Irmeli Harmaajärvi – Aimo Huhdanmäki – Pekka Lahti

Urban form and greenhouse gas emissions

Summary

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Abstract

Finland's regional form is becoming concentrated as a result of economic and social changes. Because of uncontrolled development, the urban form of the growth regions is becoming fragmented. The effects caused by the changes in Finland's regional and urban forms on greenhouse gas emissions have been studied up to the year 2010, when Finland's greenhouse gas emissions, in accordance with the Kyoto protocol, should be reduced to the 1990 level. Qualitative estimates of the effects of the urban form on greenhouse gas emissions have already been made. This study estimates, for the first time, the effects caused by changes in the regional and urban forms on the levels of greenhouse gas emissions in Finland. The changes in the regional form concern factors between regions while changes in the urban form concern factors inside regions. The urban form affects especially transportation within regions, the potential to utilise district heating and the need for infrastructure.

If urban sprawl continues at the same rate as it has during the last 10 years, the annual vehicle kilometres of passenger traffic inside regions will increase by altogether 36 %, i.e. 6,000 million vehicle kilometres, and carbon dioxide emissions by 9 %, i.e. 0.3 million tonnes from 1990 to 2010. The growth estimate is sensitive especially in regard to the following three factors: economic growth, control of the urban form and specific emissions of vehicles. If economic growth is strong and if it is not entirely possible to slow urban sprawl or a decrease in the grade of service of residential areas, or if the specific emissions do not decrease at the estimated rate, the vehicle kilometres and emissions might increase more than estimated.

Annual greenhouse gas emissions caused by heating and electricity use in residential and service buildings are estimated to increase by 4.8 million tonnes, i.e. 27 %, from the year 1990 by 2010. In addition to the increase in the building stock, the higher emission levels result from greater use of electric heating and electricity in general. The increase in the residential building stock is caused mainly by the added square metres in living space.

The annual greenhouse gas emissions caused by construction and use of infrastructure will increase by 0.1 million tonnes, i.e. 12 %, from the year 1990 by 2010. The increase is caused by a greater need for infrastructure in a decentralised urban form.

In the target-oriented scenario, regional form develops in the same way as in the business as usual scenario. In other words the population is located in the same commuting areas. Urban sprawl of the regions has been prevented by locating new housing nearer to regional centres, and by locating housing closer to work places. By integrating the urban form it is possible to reduce annual carbon dioxide emissions of passenger traffic inside the regions by 0.8 million tonnes by the year 2010. Furthermore, more teleworking and lifestyle changes can reduce carbon dioxide emissions by 0.2 million tonnes. Altogether it is possible to reduce annual carbon dioxide emissions of passenger traffic inside the regions by 1.1 million tonnes, i.e. 27 %, by the year 2010. When the urban form is more integrated, the potential to utilise district heating will increase, which can further reduce emissions by 1.1 million tonnes, i.e. 5 % of the emissions of residential and service buildings by 2010. A more compact municipal

infrastructure reduces emissions by 0.1 million tonnes, i.e. about 6 %.

Developing urban form according to the target-oriented scenario would reduce greenhouse gas emissions by 2.3 million tonnes in 2010 compared with the present trend. This amounts to 15 % of Finland's target for greenhouse gas emissions reductions in 2010. If the target-oriented scenario is realised, the subsequent decrease of emissions would accelerate. At the same time, other emissions which are harmful to human health and the nature will also decrease. Furthermore, significant cost savings will be achieved, the quality of the environment can be improved and the preservation of 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 as well as in transportation and taxation policies. Additionally, more needs to be done in regard to co-operation, interaction and information dissemination. Sprawl has been encouraged by, among other things, the tax deduction for commuting. By eliminating this tax deduction or 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.

Preface

This report studies the impacts of changes in regional and urban form on greenhouse gas emissions to the year 2010, when, in accordance with the Kyoto protocol, Finland's greenhouse gas emissions should be reduced to 1990 level.

The main links between social changes, regional and urban form and greenhouse gas emissions were identified. Two scenarios have been prepared on the future development of regional and urban form in Finland to the year 2010. The first, the business as usual scenario, is based on the present trends. The other, the target oriented scenario, assumes decreased greenhouse gas emissions. The impact of each scenario on greenhouse gas emissions was assessed. Appropriate measures to control urban development were determined and thus achieve the goals.

The study was carried out for the National Climate Programme of Finland, and the first results were presented in reports of the Ministry of the Environment and the Ministry of Transport and Communications Finland. The study is part of the LYYLI Research Programme and was commissioned by the Ministry of the Environment and the Ministry of Transport and Communications Finland.

Senior Research Scientist Irmeli Harmaajärvi, Research Scientist Aimo Huhdanmäki and Chief Research Scientist Pekka Lahti, from VTT Building and Transport conducted the study. Senior Technical Adviser Leena Silfverberg from the Ministry of the Environment and Ministerial Advisers Raisa Valli and Riitta Viren from the Ministry of Transport and Communications Finland supervised the work.

Table of contents

1 Impacts of the regional and urban form on 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. Comparable reductions are also achieved in other emissions harmful to human health and the environment.

This study looks at the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Methane and nitrous oxide are presented as carbon dioxide equivalents.

Regional form in this study is defined as the entire built environment of Finland including buildings and networks in both urban and rural areas.

Urban form in this study is defined as the built environment within commuting or other functional areas.

Regional and urban forms have an indirect effect on traffic, on the district heating systems in urban areas and on the need for municipal infrastructure.

2 The business as usual scenario

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.

The trend has been defined on the basis of the population changes in municipalities, traffic growth, the increase in building stock and changes in heating systems and in municipal infrastructure.

Population changes in municipalities to the year 2010 were forecast by Statistics Finland. Changes in the residential building stock are based on, among other things, changes in population, economics, living space, sizes of dwellings and households, and housing reserves and losses. Changes in the service building stock are extrapolated from the changes in the last ten years.

Regional form is described as residential building stock in municipalities in the year 1998, the changes in building stock between 1999 and 2010, and building stock in 2010 (square metres, Figures 1-2). Changes in urban form in the Helsinki and Oulu regions are presented as built-up areas in Figures 3-4.

Table 1 shows the predicted trends in population and building stock in Finland. The figures for 1999-2010 are changes in the building stock. In all categories more floor space will be needed.

Table 1. Population and floor space of residential and service houses in Finland 1998-2010 according to the business as usual scenario.

Year	Population	Floor space (million m² floor space)				
	millions	Detached houses	Terraced houses	Blocks of flats	Services	Total
1998	5.2	127.9	28.3	73.4	81.1	310.7
1999-2010	+ 0.1	+ 17.9	+ 4.4	+ 12.9	+ 14.6	+ 49.8
2010	5.3	145.8	32.7	86.3	95.7	360.5

New buildings will also be needed to substitute for a reduction of old building stock. During this period the need for new detached houses will be 20.2 million square meters of floor space, for terraced houses, 4.9 million square meters, and for blocks of flats, 13.8 million square meters. The total for all new dwelling houses will be 38.9 million square meters of floor space.

The changes in traffic have also been assessed based on the changes in the average commuting distances in municipalities. In the business as usual scenario, the situation in 2010 is based on the trend between in 1991 and 1997.

Commuting distances are based on straight-line distances from houses to work places for commuting trips of more than 0 but less than 100 kilometres (Table 2, Figure 5).

Table 2. Average straight-line commuting distance in Finland.

1991		8.7 km
1997		9.6 km
2010	business-as-usual	11.4 km

These straight-line distances can be converted to real distances by multiplying them by 1.3. This is an average coefficient. The real coefficient varies case by case.

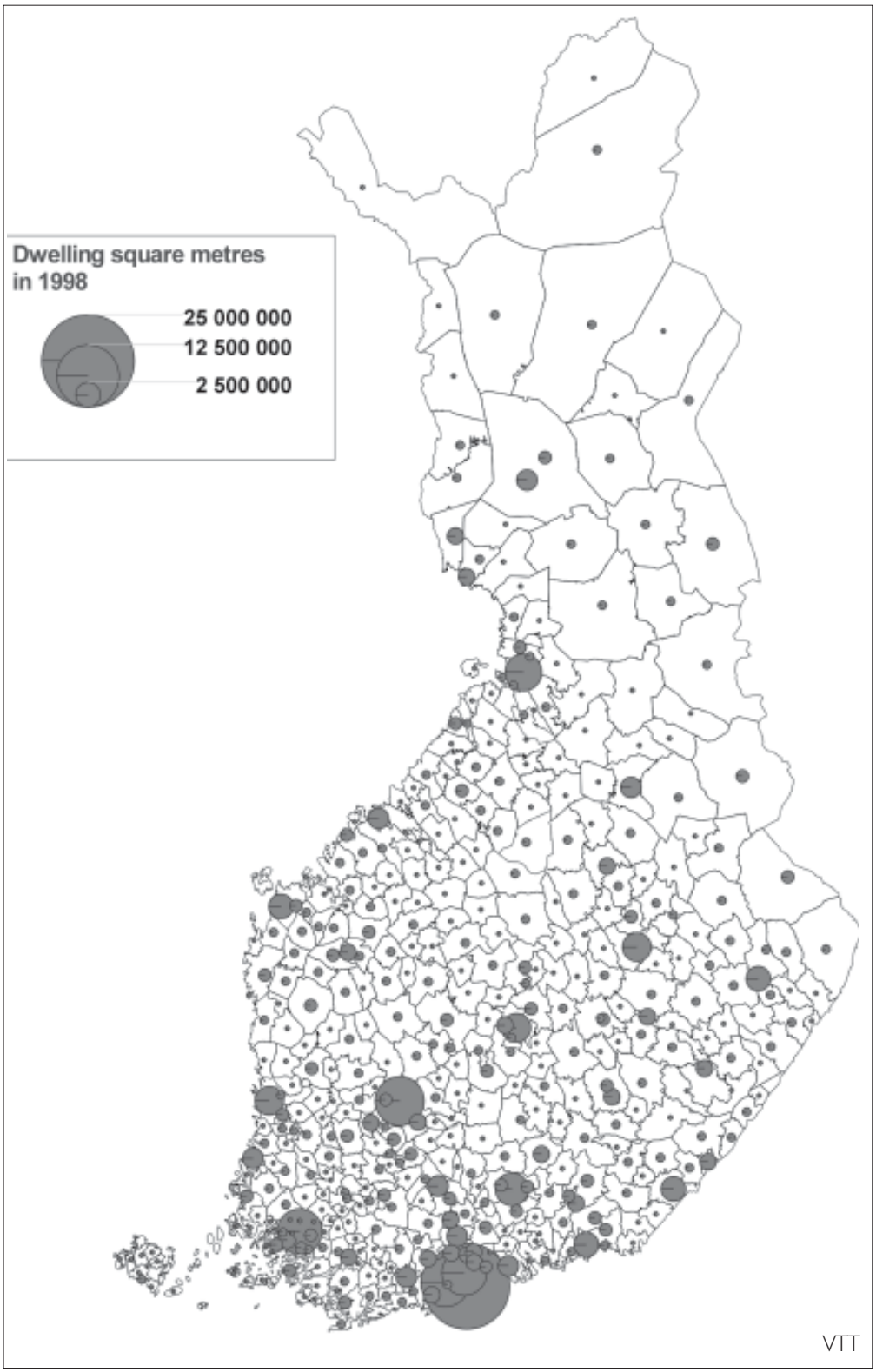

Figure 1. Finland's regional form, shown as square meters of dwelling space, in 1998.

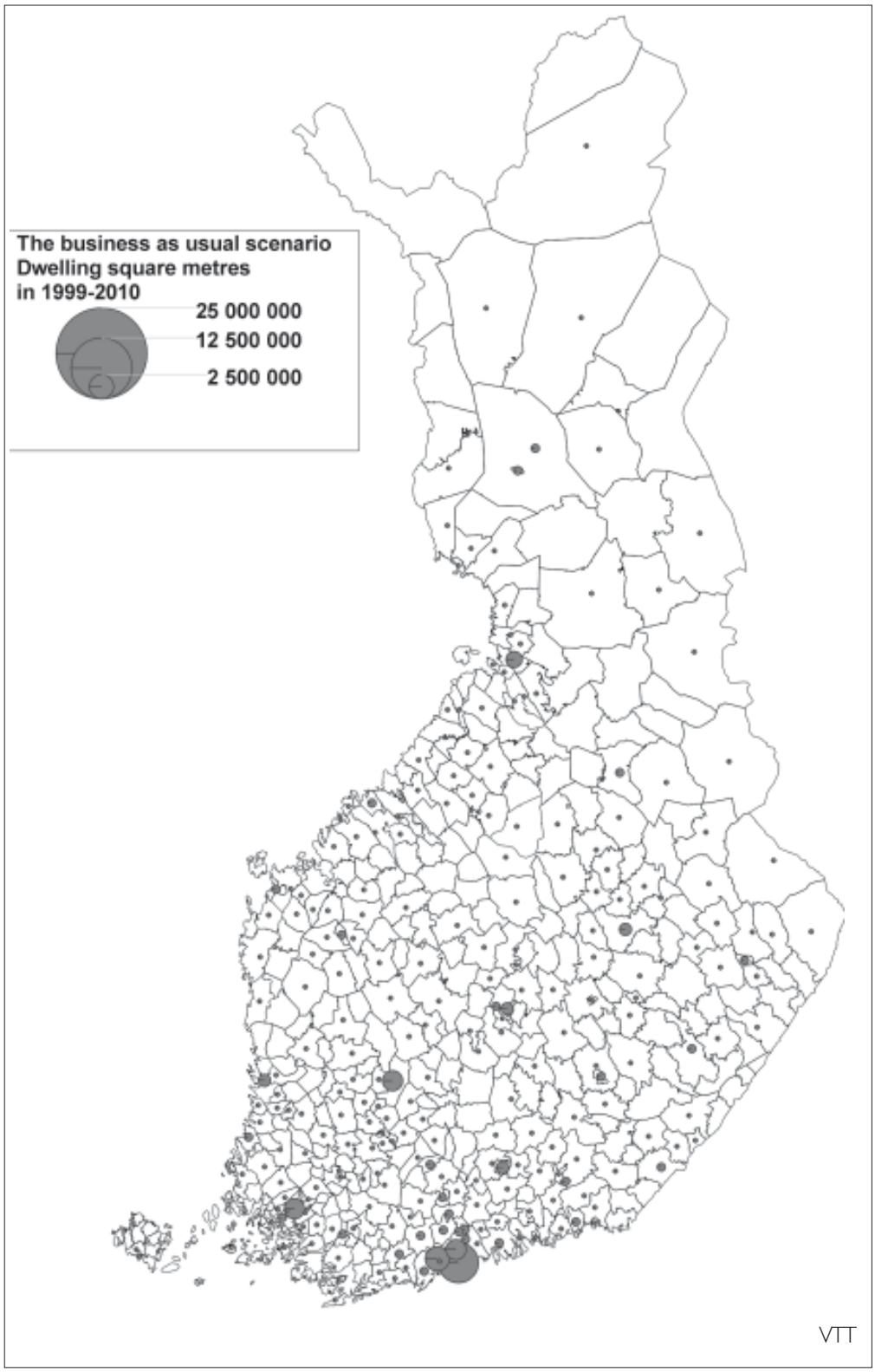

Figure 2. Change in Finland´s regional form in 1999-2010 under the business as usual scenario, shown as square meters of dwelling space. Form is becoming concentrated.

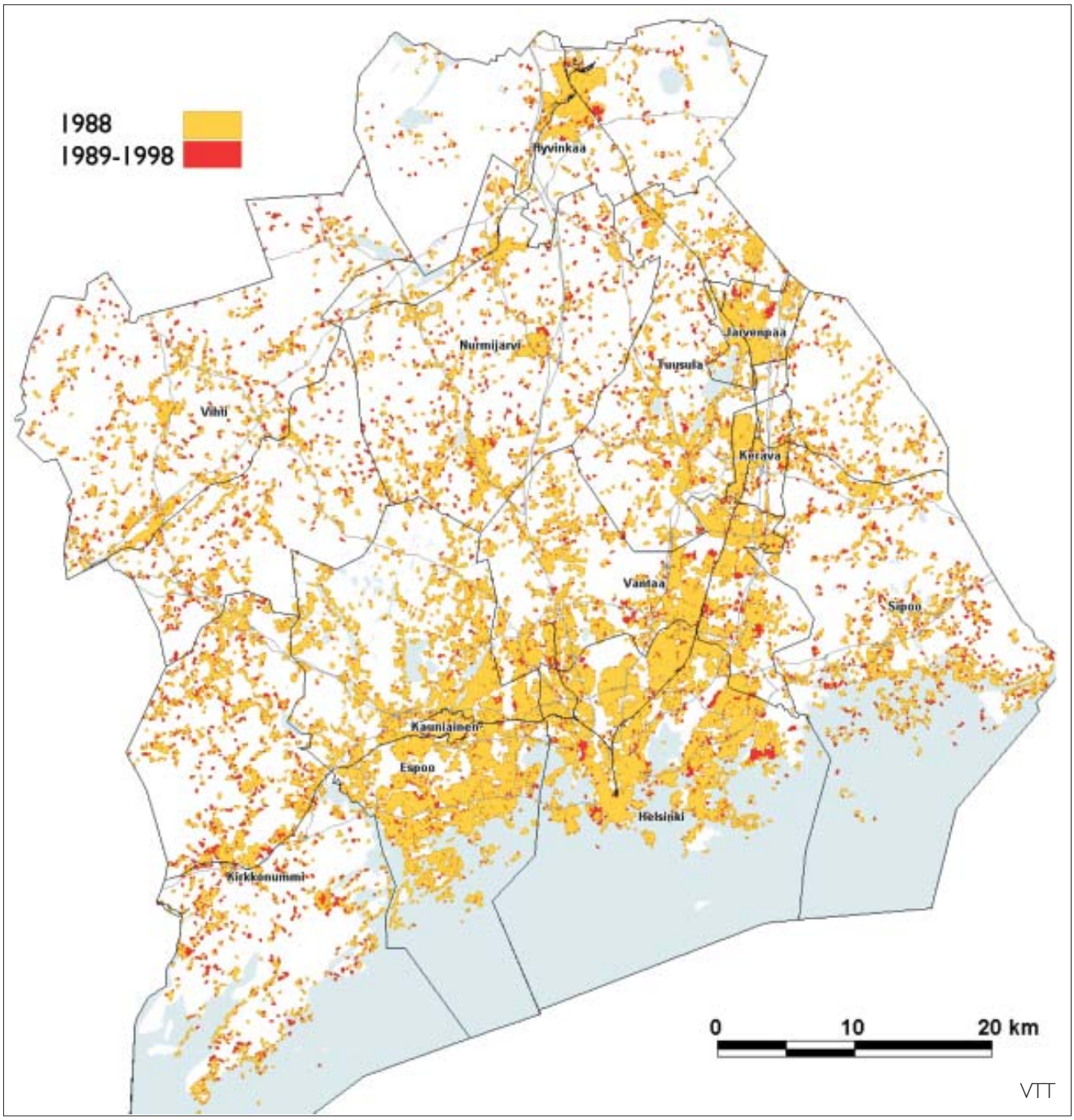

Figure 3. Change in urban form in 1989-1998 in the Helsinki region, shown as built-up areas defined by GIS methods developed by VTT. Sprawl has been continuous. Under the "business-as-usual" scenario this trend continues. The buildings outside the built-up areas are not shown.

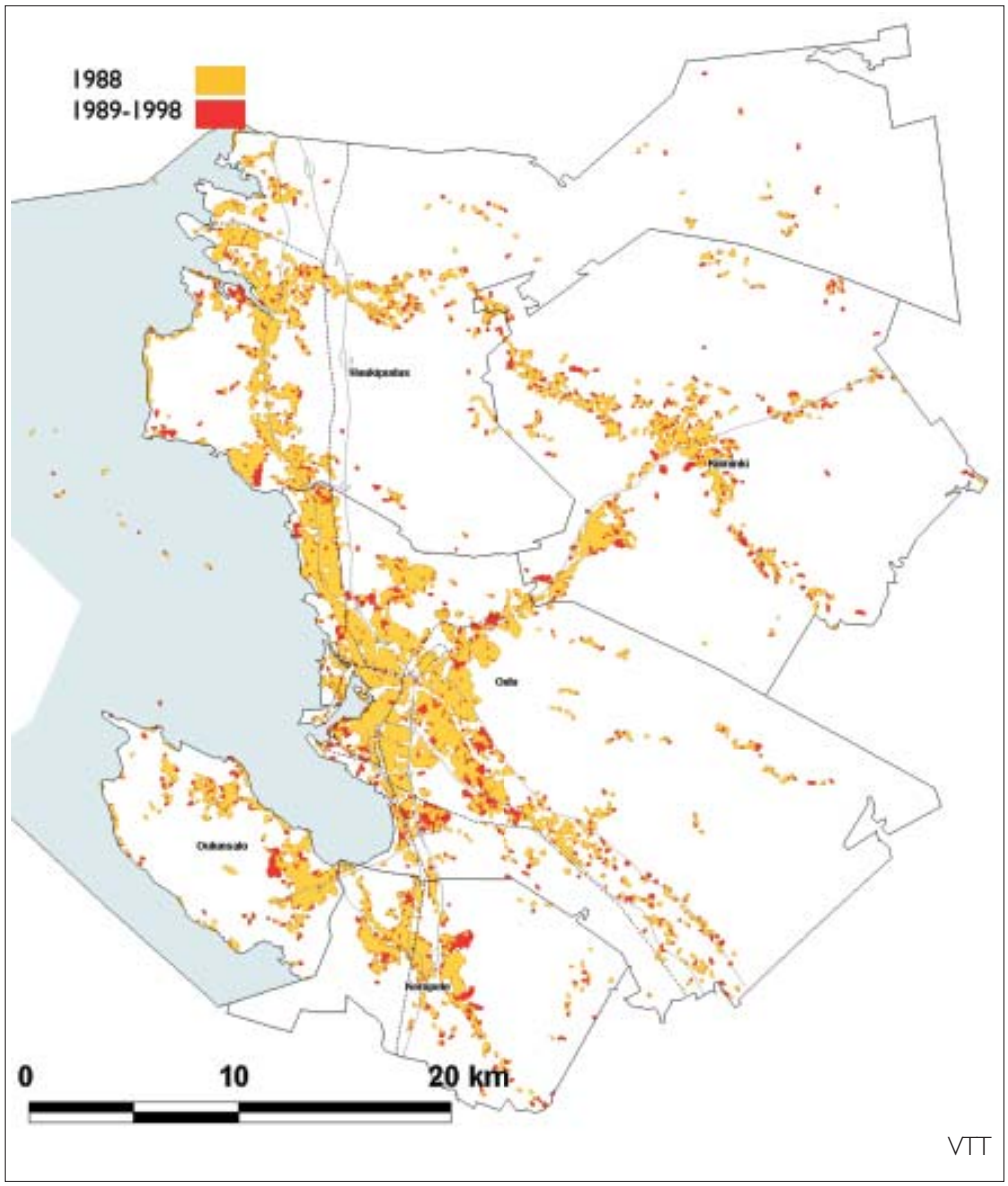

Figure 4. Change in urban form in 1989-1998 in the Oulu region, shown as built-up areas defined by GIS methods developed by VTT. Sprawl has been continuous. Under the "business-as-usual" scenario this trend continues. The buildings outside the built-up areas are not shown.

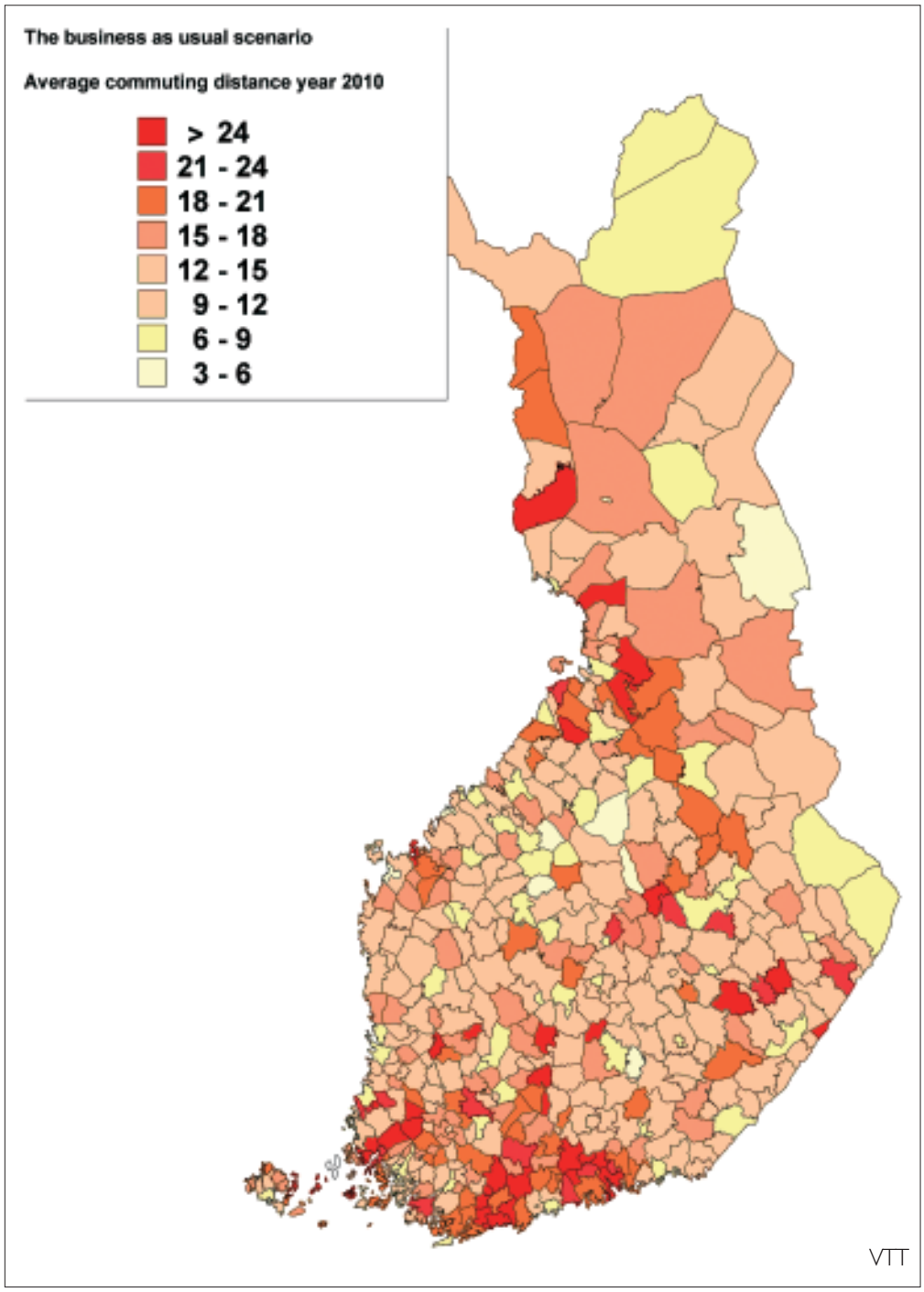

Figure 5. Average straight-line commuting distances from residences to work places in Finnish municipalities in 2010. The average was 8.7 km in 1991 and 9.6 km in 1997. According to the business as usual scenario it will be 11.4 km in 2010. Increased commuting distances in outskirts are particularly pronounced.

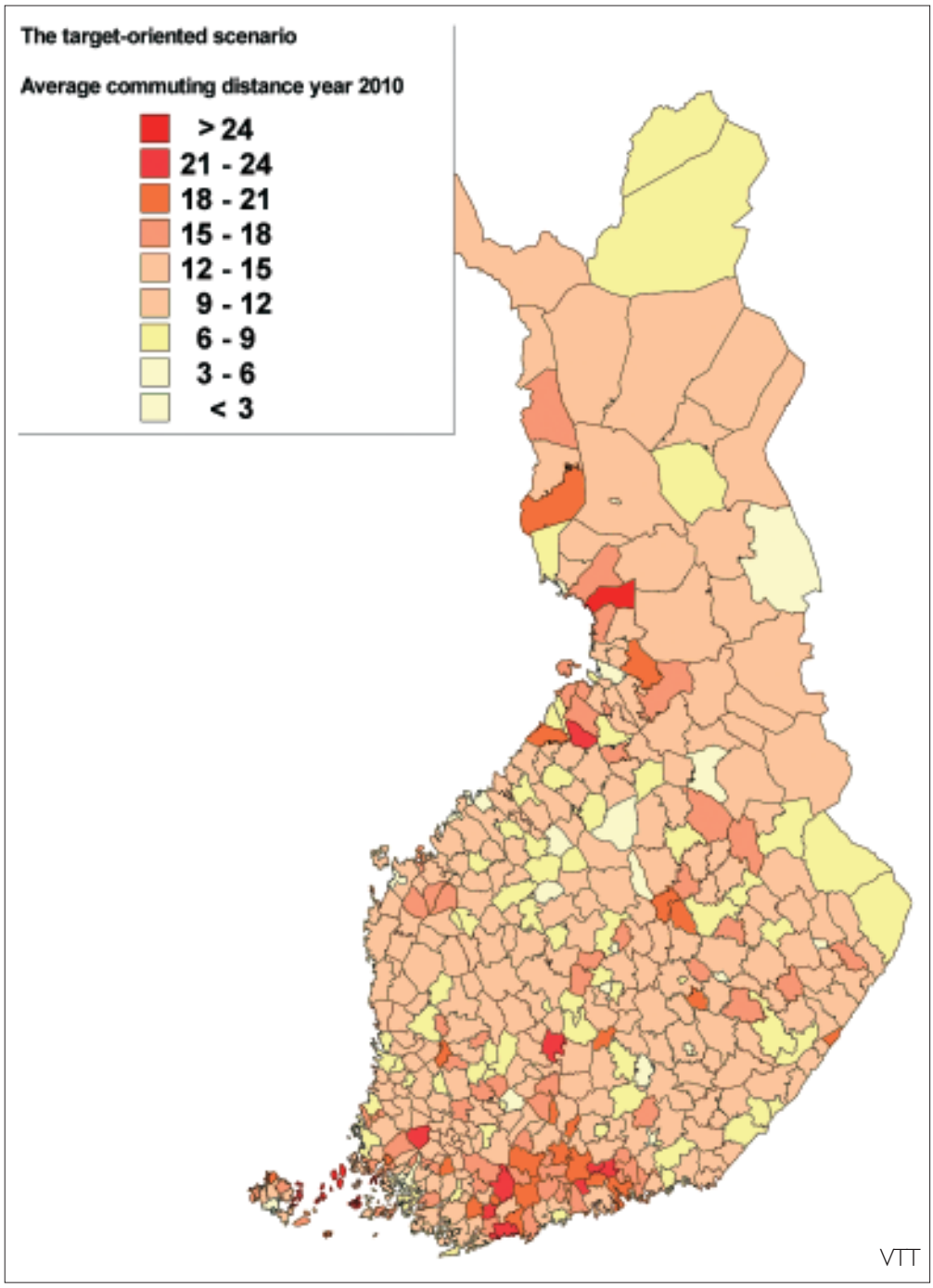

Figure 6. Average straight-line commuting distances from residences to work places according to the target-oriented scenario in 2010. The average in Finland will be no more than 9.1 km. Commuting distances in outskirts now exhibit more controlled increases.

3 The target-oriented scenario

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.

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.

Residential building stock is about 111 000 square metres of floor space less than in the business as usual scenario in 2010. There are more terraced houses and blocks of flats than in the business as usual scenario, and district heating is used more extensively.

Residential building stock in 2010 is divided into different housing forms in the target-oriented scenario as follows:

Detached houses

145.1 mill.m^2 floor space (-0.7 mill.m^2 difference from the BAU scenario)

Terraced houses

32.8 mill.m^2 floor space (+0.1 mill.m^2 difference from the BAU scenario)

Blocks of flats

86.8 mill.m^2 floor space (+0.5 mill.m^2 difference from the BAU scenario)

Total

264.7 mill.m^2 floor space (-0.1 mill.m^2 difference from the BAU scenario)

The change in regional form in the target-oriented scenario is described as the change in the residential building stock in municipalities in 1999-2010 and in the residential building stock in 2010. The aim is infill development in urban areas.

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 6).

Trends in greenhouse gas emissions

4

4.1 Passenger traffic within regions

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.

Commuting kilometres have been estimated using GIS-based commuting statistics by Statistics Finland.

> Passenger commuting kilometres (of a municipality) = number of working people * 230 (number of working days per year) * 2 * straight-line commuting distance * 1,3 (average real distance coefficient).

Kilometres of other trips (personal business, leisure etc.) have been estimated using the national passenger transport survey of the Ministry of Transport and Communications Finland and commuting statistics by Statistics Finland. Other trips seem to be dependent on the average commuting distance of a municipality as follows:

> Passenger kilometres of other trips (of a municipality) = (0,589 * average straight-line commuting distance + 13,2) * number of inhabitants * 0,923 (average share of people over 6 years) * 365 (days in a year).

Vehicle kilometres have been estimated using average modal split in different trip lengths and average load rate of different vehicles in Finland. Specific emissions of different vehicles have been estimated based on LIPASTO, VTT's calculation system for traffic emissions and energy consumption. According to LIPASTO, specific emissions of vehicles are supposed to decrease by about 15 - 20 % from 1990 to 2010.

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 CO_2 equivalent, i.e. 9 % in the business as usual scenario.

Commuting accounts for about one-quarter of all vehicle kilometres and emissions. Private cars compose 99 % of vehicle kilometres and 94 % (in the target-oriented scenario 93 %) of emissions. (Figures 7-10)

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 CO_2 equivalent, i.e. 27 %, in 2010 compared to the business as usual scenario and vehicle kilometres driven will be 22 % lower (Figure 11). Thus, a compact urban form will result in a 0.8 Mt CO_2 eq. reduction

in emissions, and an increase in teleworking and other kind of lifestyle changes will result in a 0.2 Mt CO_2 eq. reduction in emissions.

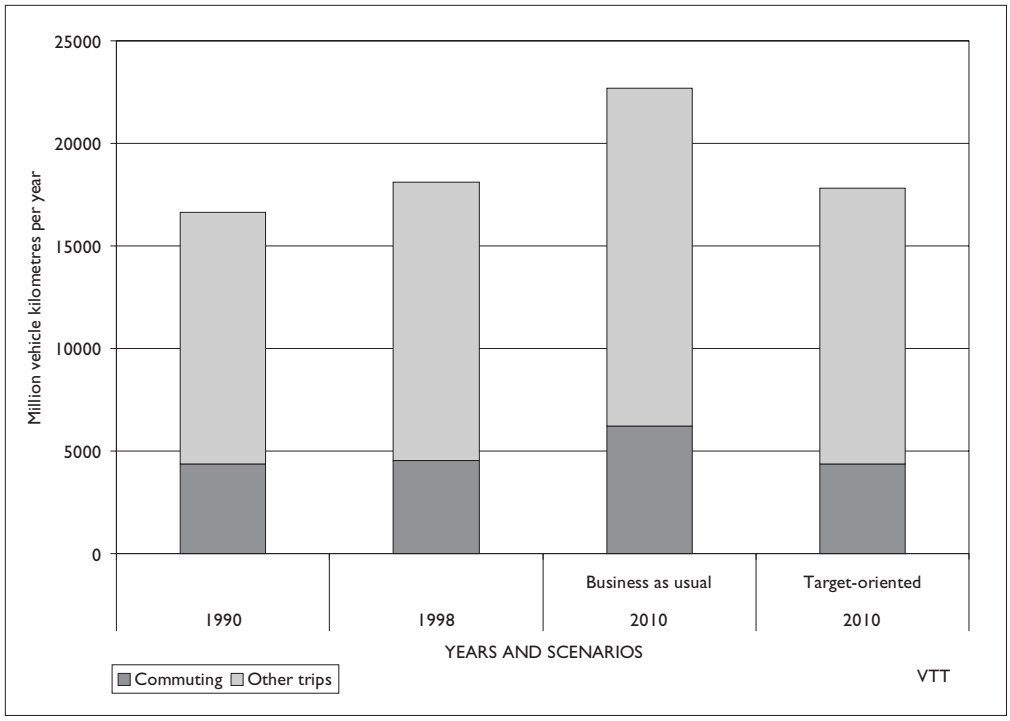

Figure 7. Vehicle kilometres of commuting and other trips within regions in Finland in 1990, 1998 and 2010 in the business as usual and target-oriented scenarios (change in urban form). Vehicle kilometres increase 36 % from 1990 by 2010. The target oriented scenario reduces vehicle kilometres by 22 % in 2010 compared to the business as usual scenario. Commuting accounts for a quarter of the kilometres driven.

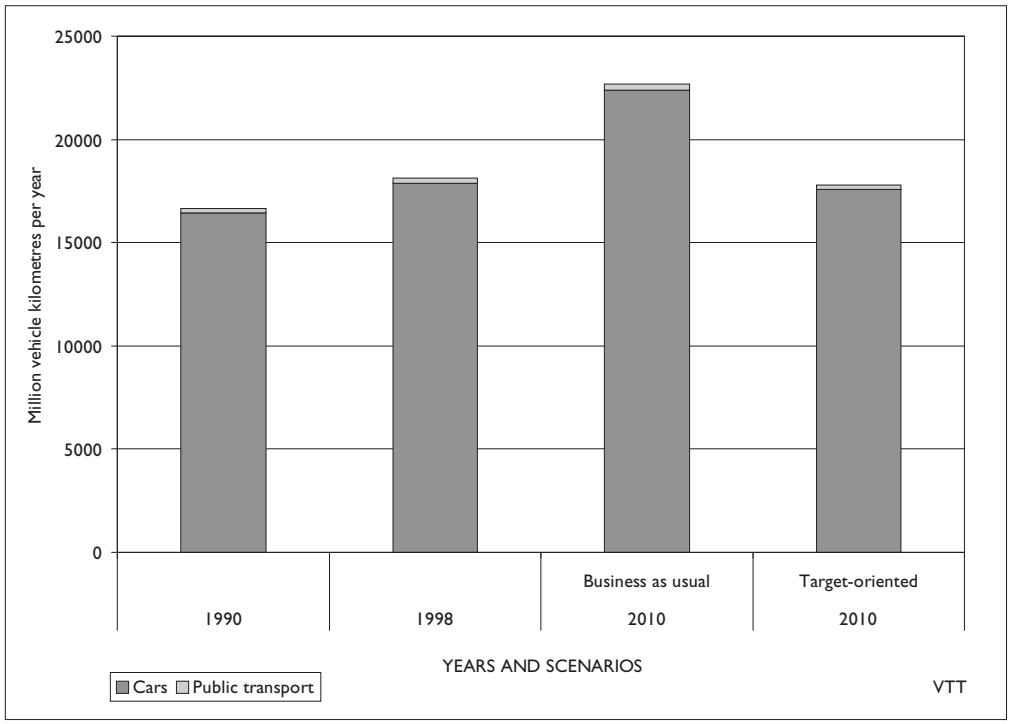

Figure 8. Private car and public transport vehicle kilometres within regions in Finland in 1990, 1998 and 2010 in the business as usual and target-oriented scenarios (change in urban form). Private cars account for 99 % of the kilometres driven.

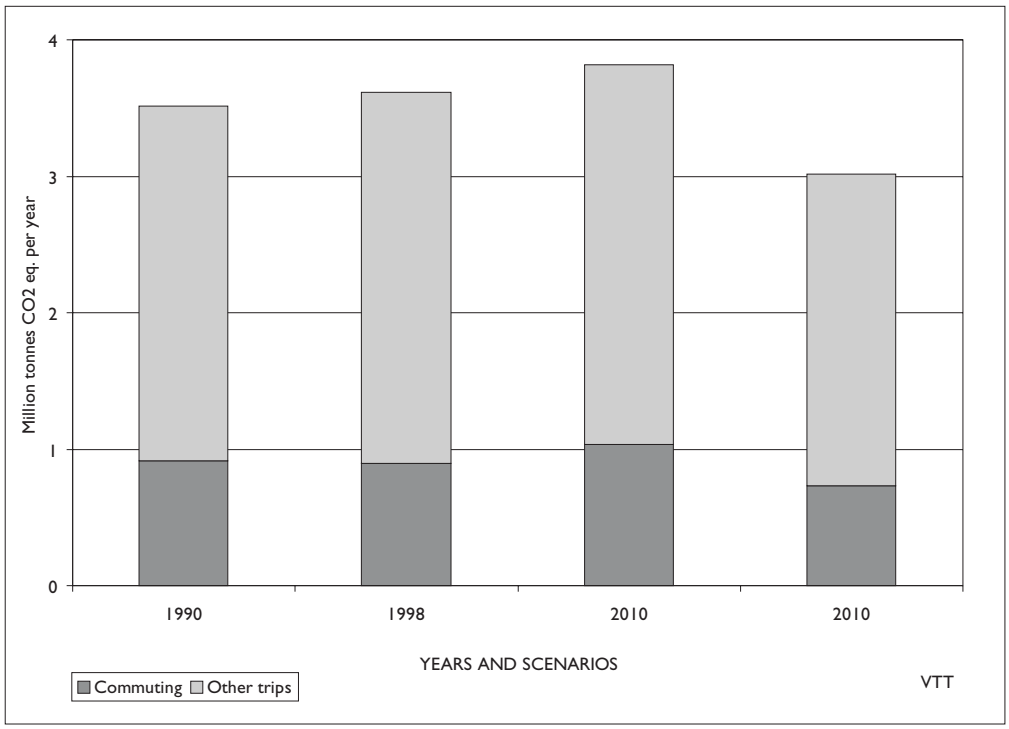

Figure 9. Greenhouse gas emissions of passenger traffic within regions in Finland in 1990, 1998 and 2010 in the business as usual and target-oriented scenarios (change in urban form). Commuting accounts for a quarter of the emissions.

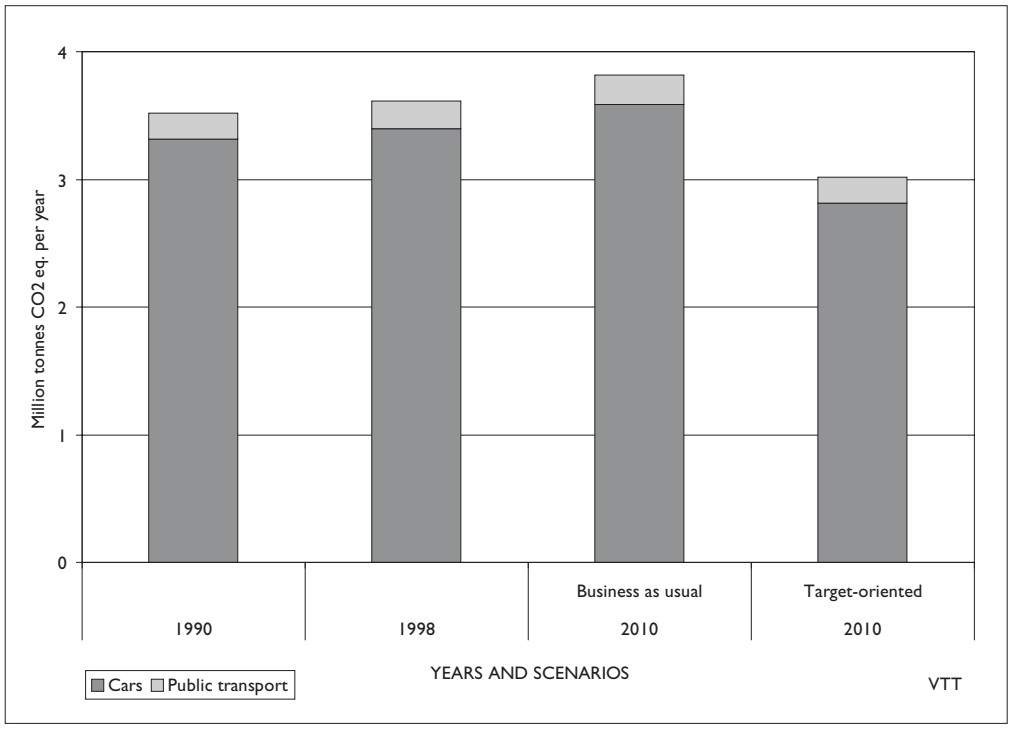

Figure 10. Greenhouse gas emissions of public transport and private cars within regions in Finland in 1990, 1998 and 2010 in the business as usual and target-oriented scenarios (change in urban form). Cars account for 94 % of the emissions (in the target-oriented scenario 93 %).

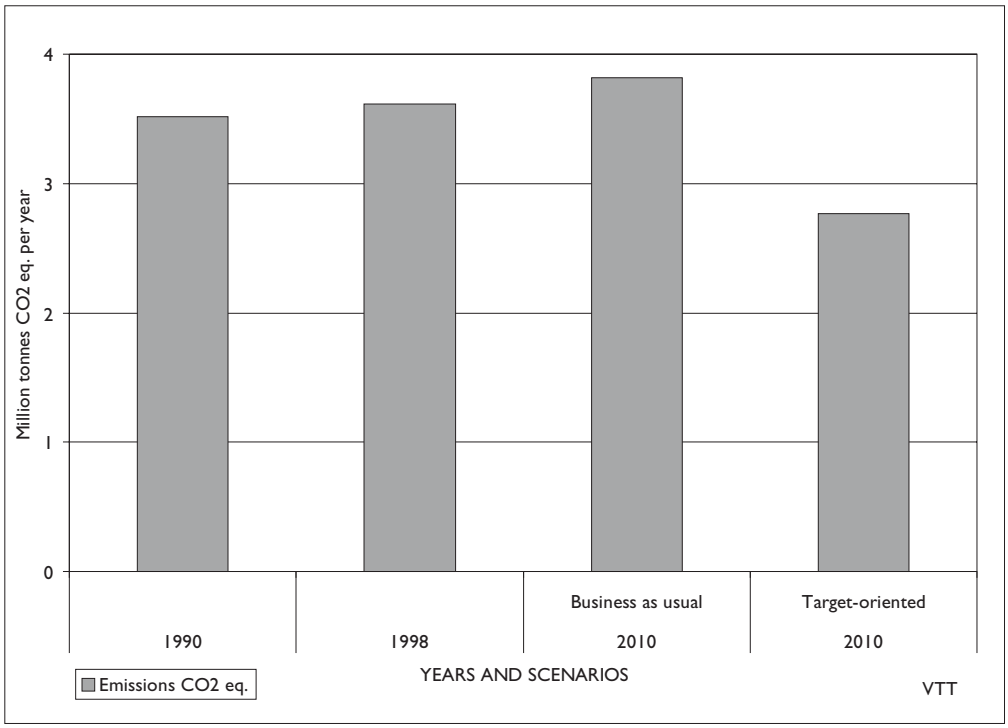

Figure 11. Greenhouse gas emissions of passenger traffic within regions in Finland in 1990, 1998 and 2010 in the business as usual and target-oriented scenarios (including change in urban form, increase in teleworking and lifestyle changes). The target-oriented scenario reduces emissions by 1.1 Mt CO_2 eq., i.e. 27 % in 2010 compared to the business as usual scenario. In 2010 emissions in the target-oriented scenario are less than in 1990.

4.2 Energy use in buildings

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 4.8 Mt CO_2 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 CO_2 eq. in 2010. (Figure 12)

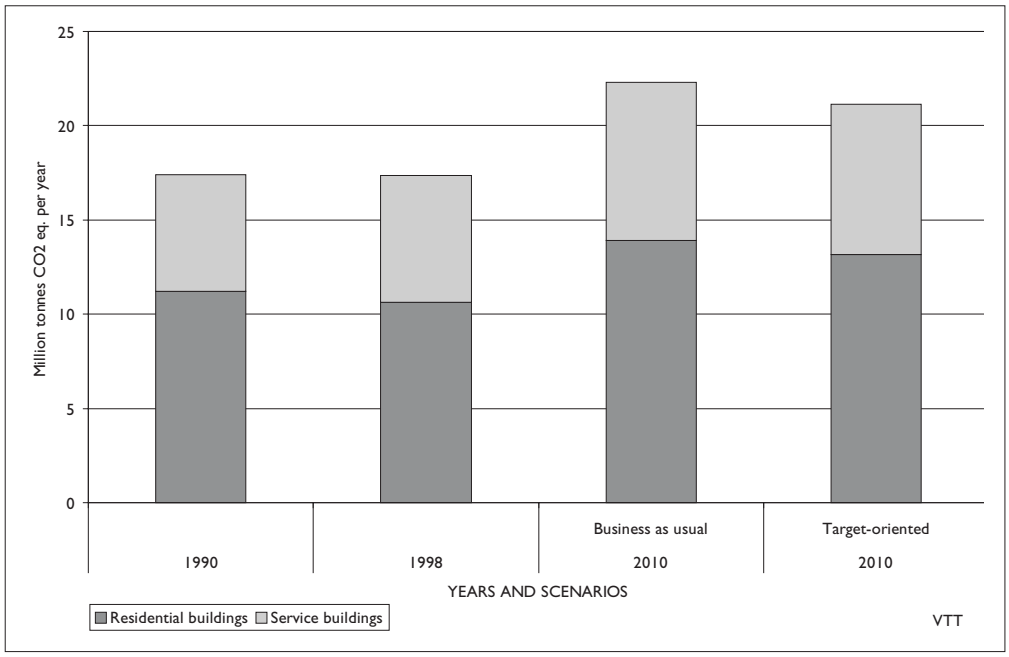

Figure 12. Greenhouse gas emissions from residential and service buildings from the year 1990 to the year 2010 in Finland in the business as usual and the target-oriented scenarios.

4.3 Municipal infrastructure

Construction and use of infrastructure networks causes annual greenhouse gas emissions of about 1 Mt CO_2 eq. Urban sprawl increases the need for infrastructure networks and thus emissions will rise by 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 CO_2 eq. in 2010.

4.4 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. The increase in passenger traffic within regions is estimated to be 0.3 Mt CO_2 eq., in the energy use in buildings, 4.8 Mt CO_2 eq., and in municipal infrastructure networks, 0.1 Mt CO_2 eq. (Table 3).

Table 3. 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 by 2.3 million tonnes in 2010 compared to the business as usual scenario. Reductions would be as follows (Figure 18):

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 CO_2 eq.**

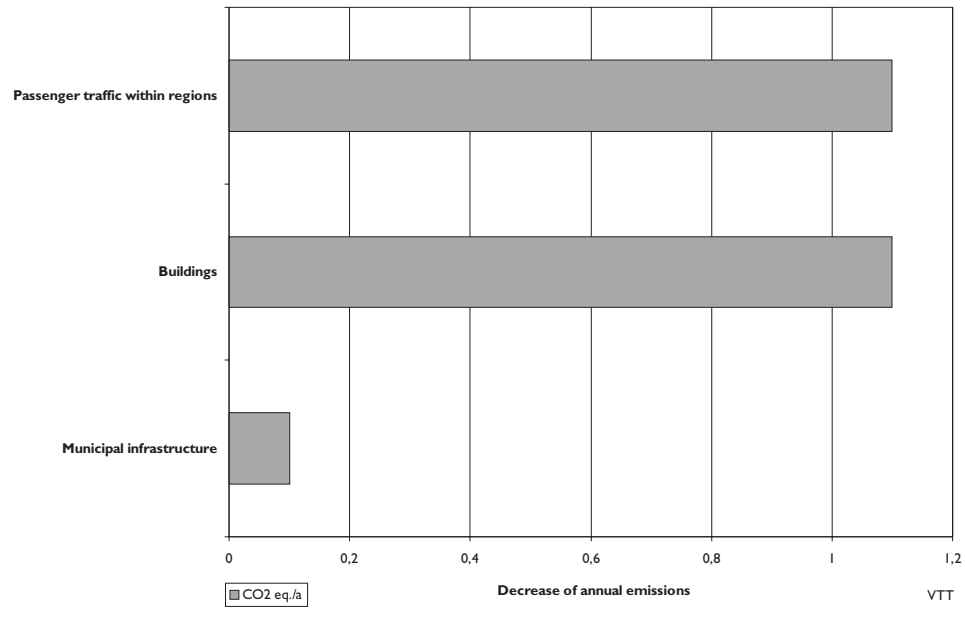

Figure 13. Potential reduction in greenhouse gas emissions in the target-oriented scenario to 2010 in three different categories. Careful development of the regional and urban structure would result in an estimated reduction of 2.3 Mt CO2 eq.

5 Conclusions

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. As a result of urbanisation, Finland's regional structure is becoming more concentrated, while urban sprawl is causing growth centres to become fragmented.

If the present rate of urban sprawl were to continue, internal passenger traffic within regions is estimated to increase by 6,000 million vehicle kilometres, i.e. 36 %, and greenhouse gas emissions will rise by 0.3 million tonnes CO_2 eq., i.e. 9 %, from 1990 to 2010. The increase would be even greater 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.

Greenhouse gas emissions from residential and service buildings are estimated to rise by 4.8 million tonnes CO_2 eq., i.e. 27 % from 1990 to 2010. This is caused by an increase in building stock, and especially from greater use of electric heating and electricity in general.

In the target-oriented scenario, urban sprawl was stopped by locating new dwellings nearer to central municipalities of regions and by locating dwellings and working places nearer to each other. If community structures were more concentrated it would be possible to reduce passenger traffic emissions annually by 0.8 Mt CO_2 eq. An increase in teleworking and lifestyle changes would further reduce emissions by 0.2 Mt CO_2 eq. Altogether it is possible to decrease greenhouse gas emissions of passenger traffic within regions by 1.1 Mt CO_2 eq., i.e. 27 %. At the same time, the potential for district heating would grow. Greater use of district heating would result in 5 % fewer emissions from residential and service buildings by 2010, or 1.1 Mt CO_2 eq. The estimated emission reduction potential for municipal infrastructure networks would be 0.1 Mt CO_2 eq., i.e. 6 %.

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.

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Julkaisun nimi	Urban form and greenhouse gas emissions. Summary (Yhdyskuntarakenne ja kasvihuonekaasupäästöt)	
Julkaisun osat/ muut saman projektin tuottamat julkaisut		
Tiivistelmä	Suomen aluerakenteen keskittymisen ja yhdyskuntarakenteen hajautumisen vaikutuksia on tutkittu aikatähtäimenä Kioton pöytäkirjan tavoitevuosi 2010, jolloin kasvihuonekaasupäästöjen tulisi olla enintään vuoden 1990 tasolla. Yhdyskuntarakenteella on merkitystä erityisesti kaupunkiseutujen liikenteeseen, kaukolämmön edellytyksiin sekä yhdyskuntateknisten verkostojen tarpeeseen. Jos yhdyskuntarakenne hajautuu edelleen yhtä voimakkaasti kuin viimeisten kymmenen vuoden aikana, kasvaa seutujen sisäisen henkilöliikenteen ajoneuvosuorite 1990-2010 kaikkiaan 36 % ja liikenteen vuotuiset kasvihuonekaasupäästöt 0,3 miljoonaa tonnia. Asuntojen lämmityksestä ja sähkönkäytöstä puolestaan aiheutuu 4,8 miljoonan tonnin ja yhdyskuntateknisten verkostojen lisätarpeesta 0,1 miljoonan tonnin lisäys vuotuisiin kasvihuonekaasupäästöihin. Jos talouskasvu on voimakasta tai jos yhdyskuntarakenteen ohjaus tai ajoneuvojen ominaispäästöt eivät kehity nyt oletetulla tavalla, voi etenkin liikenteen päästöjen kasvu olla arvioitua suurempaa. Tutkimuksessa laadittiin tavoitteellinen skenaario, jossa muuttoliikkeen oletettiin jatkuvan samoille työssäkäyntialueille kuin em. nykykehitysskenaariossa mutta yhdyskuntarakennetta eheytettiin sijoittamalla uutta väestöä lähemmäksi keskuskuntia sekä asuntoja ja työpaikkoja lähemmäksi toisiaan. Lisäksi oletettiin, että etätyö yleistyy jonkin verran ja että elämäntavat kehittyvät ympäristöystävällisemmiksi. Tulosten mukaan kasvihuonekaasupäästöjä kyetään vähentämään vuoteen 2010 mennessä seutujen sisäisen henkilöliikenteen osalta jopa 1,1 miljoonalla tonnilla, asuntojen lämmitysenergian osalta 1,1 miljoonalla tonnilla ja teknisten verkostojen osalta 0,1 miljoonalla tonnilla vuodessa. Tämä yhteensä 2,3 miljoonan hiilidioksidiekvivalenttitonnin vähennys vastaa 15 %:a koko Suomen vuoden 2010 vähennystavoitteesta. Jos tavoitevuoden jälkeinen kehitys jatkuu tavoitteellisen skenaarion mukaisesti, tulee päästöjen väheneminen voimistumaan entisestään. Yhdyskuntarakenteen eheyttämiseksi tarvitaan toimenpiteitä maankäytön suunnittelussa, tontti- ja asuntopolitiikassa sekä liikenne-, talous- ja veropolitiikassa. Lisäksi on tarpeen kehittää yhteistyötä, vuorovaikutusta ja tiedotusta.	
Asiasanat	yhdyskuntarakenne, aluerakenne, ilmasto, kasvihuonekaasupäästöt, liikenne, asuminen, ympäristövaikutukset	
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Presentationsblad

Utgivare	Miljöministeriet Markanvändningsavdelningen
Datum	Juli 2002
Författare	Irmeli Harmaajärvi, Aimo Huhdanmäki, Pekka Lahti
Publikationens titel	Urban form and greenhouse gas emissions. Summary (Samhällsstruktur och utsläpp av växthusgaser)
Publikationens delar/ andra publikationer inom samma projekt	
Sammandrag	Regionstrukturen i Finland blir allt mer koncentrerad, men strukturen i tillväxtområdena håller på att splittras. Denna studie gäller förändringarna i Finlands region- och samhällsstruktur och hur de inverkar på utsläppen av växthusgaser fram till år 2010, då Finland enligt Kyotoprotokollet skall ha återfört dessa utsläpp till 1990 års nivå. Samhällsstrukturen påverkar i synnerhet trafiken i tätorterna, möjligheterna att använda fjärrvärme och behovet av kommunaltekniska nätverk. Om splittringen av samhällsstrukturen fortsätter på samma sätt som under de tio senaste åren, ökar den årliga lokala persontrafikens fordonsarbete mellan år 1990 och 2010 sammanlagt med 36 % och koldioxidutsläppen med 0,3 miljoner ton. Utsläppen av växthusgaser från uppvärmning och elförbrukning i bostads- och servicebyggnader uppskattas öka med 4,8 miljoner ton och utsläppen från kommunaltekniska nät med 0,1 milj. ton. Om den ekonomiska utvecklingen är kraftig och om man inte kan stävja splittringen av samhällena, eller om de specifika utsläppen inte minskar enligt beräkningarna, kan utsläppen särskilt från trafiken öka ännu mera. I det målinriktade scenariot antas migrationen fortsätta till samma pendlingsområden som enligt nuvarande trend, men splittringen av tillväxtregionerna förhindras genom att ny befolkning placeras närmare centralt belägna kommuner och genom att bostäder och arbetsplatser placeras närmare varandra. Därtill förmodas att distansarbetet i någon mån ökar och att levnadssätten utvecklas i miljövänligare rktning. Enligt scenariets resultat kan de årliga koldioxidutsläppen från intern trafik minskas med så mycket som 1,1 milj. ton, från eldning av bostads- och servicebyggnader med 1,1 milj. ton och från kommunaltekniska nät med 0,1 milj. ton. Allt som allt minskar utsläppen av drivhusgaser fram till år 2010 med 2,3 milj. ton/år, vilket motsvarar 15 % av Finlands mål för minskning av utsläppen fram till 2010. Om samhällsstrukturen också därefter utvecklas enligt scenariot, blir den relativa minskningen ännu snabbare. För att splittringen skall stanna av bör åtgärder vidtas i planeringen av markanvändningen, tomt- och bostadspolitiken och trafik-, finans- och skattepolitiken. Dessutom behövs bättre samarbete och mer växelverkan och informationsspridning.
Nyckelord	samhällsstruktur, regionstruktur, klimat, utsläpp, drivhusgaser, växthusgaser, trafik, boende, miljöverkningar
Publikationsserie och nummer	Miljön i Finland 573
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