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02/2012

Achieving sustainability in urban transport in developing and transition countries

ENVIRONMENTAL RESEARCH OF THE
FEDERAL MINISTRY OF THE ENVIRONMENT,
NATURE CONSERVATION AND NUCLEAR SAFETY

Project No. (FKZ) 3710 96 148
Report No. (UBA-FB) 001546/E

Achieving sustainability in urban transport in developing and transition countries

by

Prof. Dr. Michael Bräuninger, Dr. Sven Schulze, Leon Leschus
Hamburg Institute of International Economics (HWWI), Hamburg

Dr. Jürgen Perschon, Christof Hertel, Simon Field, Nicole Foletta
European Institute for Sustainable Transport (EURIST), Hamburg

On behalf of the Federal Environment Agency (Germany)

UMWELTBUNDESAMT

This publication is only available online. It can be downloaded from <http://www.uba.de/uba-info-medien-e/4239.html> along with a German-language summary.

The contents of this publication do not necessarily reflect the official opinions.

ISSN 1862-4804

Study performed by:	Hamburgisches WeltWirtschaftsInstitut gemeinnützige GmbH Hamburg Institute of International Economics Heimhuder Straße 71 20148 Hamburg	European Institute for Sustainable Transport Weidenbaumsweg 13 21029 Hamburg
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Study completed in: August 2011

Publisher: Federal Environment Agency (Umweltbundesamt)
Wörlitzer Platz 1
06844 Dessau-Roßlau
Germany
Phone: +49-340-2103-0
Fax: +49-340-2103 2285
Email: info@umweltbundesamt.de
Internet: <http://www.umweltbundesamt.de>
<http://fuer-mensch-und-umwelt.de/>

Edited by: Section I 3.1 Environment and Transport
Dr. Hedwig Verron

Dessau-Roßlau, January 2012

Report Cover Sheet

1. Report No. UBA-FB 001546/E	2. -	3. -
4. Report Title Achieving sustainability in urban transport in developing and transition countries		
5. Autor(s), Family Name(s), First Name(s) Prof. Dr. Michael Bräuninger, Dr. Sven Schulze, Leon Leschus Dr. Jürgen Perschon, Christof Hertel, Simon Field, Nicole Foletta		8. Report Date August 2011
6. Performing Organisation (Name, Address) Hamburg Institute of International Economics gGmbH (HWWI) Heimhuder Straße 71 20148 Hamburg		9. Publication Date January 2012
7. Sponsoring Agency (Name, Address) Umweltbundesamt, Postfach 14 06, 06813 Dessau-Roßlau		10. UFOPLAN-Ref. No. 371096148
		11. No. of Pages 148
		12. No. of Reference 208
		13. No. of Tables, Diagrams 4
		14. No. of Figures 21
15. Supplementary Notes		
16. Abstract Sustainable transport is an urging issue on a few accounts: The transport sector was responsible for 23% global CO ₂ emission in 2007. It also has a number of other effects like air and noise pollution, land use etc. These effects are especially relevant in cities, where already half of the world's population is living today. With a growing world population and ongoing urbanisation the number and share of city dwellers will rise considerably in the next decades. Thus, sustainability in urban transport becomes increasingly important. This report first provides a short overview of the most important data behind the sustainability problems in urban transport. Then the question is addressed, what sustainable mobility is and where the main obstacles are on the path to more sustainability. The central part of the study deals with the most important policies and instruments enhancing sustainable (urban) mobility. The main feature of each section within that part of the study is the combination of theoretical background information and arguments with case studies from developing and transition countries. Accordingly, the reader gets an idea of the vast range of available instruments in order to promote sustainable mobility. But it is also shown that it is not only necessary but also possible to introduce or enhance sustainable urban transport regardless of the income position of the specific region, country or city. Besides, success factors for different instruments are identified, thereby deriving promising routes for countries or a group of countries according to their state of economic development.		
17. Keywords Transport, mobility, cities, developing countries, transition countries		
18. Price	19.	20.

Berichts-Kennblatt

1. Berichtsnummer UBA-FB 001546/E	2. -	3. -
4. Titel des Berichts Wege zu nachhaltigem urbanen Transport in Entwicklungs- und Schwellenländern		
5. Autor(en), Name(n), Vorname(n) Prof. Dr. Michael Bräuninger, Dr. Sven Schulze, Leon Leschus Dr. Jürgen Perschon, Christof Hertel, Simon Field, Nicole Foletta		8. Abschlussdatum August 2011
6. Durchführende Institution (Name, Anschrift) Hamburgisches WeltWirtschaftsInstitut gGmbH (HWWI) Heimhuder Straße 71 20148 Hamburg		9. Veröffentlichungsdatum Januar 2012
7. Fördernde Institution (Name, Anschrift) Umweltbundesamt, Postfach 14 06, 06813 Dessau-Roßlau		10. UFOPLAN-Nr. 371096148
		11. Seitenzahl 148
		12. Literaturangaben 208
		13. Tabellen und Diagramme 4
		14. Abbildungen 21
15. Zusätzliche Angaben		
16. Kurzfassung Nachhaltigkeit in der Mobilität ist aus verschiedenen Gründen ein drängendes Problem: Der Transportsektor war in 2007 für 23% der weltweiten CO₂-Emissionen verantwortlich. Er hat zudem eine Reihe weiterer Effekte wie Luftverschmutzung, Lärmemissionen, Landverbrauch usw. Diese Phänomene sind besonders in Städten von Bedeutung, wo bereits heutzutage die Hälfte der Weltbevölkerung lebt. Mit einer weiter wachsenden Weltbevölkerung und fortschreitender Urbanisierung wird die Zahl und der Anteil der Stadtbewohner in den kommenden Jahrzehnten deutlich zunehmen. Deshalb kommt der Nachhaltigkeit im städtischen Verkehr eine zunehmend wichtige Rolle zu. Der vorliegende Report gibt zunächst einen kurzen Überblick zu den wichtigsten Daten des Nachhaltigkeitsproblems im urbanen Transport. Danach wird die Frage diskutiert, was unter nachhaltiger Mobilität zu verstehen ist und welches die wesentlichen Hindernisse bei ihrer Erreichung sind. Der Hauptteil des Berichts widmet sich den wichtigsten Politikbereichen und Instrumenten zur Förderung nachhaltiger (urbaner) Mobilität. Die einzelnen Abschnitte zeichnen sich dadurch aus, dass theoretische Hintergrundinformationen und Argumente mit Fallstudien aus Entwicklungs- und Schwellenländern kombiniert werden. Einerseits erhält der Leser damit Einblick in die große Zahl an Instrumenten, um nachhaltige Mobilität zu fördern. Andererseits wird damit verdeutlicht, dass nachhaltige urbane Mobilität unabhängig von der Einkommensposition bzw. vom Wohlstand einer Region, eines Landes oder einer Stadt möglich ist. Die Studie zeigt Erfolgsfaktoren für verschiedene Instrumente auf, auf deren Grundlage erfolgversprechende Strategien für Länder oder Ländergruppen in Abhängigkeit von ihrem ökonomischen Entwicklungsstand abgeleitet werden können.		
17. Schlagwörter		
18. Preis	19.	20.

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List of abbreviations and acronyms

ADB	Asian Development Bank
BRT	Bus Rapid Transit
BRT lite	Bus-Based Transport System with some but not all the characteristics of a full BRT system
CBD	Central Business District
CDM	Clean Development Mechanism
CER	Certified Emissions Reduction
CIF	Climate Investment Fund
EEA	European Environment Agency
ERP	Electronic Road Pricing
GEF	Global Environment Facility
IADB	Inter-American Development Bank
IEA	International Energy Agency
JI	Joint Implementation
LAMATA	Lagos Metropolitan Transport Authority
LRT	Light Rail Transit
NAMA	Nationally Appropriate Mitigation Actions
ODA	Official Development Assistance
PPP	Public Private Partnership
RMB	Chinese currency (Yuan)
TDM	Transport Demand Management
US-\$	United States Dollars
WB	The World Bank

Executive summary

The general problem

Transport accounted for 23% of global CO₂ emissions in 2007. It is expected that both the overall emissions and the demand for energy in transport will continue to rise in the next decades unless appropriate policy measures are introduced. While fossil fuels will become scarce over the next decades, mobility is one of the basic needs of people today and there is a reinforcing correlation between economic and social development on the one hand and mobility and accessibility on the other. There is a pressing need to improve the sustainability of transport in order to reduce its impact on climate change, better support economic growth, improve energy security and achieve the Millennium Development Goals (MDGs).

Unsustainable transport can cause air pollution, noise, accidents and other negative side-effects harming people and the environment. These effects are especially relevant in urban areas. Today about 50% of the world's population of 6.9 billion people lives in cities. This share will rise to nearly 70% in 2050, when the planet is expected to host more than 9 billion people. Today cities account for nearly two thirds of global energy consumption and more than 70% of CO₂ emissions (from buildings, industry and transport). Sustainability is therefore a major issue and its importance is only going to grow. The focus of this study is sustainability in urban transport, but policy strategies are also needed to promote sustainability in transport at the global and regional levels. This will require strong and skilled governments and institutions, together with reliable data to evaluate the impacts of measures taken.

Challenges

The main challenges stem from both demographic and economic trends. The world's population is going to rise considerably over the next 40 years and by 2050 more than 6 billion people will live in urbanised areas. In a regional perspective urbanization is especially relevant for emerging and developing countries. This is exacerbated by economic growth, leading to the rapid growth of individual motorisation, starting with 2- and 3-wheelers that are subsequently replaced by cars.

There is a close correlation between urban density (land use) and car use. In denser cities cars are less important as a means of transportation. Unfortunately, the causality is not

clear, as on the one hand lower density requires car use but on the other hand car use makes lower density possible. The causes and consequences of urban sprawl are important lessons to be learned and avoided in the future.

There is a clear connection between fossil fuel prices, car density and car use. Cheap fuel induces car ownership and use. Some countries – even those with high incomes – still subsidize fossil fuels instead of taxing them appropriately, resulting in distorted incentives to buy and use fossil fuel driven vehicles for both passenger and goods transport. To promote cost transparency (internalisation of external costs) and a shift to more affordable transport, these subsidies should be removed, possibly supported by an international agreement to do so.

Beside the need for access to affordable means of transport, which are a key to achieve the MDGs, transport-induced CO₂ (and other) emissions have a clear impact on the extent of climate change. Transport must be decarbonised to achieve the 2 degree target advised by the IPCC report 2007 and agreed upon in the Copenhagen Accord 2009.

Sustainable mobility

According to a widely accepted definition by the Centre for Sustainable Transportation a sustainable transportation system is one that

- allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations.
- is affordable, operates efficiently, offers choice of transport mode and supports a vibrant economy.
- limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise.

Policies for sustainable mobility

The concept of Avoid-Shift-Improve (ASI) is widely accepted as a guideline for policies to promote sustainable mobility. This means that transport policy should (in this order) attempt to reduce the need to travel and shorten trip lengths, promote a shift to sustainable modes and to improve the sustainability of all modes. Although ASI originally focused on carbon

emissions, the identified policy instruments can also be applied in a broader context due to the co-benefits they generate in addition to emissions reductions. The policy instruments can be categorized into planning, regulation, technological measures, economic incentives and information.

Three crucial observations hold regarding transport policies. Firstly, any instrument or concept works differently in developed and developing countries. While avoid-strategies can be more successful in poorer countries, richer countries often have to resort to shift-strategies because motorisation is already widespread. Secondly, the consequences of policy decisions are long-lasting and difficult to reverse. This is generally termed path dependency, i.e. processes over time are strongly shaped by incidents at some point in time. If a country or city is on the path of strong motorisation, this could become a process which reinforces itself, thus calling for timely and forward-looking measures to avoid this process altogether. Thirdly, governance and national as well as regional institutions play a pivotal role in transportation policy. Hence, consulting in institution- and capacity-building could be a promising option for developed countries to assist developing and transition states.

The financing of infrastructure is an important issue in transport policy. The general economic problem is that transport infrastructure often has characteristics of a public good or of natural monopolies. These market failures call for public intervention, e.g. by publicly supplying the infrastructure. The substantial amount of funds needed to build and operate transport infrastructure of any kind is an additional challenge.

Above all financing should be policy-oriented, requiring systematic planning and prioritization, and increasingly needs to be secured from a variety of private sources and international financial institutions. Additionally, all stakeholders should participate in planning processes to ensure acceptance.

Regardless of the state of economic development, the available means today are predominantly used for unsustainable transport in most countries of the world. This could be changed if the impacts of financing decisions were analysed in advance, existing resources were prioritised for sustainable mobility and the full costs of all transport modes were considered.

Funding sources are either public, private or both (Public Private Partnerships). Fiscal instruments with a focus on climate change and development include Official Development Assistance, Climate Finance Mechanisms, Clean Development Mechanisms (CDMs) and Nationally Appropriate Mitigation Actions (NAMAs) have to be mentioned. Best practice

examples from the developing and emerging countries of Tanzania, Vietnam and Romania show that, even with scarce financial resources, sustainable mobility can be brought forward.

Land-use and city planning are powerful tools to influence settlement structures and thus mobility patterns in cities. The idea is to shape the demand for transport and the costs of travelling in order to avoid the dispersion of cities and the resulting traffic. Examples from Curitiba (Brazil), Bogota (Columbia), Beijing (China) and Kunming (China) show that land-use planning, especially if coordinated with other policy areas, can have great effects in promoting sustainable mobility. An important prerequisite is the existence of institutional structures to facilitate this.

Technological solutions other than vehicle efficiency improvements include alternative fuels and the electrification of transport. Sometimes efficiency and emission requirements are used in order to promote the development or use of technologies. Electric and hydrogen-based mobility could become an option for both developed and developing countries in the long run but are not yet sufficiently competitive. However, electrically-assisted bikes could prevent or slow down the rise of car ownership or at least the use of private cars in large and fast-growing cities in emerging countries. First generation biofuels suffer from sustainability deficits and potential competition for land with food production. Only under specific conditions – see the example of biofuels in Brazil – can biofuels offer a genuine improvement in sustainability. Second generation biofuels show more promise but they are not yet competitive. In summary, technology can play a supporting role but is not able on its own to make mobility more sustainable.

Non-technological solutions offer the most diverse and effective set of measures to promote sustainability in urban transport. Their general aim is to influence the relative attractiveness of different transport modes. Rather than trying to keep up with growing demand for transport, these measures try to affect travel behaviour. Non-technological solutions can be categorized into push- and pull-measures: push-measures are designed to make unsustainable modes of transport less attractive while pull-measures try to make sustainable modes relatively more attractive in terms of price and quality, following the 'polluter pays' principle. Single push- and pull-measures in isolation usually only have small effects and should be embedded in larger and comprehensive policy frameworks.

Push-measures are mainly economic instruments but can also take the form of regulations. The main economic instruments are fuel taxes, vehicle taxes, road or congestion charges and parking fees. Empirical evidence suggests that all of these instruments work into the expected direction, i.e. higher taxes, charges or fees discourage car use (and to some extent ownership) in the short and in the long run. However, implementation of such measures requires political commitment, which is often absent in the developing and developed world alike. Direct fossil fuel subsidies should be scrapped as an immediate priority. Regulatory instruments such as parking management and access restrictions need even stronger governance and are thus rather more suited for developed countries.

Pull-measures enhance the relative attractiveness of alternative modes to the private car. While numerous possibilities in public transport exist from metros to Light Rail Transit (LRT) to Bus Rapid Transit (BRT): under most circumstances BRT offers the cheapest solution to transport large numbers of people in poorer countries. However, careful assessment is needed in any city to identify the best solution(s). Existing public transport should be integrated and/or expanded rather than being completely replaced. This holds true for countries in all states of economic development.

Case studies ranging from Lagos in Nigeria to the Medina of Fes in Morocco to Guangzhou in China demonstrate that making alternative modes more attractive is achievable in emerging and developing countries.

Policy options by country group

In this study five country groups were defined according to their level of economic development, consistent with the World Bank classification system: high income OECD countries, high income non-OECD countries, upper middle income countries, lower middle income countries and low income countries. Though heterogeneity is large even within the country groups, some general conclusions can be drawn.

High income countries are in a good starting position to make transport in their cities more sustainable as the funding of measures is usually easiest for them. Overall, they should try to reduce and shift away from motorized individual transport. This could be done by channelling available funds towards more sustainability-oriented city development. Technological as well as non-technological solutions can be used. From the latter, economic instruments like fuel taxes, road charges or parking fees paired with a set of pull-measures towards sustainable modes appear promising. Some high income countries still subsidize fossil fuels and follow road-focused strategies: this approach should be revised.

When providing help to poorer countries, high income countries do not necessarily have to supply additional funding. It would instead be helpful if these funds were more clearly related to sustainability criteria. Much could be gained by knowledge-transfer (especially in planning) and the institutional reform of local and national planning and implementation agencies.

Upper and lower middle income countries are often at the beginning or already in the midst of motorisation. Financial limitations mean that they do not have all the policy options of high income countries. Nevertheless they have shown that transit-oriented development or mode shift is also possible with limited resources if the political will and good governance arrangements exist. Timely planning is important as car dependency tends to accelerate as soon as a certain income threshold is passed. At the national level fuel taxation can stem this growth. On the city level, parking fees together with pull-measures – especially attractive public transport systems – and electric mobility for 2- and 3-wheelers could prevent future problems.

Low income countries have the least options for developing sustainable transport systems due to financial restrictions but especially due to the lack of functioning institutions to implement the necessary strategies. However, they are in a good position to avoid car-oriented city-development. Planning and Travel Demand Management can play a crucial role here, because the earlier these instruments are used, the less likely these countries will

encounter the problems of more developed cities. The potential of avoid-strategies is usually large in developing countries. If public transport is already in place, it should be retained, modernized and expanded. Otherwise mass transit systems like Bus Rapid Transit (BRT) can offer an alternative as they are relatively cheap and if appropriately implemented also financially self-sufficient. In general, financial limitations increase the need for pragmatic approaches, which in turn require capacity-building support from high income countries. International or regional agreements between countries could support national reform efforts to remove subsidies on fossil fuels or to introduce fuel taxes. A reorientation of transport financing to meet broad sustainability criteria is essential.

Conclusions

Despite the abundance of policy instruments, there is no single silver bullet to fit all national and regional circumstances. The complicated matter of urban transport policies calls for integrated and comprehensive programmes for the medium- to long-term, taking account of the local and regional context. It has been shown in this report that many instruments have been deployed successfully in developing and emerging countries. These case studies can serve as examples for poor and indeed wealthy countries on how to make their urban transport systems more sustainable.

1. Introduction

Numerous questions arise with regard to global sustainable transport. Transport accounted for 23% of global CO₂ emissions in 2007. It is expected that the overall emissions will continue to rise in the next decades unless action is taken. But transport is not all about CO₂ emissions and its climatic effects. Mobility is one of the basic needs of people today and there is a connection between economic development on the one hand and mobility and transport on the other.. There is also more to sustainability in transport, as it causes air pollution, noise, accidents and other negative side-effects harming people and the environment. These effects are especially relevant in urban areas. Today about 50% of the world's population of 6.9 billion people lives in cities. This share will rise to nearly 70% in 2050, when more than 9 billion people are expected to live on this planet. Cities nowadays account for nearly two thirds of global energy consumption and more than 70% of CO₂ emissions (from buildings, industry and transport). Sustainability is therefore a major issue and its importance is only going to grow. This study concentrates specifically on sustainability in urban transport.

The study is structured as follows: Chapter 2 highlights the most important data justifying our research focus. In chapter 3 the characteristics of sustainable mobility are identified and defined, in order to set the scene for the policy measures described in subsequent chapters. Chapter 4 constitutes the central part of this study as it compiles policies to promote sustainable urban mobility and discusses their economic and other advantages and disadvantages. After some basic thoughts on policy for sustainable transport, four major topics are considered in more detail, namely the financing of infrastructure, the role of settlement structures, technological and finally non-technological measures. The theoretical and political background are presented, followed by best-practice examples almost exclusively from cities in developing and transition countries. Each case study explains the regional background, provides an overview of the implemented strategy, assesses transferability and makes some recommendations implementation elsewhere. Chapter 5 summarises the findings and offers some conclusions.

2. Data and challenges: An international perspective

The future of fuel consumption in the IEA 450 Scenario

To obtain an impression of the world future energy demand we look at the International Energy Agency (IEA) scenarios. The IEA (2010a) report presents scenarios which differ with respect to energy and climate policy. Here we concentrate on the 450 (CO₂ parts per million) scenario which sets out an energy pathway consistent with the objective to limit the global temperature increase to 2°C. In this scenario the power sector achieves such significant CO₂ reductions that transport becomes the largest source of energy-related emissions.

In total global transport oil consumption will grow from 2150 million tonnes of oil equivalent (Mtoe) to 2300 Mtoe in 2020. Thereafter it remains constant and decreases to about 2200 Mtoe in 2035. Even in this scenario oil stays the dominant fuel in transport. Its share declines from 94% in 2008 to 77% in 2035. Most of the oil savings occur in road transport, which accounts for more than 80 % of all oil savings by 2035. Among road vehicles, light-duty passenger vehicles account for more than three quarters of the oil savings.

In 2035 biofuels will be the main alternative to conventional oil. They will reach a share of 14%. Natural gas and electricity will each have a share of about 4.5% of total fuel consumption. IEA 450 provides the greatest CO₂-reductions of all the scenarios considered by the IEA, and considers measures that achieve this path (see also chapter 4, IEA 2009a, IEA 2010a, IEA 2010b, WBCSD 2004 and Kahn Ribeiro et al. 2007). The importance of a reduction in fossil fuel subsidies is highlighted (see chapter 4 for a further discussion).

Mobility in different stages of economic development

Mobility and requirements for mobility differ between countries due to different stages of economic development as well as due to other social and cultural factors. This chapter concentrates on economic factors influencing mobility. Clearly in an early stage of economic development missing infrastructure might be the main problem for economic development. In later stages of development pollution and congestion might be more significant problems. To illustrate the relationship between economic development and mobility we have analysed countries in accordance to the World Bank's economic development classification. The income groups are high income OECD (1), high income non OECD (2), upper middle

income (3), lower middle income (4), and low income (5).¹ For the purpose of this study it makes sense to use this classification instead of a regional differentiation because the basic causalities we are presenting are independent of geographical circumstances. The same applies to the policy instruments analyzed later, although implementation may vary according to the regional and local context.

Important aspects for mobility related to economic development are population growth, urbanization and urban density. Figure 2.1 shows the rising world population and the number and share of people living in cities.

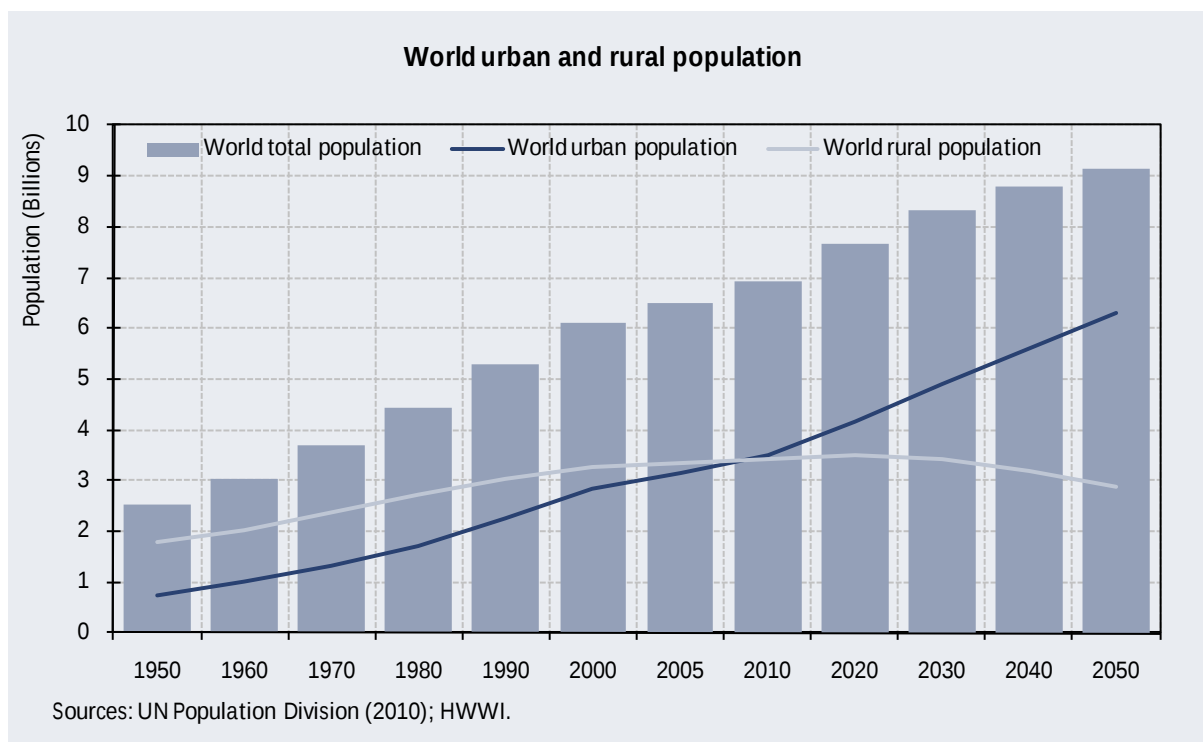


Figure 2.1: World urban and rural population

Urban density

Urban density influences mobility in several ways. At first, increasing urbanization opens up the possibility for public transport and can reduce the demand for long distance travel. Figure 2.2 shows that the car use per capita declines with urban density. On the other hand, insufficient public transport opportunities combined with high individual mobility demand will lead to congestion. Low-density suburbanization leads to greater car ownership and use, particularly where the suburban road network is well developed. All the available evidence

¹ See the Appendix for the complete list and classification of countries.

suggests that differences in the growth and expansion patterns of cities can have adverse outcomes for the sustainability of mobility. The direction of causality is not always clear: lower densities encourage car use and threaten the economic viability of public transport, but the availability of cheap motoring makes lower-density cities possible (see Angel et al. 2005 for a discussion).

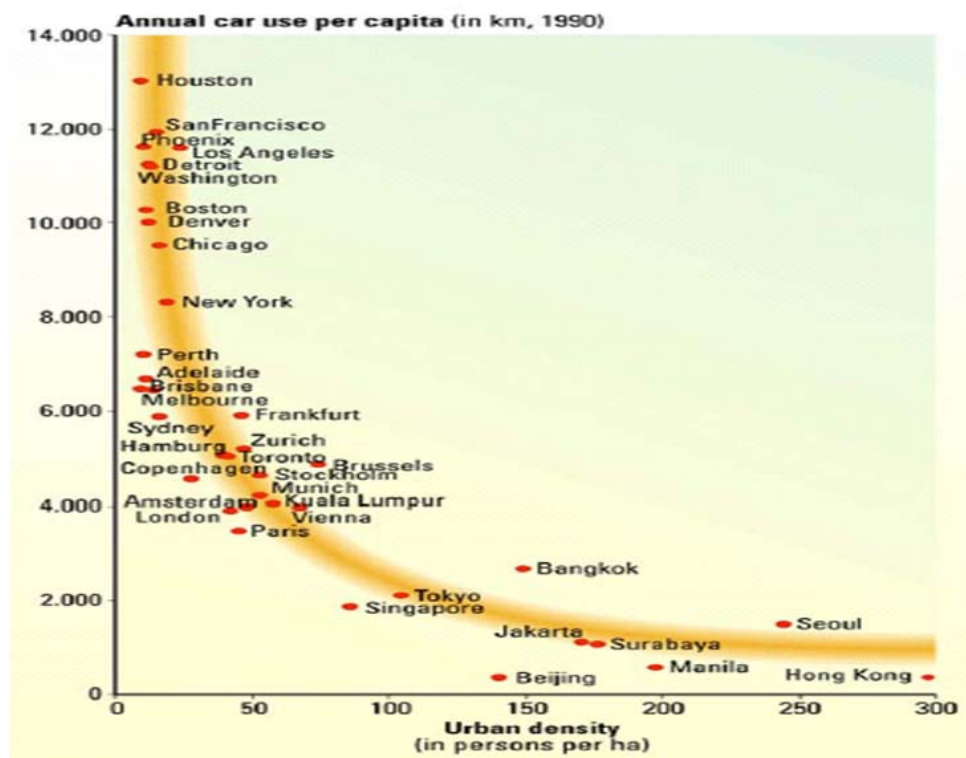


Figure 2.2: Urban density and car-use

The figures 2.3 and 2.4 show box-whisker-plots for the degree of urbanization in 2008 and predicted for 2050 (see UN Population Division 2010). The plots provide a description of the distribution of urban density within the different income categories. The data are divided into four quartiles: the upper and lower quartiles are displayed as whiskers. The inner quartiles are represented by the box and the bar in the box shows the median. The figures demonstrate the large heterogeneity within each income group. Compared to high income OECD countries (income group 1) the other income groups show even greater heterogeneity. The heterogeneity is highest for high income non OECD countries. Figure 2.4 shows that urbanization is going to increase in all income groups. However, the development in lower-income countries is much more pronounced than in the industrialized countries and therefore the change in urbanization is larger in the lower income countries. Still, it is worth noting that even in 2050 there will be countries with low urbanization.

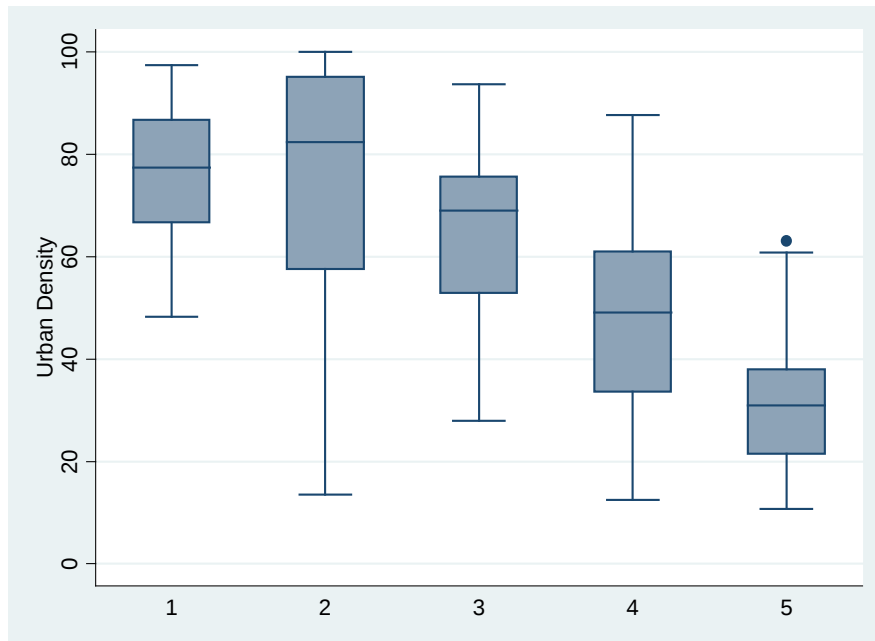


Figure 2.3: The distribution of the degree of urbanization in different stages of economic development in 2008

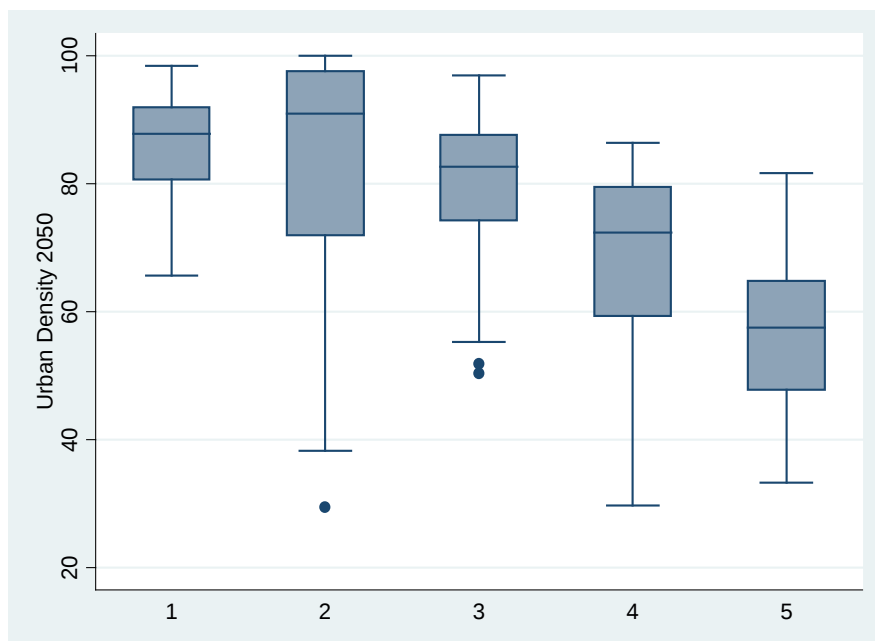


Figure 2.4: The distribution of the degree of urbanization in different stages of economic development in 2050 (World Bank Projection)

With the coming change in urbanization, patterns of mobility will change. The early adoption of sustainable urban development principles is required to prevent the mistakes seen in western cities.

Car Density

Figure 2.5 shows the car density for different income groups. Although there is large heterogeneity within the highest OECD countries (and heterogeneity is even higher for high income non OECD countries), it is clear that car density increases with income, representing a key challenge for developing countries.

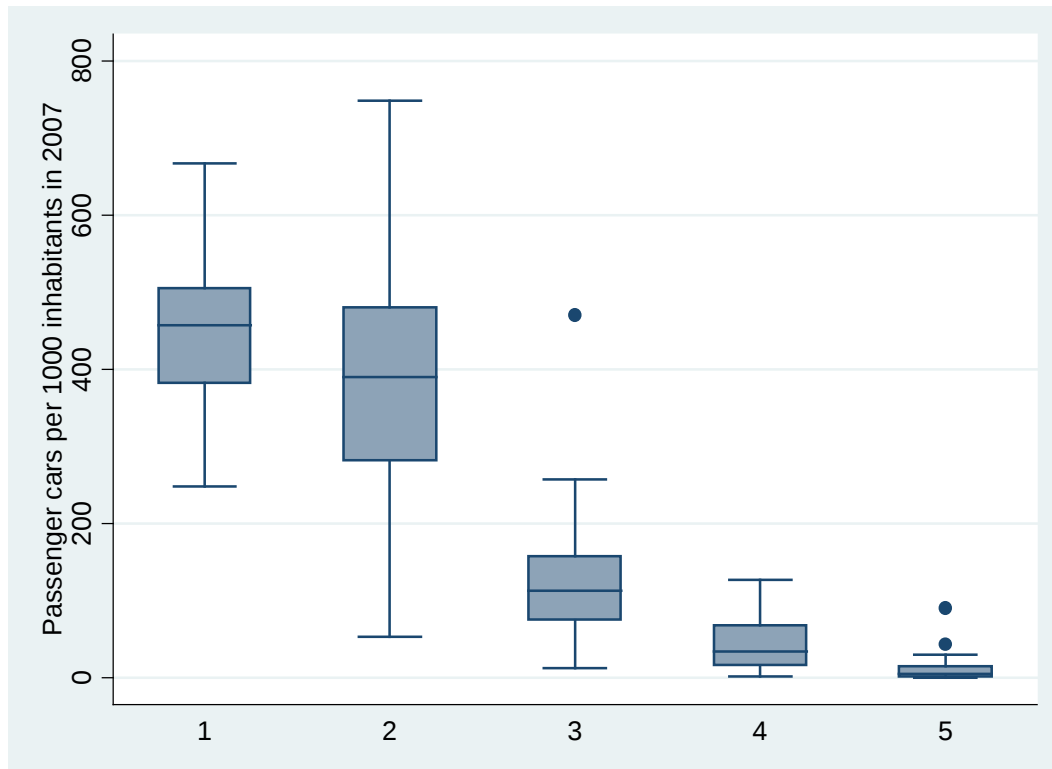


Figure 2.5: The distribution of car density in different stages of economic development

Fuel Prices

Fuel prices have an important impact on urbanization and car density. Furthermore, they are an important factor in the competitiveness of public transport. It is therefore important that fuel prices reflect the true cost of individual transport. In many countries fuels are taxed to raise tax revenues and increase the fuel price. Economic theory states that this increases welfare if the social costs of fuel use exceed the private cost, reflecting the negative effects of fuel consumption on the environment and human health. However there are a number of countries where fuel is not taxed but subsidized. The IEA (2010a) estimates that oil product subsidies alone have amounted to about 312 billion US-\$ in 2009.

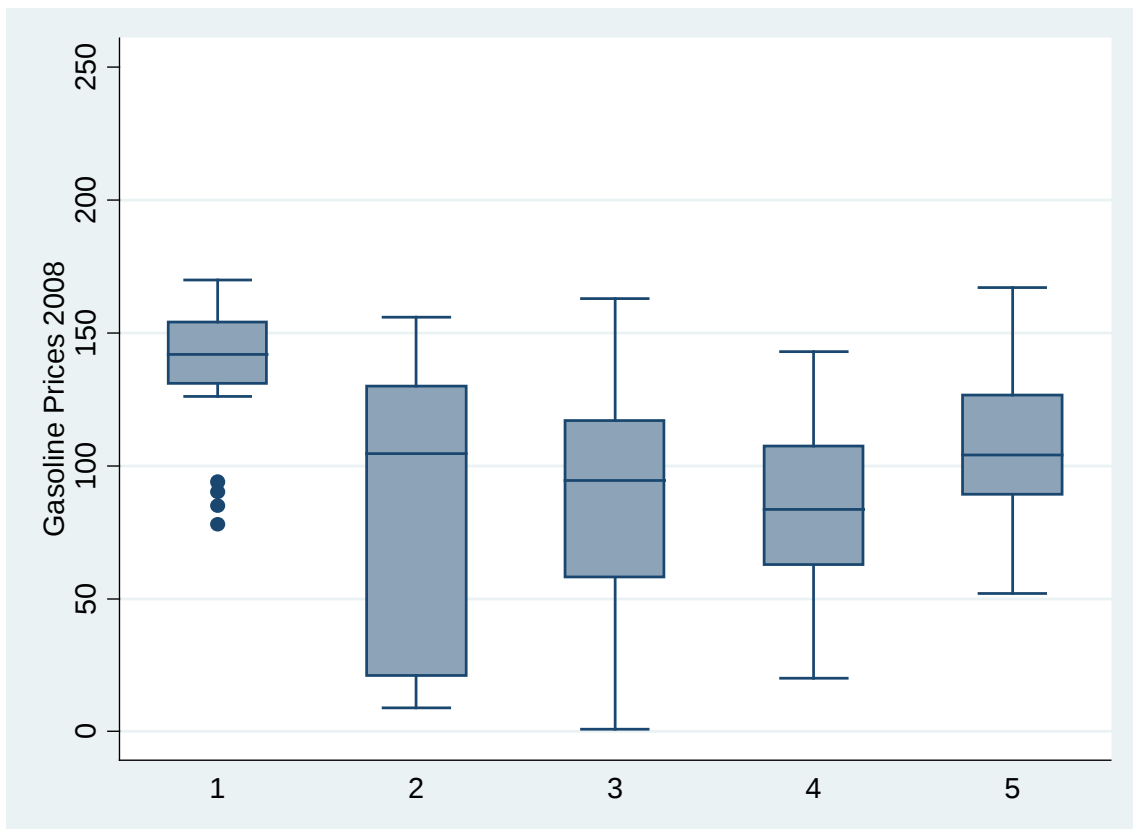


Figure 2.6: The distribution of petrol prices in different stages of economic development

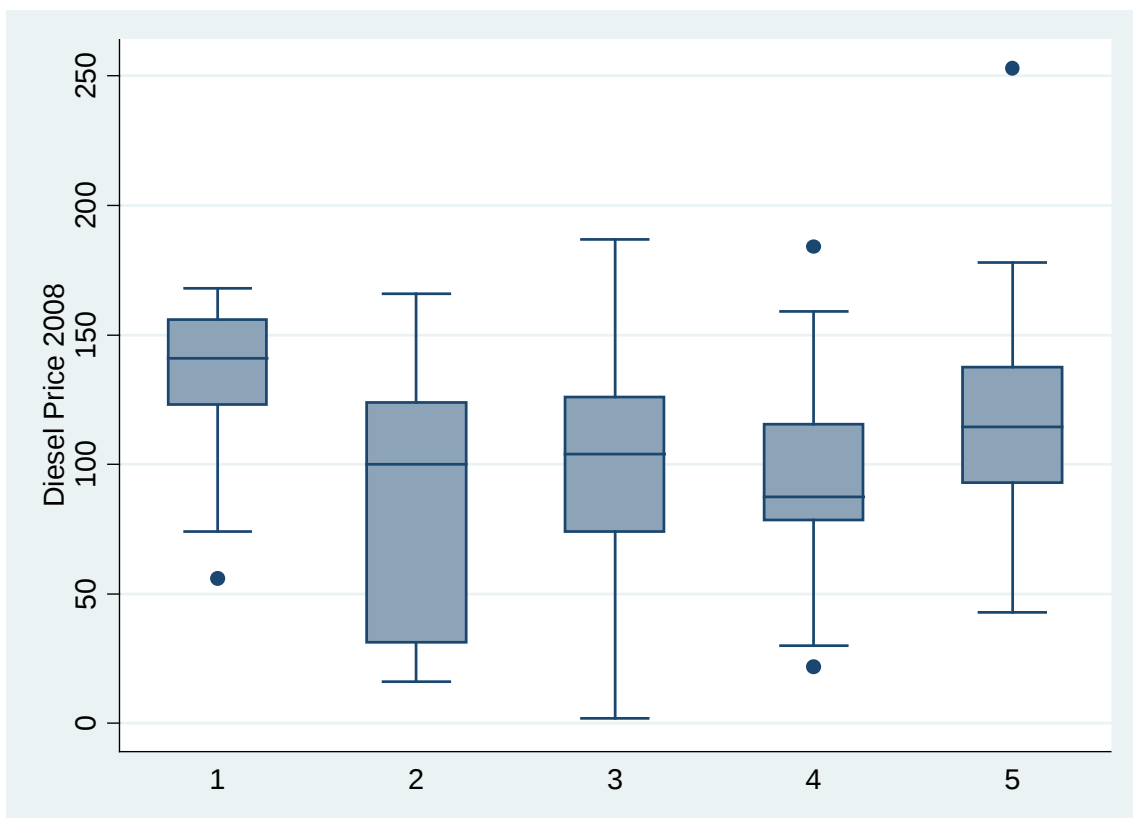


Figure 2.7: The distribution of diesel prices in different stages of economic development

Figure 2.6 shows fuel prices for the different country groups. Fuel prices are highest in OECD countries. However, there is considerable price heterogeneity within all income groups. Since there is an international market for crude oil as well as for naphtha and diesel, price heterogeneity is largely a result of differences in taxes or subsidies. For diesel these differences are smaller than for petrol. Fuel prices vary most in high income non OECD countries and in high middle income countries.

A collaboration of the Global Subsidies Initiative, the International Institute of Sustainable Development (IISD) and the Bali to Copenhagen project has looked at how to measure fossil fuel subsidies, estimate their impacts on GHG emissions and documented reform attempts in a number of countries. The project showed that many governments provide financial assistance to boost the economy, but that fossil-fuel subsidies reduce government budgets and increase energy use and GHG emissions. In 2009 the leaders of the Group of Twenty (G-20) countries agreed fossil-fuel subsidies should be phased out in the medium term. However, even if this is believed to be a “win-win” policy that would also increase energy security, phasing out will be difficult in the absence of political consensus and fears about price increases, job losses and environmental impacts (if consumers switch to dirtier fuels). An international agreement on subsidies could support national reform efforts to reduce subsidies.

To illustrate and quantify the effects of fuel prices on CO₂ emission we performed multiple country regression analysis. As dependent variables we used energy use per capita and CO₂ emissions per capita. Explanatory variables are per capita GDP, fuel prices and the degree of urbanization. All variables are on log scales so the estimated coefficients can be interpreted as elasticities. In both cases the regression coefficients (R^2) illustrate the importance of per capital GDP and fuel prices. An increase in GDP per capita by 10 % implies an increase in per capita CO₂ emissions of 7 % to 8 %. Increasing fuel prices by 10 % lead to a decline in per capita CO₂ emissions of about 5 %. The effects on per capita energy use are slightly smaller.

Quick facts

- Population density, the degree of urbanization and urban density are going to increase significantly in the next few decades.
- This will mean that mobility patterns are going to change.
- Fuel prices are an important determinant for the development of urban density and mobility patterns.
- There are many countries where fuels are still subsidized. A removal of fuel subsidies and an increase in fuel taxes would help to facilitate sustainable mobility by discouraging car use.

3. The characteristics of sustainable mobility

According to the famous Brundtland Report, “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”²

While this has initiated extensive discussions on the concept, one can derive three central characteristics from this definition, namely that sustainability has to take account of economic, environmental and social (equity) aspects. This holds true for sustainable development as a whole as well as for sustainable mobility.

Definitions of sustainable mobility (or sustainable transport) can also be found in various forms and they are often adapted to various contexts (see e.g. Litman 2011, p. 7, Poor & Lindquist 2009). According to a widely accepted definition by the Centre for Sustainable Transportation³, a sustainable transportation system is one that

- allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations.
- is affordable, operates efficiently, offers a choice of transport mode and supports a vibrant economy.
- limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise.

Litman (2011) argues that this definition underscores the fact that policies in sustainable transport should strive for economic, social and environmental goals at the same time. An indispensable precondition for the implementation of such policies is good governance and

² See Report of the World Commission on Environment and Development: Our Common Future, Part I, Chapter 2, Number 1, <http://www.un-documents.net/wced-ocf.htm>.

³ See The Centre for Sustainable Transportation (2005) and the quotation in Litman (2011, p. 8).

Besides, the slightly modified definition by the European Conference of Ministers of Transport (ECMT) from the year 2004 is worth mentioning, as it is also used by the GIZ formerly named GTZ. The main differences are that companies are additionally mentioned under the first bullet point and that under the second bullet point “a vibrant economy” is replaced by “a competitive economy, as well as balanced regional development”. It is worth noting, that both definitions do not explicitly refer to sustainable transport modes but merely to transport modes in general. This should be taken with a grain of salt when defining sustainable mobility.

planning. He also discusses the objectives of sustainable transport and how these can be measured in order to secure a targeted policy approach. As this is beyond the scope of this study, we do not elaborate on this any further.

Wiederkehr et al. (2004) report on the OECD's EST (Environmentally Sustainable Transport) Project, which tried to derive measurable criteria of the influence of the transport sector on the environment as well as policies and strategies to achieve desired targets. The general approach is depicted in figure 3.1. The principle behind backcasting is to compare a business as usual scenario (BAU) with a desired outcome (EST) to get an idea of necessary measures, i.e. the policy gap. In general, sustainability goals require policy interventions.

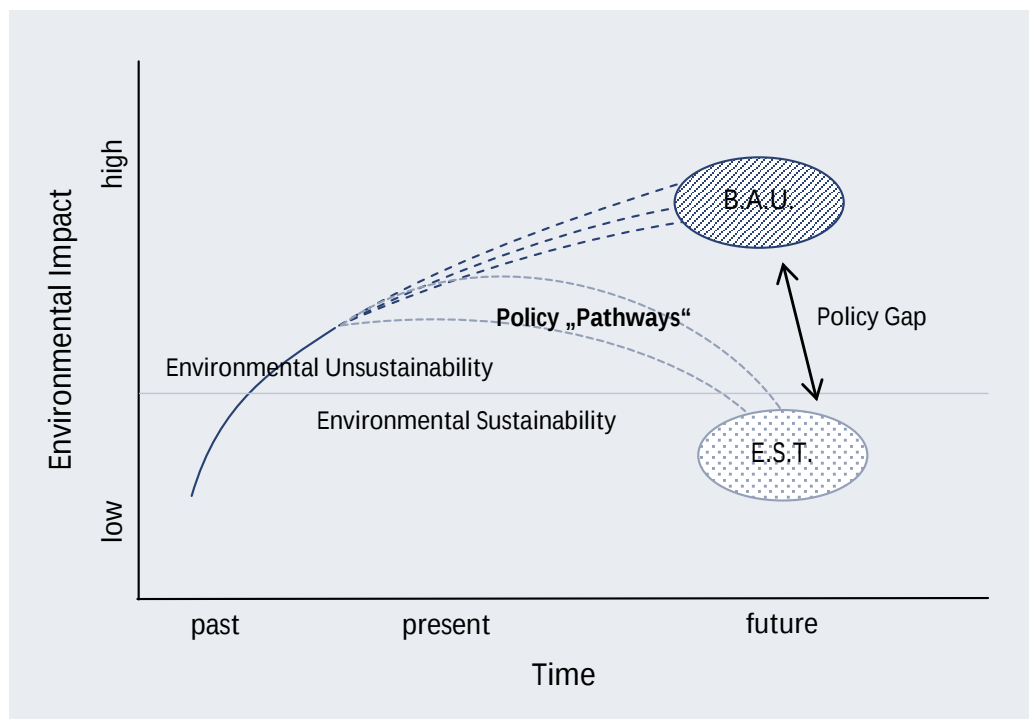


Figure 3.1: Environmental sustainability targets and backcasting method⁴

Black et al. (2002, pp. 186-187) define a sustainable urban transport and land use system as one which

- provides access to goods and services in an efficient way for all inhabitants of the urban area,
- protects the environment, cultural heritage and ecosystems for the present generation and

⁴ Wiederkehr et al. 2004, p. 13.

- does not endanger the opportunities of future generations to reach at least the same welfare level as those living now, including the welfare they derive from their natural environment and cultural heritage.

These characteristics again reflect the three pillars of sustainability while additionally highlighting inter- and intra-generational equity.

Black et al. (2002) also note that the following sub-objectives are necessary: economic efficiency, liveable streets and neighbourhoods, protection of the environment, equity and social inclusion, safety and contribution to economic growth. The last of these serves as a reminder that sustainable transport is linked to many other sectors, complicating the analysis and resulting policies (see also Goldman & Gorham 2006).

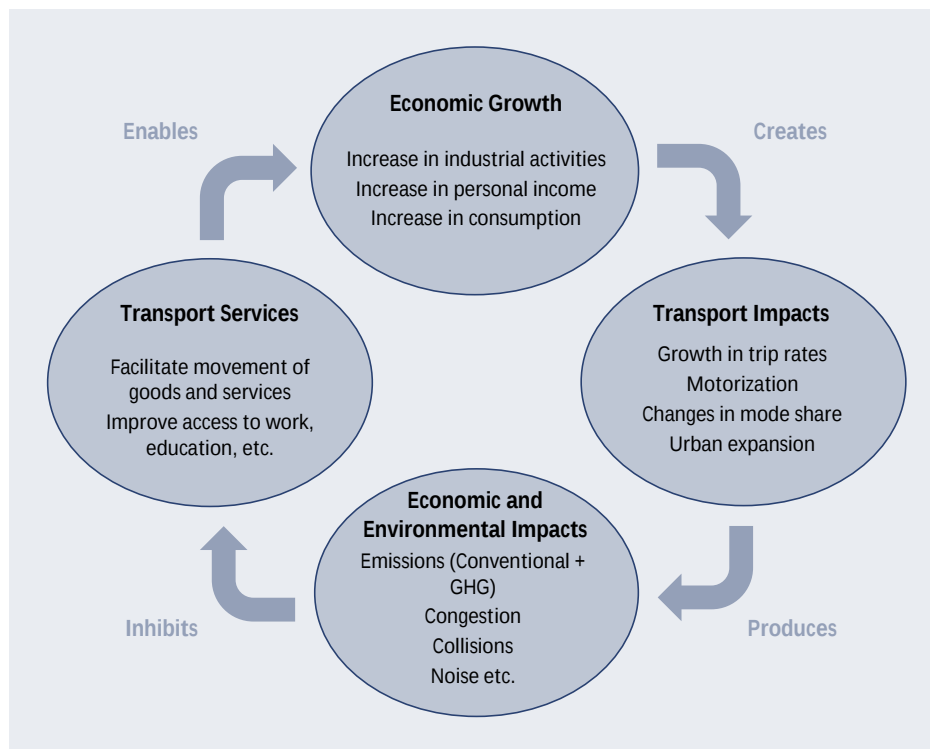


Figure 3.2: The challenges of making mobility sustainable

The WBCSD (2004, p. 13) uses figure 3.2 to illustrate the challenges of making mobility sustainable. Transport has a number of direct benefits and is in itself a good, playing a crucial role in the economic development of societies, thus enabling economic growth. However, this has repercussions, most notably on settlement structures and negative externalities in terms of CO₂ and air pollutant emissions, congestion and health impacts (caused by accidents or air and noise pollution).

Increasing mobility (and motorisation) has obvious benefits to individuals and societies, but at some point is offset by negative externalities. Figure 3.3 (see Gilbert 2000, p. 15) shows that the benefits of motorisation are positive and increase until a peak is reached, after which they start to decrease but remain positive until reaching a threshold beyond which additional motorisation is detrimental.

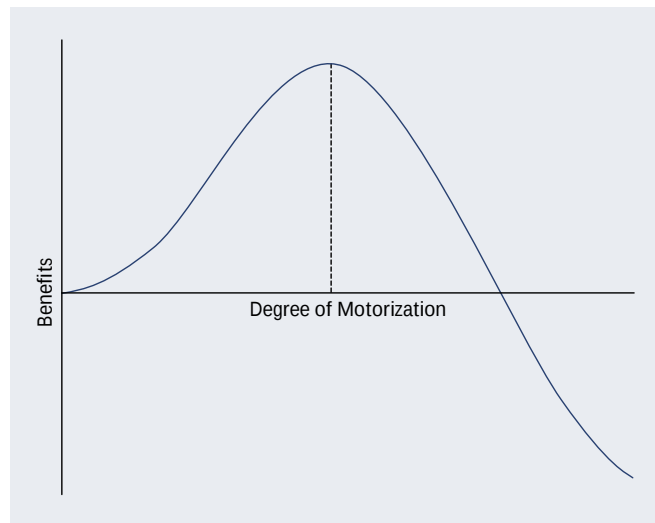


Figure 3.3: Balance of the costs and benefits of transport with increasing motorisation

In order to make transport sustainable in the foreseeable future, developed countries will have to cut down on their motorisation (or at least on the per capita use of their existing motorized vehicles) whereas developing countries should attempt to avoid the unsustainable path taken by industrialized countries in the past (see chapter 4 for details).

Various studies have tried to estimate the external costs of the transport sector, particularly in developed countries. Nevertheless their results can play an important role in advising developing countries, in order to avoid patterns of development that would incur similar or higher external costs. In essence, prevention is more effective than attempts to undo entrenched travel behaviour through belated cost internalisation.

Some estimates for the external costs of transport in the European Union are presented and discussed in Persson & Song (2010), while the World Bank (2002) summarizes worldwide studies on this issue. Summary tables from Persson & Song (2010, pp. 48) and from the World Bank (2002, p. 9) are given in tables 3.1 and 3.2 respectively. For the EU-countries it is interesting to observe that the external costs of congestion as given by Persson & Song

(2010) dominate. The figures collected by the World Bank (2002) are more mixed, reflecting regional differences in the level of economic development.

External cost components of the CE Delft Handbook									
Cost component		Passenger car (EUR ct/vehicle-km)				Goods vehicle (EUR ct/vehicle-km)			
		Urban roads	Motor ways	Rural roads	Weighted average*	Urban roads	Motor ways	Rural roads	Weighted average*
Congestion	Peak	30,0	10,0	5,0	11,1	75,0	35,0	13,0	31,0
	Off-peak	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
	Weighted average	12,0	4,0	2,0	4,4	30,0	14,0	5,2	12,4
Accidents		4,2	0,3	1,6	1,7	10,7	0,3	2,7	3,4
Noise		0,8	0,0	0,0	0,2	7,6	0,0	0,1	1,4
Air pollution		0,5	0,3	0,3	0,3	7,0	5,3	5,8	5,9
Climate change		0,7	0,4	0,4	0,4	1,8	1,5	1,6	1,6
Up and downstream		0,9	0,6	0,6	0,7	2,1	1,7	1,9	1,9
Nature and landscape		0,0	0,4	0,4	0,3	0,0	1,2	1,2	0,9
Soil and water pollution		0,1	0,1	0,1	0,1	1,0	1,0	1,0	1,0
Total	Peak	37,2	12,1	8,4	14,8	105,2	46,0	27,3	47,1
	Off-peak	7,2	2,1	3,4	3,7	30,2	11,0	14,3	16,1
	Weighted average	19,2	6,1	5,4	8,1	60,2	25,0	19,5	28,5
* Weighted average values reflect share of vehicle-kilometre for road categories and share of peak time.									
Sources: Persson and Song (2010); HWWI.									

Table 3.1: External cost components of the CE Delft Handbook

Estimates of External Costs of Road Transport (as Percentage of National and Regional GDP)															
Country or city	Year	Source	Road costs	Land and parking	Congestion	Accidents, net of insurance	Pollution				Sub total	Revenue from road users	Net subtotal	Others	Total
							Noise	Local air	GHGs	Other					
United States 1	1989	WRI	1,64a	1,56	-	1,00	0,16	0,18	0,50	-	5,04	a	5,04	0,46	5,50
United States 2b	1990	NRDC	1,25a	0,43-1,74	0,19	1,71	0,05	2,09-3,83	-	0,07	5,69-8,84	a	5,69-8,84	0,78-2,61	6,47-11,45
United States 3	1991	Lee	1,76	2,41	-	0,24	0,19	0,73	-	0,26	5,59	0,88	4,71	0,87	5,58
EU1	Early 1990s	ECMT	1,75	-	0,74	2,40	0,30	0,60	0,50	-	6,30	1,67	4,63	-	4,63
EU2	Early 2000s	ECMT	1,49	-	0,75	1,20	0,30	0,15	0,47	-	4,36	1,67	2,69	-	2,69
United Kingdom	1993	CSERGE	0,24	-	3,03	0,46-1,49	0,41-0,49	3,12	0,02	-	7,28-8,39	2,60	4,68-5,79	-	4,68-5,79
Mexico City	1993	Ochoa	-	0,08	2,56	2,32c	-	0,64	-	-	5,60	-	5,60	-	5,60
Poland	1995	ISD	1,14	-	0,30	1,60	0,10	0,30	-	-	3,44	2,81	0,63	-	0,63
São Paulo	1900	IRBD	-	-	2,43	1,11	-	1,55-3,18	-	-	-	-	5,09-6,72	-	5,09-6,72
Buenos Aires	1995	FIEL	0,73	-	3,42	0,5-2,00d	-	0,97	-	-	5,62-7,12	1,01	4,61-6,11	-	4,61-6,11
Bangkok	1995	Misc.	-	-	1,00-6,00	2,33	-	2,56	-	-	5,89-10,89	-	5,89-10,89	-	5,89-10,89
Santiago	1994	Zegras	1,37	1,92	1,38	0,94	0,15	2,58	-	-	8,35	1,64	6,71	-	6,71
Dakar	1996	Tractebel	-	-	3,37	0,16-4,12	-	5,12	-	-	8,65-12,61	-	-	-	8,65-12,61
a Road costs given net of revenues from road users.															
b Cars only.															
c Gross of insurance compensation.															
d Calculated on nationwide basis and gross of insurance compensation.															
Sources: World Bank (2002); HWWI.															

Table 3.2: Estimates of external costs of road transport (as percentage of national and regional GDP)

The externalities of transport seemingly favour avoid-strategies over technological solutions. While we agree in principle, there is never a one-size-fits-all strategy, nor can individual or

small sets of measures solve all the problems arising from growing (urban) populations and traffic. Only integrated approaches are able to deliver sustainable mobility.

Before analyzing policy options, a recap of the reasons for unsustainable transport in cities is helpful. According to Punte (2010) the main reasons lie in the absence of a city development strategy, demand-driven transport policies, ineffective planning (also with regard to available budgets), a lack of performance reviews and overall governance problems. Serviceable policy advice has to keep this in mind in order to be successful.

Quick facts

- Sustainable mobility in general takes account of economic, social and environmental aspects.
- A sustainable transport system provides goods and services to all inhabitants of an area, is affordable, safe and efficient and protects the environment and its services.
- The challenge to make transport sustainable stems from the observation that transport services enable economic growth, creating transport impacts, which in turn produce economic and environmental impacts, which thereby might inhibit transport services and quality of life.
- Increasing mobility generates benefits, but causes problems above a threshold level of private motorisation.
- Transport causes positive and negative externalities, justifying policy intervention to internalize and reduce them as appropriate.

4. Policies to promote sustainable mobility

Sustainable mobility is a lively research area with a vast amount of existing literature stemming from scientific, public or non-governmental sources. This also holds true for the sub-topic of transport in urban areas or cities. In this chapter we provide an overview of the resulting policy recommendations in this respect. After some initial thoughts on principal policy aspects we subsequently deal with the financing of transport infrastructure, the role of settlement structures and land use planning, technological and non-technological solutions.

Although plenty of literature has been reviewed, at the time of writing this study we have identified some essential sources simultaneously delivering overviews and in-depth information. These sources are:

- European Environment Agency (2010): Towards a resource-efficient transport system – TERM 2009
- World Business Council on Sustainable Development (2004): Meeting the challenges
- World Business Council on Sustainable Development (2009): Mobility for development – Facts and Trends 2009
- World Bank (2002): Cities on the move
- Asian Development Bank (2009): Changing course
- GTZ (different years): Sustainable transport – A sourcebook for policy-makers in developing cities, Module 1a-5f and GTZ (2002a): Introductory module - Sourcebook overview (see www.sutp.org).

1. Basic considerations

The concept of Avoid-Shift-Improve (ASI) is often mentioned in the context of GHG emissions (GTZ 2010a, Module 5e, p. 7). ASI is a good starting point for considering sustainable mobility, illustrated in figure 4.1. The general idea is to affect individual mobility decisions such that some trips do not take place, others are shortened and that the remaining motorised trips are as sustainable as possible.

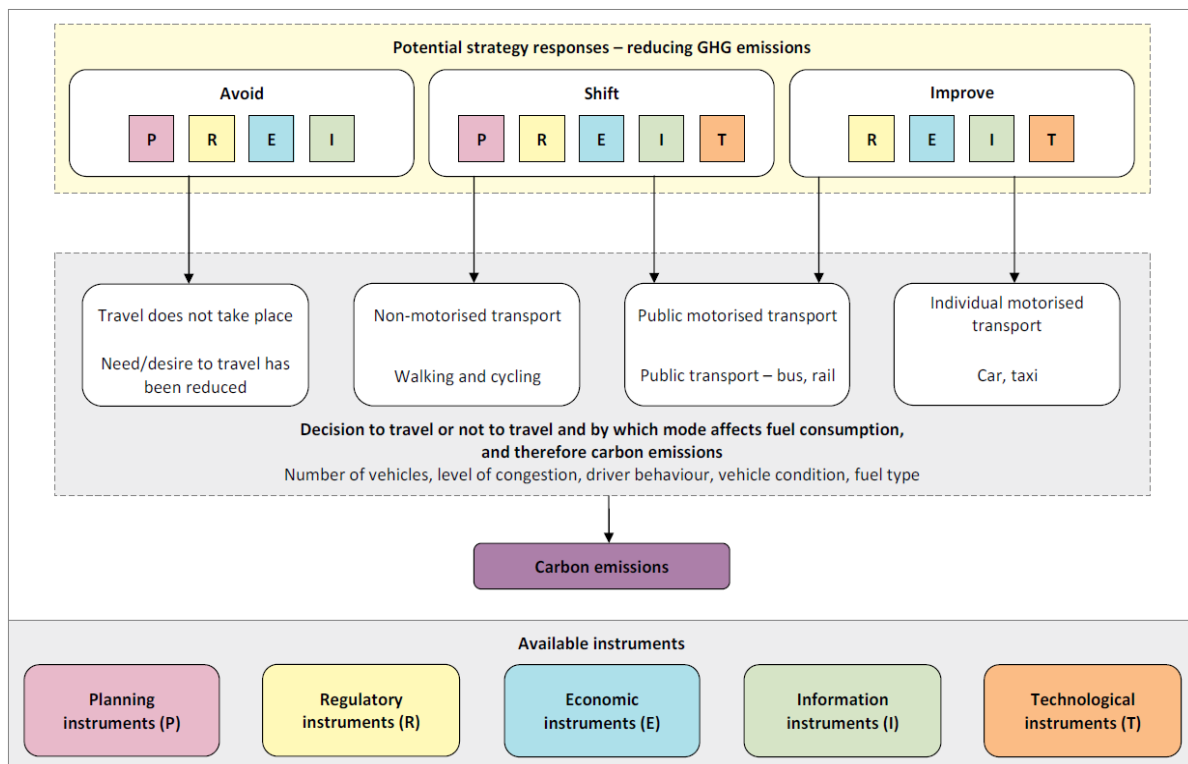


Figure 4.1: The Avoid-Shift-Improve concept

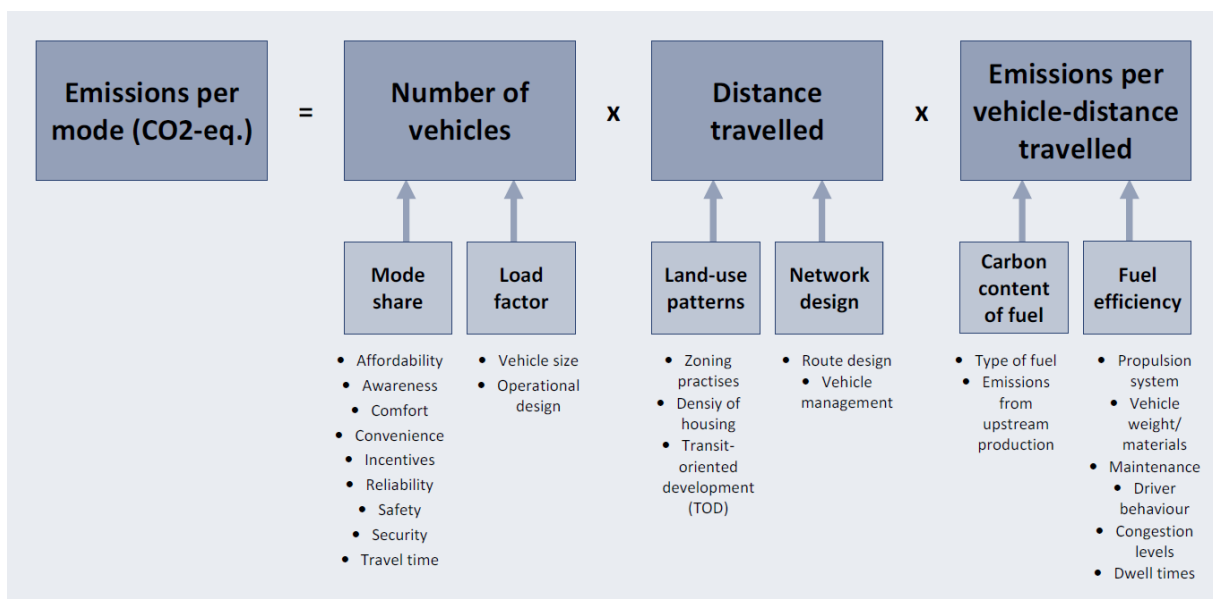


Figure 4.2: Factors affecting GHG emissions from the transport sector⁵

Wright & Fulton (2005, p. 701) identify behaviour, design and technology as the three targets of policies designed to reduce CO₂ emissions. These components are themselves influenced by a number of other factors like modal share, land-use patterns and the carbon

⁵ See Wright & Fulton (2005, p. 701).

intensity of fuels used. Care must be taken to consider interdependencies and safeguard the effectiveness of single measures and packages of policies alike.

In the context of ASI different policy categories to reduce carbon emissions are proposed. They relate to planning, regulation as well as to economic, informational and technological measures and differ in their ability to reduce the need to travel, induce modal shift or improve transport efficiency. A differentiation of policy instruments taken from EEA (2010, pp. 25) can be found in table 4.1., with further discussion in the following sections.

Policy instrument	Strategy responses			
	Avoid		Shift	Improve
Planning	High density mixed land-use development. Restrictive parking standards. Car-free settlements.	<i>Planning and regulatory cross-cutting instruments through planning legislation and infrastructure provision.</i> <i>Development of freight hubs/ consolidation points.</i>	Integrated public transport. High density mixed use land to be achieved through spatial planning. Investment in passenger transport through land use planning. Infrastructure for NMT. Road freight to rail and sea. Travel planning through planning process.	n/a
Regulatory	Parking restrictions and availability. Vehicle access restrictions.		Traffic management measures including: parking restrictions, access restrictions on the type of vehicles that can be used. Regulation of transport providers.	Vehicle emissions and fuel efficiency standards. Set and enforce speed limits. Restrictions based upon emissions e.g. low-emission zones.
	<i>Parking restrictions can be used to 'avoid' and 'shift'</i>			
Economic	Fuel taxes, vehicle taxes. Road user charges, parking charges, emission trading.		Subsidise alternative modes. Fuel taxes, vehicle taxes, emissions trading, congestion charging. Low emission zones.	Use of pricing instruments to encourage investment in more carbon efficient energy and vehicles.
<i>Fuel pricing discourages travel, encourages modal shift and encourages improved fuel efficiency</i>				
Information	Promotion of alternatives to travel.		Travel awareness campaigns. Personalised travel planning. Public transport information. Increase awareness of alternatives. Mobility management and marketing. Co-operative schemes. Travel planning.	Improve driver behavior (eco-driving schemes). <i>Public awareness campaigns aimed at informing consumers about vehicle efficiency.</i>
Technology	Enable virtual interactions: virtual — conferencing, remote working. <i>Travel plans introduced through planning instruments include remote working and teleconferencing.</i>		Improvements in the efficiency and quality of passenger transport.	Vehicle efficiency improvements. Regenerative breaking, biofuel. Hybrid electric vehicles, plug-in hybrid electric vehicles, and electric vehicles. Hydrogen vehicles. Rail electrification.
			<i>Traffic management is both a 'shift' and 'improve' policy measure.</i>	

Table 4.1: Policy instruments to implement transport strategies

The definition of sustainable mobility given in chapter 3 encompasses more than GHG emissions. In addition, transport policies designed principally to reduce emissions normally generate considerable co-benefits which are potentially larger than the benefits accruing from GHG reductions. However, it is often more difficult to measure these co-benefits. Figure 4.2 shows the connection between the (direct and indirect) benefits of transportation policies and their measurability. Measurement problems clearly increase with the indirectness of the benefits.

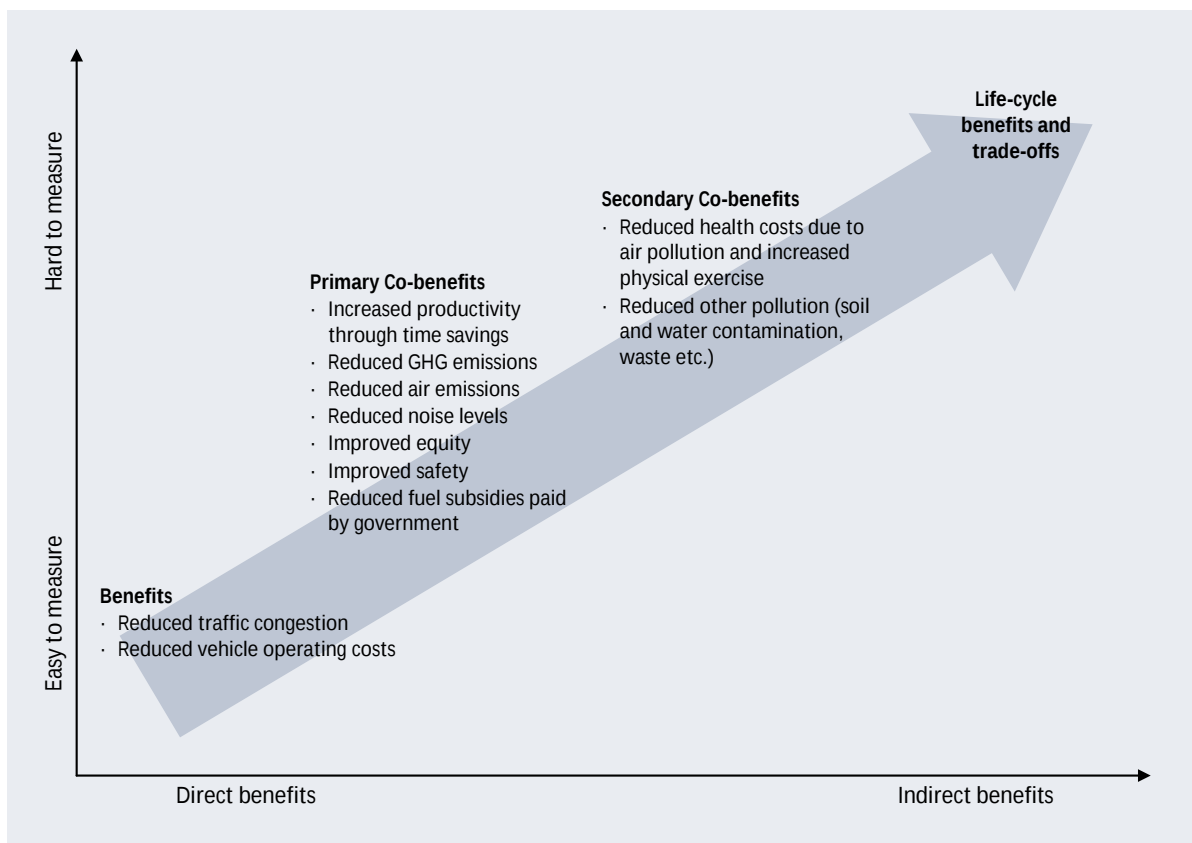


Figure 4.3: Benefits of transport policies and their measurability⁶

When considering CO₂ emissions, two common conclusions appear in the literature (see e.g. Prograns 2010). Firstly, mitigation in transport is more costly than in other sectors, and secondly technological solutions offer the greatest potential. However, the EEA (2008, p. 30) concludes that, “Combined policy measures are likely to have the greatest impact. They help lock in benefits, minimise rebound effects, maximise wider societal benefits and optimise cost-effectiveness.” In other words, policies to make transport more sustainable should have a wide set of objectives using comprehensive combinations of available policy instruments.

⁶ See Punte (2010, p. 15).

Concepts that aim to make mobility more sustainable work differently in developed and developing countries (see table 4.2). The decisive distinction is that individual transport has to be reduced in developed countries whereas its growth has to be curbed in developing countries. In both cases technological developments play a supporting role.

Principle	Developed countries	Developing Countries
Avoid	Reduction of vehicle kilometres travelled	Avoid generation of vehicle kilometres travelled
Shift	Shift from private vehicles to public transit and non-motorized transport	Prevent shift from public transit and non-motorized transport to private vehicles
Improve	Amend and downsize existing vehicles	Make future vehicles as clean as possible and discourage the up-sizing of vehicles

Table 4.2: Avoid, shift and improve and the state of economic development⁷

Regardless of the regional context there are several common factors to be aware of when designing and implementing instruments and programmes.

Governance plays a vital role in transport policies. Without going into the details of responsibilities in deciding, planning and execution, we want to highlight two important facts. Firstly, an approach with elements of “debate and decide” instead of solely sticking to “predict and provide” has a greater chance of generating high levels of sustainability. The first approach fosters greater acceptability through consultation, shifting the focus from traffic to meeting the needs of people and business. Secondly, one needs feasible strategies instead of desirable outcomes. The question to be addressed then is “what works?” in place of “what should be?”

Finally, Wright & Fulton (2005) emphasise the importance of development paths and the Asian Development Bank (2009) stresses the danger or the possibility of path dependencies. Path dependencies in general occur when processes over time are shaped by the decisions (or routes) taken at some point in time. This entails that a path once adopted cannot (easily) be reversed or otherwise changed. Figure 4.4 visualises this idea with regard to the urban transport sector. Horizontally one finds the degree to which private modes of transportation matter. Vertically the degree of mobility is depicted. The most sustainable and desirable situation is a high mobility city where public modes dominate. Regardless of the degree of mobility, cities dominated by private motorised modes are often not sustainable. They either

⁷ Adapted from Dalkmann et al. (2009).

lack accessibility or mode choices, or they suffer from the external effects of fast and widespread motorisation. Although growing motorisation is difficult to stop or reverse in the context of rising incomes, a more sustainable path can be taken given the political will and policy-oriented funding criteria.

At some nodes political decisions have to be taken on the further route, e.g. whether a city dominated by non-motorized transport increases private motorisation or whether a shift to public transit should be made. These decisions mainly relate to urban planning, especially of transport infrastructure, but also to national policies regarding planning or taxation in transport. Transport systems require careful decision-making and long-term planning in order to develop sustainability.

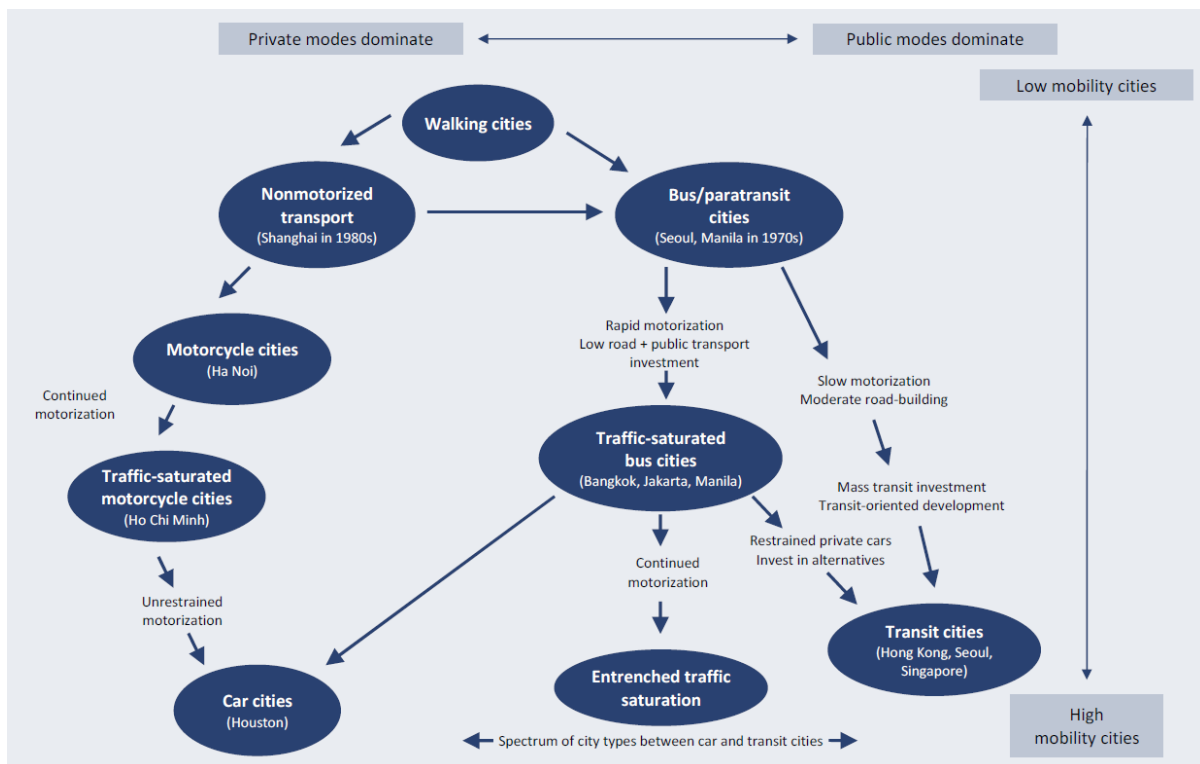


Figure 4.4: City typology and development paths⁸

⁸ See ADB (2009, p. 13).

Quick facts

- The concept of Avoid-Shift-Improve is a fundamental guiding principle for the development and implementation of strategies and instruments to promote sustainable transport.
- Strategies to make transport more sustainable should be designed to achieve a wide set of objectives using comprehensive combinations of available policy instruments.
- Any concept attempting to make mobility more sustainable works differently in developed and developing countries and even within these country-groups.
- There is a high path dependency in policies and decisions on transport, which can be difficult to reverse once an unsustainable path has been adopted.

2. Financing of infrastructure

1. Background

Financial issues are the inevitable starting point for considerations on transport policies. As we are mainly concerned with aspects of sustainability and thus of transportation systems and how they can be embedded in a larger policy approach, we concentrate on the financing of infrastructure. There are nevertheless many questions to be resolved with regard to the operation of public transport or roads, for example the degree to which the private sector should play a role and how efficient pricing of recurring expenses can be attained. Furthermore, existing infrastructure needs constant maintenance, also requiring significant funding.

The economic phenomena with regard to transportation infrastructure and the ensuing market failure are the prevalence of natural monopolies and the public good characteristics of infrastructure. A natural monopoly exists when it is most efficient to have only one supplier of a good. This is often the case, where large infrastructures, especially networks, have to be built and the investment costs outweigh the operational costs. Public transport systems belong to the common examples for natural monopolies and their construction and operation needs to be carefully designed by economic policy. Public goods have two important features: they are non-excludable and non-rival in consumption. This means that in the case of a pure public good nobody can be excluded from using this good and that the fact that he uses this good does not interfere with the use by others. While pure public goods are rare to find, infrastructure like roads has the same characteristics. As the market would not provide (enough of) the public good, the state has to supply it and the question arises, how this should be financed. Developed countries normally use their tax systems to do so, but developing countries might need additional means. In order to promote sustainable transport globally one needs satisfactory concepts to provide these funds.

From a policy perspective, the question of financing is anything but innocuous. Budgetary considerations should always be the starting point of planning. Available funds must be assessed and then spent effectively. In other words rational transport policy should pursue the maximum effectiveness principle. This could diminish the tendency of policy makers

towards prestige projects and foster a policy-oriented prioritization of projects. Moreover, financing itself must be sustainable, i.e. expenditure and revenues should be brought into balance.⁹

Relevant stakeholders in the financing of urban transport are (see GTZ 2010b):

- City administrations
- National and regional governments
- Donors and international organizations
- Private sector (entrepreneurs and firms operating public transport building and providing vehicles and infrastructure)
- Citizens

The importance of these groups differs according to local and regional conditions.

However, quite regularly the citizens are disregarded in two respects: Firstly, they are rarely involved in relevant planning processes. Secondly, their reactions to different financing systems are uncommonly assessed. This is problematic, because their involvement is crucial as their behaviour determines to a great amount the modal split in a city, and thus the sustainability of transport.

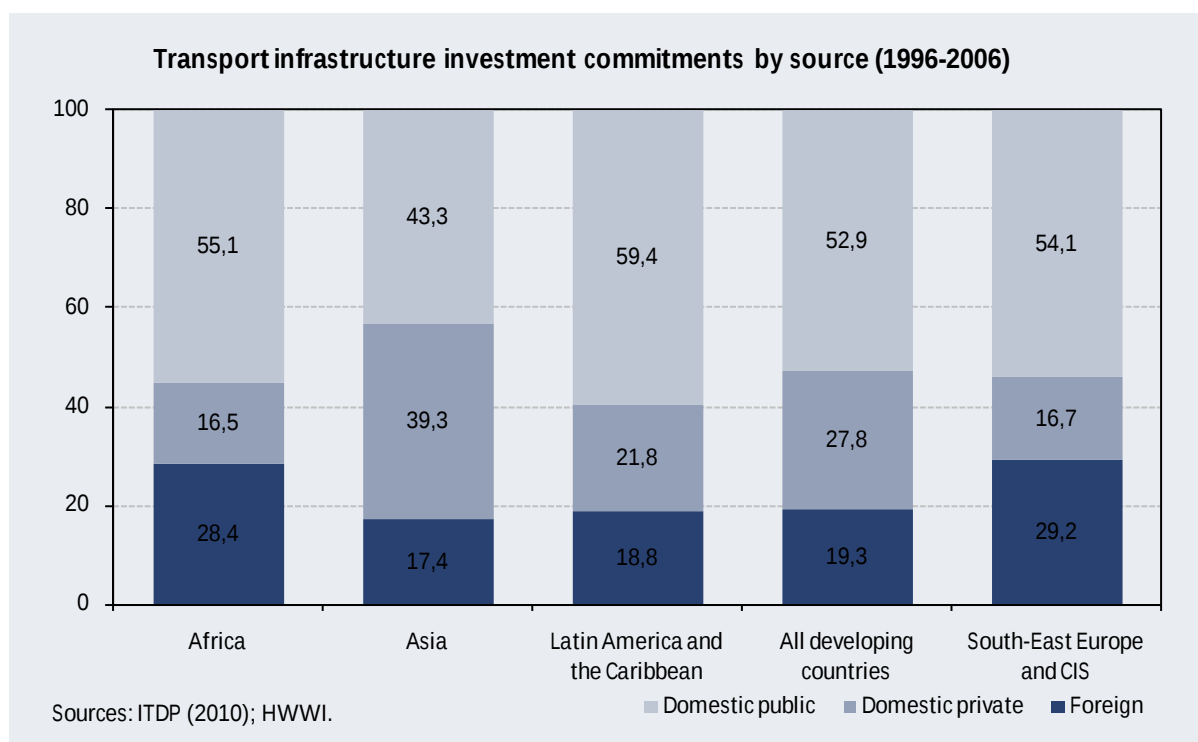


Figure 4.5: Transport infrastructure investment commitments by source (1996-2006)

⁹ The Asian Development Bank offers a whole online guidebook for the economic analysis of projects under http://www.adb.org/documents/guidelines/eco_analysis/default.asp.

Before turning to the different modes of financing, we would like to highlight some facts from the available data.

Firstly, transport plays an important role in government budgets around the world. According to ITDP (2010) countries normally use between 2 and 13% of their public budgets on transport. In cities these shares even rise to 15 to 25%.

Secondly, as can be seen in figure 4.5, domestic public financing dominates the investments in infrastructure in developing and emerging states.

Thirdly, by far the largest share goes into the financing of unsustainable transport. Unfortunately, ITDP (2010) is not fully able to quantify these shares, but the fact that transport lending by the World Bank between 2001 and 2006 was to more than 75% given for roads offers an indication for this statement. GTZ (2010b, p. 12) offers the same assessment.

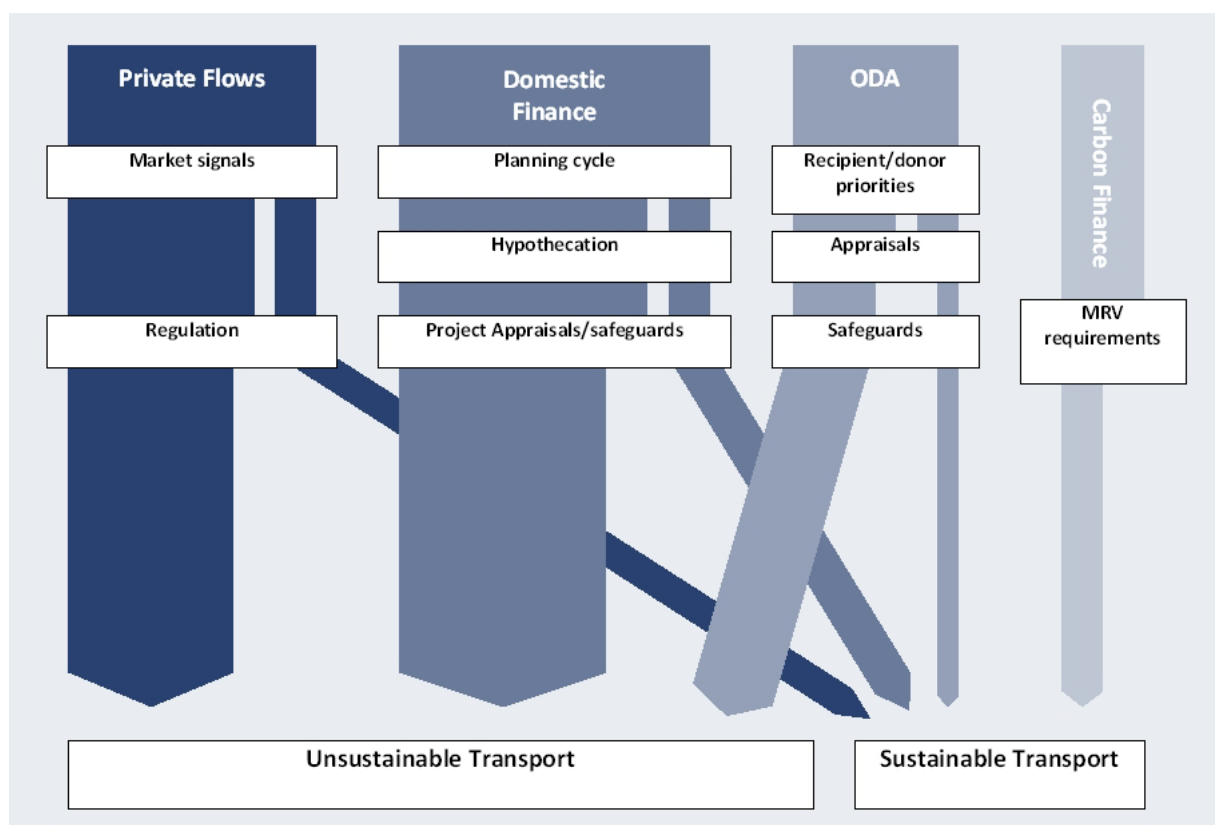


Figure 4.6: Patterns of financial flows for transport

Public financing is especially relevant for the parts of transportation systems exhibiting properties of a public good. The funding depends mostly on the generation of sufficient tax revenues. This in turn necessitates the existence of adequate governmental and institutional

structures to collect taxes, for example on income or consumption, and to be able and willing to re-direct the revenues into productive utilization. With regard to these institutions, more developed countries are potentially in a better position to achieve good governance. The performance or existence of institutions is usually measured directly or indirectly with the help of indices or sub-indices as in the Global Competitiveness Report by the World Economic Forum or the Index of Economic Freedom by the Heritage Foundation.¹⁰ Both point to a clear relation between established and functioning institutions on the one hand and the state of development on the other hand. However, both are also reinforcing one another, so that this does not reflect a simple causal relationship.

To enhance public financing, especially in the absence of other sufficient funds, various financing instruments at the local and the national level can be used.¹¹ Many of these instruments also have the potential to influence behaviour. As this aspect is taken up in a later chapter, we just list the most important instruments taken from GTZ (2010b) and ADB (2009, pp. 33-34) here:

- | | |
|----------|---|
| Local | <ul style="list-style-type: none"> · Parking charges · Road pricing and congestion charges · Land value taxes · Property development gains tax: Charging of the land value increase induced by measures in transportation infrastructure. · Tax-increment financing: Dedication of future tax increases due to current improvements for the funding of the project at hand. · (Auctioned) certificates of entitlement |
| National | <ul style="list-style-type: none"> · Fuel taxes · Vehicle taxes · Loans and grants by national authorities |

Private financing of infrastructure is rare to find and as mentioned above there are few incentives for private investors to build (transport) infrastructure without being able to refinance the investment via some kind of user charges or tolls. However, incentives are provided if the revenues of infrastructure-provision directly accrue to the investor. This can

¹⁰ See the websites <http://www.weforum.org/reports> and <http://www.heritage.org/Index/> respectively.

¹¹ See also Case Studies 1 “National financing instruments: Second generation road funds – The case of Tanzania” and 2 “Local financing instruments in Sibiu, Romania”.

be achieved for example by awarding concessions to collect user-charges over predefined periods of time (see GTZ 2002b for an in-depth analysis). The difference between these and Public Private Partnerships is not well defined, as discussed in the following section.

Their major characteristic of **Public Private Partnerships (PPPs)** is that public institutions and private sector actors conclude a legally-binding contract for the provision of assets and/or the delivery of services. Doing so, there is an allocation of responsibilities and business risks among the partners. Typically, the public actor remains actively involved throughout the project's life cycle. The private sector is responsible for the more commercial functions such as project design, construction and operation. The degrees of public and private sector involvement, as well as the levels of public and private sector risk can vary significantly. Hence, from a government's perspective, the main drivers for engaging in PPPs are the chance to reduce financial burdens and risks for the public sector or to foster private sector investment through reducing their financial burdens and risk.¹²

According to Bowerman (2007) private participation in road financing enhances efficiency, transfers risk and spreads capital costs. The Asian Development Bank (2009) points out that many countries in Asia have collated their experiences with PPPs. A key conclusion is that good governance with regard to project monitoring is a prerequisite for this instrument to work effectively.¹³

According to the OECD **Official Development Assistance (ODA)** refers to “flows of official financing administered with the promotion of the economic development and welfare of developing countries as the main objective, and which are concessional in character with a grant element of at least 25 percent (using a fixed 10 percent rate of discount)”.¹⁴ ODA given by industrialized countries is typically divided into two categories. The first is multilateral assistance through multilateral development banks (MDBs) and other international development organizations. The second is bilateral assistance, conducted by country-specific development agencies and banks such as USAID (USA), JICA (Japan) and AFD (France).

ODA does not play a major role in global transport investment with a share of slightly below 1% in the year 2000 (see ITDP 2010, p. 10). The experience of recent years seems to show

¹² The website <http://www.unescap.org/ttdw/ppp/index.html> offers a large set of information on PPPs from country reports over guidebooks to online courses.

¹³ See Case Study 3 “Public Private Partnerships in Transport” for more details.

¹⁴ See the OECD (2003): Glossary of Statistical Terms.

that the focus of ODA is on road-building and measures supporting individual motorized transport. Furthermore, the use of ODA has been much criticized in general as many funds did not have the desired effects on economic development. Acharya (2003) notes that in the transport sector this largely had to do with poor planning and implementation. This demonstrates the importance of institutions and knowledge transfer.

Climate Finance Mechanisms have garnered increasing interest in the preceding years. As per Binsted et al. (2010, p. 4) “climate finance describes funding that can be used to support climate mitigation and adaptation.” To date, climate finance itself has only been used on a relatively small scale, especially in the transport sector (see table 2 in Binsted et al. 2010, p. 10).

Binsted et al. (2010) provide an overview with regard to existing versus future and multilateral versus bilateral mechanisms.¹⁵ The climate funds described in detail are:

1) Multilateral funds

a. Global Environment Facility (GEF)

The GEF is an operating entity of the financial mechanism of the UNFCCC. It helps developing countries in climate change mitigation via grants or technical assistance and is supposed to co-fund projects, i.e. other funding either by national authorities or other donors is needed. For the period from 07/2010 to 06/2014 (called GEF 5) investments in sustainable transport of 250 million US-\$ are planned, representing about 5.8% of the whole means available. The investments are supposed to mobilize 1,2 billion US-\$.¹⁶

b. Clean Technology Fund (CTF)

The CTF is one of the two parts of the Climate Investment Fund (CIF) of the World Bank. The second part is the Strategic Climate Fund (SCF). Its goal is also to supplement and entice additional financial commitments from other sources via grants (for project preparation) and loans. According to GTZ (2010b, p. 67), seven of the twelve country investment plans approved by the CTF relate to the transport sector, handing out 600 million US-\$.¹⁷

¹⁵ The website <http://www.climatefundsupdate.org/> provides even more information on available funds targeting developing countries in general.

¹⁶ See Case Study 4 “Global Environment Facility (GEF): The Latin America regional sustainable transport and air quality project” for an application.

¹⁷ See Case Study 5 “Climate Investment Fund & Clean Technology Fund for comprehensive urban transport systems: Hanoi and Hi Chi Minh City, Vietnam” for details.

c. Global Climate Change Alliance (GCCA)

Set up by the EU in 2007 and managed by the European Commission, the GCCA supports vulnerable developing countries financially and technically. The financial support comes in the form of grants to national governments, but until 2010 no grants have been used for the transport sector.

d. Inter-American Development Bank (IDB) Sustainable Environmental Climate Change Initiative (SECCI)¹⁸

SECCI was implemented in 2007 and builds on four strategic pillars: Renewable energy and efficiency, sustainable biofuel development, access to carbon markets and adaptation to climate change. The initiative is supported by eight industrialized countries including Germany. It hands out grants, loans and technical assistance to governmental and private stakeholders. While it would be principally possible to finance transport-related projects with SECCI, this has not yet been done.

e. Asian Development Bank Climate Change Fund (CCF)

The CCF was put in place in 2008 and provides mainly grants and technical assistance to the developing countries within the domain of the ADB. Approximately 63% of the overall initial budget of 40 million US-\$ was used for mitigation purposes in all sectors including transport. The share of mitigation measures is supposed to rise to about 75% of future funds. Until 2010 two transport related projects were financed with an overall amount of 2.9 million US-\$.

f. Asian Development Bank Clean Energy Fund (CEF)

This relatively small fund was set up in 2007. Over a 2-year period it used less than 1 million US-\$ for transport projects. Accordingly, it has at present little significance.

2) Bilateral

a. Hayotama Initiative

This is a Japanese initiative from 2009 supporting developing countries already trying to reduce GHG emissions (and the successor to the Cool Earth Partnership).

¹⁸ See also IADB (2011).

There is no systematic information on the allocation of funds, thus the extent of transport-related measures supported cannot be assessed.

b. German International Climate Initiative (ICI)

Stemming from 2008, the ICI supplements the ODA of Germany. The annual budget for developing countries and those in transition is 120 million Euros. One half of the budget is intended for adaptation to climate change and the other half for energy-related projects. The majority of the grants focus on capacity building. The importance of the transport sector has been low and it is likely that it will stay that way in the future.

In addition to the aforementioned funds and initiatives, the **Clean Development Mechanism (CDM)** as an application of carbon markets and the **Nationally Appropriate Mitigation Actions (NAMAs)** as a new form of financing resulting from the UNFCCC negotiations are worth mentioning in the context of transport.

The general idea of carbon markets is to facilitate the reduction of CO₂ emissions at the lowest overall cost. This is principally done by certifying emission rights and making these tradable on a market, with the European Union Emissions Trading Scheme (EU-ETS) being the most prominent example. Within the Kyoto Protocol two market-based instruments were implemented, namely Joint Implementation (JI) and CDM. Both are project-based instruments enabling industrialized countries to invest in emissions-reducing projects in less developed countries while getting credited with these reductions. Although a few thousand CDM-projects have been certified only three of them in operation have to do with the transport sector: The Bus Rapid Transit system in Bogota (2006), the regenerative braking technology for the metro in Delhi (2007) and the cable car system in Medellin (2010). Although 23 other projects are still being evaluated and the expected reform of the CDM-scheme might offer further opportunities, the future scope of CDM to promote sustainable transport seems limited (see Binsted et al. 2010, GTZ 2010, sourcebook 1f and Wright & Fulton 2005).

NAMAs will probably serve as one of the most important instruments for mitigation actions in developing countries in the near future and beyond 2012. NAMAs are “voluntary emission reductions by developing countries that are reported to the UNFCCC” (see GTZ 2010b, p. 68). They can be a policy, a programme or a project. No official guidelines exist, but three types have been discussed in UNFCCC negotiations: unilateral, supported and credited NAMAs.

One might expect the supported version to emerge as the most prominent one (see Binsted et al. 2010, GTZ 2010b and Huizenga & Bakker 2010).¹⁹

In concluding this section on financing, we would like to draw the attention to the ASAP-Strategy formulated by the Institute for Transportation and Development Policy (ITDP). They propose to reorient financing of transport towards sustainability to tackle future problems. The four key elements of their ASAP-strategy (Analyse, Shift, Add and Pay) show, how the current unsustainable financial mechanisms could be modified (see ITDP 2010, p. 24):

<i>ANALYSE</i>	the impacts of financing decisions taken by relevant stakeholders on sustainability
<i>SHIFT</i>	existing resources towards a sustainable direction
<i>ADD</i>	funding for those areas where resources are lacking and
<i>PAY</i>	for the full costs of transport including environmental depreciation

Especially the element “pay” is also emphasised by GTZ (2010b). They argue that better engagement of the private sector and a move towards appropriate pricing of all transport modes can enhance sustainability and the financial basis of the transport sector at the same time.

The following table lists success factors for the financing of infrastructure and gives a tentative and qualitative assessment of their prevalence in different country groups. This has to be taken with a grain of salt as the situation within these country groups can also differ widely.

Country group	High income OECD	High income Non-OECD	Upper middle income	Lower middle income	Low income
Factor of success					
Governance and institutions	+	+	=	-	-
Adequate budgets	+	+	=	-	-
Capacity and knowledge	+	+	=	-	-

¹⁹ See Case Study 6 “Nationally Appropriate Mitigation Actions Morocco” for more information.

Quick facts

- Transport infrastructure of any kind has the characteristics of public goods or natural monopolies. The large investment costs require systematic planning and coordination and prioritization of projects.
- Important modes of financing are public or private budgets, Public Private Partnerships (PPPs), Official Development Assistance (ODA) and Climate Finance Mechanisms. Their roles differ according to the state of economic and institutional development.
- In addition to sufficient funding, institutions and available knowledge are crucial to implement efficient and sustainable infrastructure-financing in the transport sector.

2. Best-Practice Examples

Case Study 1: National Financing Instruments: Second Generation Road Funds - The Case of Tanzania

Key Statistics: Tanzania
<i>World Bank classification:</i> Low income
<i>Population:</i> 41 million
<i>Population density:</i> 39 /km ²
<i>GDP per capita:</i> 503 US-\$ (2009) ²⁰
<i>Transport data:</i>
<i>Car/motorcycle mode share for all trips:</i> n/a
<i>Cars per 1,000 inhabitants:</i> 4 (in 2007; source: The World Bank)

The poor condition of road networks is still a problem worldwide. In the last few decades, many countries reformed their road maintenance institutions and installed so-called “second generation road funds” and autonomous road agencies (The World Bank 2010, p. 211). The funds were developed on the basis of the (negative) experiences with the first road funds (see below). Second generation road funds in Tanzania are a successful best practice case because the road network improved and is self-sustaining with the funds generated by the road users.

Description of Background

If road maintenance is only financed from governmental money, this nearly always leads to roads being underfunded. As a consequence, road assets erode, vehicle operating costs increase and the country builds up a large backlog of rehabilitation work. The second generation road funds should solve these problems with the help of fee-for-service concepts. This concept let road user pay for the roads they use with the help of fuel tax. An independent Road Fund Administration does manage the funds and secures that “funds are not abstracted from other sectors.” (gTKP 2010)

These second generation road funds should have the following design principles (World Bank 2010, p. 214):

- § user representation on board
- § direct transfer
- § clear legal basis
- § separation of functions
- § revenue allocation rules

²⁰ Data from the World Bank: GDP per capita in US-\$, current prices.

- § road user charges
- § independent auditing

Description of Strategy

The second generation road funds in Tanzania were chosen as a best practice case because it is widely seen as one of the best and most established examples. A decade ago Tanzania had one of the worst road networks in southern and eastern Africa. The Road Fund came into operation in 2000 as the Roads Toll (Amendment) No. 2 Act, 1998. A Roads Fund Board (with individuals from various sectors and institutions appointed for 3 year terms) was established to administer the use of the Fund. A dedicated Secretariat was established. The Board is mandated to use at least 90% of the budget for maintenance and emergency repair of classified roads and related administrative costs (Andreski 2008, p. 11).

The Road Fund allocates 63% of its funding to the main delivery agency Tanroads for maintenance of the trunk and regional road network, 7% to Ministry of Works for development projects on Trunk and Regional Roads and 30% to PORALG for local roads. The key advantage of the new system is the generation and allocation of funding to specifically maintain existing assets to minimum safety and comfort standards, an area which had hitherto been neglected in favour of new infrastructure.

Applicability

Tanzania has made good progress in recent years following the creation of the Road Fund Board and TANROADS. The road network quality has improved and funding has increased.

The existence of performance agreements between the Road Fund Board and the implementing agencies has improved accountability and local roads now receive significant funds for maintenance.

As several other countries already have a second generation road fund (see World Bank 2010, p. 214), there is no institutional barrier to reallocating funds to maintenance work and to replicate this in other countries.

Policy Recommendations

Tanzania's financial management has improved since the Road Fund is an autonomous and quasi-commercial organisation working under performance agreements. The country's decentralisation efforts have also been enhanced by disbursing funds directly to local

authorities through an agreed formula. These allocations have been transparent and published in the local press. Annual reports have been produced by the Road Fund regularly. This approach, with the Fund operating as an independent organisation, is recommended for adoption elsewhere (Andreski 2008, p. 16).

See also...

The following World Bank Website deals with the general issue of road financing and road funds. It covers developing a road financing plan, restructuring road user taxes and charges, putting roads on a fee-for-service basis, restructuring an existing road fund, or setting up a new road fund.

http://www.worldbank.org/transport/roads/rd_fnds.htm, accessed 08 April 2011

See especially:

- Road Fund in Jordan
Sylte et al.(1997): http://www.worldbank.org/transport/roads/rf_docs/annex20.pdf,
accessed 08 April 2011
- Road Funds and Road Maintenance - An Asian Perspective
ADB (2003):
http://www.adb.org/Documents/Reports/Road_Funds_Maintenance/default.asp,
accessed 08 April 2011
- A Review of Institutional Arrangements for Road Asset Management: Lessons for the Developing World
Queiroz & Kerali (2010):
http://siteresources.worldbank.org/INTTRANSPORT/Resources/336291-1227561426235/5611053-1229359963828/TP-32-Road_Asset_Mgmt.pdf, accessed
08 April 2011

Case Study 2: Local Financing Instruments in Sibiu, Romania

Key Statistics: Sibiu/ Romania	Description of Background:
<i>World Bank classification:</i> Upper middle income <i>Population:</i> 154 thousand <i>Population density:</i> 1,227 /km ² <i>GDP per capita:</i> 7,500 US-\$ (2009, Romania) <i>Transport data:</i> <i>Car/motorcycle mode share for all trips:</i> n/a <i>Cars per 1,000 inhabitants:</i> n/a	It is also possible to generate funding for sustainable transport systems more locally. In comparison with national or international projects, local measures are often easier to implement. Fiscal traffic demand management measures such as parking fees and road user charges can reduce car use as well as generating revenues for sustainable transport projects that offer the motorist attractive alternatives to the car. ²¹

Description of Strategy

From the late 1990s the German Government has been supporting efforts made by the city of Sibiu, Romania, to redevelop its old city. This contributed to the 2004 decision of the European Union's 25 ministers of culture to designate the city the 2007 European Capital of Culture. Previously the city centre and the “picturesque squares in the old city were constantly full of parked cars, and many drivers took shortcuts through the city centre’s narrow streets” (GTZ 2011a).

The parking management was recently introduced, which was developed since 2003. The city centre was divided into various park zones based on the principle that the closer a zone is to the centre, the more expensive it is. Residents can park their car still very inexpensive, while, short-term parking in the inner city is more expensive and thus less attractive. “Parking your car for 30 minutes in the historic city centre costs as much as it does for an entire day outside the centre.” (GTZ 2011a)

According to the project advisers, the project is already a success:

- § The number of cars in the historic old city has dropped drastically.
- § The parking fees already cover half the original costs of the new car parks, and in a few years the system will have paid for the entire cost of construction.
- § Residents also benefit from the new parking system, as fewer vehicles in the city centre also means less traffic noise and exhaust pollution.

²¹ Relevant background information on Traffic Demand Management (TDM) can be found in section 5.1.

Applicability

Local financing measures such as parking management can be introduced in any city.

Policy Recommendations

It is recommended to actively use parking fees to finance sustainable transport projects, preferably those related to encouraging the use of non-motorised transport and public transport for at least part of the journey. Although moving car parking out of city centres has a demand management effect, a net reduction in the total supply of parking, coupled with improvements to alternative modes, would increase this effect further.

New legislation may be required for the hypothecation of revenues for transport projects.

As a rule of thumb one hour of car parking should be at least as expensive as a single bus trip.

See also...

- SUTP (2010):
http://www.sutp.org/index.php?option=com_content&task=view&id=2578, accessed 8 April 2011:
The report lists available material on parking management. The document lists out some influential and informative resources that highlight the importance of parking management in cities and shows opportunities to improve the existing situation.
- Barter, Paul (2010): Parking Policy in Asian Cities. Final Consultants Report.
<http://www.reinventingparking.org/2010/11/parking-policy-in-asian-cities-report.html>, accessed 8 April 2011:
The report investigates parking issues in 14 large Asian cities.
- Kodransky, Michael & Hermann, Gabrielle (2011): Europe's Parking U-Turn: From Accommodation to Regulation. ITDP. New York.
http://www.itdp.org/documents/European_Parking_U-Turn.pdf, accessed 8 April 2011):
The report examines European parking over the last half century, drawing on case studies of ten European cities.

Case Study 3: Public Private Partnership (PPP) in Transport – Hong Kong

Key Statistics Hong Kong
<i>World Bank classification:</i> Lower middle income (China) <i>Population:</i> 6.72 Million <i>Population density:</i> 28,600 <i>GDP per capita:</i> 30,065 US-\$ (2009) <i>Transport data:</i> <i>Car/motorcycle mode share for all trips:</i> 18.5% <i>Cars per 1000 inhabitants:</i> 46.5 (Source: Millennium Cities Database)

Description of Background

Public Private Partnerships (PPPs) are a method to combine the advantages of public administration with the possibilities and efficiencies that the private sector can offer.

Although the most widely used partnership scheme is Build-Operate-Transfer (BOT), several others exist, e.g.:

- Design-Build-Operate-Maintain (DBOM),
- Build-Own-Operate (BOO),
- Build-Own-Operate-Transfer (BOOT),
- Design-Build-Finance-Operate (DBFO),
- Rehabilitate-Operate-Transfer (ROT),
- Build-Lease-Transfer (BLT).

Description of Strategy

According to GTZ (2002b), Hong Kong's Central Harbour Crossing was the first project in modern experiences of public private partnership in urban transport infrastructure. The PPP model was to build, operate and transfer this road tunnel, which opened in the year 1972.

„Hong Kong continued at the forefront of urban transport infrastructure concessions, using the mechanism to deliver two other tunnels during the 1980s and a fourth in 1997. Hong Kong used DBO and DBFO in situations that required innovative integration of design, construction, financing and long-term operation (Miller 2000 cited in GTZ 2002b, p. 7).”

Besides of the need for competing bidders even in the late design stage, Miller (2000, after GTZ (2002b)) sees three general success factors for PPP from these projects:

1. 'Good' sponsors – Partners have good knowledge of the local context and are able and willing to risk a substantial amount of capital early in the project and to overcome problems.

2. 'Good' project rationale – the project makes strategic and economic sense, has political support, and has the support of local financial institutions.
3. 'Good' returns – the project provides higher financial returns to the concessionaires and the financial investors than more traditional investments.

Applicability

PPPs can be used in all transport areas for sustainable development. But up to now, sustainability in PPP transport infrastructure projects played a minor role. This is the case for financing the projects (see Estache & Serebrisky 2004), as well as for the design and benefits. Projects can only be financially sustainable if the government is a reliable and professionally competent sponsor, defining well the scope of the individual projects (including technical, political, economic, and social/environmental rationale), promoting transparent and head-to-head competition, remaining open to technological innovation, and, importantly, being capable to implement (GTZ 2002b).

Policy Recommendations

Public Private Partnerships offer the promise of lower costs and more efficient project delivery, but GTZ (2002b, pp. 3) notes, that „there is insufficient empirical data available to make any general conclusions regarding the impacts of private sector participation on project costs and, in particular, cost overruns.“

A PPP-approach is not per se a sustainable approach. It is necessary to develop the specific project in a sustainable manner, keeping pro-poor approaches and consistency with the Millennium Development Goals (MDG).

Choosing the right scheme for the local conditions and the planned project is complex and depends highly on the individual case.

Finally, concessions should not drive the overall urban strategic transport planning process. Otherwise „investment decisions are devolved to market forces“, which will lead to „the delivery of some major infrastructure (particularly motorways), but not to „coherent urban transport programs“ (Menckhoff & Zegras 1999). PPP is a tool to deliver a policy, not a substitute for effective long-term policymaking and project prioritisation based on the three pillars of sustainability.

See also...

The Public Private Infrastructure Advisory Facility (PPIAF) was created in 1999 to act as a catalyst to increase private sector participation in emerging markets. It provides technical assistance to governments to support the creation of a sound enabling environment for the provision of basic infrastructure services by the private sector. PPIAF's mission is to help eliminate poverty and achieve sustainable development through public-private partnerships in infrastructure (see <http://www.ppiaf.org/>, accessed 8 April 2011)

The World Bank offers a great deal of information on toll roads. It covers the extent of toll road provision internationally, the objectives, benefits, and costs of a toll road program, tariff setting and development issues, and involvement of the private sector (see http://www.worldbank.org/transport/roads/toll_rds.htm, accessed 8 April 2011).

The Seoul Declaration on Public Private Partnerships for Infrastructure Development in Asia and the Pacific (5 October 2007) was slightly revised and adopted by the United Nations Economic and Social Commission for Asia and the Pacific on 30 April 2008. Its statement can be found at <http://www.unescap.org/ttdw/ppp/SeoulDeclarationonPPPs.html> (accessed 8 April 2011).

Case Study 4: Global Environment Facility (GEF): The Latin America Regional Sustainable Transport and Air Quality Project

Description of Background

“The Global Environment Facility (GEF) unites 182 member governments — in partnership with international institutions, non-governmental organizations, and the private sector — to address global environmental issues. The GEF provides grants to developing countries and countries with economies in transition for projects related to biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants” (GEF 2011). “Established in 1991, the GEF portfolio represents one of the largest sustainable urban transport programs in the world: this includes 37 projects worldwide, with 201 million US-\$ committed and an additional 2.47 billion US-\$ leveraged in co-financing from the private sector and elsewhere” (GEF 2009, p.1). The trend in GEF interventions in the transport sector is towards comprehensive transport strategies, while technological solutions and stand alone investments are of less importance (see GEF 2009, p. 17, Figure 9).

The Latin America Regional Sustainable Transport and Air Quality Project is funded by GEF with 21.05 million US-\$ and co-financing of 58.5 million US-\$. Because financing transport through international agencies is still not relevant at global scale and because there are only very few GEF projects that focused on transport the project represents one of the best practices available to date.

About 75% of Latin Americans currently live in urban areas (United Nations 2001, p. 2). The current car ownership level is still low (e.g. Mexico 2008: 181 cars per 1000 people but rapidly increasing with a rate of 11.6% from 2006-2008, see <http://data.worldbank.org/indicator/IS.VEH.PCAR.P3>).

Description of Strategy

Initiatives under The Latin America Regional Sustainable Transport and Air Quality Project are still under development or in the implementation phase. “The project is divided into a regional project and three country projects in Argentina, Brazil, and Mexico. The regional project focuses on capacity building (knowledge sharing, regional cooperation, and fostering of policies and guidelines). The country projects include technical assistance and pilot

investments aimed at introducing and developing sustainable transport initiatives in 11 cities in these 3 countries.” (GEF 2009, p. 17)

The Latin America Regional Sustainable Transport and Air Quality Project includes activities in the following thematic areas:

- § Integration of land-use planning, transport and environmental management
- § Design and implementation of TDM measures to reduce private car-use
- § Management of freight transport
- § Improving public transport
- § Developing non-motorised transport

The project is expected to result in a direct reduction of 2.4 Mt CO₂ during the timeframe of four years of the project (see GEF 2009, p. 17).

Applicability

The comprehensive transport strategies can be replicated in any regional context, subject to the existence of sufficient institutional capacity to develop and implement sustainable transport pilots.

The Fund is accessible for all developing and transition countries.

Policy Recommendations

- § Show a strong commitment for sustainable development through GEF funding for the project.
- § Initiate multilateral co-operations and learn from common experiences with the help of GEF projects.
- § Get co-funding from other institutions through project approval by GEF, which is a sign for good planning practice.

See also...

The GEF project database: All GEF funded projects can be found in the database. With the keyword “transport” all transport related projects and their project status can be found. Clicking on the individual GEF ID leads to more information on the respective project. See <http://www.gefonline.org/>, accessed 08 April 2011.

Case Study 5: Climate Investment Fund (CIF) & Clean Technology Fund (CTF) for comprehensive urban transport systems: Hanoi and Ho Chi Minh City, Vietnam

Key Statistics Hanoi/Vietnam (2003)

World Bank classification: Lower middle income

Population: 3.1 million

*Population density:*3,365 /km²

GDP per capita: 1,113 US-\$ (2009)

Transport data:

Car mode share for all trips: 2.5%

Motorcycle mode share for all trips: 59.6% (2005 data; Vietnam Development Forum 2006)

Cars per 1,000 inhabitants (Vietnam): 13 (source: The World Bank)

Description of Background

Climate Investment Funds (CIF) are administered by the World Bank and channelled through the regional banks (African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, Inter-American Development Bank). Multilateral Development Banks (MDBs) distribute them to support the implementation of country-led programs and investments. MDBs assist developing

countries in their efforts to mitigate or adapt to climate change. The funds complement existing bilateral and multilateral financial mechanisms and are therefore coordinated with other financial institutions. CIF (and the “sub fund” Clean Technology Fund, CTF) are “an interim measure for the MDBs to demonstrate what can be achieved through scaled-up financing blended with development finance” (CIF 2011a). It can be called best practice because like the GEF project the CIF/CTF is one of the few international instruments for financing transport infrastructure with a focus on sustainability – in this case however not a grant- but a credit-based source.



Figure 4.7: Structure of the Climate Investment Funds (CIF)²²

²² Source: CIF (2011c).

Vietnam has been one of the fastest growing economies in Asia for the last two decades, with real GDP growth averaging 8% annually in the period 2003–2007. For the past ten years, energy consumption has been increasing faster than GDP, averaging about 13% per year. This is attributable to the rapid expansion of heavy industry and motorised transport, as well as increased use of fossil fuels for power generation. Vietnam's CO₂ emissions have more than doubled over the past decade and are projected to reach 101.5 million tonnes of CO₂-equivalent from energy-related sources by 2010. Under a business as usual scenario, Vietnam's primary energy demand will more than double and total energy-related greenhouse gas emissions will triple between 2010 and 2030 (CIF 2011b).

Description of Strategy

Most initiatives to be funded by the Clean Technology Fund (CTF) in Vietnam are still in development or in the implementation phase. The investment plan for the Clean Technology Fund (CTF) in Vietnam has been approved, facilitating the implementation of one project to date. The total funding from CTF is 250 million US-\$, while the total cost of the whole project will be approx. 3.5 billion US-\$ (CIF 2011b).

One program component of the CTF Vietnam will be two comprehensive urban transport systems in Hanoi and Ho Chi Minh City. The largest opportunities for greenhouse gas mitigation (up to 2 million tonnes of CO₂-equivalent per year) in the transport sector are the expansion of urban rail and bus systems to achieve modal shift, complemented by the use of improved vehicle technology and modest contributions of renewable fuels. The Government is mobilising substantial investments in public transport systems in large urban areas, with the objective of increasing public transport modal share from about 10–15 % to 50 % of passenger kilometres travelled by 2020.

The highest priority is the development of urban rail lines in Hanoi and Ho Chi Minh City, complemented by a feeder network of buses (CTF 2009, p. 3). The project will strengthen linkages between transport modes and introduce high efficiency buses, urban rail/bus interchanges, integrated ticketing, park and ride facilities and parking charges in core urban areas (CTF 2009, p. 3). The urban transport component is estimated to have an emissions reduction potential of about 1.3 Mt CO₂e per annum (CTF 2009, p. 4).

Applicability

The CIF and CTF are open to all developing countries. CTF supports specific investment plans that meet the criteria of significant GHG emissions savings, demonstration potential at a bigger scale and implementation readiness (CTF 2010, p. 2).

A Strategic Environmental and Social Assessment with a comparable Results Framework is under development. The assessment includes social indicators, such as measures of sustainable development and poverty reduction, as well as environmental metrics. This reflects the close relationship between climate change and development, and that the funds pledged to the CIF from the ODA are designed to maximise the co-benefits of the funding (ToR 2010, p. 3).

Policy Recommendations

CIF can help to promote national projects and attract co-financing. It can be used to gain and share knowledge for effective global solutions to climate change by sharing lessons and experiences in an inclusive, transparent and strategic manner. Within the annual CIF Partnership Forum all stakeholders can engage in dialogue on the CIF's strategic directions, results and impacts (CIF 2010, p. 2).

CIF can be used to fund comprehensive urban transport improvements involving TDM and the expansion of integrated public transport networks, which is essential to combat rapidly increasing car ownership in transition countries in particular.

See also...

Other Climate Investment Programs are bundled in the Strategic Climate Fund (SCF). SCF serves as an overarching fund to support targeted programs with dedicated funding to pilot new approaches with potential for scaled-up, transformational action aimed at a specific climate change challenge or sectoral response. Targeted programs under the SCF include the Pilot Program for Climate Resilience (PPCR). PPCR aims to pilot and demonstrate ways in which climate risk and resilience may be integrated into strategic development planning and implementation. In this way, the PPCR provides incentives for scaled-up action and initiates transformational change.

See <http://www.climateinvestmentfunds.org/cif/node/4>, accessed 08 April 2011.

Case Study 6: Nationally Appropriate Mitigation Actions (NAMA): Morocco

Key Statistics Casablanca (Morocco)
<i>World Bank classification:</i> Lower middle income <i>Population:</i> 3.7 Million <i>Population density:</i> 15,470 <i>GDP per capita:</i> 2,811 US-\$ (2009) <i>Transport data:</i> <i>Car/motorcycle mode share for all trips:</i> 29.7% <i>Cars per 1,000 inhabitants:</i> 129 (Source: Millennium Cities Database 1995)

Description of Background

NAMAs are well suited to climate change mitigation activities in the land transport sector and, as detailed in a *Bridging the Gap Guidance Note for Parties*, there are a wide range of transport projects, policies and programmes that can be formulated as NAMAs. “Interventions in the transport sector can, for example, reduce emissions by avoiding or reducing demand for travel, shifting to and maintaining the use

of low carbon modes, and improving the vehicle and fuel technology efficiency of all modes of transport” (Dalkmann et al. 2011, p. 3).

Although the funding sources of NAMAs are not yet clarified, Dalkmann et al. (2011, p. 6) see possible sources in the funds of the so called “fast-start finance of 30 billion US-\$ between 2010 and 2012”. In the later project-cycle of successful NAMAs additional money can be obtained from carbon markets e.g. via CDM (see Dalkmann et al. 2011, p. 7, Figure 1).

Description of Strategy

A good example to document the process and the content of NAMA submissions is in Morocco. Morocco submitted NAMAs in the land transport sector for an “avoid, shift and improve” strategy and estimated the possible CO₂-reductions (Botschaft des Königreichs Marokko, 2010).

The strategy combines regulatory policy measures with land use planning and infrastructure development/enhancement in the road and rail sectors (Binsted, Davies and Dalkmann 2010, p. 3).

The following measures are part of the submission (Botschaft des Königreichs Marokko, 2010, p. 3):

- § Technical vehicle inspections, to remove highly polluting vehicles from the road (54kte CO₂ p.a.)
- § Renewal of freight vehicles and taxis (501kte CO₂ p.a.)

- § Promotion and development of rail transport: High-Speed (TGV) Tanger-Casablanca and electrification of Fès-Oujda (not yet calculated)
- § Urban transport project: Regional Express Train Network for Casablanca (880kte CO₂ p.a.)
- § Introducing a tram in the City of Rabat (119kte CO₂ p.a.).
- § Integrated land-use planning, considering avoided emissions through reductions in the need to travel.

Applicability

There is still uncertainty over how the required technical, financial and technological support for NAMA actions will be delivered, with related frameworks likely to emerge over the coming year under the UNFCCC climate change negotiation process. The Bridging the Gap project, as part of the Partnership on Sustainable Low Carbon Transport (SloCaT, www.slocat.net), will actively observe and contribute to this process. Bridging the Gap will also seek to support developing country parties who wish to develop transport NAMA projects.

Policy Recommendations

A good national data inventory on emissions in the transport sector is helpful to identify strategic measures for significant reductions in transport-related GHG emissions reductions, and should therefore be developed as a prerequisite for NAMA proposals. The support of partnerships like SloCaT should be used within the process to submit NAMAs in the transport sector.

It is recommended that developing countries study the potential of NAMAs to fund low-carbon transport projects.

By sharing the responsibility to reduce GHG emissions and making the transport sector a key element in achieving this goal, countries can move directly to the front of climate mitigation action (Dalkmann et al 2010, p. 3).

Sustainable and modern low-carbon transport systems increase the competitiveness of countries and cities by attracting top companies and highly qualified workers. Further benefits are better air quality and health, increased energy security, reduced congestion, improved safety, social inclusion of poor people and enhanced tourism (Dalkmann et al. 2010, p.3).

See also...

The Partnership on Sustainable Low Carbon Transport (SloCaT) activities improves the knowledge on sustainable low carbon transport, helps to develop better policies and catalyse their implementation:

See www.slocat.net, accessed 08 April 2011.

Bridging the Gap encourages international action to slow the growth of CO₂ emissions in the transport sector. The Initiative is currently seeking a post-2012 Climate Agreement that will be fully applicable to the sustainable land transport sector.

See <http://www.transport2012.org/>, accessed 08 April 2011.

3. Settlement structures

1. Background

The need for transportation of individuals and goods in a society depends to a large extent on the supraregional settlement structure. The supraregional level is decisive for the question whether most people live within urban agglomerations or whether they live equally distributed across the country. In the first case sustainable mobility is a question of how to avoid negative agglomeration effects such as congestion and pollution. In the second case it is the question of how to organize long distance travel to let everybody participate in economic and social life.

The New Economic Geography (NEG) undertakes an economic analysis of location decisions. The theoretical framework of urban and regional economics is built on economies of scale in agglomerations and transportation costs. In general larger cities provide more specialized goods and services to the local market and surrounding areas, function as transport and trading hubs for smaller places, and accumulate more capital, financial service provision, and an educated labour force, as well as often concentrating administrative functions for the area in which they lie. As agriculture, more traditional local services, and small-scale industry give way to modern industry, the agglomeration advantages increase in importance. Declining transport costs have also fostered agglomeration. As a consequence, urbanization has increased and there is little reason to doubt that this will continue further.

By 2008 more than half of the global population, 3.3 billion people, lived in towns and cities. The number and proportion of urban dwellers will continue to rise quickly, to 4.9 billion by 2030 (UN Population Division 2010). Within agglomerations there are two trends which are important for sustainable mobility. The first is suburbanization and its correlation with increased car use. Suburbanization results from the fact that households try to combine the positive effect of agglomeration with positive country side effects. They live in rather rural areas and commute into the town centres for economic activity. A second important trend is the development of megacities, where congestion poses a threat to economic activity and, specifically, public transport reliability and viability. The decentralisation of economic activity can help to overcome this.

A settlement structure with people living close to workplaces and services leads to lower transport demand. This holds in particular if distances are short enough for walking or cycling. To a large extent, settlement structures of this type can be realised by urban planning: land development plans have to take account of an appropriate mixture between living, shopping and working areas. For the implementation of such urban planning good governance and regulatory capacities are needed (see Corfee-Morlot et al. 2009). Furthermore, coordination between authorities could help to tackle the challenges. Planning should be coordinated with other sectors, such as economic development, social affairs and transport (see European Commission 2007). In many cases urban planning is restricted by the existing city structure. However, the redevelopment of industrialized areas close to city centres can contribute to inner urban regeneration as the first step towards a new urban structure.

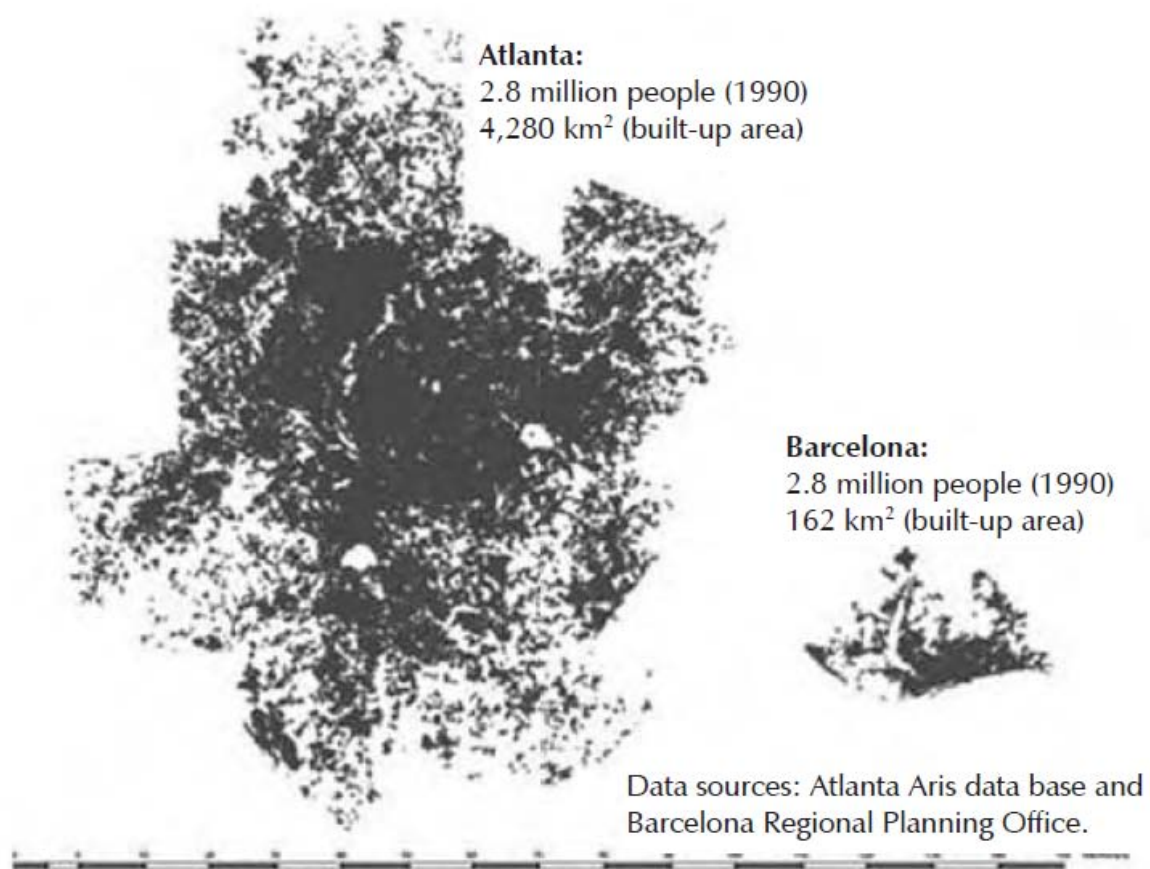


Figure 4.8: Urban sprawl: Atlanta versus Barcelona in 1990²³

²³ Source: Bertaud & Poole (2007), Figure 2, p. 3.

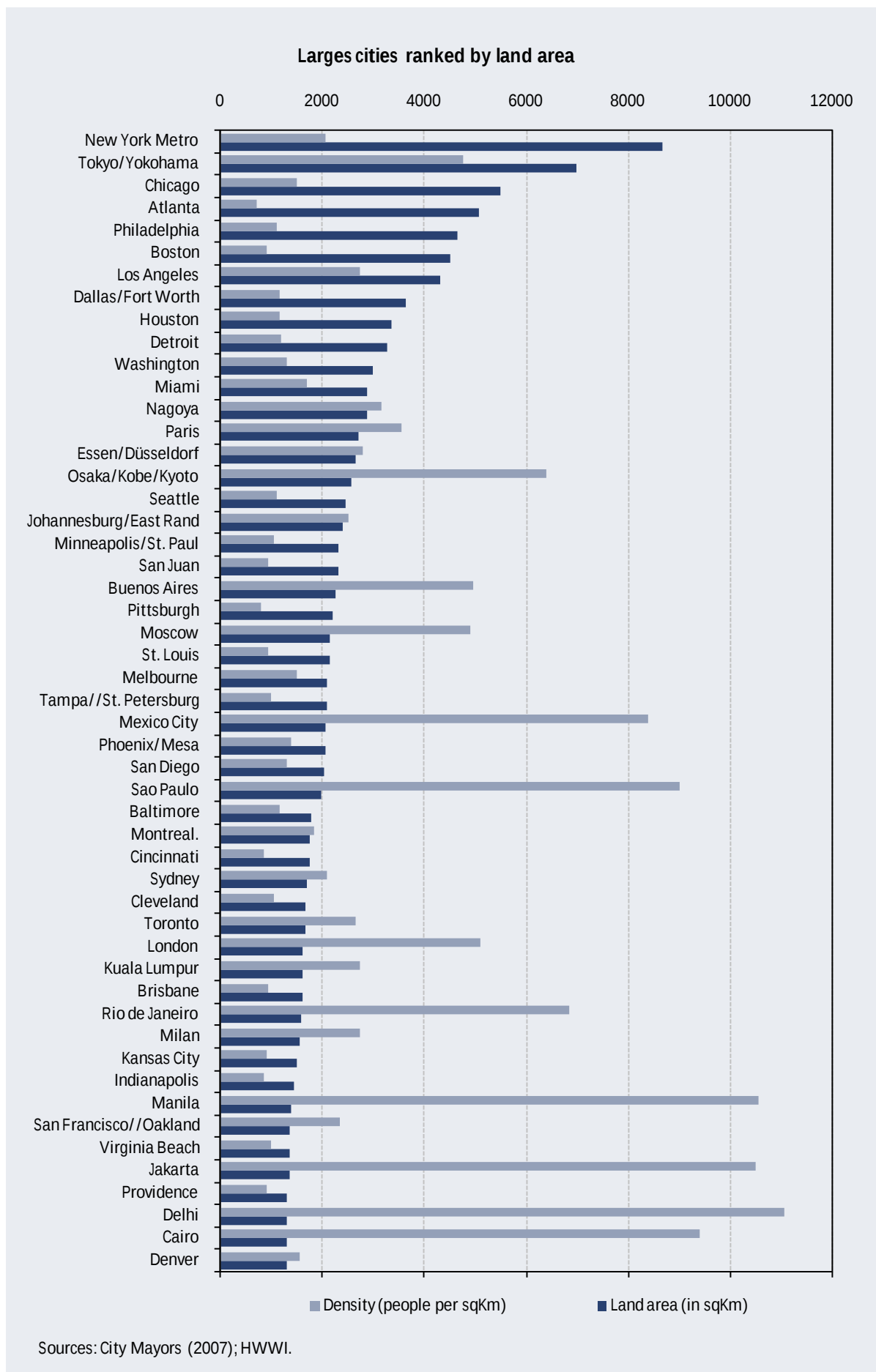


Figure 4.9: Large cities ranked by land area

Figures 4.8 provides an illustration on urban sprawl in two cities with a similar number of citizens and figure 4.9 shows that there are vast differences in urban density in the largest cities of the world (by land area) which is due to the respective settlement and transport policies.

Ultimately residential decisions are undertaken by individual households and they depend on house prices and housing quality as well as generalised travel costs, comprising travel time and monetary costs. Transport costs are determined by fuel prices and usage taxation and other costs, or by fares for public transport. Travel time costs depend on infrastructure quality, congestion, parking availability, priority measures and/or service quality.

Policy can influence residential decisions in different ways. Improvements to the transport infrastructure reduce travel time and therefore increases welfare in the better connected area. However, more people might decide to live in the better connected area. This might lead to a trend towards suburbanization and urban sprawl which leads to low-density, spatially segregated land use. The resulting dispersal of home, work and leisure facilities increases transport demand. The lower densities in peripheral areas make it difficult to offer high quality public transport solutions of sufficient quality to attract users.

It is therefore necessary to influence travel costs through economic instruments such as fuel and car taxation, road user charging and parking fees. These measures might reduce suburbanization and promote the use of public transport.

To improve the attractiveness and safety of walking and cycling, authorities should ensure that these modes are fully integrated into the development and monitoring of urban mobility policies. More attention should be paid to the development of adequate infrastructure, while initiatives in cities, companies and schools can promote cycling and walking (see European Commission (2007)).

Country group	High income OECD	High income Non-OECD	Upper middle income	Lower middle income	Low income
Factor of success					
Governance and institutions	+	+	=	-	-
Increased taxation of fuels	+	=	+	+	-
Efficient public transport	+	=	+	-	-

Quick facts

- Settlement structure is a major determinant of sustainable development.
- The evolution of settlement structures depends on travel costs as well as spatial planning policies.
- Generalised travel costs incorporate direct mobility costs and time.
- To a large extent sustainable settlement structures can be attained by urban planning.

2. Best-Practice Examples

Case Study 7: Coordination of Transportation and Land Use Planning in Curitiba, Brazil

Key Statistics: Curitiba

World Bank classification: Upper middle income
Population: 1.75 million
Population density: 4,060/km²
GDP per capita: 8,230 US-\$ (2009, Brazil)

Transport data:
Car/motorcycle mode share for all trips: 44%
Cars per 1000 inhabitants: na

Background

Curitiba was selected as a best practice city based on its innovative approach to city planning. Brazil saw a rapid migration of people from rural to urban areas from the 1950's to the 1980's due to technological improvements in agriculture reducing the number of farm labourers needed. During this time, Curitiba was one of the fastest growing cities in Brazil, with a growth rate of about 5.7% per year (Parasram 2003).

This hasty expansion caused a strain on social services, housing, sanitation, the environment, and transportation within the city. In an attempt to mitigate this, urban planners began creating an Urban Master Plan which would give priority to public services such as sanitation, easing traffic congestion and creating centres for social and economic growth.

In the 1960's Mayor Ivo Aruza Prereira commissioned Curitiba Research and Urban Planning Institute to create the Master Plan for the city, which was approved in 1966. Transportation was a key component in the plan, which called for linear urban expansion along transit lines. In 1971 a Mass Transit Terminal Plan was developed and in 1974 a bus rapid transit (BRT) line, the first of its kind, began to operate along the city's



Photo: Curitiba showing high density development along BRT corridor

Source: IPPUC

main corridors (see Case Study 11 on the Curitiba BRT for more information about this system). By 1982 all five of the city's core corridors had been completed.

Description of Strategy

At the core of the City's plan were the five arterial corridors, which fan out from the city centre. These corridors were developed using existing streets with only minor physical modifications. Centre lanes within each corridor were assigned as dedicated busways, allowing the reliable operation of frequent, high-speed bus services.

Land use controls were used to target two basic parameters: the type of use and the density of development. Mixed-use was encouraged, even at the request of residents themselves who wanted to be able to walk to commercial facilities from their homes (Rabinovitch 1996). In addition, in the 1970's, zoning laws were set to increase residential and commercial density along the corridors in order to push new growth along these pathways and ease congestion in the city centre.

In a further attempt to remove traffic from the city centre, in 1971, Mayor Jamie Lerner's administration created Brazil's first pedestrian network, converting wide central avenues in the city centre to pedestrian malls and walkways.

The City made a concerted effort to increase the amount of green space, which was quite scarce. In 1970 Curitiba had a mere 0.5 square meters of green area per capita, while by 1992 the rate had increased to 50 square meters per capita (Rabinovitch 1996). Green space, in the form of parks and public gardens, was strategically located throughout the city. Plots in the city centre were small while larger plots were located in the outskirts of the city, between growth corridors. Beyond providing space for residents to get outside, interact and exercise, these green spaces also play a role in protecting the city's floodplains.

The City also showed foresight by strategically acquiring land along the corridors before they were developed. City-subsidized, low-income housing was built on this land in order to provide transit access to those who would need it most. Unlike other cities, Curitiba planners saw that transportation systems can serve as the backbone for development and growth.

The City also encouraged the development and maintenance of residential housing in the downtown area. In addition to providing residents with easy access to jobs, downtown residences also support a mix of residential services in the downtown area such as restaurants, bakeries, pharmacies and supermarkets, giving a 24-hour-a-day vitality to the downtown area. This vitality contrasts sharply with the after-hours silence found in other cities' downtown areas that serve primarily as commercial employment centres. Furthermore, parking is limited in this area to discourage car ownership. Rather than driving,

residents can take advantage of the city centre's excellent pedestrian, cycling and transit facilities.

Curitiba has been in the forefront of integrative innovation. It was the first city to implement a fully functioning BRT system. In addition, it was the first city in Brazil to implement not only pedestrian streets but also a whole pedestrian network. A variety of innovative instruments have been used to shape Curitiba's urban structure, integrating land use legislation and the public transportation network to direct urban growth.

Applicability

Curitiba's integrative approach is particularly relevant to developing countries, where high rates of urban growth are responsible for a variety of problems related to the uncontrolled and unplanned physical expansion of cities. Insufficient infrastructure services, lack of enforced land use regulations and land speculation resulting in the loss of green spaces are among the factors contributing to the social, environmental and economic consequences of rapid growth. Curitiba addresses each of these issues through integration of land use and transportation policies, recognizing that land use is linked to transportation, housing, development and green space.

Curitiba's innovative measures did not depend on any particular economic advantage of the city. Rather, the city's success revolved around looking at the big picture, setting long-term goals, and applying appropriate policies to meet those goals. Similarly, these policies can be applied to a range of countries, regardless of their economic status.

Policy Recommendations

Rapidly growing cities can apply Curitiba's strategy of integrating land use and transportation policies in order to alleviate the growth pressure on the central area, subsidize low-income housing, integrate peripheral districts, and control urban sprawl in harmony with open green areas. Cities should first develop a long-term land use Master Plan. The plan should identify major public transportation corridors within the city or stipulate that these corridors be created if they do not already exist. Areas along these corridors should be zoned for high density, mixed-use development. A growth boundary should be designated to limit sprawl. In addition, provision of pedestrian and cycling infrastructure should be specified as well as strategic preservation of green space.

See also...Portland, Oregon

The city of Portland has also been recognized internationally as a best practice example of integration of transportation and land use planning. The city follows the principles of transit-oriented development, focusing high density, mixed-use development around transit stations and has avoided sprawl by imposing an urban growth boundary. Portland also places an emphasis on maintaining parks and green spaces within the city.

See <http://www.portlandonline.com/bps/>.

Zurich, Switzerland

The city of Zurich has been coordinating planning at a regional level since 1958, incorporating transportation, housing, employment, retail and open space. As a result of the city's support for high density, mixed-use development combined with its transit first policies and limited parking, Zurich is not only a desirable place to live, but has one of the highest rates of public transportation use per capita in the world.

See <http://www.stadt-zuerich.ch/prd/en/index/stadtentwicklung.html>.

Case Study 8: Affordable Housing in Bogota, Columbia

Key Statistics: Bogota

World Bank classification: Upper middle income
Population: 7.4 million
Population density: 4,670/km²
GDP per capita: 5,126 US-\$ (2009, Colombia)

Transport data:
Car mode share for all trips: 10%
Cars per 1000 inhabitants: 130

high growth rate, causing a strain on social services, housing, sanitation, the environment and transportation. Due to the lack of low-income housing, the number of informal settlements grew, typically at the borders of the city. In response to these factors, Metrovivienda, a municipal authority in charge of development

of affordable housing, was created in 1999. Construction of low-income housing along with the opening of the TransMilenio BRT system in 2000 and major investments in pedestrian and cycling infrastructure throughout the city caused a major transformation for Bogota, contributing to an improved quality of life for its citizens.

Background

Bogota was selected as a best practice case study because of its success at building affordable housing with good public transit access.

Like Brazil, Columbia also saw a rapid migration of people from rural to urban areas between the 1950's and the 1980's. Bogota, in particular, experienced a



Photo: La Ciudadela El Recreo Housing Development in Bogota

Description of Strategy

Metrovivienda acquired land within the city of Bogota in areas that were to be served by TransMilenio BRT feeder services, either through negotiated purchase or through use of eminent domain. The use of eminent domain at times meant the displacement of inhabitants of informal squatter communities; however, in these cases the government provided assistance with relocation. Generally this land was cheap, but likely to increase in value due to its proximity to public transit. Through these lower purchase prices,



Photo: Metrovivienda Housing Development in Bogota

Metrovivienda was able to ensure an increase on its investments, which could be used to fund further city improvements. Rather than managing all the stages of development, Metrovivienda increased its efficiency by then selling the land to experienced private

developers under the requirement that they must construct affordable housing. The neighbourhoods created incorporate access to public transit, pedestrian and cycling infrastructure, green space, local retail and educational facilities. In addition, they satisfy a need for increased levels of affordable housing. In this way, the government was able to ensure residential development that is environmentally, economically and socially sustainable. Such neighbourhoods include La Ciudadela El Recreo, El Provenir and Usme.

Applicability

This case study is an example of a public-private partnership that satisfies a local need and benefits residents. This strategy can be applied to cities planning to expand public transportation services in countries where the government has the authority to purchase land. Purchasing the land at a low price is crucial to ensure that building low income housing will be financially feasible. Government involvement is important to ensure that the right type of housing is built in the most appropriate locations, enabling more people, particularly those of low income, to have access to transit services. Involvement of private developers allows construction to be carried out by those with experience and enables the government to focus on additional city investments.

Policy Recommendations

Cities who would like to replicate this strategy should identify locations where transit lines will be expanded and purchase the land before transit expansion to ensure low costs. During this process, the government should be careful not to displace residents currently living in these locations. Previous landowners should be given a fair price and residents should be

given assistance for relocation as well as priority in the new housing developments built. These areas should be zoned for high density, mixed use development. Regulations should stipulate that a certain amount of affordable housing must be built, and this type of housing should be clearly defined. The city must continue to monitor developers to ensure that regulations are being met.

See also...

Denver, Colorado

The Denver Transit-Oriented Development Fund was set up to create and preserve affordable housing through strategic acquisition of property in current and future transit corridors.

See <http://www.urbanlandc.org/tod>.

Case Study 9: Brownfield Redevelopment in Beijing, China

Key Statistics: Beijing

World Bank classification: Lower middle income

Population: 19 million

Population density: 1,300/km²

GDP per capita: 3,744 US-\$ (2009, China)

Transport data:

Car mode share for all trips: 30% (in 2005)

Cars per 1000 inhabitants: 250 (in 2010)

Background

Beijing was selected as a best practice case study based on its efforts to transform brownfields into decontaminated and sustainable redevelopment projects.

Land contamination is a serious problem in China. Many industrial sites are being relocated away from urban centres due to rapid urban growth, creating urban brownfield sites. Several organizations have defined 'brownfield' in various ways. A definition

appropriate for China is the following: "the industrial and commercial lands, sites and facilities in urban areas, which are abandoned, idled or underused due to real or perceived environmental threats and other developing obstacles, and cannot be immediately put into use without treatment" (Kang and Hua, 2007). Site remediation and redevelopment of these locations are needed and have the potential to bring about environmental, economic and social revitalization.

The relocation of industrial facilities is particularly common in Beijing. More than 200 polluting enterprises are being relocated from inside the Fourth Ring Road to more rural areas, leaving more than eight million square meters of urban industrial land to be redeveloped. This isn't to say that the problem is just being moved elsewhere. The new sites must follow strict standards, making production processes more efficient and cleaner than in their previous locations. In addition, the State Environmental Protection Administration (now MEP) of Beijing issued the "Notice on Effective Prevention and Control of Environmental Relocations" in 2004, requiring local environmental protection bureaus to carry out pollution prevention and control during the relocation process. (Xie and Li 2010)

The government has actively encouraged redevelopment of brownfield sites in order to promote densification. However, before development can begin, site remediation must take place. Remediation is a complicated process since it is desirable to keep costs low while still managing to remove harmful substances; furthermore, some of the long-term effects of the pollution are hard to predict. In 2007 Beijing's Environmental Protection Bureau (EPB) issued

“Guidelines on Site Environment Assessment (SEA)” and “Notice on SEA of Industrial Wasteland after Relocation” (Xie and Li 2010). The remediation of several contaminated sites has been successfully completed, including Beijing No. 3 Chemical Plant, Red Lion Paint Factory, Beijing Coking Plant, and Beijing Dyestuffs Plant (Xie and Li 2010). These examples are helping to build technical and management experience on brownfield remediation and redevelopment in China. However, national standards and guidelines are still needed.

Description of Strategy

One example of a mega-plant that was successfully relocated is Capital Steel (Shougang), which began relocation in 2005. The relocation and remediation process took several years and was finally completed in 2010. The new plant was built in Caofeidian, approximately 220km east of Beijing. Taking advantage of new technologies, this plant has higher efficiency, lower resource consumption, less pollution and higher economic returns than

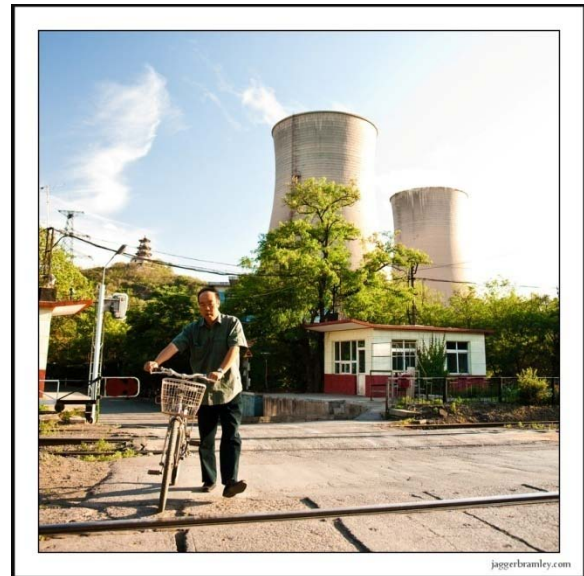


Photo: Shougang Factory in Beijing
Source: Adam Bramley

the old plant. One key to financing the relocation and remediation process is the recovered capital from land transfers, due to the high value of land in Beijing (Xie and Li, 2010).

Now that the Capital Steel plant has moved, the area has become a more attractive place to live, demonstrated by the fact that housing prices have doubled in the past two years (Xie and Li, 2010). Authorities in Beijing are working on transforming the brownfield site into a Central Recreation District including a museum of steelmaking history, centre of modern logistics and real estate development, among other uses.

One key to the success of this project is involvement by the environmental authority, which has ensured proper site cleanup and risk control. Beijing has incorporated environmental consideration and requirements into regulations regarding land ownership transfer and redevelopment of contaminated industrial sites.

Applicability

Brownfield redevelopment is a new land use planning strategy to pursue the ideal of sustainable development. It reduces environmental pollution and urban sprawl, and economically revitalizes urban areas. This strategy can be applied to any city with previously used industrial land. It is especially useful for cities with brownfield sites in urban areas where high growth rates have created a demand for urban land for development. Often these sites are large and near urban centres, creating the opportunity to develop sustainable, high density, mixed use neighbourhoods with good access to the city centre. Although the initial investment is high, this strategy can lead to long term environmental and economic benefits. As mentioned previously, regulation is required to ensure that cleanup is done properly.

Policy Recommendations

Stakeholders involved in brownfield redevelopment include the industries themselves, governments at all levels, local communities, the public and new developers. Regulations should be made at the national level to specify what should be done with brownfield sites. In order to be successful and sustainable over the long term, regulations should ensure that the polluter pays, the investor benefits and the land owner takes responsibility. Each site should have an environmental review, followed by a soil remediation plan which must be paid for by the factories which caused the pollution; contaminated sites cannot be redeveloped until the remediation reaches environmental targets. A Master Plan should be created for the remediated site to ensure that any new development is sustainable, including high densities, a mix of uses and good accessibility by public transportation, walking and cycling.

Developers are often hesitant to invest in brownfield redevelopment projects due to uncertainty. Governments should therefore eliminate impediments and minimize uncertainties in the redevelopment process whenever possible. One potential solution is to offer subsidies to developers.

The public may also be tentative to embrace such new developments due to worries about pollution or lack of knowledge. Advertising campaigns in the form of print, TV and web media can be helpful to reassure the public, especially neighbours and potential residents. These campaigns can lead to positive public opinion and political support for such projects.

See also...

Greenwich Millennium Village (GMV), London, UK

GMV is a development project built on the Greenwich Peninsula in London, a site with a history of industrial uses including the manufacturing of chemicals, steel and gas. The site was remediated and developed as part of England's Millennium Communities Programme. GMV was designed as a modern, mixed-use, sustainable urban village with an ecology park, cycle paths, recreational areas, limited car access and good public transportation connections. See <http://www.gmv.gb.com/> for more information.

Bo01, Malmö, Sweden

The Western Harbour in Malmö was once used as a port and industrial area and was home to the Kockums shipyard. However, in the 1990's the City recognized the district's potential as an attractive waterfront area, located close to the city centre, and decided to convert this once industrial zone into a new urbanized district with a focus on sustainable living. The City received money from the national government for site remediation and the Bo01 "City of Tomorrow" was built, incorporating reduced car access, mixed use, high quality cycling and pedestrian infrastructure, good transit access and energy saving features.

See <http://www.malmo.se/English/Western-Harbour.html>.

Additional references:

- *The Management of Brownfields Redevelopment: A Guidance Note*, The World Bank, Europe and Central Asia Region Sustainable Development Department, March 8th 2010. See <http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/brownfields.pdf?resourceurlname=brownfields.pdf>
- BERI (Brownfield European Regeneration Initiative): <http://www.berinetwork.com/>
- NICOLE (Network for Industrially Contaminated Land in Europe): <http://www.nicole.org/>
- CABERNET (Concerted Action on Brownfield and Economic Regeneration Network): <http://www.cabernet.org.uk>

Case Study 10: Sustainable Urban Development in Kunming, China

Key Statistics: Kunming

World Bank classification: Lower middle income

Prefecture population: 6.3 million

Urban population: 3.2 million

Prefecture population density: 300/km²

Urban population density: 9,700/km²

GDP per capita (China): 3,744 US-\$ (2009)

Transport data:

Car mode share for all trips: 13% (2008)²⁴

Cars per 1000 inhabitants: 170 (2009)²⁵

Background

Kunming was selected as a best practice case study due to its sister city partnership with Zurich and its sustainability-focused Urban Development – Public Transport Master Plan.

Like many Asian cities, Kunming has experienced rapid population increase, mainly due to migration from rural areas of the Yunnan province, which has led to pressure for development. A sister city partnership was formed between Kunming and Zurich, Switzerland, in 1982, initially to address

water supply and drainage issues. This partnership created a strong relationship between the two cities, laying the foundation for a collaboration which began in 1993 to develop the Kunming Urban Development-Public Transport Master Plan. The project aimed to protect the environment and show how to avoid environmentally damaging development, and was supported by the Swiss Federal Government, the Swiss



Photo: Downtown Kunming, showing open space, pedestrian plazas, public transportation and high density development
Copyright Douglas Janson, <http://www.pbase.com/dougj/profile>

Development and Cooperation Agency, the canton of Zurich, the ORL Institute at the Swiss Federal Institute of Technology, and China's central government. The collaboration was to be seen as a pilot project, developing strategies that could be used by other Chinese cities to encourage sustainable urban development.

²⁴ Kunming Transportation Development Annual Report 2008.

²⁵ Kunming Traffic Police Bureau as published in the Kunming Transportation Development Annual Report 2009.

Description of Strategy

The Kunming Urban Development–Public Transport Master Plan aimed to:

- Plan residential areas so as to limit traffic demand
- Promote cycling and walking
- Develop an efficient, affordable public transportation system that has priority on the road network
- Develop parking and traffic management programs to limit traffic congestion
- Determine best practice solutions that can be applied to other Chinese cities

Instead of the traditional Chinese expansion of the city in rings, the plan called for radial development along modern rail and bus lines. This plan would give Kunming a finger-shaped pattern of housing development, while maintaining green space between the fingers. Additionally, new satellite towns would form chains along the existing railways lines. The new towns would implement a dense, mixed-use structure to encourage walking and biking trips close to home. Focusing on residential uses close to public transportation stations would encourage transit use for trips to the city centre or other areas outside the local neighbourhood.

In order to further promote cycling and walking, a pedestrian zone was created in the centre of the city. In addition, Kunming's old town was declared a protected area, and a historic city preservation office dedicated to protecting the old town was established in 2000.

A bus-based public transportation network was planned, primarily to maintain low costs and flexibility. A bus-only lane demonstration project was designed and implemented in 1999.



Photo: BRT buses in Kunming

This was the first dedicated bus lane in China. Its success was immediate and within its first year of operation, more than 100 delegations from other Chinese cities visited Kunming to see the unique bus line and learn from its success. The city now has four dedicated busways and has plans to upgrade the

lane design and ticketing system in order to update the routes to full bus rapid transit (BRT) corridors. As a result of these efforts, the city experienced an immediate increase in public transportation use. Between 2000 and 2004 the annual mean growth rate of Kunming's bus passenger transport volume was 11.5%.

Kunming has also supported the promotion of high speed rail. In 2008 the Kunming Municipal Traffic Research Institute completed the Kunming Municipal High-Speed Rail Transportation Network Plan. A dedicated high-speed passenger line connecting Kunming to Shanghai is currently under construction and expected to be completed by 2015.

In parallel to developing the Kunming Urban Development–Public Transport Master Plan, seminars, discussions and on-site visits to Europe were organized to allow Chinese experts and policy makers to see modern bus priority measures, tramways and effective cycling and pedestrian infrastructure. The collaboration with the city of Zurich proved extremely valuable and contributed to the improvement of the urban planning and management skills of Kunming's officials, especially in dealing with sustainability issues.

Applicability

Any city in a developing country can benefit from the knowledge and experience of cities in more developed countries, with stronger histories of sustainable urban planning. Sister city programs are perfect opportunities for cities from different countries to promote capacity building and collaborate on projects.

Developing an urban master plan is the first step in avoiding future negative developments. Many cities in developing countries do not think about the big picture when it comes to development, and poor decisions can result in sprawl and traffic congestion. Developing a plan to structure growth will help cities expand more sustainably.

Policy Recommendations

All cities should have an urban master plan to provide guidance for urban development. These should consider the long-term consequences of development in city regions, incorporating both land-use and transportation planning. Multi-disciplinary cooperation on transportation issues between all stakeholders, including transportation and planning departments, urban planning bureaus, transit authorities, traffic police, and residents is needed to provide the best results.

See also...

Stockholm, Sweden:

The city of Stockholm, Sweden has structured growth along rail lines that radiate from the city centre. Today half the population of Greater Stockholm lives in self-contained satellite communities, focused around rail stations, referred to in the Stockholm City Plan as “strategic nodes”. These communities provide services and amenities located near a rail station and have good pedestrian and cyclist infrastructure. See

<http://international.stockholm.se/Future-Stockholm/Stockholm-City-Plan/>.

Tianjin, China

The Tianjin Eco-City is expected to be up and running by 2020. This is a 30 square kilometre development in the city of Tianjin, one of the largest cities in China. The city will feature the most cutting edge green technologies and, like Kunming, will serve as a model for sustainable development in other Chinese cities. An important feature of the development is the advanced light rail transit system, which will provide easy access to jobs in the nearby Tianjin Economic-Development Area, reducing dependence on cars for work trips. The project takes a holistic approach to land use planning and sets qualitative as well as quantitative performance measures to monitor its success in several areas, including the following:

- Ambient Air Quality: The air quality in the Eco-city should meet at least China’s National Ambient Air Quality Grade II Standard for at least 310 days. The SO₂ and NO_x content in the ambient air should not exceed the limits stipulated for China’s National Ambient Air Quality Grade I standard for at least 155 days.
- Carbon Emissions per Unit GDP: The carbon emissions per unit GDP in the Eco-city should not exceed 150 tonnes per US\$1 million.
- Proportion of Green Trips: At least 90% of trips within the Eco-city should be in the form of green trips by 2020. Green trips refer to cycling, walking and public transport.

See <http://www.tianjinecocity.gov.sg/> and

<http://www.eco-city.gov.cn/eco/shouye/zoujinshengtaicheng/shengtaichengjianjie/en/en.html>.

4. Technological solutions

Efficiency and emission requirements

Emission standards are usually implemented at the national level and set a limit to the emission of air pollutants such as CO₂, NO_x, SO_x and particulate matter for (new) motorized vehicles. In an urban context these standards can play a role, if they are used to restrict access to parts of the city. These so-called environmental zones belong to the category of non-technological solutions (see section 4.5). Emission standards aim to reduce CO₂ emissions or air pollution and their negative (health) consequences by pushing technological innovation.²⁶ The observed effects in air pollution and CO₂ emissions are in the right direction, as shown by the EEA (2010) and the International Council on Clean Transportation (see <http://www.theicct.org/>). However, vehicle turnover is slow, meaning that the effects of pollution regulations on CO₂ emissions and air quality take time to appear. To date, most industrialized and some emerging countries have adopted emission standards. The institutions responsible for their implementation and monitoring commonly do not exist in poorer countries. Hence initiatives to promote motorized vehicles using clean technologies must come from the developed world.

It has been shown that an increase in energy efficiency induces economic reactions that partially offset the original energy saving effect. As the energy efficiency improves, the process becomes cheaper, thereby providing an incentive to increase its use. Hence, more efficient motors might lead to a reduction in fuel consumption, CO₂ emissions and other pollution. However, even though individual cars become more efficient the use in terms of mileage, the number and capacity of cars increases. This rebound effect might lead to a less than proportional decline in energy use and CO₂ emissions. Instead, they might stay constant or even increase (see Greene et al. 1999 and Greening et al. 2000).

The following section examines takes a closer look at alternative fuels as a technological solution to increase transport sustainability.

²⁶ An overview of existing standards around the world can be found under http://www.conti-online.com/generator/www/de/en/continental/automotive/general/contact_services/downloads/passenger_cars/powertrain/common/pow_emission_booklet_pdf_en.pdf, accessed 08 May 2011,

Electro and hydrogen mobility

In the long run electro- and hydrogen-based mobility have potential to improve the sustainability of the transport system in a complementary way. In general they reduce noise and local pollution. The reduction in CO₂ emissions depends on the method of electricity and hydrogen generation. If, for example, the current EU-electricity mix is used for a standardized car, then CO₂ emissions from electro -mobility are 55 % below that of conventional car engines (on a well-to-wheel (WTW) basis). However, data for Germany by the German Renewable Energies Agency currently imply a reduction of only 20%. The results of these comparisons hinge on assumptions regarding car characteristics like weight and energy consumption per 100 km. Since hydrogen generation is very energy intensive, the CO₂ emissions of hydrogen cars are even higher than those of conventional fuels. However, if electricity or hydrogen is produced by renewable energy, then there is a large CO₂-reduction potential. Hydrogen also opens the possibility to store renewable energy. Hence, hydrogen production would help to stabilize renewable energy supply. See dena (2010) for an evaluation of CO₂-reduction potentials from alternative fuels.

The potential of electro-mobility for cars is still limited due to relatively low storage capacities of batteries. Battery capacity limits the use of E-cars for short- to medium-distance journeys. Estimates show that costs per kilometre for E-cars are two to three times greater than for those using conventional fuels (see Bräuninger et al 2010). In addition, E-mobility requires high investments in infrastructure and the costs for a hydrogen infrastructure are even higher. It is unlikely that there will be high individual investment into E-mobility before there is a sufficient infrastructure. On the other hand it is difficult to justify high public investment into infrastructure if there is no individual need for it. The implementation of other forms of E-mobility, such as E-bikes and E-buses might help to build a bridge to electro mobility in the long run.

Motorised two-wheelers are an important means of mobility around the world. In many developing countries, they are a first affordable step towards individual mobility. More than 95 % of all powered two-wheelers are produced in China, Southeast Asia and Japan. Although powered two-wheelers are generally very fuel efficient, they contribute disproportionally to pollutant emissions and noise (IEA 2009b). There could be a niche for electric two-wheelers (E-bikes), which generate no emissions and little noise during operation. Electrically-assisted bikes are bicycles powered by normal human effort, but able to be boosted by a modest battery and motor. The scooter-style E-bike is a more

sophisticated machine which does not require human effort. It offers a range of about 40 kilometres. Electric bikes could become a very important means of transport, especially in hilly and/or large urban areas, where problems with local pollution, noise and congestion are pressing. E-bikes are particularly popular in China, partly due to the ban on petrol-fuelled scooters in several big cities, such as Beijing and Shanghai. How far E-bikes can substitute other forms of transport in the future is unknown. In the 450 Scenario (IEA 2010b), E-bikes are assumed to replace other motorized two-wheelers and are projected to make up around 20 % of two-wheeler sales by 2035.

Biofuels

Currently approximately 3 % of world fuel demand is satisfied by biofuels. According to IEA scenarios this ratio might increase to 8 % in the year 2035. However, the use of biofuels differs dramatically between countries: The highest fraction of biofuels can be found in Brazil where they satisfy 20 % of total fuel demand.

Biofuels have the potential to reduce CO₂ emissions, but not all biofuels lead to a sizable reduction in CO₂ in reality. The CO₂-reduction potential depends on the crops, the way they are grown and harvested, the distance they are transported and on the way biomass is converted to usable fuels. Figure 4.10 provides an overview of CO₂-reduction potentials from different biofuels.

Although biofuels might reduce CO₂, their potential for sustainable mobility is limited. Current first generation biofuels are grown in competition to food, limiting their potential. There are also potential conflicts with other sustainability aims, such as the protection of biodiversity. Although second generation biofuels are less affected by these issues and have higher CO₂-reduction potential, they are still far from being economically competitive.

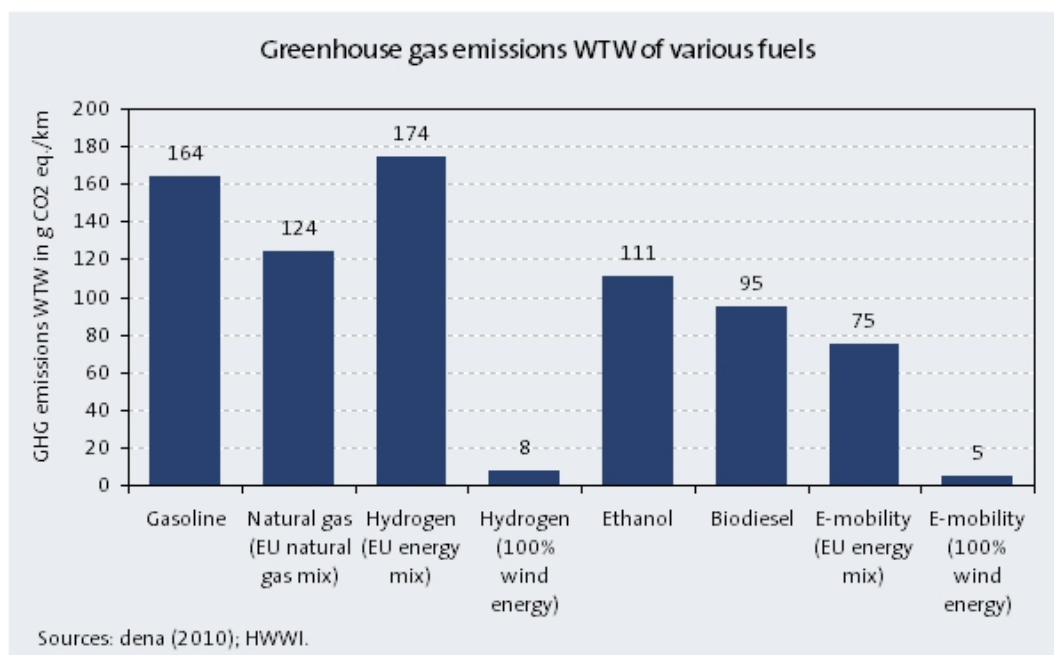


Figure 4.10: GHG emissions WTW of various fuels²⁷

Factor of success	Country group				
	High income OECD	High income Non-OECD	Upper middle income	Lower middle income	Low income
Investment into infrastructure	+	=	-	-	-
Bridging solution	-	-	+	+	+
Sustainable biofuels	+	-	+	=	-

Quick facts

- In the long run electro- and hydrogen-based mobility might help to improve transport sustainability.
- High infrastructure investment costs limit the potential of hydrogen and electrification in the short- and medium-term
- The CO₂ reduction potential of electric mobility depends on how the electricity is generated.
- Biofuels are a potential route to CO₂ emissions reductions .
- Biofuels might be in conflict to food production and to other sustainability aims, such as biodiversity. This limits the potentials of biofuels and requires certification.

²⁷ The reference vehicle is a standardized middle class car consuming 7 litres of petrol per 100km. The underlying data stem from EUCAR/JRC/CONCAWE (2007).

Tech-Box 1: Trolleybuses

Trolleybuses are still running in 313 cities in 47 countries around the world (see www.trolleymotion.com). They can be found predominantly in the states of the former Soviet Union and other countries of eastern Europe, but also in Italy and Switzerland. After the fall of the iron curtain, the already decreasing number of trolleybus-systems took a further hit. However, some proponents see trolleybuses as a sustainable alternative to both trams and fossil fuel-powered buses. Trolleybuses themselves are in general powered by electricity supplied by overhead contact wires. The following are representative of modern designs:

Vancouver, Canada



http://bc.transport2000.ca/images/TL_2007_NFI_E60LF_2533.jpg

St. Gallen, Switzerland



<http://www.bus-bild.de/bilder/naw-trolleybus-16607.jpg>

Infrastructure investment costs for trolley buses are generally lower in comparison to trams but higher compared to diesel buses. They can also be used in difficult terrain, favouring them against both competitors. An advantage against diesel buses lies in the use of electricity as the energy source, normally leading to lower carbon emissions. As with trams, trolleybuses do not cause significant noise pollution. Being dependent on overhead contact wires, trolleybuses are not very flexible: Re-routing is difficult and overtaking impossible, possibly causing trouble in badly managed and maintained systems. Another disadvantage, at least to some critics, is the aspect of the visual nature of wired transport systems, which also applies to trams.

The decisive facts in favour of or against trolley buses should nevertheless be the infrastructural and operational costs as well as their contribution to sustainability in inner-city transport.

For further information see for example

- <http://www.trolleymotion.com/de/>;
- <http://www.uitp.org/>;
- http://bc.transport2000.ca/learning/etb/trolley_alert.html (accessed 02 March 2011).

Tech-Box 2: Bioethanol in Brazil

Brazil was one of the first supporters of biofuels. In the wake of the first oil crisis, the programme PROÁLCOOL was launched in 1975 and enhanced after the second oil crisis with the aim of reducing Brazil's oil dependency, primarily through the production of ethanol. This measure was also introduced to increase employment in the Brazilian sugarcane industry and promote the development of vehicles able to run on ethanol. Almost 80% of newly registered cars were able to be powered by ethanol by the mid 1980s, boosted by tax-exemptions for these cars and a regulation requiring 20-25% bioethanol blending in normal fuel.

The consumption of bioethanol in Brazil has increased further in the last decade owing to rising fossil fuel prices. In addition to this, the number of so called Flexible-Fuel Vehicles (FFVs) has increased considerably. These cars can be used on any mix of bio-ethanol and conventional fuels. They were introduced in 2004 and today account for about 90% of new vehicles in Brazil. In 2010 2.9 million FFVs were sold (National Association of Automotive Vehicle Manufacturers, Brazil 2011). More than half of the Brazilian vehicle inventory today is made up of FFVs. Their introduction also led to nationwide development of a network of E-100 fuelling stations and has strengthened consumers' trust in biofuels, as they can also react flexibly to bioethanol and fossil fuel price changes.

With the help of the governmental support programmes and on account of its tropical climate together with a vast amount of arable land, Brazil has become one of the world's largest producers of bioethanol. These advantageous conditions and the resulting technological edge enable Brazil to produce bioethanol at very low cost. The production costs – in fuel-equivalents - are as low as 0.31 Euros per litre (Fachagentur Nachwachsende Rohstoffe e.V. 2009). The production of bioethanol in Brazil amounted to as much as 28 billion litres in 2009. This corresponded to a share of approximately 39% of global production, with only the USA producing more with a share of 52%. However, the USA uses maize instead of sugar-cane to produce bioethanol (Government Brazil 2010, Renewable Fuels Association 2010).

A large share of arable land in Brazil is used for the cultivation of sugar cane, half of which is used for bioethanol. The rising production of bioethanol in the southern and south-eastern parts of the country has led to fears that cattle-breeding could be pushed into the Amazon-basin. Around 3.5 million hectares of land are currently used for the production of bioethanol, which can be seen as problematic in the face of global food scarcities. Brazil also

belongs to the most important exporters of soya beans and maize. However, it is questionable whether the land used for growing sugar cane could instead be used for the cultivation of soya beans and maize, since the nutrient-poor land used for sugar production is unsuitable for other crops. Moreover, Brazil has – according to estimates by the FAO – enough potential for additional agricultural land without endangering the primeval forests in the Amazon area. In addition to the existing 249 million hectares, about 106 million hectares could be made available without significantly harming biodiversity and the Amazon carbon sinks (Brazilian Sugarcane Industry Association (UNICA) 2009, Cremaq 2010).

Of all first-generation biofuels, bioethanol made from sugar cane has the highest CO₂ reduction potential in comparison with fossil fuels, namely about 84%. In these calculations the whole production chain is considered, so that a by-product of bioethanol production, the so called bagasse, has a positive effect as it is possible to use it for the generation of electricity (EUCAR et al. 2007). Originally, the sugar cane leaves were burnt to facilitate the harvest causing huge CO₂ emissions, but this practice has since been forbidden. In comparison to bioethanol from sugar cane, only second generation biofuels perform better in terms of CO₂ emissions reductions, because they use plant remains or fast growing grasses and trees. However, second generation biofuels still need more research and development to enable production on an industrial scale (v. Collani et al. 2009).

Brazil was able to make bioethanol competitive in comparison to fossil fuels through support for the installation of infrastructure required for mass production. The use of bioethanol has reduced Brazil's CO₂ emissions, but this success cannot be easily transferred to other countries. First generation biofuels compete with food crops for land, and the latter can be diverted into fuel production rather than food: over 35% of the annual maize harvest in the USA is used for biofuel production (USDA 2011). The additional cultivation of agrofuels can be a serious threat to primeval forests. Finally, many crops are not as well suited for biofuel production as sugar cane because they need more water and fertilizer. Fertilizer production itself is energy-intensive and may cause emissions of nitrous oxide (N₂O), which has a greater global warming potential than CO₂ emissions.

Tech-Box 3: Cable propelled transit in Caracas

Background

Caracas, the capital of Venezuela, is notable for its vast informal zones known as “Barrios”, home to half the city’s inhabitants. Located in a valley surrounded by a mountain range, Caracas is one of the deadliest cities in the world. The city faces a lack of sanitary, health care, social, and transport infrastructure. The Barrio of San Agustín is located on a hillside

Key Statistics Caracas

World Bank classification: Upper middle-income
Population: 3.2 million (2009)
Population density: 1,431.5/km²
GDP per capita: 11,490 \$ (2009, Venezuela)
Urbanization rate of Venezuela: 1.7% annual rate of change (2010-15 est.)
Car and motorcycle mode share for all trips: n/a
Cars per 1000 inhabitants in Venezuela: 110

in the centre of Caracas and houses approximately 45.000 inhabitants. It was an isolated part of the city until the City of Caracas built an inner-city cable car as a means of public transport to connect the barrio with the inner city.

Until the opening of the cable car inhabitants had to walk 45 minutes to get to their place of work in Caracas city. Narrow and steep pathways had to be taken to get to the footbridge that leads over a highway and served as the only connection between the barrio and the city. The barrio of San Agustín was never integrated into the infrastructure of the city, as building a road would have meant demolishing one third of the housing, an idea that was opposed by residents.

In 2003 the Urban Think Tank (UTT) organized a symposium at the Caracas’ central University to protest against the road building and presented the concept for a cable-car. Together with the Ministry of Infrastructure, Austrian cable car manufacturer Doppelmayr and engineers at Silman & Associates, as well as Transsolar, the concept of Caracas MetroCable was refined. Construction began in spring 2007 and the official opening was in January 2010.

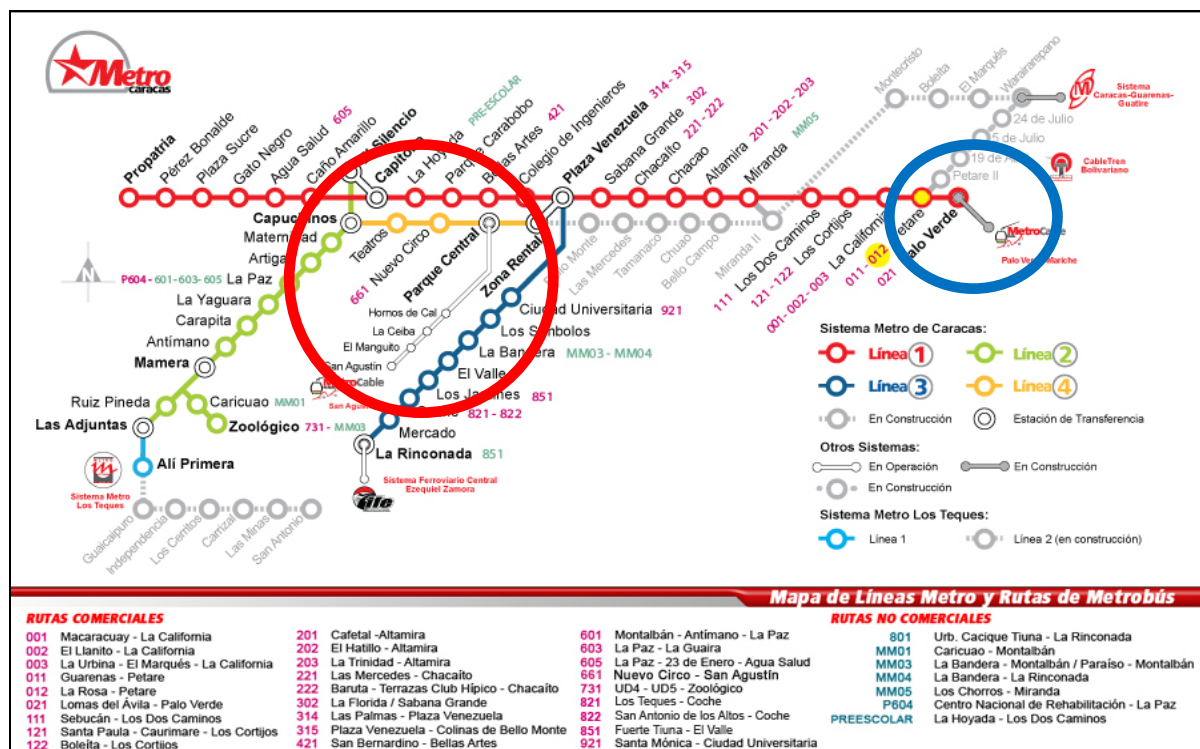
Description of Strategy

The Monocable Detachable Gondola

The Monocable Detachable Gondola (8-MGD) is a detachable cable railway cabin for a maximum of eight people. The 8-MGD of San Agustín has a mountain station, two valley- and two angle-stations. There are 50 cabins, travelling speed is up to 18 kilometres per hour and overall length is 1721 metres. The Gondolas run at regular intervals of 27 seconds, offering a carrying capacity of 15,000 to 20,000 people per day. The Metrocable is fully integrated into the local metro system. The overall cost of the project was approximately 220 million Euros.

Social projects were also implemented along the Metrocable route, including the provision of gymnasia, markets, police stations, medical facilities, theatres and libraries, further enhancing quality of life.

Metro map of Caracas²⁸



Results

Before the Metrocable was put into operation, San Agustín residents had to climb 600 steps and walk for up to 45 minutes on the journey from the city centre. The cable car now takes

²⁸ See http://www.metrodecarracas.com.ve/mapa_rutas/mapa_met_mbus.html, retrieved 10 August 2011. The Metrocable line in the red circle is in operation, the one in the blue circle under construction.

five minutes. Residents do not lose time on the way to and from work and no longer fear attacks when travelling after dark. Since the Metrocable is fully integrated into the local metro system, one Caracas Metro ticket will give passengers access to all Metro de Caracas public transport, which operates daily from 6 a.m. to 10 p.m.

The Metrocable in San Agustín also could further positive side effects as observed in the district of Medellín, where cable cars have already transformed the barrios. Residents there have embellished their huts and roofs and cleaned the streets to present a welcoming appearance to cable car users passing above. The crime rate in Medellín has also declined since the opening of the cable car, thought to be a result of it fostering a sense of pride and hope among residents.

Gondola systems have the following characteristics:

- Independent from existing infrastructure and traffic;
- Low space requirements along the route;
- High capacity;
- Detachable, as multiple stations and turning corners are possible;
- Rope sections up to 6km possible;
- Low energy requirements;
- Continuous operating system with low emissions and low noise;
- Suitable to overcome obstacles like water, highways, steep terrains, etc.



Photo: The UCTP in Caracas

Applicability

UTT demonstrates the technology's applicability to hilly urban terrain. The case of the Gondola System as an urban transport system in Caracas also provides a good example of the social perspectives of mobility questions. It represents a safe and sustainable form of mass transport that is reliable and adaptable to different terrains.

Recommendations

In order to ensure high acceptance within the community a variety of stakeholders, including residents, should be consulted when planning to introduce such a system.

See also:

<http://gondolaproject.com/>

Discusses the importance of mass urban transit in the cities of the future.

<http://www.youtube.com/watch?v=kjfz6bNqm0>

Video about the success of the Medellin Metrocable.

5. Non-technological solutions

1. Background

1. General considerations

Travel demand management (or transport demand management, TDM) is one of the key strategies of the vast set of non-technological solutions. It is the umbrella term for strategies designed to reduce the demand for private motorised modes and increase the overall efficiency of the transport system by promoting the use of sustainable modes (see GTZ 2004a).

TDM can obviate the need for additional infrastructure identified in the traditional “predict and provide” approach to transport planning to channel the need for transportation instead of trying to provide additional infrastructure for meeting growing demands. The idea originates from the USA of the 1970s and 1980s where it had a definite focus on commuting, but it has considerably broadened since then (see US Department of Transportation 2004). While it is still one of the important objectives of TDM to avoid or reduce individual car use, its scope has also become larger because offering more varied and efficient transportation systems likewise has many co-benefits and enhances sustainability.

TDM utilises the Avoid–Shift–Improve approach introduced in section 4.1:

AVOID	or reduce trips and travel distance
SHIFT	to more sustainable modes
IMPROVE	the efficiency of all modes, but not necessarily the technology

In this section we will look at a number of non-technological policy measures that have two broad features in common. Firstly they address individual behaviour, either incentivising or averting its change depending on the (societal) desirability of the behaviour. Secondly they deal with and not with the vehicle level directly. The system level in this regard especially refers to the available modes of transportation, their infrastructure and their relative attractiveness.

The related measures are divided into ‘push–’ and ‘pull-measures’ (see e.g. The PEP 2011), which can be seen as negative and positive incentives respectively. Push-measures attempt

to make the unsustainable modes of transportation less attractive, while pull-measures try to increase the attractiveness of alternative modes.

Single TDM-related policy measures usually have minor impacts, but the cumulative effect of packages of measures combined with supportive land-use and city planning have huge potential for medium- to long-term behavioural change. One also has to be aware of the fact that there might be different policy measures or bundles thereof to achieve specific objectives. This study discusses a number of individual TDM measures in more detail.²⁹

Gwilliam et al. (2005) see TDM as particularly appropriate in cities in developing countries, because it offers great potential to slow motorisation and generate multiple co-benefits at low cost. In many cases, effective TDM during the early stages of development can prevent the adoption of a car-dependent path before it is too late (see chapter 4.1 for a discussion on path dependencies). This can help support a developing country's economic, social and environmental objectives. Kahn Ribeiro et al. (2007, p. 367) state that "coordinated transport and land-use methods might have greater benefits in the developing world where dense mixed land use prevails and car ownership rate is low."

Finally, Bongardt (2010) shows that the relative potential of avoid-strategies is much larger in developing countries than in developed countries. He compares the potential contributions of avoid-, shift- and improve-measures for GHG-reductions in industrialized versus developing countries until 2050, assuming CO₂ emissions reductions targets of 80% and 50% in industrialised and developing countries respectively. He finds that the contributions of each of the three TDM components in industrialized countries in 2050 are quite similar, while avoid-strategies are twice as effective as shift- and improve-measures within developing countries.

²⁹ The Online TDM Encyclopedia <http://www.vtpi.org/tdm/index.php> of the Victoria Transport Policy Institute (VTPI 2011a) is an invaluable resource for information on this topic. We also strongly recommend this website for further information not only on single measures but also on planning procedures and on the design and evaluation of whole TDM-programmes.

2. Push-measures

The main goal of push-measures is the reduction or avoidance of motorized individual transport through pricing and regulation. The logic behind this is not necessarily to completely squeeze motorized individual transport out of the mix of transport modes, but rather to achieve realistic relative prices of all means of transportation. In that sense, push-measures serve two purposes: Firstly, they are supposed to internalize all external costs of different modes.³⁰ Secondly, they steer behaviour by setting (financial) incentives. However, this should only be done to a certain extent, namely the one given by the respective external costs. Otherwise overly ambitious attempts to repair market failures could lead to distortions into the other direction.

The financial incentives can either be negative or positive in nature. Negative incentives like taxes, fees and tolls aim at internalizing negative externalities (i.e. to reduce demand for car ownership and/or use) while positive incentives in the form of subsidies try to internalize positive externalities. In the transport sector positive externalities are rare to find, unless one counted the virtually immeasurable health benefits from cycling or walking as such. Nevertheless, positive incentives are also sometimes used to make some modes relatively more attractive. Usually those measures belong to the pull-category, which are further discussed in section 3. Negative externalities are much more common and often associated with car-use. Hence, most of the instruments below relate to cars.

Gilbert (2000) points out that strategies to reduce (or prevent) car ownership seem to have greater leverage than those that try to reduce the use of cars, which is intuitive given that car ownership is the primary determinant of use. Thus there is great potential to make or indeed keep transport sustainable in societies where the path to auto-dependency has not yet been taken. This is particularly relevant for developing and emerging countries.

Individual behaviour is shaped by the generalised costs of transport, incorporating time as well as financial cost. The relative prices of the different modes together with the preferences of the consumers are the important factors for decision-making. Trip costs include fuel costs, and possibly road use charges and/or parking fees, or ticket prices for public transport. In addition to this one has to account for the opportunity costs of time spent for travelling. Time costs include time spent on the move, waiting for public transport and searching for parking, all of which can be manipulated by TDM measures. Time costs

³⁰ See chapter 3 for data on the external costs of car use.

together with the strains of travelling itself are an often underestimated cost-component. Frey & Stutzer (2004) for example show in their commuting paradox that individuals systematically underestimate their overall commuting costs. Interestingly though, a survey by IBM (2010) on car-drivers in 20 major cities around the world reports that they are well aware of the negative impacts of traffic congestion and would obviously prefer better traffic flow and more attractive alternatives. TDM can be beneficial here, if the related measures are capable of reducing the less obvious part of transportation costs.

Economic instruments

Economic instruments like taxes or user fees have two different purposes: they (can) contribute to the financing of transport infrastructure and they influence individual decisions by altering the relative prices of alternative modes. TDM is more concerned with the second aspect, but it is worth noting that revenues generated by the economic instruments proposed could in principle be used to make transport (in cities) more sustainable by e.g. financing structural or pull-measures. This is especially true for actions on the regional or local scale if the proceeds go directly to the regional or local authority.

One can divide economic instruments into those implemented on the national level and those on the regional or local level. The main national economic instruments are taxes on fuel and/or vehicles. The main regional and local fiscal instruments are road user or congestion charges or parking fees.³¹

The IEA (2010a) estimates that global subsidies for fossil fuels, i.e. oil products, natural gas and coal, amounted to 557 billion US-\$ in 2008 representing 2.1% of GDP (on average). According to the IEA, cutting the subsidies would reduce global energy demand by 5.8% until 2020 with 66% of that relating to transportation.³² If tax rates are too low, this can also be interpreted as a subsidy. Ley & Boccardo (2009) e.g. find for a sample of OECD and BRIC countries that China, Russia, the USA, Brazil, Mexico and Canada under-tax motor fuels. But they also note that their results are sensitive to their assumptions and need further

³¹ See Cast Study 11 “Restrictions on car use in Singapore” for the implementation of a whole set of economic instruments.

³² The most relevant sources for information on fuel taxes and subsidies are GTZ (2009), the overview on international fuel prices of the GTZ 2011b, IEA (2010a) and IISD (2011) with a study on fossil fuel subsidies by the IISD and the related website <http://www.globalsubsidies.org/research/fossil-fuel-subsidies>, accessed 26 January 2011 (GSI 2011).

validation. This is though, apart from the case of Brazil, fairly consistent with the table of countries in GTZ (2004b) and the annual fuel price overview provided by GTZ.

Fuel taxes are generally thought of as a proxy for user charging, because it directly relates to individual behaviour (see GTZ 2004b) in terms of the amount of fuel consumed and the use of road infrastructure. Thus, if fuel taxes are too low or fuel is even subsidized, individual decisions on transport modes are distorted and car use becomes too cheap. While fuel taxes are in principal a good tool to influence mobility decisions there are some caveats.

The first is a general one on the sensitivity of car-use and ownership to the development of fuel prices. Economically this is reflected in the price elasticities in the short and in the long run. In the short run car owners can only adapt by driving less or more efficiently with their existing car, while they can in the long run exchange their car for a more efficient model or dispose of it altogether. More efficient cars can cause a rebound effect, i.e. the number of trips and their length compared to the original state might stay the same or even increase, leading to only an overall small (if any) decrease in fuel consumption. Empirical evidence shows that the price elasticity is larger in the long run than in the short run. In other words, a permanent price increase reduces fuel consumption by more in the long run than in the short run. The exact values however depend on the purpose of the trips, the availability of alternative destinations and modes and regional circumstances like the state of economic development. As a rule of thumb, a 10% price increase leads to about 3% less fuel consumption in the short run and 7% less in the long run. The same qualitative assessment holds true for the travel impacts: The effect is larger in the long than in the short run. However, the overall effect on distance travelled is usually smaller than the impact on fuel consumption. As a rule of thumb here, a 10% price increase leads to about 1% fewer vehicle kilometres travelled in the short run and 3% fewer in the long run (see Litman 2010 and VTPI 2011b for in-depth analysis and overviews of empirical results). With regard to car ownership, Goodwin et al. (2004) report that a permanent fuel price increase of 10% leads to a reduction in car ownership of less than 1% within one year, but around 2.5% within 5 years. The problem is that a 10% rise in income leads to a rise of the vehicle stock by 3% in the short and by 8% in the long run. Thus even if a country's income rises slower than fuel prices this might not be sufficient to reduce car use and ownership.

The second caveat is probably more relevant for developed economies: fuel taxes need to send a sufficient price signal to be effective. In countries with high fuel prices it is unlikely

that additional fuel taxes have an (immediate) impact as they might also be counteracted by short-run price fluctuations. The third caveat is the low acceptability of fuel taxes and large increases in particular. Incremental increases are more acceptable than one-off large increases, especially if these are without advanced warning (see also GTZ 2004b).

Vehicle taxes, acquisition taxes, auctioned entitlements or – acting in the opposite direction – tax bonuses for energy-efficient and low-carbon vehicles can influence car ownership. According to the World Bank (2002) these are most effective where the differentials are significant. But GTZ (2004b) also notes, relating to the case of vehicle tax differentiation in Germany, that at least some allocational effects can be achieved. It requires further inspection whether this instrument can be used successfully in developing or emerging countries.

Road or congestion charges are pay-as-you-use schemes that internalize some or all of the external costs of road use in cities. Thiel (2010) compared the total costs of urban car transport with generated revenues in 15 European cities and found that the cost recovery rate is only 14 to 47%, thus identifying hidden subsidies for cars. The aim of congestion charges is to reduce private motorized traffic in urban areas, a matter for local authorities. Road or congestion charges can take a number of different forms that we will not address further here (please refer for example to OECD 2010, [VTPI](#) 2011c and GTZ 2004b for more details).

For the implementation of road or congestion charges three basic questions need to be addressed (see also OECD 2010):

- financial issues like implementation costs, the pricing approach, tariff setting and the use of revenues;
- technical implementation; and
- acceptability.

The last point should not be underestimated: although road or congestion charges are – if designed and managed well – often seen as a sensible instrument by economists and planners alike, but are difficult to implement due to political concerns and public resistance. However, figure 4.11 (taken from OECD 2010, p. 80) shows that support for charges is lowest before implementation but increases as soon as the positive effects are felt.

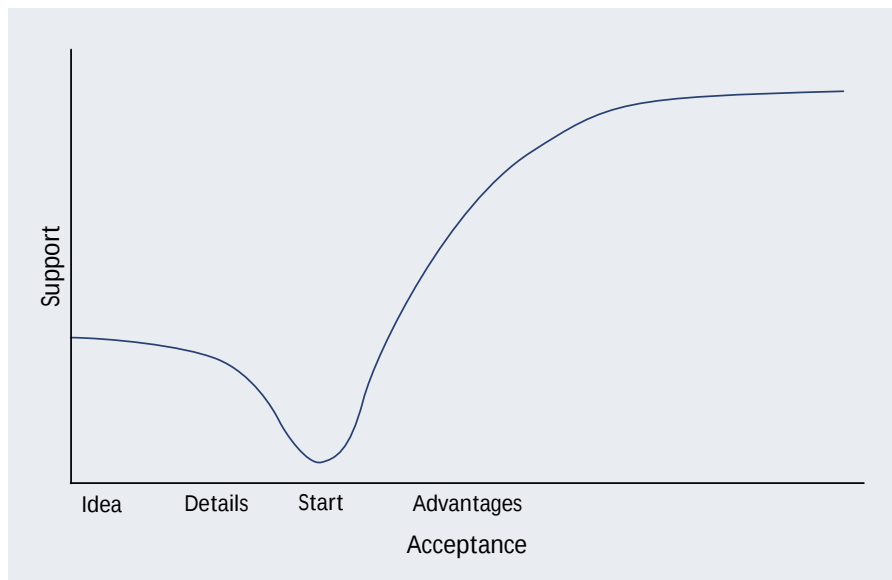


Figure 4.11: Congestion charges and their acceptance over time

Road and congestion charges can alter individual behaviour in different ways (see for example Bowerman 2007). People can change the time of travel, their route, in some cases their destination, the mode used or decide not to travel. This has two main implications. Firstly, in order to allow a change of travel mode, competitive alternatives for example in the form of public transport have to be available. Secondly, the whole system has to avoid unwanted side effects like simply channelling the traffic onto other routes and thus simply displacing rather than eliminating the congestion problem. However, Bowerman (2007) concludes that congestion charges can be an appropriate measure to relieve congestion, smooth traffic flows and raise revenues. Successful international examples like Singapore, London, Stockholm and Trondheim have emerged. The requirements regarding organization, upfront-investments and technology make congestion charges only appropriate for developed countries though.

Parking fees are direct charges for use of land set aside for parking. Parking fees can serve as a substitute measure to road charges if the financial budget does not allow the implementation of the necessary technology, thus making them an attractive option for less developed countries. From the point of view of local authorities parking fees can have several positive impacts as they provide steady revenues and, if set high enough, can reduce congestion and incentivize modal shift to more sustainable alternatives. Thus, apart from effectively planning and designing urban parking spaces, the relative costs of car use including parking and public transport is crucial: for parking fees to be an effective demand

management tool, they have to be higher than public transport fares. Data for European cities in Rau et al. (2010, p. 52) show that many cities in middle, south and eastern Europe still charge less for parking than for bus trips.

In summary, economic instruments can, if properly designed, have sizeable effects on individual transport decisions. Nowadays they mostly play a more important role in developed than in developing and emerging countries. This assessment does not refer to fuel taxes, as there is considerable scope for less- developed countries to appropriately tax fossil fuels instead of subsidising them (see also section 3.1).

Regulatory instruments to steer transport behaviour are manifold. Available measures range from restrictions on ownership and use to access restrictions to certain areas according to some predefined criteria to a diverse set of management of roads and parking spaces. It goes far beyond the scope of this study to analyse these measures in detail.³³

However, some general observations can be made. Firstly, regulatory instruments can principally support the effects of economic instruments or pull-measures. Secondly, appropriate governance arrangements and institutions are required. Thirdly, they sometimes simply reflect a command-and-control approach, which in environmental economics is considered to be less efficient than market-based or economic instruments. They should therefore complement rather than be seen as an alternative to other measures designed to support sustainable transport.

3. Pull-measures

The main goal of pull-measures is to enhance the attractiveness of alternatives to motorized individual transport, principally through changes to the relative costs of different transport modes and service/infrastructure quality. One aim is to make public transport user costs cheaper than marginal trip costs by car (NMT).

In cities the car is the chief competitor to public transport. Note that so-called paratransit is frequently the informal predecessor in developing countries or even co-exists with public

³³ As before the best starting points are the TDM Encyclopedia or the GTZ sourcebooks.

See section 4.4 for the general discussion of emission standards on the national level, which can be regarded as a prerequisite for environmental zones in urban areas. It is unlikely that they offer an appropriate solution for developing countries.

transport after it has been successively introduced. We do not discuss paratransit here. The main forms of mass rapid transit (MRT)³⁴ in cities are (see GTZ 2005a and World Bank 2002, chapter 8):

- Metros (or subways)

Coming with the highest capacity and often with the best overall performance, metros as electric rail-based systems are normally the most expensive form of MRT, depending on geographical conditions, the design and whether a new system is set up or an existing one is expanded. Common calculations assume costs of between 50 and 200 million US-\$ per kilometre. While attractive to urban policy makers due to its prestige, it is rarely an option for cities in developing countries.

- Bus Rapid Transit (BRT)³⁵

There is no clear-cut definition of BRT-systems but they have some common features like segregated bus lanes, comparatively modern bus technology, efficient off-vehicle fare collection, distinct stations and modal integration.³⁶ BRT has its cradle in South America and is most widespread there. Only recently has the idea spilt over to other continents like Asia, Australia and North America. BRT-systems are relatively cheap compared to metros as they only cost between 1 and 10 million US-\$ per kilometre. In addition to this, planning and implementation are much quicker. Contrary to the layman's perception, BRT-systems can also serve dense corridors, with capacities of up to 35,000 people per hour in Sao Paulo and Bogota.

Typically, lack of political will is one of the main impediments to the implementation of BRT systems. This can stem from a lack of understanding or institutional biases. BRT systems should be integrated into the overall public transport system and embedded in city and land-use planning.

- Bus Rapid Transit Lite

Sharing some but not all characteristics of full BRT, Bus Rapid Transit Lite systems offer an alternative for countries wishing to solve their urban transport problems sustainably but at low cost as a result of budgetary constraints.³⁷

³⁴ For details on public road transport see World Bank (2002, chapter 7).

³⁵ See most notably http://www.itdp.org/index.php/microsite/brt_planning_guide_in_english for Wright's (2007) BRT Guide and GTZ (2005b), also written by Wright though.

³⁶ See Case Study 12 „Bus Rapid Transit in Curitiba, Brazil“ for the first implementation of a BRT ever.

³⁷ See Case Study 13 „Institutional Reform and Bus Rapid Transit “Lite” in Lagos, Nigeria” for more information.

- Light Rail Transit (LRT)

LRT covers different forms of electric rail-borne means of transport. Most common are on-street tramways but also elevated systems like in Singapore belong to the class of LRT. Recently cities in developed countries have shown increasing interest in building or re-establishing trams, either as feeders for metros or as a substitute or complement to buses. In most cases they are less attractive for cities in developing countries because of high capital and operating costs, and long construction times in comparison to BRT and conventional bus systems. The preconditions are more favourable if LRT in some form already exists. In this case modernization and expansion can be advantageous compared to establishing completely new alternative systems.³⁸

- Suburban railways / Commuter rail systems

Suburban railways cater for longer-distance trips, although many have closely-spaced stops in city suburbs. Sound planning can integrate them into the urban transport network but they often suffer from inefficient (public) ownership, their age and bad maintenance resulting in cost and safety issues. The cost-benefit ratios of reviving suburban railways can be high, especially in developing countries as opposed to building new MRT-systems.

Prerequisites for the establishment of public transportation systems (and their acceptance) are the existence of strong governance and institutions, intra- and inter-modal integration, high capacity and appropriate pricing mechanisms. A key challenge according to Wright & Fulton (2005) is how to halt the shift away from the poor quality public transport found in many developing and transition countries. Policy should therefore prioritise the improvement and expansion of existing modes in order to avoid the path of individual motorisation. This can be combined with transit oriented development (TOD): “residential and commercial districts located around a transit station or corridor with ... design features that facilitate transit use and maximize overall accessibility” (see VTPI 2011d).

Non-motorized transport (NMT) is often disregarded in transportation policy. However, following a people- instead of a vehicle-centred approach requires taking all means of transportation into account. The World Bank (2002, p. xiii) states: “Traffic management should be focused on improving the movement of people rather than on improving the movement of motorized vehicles.” This should be reflected in street design and land-use and city planning. Car-free development is of increasing interest in the industrialized world, but

³⁸ See [UITP](#) (2011b) in addition to the introductory sources.

also offers great potential in developing countries (see GTZ 2003 and GTZ 2005c for details).³⁹

There are numerous other options to make transport in cities more sustainable. Worth mentioning, but probably more suited to developed or emerging countries due to the organizational requirements and its supplemental nature, are **car or ride sharing systems** and **public bike systems** (see case studies in section 2 and the TDM-Encyclopedia for further information).

Country group Factor of success	High income OECD	High income Non-OECD	Upper middle income	Lower middle income	Low income
Local governance	+	=	=	=	-
Willingness to use economic instruments	=	=	=	=	=
Appropriate relative pricing of all modes	-	-	-	-	-
Possibility to avoid path dependency	-	-	=	+	+

Quick facts

- Travel demand management (TDM) is the umbrella term for strategies designed to reduce the demand for private motorised transport and increase the efficiency of transport systems.
- TDM can especially benefit developing and emerging countries.
- There are numerous non-technological measures to promote sustainable mobility. These are most effective when combined with other TDM measures and coordinated with other policy areas, most notably land-use planning.
- Economic instruments can influence individual behaviour by changing the absolute and relative costs of transport. Fuel taxation, which is simple to implement, should replace fuel subsidies and – with the aim of internalizing negative externalities – play a prominent role to achieve sustainability in transport..
- Regulatory and pull-measures can complement economic instruments.

³⁹ See the Case Study 14 „The car-free Medina of Fes, Morocco“ and the Case Study 15 „Non-motorized transport in Guangzhou, China“ for further details.

2. Best-Practice Examples

Case Study 11: Restrictions on Car-use in Singapore

Key Statistics

World Bank classification: High income non-OECD

Population: 5.1 million (2010 data)

Population density: 71/ha (2010)

GDP per capita: 36,537 US-\$ (2009)

Transport data:

Car and motorcycle mode share for trips to work: 23.5 % (2000 data)

Public transport mode share for trips to work: 55.0 % (2000 data)

Cars per 1000 inhabitants: 111 (2010 data)

Background

The compact island city state of Singapore represents best practice in the use of economic instruments to manage the demand for car-use through pricing, coupled with investment in public transport to encourage modal shift and coordination with land-use planning to reduce the need to travel.

Singapore is one of the world's great financial centres, with a fast-growing economy and high salaries. This has presented a challenge for decision-makers keen to avoid gridlock: the aim over the last

35 years has been to discourage car ownership and use, a process which has been facilitated in part by the country's political stability.

Road pricing

Road pricing is at the heart of Singapore's transport policy. As with all successful transport demand management measures it is complemented by significant investment in public transport. Singapore has combined this with planned decentralisation from the city centre to new districts served by an expanding metro system.

The 'Area Licensing Scheme' of 1975–1998 required car drivers to pay a toll to enter a 600 ha area at the heart of the central business district, at first only in the morning peak, then extended to cover both peak periods and ultimately across the whole day on weekdays. Car parking charges were increased at the same time. The system required a simple paper sticker to be displayed and reduced traffic by 44%. In 1995 the scheme was modified and extended to three distributor roads outside the CBD.

A major change came in 1998, with the large-scale application of dynamic electronic road pricing (ERP) on expressways across a wider area of the city. Users are charged for each trip

made, at a rate dependent on time of day and prevailing congestion. Vehicles are fitted with mandatory on-board units that communicate with roadside beacons to calculate the fee payable, which is then debited from a user smartcard inserted into the on-board unit.

Electronic road pricing gantry in Singapore.



Source: Mailer Diablo

Traffic fell by a further 10–15% upon introduction of the comprehensive ERP system, thought to be a result of the higher charges faced by multiple-trip makers compared with the previous flat-rate system.

Photographs are taken of all vehicles registration plates: those of cars without on-board units are automatically retained, allowing the authority to trace owners and issue fines.

Measures to reduce car ownership

Singapore's 'additional registration fee' was introduced in the 1950s and steadily increased to a rate of 100% of the vehicle price in 1975, and 150% in 1980. Customs fees on new cars were also increased in 1972, and the cost of fuel has risen significantly over 35 years. In 1990 the Government started a 'vehicle quota scheme' for the purchase of cars.

This involves the auction of 10-year 'certificates of entitlement' (to purchase a car) for specific vehicle categories, the supply of which is steadily reduced over time. Aspiring motorists are forced to bid more and more to stand a chance of obtaining a certificate. The price actually paid after each round of auctioning is the lowest qualifying bid.

The combined effect of these measures is that the average new car costs *four* times its basic list price (including delivery and insurance). A final measure has been an increase in the difficulty of the driving test, which has had an effect on reducing the active car driver population.

Applicability

Many cities in the region and beyond face the same problem of massive motorisation in the years ahead, with a stark choice of trying in vain to accommodate the growth in traffic, or preventing and controlling it through a comprehensive set of TDM and spatial planning measures. Singapore's determination to reign in the motor car was a result of fears about falling economic competitiveness, should congestion and poor air quality render the city an unattractive place to do business: it has acted decisively to avoid this situation. Today there is little congestion, unlike in the large cities of Thailand, Indonesia and China.

Singapore's road pricing and vehicle charging policies generate a significant surplus for ploughing into investment projects such as the mass rapid transit metro system, social housing and planned decentralisation, improving quality of life for all.

It is true that Singapore's somewhat unique combination

Singapore's mass rapid transit system.



Source: Calvin Teo.

of pseudo-democratic governance and economic prosperity has enabled the government to restrict car ownership without fear of losing office. However, the policies could work anywhere, introduced incrementally if necessary, and there are parallels with the political systems in neighbouring countries. Most importantly the policies, and the investments they have made possible, have worked to make the city more attractive than it would otherwise be: satisfaction with the public transport system is greater than in any other megacity according to Gallup (2008).

Policy Recommendations

City authorities should evaluate the Singapore model of road pricing plus comprehensive public transport against transport plans based on extensive new road construction, since the latter inevitably leads to congestion, high levels of air pollution and a vicious circle of decline in public transport service quality and patronage. Hayashi (2010) argues that it is essential to

offer high quality, attractive public transport in Asian megacities before per capita GDP reaches 2,000 US-\$, at which point habitual car-use becomes difficult to reverse.

Road pricing need not be technologically sophisticated, at least initially, as shown by the area licensing scheme in Singapore. Vignette-based schemes, reinforced by changes to parking supply and price, could be effective if enforced in the same way.

Similarly, well-designed, stringent driving tests are applicable everywhere, bringing a range of safety and environmental co-benefits through eco-driving skills.

See also...

The London Congestion Charge is a cordon-based flat rate charge for access to the central area on weekdays. The scheme reduced traffic by about 20% following introduction in 2003, and revenues have been used to improve bus services. The size of the charging area has since expanded and, in an example of the political sensitivity of pricing car-use, contracted following a change of political administration.

Case Study 12: Bus Rapid Transit in Curitiba, Brazil

Key Statistics	Background
<i>World Bank classification:</i> Upper middle income <i>Population:</i> 1.6 million <i>Population density:</i> n/a <i>GDP per capita:</i> 8,230 US-\$ (Brazil 2009) <i>Transport data:</i> <i>Car/motorcycle mode share for all trips:</i> 44.4% (1995 data) <i>Cars per 1000 inhabitants:</i> 250 (1995 data)	Curitiba is widely acknowledged to have pioneered bus rapid transit (BRT) as an affordable solution to transport problems in developing and transition cities. It also demonstrates best practice in informed policymaking, with a high degree of political awareness of, and commitment to, non car-oriented transport planning principles. A bus rapid transit system was introduced to Curitiba in 1974, as part of a package of reforms to transport and land-use planning, replacing a chaotic system of unregulated paratransit routes. It resulted in a 2.36 % annual increase in bus patronage, and a drop in road traffic of 30% over its first 30 years of operation. Of particular note is that the system is financially self-sufficient: routes are competitively tendered and require no operating subsidies. Key to these initiatives was the three-time mayor of Curitiba, Jaime Lerner. Unusual for an elected policymaker, he used his academic background in urban planning to shape the city's urban development strategy in the early 1970s, maximising the benefits of the federal funding made available. In particular, an early decision was made to reject an underground metro or tramway in favour of a more extensive high capacity BRT network.

Description of Strategy

A total of five dedicated expressways were constructed, at a cost of 200 000 US-\$ per km, which is at least 100-fold cheaper than an underground metro. The key corridors are served by distinctive red bi-articulated vehicles, offering a maximum crush-loaded capacity of 270 passengers. These are complemented by a number of feeder and orbital bus routes (see table below), forming a comprehensive network that maximises accessibility across the city.

Curitiba BRT and bus network.

Route type	Description
Red	Express buses on thirteen radial routes, using 65 km of dedicated expressways on arterial roads
Orange	340 km of feeder routes
Green	185 km of inter-district orbital routes
Silver	'Speedy buses' to/from surrounding areas
Yellow	Radial routes complementing the red lines
White	Inner orbital 'circle line'

Community groups were involved in participatory planning at the network planning stage, helping to inform the location of stops and route design. Today's public transport network comprises 340 routes on a total network length of 1 100 km, summarised in the table above.

The system is fully integrated: only one flat fare ticket is required for a journey, regardless of distance and transfers. Smartcards have been in use since 2003. Passengers pay before boarding

Curitiba bi-articulated BRT vehicle, in operation since 1992.



Source: Luan Lenon

at covered terminals, offering a high quality waiting environment. In addition, school children and pensioners travel free. The system's speed and simplicity has contributed to its commuter trip modal share of 75%. It has been estimated that 28% of users would switch to the car in the absence of the expressways and other priority measures.

Private companies own the vehicles and are paid a route-specific fee per kilometre, with the municipality taking revenue risk. Fares are kept low, such that inhabitants spend only 10% of their income on transport. As mentioned above, the system requires no operating subsidy.

High density development has been permitted along the key bus corridors, providing the volume of passengers required for economic self-sustainability of a dense network of high frequency services. See Case Study 7 in section 4.3 for more details on the way in which the public transport system was coordinated with land-use planning.

Applicability

This integrated approach to urban expansion and public transport provision can be implemented in other rapidly expanding cities. Indeed, Quito in Ecuador opened the first phase of its trolleybus-based system in 1996, inspired by the Curitiba experience.

Infrastructure costs are relatively low, operating costs can be reduced by competitively tendering routes, and vehicle capital costs are borne by successful bidders. Sufficient travel demand can be generated by concentrating development along radial bus corridors, and by providing complementary feeder services. By leaving revenue risk with the tendering authority, fares can be regulated to optimise the balance between cost recovery and maximising accessibility to opportunities for the poor.

The re-allocation of road space from cars to buses on the dedicated sections sends a clear signal that public transport has high status as a priority mode in rapidly motorising transition economies, as well as cutting journey times and increasing reliability relative to conventional buses and the private car.

Policy Recommendations

- Seek independent academic and/or consultancy advice to make a more informed decision as to the most appropriate rapid transit mode for your city and/or for new corridors.
- Coordinate development along existing or planned high capacity rapid transit corridors, which should have dedicated road space and other priority measures such as traffic signal actuation.
- Design the system to function as a network, with simple 'one journey, one ticket' paper or smartcard ticketing, and optimised connections between feeder and trunk services at interchanges.
- Retain control and planning – routes, timetables and fares – in the hands of public agencies. By benchmarking the economic performance of operations, an informed decision can be made whether to offer day to day operations to the private sector by competitive tender. Contracts can include penalties for poor performance by operators and/or incentives to grow patronage.
- Ensure capacity keeps pace with demand, especially in rapidly motorising cities where a high quality, uncrowded alternative is required to dissuade car ownership and peak time car-use.

See also...

Bogota, Colombia: the 9 line, 84 km *TransMilenio* BRT system was inaugurated in 2000, and is planned to be extended to a total length of 387 km. Shares many of the characteristics of Curitiba's system, but suffers from overcrowding and competition from traditional buses.

Quito, Ecuador: 37 km trolleybus BRT system launched in 1996. It has halved journey times.

For more go to <http://www.itdp.org/documents/brtplanningguidedec04.pdf>.

Case Study 13: Institutional Reform and Bus Rapid Transit ‘Lite’ in Lagos, Nigeria

Key Statistics

World Bank classification: Lower middle income

Population: 17.5 million

Population density: 2,000 / ha

Population growth rate: 6% pa.

GDP per capita: 1,118 US-\$ (2009, Nigeria)

Urbanization rate to 2050: 1.09

Transport data:

Car and motorcycle mode share for all trips: n/a

Cars per 1000 inhabitants: n/a

Background

Lagos, the sixth largest city in the world, is notable for the speed at which it has reformed transport governance, empowered agencies to develop and finance long-term transport plans for the region, consulted with multiple stakeholders and implemented a low-cost version of bus rapid transit (BRT) to deliver major benefits to transport users.

Until the late 1990s, Lagos was the only city of more than 10 million inhabitants to lack a regulated public

transport network, having instead a chaotic ‘system’ of 75 000 private minibuses touting for business on profitable corridors. Combined with ever-increasing private car-use, this threatened to undermine the city’s economic development.

The Lagos Urban Transport Project was established in 1999, leading to the creation of the Lagos Metropolitan Transport Authority (LAMATA) in 2002, which has rapidly acquired the capacity and powers to plan and manage the city’s road network and public transport. Bus Rapid Transit (BRT) and a rail-based mass transit system became early priorities as part of a package of reform measures, with the first public services on a pilot Bus Rapid Transit (BRT) ‘lite’ route beginning a mere fifteen months after it was proposed, costing 1.7 million US-\$ per km.⁴⁰

⁴⁰ This figure is not directly comparable to the costs of 0.2 million US-\$ for Curitiba due to the different dates of opening. Another possible but not retrievable factor might be, that this figure relates to route km instead of lane km.

Description of Strategy

The BRT Lite System

Full BRT systems have dedicated road space and other traffic priority measures, stops with pre-payment and interchange facilities, and level vehicle boarding.

The Lagos pilot scheme inaugurated in March 2008 shares some of these

BRT Lite infrastructure in Lagos, Nigeria.



Source: LAMATA.

characteristics, with 85% of the 19km route length being on dedicated lanes, mostly physically segregated from other traffic by kerbing. 26 stops are served by a fleet of 220 buses that carry up to 200,000 passengers a day on a mixture of stopping and express services.

Tickets are sold by staff at all stops, with access to basic waiting areas restricted to ticket holders. Unlike the South American systems, there are two fare zones along the route.

Institutional and Legal Reform

Cooperation between several players was required to ensure realisation of the BRT lite pilot scheme, not least regarding the metropolitan and state transport agencies. Capacity has been gained through South American BRT site visits made by members of the Lagos BRT steering group.

In 2006 LAMATA was granted powers to regulate transport services in the metropolitan area, as well as specifying financial and operational arrangements for new projects. Key to the success of the pilot BRT Lite route has been the public funding of new infrastructure, with use restricted to those operators prepared to purchase suitable (larger) vehicles and adhere to other regulations on service provision. Following extensive consultation, LAMATA introduced a regulation to maximise the efficiency of the BRT lite route by specifying that:

- Only licensed bus operators may use the BRT running lanes;
- Other bus operators may only use the service lanes,
- A total ban on goods traffic applies at peak times.

Interestingly, the 220 BRT lite vehicles have proven to be inadequate to meet demand. Non-franchised traditional bus operators operating on the service lanes thus continue to play a role in supplying sufficient overall capacity, with the co-benefits of offering consumer choice and appeasing the smaller vehicle operators and unions.

LAMATA has also embarked on a programme of education for bus owners and operators to understand their new role in an organised public transport system. It further incentivised drivers by bestowing the title 'pilot' on the best re-trained drivers. Thus a majority of stakeholders has been supportive of BRT lite from the start, crucial for political consensus to develop.

Results

Average journey time savings are 25 minutes, with average headways of 30 seconds in the peaks. The maximum peak time queuing times is 15 minutes and an estimated 10 000 passengers are being carried per hour in the peak direction.

BRT vehicles carry 37% of total public transport demand along the pilot scheme corridor.

Modal shift from other modes is estimated to be as follows:

- 93% from other public transport,
- 4% from private cars,
- 2% from taxis.

This finding is unsurprising given that BRT lite is quicker, cheaper and more comfortable than traditional buses, as well as offering a direct service into the central business district.

The Future

The Lagos Strategic Transport Master Plan outlines plans for:

- 7 new railway lines
- 10 new BRT routes
- 10 ferry routes

as part of a safe, affordable and attractive integrated transport system. Most are to be developed using a similar Public Private Partnership (PPP) delivery strategy, with publicly-funded infrastructure improvements and competitively tendered service provision.

Fact box: Other Lagos Urban Transport Project initiatives.

- Institutional capacity building
- Promotion of road safety
- Development of a bus regulation framework
- Promotion of non-motorised transport
- Development of cooperative paratransit services

Applicability

The Lagos experience of institutional reform and transport/land-use master-planning is not only transferable anywhere, given the political will, but is a prerequisite for moving away from the default position of ‘predict and provide’ for the car, neglect of non-motorised modes and public transport entirely in the hands of uncoordinated private operators. The low capital costs and overall cost-effectiveness of BRT lite is such that it is particularly appropriate for the poorest regions lacking the resources to construct full BRT systems. This however at least requires a sufficient institutional framework.

Recommendations

- Establish an independent transport authority and foster a culture of vertical and horizontal cooperation with other government departments and agencies, especially those that deal with spatial planning. Consult a variety of stakeholders with regard to new infrastructure and public transport services.
- Evaluate transport infrastructure proposals based on their cost-effectiveness, ability to improve the lives of as many people as possible and external costs, including CO₂ emissions, accidents, local air and noise pollution, and congestion.
- Coordinate land use planning with public transport provision by providing appropriate public transport capacity for future levels of demand, and clustering development around the stops of high capacity transit routes.
- If budgets are limited, investigate the use of BRT lite to deliver immediate cost-effective improvements. Schemes should provide the capacity required to match expected demand, which should be estimated before detailed design work commences. This is particularly important in rapidly expanding low-income megacities. Systems should be

designed such that future upgrades e.g. to full BRT or light rail, can be made at the lowest possible cost (future proofing).

- Involve the private sector by inviting it to bid to operate publicly specified routes under regulated conditions.

See also...

Pereira (see <http://www.gobrt.org/Pereira.html>, <http://www.megabus.gov.co/>)

Introduced in 2006. Consists of 3 main lines and feeder buses which serve on non-separated lanes.

Seoul (see http://www.mta.go.kr/english/brt/sh_brt.jsp)

Introduced in 2004. 4 different bus colours to 4 different route types in the city

Case Study 14: The Car-free Medina of Fes, Morocco

Key Statistics

World Bank classification: Lower middle income

Population: 1.0 million

Population density: n/a

GDP per capita: 2,811 US-\$ (2009, Morocco)

Transport data:

Car and motorcycle mode share for all trips: n/a

Cars per 1000 inhabitants: n/a

Background

Fes, the second largest city in Morocco, has been chosen for this study to demonstrate the importance of preserving existing car-free and heavily car-reduced areas. This is the primary alternative to opening up such areas to general traffic then subsequently (re-) introducing vehicle restrictions, by which time it is politically challenging to reverse habitual car-use.

Fes is home to two car-free medinas, one of which is the largest such area in the world. Indeed, cars have never been permitted in the streets of these medinas. The larger of the two areas is the old, walled district of Fes el Bali, which has the following key characteristics:

Size (ha)	Population (2002)	Number of businesses	Average density (persons/ha)	Access restrictions
300	156 000	10 539	520	Filtered permeability: no through routes for cars, limited access from periphery

The vast medina of Fes el Bali.



Source: Michele Harmon

Description of Strategy

The medina's urban design is typical of those found in North Africa, with street widths of no more than three metres serving to restrict motorised traffic, eventually narrowing to less than two metres. This **filtered permeability** prevents cars from passing through the medinas. Although motorised two wheelers can access these streets, their progress is hampered by large numbers of pedestrians present at all times of day. A dense mix of shops, markets and residential buildings characterises the area, with the largest markets located on a central square and numerous informal gathering places in and around the smaller squares at junctions. Goods are transported by donkey and hand carts.

A co-benefit of this dense *Street activity in Fes el Bali.*

development, together with numerous arcades and overhanging upper storeys, is the cooling effect of shade, vitally important in locations with extremely high midday temperatures. Notably Fes al Bali became a UNESCO World Heritage Site in 1981, such is its importance as the largest car-free medina still in



Source: carfree.com.

existence, safeguarding it from the threat of redevelopment.

Applicability

Other examples of dense, mixed communities built around narrow street layouts include the older districts in Chinese cities, where there is often pressure to sweep away 'slums' and build high-rise apartment blocks served by multi-lane highways. The principle holds that is more difficult to apply restrictions on motorised mobility after car-based travel patterns have become entrenched. Guangzhou demonstrates that an alternative strategy based on the preservation and enhancement of liveable neighbourhoods is one that works.

By excluding motorised vehicles, such areas offer a host of benefits, including better air quality, safe areas for children to play and a respite from traffic-dominated roads in the rest of the city. They are increasingly seen as tourist magnets, bringing further economic benefits above and beyond the savings in infrastructure costs and externalities.

Policy Recommendations

Preserve and enhance existing car-free and car-lite areas, especially in central areas where distances are short and accessibility is high. The incremental expansion of car-free zones, particularly those in city centre shopping areas, is acceptable to the public if done slowly over many years.

Mixed-use urban infill development should be given priority over low-density residential suburbs on the edge of town (see section 4.3 on land-use planning). Redevelopment plans should consider incorporating and enhancing car-free areas such as these at the master planning stage, in concert with the adoption of transferable best practice from Western Europe. Although there is no 'one size fits all' model of car-free development, the common aim is to reduce car ownership, the primary determinant of distance travelled by car: reductions in parking standards, and the spatial and fiscal separation of any parking that is provided, are ways in which this can be achieved.

To maximise efficacy, car parking restrictions are also required in surrounding areas. Controlled parking zones with metered parking and/or a limited supply of residents' parking permits ensure displacement effects are minimised.

See also...

Other historically car-free areas include the island of Büyükada, Istanbul, Turkey (5 km²), the medieval walled centre of Kotor, Montenegro (0.05 km²), the centre of Venice (6 km² car-free area) and the resort town of Zermatt, Switzerland (0.32 km² car-free area).

Modern car-reduced and car-free residential areas include Vauban in Freiburg, Germany (2,000 homes and 600 jobs), which is the largest parking-free development in Europe.

One of the largest *pedestrianisation projects* is that of Copenhagen, Denmark: over the course of almost 50 years, more and more of the city centre has been closed to private motorised traffic, including the 3.2 km long Strøget shopping street. See Wright (2005; p. 65) for a summary of the economic benefits of inner city pedestrianisation projects.

Masdar in the United Arab Emirates is the sole example of a *planned new car-free settlement* on a 6 km² site, 17 km from Abu Dhabi.

Case Study 15: Non-motorised Transport in Guangzhou, China

Key Statistics

World Bank classification: Lower middle income

Population: 10.3 million (metropolitan area)

Population density: 105 / ha

GDP per capita: 3,744 US-\$ (2009 data for China)

Transport data:

Car/motorcycle mode share for all trips: 44.4 % (1995 data)

Cars per 1000 inhabitants: 20.2 (1995 data)

Background

Guangzhou, a rapidly expanding city in the south of China, was awarded the 2011 Sustainable Transport Award (ITDP, 2011) for its achievement in implementing and integrating the first phase of a BRT network. The impressive level of integration with bicycle infrastructure and a bikesharing scheme is the subject of this best practice case study, together with the city's progress in creating and improving car-free public spaces.

Description of Strategy

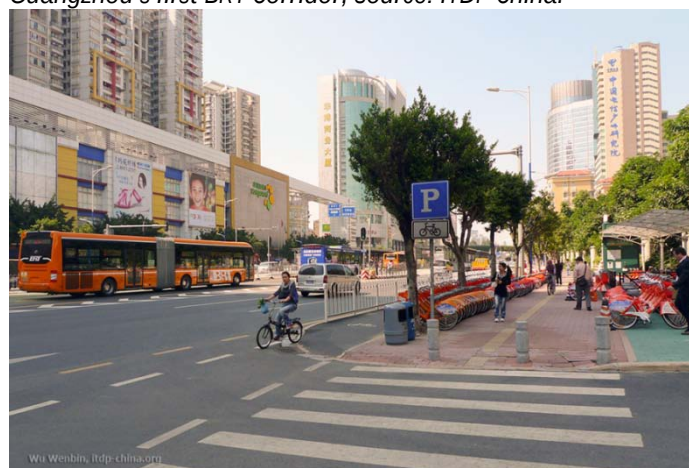
Bicycle infrastructure

Hundreds of kilometres of completely segregated 'greenways' were built in 2010, complementing a mixture of on- and off-road bicycle routes across the city. Segregated bike lanes have been provided along part of Guangzhou's first BRT route, opened in February 2010, which is 22.5 km long with 26 stations. These provide a safe route for all cyclists, facilitating fast, convenient access to the BRT stations, which are spaced at approximately 880 metre intervals.

Bikesharing

Bikesharing is essentially a pay-as-you-ride bicycle hire system, the first large-scale application of which was the Velib scheme in Paris, which was introduced with 7 000 bicycles in 2007. Bikes are hired from and returned to

Segregated bike lane and bikesharing station along Guangzhou's first BRT Corridor; Source: ITDP China.



docking stations located at regular intervals throughout a city, typically using smartcard or credit card technology to identify the user and collect payment.

Guangzhou's system was opened in June 2010 with 5 000 bikes at 113 docking stations, mostly along the route of the city's first BRT line. Capital costs of 28 million RMB (approximately 4.1 million US-\$ using the average exchange rate of 2009 and 2010) were met by the Government, as are the system's ongoing operating costs. Terminals are open 15 hours per day (three remain open all night), with the first hour of use provided free. Regular users can purchase an annual subscription, but short-term usage is also possible for visitors and other occasional users. Payment can be made with Guangzhou's public transport smartcard. A control centre monitors usage, bicycle damage and the distribution of bikes between docking stations. Real-time information is made available to the public via a website.

The system has been a success, with 26 000 registered users and an average of 3 hires per bike per day. A recent survey revealed that 50% of bike-sharing users previously made the same trip by a motorised mode, whilst 83% previously made the same trip by a mode other than the bicycle (Fjellström 2011). It has therefore reduced travel times for the third of users who previously walked, while also increasing physical activity rates and removing significant numbers of congestion-causing car journeys. The bike-sharing scheme also provides employment for 230 people.

Car-free public spaces and walking routes

A pedestrianised street in a residential area of Guangzhou.



Source: ITDP China.

A large number of public squares and traffic-free paths have been created around revitalised waterways in the city, serving the dual function of pleasant commuting routes for pedestrians and attractions for leisure walkers. Rejuvenated areas include the Lizhiwan

Canal and the Donghaochong Greenway, as well as several pedestrianised plazas and green spaces in local shopping precincts and residential neighbourhoods alike.

Other sustainable transport measures

Motorcycles are prohibited from using bicycle infrastructure through the use of physical barriers, such as bollards, and police patrols. Restrictions have increased since 2007, helping to reduce conflicts between cyclists and motorised two-wheelers.

Guangzhou's BRT route differs from many others in that direct services operate onto it from several parts of the city, reducing the need for feeder services and interchange stations. Since February 2010 it has recorded patronage figures of 800 000 passengers a day and 27 000 passengers per hour carried in a single direction. Journey times have been cut by 50–75% as a result of the dedicated infrastructure and ease of interchange with the metro (Fjellström 2011). A second BRT line is now in planning.

Applicability

Although the full package of Guangzhou's transport measures, including the large and expanding metro system, is unlikely to be affordable in other transition countries, the BRT and NMT infrastructure investments are replicable elsewhere. With the latter in place, any city could consider bike-sharing as a way to maximise door to door accessibility and offer an attractive on-demand alternative to the car for relatively short trips in the megacity.

Recommendations

Incorporate high quality NMT infrastructure in road and neighbourhood design, regardless of whether this is alongside a BRT corridor. Preserve and enhance existing car-free and heavily car-reduced areas. Pedestrianise local neighbourhood centres to encourage walking and offer social and recreational space for residents of all ages.

With the foundation of a safe and attractive network of cycle routes, consider introducing bike-sharing schemes across your city. Concentrate terminals at public transport interchanges and offer integrated ticketing, whether this is through smartcards or inter-available paper tickets.

See also:

Bike-sharing in Hangzhou, China: 50 000 bikes, with terminals located every 100 metres. See <http://www.publicbike.net/en/c/han.aspx>, accessed 08 April 2011.

Extensive European bike-sharing systems include those in:

- London (co-sponsored by a Bank; 5 000 bicycles, see <http://www.tfl.gov.uk/roadusers/cycling/14808.aspx>).
- Paris (co-funded through advertising; 20 000 bicycles; see <http://www.velib.paris.fr>).
- Barcelona (funded by the city through parking fees; see <http://www.bicing.cat/>).

Websites accessed on 08 April 2011.

Case Study 16: Cycle Rickshaw Modernisation in Delhi, India

Key Statistics

World Bank classification: Lower middle income
Population: 16.8 million (2008)
Population density: 113 / haGDP per capita: 757 USD (India; 2009 data based on 2000 constant USD)

Transport data (DIMTS, 2008a, 2008b):
Modal split (% of trips; 2008 data):
Car: 14% Motorcycle: 21%
Public transport: 47%
Bicycle: 7% Cycle rickshaw: 8%
Cars per 1000 inhabitants: 85 (2008 data)

Background

This case study discusses the importance of human-powered transport in Delhi and other parts of central southern Asia for urban sustainability and job creation in rapidly expanding and motorising cities. The challenge is particularly acute in the chronically congested city of Delhi, where the rapidly growing population is projected to reach 26 million by 2030 (DIMTS, 2008b).

Bicycle rickshaws are essentially three-wheeled bike taxis for 1–2 passengers or cargo. They are quiet, non-polluting and have low operating costs. Officially there are around 100,600 traditional cycle rickshaws in Delhi (DES, 2010).

In reality there are likely to be at least 500,000 in each of the megacities of Delhi and Dhaka, Bangladesh, providing direct employment for at least 1.25 million people apiece (Banister, 2007; ITDP, 2008). Rickshaws account for 50% of the total vehicle fleet in Dhaka, making 7 million trips per day and accounting for 70% of all trips in the city (Banister, 2007). Their existence provides low-cost public transport and employment for the poor, helping low-skilled migrant workers in particular to escape poverty (Begum and Sen, 2005).

The official statistics are underestimates on account of the many thousands of illegally operated (unregistered) rickshaws. The number of operating permits has been steadily reduced, as part of municipality efforts to clear road space for the growing number of

A bicycle rickshaw in Delhi. Note the lack of pavement for pedestrians.



Source: ITDP China.

private motorised vehicles (which remain a minority mode for the wealthy). In addition, rickshaws have been banned from the busiest city centre roads, a policy encouraged by the investment criteria of financial institutions such as the World Bank (BBC News, 2006; World Bank, undated).

NGOs and concerned citizens have mounted campaigns to postpone or reverse such restrictions, pending more detailed studies on their transport and wider economic impacts. As a result, rickshaw license quotas were declared unlawful in a landmark ruling by Delhi's High Court in 2010, while future bans on arterial roads in Dhaka will require the reallocation of space to public transport as well as “broad public support” (TheCityFix, 2010; World Bank, undated; World Carfree Network, 2005).

Bicycle rickshaws on the streets of Dhaka.



Source: ITDP China.

Rickshaw Revival

This section describes recent attempts to modernise rickshaws and hire systems, as well as the training of drivers to give better customer service and avoid creating congestion.

ITDP launched the Indian Cycle Rickshaw Modernisation Project in 2006. This comprised a research and development programme to reduce rickshaw weight and improve comfort, with consequent health and productivity benefits for operators. Over 300,000 of the improved vehicles now operate in nine Indian cities. In addition, patient transport vehicles designed and constructed in a similar initiative are currently in use in rural and urban areas alike (ITDP India, 2008).

ITDP has also promoted the use of bicycle rickshaws as feeders to Delhi's improving public transport system of metro and BRT lines, in a good example of the integration of non-motorised and mass transport. In order to reduce complaints about operators, ITDP set up a training programme to educate them about traffic laws, with the co-benefit of boosting safety for both drivers and passengers.



Source: ITDP China.

Delhi Integrated Multi-Modal Transit System (DIMTS) Limited is currently developing a project called 'GreenCAB', which will offer a 'dial-a-rickshaw' door to door and door to/from BRT station service. Local control centres take telephone bookings from the public and assign the nearest vehicle for each job, in much the same way as conventional taxi offices. Vehicles will be light and

comfortable for operators, who will also benefit from higher wages, and the service should be fully integrated into the public transport network (DIMTS, 2010). Upgrades to battery-assisted vehicles could follow.

Battery-assisted 'soleckshaws' have been trialled in Delhi: these have a range of 72 miles and a top speed of 20 km/h, helping operators to cover greater distances for less effort. Charging at solar-powered stations is required every 6–7 hours. A private company built the vehicles to a design produced by the public sector Centre for Scientific and Industrial Research. The latter was expected to offer low-interest loans to operators, thereby helping poor drivers to do business independently of the large operators that charge high rental rates (Treehugger, 2008).

4,000 battery-powered rickshaws were introduced by the Municipal Corporation of Delhi under a Public-Private Partnership deal, as part of a plan to replace traditional rickshaws and a smaller proportion of the noisy and highly polluting auto rickshaw fleet in popular tourist areas in advance of the 2010 Commonwealth Games. The private partner owns, operates and maintains the vehicles, which have a range of 95 km and a maximum speed of 25 km/h, and were deployed as feeders to/from metro stations. Drivers received higher salaries in exchange for attending customer care and English language training (The Times of India, 2010).

Applicability

Several other developing cities in southern Asia rely on cycle rickshaws: they are suitable for short trips in any city with favourable topography. Indeed, they are increasingly popular as

tourist transport in developed cities. The economic benefits of such a large industry are highly desirable in low-income countries, subject to employment laws protecting the exploitation of operators.

The vehicles are low-cost in absolute terms and relative to motorised alternatives – offering affordable transport for the low-earning majority of the population – and their use is emissions-free.

Other non-motorised transport initiatives in Delhi

- Bikesharing: a system with five bikesharing stations at stops on the BRT route in south Delhi was launched in 2009. Bikes can be borrowed for up to 4 hours. The idea is likely to be rolled out to other BRT routes, having been awarded “best NMT project” by the Institute of Urban Transport in 2010;
- NMT-friendly BRT corridors: segregated lanes for cyclists and cycle rickshaws have been built along BRT routes. Plentiful bike parking has been provided at several stops on the south Delhi BRT line;
- ‘Ciclovía’: some sections of BRT route in Delhi have been offered for the exclusive use of cyclists on Sunday mornings, facilitating leisure trips, cycle training for children and rallies to lobby for further NMT infrastructure improvements.

Sources: DIMTS (2009); The Times of India (2009).

Policy Recommendations

Suspend draconian restrictions on the use of bicycle rickshaws. Instead, consider a network of dedicated NMT routes in the central business district and along key radial corridors. Conversely, the use of private cars should be restricted through more stringent vehicle and driver licensing, the introduction of parking regulations and possible physical access restrictions in city centres. The latter should also apply to deliveries, helping to further improve safety and air quality if goods are trans-shipped to human-powered or electric vehicles for the last leg of their journey. Such measures are required at an early stage of motorisation in order to prevent the habitual car use that leads to calls for massive road building projects and is so difficult to undo retrospectively.

Modernise existing operations by supporting partnerships to introduce lightweight and comfortable electrically-assisted vehicles, which increase average speeds and deliver consequential benefits for the health and income of operators, increased attractiveness to passengers and reduced congestion. Consider synergies with plans to eliminate polluting auto rickshaws.

Provide road safety, congestion minimisation and customer service training for operators.

Governments and international institutions should maintain/expand the support given to low-income bicycle rickshaw operators, including financial assistance in the form of low-interest loans for operators to purchase their own vehicles. The use of the Clean Development Mechanism (CDM) or successor schemes to earn Certified Emissions Reductions for motorised trips avoided through the use of NMT should be examined. Transport investment in general should be policy-led, considering the full economic and environmental impacts of proposed interventions.

Investigate the potential and provide seed-funding for 'dial-a-rickshaw' services, increasing the potential of bicycle rickshaws to provide door to door and public transport feeder services.

See also:

'Eco-cabs' of Fazilka, India. The term refers to bookable vehicles through the 'dial-a-rickshaw' service. The scheme is being expanded into the Punjab and Haryana regions, where it is expected to benefit a total of 500 000 operators.

See <http://www.ecocabs.org> for more information.

5. Summary and policy recommendations

The subject of sustainability in transport offers a wide array of pressing questions. Demand for the transportation of goods and people is going to rise considerably in the foreseeable future due to population and economic growth. This also increases the impacts of transport in terms of emissions and other detrimental effects to people and the environment, including the achievement of the MDGs. Many of these effects are felt in cities and in urban areas in developing and emerging countries in particular. Nevertheless the recent and current experiences of agglomerations in the industrialized world with problems like air and noise pollution, congestion and health effects are either already prevalent in poorer countries or offer an impression for potential issues in the coming years. Thus, strategies are needed to promote sustainability in transport at the global level as well as on the national, regional and local scales.

Increasing wealth is accompanied by the growth of individual motorisation in the form of cars and motorcycles. This commonly causes sustainability problems in urban areas, because sustainable transportation systems are supposed to take economic, environmental and social aspects into account. To promote sustainability in urban transport, policy interventions and a long-term strategy (“good transport governance”) are required as transport causes negative externalities which need to be internalized by appropriate measures.

In general such a strategy should follow the comprehensive approach of avoid-shift-improve. This means that transport policy should (in this order) aim to reduce the need for transport and shorten trip distances, promote a shift to more sustainable modes and improve vehicle- and system-level efficiency through technological innovation and alternative fuels.

While further development of transport infrastructure and improved provision of transport services will still be necessary especially in developing and emerging countries, decarbonisation of transport is required to reduce GHG by 80% in developed countries and by 50% in developing countries until 2050.

One of the central messages of this study is to be aware of potential path dependencies a country or a city faces with respect to the dominant mode of transportation. This obviously could be problematic on a car-dependent path, while it would be beneficial to be on a path prioritising more sustainable modes. This is utterly important for transport policy in

developing and emerging cities: political decisions today have a long-lasting effect and should be taken with great care and foresight.

Capacities of national and local governments as well as of national and regional non-governmental institutions must be strengthened to fulfil their crucial role in achieving a more sustainable transportation policy. As political will and financial restrictions are limiting factors in implementing sustainable transport solutions in poorer countries, strong leadership is a key factor to achieve urban sustainability. Data and knowledge gaps with regard to viable alternatives to car-based planning must be filled as a prerequisite to policy-oriented financing reform based on sustainability objectives and cost-effectiveness. Thus, financial needs surely have to be addressed but it is as important to secure the effective and efficient use of available funds. Intensified cooperation between developed and developing countries can facilitate this knowledge transfer and capacity building.

Future urban planning and transport policies should seek to influence mobility patterns principally via land-use planning and packages of non-technological instruments. These again can either be push-measures, i.e. economic and regulatory instruments to make unsustainable modes less attractive, or pull-measures, i.e. instruments designed to make sustainable modes like public transport relatively more attractive in terms of price and service quality. The internalisation of external costs is required as part of the 'polluter pays' principle and is key to any strategy using price signals to influence travel behaviour.

Though heterogeneity is large even within the country groups chosen for this study, some general conclusions can be drawn for each group.

High income countries are in a good starting position to make transport in their cities more sustainable as the funding of measures is usually easiest for them. Overall, they should try to reduce and shift away from motorised individual transport. This can be done by channelling available funds towards more sustainability-oriented city development via existing planning facilities and procedures. Promising non-technological solutions include policy packages of economic instruments like fuel taxes, road charges or parking fees paired with pull-measures towards sustainable modes. Subsidies for fossil fuels and road-focussed strategies should be eliminated. When providing assistance to poorer countries, the high income countries do not necessarily have to supply additional funding. It would instead be helpful if these funds were made more contingent on sustainable use. Besides, very much could be gained by knowledge-transfer (especially in planning) and institution-building.

Upper and lower middle income countries are often at the beginning or already in the midst of accelerating motorisation. Due to financial restrictions they do not have the same variety of policy options as high income countries. Nevertheless they have shown that better land use planning (e.g. transit-oriented development in Latin American cities) is also possible with limited resources if political will and sufficient institutions are prevalent. Timely planning is important as car dependency tends to accelerate as soon as a certain income threshold is passed. Fuel taxation at the national level, city parking fees and pull-measures – especially attractive public transport systems – and new environmentally sound technologies (such as electro-mobility for 2- and 3-wheelers) can retard the growth in car ownership and use. Additionally, Public Private Partnerships can bridge financial restrictions for new infrastructure and services. They require good governance, a long-term strategy and a participatory approach in the planning, implementation and evaluation of measures.

Low income countries have the least options for developing sustainable transport systems due to financial restrictions and the lack of functioning institutions to implement the strategies required. However, they are in a good position to avoid car-oriented urban development altogether and to prevent a shift away from non-motorised modes in particular. Planning can play a crucial role here, preventing the adoption of car-based cities and lifestyles that are difficult to tackle once established. The potential of avoid-strategies is usually large in developing countries. Principally, if public transport is already in place, it should be kept, modernized and expanded. BRT systems can offer a relevant alternative as they are relatively cheap and if appropriately implemented also financially self-sufficient. Institution- and capacity-building is also required, while high income countries need to offer technical and continued financial support. Development aid and other funding from international institutions and developed countries should be made conditional on policy reform, requiring recipients to develop transport projects that support rather than hinder sustainability objectives. Policy-oriented financing is desirable for all country groups.

On a general note, an international agreement could support national reform efforts to remove subsidies on fossil fuels or to introduce fuel taxes.

The United Nations Committee on Sustainable Development (CSD) could play a facilitating role by developing a globally accepted definition and a set of commonly agreed criteria and indicators for sustainable transport and how it can be achieved. A greater focus on transport could be introduced by CSD at the forthcoming “Rio+20” global conference on sustainable development.

There is no single dominant instrument nor is there a single solution for all national and regional contexts. The complexity of urban transport policies calls for integrated and comprehensive programmes that take regional and even city-specific circumstances into account.

It has been shown in this study that not only the instruments are in place but that many of them have already been used successfully in developing and emerging countries. These cases can serve as examples for poor as well as for wealthy countries on how to make their urban transport systems more sustainable.

Sources

How to use the list of references:

- Owing to the large number of sources used, references are sorted according to the chapter.
- In chapter 4 the sources are additionally sorted according to the sections and – if applicable – subdivided between background and case study literature.
- The sources are listed as they appear within the chapters or sections, i.e. they might be mentioned several times in the whole bibliography.

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Appendix

High income OECD economies

Australia	Hungary	Poland
Austria	Iceland	Portugal
Belgium	Ireland	Slovak Republic
Canada	Israel	Slovenia
Czech Republic	Italy	Spain
Denmark	Japan	Sweden
Estonia	Korea, Rep.	Switzerland
Finland	Luxembourg	United Kingdom
France	Netherlands	United States
Germany	New Zealand	
Greece	Norway	

High income non OECD economies

Andorra	French Polynesia	New Caledonia
Aruba	Gibraltar	Northern Mariana Islands
Bahamas, The	Greenland	Oman
Bahrain	Guam	Puerto Rico
Barbados	Hong Kong SAR, China	Qatar
Bermuda	Isle of Man	San Marino
Brunei Darussalam	Kuwait	Saudi Arabia
Cayman Islands	Latvia	Singapore
Channel Islands	Liechtenstein	Trinidad and Tobago
Croatia	Macao SAR, China	Turks and Caicos Islands
Cyprus	Malta	United Arab Emirates
Equatorial Guinea	Monaco	Virgin Islands (U.S.)
Faeroe Islands	Netherlands Antilles	

Upper-middle-income economies (\$3,946 to \$12,195)

Albania	Fiji	Panama
Algeria	Gabon	Peru
American Samoa	Grenada	Romania
Antigua and Barbuda	Iran, Islamic Rep.	Russian Federation
Argentina	Jamaica	Serbia
Azerbaijan	Kazakhstan	Seychelles
Belarus	Lebanon	South Africa
Bosnia and Herzegovina	Libya	St. Kitts and Nevis
Botswana	Lithuania	St. Lucia
Brazil	Macedonia, FYR	St. Vincent and the Grenadines
Bulgaria	Malaysia	Suriname
Chile	Mauritius	Turkey
Colombia	Mayotte	Uruguay
Costa Rica	Mexico	Venezuela, RB
Cuba	Montenegro	
Dominica	Namibia	
Dominican Republic	Palau	

Lower-middle-income economies (\$996 to \$3,945)

Angola	Indonesia	São Tomé and Príncipe
Armenia	Iraq	Senegal
Belize	Jordan	Sri Lanka
Bhutan	Kiribati	Sudan
Bolivia	Kosovo	Swaziland
Cameroon	Lesotho	Syrian Arab Republic
Cape Verde	Maldives	Thailand
China	Marshall Islands	Timor-Leste
Congo, Rep.	Micronesia, Fed. Sts.	Tonga
Côte d'Ivoire	Moldova	Tunisia
Djibouti	Mongolia	Turkmenistan
Ecuador	Morocco	Tuvalu
Egypt, Arab Rep.	Nicaragua	Ukraine
El Salvador	Nigeria	Uzbekistan
Georgia	Pakistan	Vanuatu
Guatemala	Papua New Guinea	Vietnam
Guyana	Paraguay	West Bank and Gaza
Honduras	Philippines	Yemen, Rep.
India	Samoa	

Low-income economies (\$995 or less)

Afghanistan	Guinea	Nepal
Bangladesh	Guinea-Bissau	Niger
Benin	Haiti	Rwanda
Burkina Faso	Kenya	Sierra Leone
Burundi	Korea, Dem. Rep.	Solomon Islands
Cambodia	Kyrgyz Republic	Somalia
Central African Republic	Lao PDR	Tajikistan
Chad	Liberia	Tanzania
Comoros	Madagascar	Togo
Congo, Dem. Rep.	Malawi	Uganda
Eritrea	Mali	Zambia
Ethiopia	Mauritania	Zimbabwe
Gambia, The	Mozambique	
Ghana	Myanmar	

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