for energy conservations in buildings. Dense built forms and urban structure are advantageous from an energy conservation point of view.

Petter Næss' study "Sustainable town development, goals and principles" (1996) gives the following results:

Town size and regional settlement pattern

Increased urbanisation have been claimed to be favourable for sustainable development. It has been especially based on proposed high energy consumption in transport in rural areas and small urban areas. We find, however, no ground for this claim. Empirical data from Norwegian situation shows that regions with decentralized settlement pattern are as favourable as centralized regions as for energy consumption in transport.

Population density

High population density gives shorter distances between functions and ground for a higher share for public transport and non-motorized transport, and reduces energy use in transport.

Location of functions

In relation to the goal to reduce energy use for transport, location near town centre is more favourable than to periphery of town area both for dwellings and work places. Density and centralization are the two most important town planning principles when reducing use of cars in towns. The conclusion that centralized location of work places is favourable, concerns, however, not functions that are directed to local community, for example daily product shops, comprehensive school, post office and nursery.

Road network

High capacity on road network and good accessibility to parking places make it faster and more comfortable to use car, and weaken thus possibilities of public transport and non-motorized transport to compete with car. On the other hand, new roads may, at least in the short run, give a better fluency in traffic and thus decrease energy use and emissions per driven kilometre. Increased speed in road network can, however, lead people to accept longer daily travel distances. A high road and parking capacity means anyway large paved areas. This promotes both town expansion and leads to loss of green areas in town. Road construction leads moreover often to scattering of green area structure and forms barriers to use green areas.

Urban form and greenhouse gas emissions

Earlier research studies show that urban and regional form may have major impacts on greenhouse gas emissions. The most important impacts come from traffic and the energy consumption of buildings. An integrated urban form reduces transportation emissions by about 10% in the regions that have been studied in Finland (e.g. Harmaajärvi 2000b). Location and structural solutions of residential areas (e.g. building density, location and volume of buildings, networks and green areas, transportation between activities, materials and energy consumption of buildings, heating system and energy production) affect greenhouse gas emissions in urban areas more than 10 % and in rural areas even 250 % (e.g. Harmaajärvi 1995 and 2000a). Comparable reductions are also achieved in other emissions harmful to human health and the environment as well as in costs.

On a national level Finland's regional form is concentrating and moving towards south, while urban sprawl is causing growth centres to become fragmented. The impacts

caused by these changes on greenhouse gas emissions were studied until the year 2010, when, in accordance with the Kyoto protocol, Finland's greenhouse gas emissions should be reduced to the 1990 level. The urban form affects especially transportation within regions, the potential to utilise district heating and the need for infrastructure. Impacts are caused not only on greenhouse gas emissions but also on other harmful emissions, noise, costs, living quality etc.

As a result of urbanisation, Finland's regional form is becoming more concentrated, while urban sprawl is causing fragmentation of the urban form. Under *the business as usual scenario*, this trend is expected to continue. Changes in urban form in the Helsinki region are presented as built-up areas in Figure 4.

The changes in traffic have been assessed based on the changes in the average commuting distances in municipalities (Statistics Finland, 1999). In the business as usual scenario, the situation in 2010 is based on the trend between in 1991 and 1997. (Figure 5).

In *the target-oriented scenario* the regional and urban forms will indirectly result in lower greenhouse gas emissions than in the business as usual scenario (BAU) in the year 2010. Regional form is supposed to develop in the same way as in the business as usual scenario. Migration to the growth regions will continue. This is based on socio-economic trends (e.g. changes in technology, productivity, living standard, economic life, work culture, services and free time culture). Development within the commuting areas has been planned so as to concentrate residential development in city centres rather than in outskirts. Residences and work places are located nearer to each other. Commuting distances will not increase.

Figure 4. Change in urban form in 1989-1998 in the Helsinki region, shown as built-up areas defined by GIS methods developed by VTT. Sprawl has been continuous. Under the “business-as-usual” scenario this trend continues. The buildings outside the built-up areas are not shown. (Harmaajärvi et al. 2002)

Figure 5. Average straight-line commuting distances from residences to work places in Finnish municipalities in 2010 according to the business as usual scenario (on the left) and the target-oriented scenario (on the right). The average was 8.7 km in 1991 and 9.6 km in 1997. According to the business as usual scenario it will be 11.4 km in 2010. Increased commuting distances in outskirts are particularly pronounced. According to the target-oriented scenario the average commuting distance in Finland will be no more than 9.1 km. Commuting distances in outskirts now exhibit more controlled increases. (Harmaajärvi et al. 2002)

Commuting distances are shorter in the target-oriented scenario than in the business as usual scenario. The average straight-line commuting distance in the whole of Finland is 9.1 km, i.e. 2.3 km less than in the business as usual scenario (Figure 5).

Effects of changes in regional and urban form have been studied on *passenger traffic* within regions, which consists of commuting trips and other trips. This study is concerned only with trips less than 100 kilometres long (commuting trips straight-line, corresponding about 130 kilometres real distance). Longer trips are assumed to be affected more by other factors than regional and urban forms. Car traffic within regions examined in this study is about 50% of all car traffic and 40% of all road transport in Finland. Passenger traffic within regions is estimated to increase by 6,000 vehicle kilometres, i.e. 36% from 1990 to 2010 because of changes in urban and regional form in the business as usual scenario. The increase of greenhouse gas emissions is estimated to be 0.3 million tonnes CO₂ equivalent, i.e. 9% in the business as usual scenario. Private cars compose 99% of vehicle kilometres and 94% (in the target-oriented scenario 93%) of emissions. Commuting accounts for about one-quarter of all vehicle kilometres and emissions.

In the target-oriented scenario, vehicle kilometres increase only by 7% from 1990 by 2010. Under the target-oriented scenario emissions will be reduced by 1.1 million tonnes CO₂ equivalent, i.e. 27%, in 2010 compared to the business as usual scenario and vehicle kilometres driven will be 22% lower. Thus, a compact urban form will result in a 0.8 Mt CO₂ eq. reduction in emissions, and an increase in teleworking and other kind of lifestyle changes will result in a 0.2 Mt CO₂ eq. reduction in emissions.

Changes in regional and urban forms have an impact on the greenhouse gas emissions from *buildings* mainly because of changes in building types and heating systems. Greenhouse gas emissions from heating and electricity use have been estimated for residential and service buildings in Finland. In the business as usual scenario, there is a marked increase in the use of electric heating and electricity in general. Emissions are estimated to rise with 4.8 Mt CO₂ eq. from 1990 to 2010. In the target-oriented scenario a compact urban form allows the use of more district heating, which reduces emissions by 1.1 Mt CO₂ eq. in 2010.

Construction and use of *infrastructure networks* cause annual greenhouse gas emissions of about 1 Mt CO₂ eq. Urban sprawl increases the need for infrastructure networks and thus emissions will rise 12% from 1990 to 2010. In the target-oriented scenario a more compact urban form means less infrastructure is needed; thus the annual emissions are lower by 0.1 Mt CO₂ eq. in 2010.

Summary of results

Greenhouse gas emissions from the regional and urban forms are estimated to increase if the present trend continues in the business as usual scenario between 1990 and 2010. By developing regional and urban form it is possible to reduce emissions considerably (Table 1, Figure 6).

Table1. Trends and possibilities to reduce greenhouse gas emissions by developing urban form. (Harmaajärvi et al. 2002)

Trends in greenhouse gas emissions of passenger traffic within regions, residential and service buildings and municipal infrastructure networks from 1990 to 2010 (million tons of CO ₂ equivalent).				
	1990	1998	2010	Change in 1990-2010
Passenger traffic within regions	3.5	3.6	3.8	+ 0.3 Mt CO ₂ eq. (+ 9%)
Energy use in buildings	17.5	17.4	22.3	+ 4.8 Mt CO ₂ eq. (+ 27%)
Municipal infrastructure networks	1.0	1.0	1.1	+ 0.1 Mt CO ₂ eq. (+ 12%)
By developing regional and urban form as in the target-oriented scenario it is possible to reduce emissions in 2010 compared to the business as usual scenario as follows:				
Less passenger traffic within regions				- 1.1 Mt CO ₂ eq. (- 27%)
More use of district heating				- 1.1 Mt CO ₂ eq. (- 5%)
Less need for infrastructure networks				- 0.1 Mt CO ₂ eq. (- 6%)
Total				- 2.3 Mt CO₂ eq.

Figure 6. Potential reduction in greenhouse gas emissions in the target-oriented scenario to 2010 in three different categories. Careful development of the regional and urban structure would result in an estimated reduction of 2.3 Mt CO₂ eq. (Harmaajärvi et al. 2002)

In a country like Finland with a low population density and long travel distances, regional and urban form plays an important role in combating climate change.

The increase of greenhouse gas emissions would be even greater than assessed without the expected decrease of specific vehicle emissions and the decrease in the number of employed people in the population, trends which have been observed since 1990. Car traffic within regions accounts for about half of all car traffic in Finland.

Developing the urban form according to the target-oriented scenario would reduce greenhouse gas emissions by 2.3 million tonnes in 2010 as compared to the business as usual scenario. This amounts to 15% of Finland's target for greenhouse gas emissions reductions in 2010. If the target-oriented scenario is realised, the decrease of emissions would continue even faster. At the same time, other emissions which are harmful to human health and the environment will also decrease. Furthermore, significant cost savings will be achieved, the quality of the environment can be improved and the preservation of the biological diversity can be promoted.

To change the present trend requires that the problem of urban sprawl is recognised and tackled. To stop urban sprawl, measures are required in planning, land use and housing policy, and in transportation and tax policy. Additionally more needs to be done in

regard to cooperation, interaction and information dissemination. Sprawl has been encouraged by, among other things, the tax deduction for commuting. By eliminating this tax deduction or by reducing it, the trend can be changed. Urban sprawl can also be prevented by a real estate tax and by applying the “polluter pays” principle to infrastructure costs. (Harmaajärvi, Huhdanmäki & Lahti, 2001 and 2002)

Impacts from different land-use strategies on travel distances

Linda Christensen and Mogens Fosgerau have studied impacts from different land use strategies on travel distances (Christensen & Fosgerau 2003). Conclusions of the study were the following.

In this study an analysis was performed of travel distances using micro-level data correcting for a number of factors including income and car ownership. Nevertheless, strong correlations were found between the distances travelled and the urban structure expressed in terms of variables describing the location of the residence. Thus it is likely that the relationships found can in fact be attributed to the urban structure and are not due to socio-economic differences.

The analysis has shown that locating residences near the centre of the region can reduce transport volumes and car traffic considerably. The results further show that urban development at peripheral city centres reduces travel demand relative to development in suburbs and small towns. Development of rural areas and villages are likely to generate the highest level of traffic. Finally, location near rail stations has significant effect especially on car traffic.

The analysis has been repeated, this time letting variables for the urban structure determined by the location of the workplace. The conclusion from the analysis seems to be that workplaces ought to be decentralised in order to reduce the level of transport. The most likely reason for this conclusion is that residences are decentralised already. This means that workplaces near the residences might mean shorter distances between home and work for people on average. We do however feel that this conclusion need further consideration and are not prepared to give policy recommendations based on this.

The models include the effect of distance to a rail station. The result shows that the effect of locating a workplace within 5 minutes walk from a rail station decreases total travel by 10 percent and travel distance by car to 50 percent. The corresponding estimates for the location of the residence show a 7 per-cent reduction in total travel when the residence is less than 10 minutes away from a station and a 33 percent reduction in car travel when the residence is less than 5 minutes walk from a station. Hence, we conclude that a policy giving priority to locating workplaces near stations rather than residences is likely to contribute to reducing the demand for travel.

Of course this conclusion depends upon the actual density of the established areas. Offices and firms with few square metres per employee will typically have one employee per 30-50 indoor m². New residences will have one adult or big child (10-84 years old) per 40-70 indoor m². This means that the reduction in car kilometres from localising workplaces densely around rail stations related to residences are even greater than the above calculated. Buildings with offices can normally be established more densely than residential areas, which adds extra to the conclusion.

The strategic conclusion on the analysis must be that centralisation of residential areas and concentration of workplaces around rail stations will reduce travel and especially car traffic most substantially. A further effect of such policy will be a reduction of the CO₂ emissions. However, centralisation may entail more noise and air pollution in the dense areas. But serious planning of the road network and the detailed plan of the residential areas can reduce such problems.

3 Trends in urban form, transport and emissions

Statistical data

Sweden is the largest Nordic country by area and population. Denmark is the smallest country by area (excluding Faroe Islands and Greenland) and Iceland by population. Population density is highest in Denmark and lowest in Iceland. Share of city population is highest in Iceland and lowest in Finland. (Table 2)

Table 2. Population and area of the Nordic countries (Statistics Finland 2003)

Country	Area 2001	Population 2001 1000 inhabitants	Annual growth of population 1995-2000 %	Inhabitants per square-km 2001	Share of city population 2001 %
Denmark	43 094	5 359	0.4	124	85
Finland	338 145	5 188	0.3	15	61
Iceland	103 000	285	0.9	3	93
Norway	323 877	4 514	0.6	14	75
Sweden	449 964	8 896	0.1	20	83

Share of city population has been growing in the 1990s especially in Finland and in Norway. (Figure 7)

Figure 7. Share of city population 1990 – 2003 (Statistics Finland 2004).

Share of population which lives in the biggest cities (more than 100 000 inhabitants) in the Nordic countries in the beginning of the year 2003 varies from 32% (Denmark) to 62 % (Iceland). In Norway the share is 35 %, in Finland 36 % and in Sweden 44 %. The share has been growing. (Table 3)

Table 3. Biggest cities in the Nordic countries (more than 100 000 inhabitants) (Statistics Finland 2003 and 1997)

		Population 1.1.2003	Population 1.1.1997
Denmark	Copenhagen	501 300	483 700
	and surroundings	1 085 800	1 765 500 ¹
	Århus	291 300	281 400
	Odense	184 300	184 100
	Aalborg	162 500	160 700
		31.12.2002	31.12.1996
Finland	Helsinki	559 700	531 800
	and surroundings	971 800	905 100
	Espoo	221 800	196 100
	Tampere	199 800	186 100
	Vantaa	181 900	168 700
	Turku	174 600	167 000
	Oulu	124 600	111 500
		1.12.2002	1.12.1995
Iceland	Reykjavik	112 500	104 300
	and surroundings (1.12.2001)	178 000	158 600
		1.1.2003	1.1.1997
Norway	Oslo	517 400	494 800
	and surroundings	1 000 700	940 400
	Bergen	235 400	224 300
	Trondheim	152 700	144 700
	Stavanger	111 000	105 600
	Baerum	102 500	
		31.12.2002	31.12.1996
Sweden	Stockholm	758 100	718 500
	and surroundings	1 684 400	1 588 000
	Göteborg	474 900	454 000
	and surroundings	810 400	773 800
	Malmö	265 500	248 000
	Uppsala	179 700	184 500
	Linköping	135 100	131 900
	Västerås	128 900	124 100
	Örebro	125 500	120 800
	Norrköping	123 300	123 500
	Helsingborg	119 400	114 900
	Jönköping	118 600	115 600
	Umeå	106 500	102 500
	Lund	100 400	

¹ incl. Frederiksberg and Gentofte

Number of passenger cars per inhabitant is highest in Iceland and lowest in Denmark. Car stock has been growing from the 1980s up to the 2000s. (Figure 8)

Figure 8. Number of passenger cars per inhabitant 1980-2002 in the Nordic countries (Statistics Denmark, Finland, Iceland, Norway and Sweden 2004).

Volume of car passenger transport per inhabitant is highest in Denmark and lowest in Sweden. The volume has been growing. Information from Iceland was not available. (Figure 9)

Figure 9. Volume of car passenger transport per inhabitant in the Nordic countries 1980 – 2000 (Eurostat, Statistics Norway).

Carbon dioxide emissions per inhabitant are greatest in Finland and least in Sweden (figure 10).

Figure 10. Carbon dioxide emissions in the Nordic countries 1990 – 2000 (UNFCCC).

Figure 11. Carbon dioxide emissions from transport in the Nordic countries 1990 – 2000 (UNFCCC).

Carbon dioxide emissions from transport per inhabitant are greatest in Norway and least in Sweden (figure 11). Differences between countries concerning total emissions and emissions from transport result from differences in the share of transport of the total emissions and differences in characteristics of transport.

Policies and measures have been planned to control the growth of greenhouse gas emissions. (Figure 12)

Figure 12. Greenhouse gas emissions from transport in the Nordic countries 1990 – 2000 and projections

with measures 2010 and 2020 (National communications under the UNFCCC).

Denmark

Denmark has a population of slightly more than 5.3 million and a total area of 43 000 km². The population density is slightly more than 120 per km².

One-twentieth of the area of Denmark is urbanised. 85 % of Danes are town-dwellers, and most enterprises, institutions etc. are situated in towns. The total built-up area is 654 million m². Towns and cities are generally characterised by separation of residential and industrial areas, industrial buildings being situated in specially designated zones on the outskirts of the towns. The growth in the service industries and the growth in manufacturing with a small environmental impact imply new possibilities for integrating industry and housing, thereby reducing the need for transport between home and work.

Traffic has increased considerably in the last 10 years. Passenger traffic (excl. motor cycle, 2-stroke and bicycle traffic) increased from 64 billion person-kilometres in 1990 to 74 billion in 2001. In the same period, freight transport by road increased from 12 billion tonne-km to 14 billion. The transport sector accounts for 18 % of Denmark's total greenhouse gas emissions.

It is seen to be difficult to turn the upward trend of greenhouse gases in the transport sector in Denmark, which is not a car making country, without international initiatives. The transport sector's possibility, with national measures, of contributing to reduction of Denmark's CO₂ emissions shows that the cost-effectiveness of the measures depends entirely on the side effects. The decision to implement different measures within the transport sector must therefore to a great extent be evaluated on the basis of the measure's other effects and not simply from the point of view of reduction of CO₂ emissions. (Denmark's Third National Communication on Climate Change under the UNFCCC 2003)

The Danish policy on CO₂ emissions reduction is a general policy of cost-effectiveness – regardless of sector - and with a benchmark of 120 kroner/tonne for policy measures to be implemented. The outcome of this policy has been that reduction in CO₂ emissions has been given a higher priority in other sectors and the quoted explicit target value for the transport sector has consequently been abandoned.

Finland

Finland is Europe's seventh largest country with a total area of 338 145 km². Finland has over 34 000 km² of inland water systems, or about 10 % of its total area. The population of Finland is around 5.2 million, making Finland the third sparsest populated country in Europe. The population projection for 2010 is 5.26 million, for 2020 it is 5.29 million. The average population density is only 17 people per square kilometre of land (15 people per square metre of total area, including inland water area). The population is concentrated in the southern parts of the country. The capital Helsinki itself had a population of 551 000 in December 1999. The province of Lapland, although almost one third of the area of Finland, had a population of only 194 000. There is a strong internal migration from small municipalities to urban areas. In the 1990s, the population of the six largest localities increased from 1.61 million to 1.81 million, while at the same time many communities, particularly in Lapland and eastern Finland, had a declining population.

The main trends in the urban and regional structure in Finland are, on the other hand, increasing urban sprawl, and on the other hand, concentration of the population in a few urban regions. This means increasing challenges for the co-ordination of transport and land use planning in the future.

In the transport sector the climate change policy has become an integrated part of the transport policy in the 1990s both at the national level and within the European Union. The aim is to restrain the growth of transport and thereby to reduce the environmental effects of transport, including greenhouse gas emissions.

Promotion and development of inter-modal transport, rail transport and public transport have traditionally played an important role in the Finnish transport policy. Finland has also had a national cycling policy programme since 1992. Cities and towns sell convenient regional bus cards valid for one month in all major urban areas, and they also subsidise the ticket prices. The government funds half of the bus ticket prices in small urban agglomerations, but does not subsidise the bus tickets in large cities or towns. In freight transport the logistical efficiency of traffic chains has been an important objective already because the traffic distances are long and volumes rather small in a large country with low population density. Following the relatively high level of vehicle and fuel taxation in Finland compared to several other countries, the market share of public transport has remained relatively high, around 20 %, of all passenger transport.

The transport sector accounts for about 21 % of Finland's total greenhouse gas emissions.

Because of the transport and fiscal policy objectives and measures, and economic recession and changes in industrial structure, in the early 1990s, there has been only a slight increase in greenhouse gas emissions caused by transport in the 1990s. Greenhouse gas emissions from transport shall be reduced by decreasing the fuel consumption of vehicles and by disseminating information on the effects of the

transport mode and the manner of driving on fuel consumption. (Finland's Third National Communication under the UNFCCC 2001).

Iceland

The population of Iceland is 286 000, and settlement is primarily along the coast. Iceland, which is the second large island in Europe after Great Britain, has a total area of 103 000 km². Glaciers are distinctive feature of the landscape, and rivers and lakes are numerous. Relatively warm winters and cool summers characterize the climate. The population is projected to grow by about 12 % over the next two decades, reaching 312 000 in 2020. About 62 % of the nation lives in the capital, Reykjavik, and surrounding areas. In 1990 this same ratio was 57 %, demonstrating higher population growth in the capital area than in smaller communities and rural areas. The population density is three inhabitants per square kilometre. Given the large percentage of the population living in and around the capital, the rest of the country is even more sparsely populated, with less than one inhabitant per square km.

The dispersed settlement of the country results in relatively high emissions of greenhouse gases due to transport. Emissions from space heating are, however, much lower than what might be expected, keeping in mind the cold temperature climate. This is because the majority of the population relies on renewable energy sources for district heating.

In 2000 the transportation sector was responsible for about 30 % of total greenhouse gas emissions in the country. Because Iceland is a sparsely populated country, transport is a major issue for regional development, but the small population also limits the options available. Mountainous landscape and harsh climate further complicate the situation, making the design of an efficient public transport system difficult. Most households consider it necessary to use private automobiles. Population growth and an increase of the number of tourists are likely to lead to an increase in greenhouse gas emissions from the transport sector in the near term. The use of new energy carriers, such as hydrogen, if proven technically and economically feasible on a large scale, could reverse the longer-term trend. (Iceland's Third National Communication under the UNFCCC 2003).

Norway

With a total area of almost 324 000 km² and only 4.5 million inhabitants, Norway has the second lowest population density in Europe after Iceland. An increasing percentage of the population lives in urban settlements in central parts of the country. Around 1900, 35 % of the population lived in densely populated areas. One hundred years later, about 77 % of Norway's population lives in urban settlements. The number of urban settlements is small – only 19 have more than 20 000 residents. Only four cities – Oslo, Bergen, Stavanger and Trondheim – have more than 100 000 residents. Currently, almost 30 % of Norway's population lives in the four largest cities.

Norway has a varied but most subarctic climate and the demand for energy for heating purposes is therefore high. Population density is low on average, but 77 % of the population lives in urban settlements.

Norway's decentralized settlement pattern gives rise to a relatively high demand for transport, and makes public transport systems relatively costly. From 1960 to 1995, people's mobility in Norway, measured in kilometres travelled by person, rose by a factor of four, while the volume of public transport rose only insignificantly. In

addition, the Norwegian economy is largely based on the extraction of raw materials and export of goods, which means that there is a large volume of goods transport. The demand for rapid transport and more frequent deliveries of goods is also rising. As a result, the proportion of passenger transport by cars and the proportion of goods transport by road and air is rising, and this generates higher CO₂ emissions.

From 1980 up to the end of 1999, the volume of goods transport measured in tonne-kilometres has increased by 56 %, and if oil and gas transport from the North Sea is also included, the increase is no less than 176 %. The growth in transport from the North Sea to the mainland and in goods transport by road are the main factors behind this overall rise in goods transport.

In 1999, 31 % of Norway's total greenhouse gas emissions were attributed to transport. Road traffic accounted for 17 % of the total, while other mobile sources (shipping, domestic air transport) accounted for 5 %. Emissions from the transport sector have increased slightly more than total emissions over the last few years despite being taxed fairly heavily. In 1999, CO₂ emissions from the transport sector were 23 % higher than in 1990 and 5 % higher than in 1998.

CO₂ emissions from the transport sector have risen by more than 20 % from 1990 to 1999, and this is related to the rise in transport volume and a shift to more energy-demanding modes of transport (more road and air traffic). In 1999, road traffic accounted for about 18 % of total Norwegian greenhouse gas emissions, coastal shipping for about 5 % and air traffic for about 3 %. The transport sector is expected to be responsible for a substantial proportion of the projected growth in emissions up to 2010.

Emissions of greenhouse gases are projected to rise by 22 % up to 2010 if present policies are continued and no new measures are implemented. Emissions of CO₂ have already risen by about 19 % since 1990 and the total projected rise up to 2010 is 36 %. (Norway's Third National Communication under the UNFCCC 2002).

Sweden

The population of Sweden was just under 8.9 million in 1999, having risen by approximately three per cent since 1990. The long-term rate of increase is expected to decline, however. Sweden has a low population density, with an average of 22 inhabitants per square kilometre. Nearly 85 per cent of the population live in urban areas; 65 per cent live in urban areas with over 10 000 inhabitants. The total surface area of Sweden, including lakes but excluding territorial waters, is 449 964 square kilometres, of which the land area is 410 934 square kilometres. The population is heavily concentrated in the southern provinces of Götaland and Svealand. The population is densest in Stockholm county, which has 275 people in square kilometre. The most sparsely populated areas are in Jämtland and Norrbotten counties in the north, where the density is about 3 people per square kilometre. Rural depopulation is a widespread trend; the population is growing most rapidly in the conurbations of the south.

Transport increased by approximately two per cent a year in 1990s. The structure of society, the way communities are planned, the location of homes and shopping centres, and so on, affect transport requirements and the scope for taking effective action to reduce greenhouse gas emissions. Swedish municipalities have overall responsibilities for local planning, although this is coordinated with regional and national plans. Urban

and regional planning is a key tool in the long term reduction of emissions, for example when it comes to siting residential areas and routing public transportation systems.

Increased traffic has resulted in an increase in total fuel consumption and hence emissions of greenhouse gases. An official aim of transport policy since the 1970s has been for all forms of transport to bear their external costs. Among other thing, there has been a desire to adjust the taxation of petrol and diesel to reflect the average marginal costs of cars in non-urban traffic. It is estimated that the present fuel taxes generally exceed these marginal costs, however. Sweden is investing to improve rail infrastructure. Rail traffic largely runs on electric energy generated from renewable fuels.

The transport sector accounts for about 29 % of Sweden's total greenhouse gas emissions. (Sweden's Third National Communication under the UNFCCC 2001).

Key urban trends

According to the 1995 joint ECMT/OECD report Urban Travel and Sustainable Development there are the following general trends (ECMT 2003):

- About three-quarters of the population of OECD/ECMT countries live in urban areas. Settlement patterns are becoming more complex characterised by a continuous "suburbanisation" of the population and of jobs.
- Travel by car has increased in almost all countries. This has been due to long-term annual increases of 2 to 3 % in national wealth, a general lowering in the real costs of using a car and the emergence of more car dependent life styles.
- Trip length both by car and public transport has increased as activities have become more dispersed. Suburb-to-suburb journeys have shown the fastest growth. At the same time there has been a shift from walking and cycling to motorised modes.
- Car ownership has conferred on a large and increasing public a freedom to travel anywhere at any time and enabled jobs, shops and services to relocate to peripheral areas. It has also allowed more people to enjoy living in more spacious surroundings.
- Industry has taken advantage of the freedom offered by road transport. The ease with which goods can be transported between almost any locations has allowed innovations such as "just-in-time" production and a reduction in warehousing facilities. Firms of all kinds have, at the same time, tended to move to edge-of-town sites to exploit the increased personal mobility of their car-owning customers and employees.
- Innovations in logistics, coupled with increases in the consumption of goods, have caused road freight traffic to grow at nearly 5% per annum over the last 20 years, even faster than car traffic (3.3% per annum).

These trends have had their consequences: increasing congestion, difficult and costly to serve fringe areas by public transport, areas without access to a car are becoming increasingly isolated from jobs and services, deaths and injuries on urban roads increase, road traffic dominate cities, road noise, air pollution, health problems, carbon dioxide emissions etc.

Trends in the last 5 years in the Nordic countries:

1. **Share of urban population is growing and urban sprawl is continuing.** In Western Europe some reversal in the trend appears to be emerging with residents and to a smaller extent employers being attracted back to city centres. Finland reports continued growth in urban populations. Norway reports the classic pattern of business and residents moving out of city centres into the suburbs creating sprawl in the 1970s and 1980s but notes an emerging change of preference for higher density housing closer to the city centres in the 1990s.
2. **Car ownership and use have almost universally continued to grow on a strongly increasing trend.** Car ownership still tends to be lowest in city centres where public transport is available and parking space is at a premium; it is highest in suburban areas poorly served by public transport. The costs of car ownership have continued to decline relative to incomes. Costs in real terms are now universally below historic highs. At the same time the average quality of passenger cars has improved in terms of comfort, durability and accessories, creating additional value for buyers and attraction for use over public transport. In Denmark car ownership is exceptionally low when considered with GNP.
3. **Public transport ridership is falling.** Trends vary markedly. In Finland the volume of passengers using public transport is stable although its share has declined slightly to around 20% of total passenger traffic. Norway saw a decline in ridership in its main cities in the first half of 1990s partly reversed in the second half in response to investment in public transport systems. Oslo accounted for much of the growth in ridership which reached 20% of total passenger traffic.
4. **Despite of promotion of walking and cycling their share tends to reduce.** Most countries probably show a tendency for people to replace short distance trips on foot or by bicycle with travel by car or on public transport trips for reasons of convenience. This trend of a reduction of the share of non-motorised movements is reported in the review of Norway. In Denmark the share of bicycle trips is big. In Finland the goal of the bicycle programme is to double the bicycle kilometreage by 2010.
5. **Congestion concentrates on major metropolitan areas.** Commuting and leisure journeys by car have lengthened, the number of short trips substituting for walking have increased, average speeds have risen whilst congestion is encountered more frequently. Finland reports success in avoiding congestion in Helsinki through provision of public transport that accounts for 70% of peak hour passenger traffic.
6. **All Nordic countries are among the top European countries concerning traffic safety,** in 2001 Norway was the best. Norway and Finland report fluctuating trends in the number of accidents and fatalities. In Norway, whilst the number of accidents and of injured persons decreased from 1995 to 2000 by 4% from an already low base, the number of people killed in traffic accidents increased by 11%.
7. **Air quality in built-up areas in all Nordic countries has improved** in recent decades on account of modern vehicle and fuel technology, in spite of the increase in traffic volumes. The long distance pollution from other countries accounts for an appreciable proportion of the air pollution concentration measured in Nordic countries on days when the norms are exceeded. CO₂ emissions were mostly not mentioned. There is clearly a role for national climate change programmes to make inroads in shaping urban transport policies – or perhaps conversely for national programmes to take fuller account of the action taken at the local level in urban areas.

8. **Traffic is the major source of noise in all Nordic countries**, especially in urban areas.

Urban sprawl

There are common trends in the Nordic countries. Urban sprawl continues but partially slower than before, need for land increases and urban land use per capita increases. This means increasing distances, increasing need for transport and increasing use of private cars.

In *Norway* urban sprawl continues but in a slower motion than earlier. The process of centralisation – increase of working places and inhabitants in the cities – increases the need for land. In addition, the pressure on land demand is being pushed forward by the fact that the land use per capita keeps growing. The land use per capita in the cities increased from 450 m² in 1970 to 550 m² in 1990. The biggest increase took place in the seventies, but still the process of land taking is moving faster than the growth of population in the cities. As a result the cities become larger in area and lower in density.

The urban sprawl leads to increased need for transport in general and by private car in particular. The total amount of journeys by private cars increased 74 % from 1980 to 2000. The number of trips by public transport is more or less unchanged in the same period of time. However, the major cities, especially Oslo, experienced a positive trend for the public transport during the nineties. Improvements of the public transport services are being regarded as the main reason for this.

In *Finland* the growth of urban regions is slowing down. While in the period 1980 – 1985 there were 17 urban regions (out of 33 urban regions) with an annual growth rate of over 1 % the similar growth rate in the period 1995 – 2000 was experienced by only seven urban regions. During the first half of 1980's there was only one urban region with declining population growth while the latter half of 1990's showed declining growth altogether for 11 urban regions.

One of the main features of urban regions in Finland is the relatively low population density. For example there is almost twice as much densely built land area per inhabitant in Finland as there is in Sweden. Moreover the consumption of densely built land area per inhabitant is still growing in Finland while in Sweden the situation is quite steady. In Finland one third (33.2 %) of densely built land area has been produced during the last 20 years (1980 – 2000). During the same period the population growth of the densely built areas was 23 %. From the year 1980 to the year 2000 the share of the population living in densely built areas grew from 71 % to 81 %. In the monitored 33 urban regions the last 20 years have shown that the amount of urban land (ie. densely built areas) has grown faster than the amount of population. This has meant decreasing population densities. (Ristimäki et al. 2003)

The growth of urban regions has taken place through the expansion of urban land area and only a part of population growth has taken place within the existing borders of densely built areas. There are however strong signs that the trend is changing. The share of population growth taking place within the borders of existing urban, densely built areas has been growing during the past ten years. This shift has occurred both in faster growing larger urban regions as well as in smaller urban regions of relatively high growthrate. They are mostly the declining or steady urban regions, where the expansion

of urban areas is still, at least in relative terms, highest. Especially the central areas of those regions are experiencing relatively fast population losses.

The expansive growth of urban regions has also led to increasing distances in urban agglomerations.

4 Instruments to develop urban areas and transportation

Policies and measures of national climate change strategies

Denmark

National action plans have been made to reduce greenhouse gas emissions. Reduction possibilities and costs of selected measures in transport sector have been estimated. The measures are increased fuel taxes, use of biofuels, motor vehicle taxes on lorries and private cars, discontinuation of mileage allowance and better freight transport logistics in towns.

Policies and measures to reduce greenhouse gas emissions in the transport sector are green owner tax on motor vehicles, information campaign on new car's fuel consumption, low-energy driving techniques, action for compliance with current speed limits, establishment of intermodal installations, promotion of public transport, promotion of use of bicycles, promotion of environment-friendly freight transport, promotion of company plans for road safety and environment, together with transport plans, reduced travelling time for public transport and physical planning. (Denmark's Third National Communication on Climate Change under the UNFCCC 2003)

Finland

The main principles of the Land Use and Building Act, i.e. economically efficient land use and settlement structure, economical use of natural resources and promotion of the functionality of settlements and good practices in building, contribute to the aims of climate change mitigation.

Policies and measures are, for example, research and development with the aim to increase knowledge in the area of information technology, logistics, interaction between land use and transport planning and Green Commuter Plans, fiscal measures with the aim to encourage purchase of low-consumption and energy-saving cars and to promote and subsidize public transport, regulatory measures to guide development of new agglomerations with the help of public transportation system plans and intention agreements with well-functioning public and non-motorized transport activities, voluntary energy saving agreements, information, education and motivation, such as eco-driving, campaigns aiming at awareness raising and changing transport behaviour.

Major policies and measures in the transport sector are voluntary agreements with the car industries, differentiation of vehicle taxation, promotion of public and non-motorised transport, eco-driving, energy-saving and transport and land use planning. (Finland's Third National Communication under the UNFCCC 2001)

Iceland

In the Icelandic climate policy changes in taxation creating incentives to use small diesel cars, increased research and development and increased emphasis on information and public awareness. In the current system owners of diesel cars pay a special tax

every year, depending on the weight of their vehicle. The owners have a choice of a fixed tax or a mileage tax. The proposed change aims at transferring the taxes into user charge tax for using diesel fuel. This change is expected to result in a transfer of around 10 % of current gasoline use to the diesel fuel and a corresponding decrease in greenhouse gas emission. Other measures in the government policy include review of import fees for vehicles to increase the share of energy-efficient vehicles, increased coordination of traffic lights, increased emphasis on short travel distances in physical planning of urban areas and improvement of public transportation systems. The Ministry of Finance will be responsible for implementing the change in taxation, and other policy measures related to the transport sector fall under the Ministry of Transport and Communication.

Implementation of some of the measures can only be achieved in cooperation with local governments. This is especially relevant to urban planning and improvement of public transportation systems. The participation in Local Agenda 21 has greatly increased the awareness of environmental issues, and many municipalities have integrated measures to cut greenhouse gas emissions in the transport sector in their planning. Reykjavik, with almost 40 % of the population, participates in ECTOS, an international hydrogen project, and SOPRA, an independent waste management firm owned by Reykjavik and six other municipalities, has been experimenting with using methane from landfills as a vehicle fuel. Akureyri, a municipality of 15 000 inhabitants, has in its municipal planning for 1998-2018 a goal of keeping greenhouse gas emissions from transport at the same level as in 2000. Increased emphasis on information and public awareness stresses on informing the public on options altering travel habits. (Iceland's Third National Communication under the UNFCCC 2003).

Norway

The first Norwegian measure that directly addressed greenhouse gas emissions, a tax on CO₂, was introduced in 1991.

In the transport sector, fiscal and CO₂ taxes on fuels provide the strongest incentive to limit emissions. The purchase tax also provides an incentive to buy lighter, more energy-efficient vehicles. There are extensive subsidies for public transport.

The Norwegian purchase tax on cars is one of the highest in the world, and has since 1996 been differentiated according to car weight, engine output and engine volume. Maximum speed limits are low by international standards, thus contributing to lower fuel consumption.

Subsidies for the expansion of public transport may under certain circumstances limit CO₂ emissions from the transport sector, but it is difficult to evaluate their net environmental effect. Norway has a long tradition of land-use planning based on legal instruments. The government put forward a white paper on this issue in spring 2002, which focused on coordinated land-use planning and environmentally friendly transport. Policies and measures should stimulate the use of bicycles and pedestrian transport. The effect of a given level of subsidies varies according to the strategies followed in the transport sector. The government gives high priority to public transport, especially railway transport. A special programme has been established to support the country's four largest towns in improving the infrastructure for public transport.

Bicycling is a cheap and environmentally friendly mode of transport. There is a potential for increased cycling in Norway. The Directorate for Public Roads is

developing a strategy for encouraging cycling to be presented in the next national transport plan. (Norway's Third National Communication under the UNFCCC 2002).

Sweden

Planning includes everything affecting built-up areas, land and water in a municipality. All Swedish municipalities must have a current general plan. The conservation provisions set forth in the Environmental Code must be given tangible form in the general plan. One example of this are areas for production and distribution of energy, transport and communications. A detailed plan is made for areas of a municipality that are to be changed or conserved in a certain way. Regional planning in Sweden is uncommon and non-binding. The way communities are planned, the siting of homes and shopping centres in relation to other activities and the extent to which an area is developed all have a great impact on the scope for organising public transport and reasonable cycleways to various workplaces and facilities, the development of district heating, the scope of building local heat distribution stations, transport distances for oil and biomass fuels, and from any other factor that have an impact on carbon dioxide emissions.

Taxes and charges play a central part as a means of achieving the objectives of energy and climate policy. The tax burden on energy consumption has been raised while that on labour is being eased; there is also a shift in the tax emphasis between energy tax and carbon dioxide tax.

An official aim of transport policy since the 1970s has been for all forms of transport to bear their external costs. Among other things, there has been a desire to adjust the taxation of petrol and diesel to reflect the average marginal cost of cars in non-urban traffic. It is estimated that current fuel taxes generally exceed these marginal costs, however. Sweden is investing to improve rail infrastructure, in particular by removing bottlenecks in three main cities. Rail traffic largely runs on electric energy generated from renewable fuels. Efforts to reduce emissions from road traffic include training courses in "Ecodriving" and procurement of ethanol/petrol-driven hybrid vehicles.

An express aim of housing policy is sustainable housing sector and social planning. Urban and regional planning is a key tool in the long-term reduction of emissions, for example when it comes to siting residential areas and routing public transport systems.

Examples of important measures and instruments are energy and carbon dioxide taxes, conversion from electric heating to district heating, information, education etc.

Direct heating is only permitted if the building in question uses 40 per cent less energy for heating than buildings heated by other means. The measures and instruments considered to have the greatest impact in the field of transport policy are economic instruments that can be used to influence technological development, transport demand and choice of mode of transport. Instruments are increased investment in railway infrastructure, research and development projects relating to the transport system, quality assurance of transport services, "sparsam körning" and Ecodriving, joint programme for development of more environmentally compatible vehicles, and procurement of ethanol-petrol flexible fuel cars. (Sweden's Third National Communication under the UNFCCC 2001).

Land use and transportation planning

Land Use, Planning and Building Acts, national objectives and other regulations guide and control planning. They have many objectives which are supposed to promote sustainable development. Planning systems include zoning and transportation system plans on different geographical levels (international, national, regional and local).

Certain principles are in many countries regarded as good for sustainability, many of them based on research results.

Integration or infill of the urban form is to be taken as the starting point on all land use planning levels. The possibilities for supplementary building in already built-up areas are examined. New areas are located in proximity to existing areas with good public transport facilities, especially rail services. Most important services are located within easy walking distance or accessible by public transport.

Land use planning aims to keep distances between various activities as short as possible. Housing, work places and services, as well as local recreational areas, are situated close to one another.

Large shopping units are located in city centres or areas with good public transport.

The general objective of land use and transport planning is to maximize the modal share achieved by walking, cycling and public transport together. Public transport is promoted by a good and comprehensive standard of service, a rapid network, ease and comfort in use, as well as inexpensive fares. Walking and cycling are promoted with developing network of tracks and by making the surroundings attractive. Providing pedestrian precincts in central areas creates favorable conditions for comfortable urban living.

Car traffic can be reduced by traffic pricing, parking policies, car sharing, company bicycles, transportation telematics, teleworking, telepresence, taxation politics, removing or restricting tax deductions for commuting and company cars, by applying polluter pays-principle to infrastructure, by real estate and fuel taxes and by applying determined land policy.

More integrated land-use and transport planning is considered to be necessary.

Examples from Finland

The new Land Use and Building Act came into force on 1 January 2000. The main aims of the new act are to create a sustainable basis for the development of communities, to improve public participation in area development, to delegate decision-making to local authorities, and to improve building quality.

The new system has three levels of land use plan: the regional land use plan, the local master plan and the local detailed plan. In addition, the government defines national land use goals which are supervised by a central government or regional environmental authority when implemented in land use planning. The goals may apply to regional structure, quality of the living environment, infrastructure, ecological sustainability and natural and cultural heritage of national importance.

New commercial premises greater than 2 000 square metres receive a building permit only when the site is specially designated for that purpose in the town plan. The new Act emphasises matters related to community structure and the availability of services. One of the aims is to control the location of hypermarkets better than at present.

The aim of land use planning is to promote the following aims, on a basis of interactive planning and adequate impact assessment:

1. Creation of a safe, healthy, pleasant and socially well-functioning living and working environment that meets the needs of various population groups, such as children, elderly and disabled;
2. Economic community structures and land use;
3. Beautiful built environment and the fostering of cultural values;
4. Preservation of biodiversity and other natural values;
5. Environmental conservation and the prevention of environmental hazards;
6. Economical use of natural resources;
7. Well-functioning communities and good construction;
8. Economy in infrastructure building;
9. Proper preconditions for business and industry;
10. Accessible services; and
11. Practical traffic arrangements, specifically with good preconditions for public transport and non-vehicular traffic.

The aim in developing town centres is to increase their attraction as shopping and housing areas by improving the townscape, functionality and reducing the harmful effects of traffic. Various types of development projects have been initiated in cooperation with shopkeepers, property owners and local residents. Lively pedestrian areas with open-air cafés have been built, and networks of cycle routes.

There has been some opposition to the building of pedestrian streets because of the long cold winter and the threat of falling sales. However, there has been a favourable reaction to the pedestrian areas that have been built and outdoor life in Finland has become livelier in summertime. Converting old industrial and harbour areas and railway yards to residential use has also helped the revival of inner city areas in many towns.

One of the unusual things about building suburbs in Finland, compared with the rest of Europe, is the attempt that has been made to mix different population groups. Instead of areas of solely rental housing, housing with a wide variety of different types of tenure has been built. This has presumably acted as a balancing factor in reducing tendencies towards social segregation. Research has shown that there is some polarisation, but no perceptible deterioration into slums. The main challenge in improving Finnish suburbs is to prevent segregation.

One of the problems in suburbs, as in other housing areas, has been the concentration of services, particularly shopping, which has led to the closure of local shops at an alarming rate. Other detrimental effects include increasing car dependency, traffic growth and increasing environmental impacts. When the suburbs were originally planned, the aim in their design and dimensioning was to form self-sufficient units where basic services would be within walking distance. Now, however, their population base is sometimes insufficient to keep the local shops in business. (Ministry of the Environment, <http://www.environment.fi>)

Case Kuopio, Finland

Kuopio is an intermediate city of 90 000 inhabitants and the regional centre of Eastern Finland. The city has its location on narrow necks of land surrounded by lakes. For several decades the growth of the city has been directed according to structure plans, which have been the basis of master- and detailed plans. Relatively compact urban

structure of the city is based on goal oriented land use planning as well as determined land policy. Effective networks and a comprehensive network of green areas are important elements of the urban fabric. Effective street network, comprehensive network of bicycle routes and good level of bus transit are based on integrated land-use and transport planning.

New areas have been located in proximity to existing areas. Most of the services are within easy walking distance or can be reached by bus. Land use planning aims to keep distances between various activities as short as possible. Housing, work places and services, as well as local recreational areas, are situated close to one another.

In addition to these common goals of urban planning, Kuopio has for last ten years applied also some own special principles patterns in its planning.

City patterns of Kuopio

Urban sprawl has been considered as the major negative consequence of the Car City development and one of the main problems to deal with. Stopping the urban sprawl by imposing restrictions has turned out to be an unrealistic target, at least within a short period. So the major aim of Kuopio has been to promote and develop positive alternatives, which could balance the urban sprawl and help preventing it. The alternatives have been based on the patterns of the Walking City and the Transit City (figure 13).

Figure 13. City patterns (Kosonen 2003).

The alternative strategy has a compact form in the “Finger Model” of Kuopio. (figure 14). The “Finger Model” is a combination of the Inner City and the fingers, which consist of chains of neighbourhoods that spread outside the Inner City. It defines the parts of the city where citizens can now and in the future manage with only one car or even without a car. One of the main objectives of the Finger Model is to maximize the modal share of walking, cycling and public transport.

The Inner City

The major pattern of the Inner City is the Walking City Pattern, even if the layers of the Transit City and the Car City have their own important role in the City Center.

The market square is the core of the City Center with main bus stops and effective parking facilities under the square. Pedestrianization of the City Center has been one of the main topics during the latest decade.

The housing area surrounding the City Center has been developed according to the Walking City Pattern. Network of small streets, which dates from the 18th century and covers most of the Inner City, is under process of renovation and has become an extensive network of comfortable pedestrian paths. New supplementary housing construction has been promoted. Parking standard of the housing blocks has been lowered and parking standard for bicycles has been applied. The car density is low, 320 cars/1000 inhabitants, and it is not expected to increase.

Figure 14. City patterns of the City of Kuopio (Kosonen 2003). Walking city, zones 1 and 2, transit city, zone 3 and car city, zone 4.

Urban area outside the Inner City

The urban area outside the Inner City is a combination of the “Fingers” and the housing areas surrounding the fingers. The Fingers consist of neighbourhoods and housing blocks, which have relatively high population density and low car density. The surrounding housing areas are mainly detached homes and have low population density and high car density.

The fingers are developed on the basis of the Transit City pattern. According to the Transit City pattern each finger should have at least 4 000 inhabitants to maintain good level of bus transit and also own local services. Distance to adequate bus stops should not be longer than 250 m. One of the main attempts in planning of these neighbourhoods has been to mix different population groups. Instead of areas of solely rental housing, each neighbourhood has housing with a wide variety of building types and different types of tenure. This has presumably acted as a balancing factor in reducing tendencies towards social segregation.

The low density housing areas are manifesting the Car City pattern. The car density is high, 440 cars/1000 inhabitants, and it is expected to increase. On the other hand many of these areas have relatively good bus transit, because they are well combined with the dense structure of the fingers (combined Transit City and Car City Pattern).

Examples

One of the existing “fingers” has lately been an object of the development projects. The environment of the existing small neighbourhood of 2 500 inhabitants (Särkiniemi) has been renovated in a good cooperation with the residents. A supplementary housing project for 1 300 new residents has been implemented in the vicinity. The new area (Särkilahti) has been combined to the existing neighbourhood with a special bridge (figure 15). The bridge is mainly for pedestrians and cyclists, but also for the local bus, which instead of 30 minutes now drives every 15 minutes through the neighbourhood, along the bridge to the new area and back.

The finger model and the Transit City pattern are promoted also on the growth areas of the city. Kuopio is planning and implementing a district (District of Islands), which consists of a chain of new neighbourhoods for 10 000 inhabitants. A new special street (Street of Islands, figure 16) will connect the new district directly to the city center. It promotes cycling and bus transit and integrates the southern parts of the existing urban area with the Inner City. The street will cross a lake and pass several small islands. Because of the beautiful landscape the street has been designed for slow driving. It includes a good path for cyclists and pedestrians. The street will shorten the distances remarkably. A study of economic and ecological impacts (Halme & Harmaajärvi 2003) showed that the greenhouse gas emissions of the new District of Islands will be substantially lower compared with the alternative urban structure without the Street of Islands (figure 17). (Kosonen 2003)

Figure 15. The Särkilahti Bridge, the City of Kuopio.

Figure 16. The Street of Islands, illustration, the City of Kuopio.

Figure17. Greenhouse gas emissions of town structure alternatives of the City of Kuopio. (Halme & Harmaajärvi 2003)

Examples from Norway

The most significant instruments being used in order to control development of urban form and transportation is land use planning, transport planning and taxation.

There are yet no taxes in Norway being specifically designed to control urban form. High taxes on cars and fuels, however, effect the development of transportation in general, also in city areas.

The most important tool for implementing the land-use policy is the Planning and Building Act. The Government and the Storting define national objectives, while municipal and county authorities develop overall solutions on the basis of local conditions and potential. The Planning and Building Act requires each county to prepare County plans, indicating the main features of the land use pattern and the investment program in the county. County plans are meant to give directions to planning of the municipalities, but they are currently not legally binding or connected to the investment budgets for transport. Each municipality is required to prepare a plan – the Municipal Master Plan consisting of a long term and a short-term part. The land related part of the Municipal Master Plan has direct effect in law.

A set of National Policy Guidelines for Co-ordinated Land Use and Transport Planning were adopted in 1993. The purpose of these planning guidelines is to achieve better co-ordination between land use and transport planning both in the municipalities and across municipalities, sectors and different institutional levels. The guidelines which are now being revised, consist of three elements:

- National objectives of importance for land-use and transport planning.
- Practical guidelines on how to achieve more integrated land-use and transport planning within a long-term sustainable perspective.

- Guidelines for interaction between involved agencies and responsibility for implementation.

The development of shopping malls along the main road system outside towns and cities have been regarded as a barrier for achieving national objectives related to sustainable urban development. Shopping malls outside town or city agglomerations are believed to stimulate car transport and weaken existing town and city centres. Therefore, the Government in 1999 adopted a temporary ban of the construction of new shopping malls outside city centres.

The basis of the transport policy is outlined in the national transport plans. The National Transport Plan (NTP) formulates a differentiated policy for national transport corridors, rural areas and urban areas. The plan is however limited to national measures within the transport sector and covers the whole country, cities included.

Lack of coordination between transport planning and land use planning in general and between national and local transport planning have for decades being regarded as a major challenge in order to control development of urban form and transportation.

Coordinated investment plans for the major cities have lead to substantial improvements for the public transport infrastructure which is one important reason for the positive trend for the public transport especially in the area of Oslo.

“Oslo-package 1”

In the Oslo area the so-called “Oslo-package 1”, an overall plan for investments in road infrastructure in the period 1990-2007, is under implementation. The purpose of the plan is to finance the main road development in the city area of Oslo, and the original plan covers 50 road projects over the period. It is financed over the state budget by 45 % and revenues from the existing toll ring by 55 %. Besides financing the road infrastructure, 20 % of the available funds are to be used for public transport infrastructure. The total investments of “Oslo package 1” are stipulated to approximately 28 billion kroner (1999-value) for the whole period 1990-2007. The toll collection period will be terminated at the end of the year 2007.

“Oslo-package 2”

The next step, the so-called “Oslo-package 2” involves a package of measures to develop the public transport infrastructure in the larger Oslo area, surrounding municipalities included. It involves the co-operation of local and state authorities. The “Oslo-package 2 ” includes among others development of the railway system and subways system. The package is planned financed by the existing toll ring, additional charge of the public transport tickets, the state budget and the budget of local authorities. The Ministry of Transport and Communications proposed the economic frames for “Oslo-package 2” in the National Transport Plan 2002-2011 and holds 11 billion kroner as the financial frame for “Oslo-package 2” for the period 2002-2011.

Packages of measures are also under ways in other urban areas, as for instance the Bergen and Stavanger areas.

Alternative use of State allocations and toll road revenues on classified roads

The Storting has decided that State allocations on national roads and revenues from toll road projects can be used for developing other parts of the transport system such as rail projects, local- and county-roads, parking grounds, terminals and shelters. This so called

alternative use of state funding and toll road revenues provides documentation which proves that such projects will mean more efficient use of resources than investments in classified roads.

Alternative use of State allocations and toll road revenues have only been applied to a limited extent, except for the Oslo-area. The Ministry of Transport and Communications attaches importance to comply with local wishes for spending these allocations on public transport purposes.

Furthermore, the Ministry of Transport and Communications has since 1991 given distinct grants to the development of public transport infrastructure in the four largest city areas. Experiences from these arrangements have shown improved conditions for better co-ordination of public transport system in city areas, primarily because financial resources can be allocated freely between administrative levels.

Public transport has for some years been a priority area in Norway in the budget programmes. Increased funding of public transport companies including railways services together with financial support of infrastructure investments have contributed to a positive trend for the public transport following a negative trend especially in the eighties. This again is important to control urban form and reduce urban sprawl.

New Organisation

By the initiative of the Ministry of Transport and Communications, four major cities in Norway (Bergen, Trondheim, Stavanger and Kristiansand) has accepted an invitation to participate in studies and preparations in order to implement changes in the current organisational structure within the transport policy system in these cities. The objective is to improve the decision making process by considering the complete transport system as a whole - road and public transport - and to put local authorities in charge for many of the resources within the full sector.

By giving local authorities the necessary resources, we assume that the quality of the services offered to the travellers will be improved, especially public transport services. This will on the other hand in the long run also depend on the ability of local authorities to implement land-use-planning, and various local traffic-regulating measures in order to regulate the use of the private automobile.

On the same background the four counties covering the capital area of Oslo have established a new co-operation unit in order to co-ordinate the planning of public transport within the area. In the long run one the new unit is supposed to gather the responsibility for organising and planning, buying etc. all public transport services within the area including railways. To day this responsibility is divided between four different counties and the state. This again, will make it easier to control urban form in the long run as the co-ordination of transport policies and land use will become more feasible.

The introduction of an incentive-based state funding system

The Norwegian Government will from 2004 introduce an incentive-based state funding system which will reward local authorities in larger cities who implement measures that encourage increased use of public transportation.

Regional Spatial Plan, Jaeren

The plan includes 10 municipalities and 250 000 inhabitants. Jaeren is the third largest city region in Norway. Population growth has been of 1 - 1.5 % yearly over the last decades.

Municipalities have had continuous difficulties of finding expansion areas in their master plans. Businesses have not been localised according to co-ordinated plan. Transport growth has been 3 - 5% pr. year - only 7% of travels are public transport.

Jaeren is one of Norway's most important agricultural districts, there are important areas for nature conservation (especially wetlands), high density of cultural heritage sites (stone age to Viking) and lack of nearby recreational areas.

A comprehensive regional plan for long term urban development has been made in the Stavanger region (called Jaeren). It is a holistic plan to increase amount of environmentally sustainable transport and prevent urban sprawl.

Town and city centres must be strengthened - both jobs and housing. Additional development is located along linear structures across municipal boundaries. More city transformation as infill-development and use of brownfield areas for several reasons: to protect areas for agriculture and environment, increase the relative number of small household residences, to support the possibilities of environmentally friendly transport to education, work, leisure, to contribute to an aesthetic and environmental upgrade of city zones. Long term time frame is necessary (40 years) to elucidate the basis for long term infrastructure and main development directions. (Figure 18)

Figure 18. Regional spatial plan of Jaeren. (Froeyland Pallesen 2002)

Figure 19. Railway transport network. (Froeyland Pallesen 2002)

Long term plan is combined with short term (10 year) joint action program for development of transport system financed by state, county, municipalities and road toll collection. Program has an environmental profile: Minimum 50% of investment budget to purposes other than road (public transport, cycle ways, noise protection etc.).

Public transport network is restructured - fewer routes with high frequency (corresponding with development axes). Train and light rail system are to be developed as the backbone of public transport in the main city structure. Double rail Stavanger - Sandnes is the first step. (Figure 19)

Guidelines are made for localisation of larger enterprises (high number of jobs or high level of service) along main public transport lines. (Figure 20)

Regional green structure is defined (contains both agricultural land and natural areas) - to be developed for recreational use. Norm: Residences should not have more than 500m to minimum 3 km hiking track/ cycle way. Long term boundaries for agricultural areas are defined. (Figure 21)

Figure 20 (on the left). Guidelines for localisation of larger enterprises (high number of jobs or high level of service) along main public transport lines. Figure 21 (on the right). Regional green structure defined. (Froeyland Pallesen 2002)

The political and administrative organisation has been an important factor. Political steering group: County Council Chairman, leader, County politicians, Municipality Mayors, 1 opposition politician (Stavanger). - Administrative project group: High level civil servants from: County Council, Regional state agencies, Municipalities.

Planning process based on consensus - if disagreement alternatives have been prepared for hearing - final resolution by County Council and approved by Ministry of Environment (and cabinet). Open process with continuous public information - deal with main newspaper that gave step by step presentations. Clear signals from Ministry

of Environment and Ministry of Agriculture to Stavanger and Sandnes: Probably no approval of Municipality plan before integrated in Regional (County part) plan.

Follow up action: Government expects reporting system to describe municipalities implementation on:

- Land use according to zoning categories in the regional plan
- Number of residences by category
- Density in residential areas
- Distance to main public transport lines and centers
- Implementation of long term regional infrastructure in master plans
- Enforcement of localising guidelines
- Boundaries of centres (legally binding)
- Parking policies
- Implementation of regional green structure in master plan
- Long term boundaries for agriculture in master plan
- Implementation of energy plans

Yearly report to Ministries, County Council and Municipality Councils. Basis for need for revision.

Challenges for implementation:

- Central government must be a more reliable partner for development of infrastructure
- County level need stronger measures (economic and legally) in partnership for implementation
- Municipalities must show loyalty to the plan (very good so far - one exception)
- Central government must develop bylaws for development of regional (not only municipal) parking policy
- Central government must develop incentives to stimulate environmentally friendly transport
- Road pricing must be considered for long term financing of sustainable transport system. (Per Froeyland Pallesen 2002)

Climate strategies for cities

Many Nordic cities have established or will establish climate strategies. They cover all the sectors of municipalities. For example the Oslo region in Norway and cities of Kuopio, Jyväskylä and Kotka in Finland have developed climate strategies.

In the climate and energy strategy for Oslo region climate change and the Kyoto commitment in different countries as well as development of greenhouse gas emissions in Oslo region are described and scenarios are made for the future development for the trend, stabilizing and long term sustainability for 2030. The total increase of greenhouse gas emissions from transport is supposed to be 25 % from 1997 to 2010 according to the trend scenario, according to the stabilizing scenario emissions will be 10 % lower than in the trend scenario in 2010 and 15 % higher than in 1997, and according to the long term scenario emissions from transport will be 30 % lower than in the trend scenario in 2010, and 5 % lower than in 1997.

In the climate strategy for City of Kuopio the present situation and development projections have been described and goals and means to reduce greenhouse gas emissions have been defined in different sectors: energy production, energy

consumption of buildings, land use and transportation, services and purchase, waste management and agriculture and forestry. According to the climate strategy the share of greenhouse gas emissions from road traffic was 12 % in 2001. Traffic kilometrage is supposed to increase in the near future. In land use planning the aim is to emphasize control of increase of car traffic and secure prerequisites of public transport. Town structure is maintained compact and land use planning follows the finger model.

Large shopping malls

Problems of large shopping malls are described with an example from Sweden (Carlsson 2003). External trade establishments – especially those selling everyday commodities– have been questioned ever since they were first established in Europe in the early 1960s. Since then, criticism has been about employment in retail trade, the supply of everyday commodities in residential areas and the vitality of city centre, and the accessibility to service, especially by weak groups, such as the disabled, young people and elderly people. In more recent years, the environmental questions have come to the forefront, like increased travel by car and thus increased pollution and emissions of greenhouse gases. City centres and increased car travel are especially at the centre of debate.

The Swedish retail trade structure has changed a lot during the last 50 years. The number of stores selling everyday commodities has decreased by 80% since 1950. The total of 39 000 stores had fallen to 7 000 by 1997. The number of stores selling infrequently purchased goods fell by 20 percent during the same period. Small retail companies have had to give way to large, low price stores and chains of stores, with higher turnover and fewer employees.

Sweden's first external retail store is opened in Malmö in 1962. In 1980, there were 40 hypermarkets in Sweden, and they were responsible for 5% of the retail trade in everyday commodities. Twenty years later, in the year 2000, there were 89 hypermarkets, and they were responsible for 12% of the retail trade in everyday commodities. External trade is not as extensive as one might think. Perhaps a bigger problem is that, according to the Swedish National Rural Agency, 300 villages lost their last grocery store between 1996 and 2000.

Some reasons for the changes may be that large parts of the housing construction carried out in the “million programme of 1965-1975” (a plan to build 1 000 000 dwellings in Sweden over a 10 year period) were based on the neighbourhood concept, giving some base for shops and other services, such as schools, post offices, day-care nurseries. A great deal of the Swedish housing stock thus ended up in ready-planned areas, with minimum flexibility for surviving change over time. It is always difficult to increase concentration in existing, established areas. When the children grew up and left their parental homes in the 1980s, the populations within these areas declined. This meant that the base that had been present for shops in the housing areas was reduced. The standard of housing improved. The number of rooms per person has increased from 1.2 to 2.1 during the last 30 years. This was due both to people moving out, a better economy, and increased living standards generally. Improvement in storage, in the form of refrigerators and freezers has meant larger and fewer purchases. The number of cars has increased from about 200 000 in 1950 to 4 000 000 in the year 2000. This increase in car ownership means that consumers are more mobile. More women are gainfully employed – households have less time to do shopping.

In addition in Sweden, the endeavours of companies to maximise profits through rationalisation and efficiency has led to three company groups now being responsible for 90 % of the retail trade in everyday commodities. They are: ICA, KF and Axfood.

“Trade plans” for the future

The trade has no plans but each company has. In 2001, 59 of Sweden’s municipalities had plans for the establishment of external trade. 14 of the country’s largest municipalities had plans for continued expansion of external trade. 49% of municipalities have external or semi-external establishments, i.e. 142 municipalities of the total of 290.

Retail trade in towns and cities is, of course, affected by the establishment of external centres. Surveys have shown that the effect on city centre is often moderate. Retail sales of everyday commodities in city trade declined by 10%. In other localities, retail sales declined by 12%. Retail trade in infrequently purchased goods has had its centre of gravity in city centre for a long time, and is not affected in the centre to any great extent. Establishments can also have an effect on trade in adjacent population centres that do not have external trade of their own.

City centre trade

The central parts of towns and cities are important places for their inhabitants. They have the cultural institutions, public administration and offices. They have shops, housing, cinemas and other meeting places such as restaurants, hotels, etc.

If you want to retain a living centre in a town or city, a balance is required between external trade and centre trade. Establishments must not be permitted to get so big that they out-compete city trade. But this is not enough.

Co-operation between active public administration, the retail trade and property owners is important. Having all parties co-operate for an attractive town or city - a town or city for everyone. There are many examples of towns and cities which have managed to develop their central areas by means of active work.

The latest example is the city of Helsingborg in Skåne, in southern Sweden, which in 2003 won an award from the Swedish Association of Town Centre Management for the development of its centre.

The impact on town and city quarters and on housing areas

The effect of external establishments on town and city quarters and on housing areas is greater. Existing everyday commodity stores, with a declining customer base on account of reduced residential population density, do not survive competition in the long run, and must change their range or close. In the same way, there are consequences for other service institutions.

Large everyday commodity stores, which have a substantial inflow of customers by car from adjacent town and city areas, are subjected to severe competition when external trade is established.

Many customers have been left with a greater distance to go to the shops when the customer base becomes too small. This also means that the distance to satisfactory service increases, and the tendency to use the car for shopping and other errands increases. When you want to use the car for shopping, you can decide to go further, especially if you can reach a larger range. Those who cannot use transport themselves

must use a mobility service or other assistance to make their purchases, thus imposing costs, either on the individual or on society.

Impacts on travel

Travel increases when external trade is established in a new place. Various surveys show figures of between one percent and one thousand percent in connection with the first external trade establishment. When the next establishment arrives, the changes are not as dramatic, as then people choose to travel to the establishment that is closest to them.

The most important change is that people choose to travel by car to make their purchases, rather than walking or cycling to the shops and they make longer trips. A before and after study of six towns and cities, in which external trade was established, showed that those who changed their prime shopping location to a store in the new external centre, an average of 29 percent, increased the distance they drove by between 4.9 and 17.6 kilometres per shopping trip.

The argument that goods transport was more efficient does not compensate for the increased travel undertaken by the customers.

Establishment of external trade

There is already a general requirement in the Planning and Building Act for impact assessments for such things as the establishment of external centre. Some municipalities produce policy documents that show how they see the development of such trade, but only half of those municipalities which have external or semi-external shopping centres have dealt with the question in their comprehensive planning. The impacts as regards traffic are badly researched or not discussed at all.

General trends of shopping in Sweden

- Developments up until now have, to a high degree, been controlled by the trade, sometimes with active support from municipal decision makers.
- The centre of the town or city often manages to compete, and with active co-operation the centre can be developed favourably.
- More and more stores have been established in external or semi-external positions, with good connections to the road network.
- For consumers without access to a car, service shops or filling stations that sell groceries have become the alternative, often at higher prices.
- Legislation and practice have not managed to master the effects that the development of the trade has involved.
- External trade is often a factor used for attracting employment opportunities and expansion, in competition with neighbouring municipalities, while the negative effects are seldom taken into account.

A way to achieve a long-term, sustainable society

If we want to develop a long-term, sustainable society, we cannot accept that private car travel increases for work, services and buying everyday commodities, nor can we accept that weak groups become disadvantaged.

As regards travel with cars, developments on the fuel side can certainly improve the situation, but revolutionary changes are needed to improve the whole situation especially for the weak consumer groups.

A change in social planning is necessary

The effects of increased traffic load caused by external business establishments, as researched and established so far, contrast strongly with the national traffic-political objectives for reduced traffic load and reduced emissions of exhaust gases. They also contrast with the goals on development planning to promote good environment. The lack of co-ordination at regional level is also evident.

Community planning must be directed at communities with higher population densities. It must be possible to travel to work and services with public transport or with the services being within walking or cycling distance. With the support of planning, society must be able to offer locations to trade in which the local environment is so attractive that people choose to make their purchases and their service close to home.

At present, municipalities can decide when, where and how external trade may build, by means of their planning monopoly. In Sweden, this planning monopoly, means that the municipalities have a very strong position.

The counties (the State) may only intervene if co-ordination with other municipalities has not been carried out in an appropriate manner, or if environmental quality norms, according to the Environmental Code, have not been taken into account. Experience has shown that the county administrative boards have been very restrained with such intervention.

In Sweden, the Planning and Building Act applies to physical planning. As regards questions such as the development of retail trade, changes in legislation are needed, both at municipal level and at regional level, where legislation is, at present, very weak.

We, who work to achieve transport-political goals and goals for development planning that promote good environment, look forward to the results of the Planning and Building Act inquiry that has been set up. We are very aware that this will not be enough, but that for us to succeed, broad input is required from many parties, both in legislation, physical planning, and in active influence on citizens and the business community. (Carlsson 2003)

Promoting cycling

An example of promoting cycling is introduced from Denmark (www.cyclecity.dk). The Traffic Ministry of Denmark has selected Odense as Denmarks National Cycle City. By monitoring other cycle cities around the world the general pattern seems to be divided into three steps:

- 1) Establish rights for cyclists, e.g. by allowing cyclists to cycle in both directions on a one-way street.
- 2) Make room for cyclists, e.g. by building new cycle paths for the cyclists.
- 3) Take action to heighten the awareness for cycling, e.g. by launching campaigns for childrens' mode of transport.

To get a more complete strategy we chose to divide the entire project into these five (plus one) elements: Home, where the journey is planned and where it starts. It includes

the physical surroundings. Man, the person who decides where to go, when and by what. It includes your family and your neighbours. Horse, the means of transport that brings you from A to B. It includes the quality of the bike and what kind of equipment it has. Road, the infrastructure which is provided for your journey. It includes the cycle facilities and the rules made for cyclists. Field, the workplaces and the institutions of education. It includes the conditions which the employer offers the cyclists. Information, a complete strategy to communicate the experiences from the project to the citizens and to other cities with interest in the subject.

Action Planning is the key word of the strategy. We are working towards establishing a close contact to citizens in general, and especially to employers and employees. People need to be directly confronted with the issue of cycling. Brochures are not enough to change daily transportation habits. The Cycle City Project is divided into 60 different sub-projects. In the following text a few of the sub-projects are underlined as good examples of action planning for more cyclists in Odense.

Trailers for children are well-known in Denmark, although only a very few people have yet tried it themselves. Trailers give good training for the parents and show a good role model for the children to become cyclists too. New statistics from the university hospital of Odense show that there has only been registered one single traffic accident with a trailer for children during the last four years. This accident happened without other road users involved, and the child only fell out of the trailer because she wasn't fixed with the safety belt. So the trailer is a healthy and a safe offer for new parents. An extra advantage is that you can carry two children plus some luggage without major problems.

That is the reason why we are offering all parents with children in kindergartens to borrow the trailer for free for one week. This involves in total 7500 parents. 10 trailers were sponsored by the manufacturers, and each trailer goes to a kindergarten for 2-3 months in turn. One employee is responsible for instructing the parents. All work concerning moving the trailers from one kindergarten to another and repairs is taken care of by a team of young people from a job creation project. Parents who might want to buy a trailer afterwards are being offered a supplementary gift from the cycle shop.

Day-care institutions are invited to join the *campaign RIT*. To take part in the contest parents have to bring their children to the institution by bicycle or on foot as often as possible. For each trip done by bicycle or on foot the child receives a raffle ticket for the lottery. The more tickets the higher chance to win the price. The mascot "Anton" (a duck) characterises the campaign. He visits the institutions and inspires the children to cycle. In 2001 RIT was held for the first time, over 3.100 children from 54 day-care institutions participated. 12.000 bicycle rides were taken during the two weeks long campaign.

The 12 and 13 years old *schoolchildren* from Odense can participate in the cycle campaign *Freewheeling*. Freewheeling is a team contest where classes compete to obtain the highest number of kilometres done by bike to school or in spare time. The reason why Odense focuses on children and cycle campaigns is to show how lovely it is to ride a bicycle.

To encourage cycling in general, various *arrangements* are held for the citizens. The topic is usually about cycle holidays, which is a very popular theme. There have been five lectures with full house. The arrangements are all free and people are offered

snacks, etc. Furthermore, there has been one guided tour to a nature district where free roast lamb was offered.

Each year a *bike festival* is held at the town hall square. Normally, it is on a Saturday in May. The purpose is to show the public good examples of new quality bikes. Only bikes costing a minimum of Euro 400,- are allowed at the festival. Besides normal bikes, also special bikes are invited on the day. The arrangement is marketed by advertising and by a contest among the shop owners. They are encouraged to include the bike in the show window the week before the arrangement. The best exhibition is given a prize. Everybody who comes to the festival takes part in a contest to win several bikes. In the long term we hope that more people will buy a bike. And we hope that in general it will be better quality bikes. Because, as with cars, good and new bikes might be used more frequently than old ones.

The *Bike to Work Campaign* was launched in Denmark in 2002 for the fifth time. It is held in a four week period in the spring where people are supposed to use their bike to work at least half of the time. Your chances of winning the prizes depend on how many participants you are and how many trips you are travelling by bike. In that way the campaign is encouraging you to cycle more.

In Odense a special local effort were made to have more participants. Second to Copenhagen Odense is the most active city, and the number of cyclists in the contest has increased from 4000 the first year to 9000 the third year. Locally direct mails were sent to 2000 workplaces with at least 5 employed, and sent posters, etc. Special pins were made for the cyclists to wear. A special pin patrol was sent out to search for these pins on the streets and in the workplaces. All cyclists found wearing this pin were given gifts! After the campaign, people could propose somebody who they felt should be the cyclist of the year. The winner was pleased to receive flowers and a brand new bike.

It is very important for cyclists that the roads and the cycle paths are *maintained* well. Interviews conducted amongst Danish cyclists show this as being one of the most important issues in order to encourage more cyclists and to keep them happy as cyclists. As one initiative a contest was organized calling for the worst cycle path in town. The winner got a new asphalt layer on the path and a free holiday for two to Provence - on bikes. We got 150 proposals and one happy winner.

It is very important for the whole project to become visible in the daily life in Odense. That's why *marketing* is an important element, which has to be included at every possible opportunity. The first important step was to get a nice, clear logo to profile the project. It is now in use in several situations. Letters from the Park and Roads Administration are now written on the special stationery, no matter what the subject is. Every household has been sent the new cycle map, and each of the annual 5000 new inhabitants in the municipality will receive a map as their first welcome. In spring a lifestyle magazine is forwarded to each household in Odense. The magazine contains information about the many initiatives and projects within cycling in Odense. The press is treated with special care to ensure that every story gets as much publicity as it deserves. Main stories are planned to be "sold" to the national news. Cycle equipment with the logo printed on is used a great deal as gifts in the project, such as cycle lights, T-shirts, sweets, etc.

It is possible to arrive at green light every time in a specific traffic light in Odense. To guide the cyclists, Odense has developed a 'running light' that makes a *green wave*. It is

the first of its kind. The idea behind "the green wave" is to give the cyclist some priority in traffic and to make travelling more comfortable.

Odense offers the citizens a number of *parking facilities*. People who commute to or from Odense day-to-day, can use the lock-up cycle parking in the old railway station of Odense to avoid bad weather and reduce the risk of getting the bike stolen. There is space for 250 bikes. There are also boxes for luggage, water fountain and toilets. Behind the building there is room for 400 bikes. 150 of them can be locked by a system, which can be used free of charge.

Economic instruments

Tax policy

Taxes can be an effective way to affect people's choices of dwelling location and mode of travel. Tax deductions for commuting have been found to promote urban sprawl. Especially long (more than 20 km) commutes are often based on tax deductions. Removing or restricting tax deductions for commuting and company cars and in the other hand increasing tax deduction for public transport can lead to less transportation need and less use of private cars. Fuel taxes may promote less use of private cars especially concerning short trips. Car tax controls acquiring of cars and reduces traffic. Municipalities can control land use and direct it to favorable areas also by real estate taxes.

Financing

Municipalities which are responsible for land use and transportation planning cannot always afford large public transport investments alone and additional state financing is often needed. Coordinated investment plans can help decisions. Road customs, congestion prices etc. can be used for financing in addition to their impact on use of private cars. Instead of building new major roads investments should be made to municipal street maintenance, which promotes also integrated urban form.

Traffic pricing

Traffic pricing can be an effective instrument to promote public transport and walking and bicycling instead of use of private cars. Road customs, congestion prices and parking prices have proved to be effective.

In Norway the Government presented a bill to the Parliament on congestion pricing in December 2000. The Bill was approved by the Parliament spring 2001. A decision on when the regulation will come into force is not made. Provisions to the Act will be given. The main points in the bill are:

- The purpose of congestion pricing shall be to regulate traffic, when appropriate and effective to reduce congestion and to enhance the local environment.
- Congestion pricing and toll financing cannot be used at the same time in the same area.

- Local approval from affected municipalities and counties will be a primary requirement. However under very special circumstances the Ministry can propose that congestion pricing is imposed.
- The cost of implementation and operation of congestion pricing has to be covered by the revenues. The net revenue has to be distributed between the state (national government) and the local sector of government (municipalities and counties) with 50% to each.
- Net revenues from congestion pricing will be earmarked for transportation purposes in the affected area, including public transport, traffic safety and environmental measures. It is not considered appropriate to put restrictions on what kind of local transport the net revenues can be used for.

This bill gives a fundamental framework for the use of congestion pricing in Norway. The future of congestion pricing is now in the hands of the local politicians. However so far they have seemed hesitant to go for any such schemes.

Parking policies

Parking policies may be an important tool to control urban form. Restricting amount of parking places and adjusting the cost of parking is a good instrument to reduce use of cars especially in city centres.

Active use of the Planning and building Act can be used to influence the number of parking places when building new activities. The possibility of the local authorities to regulate parking lots is however limited by the fact that in many city centres the majority parking lots are private. As in many other countries, incorporating private parking lots into restrictive pricing is difficult.

Eco-managed telework

Great Expectations

Telework means working outside the employee's regular office, either at home, in a telework centre or some other facility, typically utilising information and communication technologies. The environmental "slice" of the "telework cake" has aroused much appetite ever since telework became known. However, it has not been much enjoyed in practice. Instead, the environmental aspect of telework has been largely presented theoretically as part of the liturgy of sustainable development. Appeals to the environmental aspect of telework have been made when motivating the promotion of telework in local agendas or in organisation policies.

Association of telework with environmental issues is thus a very early phenomenon. Efforts to bring forth the environmental impacts date back to the 1960s in California, the USA. However, there are experiences from many countries that advocating telework merely from the environmental point of view does not necessarily bring about the best results. Instead, telework should be promoted in a holistic framework where environmental motivation is closely connected to implementing telework in its socio-psychological and economic dimensions. This means improving the balance between work and family life, uninterrupted working, efficiency of work, and reduced need for office space etc.

In this jungle of expectations, shadowed by suspicions concerning telework, we have to try to gain more knowledge on what the specific impacts of telework in each field of life are. Can telework provide solid solutions to the problems of the hectic worklife, as it is argued

- by e.g. affording flexibility and undisturbed working periods,
- by making it possible to combine family life and working life in an optimal way according to the employee's situation, and by
- improving one's quality of life when the stress from commuting is relieved?

Can telework in fact improve the quality of the environment at community and society level, while it is claimed to improve the quality of life at individual level? Can telework achieve this by e.g.

- reducing the number of trips from home to work,
- reducing the energy use and pollution from commuting, and by
- making the dormitory residential areas safer and more lively?

To make the matter more complicated while pondering these questions, one must bear in mind that the interrelations between the impacts and the combined output of such impacts of telework on various key activities in communities is of crucial importance, not just the implications separately. It must be taken into account that there are also quite opposite views and arguments concerning the impacts of telework on transport. The most frequently presented arguments can be presented as follows:

Table 4. Two clusters of arguments representing different viewpoints to the relations between telework and the traffic behaviour (Andersen et al. 1997, 231; Heinonen 2000).

<p style="text-align: center;">Main hypothesis:</p> <p>Information and telecommunication technologies will replace passenger transport</p> <p>Factors reinforcing the hypothesis:</p> <ul style="list-style-type: none"> • The ICTs will replace some of the vehicle traffic because the teleworkers do not have to travel to their offices on “teledays”. • Several studies have shown that a transfer to telework has reduced passenger traffic. • One of the most important motives in the telework transfer experiments has been avoiding the job commuting. <p>Factors nullifying the hypothesis:</p> <ul style="list-style-type: none"> • The teleworkers move further away from their jobs and cause just as much commuting traffic as before (fewer trips but a longer commuting distance) • The teleworkers might decrease their commuting but at the same time increase other kind of trips (for example, personal business trips to shops, to friends/relatives, to hobbies) • On some days the teleworker will work both at home and at the traditional workplace. • Other people might fill the space on roads freed by the teleworker, for example if the teleworker’s spouse or other family member (who usually uses public transport, twowheel traffic etc.) uses the now available car.
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The actual outcome has been monitored in numerous empirical studies, showing a range of transport savings results. On average, the savings are relatively limited. However, what becomes apparent is that the transport implications are much dependant on the design and

management of the telework situation. Most telework initiatives have not come about primarily for transport saving reasons, and, thus, the way the work is arranged seldom supports this effect. As telework is used by a growing share of the labour force, it is relevant to identify in what ways this type of work can lead to an overall transport reduction, and how this may be promoted.

Savings

The savings gained from telework can be calculated if the commuting mode, distance and frequency are known.¹ In a hypothetical case where 200 000 Finnish employees who normally drive to work, telework on one day per week the savings are as follows. The emissions caused by car traffic would decrease (in tons) as indicated in the following table²:

Table 5. The reduction of emissions (measured by tons/a) through telework per year (200 000 teleworkers on one day/week).

Carbon monoxide (CO)	1300
Hydrocarbons (HC)	190
Oxides of nitrogen	360
Particles	12
Carbon dioxide	29500

Even if this telework potential does not cause a very large deduction in the total output, the decreased emissions help to diminish the environmental constraints. Every kilometre not driven directly affects the net emissions. Decreasing the total traffic is the most effective way to decrease the emissions from transport.

Table 6. The yearly savings gained from telework (200 000 teleworkers on one day/ week).

The number of commuting roundtrips	8.8 million
The time used for commuting	6 million hours
Commuting mileage	170 million kilometres
Driving expenses /socio-economy	24 million euros
Driving expenses /private households	50 million euros
Accident expenses	3,4 million euros
Emission costs	1,7 million euros
Infrastructure expenses	Postponement of investment decisions

Recommendations needed

The general recommendation concerning telework from environmental point of view is that telework should be introduced and implemented in an eco-sensitive or eco-managed way whenever feasible. This was the main argument of the Eco-managed Telework

¹ Heinonen 2000. There is also a calculation programme for telework developed by Kitou/Horwath at UC Berkeley, calculating emissions savings from telework. It can be an interesting tool when we start to use emissions trading. See: <http://cgdm.berkeley.edu/telework/>

² The emission amounts were calculated by the LIISA model, estimating road traffic exhaust discharges and developed in the VTT Communities and Infrastructures (Mäkelä et al. 1996). See: <http://www.lipasto.vtt.fi>

Project, carried out at VTT Building and Transport (Heinonen et al. 2004, <http://www.vtt.fi/rte/projects/yki4/etatyoen.htm>). The possibilities for applying eco-managed forms of telework should be considered at the outset of each telework programme. However, the *environmental benefits from telework are not automatic*.

More information about eco-managed telework is presented in Appendix 2.

Experiences from the other Nordic countries

Denmark was among the first European countries to start giving regulations on telework arrangements. In Denmark the share of teleworkers grew from 1 % to 5 – 15 % of labour force. One important factor to promote the development was the decision that a computer which employer gives to employee to use at home is not a taxable advantage.

In Norway impacts of telework have been assessed in Oslo and Bergen. The analysis showed that telework has potential to reduce transport and emissions in both regions. The government has included several telework projects into its development programmes concerning labour markets and regional policy. The Norwegian Research Council has financed a comprehensive telework programme "Project telework".

In Sweden the government has proposed large state support to a country wide broadband channel for households and rural areas. In Stockholm county merely it has been estimated to be a potential of 300 000 people who could more or less substitute their commuting trips by telework from home. According to Arnfalk (1999) a quarter of a million Swedes telework at least once a week. The cities of Stockholm and Linköping have carried out telework projects. In 2001 the government established an IT & Environmental Forum with the aim of promoting ict and sustainable development. One of its two working groups is concerned with virtual mobility.

Conclusions concerning telework

The importance of the organisation and their responsibility to make this eco-managed model of telework work cannot be stressed too much. There should be several incentives for the organisations, be they economic, social, psychological or image-wise. This is because incentives for the individuals more or less already exist in the form of direct benefits from telework, while incentives for the organisations are still missing.

The following measures have to be taken to promote the prerequisites for teleworking:

- Efforts to create such urban form which has attractive circumstances for eco-managed telework in residential areas: housing production should include to an increasing degree such solutions where work at home is facilitated (e.g. apartments with separate working space), residential areas should also have an access to a nearby teleworking centre or business park where teleworking facilities are available, libraries or other public utilities could be equipped with a teleworking hotspot etc.
- Legislation and other regulations should include such elements and modifications that make teleworking as an attractive option both to teleworkers themselves and to those employing teleworkers.
- Systematic dissemination of information and education (both theoretical and practical) for teleworkers and telework-employers as well as potential telework-employers concerning various ways of organising work.

The recommendations presented here for eco-managed telework for employees, employers, public authorities/policy-makers could be elaborated into a common Nordic framework and set of recommendations. This could be done in co-operation between the Nordic countries in the form of a new research project where all work done in each Nordic country on the subject would be integrated.

Effectiveness of certain instruments

Dutch policy makers undertook a pilot project to benchmark CO₂ reduction policies in transport. Denmark, Finland and Sweden participated in this study. The main results and findings are:

In addition to searching for cost-effective instruments governments should also focus on maintaining and improving existing policies. For example, it is important to maintain high public transport modal shifts. It is important to consider how CO₂ policy instruments contribute to and are complemented by measures to reduce traffic congestion, improve accessibility and safety, or reduce air pollution.

Financial and fiscal instruments are seen as promising in their structure, but problematic when public support is concerned. Early involvement of stakeholders and communication on its objectives are essential to bring this type of instruments in reality. Also it is easier to first get the structure of the instrument right, so that it gives the right incentive, and adjust the (charge) levels later.

Trying to influence the modal share of transport modes is often not very effective and efficient.

Table 7. Overview of benchmark assessment of policy instruments (Ministerie van Verkeer en Waterstaat, Rijkswaterstaat 2003).

Instrument	CO ₂ effect	CO ₂ cost-effectiveness	Conclusion
CO ₂ emission standards	High, >5%	High	++
Eco-driving	Medium, 2-5%	High	+
Speed limits and enforcement (highway)	Medium, 2-5 %	High	+
Fuel tax	Low-medium, <2-2-5%	High	0/+
Telematics, freight	Low-medium, <2-2-5%	High	0/+
Vehicle tax (incl. differentiation)	Medium, 2-5%	Varies	0
Road/km/congestion pricing	Low-high, <2- >5%	Medium	0
Stimulation of biofuels	High, >5%	Low	0/-
Modal shift - Public	Low, <2%	Low	0/-
Modal shift – freight	Low, <2%	Medium	0/-
Tradable CO ₂ permits	Low, <2%	High	?

% = Achieved reduction as a share of total national transport emissions

The project regards *CO₂ emissions standards, eco-driving and highway speed limits* as *highly promising*. Lowering highway speed limits with increased enforcement will reduce CO₂ emissions with additional positive effects on safety and noise.

The project considers moderate *vehicle tax or fuel tax changes, the use of telematics in freight transport and road pricing* to be *moderately promising* policy instruments. Taxation instruments may have relatively little effect on mobility since drivers appear to be less responsive to increases in costs than to increases in travel time.

5 Conclusions and recommendations

The Nordic countries have a lot of common features concerning urban form and transportation. Many of the problems are perceived in the same manner and much of the discussions deal with the same issues. Urban structure and land use have a great impact on transport volumes and on modal split and thereby also on the amount of transport related greenhouse gas emissions.

Urban sprawl has been a continuous trend in all Nordic countries for decades. Intervention to this process is commonly seen as an important task. In some old smaller cities, especially in Denmark and Sweden, urban form is still “naturally” compact with pedestrian city core. In Finland urban form has been traditionally more scattered especially outside inner city areas. As a consequence of this process, more attention is paid on integration and revitalisation of urban areas.

A relatively high density of urban areas, well-functioning and accessible public transport, high quality cycling and walking networks are good examples of measures that are most commonly referred to when aiming at reducing greenhouse gas emissions. It is also quite often recognised that these measures will promote other environmental and transport policy objectives as well, especially air quality, traffic safety and livable urban environment and town scape in general.

Instruments to develop urban form and transportation systems to reduce greenhouse gas emissions can be found in all planning and decision-making levels and sectors. These include especially land use and transport planning, urban design, certain types of taxation, financing of urban infrastructure, traffic pricing and parking policies. New ICT-related technologies implied in urban environment (homes, jobs, shops, schools, libraries, streets etc.) and urban life (like eco-managed telework or ambient intelligence) can offer new ways to provide the same urban services (easy access to information, to one's employer, colleague, client etc., automatic monitoring systems with intelligent sensors etc.) as before but with less transport impacts.

What is not clear is the future development in urban technologies and infrastructures, (energy, water, waste and telecommunication), urban services and their distribution. These issues and their impact on urban form and greenhouse gas emissions should be examined more carefully. National climate policies seem to have good but rather general level objectives as regards urban development, and not so many specific and concrete targets or instruments for urban decision-makers to control emissions.

Transport planning should be integrated more closely to land use planning. Especially public transport systems, their routes and functionality should be included in all levels of land use planning. Walking and cycling environments should also be an essential and carefully designed element in land use plans. A newly reinvented good form of integrated dwelling and work place location is a “station village”, where new building areas are located near railway stations.

Regional or local climate strategies may be good instruments to connect planning activities in different sectors and between municipalities. Climate strategies should cover all planning and decision-making levels and sectors: land use, transportation,

energy production, services, waste management etc. Municipalities are often lacking efficient sectoral cooperation, and climate strategies could promote also this objective.

Location of large shopping malls should be planned on a regional level. Different parties like municipalities, regional administrative bodies, commercial actors etc. should discuss together in order to have an optimal location as to transport impacts, accessibility and emissions. Location studies should be included in land use planning already on a regional level.

Land use and transportation systems have been studied a lot and there seems to be rather good understanding of their impacts. More is to be done concerning implementing plans. Impacts of all relevant instruments should be examined more carefully. Financial instruments seem to have great potential. Especially impacts of tax deduction of commuting costs should be studied more. Different levels of deductions result in different dwelling location. On the other hand, taxation policies have also other than urban impacts, for example on labour markets and social equity differences between regions. Impacts should be examined from different points of views. For instance, if telework or other forms of telepresence (e-business, distant learning, telemedicine etc.) are not estimated to have crucial and direct impacts on commuting, they may have bigger impacts on organisation of business logistics or inhabitants' daily activities and on the way of urban life in general - and thereby larger indirect urban impacts later on. All these possible new phenomena and weak signals should be studied more carefully and taking into account different cultural and local conditions.

It is obvious that some of the instruments which could be relevant in reducing greenhouse gas emissions can fall between ministries and other administrative sectors. This fact suggests more intensive cooperation between different levels and branches of public sector. In addition to ministries of environment, transportation & communication, also ministries responsible for financing and social welfare issues should be taken along when defining research needs and assessment of alternative measures.

Continuing discussion and more focused research initiatives are needed. Common understanding and interpretation of problems in the Nordic countries (see Appendix 3) can promote favourable national solutions and decisions:

- Cities still tend to grow larger in area but lower in density, in spite of opposite targets.
- There are great variations in the urban densities: for example in Finland the urban areas use more than twice as much land area per inhabitant as in Sweden or Norway.
- The differences between countries and localities can be explained by several factors: speed of ongoing urbanisation, level of demand on single-family houses, price differences of city dwellings, different land policies, amount and quality of cooperation within city-regions, competition between municipalities about tax-payers and enterprises, different attitudes to individual (private car oriented) and public transport.
- The biggest potential for reduction of greenhouse gas emissions is in the growing urban regions.
- Sufficient integration of land use and transportation systems is necessary on all planning and decision-making levels.

- Nordic countries share many land use and transportation planning policies, there included the aims to stop urban sprawl, to ensure good quality of living environment and to reduce traffic growth by promoting public transport, walking and cycling.
- Among the most effective planning principles to stop urban sprawl are at least the following: centralising residential land use in areas with good accessibility to public transit, concentrating workplaces near mass transit stations and maintaining near-by daily services.
- There are success stories regardless on town size or regional settlement pattern. Local innovative initiatives, active and progressive development climate can be decisive driving forces to launch a positive development spiral. For instance by making local CO₂- strategies, the municipalities can include economic, social and environmental views in their planning policies in bring together actors that are not normally cooperating.
- Examples of efficient measures in transport system planning to avoid further unnecessary expansion of urban areas and decrease of urban densities: strengthening the existing centres and suburbs, stopping building extra capacity for motorised private transport, promoting sustainable modes of traffic, setting speed limits and parking restrictions in selected areas.
- The recommendations for eco-managed telework for employees, employers, public authorities/policy-makers could be elaborated into a common Nordic framework and set of recommendations.
- Planning alone can not stop the urban sprawl. When considering and assessing different measures on national level, legislative and fiscal issues, citizen participation and other background forces should be taken under serious consideration.
- Better cooperation between researchers, politicians, civil servants and citizens is needed to find deeper understanding about economic, social and environmental long-term effects of decisions concerning urban development.

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Appendix 1. Examples of instruments

Examples of instruments (ECMT 2003)

INSTRUMENTS

- Local and regional government capacities
 - planning
 - funding
- Integration of regional and local policy making
- Central government ability to affect local policies
- Integrated transport and environmental policy
- Integrated policy making
- Effective cost benefit analysis
- Effective environmental impact assessments
- Integration of transport and land use planning
- Guidance on integrated transport and land-use
- Planning targets for reducing sprawl
- Zoning to limit out of town commercial centres
- Public transport
- Competitive tendering for public transport with effective incentive structures for reducing costs
- ridership as part of sustainable transport poivy
- Effective control of costs
- Integrated public transport passes and simplified fares
- Traffic light bus priority and real time arrival information
- Guided buses/dedicated bus lanes
- Park and ride schemes
- Economic instruments and parking policy
- Parking charges/capacity management city-wide
- Variabilisation/differentiation of road user charges
- Congestion tolling/road pricing
- Freedom to transfer of revenues from tolls to
- Traffic management
- Co-ordination of traffic lights to limit access
- Deployment of telematics
- Air quality, noise exposure and accidents
- Fleet renewal/scrappage programs
- Vehicle inspection programs
- Noise abatement
- Effective safety policy
- Non-motorised modes
- Car free zones in city centres
- Effective promotion of walking
- Effective promotion of cycling
- Consultation procedures
- and involvement in decison making
- Negotiating voluntary car and parking restraint

Appendix 2. Eco-managed telework

Eco-managed telework instead of eco-disastrous telework

Beneficial environmental impacts from telework are by no means automatic nor self-evident. Unless we use the eco-managed framework for implementing telework in organisations, cities and regions, detrimental effects are quite plausible. Near at hand – without eco-management – is a worst-case scenario of "eco-disaster" teleworkers who telework only half the day at home and speed up in their car for the office in the afternoon (Heinonen 2001; 2004). This of course reduces congestion, but does not yield any savings in energy use and pollution. Later in the evening they drive to the auto-market at the outskirts of the city, generating many vehicle kilometres. In lack of social contacts after working so hard at home in their home office or "hoffice", they may drive to see friends or go sporting. Sports and socialising in itself is of course quite recommendable for each of us, but from the environmental point of view what matters is when, how and where people do that. Teleworkers in this environmentally-worst-case scenario need a room both at office and at home, they are not very willing to share the costly office space. They want to have all necessary ICT equipment both at work and home, increasing eventually the number of computer waste. They cannot organise the material on what they are working, so they need all the reports copied as well, exploiting thus huge numbers of paper resources. Now that teleworking is possible, an employee might also decide to move further away from the office. The number of commuting days is decreased, whereas the vehicle kilometres with subsequent pollutants and energy use are increased. Even if they drive less frequently to office, when they do drive, it means actually more environmental burden to communities.

The eco-managed teleworker, on the other hand, is well aware of the environmental impacts of different forms in telecommuting. Together with his or her employer they have agreed on the best practice patterns of work and mobility. They are conscious of the value of eco-managed telework as part of the environmental strategy of the organisation. Telework in this scenario is also integrated as part of the employee's possible propensity towards ecological way of life or environmental-friendly behaviour in general. The key idea in eco-managed telework is that ecologically enlightened organisations should pave the way and provide many incentives for eco-managed teleworking among its employees. The same can be adopted in cities and larger regions as an agreed policy. Those cities, towns and regions which respond to this challenge of implementing eco-managed telework see telework as an instrument for reducing commuting and congestion and accordingly its environmental burden. However, they try to approach the issue on a holistic scope. Therefore, they are watchful for avoiding possible pitfalls in telework scheme from the point of view of the environment. Such a proactive environmental procedure is e.g. to build ict infrastructure or its reservations in new development areas when the street or road is already dug open for installing other municipal engineering.

In a recent survey by the Helsinki Metropolitan Area Council (YTV), the preliminary results show that a typical teleworker in the Helsinki Metropolitan area is a highly educated and well-off male employee, younger than an average. He lives in a detached house, drives a person car to the office and has a longer distance from home to the job than on average. Does this imply that a teleworker is prone to more mobility when trips

to work are reduced? Or, is the diminished commuting a quality-of-life target for a person who is already accustomed or obliged to much travelling? In this survey, 3.6 % of all the respondents claimed to have teleworked on the day the questionnaire was concerned with. Of the respondents active in working life, more than 5 % teleworked at least one day per week and 13 % replied to have teleworked occasionally during the last six months. (Heinonen et al. 2004)

Eco-managed telework in theory and in practice

Eco-management of telework means that regardless the main approach of telework implementation, all applications will be made as environmentally friendly as possible, and as much according to the principles of sustainable development as possible. This means systematic and conscious efforts towards eco-management of telework.

In theory, eco-managed telework can thus be defined as encompassing the whole field of various technical and functional solutions in adapting telework in a way that is as environmental-friendly as possible. The eco-friendliness of telework can be evaluated by paying attention to four basic settings concerning where, at what frequency, with what techniques and with what motivation telework is being done. These aspects are then connected to other relevant issues such as what is the usual mode of commuting or what are the other patterns of mobility in the household of the teleworker.

When the aim is for eco-managed implementation of telework, we could bring forward the areas of concern from an environmental point of view:

- transport;
- office area;
- space in the home;³
- equipment.

The relative size of these impacts, depend on the set-up of the telework, but in general, not only transport, but also office area reduction, can offer very significant savings when implemented. The extra energy used in the home is marginal, if not a separate building is used. The electronic equipment “costs” a lot in environmental terms to manufacture, but running costs are low.

Often, it is easier to define eco-managed telework in a negation i.e. as encompassing the whole field of various technical and functional solutions in adapting telework in a way that has as few detrimental environmental as possible.

³ This could include furniture.

Figure 1. Four basic settings of the teleworking mode. (Heinonen 2003)

In practice, we must look in more detail how this eco-management of telework can be achieved. In other words, the concept of eco-managed telework has to be operationalised. Practical tools for promoting telework in an eco-managed form can be given to various stakeholders as recommendations – presented as "ten commandments" of eco-managed telework 1) for employees i.e. teleworkers themselves, 2) for employers, and 3) for policy-makers and public authorities.

"Commandments" or recommendations for eco-managed telework⁴

The following "commandments" or recommendations are not presented necessarily in the order of importance. However, they have to be applicable simultaneously in an ideal case. This means that following any of the rules must not hinder following any other rules. In all cases of telework it is not possible or appropriate to follow all the rules. However, the more rules you are able to follow, the closer you are to the eco-management of telework.

When communicating with any stakeholders, and with policy-makers in particular, you need to be quite clear in your communication. Only the key points and recommendations should be brought forward. In the recommendations there is still

⁴ (Heinonen et al. 2004; <http://www.vtt.fi/rte/projects/yki4/etatyoeng.htm>). The term "commandments" implies that the rules should/must be followed at all times. However, this cannot be done. Therefore, a proper term is "recommendations". The "commandments" are here used as a compelling and provocative phrase.

abundance of rules, among which the most critical points and rules should be picked out.

"Ten commandments" of eco-managed telework for employees

1. Conceive telework as part of eco-sensitive lifestyle.
Be aware of the environmental and economic impact of your commuting.
2. Avoid half or partial telework days (do not travel to office on teleworking days).
3. Avoid car driving on telework days for other purposes (shopping, hobbies etc).
(Car driving should be limited in general, not just on teleworking days).
4. Do not move farther away from your office *merely* on the basis of teleworking possibilities.
5. Use a portable laptop and minimise technical apparatus (avoid double equipment).
6. Avoid copying or printing documents, reports etc. as double (one version at the main office, another at home). (Again, printing and copying should be avoided per se).
7. Use public transport combined with telework option.
8. Whenever feasible, extend the vacation at summer cottage by teleworking periods "pre and post holiday".
9. Create appropriate teleworking routines - for working times, communication with employer, colleagues, business partners and clients. Consider the risks of telework that are possible in your own case in advance. Will telework increase the risk of burn-out, the sense of alienation, the risk of decreased efficiency? Will these risks create need for travelling?
10. Minimise the risks of telework that are possible in your own case. Choose carefully the teleworking periods and daily rhythm that is the most suitable for you. Take care of your social network and contacts.

Further rules and advice for eco-managed teleworkers were generated in a workshop of the Eco-Managed Telework project as follows:

- Be an active telework "apostle" in your work organisation (spread the good eco-news).
- Optimise your teleworking mode according to your family life and work profile (and update such optimisation).
- Measure, evaluate and develop your teleworking model.
- Plan your working activities carefully for teleworking days/periods (tasks, logistics).
- Watch your energy use in connection with teleworking (equipment, lighting, mobility etc).
- Pay attention to the choice of location of residence (so that public transport is accessible to your current workplace or possible future workplace, or consider the choice of location of residence near your workplace).
- Take the other members of your family or household into consideration in your teleworking space. Do not conquer too much space.
- Use local services on teleworking days.

"Ten commandments" of eco-managed telework for employers

1. Adapt telework policy as part of the development of the human capital in your organisation. Bear in mind, however, that some employees are better suited to telework than some others.

2. Adapt telework policy as part of the environmental policy and strategy in your organisation.
3. Find out the telework potential among your staff as regards employees commuting long distances or hard conditions. Pay special attention to telework potential among those driving by car to and from work.
4. Find out the telework potential of the employees with long commuting distances and living in the same direction. Consider the possibility of establishing a telework facility for them near their homes.
5. Equip your employees with a portable that can be used both at telework and at office. Make sure that the recycling of disposed equipment is done properly.
6. Make sure that there is no unnecessary use of energy at a teleworker's office space (lighting, heating). When the need for extension arises for office buildings, consider fulfilling this need by telework arrangements in connection with reorganising the existing office space. Experiment with e.g. desk sharing, room shifting. Adjust, whenever possible, office space.
7. A teleworker must not be forgotten nor devaluated in any other ways as compared to other employees e.g. as regards career development or exchange of information. Special emphasis must be paid to full-time teleworkers so that they will have access to counseling and to technical support when problems of work process or of communications should arise.
8. Provide regular teleworkers and mobile teleworkers with mass transit ticket as part of their job benefits.
9. Give mobile teleworkers a possibility to include the time used in teleworking at train in their regular working hours.
10. Try telework in your own position and tasks and think about making it as eco-managed as possible. Make the commitment: "I recognize these recommendations very well, and hope that you recognize this fact..."

The following further advice for employers were generated in the workshop of the Eco-managed Telework project:

- See the opportunities that arise from telework in recruiting employees. This adds to competitiveness.
- Make telework available in your organisation and optimise the costs.
- Make some other options less attractive (charge car parking, convert big separate rooms into open office space).
- Encourage and reward your teleworkers.
- Adopt telework management as part of organisational management, pay special attention to communication and monitoring the results.
- Test if working extra hours can be replaced by teleworking efficiently regular hours.
- Remember to show example.
- Take telework seriously, it is a legitimate and appropriate option!
- To be more specific: take the wish for clear orders of telework seriously, and work actively to reduce or nullify the effect of stress and overwork; communication barriers during telework days; etc.

The following matrix could be used for tailor-made eco-managed solutions in a given organisation or area.

Possible gains	How to realise them
Possible drawback	How to avoid them

"Ten commandments" of eco-managed telework for public authorities (as policy makers and in recommendation no 10 as employers)

<ol style="list-style-type: none"> 1. When planning residential areas, reserve spaces for common use that can be modified to telework inside the area. 2. Set telework quotas for organisations of certain size (e.g 10 % for organisations employing more than 150 persons). Reward the best telework-applying organisations in the public sector. 3. In connection with decentralisation, give special attention to possibilities to introduce telework solutions. 4. Tax deductions to organisations permitting telework, and to teleworkers themselves. Special bonus to corporations which promote the location of jobs to out-migration areas (e.g. by establishing satellite offices and telework centres). 5. Make it feasible for organisations to introduce mass transit ticket for their employees. 6. Favour the organisations which give their mobile teleworkers a possibility to include the time used in teleworking at train in their regular working hours. 7. Support building a broadband network outside densely built-up areas, too. In earth construction, reserve space for telecommunication cables. 8. Make sure that the legislation gives an equal position to teleworkers as compared to their non-teleworking colleagues working in the same organisation. 9. Arrange annual telework campaigns during the annually arranged European Telework Week and the Carless Day. 10. Apply telework in your own organisation and consider what would be the most eco-managed forms of such telework applications. (See the Swedish recommendations http://www.utbildning.regeringen.se/eugemutbm/rapporter/f01.pdf)
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Further rules and advice for eco-managed teleworkers were generated in a workshop of the Eco-Managed Telework project as follows:

- Dissemination of information on telework ⇒ dissipation of prejudices.
- Allocation of research funding to telework schemes.
- Make the technology needed in telework accessible to all.
- Town planners and urban planning authorities: Conceive telework as part of new lifestyles, mobile telework, and ecological way of life. To support this framework, residential areas should be zoned so that they have a good access to public transit, and especially to dense job areas.
- The public sector as an employer should set an example of telework practices.
- There should be many "carrots" for organisations using telework.
- Local services must be available to the teleworkers outside the built-up areas as well. The public infrastructure of communities supported by some measures.
- The education of executives, leaders and managers should include training to be good telework managers.

The tax deductions of work trip costs could be paralleled by tax deductions from the costs of telework space (home office, telework centre, or rented space).

Ten perilous pitfalls of eco-managed telework

1. Due to poor organisational skills you have to go to your office on a telework day

⇒ **The teleworkers makes a trip to work even on teleworking days.**

2. Other members of the family ask you to help them in driving to school, hobbies etc.

⇒ **The teleworker drives other people to various errands.**

3. Other members of the family use the teleworker's car, while otherwise they would have used mass transit.

⇒ **The savings from teleworker's unmade trip to work will be consumed.**

4. Due to alienation the teleworker drives by car in the evening to get social contacts or other activities.⁵

⇒ **The teleworker moves more using motor transport during his or her leisure.**

5. The teleworker has double office space, double ict equipment, double material and generates double use of energy.

⇒ **The teleworker wastes resources while needing everything as double.**

5. The managers, colleagues and contact persons tend to forget you on the "out of sight, out of mind" principle. You will not get necessary information, you might drop off the career development.

⇒ **The teleworker will socially drop out.**

6. While working at home, the line between work and private life will become blurred and the risk of burn-out is increasing.

⇒ **The teleworker works too much.**

7. While working at home, your efficiency is decreasing little by little. You have difficulties in concentrating on work. The TV or the refrigerator become temptations.

⇒ **The teleworker works too little.**

8. Some teleworkers are not capable of good results in teleworking practices. Therefore, the possibilities of teleworking are restricted in an organisation

⇒ **The lack of trust in teleworking is detrimental to work at large.**

9. Your home is not well suited to telework due to lack of space or the lack of quietness. There is no teleworking centre near your home either.

⇒ **There is no proper space or place for telework.**

10. The teleworker has to pay the costs of teleworking, ict equipment, telecommunication, furniture etc. Other economic "losses" emerge, such as lunch benefits etc.

⇒ **The teleworking costs fall on the teleworker alone.**

⁵ This has been presented as a theoretical assumptions in several telework discussions. Yet, there is no empirical evidence to support this pattern. However, other trips such as shopping, day care, taking children to hobbies and school are still there (see Jo Skådemal, Linköpings Universitet, Licentiate's thesis). Some of these other trips can be postponed to normal commuting days. Others have to be made daily.

Appendix 3. Conclusions of the theme group

Nordic Council of Ministers / **Nordiska Ministerrådet** 14.5.2004

Sustainable Mobility –theme group / **Temagruppen för Hållbar Mobilitet**

- In efforts to reduce energy consumption and greenhouse gas emissions, land use and transportation systems have an essential role. Due to the great population and traffic volumes, biggest challenges for planning exist in the growing urban regions. Cities still tend to grow larger in area but lower in density, in spite of opposite targets.
- Nordic countries share many land use and transportation planning policies, there included: the aims to stop urban sprawl, to ensure the good quality of living environment and to reduce traffic growth by promoting public transport, walking and cycling. Studies about urban forms show, that the most effective planning principles to reach these aims would be centralising residential areas, concentrating workplaces near stations and maintaining near-by daily services. However, neither national nor local actors have succeeded to stop the strong centralisation trend of commercial services.
- There is also a great variation in the urban densities. For example in Finland the urban areas use more than twice as much land area per inhabitant as in Sweden or Norway. This can not be explained only by historical reasons or geographical differences – the longest commuting trips are not made in the countryside but in the new outskirts of the metropolitan area. Some explanation could be found in the combination of the following factors: ongoing urbanisation, high demand on single-family houses, high prices of city dwellings, competition between municipalities about tax-payers and enterprises, too car-oriented and short-sighted decision making and lack of cooperation within city-regions.
- Great differences between cities show the significance of municipal activity. There are success stories regardless on town size or regional settlement pattern. By making local CO₂- strategies, the municipalities can include economic, social and environmental views in their planning policies. This gives reasons to strengthen the existing centres and suburbs and to stop building extra capacity for motorised private transport. In local transport planning, the most promising instruments are promotion of the sustainable modes, speed limits and parking restrictions in selected areas.
- Planning alone can not stop the urban sprawl. In national level, legislative, fiscal and other background forces behind sprawl should be taken under serious consideration. Better cooperation between researchers, politicians, civil servants and citizens is needed to find deeper understanding about economic, social and environmental long-term effects of decisions concerning urban development.

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