Baltic University Urban Forum
Urban Management Guidebook IV

4

Traffic and Transport

Editor: Lars Rydén

Project part-financed by the European Union
(European Regional Development Fund)
within the BSR INTERREG III B Neighbourhood Programme.

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Series preface

The Baltic University Urban Forum, BUUF, project was designed to develop sustainability strategies for the local level. The project, conducted in a network of 20 cities and 15 universities in nine countries in the Baltic Sea region during 2003-2006, was coordinated by the Baltic University Programme Secretariat at Uppsala University in Uppsala Sweden, in cooperation with the Royal Institute of Technology, KTH, Stockholm, Sweden and the Union of Baltic Cities, UBC, the Environmental Commission in Turku, Finland.

The project was financed by the European Union through Interreg IIIB, the Swedish International Development Organisation SIDA, the Swedish Institute, and other sources, in particular the C-Framåt office in Uppsala County, as well as by the participating cities and universities.

Built on previous experiences ten areas were selected to be in focus in the BUUF project. These were.

- 1-3. Energy management; Water management; Waste management.
- 4-6. Traffic and transport; Urban green structures; The built environment and brown field restoration.
- 7-9. Socio-economic development; Urban-rural cooperation; Information and education;
- 10. Integration strategies in sustainable communities.

During the period 2003-2005 the project organised best practice conferences in all 20 participating cities addressing all ten topics as well as the integration between the topics, and sustainability strategies used in the participating cities. The discussions and study visits at the conferences inspired a series of guidebooks on the selected topics to be used for city administrations as well as researchers and teachers at universities dealing with sustainable urban development. These are herewith offered to the readers

The guidebooks are thus not proceedings of the conferences, even if several of the participants have contributed. The ten guidebooks were planned later and editors with editorial teams recruited. Authors include both practitioners from cities and researchers from universities. The production has been done during 2006 and 2007.

The main topic of the guidebooks is to report on sustainability strategies used and evaluate these strategies, and possibly suggest new strategies for sustainable development on the local level. The books also contain a number of detailed descriptions of how to work with city development in practice as well as reports more of research character. The format of the guidebooks is about 50 pages in A4 format and some 12 chapters.

The guidebooks are published as pdf documents on Internet to be available in the public domain and thus a generally available resource at the site www.balticuniv.uu.se/buuf. The site contains further resources developed in the BUUF project. These include an indicator book, city reports and benchmarking reports.

I want to express my gratitude to all editors and authors who have contributed to these books, and hope that the results will be used widely both by the cities and universities of the project as well as by many others.

Uppsala in May 2007

Lars Rydén
Project leader
Baltic University Urban Forum

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Mobility Management

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Lars Rydén, Uppsala University

Mobility Management is becoming an established method to promote sustainable transport. The traditional core of mobility management is so-called soft measures. These include all kind of user services, such as information, coordination, education, etc. These soft measures are combined with, and increase the value of, hard projects, that is, infrastructure developments such as building roads, bridges, bike roads, tram lines etc. The soft measures are targeting the mobility behaviour of the inhabitants of a city or region, while the hard projects are addressing the structure in which they move around. A core objective of Mobility Management is to reduce car use and thereby car traffic.

Mobility management is typically introduced, developed and run by medium-sized cities. It is found all over Europe. A coordination and support programme is the European Platform on Mobility Management, EPOMM. EPOMM it is said "is an international partnership aiming to promote and further develop Mobility Management in Europe. EPOMM provides a forum for all those interested in Mobility Management: representatatives from EU member governments, local and regional authorities, researchers, major employers, transport operators and other user groups. It aims to fine tune the implementation of Mobility Management between the Member States of the EU and other countries in Europe." (www.epommweb.org/).

1. Background

Mobility Management Centres

A Mobility Centre is the operating unit at the urban/regional level, where Mobility Services are initiated, organised and provided. The establishment of a Mobility Centre is an important milestone and serves as a focus point for Mobility Management.

A Mobility Centre is typically providing services to the inhabitants, the public, through individual access for personal visit, phone, fax, e-mail, information terminals or online services. The customers are not only individuals as we will see, but, equally much, institutions such as companies, authorities, schools, hospitals etc. The Centre concentrates all services and thus serves as a place for communication and exchange. A Mobility Centre gives Mobility Management a public face and promotes a new way to deal with mobility in a city both for public and the market.

The Mobility Centre is often placed in an easily reachable place in the city, and may thus receive customers in office hours, like a shop. It often provides some free services, such a free-of-charge bike maps, or time tables for municipal transport, but may also sell tickets for municipal transport, including month cards or other corresponding rebate tickets.

A mobility centre is typically also running several projects, which does not necessarily require immediate access for the public. These activities may or may not be located on the same place.

Work for improved mobility - Mobility Plans

The traffic in a city consists of the totality of traffic to and from a large number of sites, such as work places, shopping areas, schools etc. The task for the Mobility Management Centre is to improve, make more sustainable, the traffic to and from all these sites.

The Centre may work to this end with specific measures, which address well defined needs and situation, such as traffic to and from a specific work place. But it may also work with general measures, which will support good municipal traffic in general, such as improving bus traffic, or promote biking, etc.

A Mobility Plan is the most common instrument for Mobility Management in an area. A Mobility Plan is – according to EPOMM – "a comprehensive and directive document that indicates how to implement a Mobility Management scheme for a specific site." In this case *the site* may be a working place, such as a hospital, a larger industrial plant etc. The Mobility Plan can "apply all measures that help to reduce motorised vehicle trips to and from the site. It can be limited to certain trip purposes on the site such as visitor traffic or commuter traffic of a company."

The mobility plans are typically implemented through a number of projects, as will described below. But equally important is that the individuals, who are addressed by such a mobility plan, are informed and encouraged to follow the plan and that the good arguments for the plan are made visible. It is also crucial that the results of the plan are monitored and published continuously, so everyone concerned can follow how it is developing. Data showing success are often very inspiring for the individuals taking part, especially if several such activities are going on in a parallel so there is an opportunity to see how these compare and a component of competition – being best! – is introduced.

II. Mobility Management projects

It appears that a Mobility Management Centre typically works with some 30 projects at a time. These, as mentioned are ordinarily soft projects. But it is essential that the activities of a Centre does is coordinated with what the city works with in terms of infrastructure developments. These "hard projects" may be either large investments, such as bridges, roads, or tram lines, but more often a collection of smaller scale investments, such as parking places, bike roads, bus stops etc. As mentioned, most projects aims at reducing car traffic.

Car sharing

One way is to promote *car sharing*. Car sharing may be that individuals, who travel to the same working place, get to know each other and organise driving together. Finding friends for car sharing may be organised by a Mobility Centre. A car pool is a different way of sharing cars. Car pools are organised common use of a number of cars. They are advantageous for individuals who use a car less often, but needs it sometimes for trips for example to far away shops for buying furniture, delivering waste, or to visit family not easily reachable by public transport, or public transport is inconvenient for some reason. For those using a car a few times a month a car pool may be the easiest and by far the cheapest solution for getting access to a car. Car pools are common and they may be organised by a mobility management centre.

Typical Mobility Management (MM) Centre activities

- Counselling and consulting
- Information and education
- Marketing MM services and products
- Support MM projects
- Develop new services and products
- Coordination of activities
- Improve localisation of activities
- Research
- Improve access to information on e.g. timetables
- Environmentally friendly transports
- Bike campaigns

Promote the use of distance technologies

Another typical mobility management project is to *promote use of distance technologies*, ICT – Information and Communication Technologies – to avoid travel all together. Distance work may take several forms. A centre may e.g. set up a place where there is access to video conferencing for meetings, or provide short courses (instructions) on how to do it, and how to run and get access to the best equipment. Such distance communication equipment in general may be used either for meetings or simply for being able to work on a closer to home if the office is far away. Another typical use is distance education and thus being able to study without travelling very often.

Improve deliveries of goods

Transports to and from shops is often a large and sometimes quite unsustainable part of city life. *Deliveries of goods* may be improved in several ways. One is to coordinate it. For example that there is in the outskirts of the city a central to which distance transport – typically rather large trucks – delivers the goods. Then a smaller and environmentally better lorry, it may eg be electric or run on biogas, takes the goods to all shops in the city in one delivery. Shopping malls outside cites are also causing a considerable amount of car traffic. If the local and centrally placed shops are supported, e.g. with easy delivery of goods, this may be quite important for reducing car traffic and also for keeping the centre of cities live and interesting.

Promote biking

A standard component in any Mobility Centre use to be *promotion of biking*. This may take many different forms. For biking it is important that biking roads are in good shape and are well maintained. The Centre should keep track of that and require from the responsible administration of the city to do what ever is needed to keep biking roads in that way. Projects with this purpose include e.g. good pavement good lightening, proper signs at biking roads, prompt snow removal after snowing, and good parking places for bikes. Softer projects may be biking schools for children, campaign for biking either generally or at some work places.

Promote public transport

Finally Centres typically *promote public transport* in many ways. This again may consist of some harder projects, such as improving bus stops, but also many soft projects. These may be campaigns for using trams or buses, research to find out what is good and less good in the existing public transport, and improve whatever is not working well. It may contain the development of schemes for reduced fairs in some cases, or improving the information on the public transport system.

III: Other activities under the EPOMM platform

Mobility management for large events

Large events to which several thousands or tens of thousands of spectators attend, such as rock concerts or sports events etc, are typically characterised by a smaller or larger crisis in car traffic. One of the challenges of mobility management is to improve the situation in connection with such events.

One project addressing this problem is Smash-Events. On their website we may read "The international 'SMASH-EVENTS' project aims at developing a standard for integrated environmental management for large events like cultural events, music festivals, exhibitions, etc. More particularly, it tends to add the aspect of mobility management to already existing practices in reducing the environmental impact of large events." http://www.smash-events.net/index.phtml?sprache=en

Research on mobility

Several research institutions have joined the EPOMM to contribute their results in applied projects and to become more visible.

MOST is maybe the largest European R&D project in the field of Mobility Management. MOST has been running from January 2000 until December 2002. On the MOST website the reports, an overview on results, as well as a Monitoring and Evaluation Toolkit may be downloaded.

The Swedish Transport Research Institute, TKK, is an independent transport research institute founded by the Royal Swedish Academy of Engineering Sciences in 1949. TFK is based on corporate memberships by companies and organisations from the public as well as the private sector. TFK has offices in Stockholm, Göteborg and Borlänge (www.tfk.se).

IV. Mobility Management Cases

The European platform

Mobility Management Centres have been established in several dozens of European Cities and the experience is considerable. They include demonstration projects, case studies or other applications of Mobility Management. The Centres have been established not only in cities but also in for example companies and educational institutions. EPOMM serves as platform for the sharing of experience. (http://www.epommweb.org/epomm_examples_all.phtml?sprache=en.) On the site it is also possible to add your own example.

Borlänge, Sweden

Reducing truck traffic in the city

Borlänge is an industrial city in mid Sweden with about 50,000 inhabitants. It is dominated by a large steel mill, and the Dalälven River. The city has established a Mobility Management Office since several years. The projects listed for the office include

- Car pools
- Biking in Borlänge
- Children in traffic
- Support public transport
- Services to private sector- meeting with companies
- Reorganising flow of goods in Södra Backa industrial area
- Supporting tourism
- Information and service campaigns

The reorganisation of the goods traffic to the industrial area Södra Backa is an example of an usually creative and efficient project.

Södra Backa is fairly close to the city centre and the regular traffic of large trucks, about five per day, to the areas was quite a problem in the city. When the mobility Centre personnel visited the company to discuss this they discovered that the company in fact had railroad access since long, but is was not used at all. The main reason was that the whole area for loading and unloading was occupied by all kinds of not used material and equipment which made any work impossible. The company agreed that reestablishing rail road transport would be better environmentally and economically. The calculation of costs for a clean-up operation indicated that return of investments would be good and rather quick. The reestablishment of train access to the company was thus made. A year later the truck traffic through the city had reduced considerably.

Graz, Austria

Teaching children how to bike in city traffic

Graz is a city of cyclists. Children, who use the bike for going to school and in their leisure time, make up a large proportion of cyclists.

In Austria only children aged 12 and over are allowed to ride the bicycle in real road traffic (without adult escort) unless they take a non-compulsory cycling exam at the age of 10. These exams usually take place in safe training areas where there is no real traffic.

The children don't get used to cycling in a real traffic environment. Therefore Austrian Mobility

Research (FGM-AMOR) launched a school project which aimed at conveying the basics of road traffic to the pupils. The training sessions did not take place in safe areas but in a real traffic environment!

Lund, Sweden

Mobility Centre Activities

In 1997 a plan for a sustainable transport system was adopted in the city of Lund in southernmost Sweden, and in 1998, the Mobility Centre was set up. The Centre works with mobility consulting directed to inhabitants and employees in the region of Lund. The aim is to achieve a better use of the existing infrastructure through Mobility Management and the activities should contribute to a higher use of alternatives to the car and thus a modal shift. Since January 2000, the Mobility Centre has on average had 4 employees, working on five main groups of projects:

1. Mobility Management in the City: awareness raising campaign on green travel policies among decision makers, multipliers and employees; education in eco-driving; pilot on tele working
2. Mobility Management in companies: awareness and consulting campaign in companies with tailor made brochures
3. A pilot project in Södra Sandby village to test whether travel behaviour can be changed only by combining several mobility management activities
4. Promotion of use of eco-cars and car sharing
5. Supporting local production and local services; contests in the context of leisure activities

Sandwell, United Kingdom

Mobility Management at Sandwell Hospital

Sandwell General Hospital is situated in a residential area. The hospital employs 3,600 staff and an average of 140,000 out patients attend the hospital for treatment each year. Due to a growth of clinical services and a reduction in parking spaces, the residential neighbouring streets are more and more used by staff and patients for parking. These factors, together with increasing car use, have resulted in severe congestion. Main objectives of the hospital are therefore to implement effective traffic management on site and to implement initiatives to reduce car use by those visiting the site, particularly staff.

A staff survey carried out at the end of 2001 revealed that 25% of staff lives within 2 miles (3 km) of the hospital, whereas 74% use the car to come to work. In the course of the European MOST project the following existing measures were further developed:

1. Public transport season tickets: annual tickets at a discounted rate purchased by the hospital and to be repaid through an interest free loan over a 12 month period; the scheme attracted 13.5% of employees to public transport from other modes;
2. Scooter project: 4 scooters available for one/two weeks of free trial to assess whether a scooter is a viable alternative to a car to come to work; interest free loans for staff that decide to purchase a scooter as a result; those employees now travelling to work by scooter created a modal shift of 38% from other modes of transport;
3. Cycling to work: incentives to try cycling through short-term bicycle loans, secure parking store and interest free loans to purchase bicycles and protective clothing; provide details of personalised cycling routes; buddy scheme to cycle with colleagues;
4. Walking to work: personalised walking routes; buddy scheme to walk with colleagues.
5. Car park management scheme, car sharing, patient call centre, were not yet implemented.

The Author

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Muncipal Road Safety in the Baltic Region

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Magnus Andersson, Cajoma Consulting, Uppsala, Sweden

It can never be ethically acceptable that people are killed or seriously injured when moving within the road transport system.
Claes Tingvall, road safety director, the Swedish Road Administration

1. Road accidents in the Baltic region

Ever greater mobility comes at high price. Every year 1.2 million people are killed worldwide as a result of road accidents and up to 50 million are injured. Sadly, many of the victims are children.

In the countries around the Baltic Sea some 50,000 people were killed in road accidents in 2004 (Table 1).

The Nordic countries belong to the countries in Europe which have the highest road safety performance. The countries in Central and Eastern Europe have still a long way to go to reach a similar safety level.

Pedestrians and cyclists are particularly vulnerable groups in the road traffic. As far as pedestrians are concerned there is a significant difference between the Nordic countries and the other countries. In the Nordic, some 10-15% of the annual fatalities on the roads are pedestrians. In the other countries more than 30% of the annual fatalities are pedestrians (Table 2). Thus pedestrians is a key target group for policies and measures to improve the road safety situation, especially in Central and Eastern Europe.

Approximately 10% of the fatalities are cyclists.

Costs to society

The accidents in the road traffic cause considerable economic losses to society due to costs for medical treatment, material losses and loss of production. In Sweden, it is estimated that road accidents cause an annual loss of 1% of GDP. In Poland the annual loss has been estimated to 5 billion Euro.

In the European Union the loss is about 2% of GDP.

Risk factors

In most accidents in the road traffic, speed is an important risk factor. High speed contribute to accidents and the severity of injuries are directly related to the speed. Excessive speed is the main cause for road accidents.

The Transport Research Laboratory in the UK has shown that a reduction of the average speed by 3 km/h would save 5,000-6,000 lives in the EU area. Furthermore, the number of accidents would be reduced by 120,000-140,000 and 20 billion Euro would be saved.

The consumption of alcohol and drugs is another risk factor. In the European Union, drinking and driving is responsible for more than 10,000 deaths each year. In Sweden there are at least 15,000 drivers in the everyday traffic who are under influence alcohol. Increased consumption of alcohol in society tends to worsen this problem.

Failure to wear a seat belt or crash helmet is a major aggravating factor in accidents. If the rate of seat belt use could be increased everywhere to the best international rate, many thousands of lives would be saved each year.

Many serious road accidents at the roads involve long-distance trucks. A collision between a car and a truck often leads to fatalities or serious injuries. The number of long-distance trucks have been growing

Table 1. Number of deaths in the road traffic in the Baltic region, 2004

Country	Number of deaths	Trends 2004-2003
Denmark	369	14.6%
Finland	375	1.1%
Sweden	480	9.3%
Estonia	170	+3.7%
Latvia	516	+4.7%
Lithuania	752	+6.1%
Poland	5,712	+1.3%
Russian Federation	34,506	3.1%
Ukraine	6,966	2.5%

Table 2. Numbers killed by road-use category (%), 2001

Country	Pedestrians	Cyclists
Denmark	11.4	13.0
Finland	14.3	13.6
Sweden	14.9	7.4
Estonia	30.2	9.0
Latvia	36.0	7.7
Lithuania	35.8	13.3
Poland	33.7	11.0
Russian Federation	44.2	2.1

Table 3. Safe speeds in various situations. Source: Tingvall, Claes and Narelle Haworth (1999).

Type of infrastructure and traffic	Safe travel speed (km/h)
Locations with possible conflicts between pedestrians and cars	30
Intersections with possible side impacts between cars	50
Roads with possible frontal impacts between cars	70
Roads with no possibility of a side impact or frontal impact	
(only impact with the infrastructure)	100+

rapidly in the past decade, especially in Central and Eastern Europe.

It should be emphasized that the risk factors that contribute to accidents interact in complex ways.

2. Road safety policy at the EU-level

Road safety has emerged as a new policy area for the European Union. The main domains of European Union action in the area of road safety are the following:
- User behaviour (campaigns, enforcement)
- Vehicle safety: passive safety (damage prevention) and active safety (accident
- prevention)
- Road infrastructure safety
- Professional driving and commercial transport

The European Union uses a defined set of instruments for its road safety policy:
- Legislation
- Best practice guidelines
- Research and studies
- Financial support to projects
- Road accident data and information

An important platform for EU road safety policy is the European Road Safety Programme for the period 2003-2010. The programme aims at halving the number of deaths to the year 2010 compared to the level 2000. It emphasizes that road safety is a shared responsibility. Thus, it is a challenge for national and local government, the private sector as well as for the citizens and non-governmental organisations.

The action programme aims to:

1. Encourage road users to improve their behaviour, in particular through better compliance with existing legislation, basic and continuous training for private and professional drivers and by pursuing efforts to combat dangerous practises.
2. Make vehicles safer, in particular through technical harmonisation and support for technical progress.
3. Improved road infrastructure, in particular by defining best practices and disseminating them at local level and by eliminating accident black spots.

3. Road safety policy at the national level

At the national level the government and/or the parliament could approve a *national road safety programme*[1] that addresses the following three elements:

1. Safety measures in the infrastructure (roads and streets)
2. Safe behaviour of the road users (drivers, pedestrians, cyclists etc.)
3. Safe vehicles

An effective road safety strategy should, first and foremost, aim at policies and measures which can reduce the speed.[2] There are four important measures that can be taken to reduce the speed:

1. Reduced speed limits, especially at roads with many accidents
2. Speed control by the police
3. Automatic cameras for speed control, especially at roads with many accidents[3]
4. Fines for excessive speed. The fines have to be sufficiently high in order to provide incentive for drivers to comply with the speed limitations.

A new solution that has been developed in Sweden in the past few years is to separate roads by a barrier. These barriers make it impossible to overtake other cars. Thus, collision accidents are completely avoided. It should be emphasized that it is a cost-effective solution that saves many lives.[4]

A general bicycle helmet law will save the life and health of many cyclists. Until now only three countries in the world has a bicycle helmet law: Fin-

[1] Preferably, the road safety programme should be accompanied by a national target for how many lives should be saved. In addition, sub-targets could be adopted. For instance, seat belt wearing or the use of bicycle helmet should increase by x per cent until the year x.
[2] Swedish researchers have concluded that a 10-20 per cent reduction of the speed can reduce fatalities by almost 50 per cent.
[3] This is a quite new technology which is being used more and more in Sweden. It is a very cost-effective measure to reduce accidents.
[4] The Swedish experience shows that it is much cheaper to save a life in this way than by building a new motorway.

"Vision Zero" – the Swedish approach

Vision Zero constitutes the basis for road safety policy in Sweden since 1997. It embodies a set of principles for designing road safety policy. The most important principles of Vision Zero can be stated as follows:

- The level of violence that humans can sustain without getting killed or seriously injured constitutes the basic design parameter for the road transport system. This means that no accident should expose those involved to an amount of biomechanical energy that exceeds the threshold for sustaining a serious injury,
- Vehicle speed is the most important regulating factor for road traffic.
- The designers of roads and vehicles are responsible for deigning roads and vehicles so as to comply as closely as possible with the injury design parameter.
- Road users are responsible for complying with the rules for using the road system set by the system designers.
- If road users fail to comply with the rules set by the system designers, the system designers are required to take further action in order to counteract people being killed.

Source: Elvik and Amundsen, 2000

land, Australia and New Zealand. In Sweden there is a bicycle law for children up to the age of 15.

4. Road safety at the municipal level

At the local level, it is important that priorities and targets are laid down in a *municipal programme for road safety*. It is important that such a programme be communicated to all relevant actors at the local level.

Possible measures for a municipal road safety programme include the following:

– Reduction of the speed limits to 40 or 30 km/h in urban areas[5]
– Traffic control (separation of) pedestrians and cyclists
– The establishment of safe pedestrian crossings
– Speed reduction devices at "black spots" or "black areas" in the cities
– Construction of roundabouts[6]
– Urban planning and traffic planning
– The establishment of mobility centres that can help citizens to find solutions to travel without increasing the numbers of private cars
– Car free areas in city centres[7]

Perhaps the most important driving force for improved road safety at the local level is the power of the good example. Once a good example is in place, other cities tend to become interested in the solution.

Below there follows a set of examples which illustrates how municipalities have worked to improve the urban road safety situation.

1. 30 km/h in built-up areas

In the past decade, more and more cities in Sweden have been able to establish a 30 km/h speed limit in built-up areas. In 2005, the authorities in Stockholm decided that the speed was to be limited to 30 km/h in *all* built-up areas. The main reason for this decision is that pedestrians and cyclists are likely to survive a collision with a car when its speed is about 30 km/h. If speed is higher, for instance 50 km/h, the chances for the pedestrians and the cyclists to survive are signicantly lower.

2. Roundabouts ('circulation places')

Everyone who travels in Sweden will notice that there are a large number of roundabouts in the cities. Roundabouts, which have been commonplace at intersections, have a traffic calming effect. The consequences of a collision is considerably less severe in a roundabout than in a normal intersection. This is due to lower speeds and different angles of impact. Furthermore, a calmer traffic leads to less emissions of air pollution from the car traffic.

3. Urban road safety project in the Czech Republic

In June 2005 the Ministry of Transport of the Czech Republic launched a project aiming at improving the road safety situation in urban areas. The project support road safety activities of municipalities by pro-

5 In 2005, 30 km/h was introduced in Stockholm. After that, the number of injuries went down by 10-20 per cent.
6 Roundabouts (1) reduces the number of serious accidents, (2) calms down the traffic and improves the flow of traffic which in its turn reduces emissions of carbon dioxide and (3) reduces maintenance costs compared to traffic-light solutions.
7 This is not only beneficial road safety but also for the urban air quality. In many instances care free areas attract more tourists and are beneficial for local business.

viding information on best examples and possible solutions. The project covers three types of 'interventions': education, enforcement and engineering.

A working group has been established for the project. It consists an interesting mix of stakeholders and policy-makers such as the Czech association of municipalities, representatives of different types of municipalities (small and big) and Transport Research Centre, regional directorates of the traffic police, and the national healthy cities network.

4. Creating safe ways to school

How could municipalities around the Baltic Sea create safe ways for children who go to school every day? The Swedish municipality of Helsingborg[8] several ways to increase the safety of children in the traffic between home and school.

- Measures are taken by the municipality to increase the number of children walking or biking to school (to reduce congestion and air pollution and provide an opportunity more physical exercise for children). 'Walking school bus' has been successfully implemented.

- The municipality promotes of the use of safety equipment such as helmet for bikers and, safety belt in cars.

- The municipality carries out physical changes in traffic environment to increase the safety of the school children in the traffic, particularly near the schools (e.g. speed reduction measures).

- Increased traffic safety awareness is promoted among school children by integration of 'traffic' in the ordinary school subjects. Co-operation has been established between Miljöverkstan – an educational centre for environmental protection – and teachers to find pedagogical ways to integrate traffic in ordinary school subjects.

Thus, the municipality of Helsingborg has developed integrated working methods to achieve safe ways to come to school. Both pedagogical methods and physical measures are elaborated jointly between traffic engineers and teachers.

6. Mobility management

Mobility management can be used by municipalities in order to reduce the dependency of the car for transports within the city. A reduction of the numbers of cars is, generally speaking, beneficial for urban road safety and urban environmental conditions.

The first centre for mobility management in Central and Eastern Europe has been established in Prague.

A major principle main in transport policy for Prague is to provide as much information as possible. Prague Public Transport (PPT) offers free information on transport in its five information centres. However, these centres work without any direct link to the railway or national bus information centres and other transport and city information. The newly established integrated Mobility Centre offers multi-modal transport information. The following services is offered to the general public:

- Comprehensive individual time tables and multi modal transport information
- Sales and reservations
- Event information and reservation
- Internet and phone accessibility

The Mobility Centre is a core element for mobility management in Prague. The concept is oriented towards the public transport system, which is the basis for a sustainable city development in Prague.

7. Speed reduction measures

The Swedish city Göteborg has invested in a lot of speed reduction measures since 1990. Today it has the best road safety performance of all cities in Sweden. The number of fatalities and seriously injured persons was reduced by 60% in a decade.

In several cities around the Baltic Sea various stakeholders are invited to the city hall to discuss the urban road safety situation and to put forward proposals aiming at improving the situation. Such processes tend to increase the general commitment for road safety among stakeholders.

5. A challenge for all stakeholders of the road transport system

Action to promote the wearing of seat belts is a good example of the interdependence of different road safety measures and stakeholders and the need for interaction at all levels of government, whether local, regional, national or EU, as well as the private sector (Table 3).

[8] Helsingborg is a Swedish municipality with approximately 100,000 inhabitants. There are 79 primary schools with 14,000 children. The total number of the children's travels between home and school amounts to 5.2 million every year.

Table 3. Possible actions by different stakeholders to increase seat belt use. Source: European Commission (2003).

PRIVATE SECTOR	innovation and initiatives development and marketing of more efficient restraint systems reduced insurance premiums for users of equipped vehicles campaign at company level for the workforce
REGIONAL /LOCAL LEVEL	police enforcement seat belt information in schools
NATIONAL LEVEL	implementation of EU rules setting national compliance objectives securing compliance through resources for police enforcement targeted national information monitoring of seat belt use encouraging set belt use policies in the public and private sectors
EUROPEAN UNION	rules on the mandatory fitting and use of equipment performance standards for safety belts and restraints a framework and support for campaigns to support seat belt use monitoring the incorporation of Community legislation by the member states into their national law

6. Conclusions

Road safety is an increasingly important policy area for the European Union and the countries in the Baltic region. It is particularly important to focus on the safety for pedestrians and cyclists who are the most vulnerable groups in the road traffic. Programmes for road safety are needed at national, regional and local levels of policy-making. Reduced speed is the single most important factor for a successful road safety policy. It has been estimated that 10-20 km/h less speed could reduce the number of fatalities by approximately 50%. There are a number of win-win situations between road safety, environmental protection and economic benefits. Policies aiming at a sustainable transport system should indeed take into account the road safety dimension.

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The most recent European transport statistics:
http://europa.eu.int/comm/energy_transport/etif/index.html

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http://europa.eu.int/comm/dgs/energy_transport/rtd/6/call_2/index_en.htm

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Biking in Cities

3

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1. Introduction

Background

The cities in the Baltic Sea region have since long experienced increased car traffic. Its consequences include large fossil fuel use, air pollution and crowding of the city centres. The city becomes less healthy, less friendly and less pleasing for its inhabitants. Thus much thought has been invested into how to restrict car traffic with out too much loosing possibilities to easily move around. Here we will focus on how increased biking can do that and which are the measures needed for it and the pluses and minuses of increased biking.

Today a large share of local transport in cities is made by car. 60% of all personal transports were less than 5 km, and out of these half was made by car (Sweden 2003). The short distance car transports are especially harmful since they mostly start with a cold motor, which then pollutes far more than a warm motor. (The converter does no work at low temperatures.) Short car trips then should first of all be replaced, and it is easier to do that, than for long travels. Alternatives are walking, biking, bus or other municipal transport. Here we will focus on biking.

In general biking does not represent a very large share of transports in our cities. The number of trips on bikes was in the west of the region about 10% (12% in Sweden 2003), and they are certainly much less in the Eastern part of the Baltic Sea region. It could be increased considerably. In some cities biking is much larger, up to 30 or 40%.

Biking versus car traffic

To move over part of the local transport to bike has a large potential for improving urban environment and quality. There are however a number of obstacle which have to be removed.

These include

- insufficient road, parking and other infrastructure for bikes
- insufficient maintenance of bike roads
- lack of a biking culture
- insufficient road safety in general and for bikes in particular

But the most difficult problem to deal with is probably habits and knowledge. People who did not use a bike for their entire life will have difficulties to change their habits. The understanding of the conditions and advantages of biking is low in the general population.

Increased car use is related to increased economic possibilities in the population. However using car in all situations is not necessarily promoting wellbeing. Biking as an alternative provides more physical exercise, and improves the environment, as well as the cityscape. It is also less expensive for the individual. A Danish study concluded that if fuel price increased by about 10%, the car use would decrease by 3.5%. If all this transport work is transferred to bike, biking would increase by 40%!

Research on biking in cities

Although transport research is dominated by projects on car and, in general motorised, travel, biking has also been looked at. This review is based on several Swedish research reports on biking (Nilsson 2003, Nilsson, 1998; Hydén, Nilsson and Rissner, 1998; Bergman 1998). Especially the report by Anna Nilsson, Blekinge Higher School of Technology *Increased Biking* has been useful, which is gratefully acknowledged. The reader is referred to these for more details. There are also extensive experiences in individual cities. Some of these are referred to below. Others are available on websites of the cities.

2. Comparing the bike, the car and public transport (PT)

Travel and socio-economic factors

The choice of means of travel almost always is an expression of economic and practical opportunities. Persons in different life situations travel more or less, because of different needs to travel, economic and physical possibilities, etc. The factors influencing what *means of transport* people choose come from the individual situation, infrastructure in the city, and societal factors.

Increased economic possibilities leads to more car use: A 1% increase in income makes a 0.3% increase in car access. Men with access to car use the car for almost all their travelling, also short distance. Walking and biking is for this group minimal and public transport is almost never used.

The increased number of individuals with an office work, where all day is spent in front of a computer, has changed this a little. Commuting to work by bike offers a physical exercise twice a day, which is often appreciated. These trips seldom require much luggage, which is also making it easy to use a bike.

For service and shopping trips it is often a less easy to use bike since both direction are made together - the trip is seen as being twice the distance - and some goods need to be taken home.

Access to a car is the most decisive factor for choosing the car. Those who have a car make both more travels, and longer travels by car. Without a car biking trips becomes both longer and more frequent. The need to have a car in the job itself is by far the most common reason to use it for commuting to the workplace.

Comparing bike and car

The positive factors connected to biking include the physical exercise, that it is nice, and that it is independent of time schedules. A very large share of travels consists of short trips with few errands. For these biking is a realistic alternative. But many factors are against it.

The negative factors connected to biking include large differences in altitude (hills) bad or non-existing bike roads, risk of theft, improper road maintenance during winter, low quality parking places for bikes, and safety risks in traffic. Also distance matters. For most people 3 km is the maximum distance to bike. Depending on circumstances some are biking longer distance, especially for work.

The positive factors for car travel are that is fast, comfortable, and independent. Too often this translate into that biking is slow, laborious, and dirty. Repetitive travels by bike may reduce negative expectations. By choosing proper, roads, safety equipment and (if necessary rain clothing) one get used to the bike.

The negative factors for car owners include inefficient time saving, parking problems, and price of petrol.

Bike vs Public transport (PT)

Experience tells us that it is not the car, which is the larges competitor to the bike, it is the public transport. Several reports have concluded that biking and public transport both competes with and complements each other. Those, who do not have a car, typically choose between walking and biking for short distances, and between bus and biking for longer distances. To travel by public transport often takes longer, especially if there are waiting and changes included.

3. The culture of biking

When and why biking

Each city has its own traditions and its own cityscape. This is decisive for how large share of the population is biking. Biking will continue if there is a strong tradition, and social acceptance. Especially in university cities this is common.

The bikers will normally point to a number of advantages with biking:

- Costs lower with bike (but not totally unimportant).
- Travel time in cities is often shorter with bike than with either PT or car
- It is often come closer to where you want to go with a bike, than with car of PT
- It is often much easier to park a bike than a car
- The quality of life is improved by biking, through better health and freedom.

The biking city

There are many potential advantages for everyone in a biking city. A well working infrastructure for biking is requires less space than a car infrastructure. More biking will free the trafficscape to be used for better purposes and often create a more alive and aesthetically appealing urban space. And it is often easier to find your way in city by bike.

Today the short travels represent 3.1% of distance travelled but 26% of exhausts. Much environmental improvement is possible by increased biking.

Biking and health

British researchers have shown that biking promotes self-confidence, stress tolerance and wellbeing. Certain health problems are decreasing with increased biking, such as diabetes, depressions, circulatory disease, reduced bone status, and insomnia. More recently it is clear that mental capacity is promoted by physical exercise. The requested 30 minutes or more of physical exercise for wellbeing according to medical research, may be all taken care of by biking.

Risks of injuries are on the other side higher with bikes than with car, about 6 times higher in Sweden per km compared to car. Risk of death is about 5 times higher per km. Serious accidents are reduced by 50% if the biker uses a helmet. However accidents on bikes per kilometre are reduced when biking increases as concluded from a comparative study between the Netherlands and Italy.

4. Actions to promote change

Is it possible to change?

It is clear that people change means of transport rather slowly and it takes a long time before any change is seen when some activities are implemented. Attitudes are the most important. How to change them? Studies show that it is much easier to strengthen a positive attitude, than to weaken a negative one.

Habits are also important. People with a car often go on as they always did, using the car, without questioning if there may be other options.

The car is well anchored in our culture, it has very many symbolic values; it is difficult to choose something else. Car travel has also during a long period increased the freedom of mobility, as it does not require long term planning. All this makes it difficult to promote biking. It is complex to move a group of car user to start biking.

Actions to promote biking should focus on changing the attitude of the inhabitants and thereby increase biking. Typical actions include education, information, surveillance, and campaigns.

Addressing the car drivers

Only improvement of bike infrastructure does not change much for car drivers. There is a need for a combination of actions including

- actions to improve for bikers
- restrictions in car traffic
- a well made urban planning
- a communications policy
- other actions

The most important may be to reduce the need to travel long distances. This is difficult, but one possibility is to support close-by shops.

In the shorter distances, in residential areas, it may be possible to reduce car speed to 30 km/h. This improves conditions for biking. A not so much used way is to make it possible to bring the bike on board a bus or train, or in general to support cooperation between PT and biking.

Addressing bikers, kids and parents

The most important strategy is to support those biking today to continue to do so. It is thus crucial to know about the needs and wishes of present bikers. These will most likely be the same as those of potential new bikers.

The more regular bikers and walkers include the elderly, children and youth. They are as well victims of bad traffic planning, more than anyone. One has to learn from them.

Children mostly start biking when young and do so up to 17 or 18 years of age. It is important that they perceive their biking environment as good enough to continue to bike after drivers license age.

It is also important that the traffic environment is good for them so that parents do not feel it is necessary to drive the kids to school.

Education and information

Education and information increase the understanding of the advantages of biking and respect for the values that bikers represent. It should also increase the understanding of the importance of physical exercise for a good health better.

The education often includes a general knowledge on how the traffic system in a city is made and planned. In general it is important that traffic education promotes the respect for other groups in the traffic regardless for how you travel.

Surveillance

Bad respect for the rules is often a problem. Many actions to improve for bikers are often sabotaged. This has to be improved by better surveillance and more severe consequences for those not respecting rules.

Campaigns

Campaigns are important means to change attitude. The message in the campaigns should not be just to improve the environment. Experience tells us that it will not change much (compare for example smoking). Instead it is important to point to the good side of biking.

Campaigns have to be regular to reach people making them more aware and finally change mobility behaviour. Below follows some examples of campaigns.

Bike to school. The city of Malmö made one campaign to support biking and walking to school. The campaign focused on the advantages of more walking and biking. The Walking school buses project was introduced, meaning that adults took turn to walk the kids to schools.

Health bikers. In this project, used in several cities, car users signed a contact to put the car aside for one year and use bike instead. In return they received free of charge, such things as raincoats, helmet, bike computer, and reflexes.

Bike at work. In some cities companies provided bikes to their employees. They thus could use a bike, with encouragement of top management, for shorter trips for meetings etc. This made biking more acceptable. The company bought many bikes at one time to receive a reduced price, and making many of them available.

The *In town without my car* campaign in Europe. This campaign promotes for one day (normally in September) other means of transport than car driving. It will reduce climate effect and pollution. It will help the inhabitants of a city to discover their city not being crowded by cars. It was originally a French project, now with a large participation in Italian and French cities, and support by the EU Commission.

5. Biking infrastructure

Biking infrastructure

Biking roads are important for a good biking culture. There are at least to levels of bike infrastructure. There is the local one for the nearby shop, school, etc and a long distance one for going further, between parts of the city. This large-scale network is very crucial to promote biking and making it attractive.

The biking infrastructure should be such that there is an access to all the services etc offered in a city. The biking road infrastructure should allow a reasonable speed, good comfortable biking, and easy access year around.

Bikes and cars may use the same streets if traffic is limited (not more than 8000 cars per day is a rule of thumb). It is also then important that speed limits are low. In many areas with schools and residential it should be 30 km/h.

But easiest most common is to separate different traffic categories, especially bike and car traffic. The detailed way to do it is dependent on the conditions of the streets etc.

Good biking roads

Normally one differentiate between three kinds of biking areas:

Biking field: This is a reserved part of the street for bikers. Other vehicles may only cross the biking field.

Biking lane. A lane is a part of the street separated from the others by a well-indicated physical or/and painted margin or difference in height etc. They may be either double or single direction. For safety a single direction is the best.

Biking roads. A road is separate from other kinds of traffic. They may be either more for recreation, or more for quick connection between different parts of the city.

Biking roads should preferably not go through dark places, along fences or walls, or through tunnels. These used to be experienced by bikers, especially women bikers, as unsafe. If a bike road passes through a tunnel, the tunnel should be straight so it is possible to look through them. They should neither have a low ceiling.

Lighting is important. Roads may be very different during dark and light hours.

Signs and traffic lights

Signs are important and it should be clear enough to allow easy use. Biking roads are often so well integrated that it is not obvious where the go. Therefore signs are important. If this is not good - you do not know where you end up - it is one reason for not biking. It is then easier to use the open streets.

Traffic lights are often a problem for bikers since they are adapted to cars. It is important to make the passage of bikes as easy as for cars. If not bikers are tempted pass against red light.

Parking places

Parking places for bikes are part of a good biking infrastructure. Bike parking at railway stations, or centre of the city etc. should be well kept easily available and not too crowded. In some cities there are protected parking places for bikes offered to some costs. Then there is minimal risk of theft.

6. Cases – Cities were biking is promoted

The information in the review is extracted from the home pages given.

Varberg

The biking project in Varberg aimed to decrease the use of car to bring children to school, as well as to give the children an understanding of environmental protection and proper environmental behaviour. Both schoolteachers and children went through workshops and training together. One result is deceased CO_2 emissions, estimated to be about 23 tonnes yearly.

Contact info: http://www2.varberg.se/

Kristianstad

In Kristianstad a biking strategy was worked out. It consists of five elements.

1. The Vision. In the city the bike is the natural way to use for short distance travels to be used for commuting to work, to a bus or train stop, to schools, places for recreation etc. There is a good network of functioning and safe biking roads. There are good possibilities for parking the bike. Biking is treated equal to other means of transport.

2. The Goals. It will be more attractive to bike in the city; biking will increase by 25% with a focus on short distance travel; no biker should be seriously hurt or killed in traffic

3. Biking infrastructure work. Each year a three-year work plan and budget for extending the bike roads are made. The priorities are made according to potential for increased biking (more in the dense areas and for shorter distances); work and school commuting is more important than recreational. The main biking infrastructure is analysed to identify missing links, standard, safety and information, and an action plan and budget is made for each object.

The bike parking facilities at each important bus or transport are improved. Bike parking is given the same weight as car parking, e.g. at shopping centres, libraries, municipal transport key points etc. Protected parking and possibility sot lock a parking place is promoted.

Lightning of biking roads is improved. Traffic lights gives automatically green light to bikes when cars get it. Crosses with cars are especially important.

Maintenance of biking roads are always high class, especially during winter and snowy season.

4. Means of working. Cooperation is promoted, both with authorities, like the police and the road authority, as well as with NGOs.

5. Knowledge base. Test the option of painted bike roads; Analyse all accidents with bikes together with hospitals, and find out about how to remove what caused he accidents: Questionnaire address bikers; Analyse traffic intensity on defined stops; Talk to parents and children for improving school roads

6. Information. Open and maintain an interactive biking home page; Arrange yearly campaigns; Cooperation with local media; Maintain improve and distribute a biking map.

Contact info: http://www.kristianstad.se/cykla/cykelstrategi/index.asp

Borlänge

How long time does it take?

Biking is good for the health, environment and economy. Change your car queuing and enjoy fresh air, physical exercise and in fact often save time by biking to central parts of the city.

Below follows time to travel by bike and car from different areas to Borlänge energy office in the centre of the city. A GPS equipment was used to measure distance and time. The times given include getting in order for the trip before and after.

As a whole a distance of 2 km takes the same by car and by bike. Up to 5 km you will save no more than 10 minutes by taking the car. By taking the bike you save money and the environment and improve your health.

Borlänge energy may give you free of charge an biking map of the city. There are also several places where you may rent a bike.

Baltic Sea Cycling

Interreg IIIB project Baltic Sea Cycling: encourage cycling in urban traffic

Local authorities and cycle associations from six Baltic countries are participating in the project. The partners will develop sustainable local transport policies with specific attention for cycling in local traffic.

The countries in the Baltic Sea Region (Germany, Sweden, Norway, Lithuania, Poland and Latvia). The project addresses problems and obstacles that local authorities are faced with when trying to promote cycling as a viable alternative mode of transportation within urban areas.

Table 1. Tame to travel by bicycle and car. (Contact info: http://www.borlange.se/templates/BlgPage____7750.aspx

From	Distance (km)	Time by bike (min)	Time by car (min)
Årby	5.0	19	10
Åselby	4,8	19	10
Kälarvet	4.0	16	8
City Hall	2,2	< 10	8
BE Bäckelund	1,1	<6	5
Skräddarback School	2,6	<10	6
Hönsarvet	5,5	21	11
Mård School	3,5	13	8
Medväga	6,1	22	13
Kvarnsveden	5,6	20	10

The project consists of four work packages, each addressing different problems.

Work package 1 focused on creating city cycling profiles. Surveys of the current cycling situation were carried out in each city and town and presented in a report. These reports are available on the project's website.

Work package 2 was the role of cycling in enhancing the attractiveness of cities. Several pilot actions were implemented on: developing a bike supply system; improving signage and information for cyclists; cycling as a means of transport of people and goods; promoting cycling among tourists; cycling between towns

The work package 3 focused on promoting cycling as a tool to decrease environmental, health, social and economic problems in the city. Five pilot actions were implemented, each with its own theme: cycling to work, cycling to school, a system for combining bikes with public transport, healthy cyclists, cycling in cold and rainy weather

Work package 4, the cities will develop its own urban cycling policy. This will form a basis for their urban cycling strategy. The final actions for Baltic Sea Cycling will be to set up an investment plan Baltic Sea Cycling project is a cooperation between 22 partners from six European and a durable transnational network as well as producing a cycling inspiration book.

Contact info: City of Örebro, Sweden, Carinne Lancereau

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New Technologies for Sustainable Urban Transport Systems

4

A vision of fuel cells as deliverer of improved urban quality

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Introduction

Why focus on the city/urban network level? The answer is: Most day-to-day mobility takes place within local-regional labour and service markets. Thus, it is above all, mobility on this level that has to be reformed and brought into the framework of environmental sustainability, particularly if mobility on other levels (long-distance travel and transports, at least some air travel) is to be possible. These micro-regions typically have diameters of roughly 100 kilometres (60 miles). Their size is a function of the time at households' disposal, which in turn sets the bounds for what activities are socially and humanly possible, given the multiple roles individuals play in their daily lives. Freedom of mobility is often a criterion of "quality of life"; too little can reduce the quality, too much do exploit the quality. It is hardly surprising that mobility is a central theme among cultural geographers, in Sweden represented by researchers from Torsten Hägerstrand to Bertil Vilhelmson (Hägerstrand, 1973). It seems as a paradox that modern urban life demands more mobility, despite the fact that we live in more dense structures.

If we can develop ecologically efficient systemic solutions, that fit these "60-mile networks" around the world, we will have acquired a tool of great significance in quantitative terms. Global warming/the greenhouse effect is, after all, a question of quantity, more precisely, the amount of greenhouse gas emissions world-wide. Whereas the problems of the largest metropolises may be of staggering dimensions, the solutions achieved in medium-sized urban centres, all told, are both somewhat less complex and within closer reach, while they are also more easy to generalise on a world wide scale. Consequently, smaller communities may afford advantages in our search for democratically founded systemic environmental solutions with appropriate technology and organisational structures. Some solutions may also prove to be appropriate for the planet's mega-cities, as well. In principle, the vision below is applicable to

Abstract

There are tremendous pressures on cities to be ecologically sustainable and socially balanced. Systems for urban mobility, climatic customization of the built environment and treatment of the organic wastes are among the most problematic local infra-systems. When solving these problems medium-sized cities have a key role to play, since they are so many in the urban world. In what ways might fuel cells help us to solve urban dilemmas: are there new possibilities to make those systems function in a more synergetic way?

Our paper starts with an analysis of an abstract model of a medium-sized city (Uppsala) in its regional context and how close to the environmental goals of 2025 that city could come, if fuel cells were introduced in public transport and if local hydrogen was produced enough for that system. Then we calculate the effects if the use of fuel cells were expanded to motorized urban mobility in general and more integrated with the energy system of the city. Finally, we make some statements on appropriate design principles and criteria regarding fuel cells used (cf. Karlström, 2004).

In this paper we investigate how the FC-H2-technology might deliver sustainable urban quality in some basic respects. We do not argue that corresponding values could not be achieved by other means – so far we have not been able to perform the comparisons needed to prove that.

Acknowledgement

This paper is a comprehended version, based on our papers for the Swedish Foundation for Strategic Environmental Research, MISTRA (Karlström, 2004).

any middle-sized centre that has essentially agrarian, lightly populated surroundings. Most urban centres have arisen out of interplay with the cultivated landscape – the only exceptions being mining towns and similar ”outposts”. Ultimately, all towns and cities face the conversion to sustainability, whether or not they are expanding.

The vision offered here takes its point of departure in the relationship between economy of resources and quality of life. Quality of life that is sustainable may be termed “liveability”, the community's ability to satisfy life's day-to-day needs and to offer the makings of a pleasurable existence in a sustainable fashion. Liveability is a question of accommodating individuals' social and economic activity within the framework of what sustainable use of finite resources allows. Sizeable variations may be possible provided that mean values overall keep within the bounds of sustainability. Uppsala, Sweden´s fourth municipality of about 180.000 inhabitants, the medium-sized centre in our example, is in an expansive phase, as is the surrounding region. At the same time, Uppsala needs to reform its infrastructure systems like any other similar city, so that they may function in a more sustainable way. However, how to go on without fossil fuels and nuclear power?

New modes of urban public transport

Most likely, new modes of public transportation will be necessary if we are to solve the problems of global warming, traffic congestion and the quality of urban life simultaneously. Most likely we are also facing a future with more expensive vehicle fuels, both regarding the fossil ones and the non-fossil fuels. The alternatives of daily mobility will be very important.

Rail-borne solutions are not prone to congestion, but, on the other hand, they impact more on the urban environment. Personal Rapid Transport (PRT) systems such as rail-taxi, used as a full-coverage urban alternative, call for an unreasonable number of passenger modules, too many rails and too many islands, etc., for stops. Automated rail-borne solutions give rise to barrier effects along fenced-in tracks, which contradicts the very idea of urban life; the absence of personnel, what is more, is a source of anxiety for many people. This leads to the question: Are there possible syntheses and/or innovative vehicle types, that pose viable solutions to these problems? And how effective does a public transit system need to be in order to create leeway for at least some use of cars in the city, when also the cars will become more “green” and will be using non-fossil fuels? With higher fuel costs after peak oil, those cities that will install attractive alternatives to daily car use, probably will become very popular to live in. The households will then be able to save fuel for the most valuable use of their car, which they would probably still own.

Fuel cell technology does in fact open up some new avenues and can improve the cost-effectiveness of public transportation as well as the comfort of the users. The crucial factor is the cost of drivers. The cost of fuel, vehicles, even tracks etc., weigh much lighter over time, than drivers' wages, but improvements in these areas too, do help. To what extent can fuel cell technology radically reduce personnel costs and simplify the installation? Can fuel cells cut those costs without impinging on the quality of the urban environment in general and the transport system in particular? Semi-automated systems with new “seamless” logistic, are then quite helpful and fuel cells will be able to support such qualities in public transport (Karlström et al, 2004) in an environment- and user-friendly ways.

In concrete terms, fuel cells permit quite a new ”design freedom”. These factors suggest that the main beneficiaries of fuel cell technology may be the manufacturers of vehicles for use in public transport systems, particularly those manufacturers who can produce fuel cell trams at roughly the same cost as buses, yet sell them at tram car prices – generally four to five times the cost of a bus. Moreover, fuel cell trams do not require the trolley-wire, the installation of which can represent a costly part of the total construction and maintenance costs (ca. 30 %, according to Bombardier Transportation). There is much that speaks for collaboration between municipalities with regard to technology procurement, both nationally and internationally, in this field. The “noble art of demand shaping” has to be progressively practised in this delicate field of product development.

Urban structure versus manned and unmanned public transport operation

The abstract model of Uppsala was developed in several steps (Figure 1) – most cities do not look like this, but still they might function more or less like it. Originally it was derived from a discussion related to documents presented at the 1996 UN Habitat Conference in Istanbul, inspired by “The University Charter for Sustainable Development”. This included four imperatives: the ecological, the social, the democratic imperative and an imperative regarding settlement. Some basic system properties regarding public transport in a medium-sized city were defined (Hultén, 1997) and further developed as a GIS model.

At this stage we examined how the fundamental qualities of the vision could be maintained even if some basic costs were reduced (such as costs for drivers, trolley wires, bulky infrastructure etc) and if some new sources of revenue (generation of heat & power, multifunctional use etc) could be developed

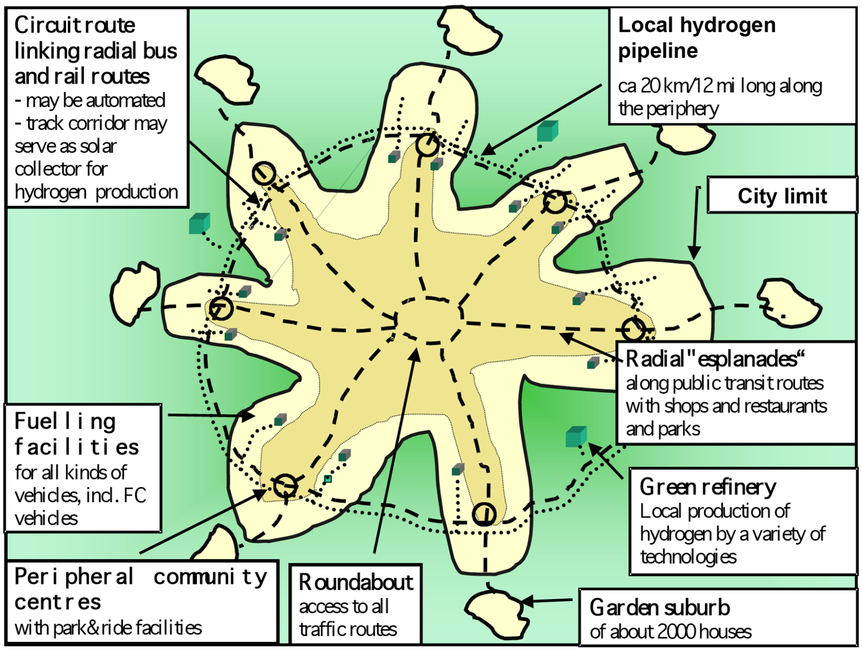

Figure 1. Hydrogen infrastructure in a medium sized city. The radius of the urban area is about 7 kilometres and a quarter of a million inhabitants will live there in the year 2030. An interesting question of urban morphology is: How much – and in what respects – may a real city diverge from this model and still include the urban qualities?

based upon already included qualities (Karlström, 2004). We also examined how well this version of our urban model might help medium-sized cities fulfill their environmental goals regarding climate and congestion (Karlström, 2004).

If the radial public transport lines (Figure 1), to and from the city centre, are served by manned vehicles, and tangential and rim lines are served by automated vehicles, the personnel costs for drivers can be reduced with roughly one-third without impairing the urban environment – perhaps even improving it significantly (Karlström, 2004).

Automated lines may, naturally, be furnished with drivers and attendants as needed. We should bear in mind that drivers are fully occupied and cannot easily leave their positions, for which reason additional staff (conductors or attendants) may be required when rowdiness or other disturbances can be anticipated. In the central, densest parts of the city, vehicles and sets of cars may proceed slowly, particularly in plazas and anywhere where they share space with pedestrians. Solutions like these contribute significantly to the city's accessibility and add to the social value of urban space. Slowing down to "pedestrian paces" on a certain percentage of the system need hardly impair its efficiency overall.

Given a combination of manually and automatically driven vehicles the patterns of service become entirely flexible. For example: a set of three cars may be sent out to a local node on the edge of town. There, the set divides up, with automated cars diverging to tangential routes, while the first, manually driven vehicle may proceed on the main line to an end station situated in a neighbourhood of a couple of thousand households – perhaps a house-and-garden neighbourhood 3-4 kilometres (2-3 miles) outside the city. On the return route, the vehicle awaits new automated cars that are then coupled to it and the 3-car set proceeds toward the city centre and on out to a similar constellation on the far side of town (Hultén, 2004).

All vehicles may be designed for both manned and unmanned operation, which the fuel cells technology will promote, due to the advanced electronic support systems that are needed anyway, and due to the distributed power-train onboard (all carriages might be individually powered).

In addition to more efficient use of personnel (and the savings that implies), the pattern of service outlined here offers significant improvements from passengers' point of view, as well: (i) the frequency of service to small neighbourhoods outside the city proper will be enhanced; (ii) peripheral neighbourhoods will be able to have the same frequency of service as more central parts of town, despite a weaker population base; (iii) passengers can travel directly without the inconvenience of transfers, which may be expected to make the transit system as a whole much more attractive. The system is also more accessible to the elderly and passengers with physical hindrances and offers all users considerably more comfort. Karlström (2004) shows that passenger ergonomics, economic efficiency ant the trafficability of the vehicles might be combined, thanks to the new "design freedom" of the fuel cells.

Urban hydrogen infrastructure

Hydrogen works of roughly equal size may be installed at two or three sites outside the urban centre. Since hydrogen production also yields several valuable hydrocarbon-based by-products (feed, polymers, etc.) as well as fertiliser for use on the nearby acreage, we prefer to use the term "green refineries".

These green refineries are a concrete expression of the exchange of assets between town and country. Energy crops, especially selected for hydrogen generation (e.g. poplar/aspen) feed the refineries and are thus commercially attractive elements in crop rotation on farms near the urban centre. A second kind of biological hydrogen generation is based on organic waste from the city, plus other biomass. An interesting hydrogen carrier is methanol: easy to handle and store. Methanol might be generated and reformed (to hydrogen) in many different ways (Olah, 2006)

An interesting question of urban morphology is: How much – and in what respects – may a real city diverge from this model and still include the urban qualities?

A third line is based on bio-photolytic hydrogen generation using cyanobacteria. Finally, a fourth line – not necessarily linked to the refinery, but rather to the distribution network – is based on photo-electrochemical hydrogen generation (PEC, photo-electric conversion). The solar cells might furthermore be integrated into the physical infrastructure and buildings.

The solution that is closest at hand, until the above-mentioned technologies have matured, is natural gas – particularly in regions where pipelines already exist – in the future perhaps combined with separation and storing of carbon dioxide (sequestration). In eastern Sweden, where Uppsala is located, there are no such pipelines. The question is if safe storing of carbon dioxide (re-injection) is possible (in the region) – if so natural gas pipelines may be built, even if this is not a sustainable solution. The installed local infrastructure might, later on, serve the more sustainable alternatives to come. And it might be designed for multifunctional use; some flows could be combined and the installation could also feed back CO_2 for re-cycling flows of a "hydrogen carrier" like methanol.

The distribution of hydrogen gas (or a corresponding carrier of hydrogen) close to the traffic lane or track bed, running concentrically along the rim of the city proper, offers several advantages: In a city of Uppsala's size this would mean a pipeline of about 20 kilometres, hardly any distance at all, as pipelines go. It would replace numerous tank-truck transports, which entail energy losses inasmuch as the hydrogen would have to be transported under high pressure or very low temperature. Figure 1 shows a possible arrangement of such a system.

The installation also has a revitalising potential considering the many different kinds of businesses and activities that can be connected to it and the environmental problems that are brought closer to a solution at a systemic level. Garages for off-duty cell-fuelled vehicles may function as "virtual energy plants" adjacent to housing, workplaces and service areas in the semi-central margin of the city and in new neighbourhoods immediately outside it.

Installing the hydrogen pipeline close to the traffic lane for cell-fuelled buses and trams enhances the system's safety, compared to installing it under buildings or in city streets. If a two-lane traffic system is used consistently in this manner, the combined area of the solar collector – an area that can hardly be put to any other use – approaches 250,000 square meters, or about 2.7 million square feet. The two or three "green refineries" described earlier, supplement the hydrogen generation.

To be able to steer the course of development at an early stage, municipalities need to evaluate the promise fuel cell technology holds and begin gearing up their technology procurement regarding public transport. This will in turn stimulate manufacturers' interest in producing cell-fuelled vehicles in general. There are many opportunities for collaboration between different actors, households included.

Several researchers who have studied the question of how to go about introducing the technology and establishing a fruitful supply-and-demand situation (the classic problem of "the chicken and the egg") recommend starting with public transportation systems (Karlström, 2004). Public transit needs are more predictable than the private commercial market for vehicles and the scale of the vehicles more easily accommodates the new technology. Successful introduction of fuel cell technology needs the "pull" of public investments, which also opens a door to democratic processes that can guide urban development, so that people and the environment are kept in focus.

The potential of the city block

Both the Agenda of the Swedish Urban Environment Council and New Urbanism's Charter (Bergström, 2003) emphasise efficient use of land, existing buildings and infrastructure as opposed to "urban sprawl", a wasteful use of land. The two organisations also argue for a certain concentration and mixed use of the built environment in order, among other things, to reduce the need of mobility.

If it becomes common practice to let idle cell cars and other cell-fuelled vehicles generate electricity and heat while they are parked, there will be a need to arrange for cell vehicle parking in city blocks and at park & ride facilities. The vehicles will more than pay for their parking space; the distance between generator and the space to be heated will be very short; and the vehicles will be parked under safe and secure conditions (Lipman, 1999). Meanwhile, cell car owners can be given palpable incentives to leave the vehicles in their parking spaces and walk, cycle or use public transportation on a day-to-day basis, instead. They will still have access to the vehicle when travel by car is called for. The cost of bus/tram passes for everyone in the household will be more than covered by the energy the vehicle produces. Positive incentives may, of course, be combined with negative incentives like congestion tolls (at peak traffic hours), particularly in metropolitan areas.

Urban blocks may be grouped around avenues that carry advanced public transportation lines in such a constellation that a stop or station is always within a couple of hundred meters' distance – in most cases much closer. If the avenues radiate spoke-like out from the centre, the spaces between them can be multifunctional urban districts. This would spare the green spaces – which are narrow toward the centre and gradually widen, geometrically, as they approach the rim of the city ("green fingers"). The more or less wedge-shaped districts of the city are interconnected by public transport lines, both radially (to the centre and on out to the other side of town and back) and concentrically, across the green fingers to other districts (Hultén, 2004).

Installations of this kind may stimulate further development of multifunctional city blocks, but also garden-city districts on the rim of the urban centre, which will enjoy good public transportation service (provided they are no more than 3-4 km (2-3 miles) from the edge of town and have at least a couple of thousand households). Regio-tram lines, compatible with the urban tram system, may reach 20-30 km outside the city.

While such a structure gives the city an extensive interface toward the countryside, affording its inhabitants contact with the country for recreation, etc., it also allows the city to continue to grow without loosing its urban density, while still remaining "green". The structure is also readily adaptable to topographical features of the landscape. Thus, rapid public transport (more rapid than using ones car, even at off-peak hours) brings the whole of Uppsala, or like-sized city, within 15-20 minutes' reach; furthermore, the centre and railway station, the link between Uppsala and its hinterland and nearby metropolitan Stockholm, are within reach without having to transfer between local lines.

Rough estimates suggest that city blocks with features like these will not only be self-sufficient in terms of heating, but will be able to deliver energy to surrounding blocks. The key is cell-fuelled vehicles parked in the block, where they generate both electricity and heating (Karlström, 2004). The hydrogen needed might be produced from biomass and preliminary calculations suggest that biomass, generated from not fully used agriculture land within the region will be enough for all cars in the analysed medium-sized city (Hultén et al, unpublished 2006).

An important concern is whether households will want to lend their cell-fuelled vehicles to this kind of community "energy transfusion" system. It seems rather unlikely, however, that households would refuse an added return on a sizeable investment like the cars of theirs. And if passenger car manufacturers see the possibility to sell a product that has added value to the user, the concept of the passenger car is likely to evolve accordingly.

Fuel cell stack design criteria

If fuel cells could reduce the traditional costs for drivers, trolley wires and infrastructure in future public transport systems by 20-30 % plus the added environmental and urban quality benefits, this represents a very valuable use of the technology. Especially if this use could trigger the more general shift to a hydrogen economy and a move away from petroleum, as we argue in this paper.

In general terms, there are also some crucial requirements regarding the fuel cells themselves, more or less regardless of in which vehicle body they are installed. These are cost, durability, efficiency, working temperature, robustness, safety, starting up conditions, freezing resilience, the use of rare metals, and components. The fuel cell technology we are researching is not without problems and one of the aims of this paper is to discuss stack design criteria in a creative way.

The National Academy of Engineering has presented a list of problems with fuel cell technology that needs to be solved to make it a feasible alternative for stationary and mobile use. For mobile use the problems are high cost, weight, to large, adaptation to rapid cycles, handle on-road vibrations, nit reliable up to 4,000 to 5,000 hours and issues regarding cold and hot weather (National Research Council, 2004).

Stationary fuel cells also have some other design criteria, such as higher durability up to 40,000 to 50,000 hours due to high temperature membrane (needed for heat utilization, power electronics, rapid start-up if used as backup power, fuel processing and development of non-precious catalysts and water management technologies) (Karlström, 2004).

Depending on which combined strategies might be developed in future, regarding these basic functions of the cell technology, the basic design features like volume, spatial structure, weight and so on will be impacted. Some other characteristics are in turn, dependent upon the chosen strategy, such as design freedom and multifunctional usage capacity of the vehicle system. For example, should public transport vehicles use the same fuel cells as normal cars (PEMFC = Proton Exchange Membrane Fuel Cells) or hotter and more durable ones (HMFC = Hydrogen Membrane Fuel Cell; SOFC = Solid Oxide Fuel Cell)? If the PEMFCs are used in a bus or tram, they probably have to be reconditioned once a year, but if that is a simple operation combined with normal

Ten statements on appropriate FC design principles for (public) transport usage

1. Since many other costs may be reduced because of the light-weight vehicle design, the cost target for the fuel cell stack could be less demanding than if installed in traditional vehicle bodies.

2. The durability of the stack needs to be improved for use in our vision. It might, however, be a good idea to use the same cell types as in ordinary cars, to gain from the resulting price press from economies of scale. Reconditioning the stacks once a year could be coordinated with other kinds of regular maintenance.

3. The total drive train, but perhaps not the stack itself, must tolerate rapid cycling. Hybridization is necessary and very fruitful, for heavy loaded vehicles driven in the rhythm of urban traffic.

4. Several vehicle designs could be achieved if it is possible to give the stack different geometric designs – modularized and built up of much the same components (versatile design).

5. It would be useful if complementary technology, around the basic cell components, were of the same size and capability as in cars, because that would probably lead to lower costs. This also points to modularized design methods.

6. The scarcity of platinum could be a problem if fuel cell systems are used on a large scale. Therefore, it is important that platinum is recycled and that the design and maintenance routines are made to simplify this recycling.

7. We argue that hydrogen (renewable) should be used as fuel and that safety issues are very important, especially when used with public transport. All parts of the H2-FC system should be located so that they meet the open air above the passengers and people around. This is a very good, basic design recommendation and fits very well with other ergonomic and functional properties of the vehicles and the system around.

8. Low noise, low vibrations and no emissions are strong and popular arguments for fuel cells in buses. No trolley wires, "wireless trams", are also a strong economic argument for fuel cells in trams. Buses and trams could belong to the same product family, having the same drive train and almost the same task.

9. No stops. It is a good idea to develop a non-stop usage of fuel cell systems in public transport vehicles in order to prolong the life of the systems. This motivates the semi-stationary use of vehicles.

10. It is important to develop facilities for renewable local production of hydrogen. This ought to be regarded as a new kind of municipal technology, which society initially may support as a transition strategy, starting from already existing biogas plants.

maintenance, you may gain from the overall price press resulting from the car industry.

A more detailed QFD (Quality Function Deployment) analysis has to deal with such complexities (Steen,1994). The challenging perspective of using parked vehicles in semi-stationary ways, such as generating heat and electricity, is dependent upon strategies of this kind, as well as the possibility to assess in what situations fuel cells are profitable compared with available alternatives.

Conclusion

If enough hydrogen could be delivered in a CO_2-neutral way, the climatic goal for a medium sized city in the year 2020 (in this case: 30 percent less CO_2 emissions compared to the level of 1990) may be reached if at least one quarter of the vehicle fleet consists of fuel cell cars and the rest of the fleet is modernised with hybrid and electric cars. That is self-evident. But you may also reach that goal – plus goals of urban quality such as reduced congestion etc – if an advanced system of fuel cell-driven local public transport is installed. A combination would be the very best alternative to prepare the city to face the even tougher climatic goals to come. The city may also substitute its part of the national nuclear power program: if about half of the fuel cell car fleet mentioned above is generating electricity about half of the time the cars are parked. The precondition for local sustainability in this respect is that the initially waste- and bio-based hydrogen production is succeeded also by other renewable hydrogen production methods, working together ("Green/Bio Refineries"). New built up areas may be climatically customised (heated, air conditioned etc.) by heat left over from parked fuel cell cars – while generating electricity – if these buildings are well designed for energy economising and adapted to synergy in this respect.

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Towards Environmentally Sustainable Transport

5

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Introduction

Transportation has become an important dimension of the concept of sustainability, and equally sustainability is expected to become the prime focus of transport policies in the coming decades. The transportation sector is often subsidized by the society, especially through the construction and maintenance of infrastructure. The total cost of transportation, notably its environmental damage, is generally not paid by the users (Rodrigue, 2006).

The relationships between transport and the environment are multidimensional.

An understanding of the reciprocal influence between transport and environment as well as the integrated assessment of the environmental impact of traffic and the transport infrastructure is an important task for the scientific community, especially in order to assist policy making (COST 350, 2006).

Environmental Consequences of Mobility

The environmental consequences of transport and traffic are multidimensional. The most important impacts are the following.

Air Quality. The transport sector, especially road and air transport, contributes to air pollution, acidification and climate change through emissions of carbon monoxide (CO), carbon dioxide (CO_2), nitrogen oxides (NO_X), hydrocarbons (HC), particulate matter (PM), heavy metals, and volatile organic compounds (VOC). These pollutants are released during the combustion of fossil fuels, the primary energy source for transport.

Secondary air pollutants are substances created in chemical reactions of the primary pollutants. Most importantly, NO_X and HC in the presence of sunlight create ozone (O_3). Ozone is the main component of photochemical smog and a major air pollutant in urban areas in temperate regions.

Noise. Noise is probably the most obvious impact of the transport sector. Excessive noise levels (65dB(A) and higher) is damaging to public health. It contributes to high blood pressure and cardiovascular diseases (OECD, 2001). In the OECD countries, around 30% of the population is exposed to noise levels higher than 55dB(A). Continuous exposure to noise can lead to weakening of the auditory system and sleeping disorders. Noise has also negative affects also on wildlife.

Water quality. The contribution of sea transport to the pollution of rivers, seas and oceans is considerable. International sea traffic is difficult to regulate, and this impact is only recently addressed by international legislation. Considerable progress has been made in a number of areas such as legislation on ballast water, the management of waste, and reducing oil spills. Still the environmental burden on sea transport is considerable. As the comprehensiveness of legislation increases the more the transport industry is forced to adapt. For example the dredging of ports to deepen channels in order to keep pace with the growth of vessels size, places a growing financial burden on port authorities, as the environmental constraints increase.

Space intrusion. Increased demand for transport places an enormous pressure for new infrastructures. Many of these, such as airports and ports, require very large areas of land for their own internal operations and for the required access transport links, which have to be built. A fundamental question is: can the environment and society afford to provide sites of the scale required by the transport industry?

Transport and Energy Consumption

The transportation sector is heavily dependent on the use of petroleum fuels. Only in OECD countries, the use of fossil fuels for transport increased by more than 45% from 1980 to 1997 and is expected to continue growing (OECD, 2001). Alternative fuels in the form of non-crude oil resources are drawing considerable attention as a result of shrinking oil reserves, increasing petroleum costs and the need to reduce the emission of pollutants.

The ecological footprint of fuels is considerable. It consists of three main components; the area needed for energy production; the area needed to sequester emissions of greenhouse gases; and the area needed for the safe deposit of nitrogen and sulphur (Holden and Hoyer, 2005). (The concept of ecological footprint developed by Rees and Wackernagel

Table 1. Comparing energy efficiency between fuels using the concept of energy chain.

Energy chain	Ecological footprint compared to the reference energy chain (%)[a]
The hydropower-based energy chains (nos. 13 and 14)	75% reduction
The natural-gas-based energy chains (nos. 7–12)	45–75% reduction
The raw-oil-based energy chains (nos. 4–6)	15–30% reduction
The biomass (wood)-based energy chains (nos. 15–18)	0–50% increase

[a] *The reference energy chain refers to energy chain no. 3 (raw oil–petrol–conventional power train in 2010).*

in the early 1990s, is an elaboration of the 'carrying capacity' concept (Wackernagel and Rees, 1996); it summarises the environmental impact of an activity in a single measure, ha).

Using conventional technology, the potential for reducing the ecological footprint of fuels by 2010 is substantial; 22% reduction can be achieved for petrol cars and more than 35% for diesel-fuelled cars. Compared to a reference process (conventional raw-oil-based petrol used in an internal combustion engine, called "energy chain no. 3") the energy chains of fuels have very different ecological footprints. It seems that differences between the groups of fuels are more important, than within each group (Table 1).

The question is which are the alternatives? Hydropower has a very small ecologi¬cal footprint, but is not a global resource with sufficient volumes to support the ever-increasing transport system. Natural gas has a small footprint and is plentiful enough, at least for several decades, but it is not a renewable energy resource, and it does not fulfil the long-term requirements of a sustainable energy system. Biomass is globally available in large volumes and is a renewable resource. Its large-scale use, however, would lead to an unacceptable increase in our global ecological footprint.

Therefore, it seems that several measures are needed to address this dilemma. We need a combination of different resources, substitution to less environmentally harmful fuels, and reduced transportation to meet long-term sustainability objectives. To monitor this process properly the methods to estimate the ecological footprint of fuels should also be improved.

Urban Transport and policy measures

The worldwide increase in urban mobility since 1960 has been the direct result of increased affluence and the following greater accessibility to private motor vehicles, as well as population growth. Cameron and coworkers (2004), who investigated the causes of increased urban traffic in world cities between 1960 and 1990, concludes that population growth, urban sprawl, increased car ownership, and decreased vehicle occupancy are the key factors causing the steep rise in urban vehicle kilometres (vkm).

There is very wide range of policy instruments available to those responsible for developing transport strategies for urban areas. One recent study identified some 60 types of instrument, and this excluded those relating specifically to vehicle technology (May and Matthews, 2001). Common elements of urban transport strategies include reduction of car use; improvement in public transport; improvement in the performance of other modes; improvements in the performance of the road network; and improvement in the performance of vehicles (Nakamura et al. 2004).

Reducing the need to travel. The demands on the transport system are reduced if people make fewer or shorter journeys, or both. Fewer journeys may reduce economic and social activities; however some journeys can be replaced by telecommunication, as an alternative to travel.

Reducing car use. Car use leads to larger costs of pollution, noise, congestion and accidents per person-km than other modes of transport. Reduction of car use will thus lead to a reduction in the overall traffic level, and hence to improvements in transport efficiency, better environment, liveable streets and - if the alternative modes are not significantly less safe - improved safety.

Improving public transport. Improvements in the coverage and quality of public transport provide an alternative to the car. It will in addition be a benefit for those who anyway depend on public transport.

Improving other modes. The same argument holds for walking and biking, which are the two modes available to everyone, who does not have a mobility handicap. Walking and biking also have the advantage of being non-polluting and not consuming any energy. Each one is limited in its range, but a large proportion of trips by car cover distances, which equally well could be done on foot or by bicycle.

It is unlikely that improvements in freight traffic would lead to any modal change, although improved logistics would reduce freight traffic.

Improving the road network. Whether or not the need to travel, and travel by car, is reduced, there will be a need for remaining travellers to use the road network, and there are clear arguments for enabling them to do so efficiently. Improvements can include increases in capacity to allow the management demand for road use to be met more effectively, reallocation of road space between competing uses, and reduction of road space in areas which would most benefit the environment.

Improving the performance of vehicles. Whatever the level of use of cars and public transport vehicles, there is a case for making them safer, quieter, less polluting and more fuel-efficient. Technology instruments introduce improved vehicles designs, which include new motive power, improved emission, noise and safety standards.

Transport of Goods

From the environmental point of view, the main concern in transport of goods is to avoid transports and to shift transports from road back to more environmentally friendly means like rail or waterways, as this strategy offers the main potential of a sustainable reduction of the environmental impacts from road transport. Other possibilities to reduce the negative effects from transportation include technical improvement of the transport systems as well as advanced alternative propulsion.

Through the years, traffic planning has been divided into sectors in most countries. This has led to a lack of coherence, customer information and future planning. The individual sub-sectors have been working independently of each other and often been competing between themselves. Furthermore, the individual sectors in Europe have been nationally based, and thus further disintegrated. The result has been a lack of integration and synergy between the different methods of transport, as well as transport across the borders. This has caused considerable customer irritation as well as extensive social and business economic losses (Future Transport of Goods, 2002).

Politically, there is a gradual understanding of the necessity to establish a general holistic traffic planning which runs across sectors and is based on cross-sector junctions. This requires an entirely new political thinking on traffic. International connections between transport by road, ship, rail and air must be created. Here *intermodality* is the prerequisite for it to work. Intermodality creates synergy and coherence between the different means of transport and between the standards of the various countries.

A new intermodal transport structure may create coherence and growth within transport of goods. A prerequisite that intermodality will work efficiently is that international standards are established. These standards should apply across all sectors so that loading between the individual transport methods and between the individual countries can take place. Efficient *intermodal* junctions require technical standardisations as well as administrative simplifications.

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Policy Measures for Sustainable Urban Transport

6

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The challenge of growing mobility

The growth of traffic is today dramatic in the Baltic Sea region. For both transport of people and of goods the development is going in a non-sustainable direction. Despite proud statements from the officials in the European Union Commission to develop public traffic and transports on rail, car and lorry traffic becomes an increasingly larger part of the transport system.

In Sweden, for instance, the transportation of people has increased 25 % over the last 25 years. On the average people make three shorter trips daily, mostly by car, which add up to some 40-50 km/day.

The increasing traffic is a result of growing economies and more material welfare. The growing traffic in turn is itself also producing growing economies and more material welfare. Such a self-reinforcing system with positive feedback is not sustainable in the long run and it is necessary to take action to control it. While other sectors in the economy have reduced its energy use and emissions, it has increased in the transport sector. The transport sector today contributes about 40 % of the CO_2 emissions in Sweden. About 70 % of this is due to road traffic.

There are many strong interests in the society connected to the traffic system. This article will discuss what can be achieved in the cities and towns, the municipalities in the Baltic Sea region, to approach a more sustainable traffic system.

The total transport system can be discussed either as an issue of the movement of people or transport of goods, or in terms of distances. Distance-wise transports, for either people or goods, may be subdivided in six broad categories as shown in Table 1.

It is obvious that a reasonable agenda for a local transport policy concerns the last three, regional, local and sub-local transport systems. This is the main interest of the discussion here.

Table 1. Categories of distance-wise transports.

1. Trans-continental	>2000 km	around the world
2. Trans-national	1000-2000 km	between countries
3. National	250-1000 km	between cities
4. Regional	40-250 km	around the city
5. Local	5-40 km	between parts of the city
6. Sub-local	0-5 km	inside parts of the city

Strategies to reduce traffic

The strategies to reduce traffic will be seen from five principle perspectives. They will result in actions in five steps, where it is important to go from top to down. The steps are the following.

1. Reduce the need of travelling.
2. If travelling is necessary, the journeys should be made to best place according distance and possibilities to travel in a sustainable way.
3. When the best place is chosen, the best transport mode should be used.
4. When the best transport mode is chosen, the best vehicle should be used.
5. When the best vehicle is chosen, it should be driven in a sustainable way.

All strategies have to take in consideration that municipalities are competing with each other. Every city tries to attract people and business by offering an efficient infrastructure and possibilities for transport. It is important to identify what kind of need there is for transports. A large logistic-oriented company needs efficient transport solutions, while a human power orientated consultant company rather needs efficient IT-communication, attractive workplaces and an attractive city as a whole to live in. The city may therefore, in that sense, be planned in a zoning system, where the transport oriented companies will get good access to the national and international transport system, while others can be located in more densely built areas, not so favourable for car traffic.

Some cities are focusing on transport intensive solutions, which they believe are crucial. In the Baltic Sea region much efforts are made to place their own municipality in ”the middle of the world” to attract new business. There is anyhow no guarantee that a good geographical position is enough. On the contrary it is sometimes not necessary at all. Regions and even countries, which are very much in the hinterlands and far away from the main transport corridors, can be economically very successful, for instance Ireland and Iceland.

Thus there is one category of strategies, which may be described as the 'large city' working with transport oriented solutions on the world market, while another group of strategies are aiming towards a 'small city', to improve the quality of life for inhabitants and visitors.

In the small city the methods, which are discussed here, can be implemented very systematically. The small city strategy is not only resulting in a more sustainable city from a narrow environmental point of view. It is also giving much better quality of life and more attractive cities to live in and for people to visit. To attract new business to the city is not anymore only about offering good investments solutions. It is also important to create an attractive city where the enterprises can offer co-workers a good place to live in.

Tools to implement strategies

Even if the possibilities for the municipalities are limited, because of the very complex situation of interests and stakeholders in the system, some important political tools are available to implement the five steps strategy. These are shortly described below for each of the five steps.

Reduce the need of travel. The urban areas can be organised to decrease distances by reducing urban sprawl. The city should be multifunctional in a way that many visit points are close to where people live. Look at streets as a design element in the city rather then transport corridors!

Go to the best place. Create places with good accessibility for sustainable transport modes. The municipality should develop the urban areas in a way that the need for one or even two cars in the household get minimised. It could be done by prioritising new multifunctional areas close to the city centre or along important corridors of the public transport system.

Use the best transport mode. The municipality should have a strategy to change the modal split away from car dependency. It can be done by giving good conditions for the alternatives by supporting an effective public transport system, a network of good bicycle lanes, but also measures for a more efficient use of private cars: congestion charging if necessary, parking policy, speed limits, encouraging car sharing. By reducing the allowed speed for cars and prioritising bikes and public transport in crossings the alternatives are getting more competitive and increase the possibilities that more sustainable vehicles will be preferred.

Use the best vehicle and fuel. The municipality is running many vehicles in the system. By purchasing the best environmentally friendly technique the municipality support energy-efficient and/or alternative vehicles to get a market. It can also be done by giving advantages for environmental vehicles e.g. in the parking system. In the cities biogas can be produced from waste, and used as fuel.

Drive in a sustainable way. Too much energy is used, too much noise, accidents and pollution are produced because of poor driving technique. Many trips are made by vehicles, which are managed directly or indirectly by municipality institutions. Produce systems, which are using the vehicles in a sustainable way. New techniques, e.g. for transporting elderly and disabled, allow a much more cost effective use of the vehicles and less empty cars and buses.

Methods to influence policies

To fulfil the five steps described municipalities have a full orchestra of different methods to influence the development in a chosen direction. The examples given below are mainly taken from policies, discussions and actions in the municipality of Örebro in Sweden (about 125 000 inhabitants) but can be used in municipalities all over the Baltic Sea region.

Land use planning

Organise the urban area in a way, which make it possible to reduce transports needs and make transport modes more sustainable. Prioritise parking for bikes instead of cars in the city centre. Create service close to large residential areas.

Examples: New residential and multifunctional areas are built close to the city centre. The maximum distance from the city centre for the main new infrastructure should be about 5 km, which will make it easy to reach by bike. The grid of streets is made as in the pre-car period to reduce the need to drive car long distances. Food shopping should be as close to residential areas as possible. In the central part of the city a very large number of parking places for bikes are organised.

Produce sustainable infrastructure

Use the public investments in a sustainable way. Build more bicycle lanes, tracks to trams and buses and less roads for cars. Use existing infrastructure more efficient instead of building new. Support alternative fuel stations.

Examples: The infrastructure investments are concentrated to get good conditions for logistic orientated business and otherwise create a non-car orientated systems with an excellent grid of bicycle lanes and an effective public transport system. Investments, which support alternative fuels, are encouraged. The permitted maximum speed of cars is reduced to 30 km/h in many parts of the urban area. Implement local rules in the traffic systems, which prioritise a more sustainable traffic in the everyday traffic situation. The accessibility for cars are reduced by building a multitude of bicycle lanes. The rules in the traffic give pedestrians and bikers good shelter. Try to influence the regional road planning for more cost effective investments.

Public procurement

Use the economical power in the municipality as a good purchaser that is demanding environmental behaviour from its contractors.

Examples: The municipality has a large part in the transport sector by running residential areas, public service, infrastructure, etc. In the management of this they use and choose sustainable solutions and put demands on the contractors that that should act in environmentally responsible when making business with the municipality. A public procurement (purchase) policy is implemented.

Public awareness

Campaign about participation in creating a more sustainable traffic system. Campaign for environmental lifestyles.

Examples: Campaigns are made all the time to get more bikers, to more customers to public transport. Environmental goals have been approved. Develop bicycle renting system to increase the total supply of bicycles. Give status to peoples who are using public transport and bikes. The leadership of the city, who takes the bus or bike to work, are good examples.

Public transport

Participate in running a successful public transport system.

Examples: The municipality subsidise through tax money the public transport system. Develop transport systems which fill the needs for different travellers; high speed, safe, comfortable etc. Give priority to the public transport vehicles by separate lanes and give green lights quicker in crossing, are components in agreements when purchasing public traffic.

Distribution of goods

Be engaged in the distribution of goods. Participate in the development of collected distribution.

Examples: The municipality has a project, which tries to change the distribution of goods in the city to a common distribution system. Create environmental zones in some parts of the city.

More efficient use of vehicles

Engage in developing car sharing systems and other methods to have more transport per vehicle.

Examples: The municipality-owned housing company runs a car sharing system. Offer education to all drivers in eco-driving. Demands on contractors to use sustainable transport systems and vehicles. Give status to peoples who are using public transport and bikes. The leadership of the city takes the bus or bike to work and are good examples. Give privileges to cars, which are environmental friendly by e.g. cheaper parking, more access to parking.

Final comments

All these tools and method are of course dependent of the willingness from the leadership of the municipality. If there exist a will, there are possibilities to change the direction of the society, as we know form experience in many places around the world. In many cases the steps are small but if small steps are produced in the same direction the results will be accountable. Implement actions, which are supported by the majority e.g. after surveys. In Swedish cities like Malmö, Linköping, Sundsvall and Örebro all surveys have shown that people want a less car-friendly city centre.

This aim of the article to give a short, condensed description of the existing tools for the development of a more sustainable urban transport system, has made it slightly propaganda-like. Of course it is recognised that the range of political strategies municipalities may use is limited, and they differ from country to country, due to economical power, political leadership, and the legal situation. But still, in general they can be used for many of the ordinary medium-sized Baltic Sea region municipalities. The metropolitan areas have more specific needs, and their large and dense population is a source of more complex problems. But this also give possibilities for e.g. an effective, sustainable and even and cost effective public transport system.

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