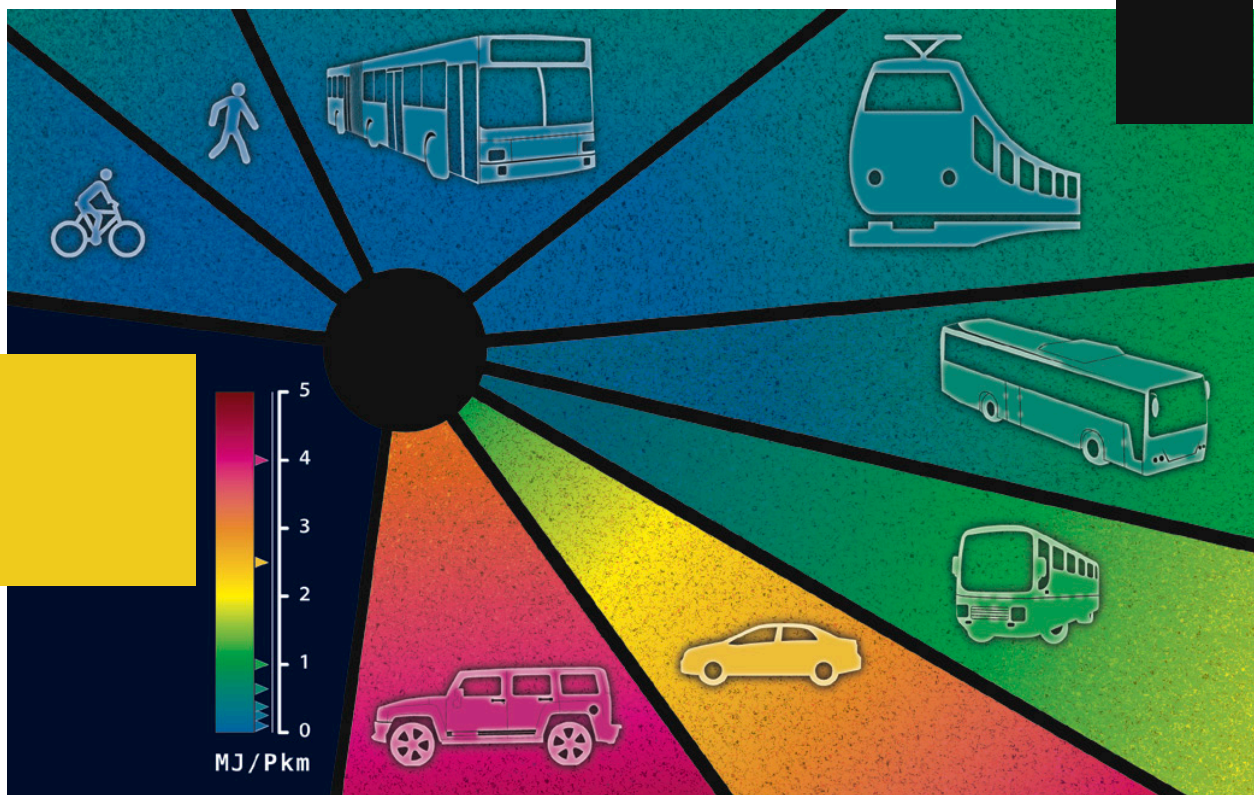
BMZ Federal Ministry for Economic Cooperation and Development

Urban Transport and Energy Efficiency

Module 5h

Sustainable Transport:
A Sourcebook for Policy-makers in Developing Cities



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OVERVIEW OF THE SOURCEBOOK

Sustainable Transport:
A Sourcebook for Policy-Makers in Developing Cities

What is the Sourcebook?

This *Sourcebook* on Sustainable Urban Transport addresses the key areas of a sustainable transport policy framework for a developing city. The *Sourcebook* consists of 31 modules mentioned on the following pages. It is also complemented by a series of training documents and other material available from http://www.sutp.org (and http://www.sutp.cn for Chinese users).

Who is it for?

The *Sourcebook* is intended for policy-makers in developing cities, and their advisors. This target audience is reflected in the content, which provides policy tools appropriate for application in a range of developing cities. The academic sector (*e.g.* universities) has also benefited from this material.

How is it supposed to be used?

The *Sourcebook* can be used in a number of ways. If printed, it should be kept in one location, and the different modules provided to officials involved in urban transport. The *Sourcebook* can be easily adapted to fit a formal short course training event, or can serve as a guide for developing a curriculum or other training program in the area of urban transport. GIZ has and is still further elaborating training packages for selected modules, all available since October 2004 from http://www.sutp.org or http://www.sutp.cn.

What are some of the key features?

The key features of the *Sourcebook* include:

- A practical orientation, focusing on best practices in planning and regulation and, where possible, successful experiences in developing cities.
- Contributors are leading experts in their fields.
- An attractive and easy-to-read, colour layout.
- Non-technical language (to the extent possible), with technical terms explained.
- Updates via the Internet.

How do I get a copy?

Electronic versions (pdf) of the modules are available at http://www.sutp.org or http://www.sutp.cn. Due to the updating of all modules print versions of the English language edition are no longer available. A print version of the first 20 modules in Chinese language is sold throughout China by Communication Press and a compilation of selected modules is being sold by McMillan, India, in South Asia. Any questions regarding the use of the modules can be directed to sutp@sutp.org or transport@giz.de.

Comments or feedback?

We would welcome any of your comments or suggestions, on any aspect of the *Sourcebook*, by e-mail to sutp@sutp.org and transport@giz.de, or by surface mail to:

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Further modules and resources

Additional resources are being developed, and Urban Transport Photo CD-ROMs and DVD are available (some photos have been uploaded in http://www.sutp.org – photo section). You will also find relevant links, bibliographical references and more than 400 documents and presentations under http://www.sutp.org, (http://www.sutp.cn for Chinese users).

Modules and contributors

(i) *Sourcebook Overview and Cross-cutting Issues of Urban Transport* (GTZ)

Institutional and policy orientation

1a. *The Role of Transport in Urban Development Policy* (Enrique Peñalosa)

1b. *Urban Transport Institutions* (Richard Meakin)

1c. *Private Sector Participation in Urban Transport Infrastructure Provision* (Christopher Zegras, MIT)

1d. *Economic Instruments* (Manfred Breithaupt, GTZ)

1e. *Raising Public Awareness about Sustainable Urban Transport* (Karl Fjellstrom, Carlos F. Pardo, GTZ)

1f. *Financing Sustainable Urban Transport* (Ko Sakamoto, TRL)

1g. *Urban Freight in Developing Cities* (Bernhard O. Herzog)

Land use planning and demand management

2a. *Land Use Planning and Urban Transport* (Rudolf Petersen, Wuppertal Institute)

2b. *Mobility Management* (Todd Litman, VTPI)

2c. *Parking Management: A Contribution Towards Liveable Cities* (Tom Rye)

Transit, walking and cycling

3a. *Mass Transit Options* (Lloyd Wright, ITDP; Karl Fjellstrom, GTZ)

3b. *Bus Rapid Transit* (Lloyd Wright, ITDP)

3c. *Bus Regulation & Planning* (Richard Meakin)

3d. *Preserving and Expanding the Role of Non-motorised Transport* (Walter Hook, ITDP)

3e. *Car-Free Development* (Lloyd Wright, ITDP)

Vehicles and fuels

4a. *Cleaner Fuels and Vehicle Technologies* (Michael Walsh; Reinhard Kolke, Umweltbundesamt – UBA)

4b. *Inspection & Maintenance and Roadworthiness* (Reinhard Kolke, UBA)

4c. *Two- and Three-Wheelers* (Jitendra Shah, World Bank; N.V. Iyer, Bajaj Auto)

4d. *Natural Gas Vehicles* (MVV InnoTec)

4e. *Intelligent Transport Systems* (Phil Sayeg, TRA; Phil Charles, University of Queensland)

4f. *EcoDriving* (VTL; Manfred Breithaupt, Oliver Eberz, GTZ)

Environmental and health impacts

5a. *Air Quality Management* (Dietrich Schwela, World Health Organization)

5b. *Urban Road Safety* (Jacqueline Lacroix, DVR; David Silcock, GRSP)

5c. *Noise and its Abatement* (Civic Exchange Hong Kong; GTZ; UBA)

5d. *The CDM in the Transport Sector* (Jürg M. Grütter)

5e. *Transport and Climate Change* (Holger Dalkmann; Charlotte Brannigan, C4S)

5f. *Adapting Urban Transport to Climate Change* (Urda Eichhorst, Wuppertal Institute)

5g. *Urban Transport and Health* (Carlos Dora, Jamie Hosking, Pierpaolo Mudu, Elaine Ruth Fletcher)

5h. *Urban Transport and Energy Efficiency* (Susanne Böhler, Hanna Hüging)

Resources

6. *Resources for Policy-makers* (GTZ)

Social and cross-cutting issues on urban transport

7a. *Gender and Urban Transport: Smart and Affordable* (Mika Kunieda; Aimée Gauthier)

About the authors

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Module 5h

Urban Transport and Energy Efficiency

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CONTENTS

Energy efficiency: more with less!

Developing countries and emerging economies are experiencing a rapid increase in demand for transport energy. High rates of population growth and urbanisation are causing transport needs to expand, and the emerging middle class aspires to the use of private motor vehicles, which means fuel consumption is also escalating. It is therefore no longer a luxury but a necessity to establish an efficient transport system that meets demand, but consumes as little energy as possible. This is important as the fast and safe transportation of people and goods is a prerequisite for economic growth. Considering the challenges of climate change, limited oil resources, increasing energy prices, environmental pollution and health risks, it is essential that we take the right path in order to cope with the rapidly growing demand for transport.

Decision makers in developing cities face the challenge of establishing sustainable urban transport systems. The pursuit of energy efficiency is a huge opportunity for achieving this goal. Not only do energy efficiency measures reduce fuel consumption, they also help us tackle other transport-related problems. Organising and operating urban transport efficiently reduces costs (for energy), and also lowers congestion, noise emissions, local air pollution, accident risks and global greenhouse gas emissions, while securing economic growth.

Figure 1: Vehicle emissions in Bangkok, Thailand.
Source: GIZ Photo Album, 2004

Figure 2: SBS Transit, public transport in Singapore.
Source: Carlos Pardo, 2008

This GIZ *Sourcebook Module* looks at measures and instruments for increasing energy efficiency in urban transport. Improving energy efficiency means using less energy to provide the same service or level of activity, or it means getting more of a service for the same energy input. A relative reduction in energy consumption may be associated with technological changes, but it can also be achieved through better organisation and management, and through behavioural changes.

The *Sourcebook Module* provides a comprehensive overview of activities with which key local and national actors can prompt the transition to energy-efficient urban transport systems.

Box 1: Important terms

Primary energy is energy captured in natural resources like crude oil, hard coal or natural gas before they have been refined. As well as fossil fuels, primary energy carriers can also be renewable energy sources. Renewable energy can be obtained from the sun, either directly (solar) or indirectly (*e.g.* wind and biomass), and it can include gravitational or geothermal energy.

Secondary energy results from the transformation of primary energy. Petrol products are secondary energy carriers resulting from the transformation of crude oil (primary energy).

Crude oil is the most important oil from which petroleum products are manufactured.

Petroleum is a complex mixture of hydrocarbons (chemical compounds containing hydrogen and carbon) occurring as a fossil fuel in underground reservoirs. The term is often interchanged with the word 'oil'. The term petroleum can refer to both primary (unrefined) and secondary (refined) products.

Final energy consumption means the energy supplied to the end consumers for all energy uses. The energy carriers are consumed for the energy service intended (in our case, transportation) and not transformed into other forms of energy for sale.

The **rebound effect** describes a situation in which actions that increase efficiency and reduce consumer costs lead to increased energy consumption when, for example, more frequent use is made of an efficient vehicle.

Source: OECD/IEA/Eurostat, 2005

How to use this Sourcebook Module?

This publication provides a comprehensive overview of measures, approaches and policies designed to promote greater energy efficiency in transport. Its focus is at the local level, where it helps decision makers and stakeholders to navigate the challenges they face. Every intervention has to be adapted to local circumstances, so the Sourcebook cannot address all those challenges and barriers in detail.

Many different interest groups can influence a transport system and its efficiency through their activities, opinions and decisions. This document looks at the development of a transport system from the point of view of the stakeholders, focusing on the authorities, organisations and other institutions that actively shape urban transport systems and affect their efficiency. It does not address the individual users.

Of the various different actors who shape urban transport systems, this *Sourcebook Module* focuses on three main groups:

1. Local authorities;
2. Local companies and non-governmental organisations;
3. National authorities which set the framework for local transport.

To give its overview of the various options for increasing energy efficiency, the *Sourcebook Module* assigns the energy efficiency measures and policies to the relevant key actors. It answers the question: '*Who can contribute to energy-efficient urban transport, and in what ways?*' and it refers to other, more detailed modules of GIZ's Sourcebook for decision makers in developing cities. Case studies are used to demonstrate energy efficiency activities in cities around the world.

The main sections of this module

- ***Section 1*** describes current trends in energy consumption and the consequences of these. This section is intended as a starting point to justify and support energy efficiency measures.
- ***Section 2*** explains the different strategic levels at which energy efficiency can be influenced (*i.e.* system, travel and vehicle efficiency), and it introduces the 'Avoid – Shift – Improve' approach.
- ***Section 3*** describes options through which each of the actors identified can help to increase the energy efficiency of urban transport systems.
- ***Section 4*** explains the need to use packages of different policies and measures, and it provides a step-by-step approach towards achieving an energy-efficient transport system.
- ***Section 5*** outlines the barriers currently impeding the implementation of energy efficiency measures and hampering the development of sustainable transport systems.

1 Transport – its contribution to global energy demand

Global energy demand has increased significantly in recent decades. Between 1973 and 2007, global primary energy demand doubled (IEA 2009a). Even more energy will be consumed in the future unless energy efficiency measures are taken.

The World Energy Outlook (WEO), published each year by the IEA (2009c, 2010), provides an insight into possible future trends in energy supply and demand. In their *Reference Scenario* (WEO 2009), which will be cited throughout this section, the IEA describes how global energy markets will evolve if governments make no changes to their existing policies and if the trends in energy demand and supply continue. The *Reference Scenario* should not be seen as a forecast, as it does not include possible or likely future policy initiatives. Rather, it takes into account only those initiatives that were already adopted by mid 2009 (IEA 2009c).

Average annual worldwide primary energy demand is projected to increase by 1.5 % by 2030. This would lead to an overall increase in energy demand of 40 % between 2007 and 2030 (Figure 3). Fossil fuels will remain the primary source of energy worldwide, while the share of renewables will only increase slowly.

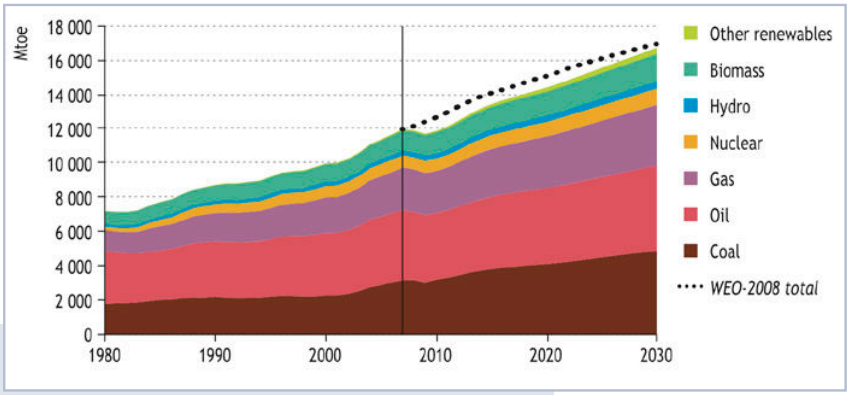

Figure 3: World primary energy demand by fuel in the IEA's Reference Scenario.

The growth in energy demand will vary regionally. Over 90 % of the projected increase will come from non-OECD[1] countries. They will experience an annual increase in primary energy demand of 2.4 %, whereas the OECD countries are expected to have an annual growth of 0.2 %. The highest growth rates are projected for China, India, and the Middle East (IEA 2009c). Despite the higher

[1] OECD (Organisation for Economic Co-operation and Development) is an international economic organisation of 33 countries. Most member states have a high per capita income and are regarded as developed countries. The term non-OECD country is often used to summarize less developed nations. However, it should be noted that the level of development varies significantly within both categories.

annual increase in the demand for energy of non-OECD countries, their per-capita consumption will remain much lower than in the rest of the world.

The different sectors of end use (transport, industry, households, services, agriculture and non-energy uses) will drive the growth in demand in different ways, but transport will remain the single largest final energy consuming sector (Figure 4) (IEA 2009c).

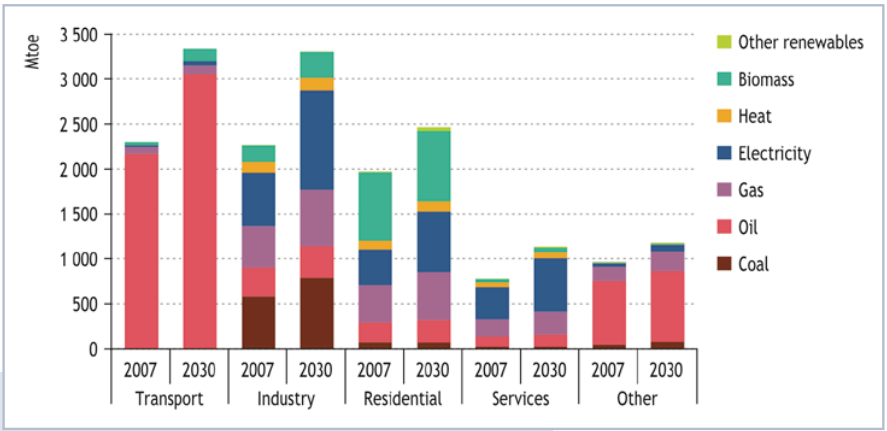

Figure 4: World final energy consumption by fuel and sector in the IEA's Reference Scenario.
©IEA/OECD 2009 – World Energy Outlook 2009

Road transport consumes approximately 70 % of the energy used in the global transport system. Road passenger transport alone accounts for 50 % of this energy consumption. There is close correlation between income levels and passenger light-duty vehicle (LDV) ownership, although a specific per capita income does not always result in the same ownership rate. Today, the LDV ownership rate in the USA is higher than 700 per 1 000 people, while the highly industrialised countries of Europe have around 500 vehicles per 1 000. By contrast, in emerging countries like China and India the ownership rate is well below 100 per 1 000 people. At present, as well as non-motorised vehicles, two- and three-wheelers are a primary mode of transport in India and China. The IEA's Reference Scenario assumes that the global fleet of passenger LDVs will double from 770 million in 2007 to 1.4 billion in 2030 (IEA 2009b).

Figure 5:
Most urban trips are still made on foot: a crowded street in Bangkok, Thailand.
Source: Armin Wagner, 2006

The global transport energy use has grown steadily in recent decades. From 1971 to 2006, energy consumption in the transport sector rose by between 2.0 and 2.5 % annually. The road transport sector uses the most energy, followed by aviation. Whereas in industrialised countries energy consumption has now stabilised at a high or slightly declining level, the growth rate of transport energy consumption in non-OECD countries between 2000 and 2006 was 4.3 %, and that rate will continue to grow (IEA 2009b).

Today, there are huge regional differences in transport energy consumption. The USA, Canada, Australia and Saudi Arabia are among the countries with the highest energy use per capita (see Figure 6). In comparison, India and neighbouring countries as well as some parts of Africa use about 20 times less transport energy per capita (IEA 2009b).

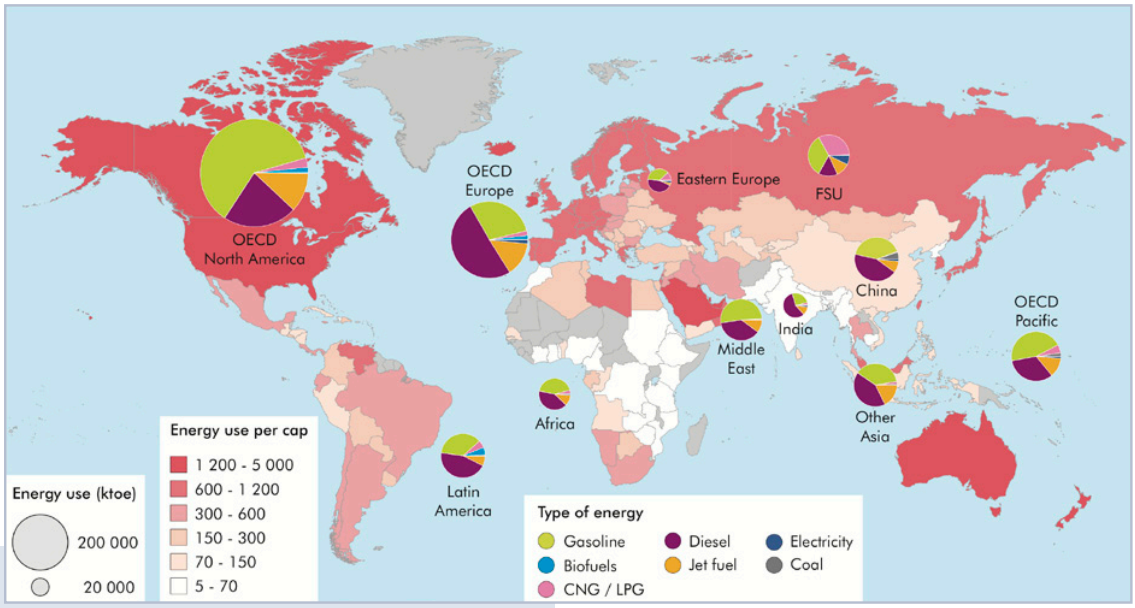

Figure 6: Transport sector energy use per capita 2006.
©IEA/OECD 2009 – Transport, Energy and CO_2

Fuels produced from oil make up by far the largest share of final energy consumption in the transport sector. In Europe, Latin America and India, diesel is the main fuel used in transport, while in North America, the Middle East and the OECD countries of the Pacific region, gasoline predominates. In the former Soviet Union, compressed natural gas (CNG) and liquefied petroleum gas (LPG) make up a relatively large share of transport fuels. Only a small proportion of the energy used derives from natural gas, electricity or biomass. Even though the share of renewable fuels is projected to increase, oil-based fuels will continue to dominate transport energy use with a share of more than 90 %. This will lead to an increase in oil consumption. The IEA *Reference Scenario* projects a growth of 25 % in the demand for oil from 2008 to 2030 (IEA 2009b). However, future developments in this demand vary a great deal from region to region (Figure 8). Transport is expected to account for 97 % of the overall increase in

Figure 7: Gas station in Bangkok, Thailand.
Source: Armin Wagner, 2006

global primary oil demand (Kojima and Ryan 2010), and will therefore be the main driver of that demand.

Energy-efficient transport offers huge potential for reducing the demand both for oil and for energy in general. The IEA estimates that advanced technologies and alternative fuels (*e.g.* hybrid vehicles, electric vehicles and fuel-cell vehicles) can reduce the energy intensity of transport by 20 to 40 % by 2050, compared to its own *Reference Scenario*. Such achievements could also halve the need for fossil fuels. However, even if the energy intensity is reduced total energy demand is still likely to rise above current levels due to the overall increase in demand for transport and motorisation. To cut future demand from the current levels, it is necessary not only that we shift to more efficient modes of transport, but also that we reduce the overall per capita demand for travel.

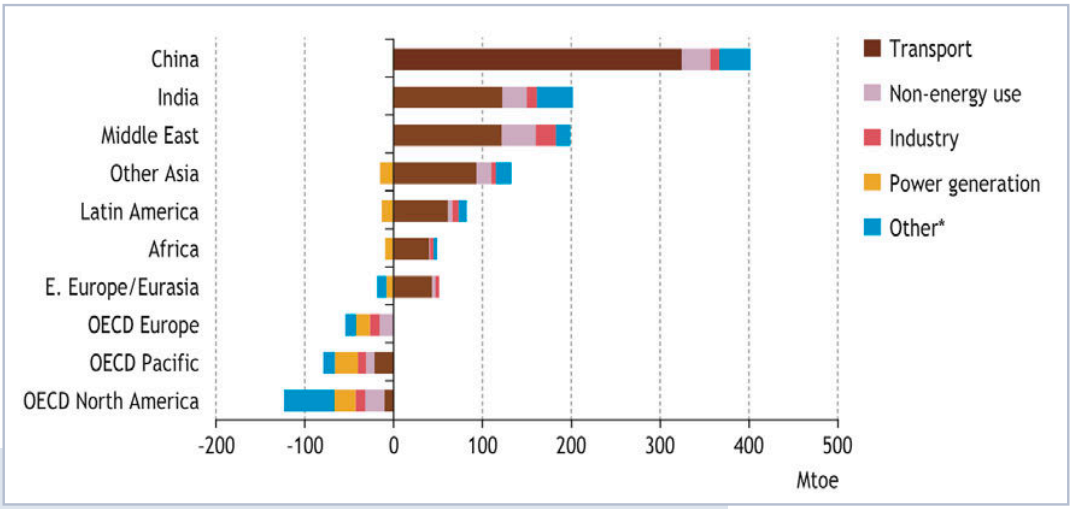

Figure 8: Projected change in primary oil demand by region and sector (2007–2030).
©IEA/OECD 2009 – World Energy Outlook 2009

Box 2: The challenge of rising oil dependency and peak oil

The IEA's *Reference Scenario* projects an annual one per cent increase in oil demand until 2030. This means that oil consumption will increase from 85.2 million barrels per day (mb/d) to 105.2 mb/d (IEA 2009c). That growth results mainly from the rise in demand in developing and emerging countries. With rising consumption, many countries are becoming much more reliant on oil imports. Today, India already depends on foreign suppliers for 70 % of its oil. In 2008, China's oil imports exceeded domestic production for the first time (IEA 2009c).

Since most countries continue to rely on oil as a major source of energy in transport and other sectors, energy security is becoming a major issue around the world. Energy security is not only influenced by the level of imports, but also by the vulnerability of supplies to disruption, the diversity of the fuel mix, and the degree of concentration of market power.

Energy security is threatened by disruptions to the oil supply. Supply routes are often vulnerable to political unrest, piracy, terrorist attacks or accidents. Moreover, oil extraction can be hindered by natural hazards. In recent years, hurricanes in the Gulf of Mexico have reduced the oil supply and prompted rising international prices. In 2010, the Deepwater Horizon oil spill not only resulted in supply disruptions and increasing prices, but also extensive environmental damage.

Another major threat to energy security is the decline of suitable oil reserves. 'Peak oil' refers to the moment when worldwide oil extraction reaches its maximum, after which it must decline. It is difficult to predict that moment because uncertainties remain about the available resources and reserves. Estimates for peak oil are very different, ranging from right now, to 2050. The International Energy Agency suggests that conventional production[1] peaked in 2006 (IEA 2009c). Due to the concentration of market power in the hands of just a few actors, pricing and production policies will become major issues for oil importing countries. The rising demand for oil coupled with a decline in supply could result in tremendous fuel price hikes. Their dependency on oil might hinder the economic development of oil importing countries.

Figure 9: Historic oil extraction in Bahrain.
Source: GIZ Photo Collection, 2010

[1] Conventional production includes crude oil and natural gas liquids (NGL). Unconventional oil includes oil sands, oil shale, coal-/biomass-based liquid supplies and liquids produced from chemical processing of natural gas.

2 Increasing energy efficiency in the transport sector

Energy-efficient transportation needs to be encouraged on three different levels. There is potential to achiever greater energy efficiency for individual vehicles (***vehicle efficiency***) and trips (***travel efficiency***), as well as the whole transport system (***system efficiency***).

Corresponding to these three levels of energy efficiency in transport, three basic strategies exist to improve energy efficiency:

- Avoiding increased transport activity and reducing the current demand for transport;
- Shifting demand to more efficient modes of transport;
- Improving the vehicles and fuels used.

The GIZ summarised these principles in the Avoid–Shift–Improve (ASI) Approach, which provides a holistic framework for strategic action to encourage a sustainable transport system.

Each strategy addresses a different level of energy efficiency: avoiding/reducing the demand for transport improves system efficiency; shifting demand increases travel efficiency; and improving vehicles and fuels will increase vehicle efficiency.

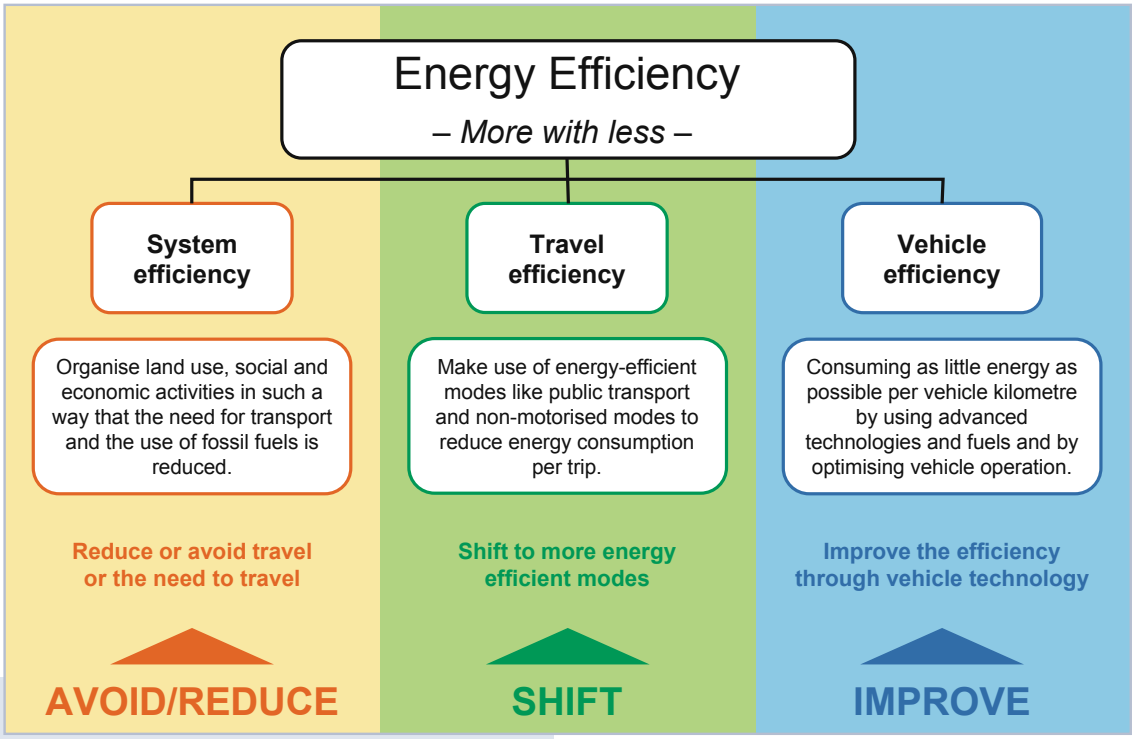

Figure 10: The energy efficiency system.

As Figure 10 shows, overall energy efficiency of the urban transport system results from the performance on all three levels:

$$E_{\text{urban transport}} = \text{vehicle efficiency} \times \text{travel efficiency} \times \text{system efficiency}$$

(adapted from Kojima and Ryan 2010)

In the following sections, each of the three levels is described in more detail and the corresponding strategy explained. Case studies from around the world are also provided, showing examples of how energy efficiency has been successfully increased. These are sections are followed by an outline of indicators that can be used for measuring energy efficiency performance. The chapter ends with a presentation of some of the co-benefits associated with enhanced efficiency.

2.1 System efficiency – the avoid/reduce strategy

System efficiency relates to how the demand for transport (and the different modes of transport) is generated. Research has shown that infrastructure and city structures influence transport demand. Energy consumption per capita rises proportionally as city density falls (see for example Newmann and Kenworthy 1989). The reduction of traffic volume is a crucial aspect of energy-efficient transport. Land-use planning should therefore optimise the positioning of settlement and production structures to avoid traffic or to reduce travel distances. A dense urban structure with mixed uses is essential for high system efficiency, because it involves shorter travel distances and a modal shift from road transport (which consumes an enormous amount of space) to more efficient transport modes such as walking, cycling and public transport. The prerequisites for system efficiency do not

Box 3: Induced travel

Induced travel describes a situation in which the amount of travelling done increases as a result of improved travel conditions, such as a reduction in journey times. If additional roads are built to avoid congestion, or if traffic management is improved, people's ideas about travelling alter and their patterns of movement may change. They might travel further or more often, or they might change their mode of travel. Over time, it might even become acceptable to travel greater distances between home and work, which means the rate of vehicle ownership can rise.

Because of the phenomenon of induced travel, investments in infrastructure can lead to greater overall travel demand. Expanding the capacity of roads or building new roads are popular ways to avoid congestion. However, experience has shown that such infrastructure investments do not necessarily reduce the long-term level of congestion. It has been observed that 30–80 % of the increased capacity is filled by rising demand within five years. This additional traffic consists partly of vehicles that were not on the road before, and partly of vehicles that use the new highway because it is faster than other options. Induced travel drastically reduces the success of infrastructure expansion.

Local planning authorities should be aware that increased transport choices and improved conditions cause demand to rise and can even influence the spatial development of the urban area. Therefore, it is necessary to compare different planning options and to include the possible occurrence of induced travel when forecasting travel demand, as this will allow a realistic economic and environmental evaluation of infrastructure projects.

All strategies may have adverse side effects (*e.g.* fuel consumption is higher on congested roads). Decision-makers have to evaluate the long-term effects carefully to choose the best alternative.

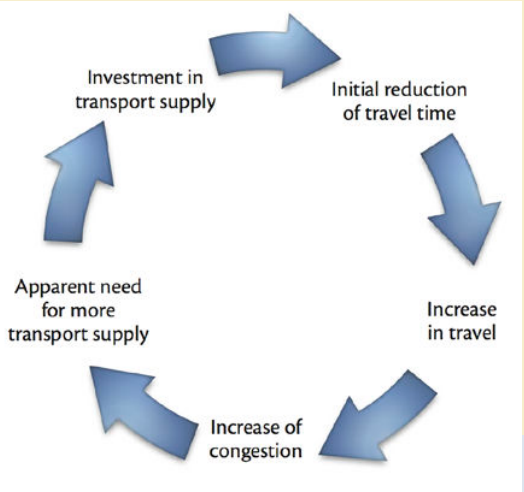

Figure 11: The vicious cycle of induced travel.
Source: VTPI 2010; Gorham 2009

only include a dense city system, but also proper management of the demand for transport and an adequate public transport network.

***Avoid** travel or reduce the need to travel, to increase system efficiency!*

Freight transport also benefits from dense city structures with short distances. Combining residential and commercial areas reduces the transportation of private goods. The challenge, however, is to ensure there is sufficient space and high-quality infrastructure for modern industry. One possible solution is to locate a dense, suburban industrial area close to a freight consolidation centre. This would make it possible to consolidate cargo from/to similar sources/destinations. Outgoing and incoming freight is therefore organised and freight transport efficiency can be improved. Moreover, the bundling of deliveries to the city centre minimises pollution and noise. Further information on consolidation centres can be found in the SUTP *Sourcebook Module* 1g: Urban Freight in Developing Cities.

Case Study 1

Towards greater system efficiency – Eco-density charter in Vancouver

In 2008, the city council of Vancouver adopted an Eco-density Charter, which commits the city to strive for environmental sustainability in all planning decisions. Greater density will be created especially in low-density areas and along transit routes. Areas of mixed usage are to be developed, where shopping, employment and public amenities are within walking distance of each other. The aim is to create high-density areas that are attractive, more energy-efficient and have a low ecological footprint.

Source and further information: City of Vancouver 2008
http://vancouver.ca/commsvcs/ecocity/pdf/ecodensity-charter-low.pdf

2.2 Travel efficiency – the shift strategy

Travel efficiency relates to the energy consumption of different modes of transport. The main parameters of travel efficiency are the relative preponderance of the different transport modes (modal split) and the load factor of the vehicles. Specific energy consumption per passenger-kilometre or per tonne-kilometre varies between different modes of transport (Figure 12). An effective way of enhancing energy efficiency is to encourage travellers or shippers to use more efficient forms of transport, such as public transport and non-motorised vehicles.

***Shift** to more energy-efficient modes!*

In general, private motorised modes of transport are much less energy-efficient than public transport. Other important alternatives include non-motorised forms of transport that do not need any fuel at all. Per capita energy consumption depends to a great extent on the occupancy rate of the vehicles used.

Travel using private motorised transport needs to be reduced, while the share of non-motorised and public transport must be increased. Especially in urban areas, most journeys involve distances of below five kilometres. A variety of measures can be implemented to encourage citizens to travel such distances by bike or on foot, thus avoiding unnecessary fuel consumption. For longer journeys, public transport provides an alternative to the automobile. Increasing the share of public transport will lead to higher rates of occupancy in buses and trains, which will further increase their energy efficiency.

Besides passenger transport, energy efficiency also needs to be increased in freight transport. Rail freight is particularly energy efficient because of the high load factor; its flexibility is, of course, limited. A sophisticated logistics network, including multimodal logistics centres (rail/road or port/road) can help to shift freight to more efficient modes of transport (see Sourcebook, Module 1g: Urban Freight in Developing Cities).

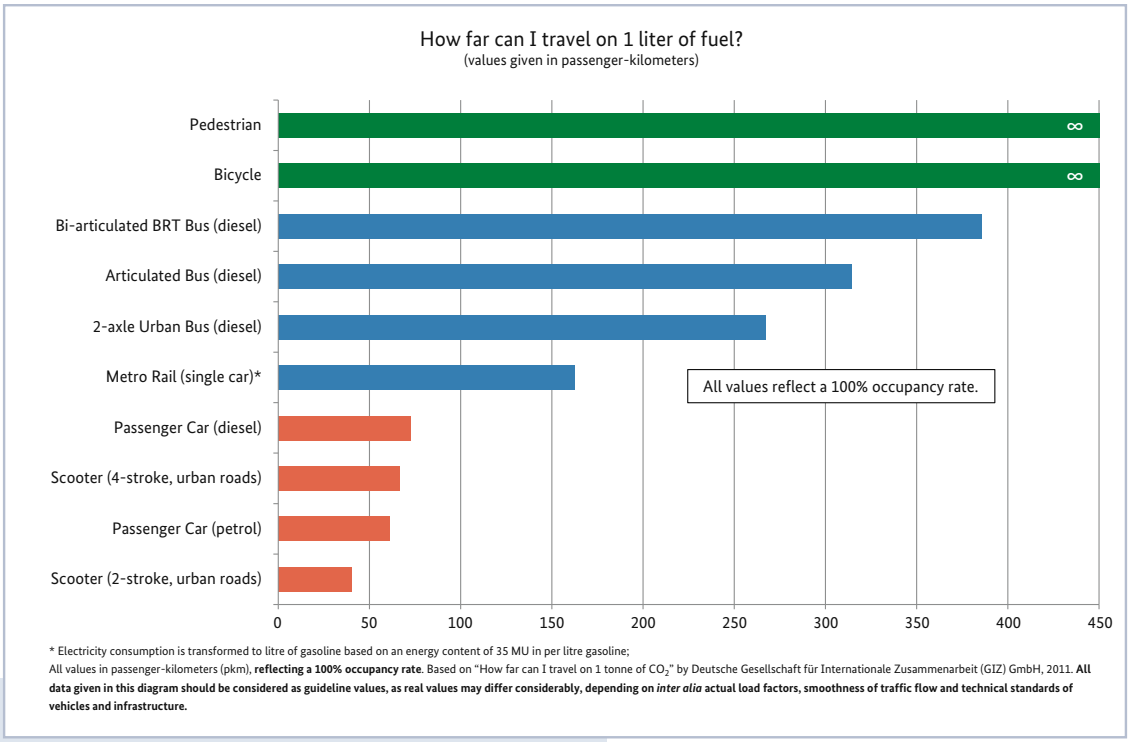

Figure 12: Energy efficiency of different modes of urban transport. Source: Adapted from GIZ, 2011

Case Study 2

Bus rapid transit in Bogotá

A bus-based transit system, TransMilenio, is the project that has done the most to improve the local transport system in Bogotá.

Today, the system accounts for more than 1 400 000 daily journeys; on average the main line carries more than 45 000 passengers per hour, with a peak level of more than 70 000. TransMilenio users save an average of 223 travel hours annually. By 2015, TransMilenio should be moving more than 80 % of the city's approximately 7 Million people.

As fully occupied buses have enormous efficiency advantages compared to cars, this measure has raised energy efficiency in Bogotá while at the same time reducing congestion.

Although the system is bus-based, its operation is similar to a rail-based system. Articulated buses run on exclusive bus lanes, of which there are sometimes even two in each direction. Passengers can only board and exit the buses at designated stations.

The main advantage of TransMilenio over a rail system was its low cost: the Bogotá system cost USD 5 million of pubic funding per kilometre. Its operating costs are also low. By contrast, the cost of metro systems usually amount to USD 100–200 million per kilometre. Today, the private TransMilenio operators not only cover their costs, they are also making a profit.

Source: Peñalosa (2005) – GTZ *Sourcebook Module* 1a

Case Study 3

Examples of parking restrictions

Some local authorities limit the maximum parking capacity at particular sites or within a particular area, particularly in growing commercial centres. This helps to discourage the use of inefficient cars and promote the use of efficient public transport.

- ***Portland***. In 1975, the City of Portland set an overall cap of approximately 40 000 downtown parking spaces, including existing and new facilities. The cap had increased to about 44 000 spaces by the 1980's, and it increased again in the 1990's. The city is generally satisfied with its parking policies, which it believes helped to increase the use of its transit system, from about 20–25 % in the early 1970's, to 48 % in the mid-1990's.
- ***San Francisco***. Under the City of San Francisco's 'Transit First' policy, parking may take up no more than seven per cent of a building's gross floor area, and new buildings must have an approved parking plan before they can receive an occupancy permit. In some cases, only short-term parking is approved; in others, a mix of long, short and carpool parking is permitted. This policy has helped prevent increased peak vehicle traffic despite the considerable growth in office space.

Source: VTPI 2010

Case Study 4

Examples of plate restriction schemes

Plate restriction schemes can be very successful in forcing car users to switch to more efficient modes of transport or to share vehicles. In the following examples, at least 10 % of motorists have to leave their cars at home each day, which has proved a good way of achieving great efficiency improvements.

- ***Mexico City*** uses a scheme that prohibits the use in the federal district of cars with registration plates ending in 1 and 5 on Mondays, 2 and 6 on Tuesdays, and so on for the 5-day working week (the 'Hoy No Circula' scheme).
- ***Bogotá*** uses a scheme in which 40 % of private vehicles cannot operate in the city between 7:00 and 9:00 and between 17:30 and 19:30, in accordance with designated number plates.
- ***Beijing*** introduced a weekly No Driving Day, with the prohibition rotated through the year according to the last number of the plate.
- ***Sao Paulo*** uses a scheme over a wide central area (within the Inner Ring – about 15 km diameter) in which prohibits 20 % of vehicles from 07:00–08:00 and 17:00–20:00 on weekdays (1s and 2s on Mondays, etc.).

Source: Cracknell 2000, Davis 2008, Beijing Traffic Management Bureau 2010

Figure 13: Traffic in Bogotá, Colombia.
Source: Carlos Pardo, 2006

Case Study 5

Road pricing in Singapore

The oldest and perhaps most well known congestion-charging scheme is Singapore's Congestion Pricing Scheme. The levies a charge on vehicles at the places and during times that they cause congestion.

The first scheme, introduced in June 1975, was called the Area Licensing Scheme. An imaginary cordon was placed around the most congested parts of the city, which covered an area of 720 hectares that was termed the Restricted Zone (RZ). To enter this area between 7:30 and 10:15 on weekdays and Saturdays, cars and taxis needed to purchase and display an area license. These paper licenses could be purchased for a day (USD 2.20) or a month (USD 43), and had to be displayed clearly on the vehicles' windscreens. Offending drivers paid a penalty of USD 50. Today, a varying price of up to USD 3.00 is paid, according to the road used and the time of day.

In 1975, the proportion of people using public transport to travel to work in the city was 46 %. In 1998 it was 67 %. Thus, there was a successful shift towards more energy-efficient modes of transport and the travel efficiency of Singapore's transport system was significantly improved.

Source: GIZ TDM Training Document

Case Study 6

Vehicle quota system in Singapore and Shanghai

Singapore's Vehicle Quota System (VQS), which came into effect in May 1990, is part of a series of measures to optimise traffic flow by managing the growth of vehicle ownership at acceptable levels. Under the VQS, motor vehicles are classified into several categories, with a separate licence quota for each category. In order to register a new vehicle, the would-be buyer must bid for a licence, which is referred to officially as a Certificate of Entitlement. These are obtained through an auction and are valid for 10 years.

Shanghai has introduced a similar system. Licenses for cars are limited in number, and they are auctioned for up to USD 5 600 for a basic license. Around 5 000 licenses are sold each Month.

Vehicle quota systems limit the growth of car use and therefore improve the energy efficiency of the transport system.

Source: GIZ TDM Training Document

Case Study 7

Car Free Day in Bogotá

In Bogotá, Columbia, on 24 February 2000, the city's mayor and an international environmental organisation held the first official Car Free Day – one of the first car free days organised in any developing country. On that day, the nearly one million private vehicles of the city stopped driving for 13 hours, leaving the streets free for the citizens to walk, bike and skate; 75 % of the Bogotanos travelled by public transport; air and noise pollution was considerably reduced; and for the first time in three years, no fatal traffic accidents were reported. The day was successful and very popular, and it is now established as an annual event.

Source: Díaz (undated)

2.3 Vehicle efficiency – the improve strategy

Reducing the per-kilometre fuel consumption of vehicles increases their efficiency. This can be done with technology and design improvements, but also through efficient driving techniques. Measures can be clustered into three categories:

- Improvement of existing vehicles;
- New fuel concepts;
- Development of new car concepts.

The strategy of improvement is not only relevant for private cars, but also for freight and public transport. Specific measures for passenger cars include the use of lightweight materials, downsizing (reducing the volume of the engine and size of the car) and/or using hybrid engines. A combination of such measures significantly reduces energy consumption in comparison to an average passenger car. Comparing different cars of the same size, where consumption can vary by as much as 20%, underlines the potential benefits of vehicle technology.

> ***Improve** the energy efficiency of different modes of transport and vehicle technology!*

Such technological improvements are mainly a job for vehicle manufactures and research institutes. However, legislation and fiscal measures can be important drivers of technological advances. Local and national authorities can support the diffusion of efficiency technologies in the market by setting standards, raising awareness and creating incentives for consumers to buy more energy-efficient vehicles.

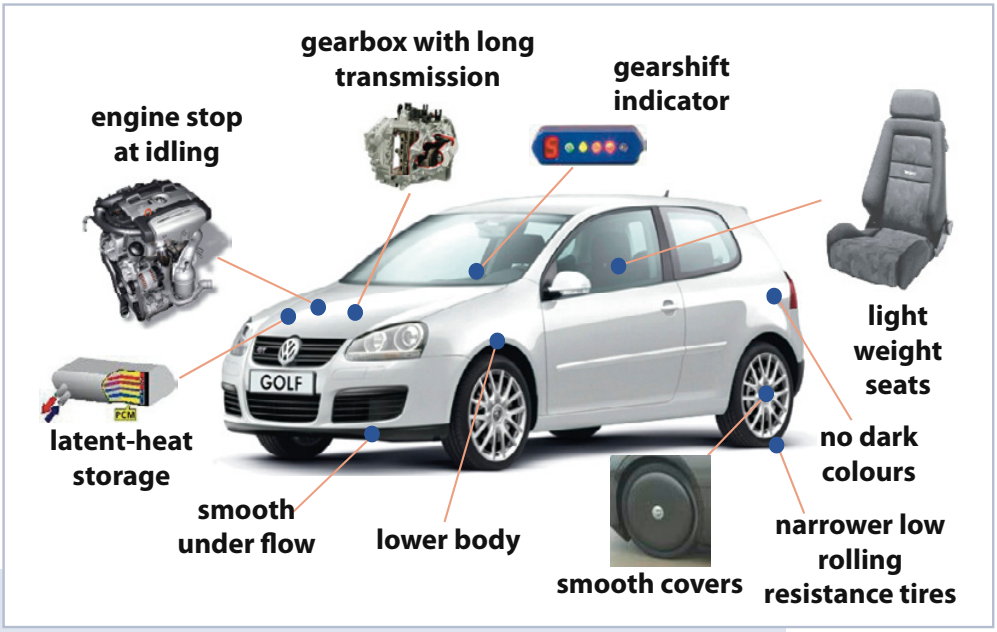

Figure 14: Technical options for improving the energy efficiency of LDVs.
Source: Axel Friedrich via GIZ

Box 4: Vehicle fuel economy standards

Fuel efficiency can be measured in terms of fuel consumption (litres per 100 km, or gallons per mile) or fuel economy (km travelled per litre, or miles travelled per gallon, mpg). In different countries, different measures have to be taken, such as meeting standards for fuel economy and CO_2 emissions. These measures serve to reduce consumption, push technological innovation and meet the CO_2 emission reduction targets set by the UNFCCC. They also reduce direct harmful emissions from cars (ICCT, 2007).

As early as 1995, the **European Union** first introduced voluntary standards for passenger cars based on CO_2 emissions targets of 140g CO_2/km by 2008. As this target could not be reached, in 2009 a mandatory limit of 130g CO_2/km was introduced for new cars on sale. This will be reduced to 95g CO_2/km by 2020 (European Commission 2009).

In the **United States**, the Corporate Average Fuel Economy (CAFE) programme was established in 1975 to reduce fuel consumption. It requires automobile manufacturers to meet a fuel economy standard for passenger cars (27.5 mpg) and light trucks (22.2 mpg for 2007) (An *et al.*, 2004). The first national greenhouse gas emissions rules for cars were enacted in 2010, setting average vehicle emission limits of 250g CO_2/mile by 2016, down from 295 grams (equivalent to 35.3mpg or 15 km/litre) in 2012 (EPA 2010).

Since 2004, the **Chinese** fuel economy standard has limited fuel consumption according to vehicle weight categories. No differentiation is made between diesel and gasoline vehicles. Since the standard was implemented, a clear change has been observed in the fuel efficiency of new vehicles being sold. Between 2002 and 2006, the standard successfully reduced the average fuel consumption of the new LDV fleet by 11.5 %. In addition to the fuel economy standard, the Chinese Government modified excise tax to provide an incentive for sales of small-engined vehicles (Oliver *et al.*, 2009).

Japan introduced a fuel economy standard for light duty vehicles in 1999, which sets targets for the distance travelled per unit of fuel (km/l), for petrol and diesel vehicles. The standard differs according to vehicle weight classes and the target fuel economy level is based on the most fuel-efficient vehicle in the respective class. The most efficient vehicle of one year sets the level for the standard of the next year. Vehicle manufacturers have to meet that target value when they average the values of all the models they sell within the respective weight class. Penalties are raised for non-compliance. The Japanese fuel economy standard is one of the tightest standards worldwide (Figure 15) (IEA 2009b, Creutzig *et al.*, 2011).

Sources: Creutzig *et al.*, 2011; EPA 2010; EC 2009; ICCT, 2007; IEA 2009b; Oliver *et al.*, 2009

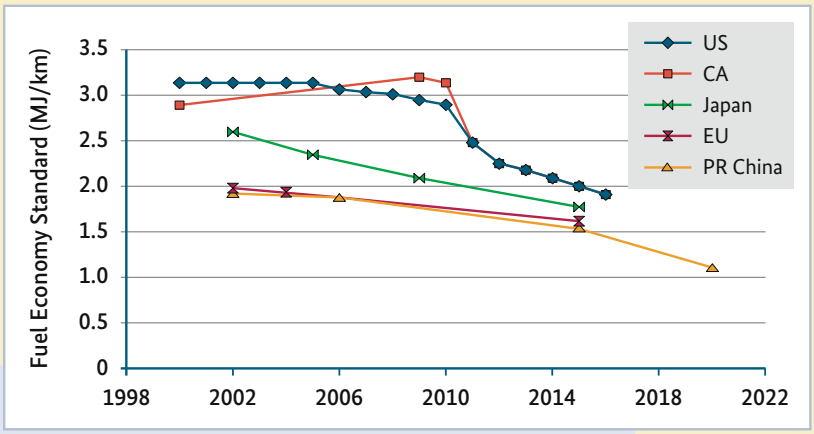

Figure 15: Fuel economy standards in units of energy intensity extrapolated from current volume and GHG standards. (1 l gasoline = 32 MJ). Source: Creutzig *et al.*, 2011

Case Study 8

Improving fuel economy in cities – a tax incentive scheme in Hong Kong

A tax incentive scheme was introduced in April 2007 in Hong Kong, with the aim of improving air quality by encouraging the use of environmentally friendly private cars – *i.e.* cars that run on petrol but have low emissions and high fuel efficiency. The programme offers a 30 % reduction in the First Registration Tax (FRT) to buyers of new environmentally friendly cars. To qualify as environmentally friendly the cars must, when compared to conventional 'Euro 4' petrol cars:

- Emit about 50 % fewer hydrocarbons (HCs) and nitrogen oxides (NO_x);
- Consume 40 % less fuel (km per litre).

This helps to promote the use of energy-efficient cars, which benefit the owners (who pay less for fuel) as well as the air quality of the city.

Source: Broaddus 2009 – GIZ TDM Training Document

2.4 How to measure the energy efficiency of transport

It is essential to monitor the impacts of policy initiatives to ensure that the respective energy savings are realised, and so that adjustments can be made if necessary. To measure the success of energy efficiency strategies and to quantify the energy savings achieved, it is necessary to use several indicators, which together describe the performance of the transport system at all three levels of efficiency.

If indicators are assessed continuously, it is possible to monitor the long-term development of the transport system. Most indicators are based on local statistics, or they require passenger and household surveys. Limited data availability often impedes proper planning or the adequate evaluation of energy efficiency measures.

1. System efficiency

The traffic volume generated and the system efficiency of a city are closely connected. Travel activity is influenced not only by the urban structure, but also by economic, cultural or behavioural factors. Nevertheless, planning decisions have a significant effect on traffic volume and the efficiency of the system.

- Because energy consumption is directly related to traffic volume, a key indicator for evaluating system efficiency is the per capita ***annual passenger-km***. This is calculated by dividing the amount of total distances travelled in a given period by the number of people who travelled. For instance, in 2006, in Germany approximately 15 000 km per capita were travelled in urban, interurban and rural areas, while in China the figure was just 2 400 km per capita (IFEU 2008).
- Another indicator for system efficiency is ***urban density*** (person/km^2), which can reveal structural reasons for different traffic volumes.
- A possible third indicator is ***passenger transport energy use*** per capita (MJ/person). This summarises the different measurements of urban energy efficiency.

2. Travel efficiency

Travel efficiency depends mainly on the share of energy-efficient modes of transport used. Besides that, the energy intensity of each mode of transport used is also important, which depends on both the vehicle efficiency and the occupancy rate.

- The ***share of each mode*** of transport in the total number of trips made, as well as the respective passenger-km or tonne-km moved can be used as an indicator for travel efficiency;
- It is also necessary to consider the ***energy use per passenger-km*** (MJ/pkm) or tonne-km (MJ/tkm) of each mode;
- Finally, the ***occupancy rate of vehicles*** is a crucial aspect of travel efficiency. (This is already considered under energy use per pkm/tkm, but a separate analysis is often useful.)

3. Vehicle efficiency

Unlike travel efficiency, which is measured using passenger-km or tonne-km, vehicle efficiency is assessed using vehicle-kilometres per energy unit. Vehicle efficiency is important both for private motorised vehicles and for public transport vehicles.

- Measuring the fuel or ***energy consumption per vehicle-kilometre*** (MJ/km) is an easy way to monitor vehicle efficiency. As fuel consumption and CO_2 emissions are related, another way to assess vehicle efficiency is by measuring CO_2 emissions per vehicle-kilometre (g CO_2/km). However, it is important to consider that not all fuels provide the same energy output.
- The overall vehicle efficiency of a city's fleet is also influenced by the ***average age of the fleet***.

Box 5: Benchmarking for energy efficiency

Benchmarks can be used to assess the performance of a transport system, of the different modes of transport, or of certain vehicle types in terms of energy efficiency. Benchmarking helps to improve performance by identifying best practices and analysing the underlying differences between the transport system being analysed, and more efficient systems. Decision makers can identify performance gaps, and set specific targets and introduce changes to close the performance gaps. Ultimately, performance can improve. Successful benchmarking involves several steps (Taylor 2006):

Self-analysis + identify best practices + analyse performance differences + implement findings = narrowed performance gap & tangible performance improvements

For the self-analysis, performance indicators need to be collected as outlined above. These help to identify the differences between transport systems. Cities differ in terms of their topographical, historical, economic and political circumstances. It is best to compare one's own transport system with those of other cities with similar conditions, as this will ensure the results are transferable. Table 1 gives examples of values for several performance indicators in different world regions[1]. More sample values can be found in Kenworthy 2003[2].

[1] It should be noted that the values refer to the situation in 1995. Thus, they cannot reflect the status quo, but such a comprehensive analysis gives a unique overview about cities in different world regions.

[2] Kenworthy J. (2003): Transport Energy Use and Greenhouse Gases in Urban Passenger Transport Systems: A Study of 84 Glob al Cities, http://cst.uwinnipeg.ca/documents/Transport_Greenhouse.pdf

Table 1: Examples of values for different efficiency indicators – mean values of several cities in each region, 1995 (adopted from Kenworthy 2003)

Indicator	US cities	Western European cities	High income Asian cities	Latin American cities	African cities
System efficiency					
Passenger transport energy use per capita (MJ/person)	60 034	15 675	9 556	7 283	6 184
Private individual mobility (pkm/capita)	18 200	6 321	3 971	2 966	2 711
Urban density (person/km²)	1 490	5 490	15 030	7 470	5 990
Travel efficiency					
Modal split of all trips					
■ Non-motorised modes	8.1 %	31.3 %	28.5 %	30.7 %	41.4 %
■ Public transport	3.4 %	19.0 %	29.9 %	33.9 %	26.3 %
■ Motorised private modes	88.5 %	49.7 %	41.6 %	35.4 %	32.3 %
Energy use per public transport passenger-km (MJ/pkm)	2.13	0.83	0.48	0.76	0.51
Vehicle efficiency					
Energy use in private passenger vehicle-kilometre (MJ/km)[1]	4.6	3.3	3.3	3.7	3.7
Energy use per public transport vehicle-kilometre (MJ/km)	26.3	14.7	14.4	16.9	9.5

[1] Note that the share of cars and two- or three-wheelers has an influence on this indicator. It is preferable to asses automobile and two- or three-wheeler vehicle efficiency separately

The values show that underlying policy differences and planning decisions determine efficiency indicators. For instance, US cities have a very low urban density as there is no proper regulatory framework to prevent urban sprawl. At the same time, car-focused urban planning leads to dispersed city structures. European cities, on the other hand, often have mixed-use structures with shorter journeys needed for shopping and working. Consequently, the share of public transport and its efficiency are lower in the US cities than in the Western European region, despite the fact they experience otherwise similar circumstances. The lower per capita use of energy for transport in African cities is not due to energy-efficient transport systems, but rather because the framework conditions are different – the limited access to motorised transport for the low-income population leads to a high proportion of non-motorised transport.

Further information on benchmarking in transport:

- Olli-Pekka H. (2011): Benchmarking efficiency of public passenger transport in larger cities;
- The Urban Transport Benchmarking Initiative (2003–2004) http://www.transportbenchmarks.eu;
- BESTTRANS – Benchmarking of Energy and Emission Performance in Urban Public Transport Operations – http://www.tis.pt/proj/bestrans.

2.5 The co-benefit approach

In many cases, those who benefit from energy efficiency measures are not the ones who made the investments or financed them. This phenomenon, known as the investor-user dilemma, is also familiar in other sectors (*e.g.* the building sector).

In the transport sector, municipalities often have to bear additional costs to provide energy-efficient transport systems, although it is companies and the population that benefit from them. However, some investments do pay back in the long run. Energy efficiency improvements may have multiple benefits and thus provide an additional incentive for local and national governments to carry out the expensive measures. Depending on the local circumstances, the co-benefits of energy efficiency policies might even be the original reason for enacting them, and may justify the investment. Common co-benefits can be grouped into the following four categories (see Figure 16).

Stronger economic development: As a rule, dependency on oil and cars does not foster local jobs or the sustainable, economic development of cities[2]. By contrast, an increase in the share of public transport and non-motorised modes of transport can bring economic advantages for cities. For instance, a reduction in congestion leads to time savings. The more efficient use of energy resources is also accompanied greater efficiency in the use of other scarce and valuable resources, such as land[3]. Cities with a smart urban transport system and low congestion levels often attract higher levels of foreign direct investment (FDI) than other cities, because large companies acknowledge that their employees are healthier, that they can commute more easily and arrive punctually, and that they like the place in which they work. The functionality of such cities as business locations is also secure, since deliveries and business trips can be planned and carried out efficiently using a smart urban transport system. Singapore and Hong Kong are impressive examples of this in Asia.

Increased quality of life: Lower energy consumption reduces emissions of pollutants and enhances urban air

[2] In many countries vehicles and fuels are the largest category of imported goods. Such costs can be reduced significantly. But even petroleum-producing countries can benefit from fuel conservation, because they can increase their export rate.

[3] An urban transport system that is based on public transport needs far less space than an automobile based transport system.

quality. Urban space is limited and a transport system based on the car usually consumes a lot of space for roads and parking. This is at the expense of urban parks, sidewalks or recreation areas. In contrast, public transport needs far less space to fulfil similar demands, which mean city planners can provide green roads as well as parks and other areas for recreation. Noise from road transport impairs the quality of life of many residents, and it decreases the value of land and buildings. Sustainable transport also reduces health risks in terms of road safety as well as air pollution. Furthermore, as many people in developing cities cannot afford to own a vehicle, investments in public transport and non-motorised modes of transport count as pro-poor policies.

Better energy security: Fuel subsidies and other forms of support for the automotive sector put pressure on a government's budget, while also worsening energy security and increasing the dependency on oil imports and prices. As 'peak oil' (see Box 2 in Section 1) becomes a reality, worldwide oil production is likely to fall over the next decade (IEA 2009a/IEA 2009c). Oil prices will rise further as a result, reaching USD 200 or more. However, lower fuel consumption due to energy efficiency measures reduces the oil dependency of a state or individual regions.

Fewer externalities: By promoting the role of public transport, traffic congestion and accident risks can be reduced significantly. A large proportion of a city's budget is spent on mitigating the negative consequences of road transport. Such costs are not borne directly by the user but are imposed upon society. Cities may have to invest in noise prevention measures, for instance, or in health care to cover diseases caused by air pollution and accidents.

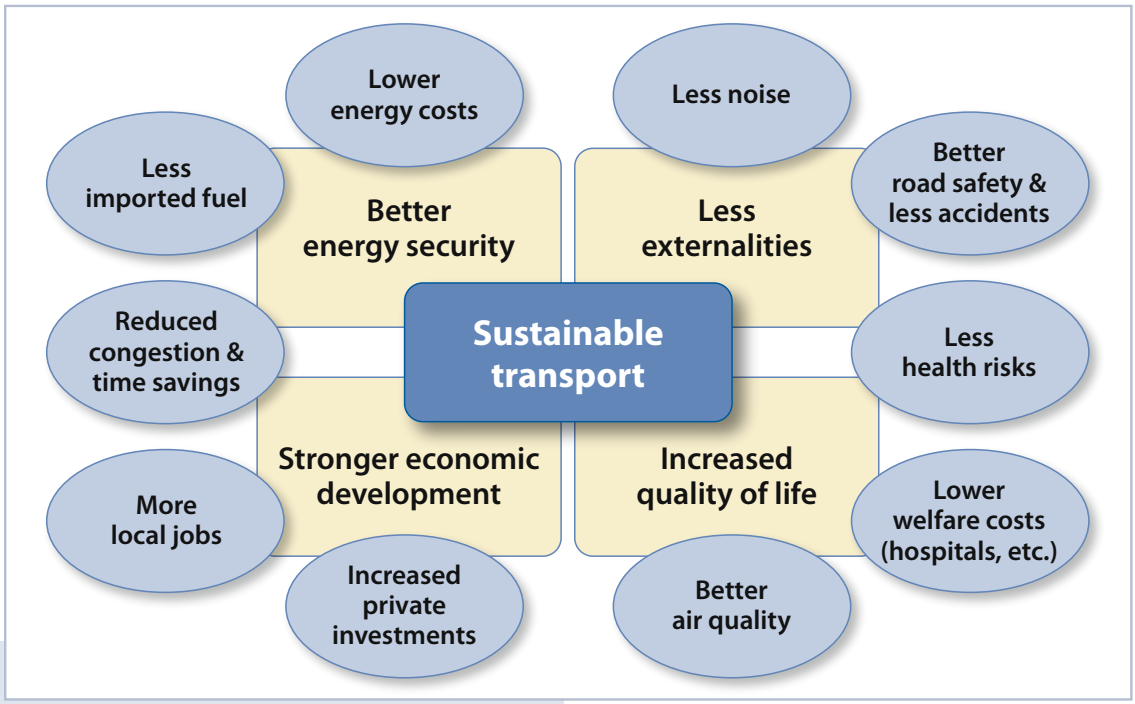

Figure 16: Possible (co-)benefits of improved energy efficiency.

3 Energy efficiency policies and measures

The experience of many cities shows that the responsibility for implementing policies and measures to enhance energy efficiency is best shared between the private and public sectors, and between the national and local levels. Table 2 gives an overview of the different actors in an urban transport system, divided into decision makers and in stakeholders.

- ***Decision makers*** are political and administrative institutions at local and national levels, which determine or influence the urban transport system. National ministries and local municipal departments, for instance, shape the transport system through their strategic planning, regulations and infrastructural provisions.
- ***Stakeholders*** are organised groups that do not have direct political power, but which can nevertheless contribute significantly to the shape of the local transport system, for example by encouraging an energy-efficient agenda, by making investments and providing funding, or by shaping the transport behaviour of large groups.

The role of users of the transport system, such as commuters and logistic companies, should not be ignored. However, these actors only influence policy and planning indirectly.

Table 2: Overview of actors in the urban transport system

(italic = stakeholders that are not addressed in the current document*)*

	Local level	National and international level
Decision makers	■ Local authorities ■ Mayors and city governments ■ Transport planning divisions ■ Land use planning divisions ■ Economic development divisions ■ Financial divisions	■ National authorities ■ Transport ministries ■ Environmental ministries ■ Ministries for financial affairs and treasury ■ Ministries of energy ■ Ministries of economic affairs and technology
Stakeholders	■ Other municipal institutions (*e.g.* municipal public relations division, enforcement authorities) ■ Public transport operators ■ Companies ■ Non-governmental organisations ■ *Private investors* ■ *Informal transport providers* ■ *Local media*	■ *International financial institutions* ■ *Development banks* ■ *Foundations* ■ *Non-governmental organisations* ■ *Vehicle manufactures* ■ *Fuel producers* ■ *Media* ■ *Research institutions and consultants*

Which actors does this Module address?

This *Sourcebook Module* focuses on urban passenger transport and is aimed mainly at the policy and planning level. As the organisational structure of local authorities is often very complex and differs considerably between cities, this overview of the different decision makers and their roles in the local transport system has been simplified.

Figure 17:
Local transport bureau, Frankfurt am Main, Germany.
Source: Armin Wagner, 2006

Some stakeholders have been identified additionally as key actors. These are the local public transport operator(s), non-governmental organisations and local businesses. Despite their lack of political decision-making power, they actively shape the transport system by promoting and enforcing efficiency measures, through internal decision making, and by influencing the political agenda.

In addition to local actors, the *Sourcebook Module* also addresses those involved at the national level, where decision makers set the framework for the local urban transport systems, and the associated plans and policies. Here too, it has been necessary to simplify the presentation of the organisational structures, and stakeholders such as the fuel and vehicle industries, the funding and investment institutions, and the media are not included in this book.

Navigating through this section

This section is organised according to the key actors identified above. While it acknowledges the wide variety of practices in different countries and cities, it does assign certain specific tasks and responsibilities to particular parties. For each actor an energy efficiency agenda chart is compiled (see Box 6), which outlines all the measures in which the respective actor might be involved, and where they could take action. In the Appendix, there is an overview of all the measures outlined in this section. The catalogue of measures is not exhaustive. It should be considered a starting point for the development of policy initiatives, and it should help to visualise the need for cooperation.

The section is divided into three sub-sections: local governments, local private companies, and national governments. At the beginning of each of these, a 'navigator' diagram is included to give an overview of the policies and measures assigned to the respective group of actors. This diagram also indicates the areas of efficiency each of the measures addresses.

For more detailed information, the text includes references to the numerous modules of GIZ's *Sourcebook for Policy makers in Developing Cities* and related publications.

Box 6:
Responsibilities in the development of energy efficiency policies and measures

The process of developing and achieving policies and measures to promote energy-efficient transport systems can be divided into different fields of activity (Figure 18):

- ***Agenda setting***: At the beginning of any political process there must be one actor – an individual, an institution, a party or group – that opens the discussion and takes the initiative. Identifying a specific problem might prompt the search for suitable solutions. This stage of the process, when one actor first voices the need for policies and measures, is called agenda setting. The initiator provides the idea or political pressure so that other decision makers can take action.
- ***Implementation***: The implementation process includes the most important steps for putting a measure into practice. The actor responsible plays a key role, being in charge of the detailed planning, securing financing, creation of the necessary legal environment, actual implementation of the measure, and maybe also its monitoring. The political decision to integrate a measure into the overall strategy takes place prior to the actual implementation process.
- ***Consultation***: Often, institutions other than the key actor have to be involved in the implementation process, in order to ensure wide approval for the measure and to integrate new and useful information in the concept. In the consultation phase, assigned actors provide information and participate in the development and implementation process of measures. This could be part of a formative and compulsory process, but it might also take the form of round tables or working groups.
- ***Legislative environment***: Some efficiency policies and measures for both local and national levels require the establishment of a legal framework at the national level. Examples would be the definition of a legal basis for environmental zones, as well as the definition of emission and vehicle categories, and the labelling and surveillance of vehicles.
- ***Enforcement***: Proper enforcement is essential if measures are to succeed. For example, parking restrictions or speed limits are meaningless if the police and other enforcing institutions do not monitor compliance and enforce the regulations effectively. It is important to evaluate the institutional capacity for enforcement before the measures are implemented. The enforcing authorities are subject to the directives of the political body.

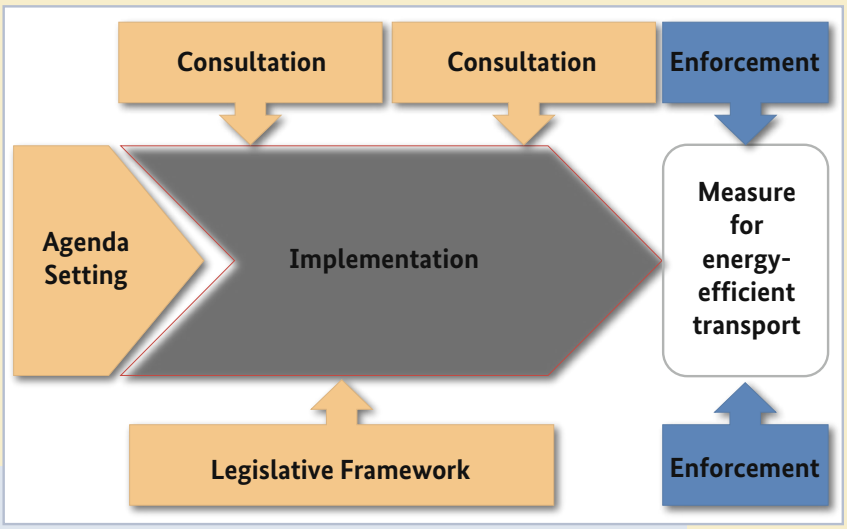

Figure 18: Fields of activity to achieve energy efficiency policies and measures.

This section sets out an ***energy efficiency agenda*** for each of the key actors identified. The chart shows the various responsibilities and describes how the respective actor is involved in developing and achieving measures (agenda setting, implementation, consultation). A short introduction to each measure is given in the sub-sections covering the key actor responsible for implementation.

3.1 Local authorities

The city government and associated institutions are responsible for spatial and urban planning, which determines the shape of the city. Strategic plans are developed for the road and rail networks and for the settlement structures. Roads and road use are managed, and infrastructural investments are agreed. Local authorities can develop policies suitable for dealing with the specific problems and challenges a city faces. They are therefore the key actors in developing long-term strategies or master plans for greater energy efficiency.

A citywide strategy could introduce a special focus on public transport and non-motorised transport. With the right incentives, the use of these highly energy-efficient modes of transport could be expanded and their attractiveness enhanced. Wrong incentives, which promote the use of private motorised vehicles, must be reduced. It is important that non-efficient modes of transport become less convenient to use throughout the entire urban structure (Böhler, 2010).

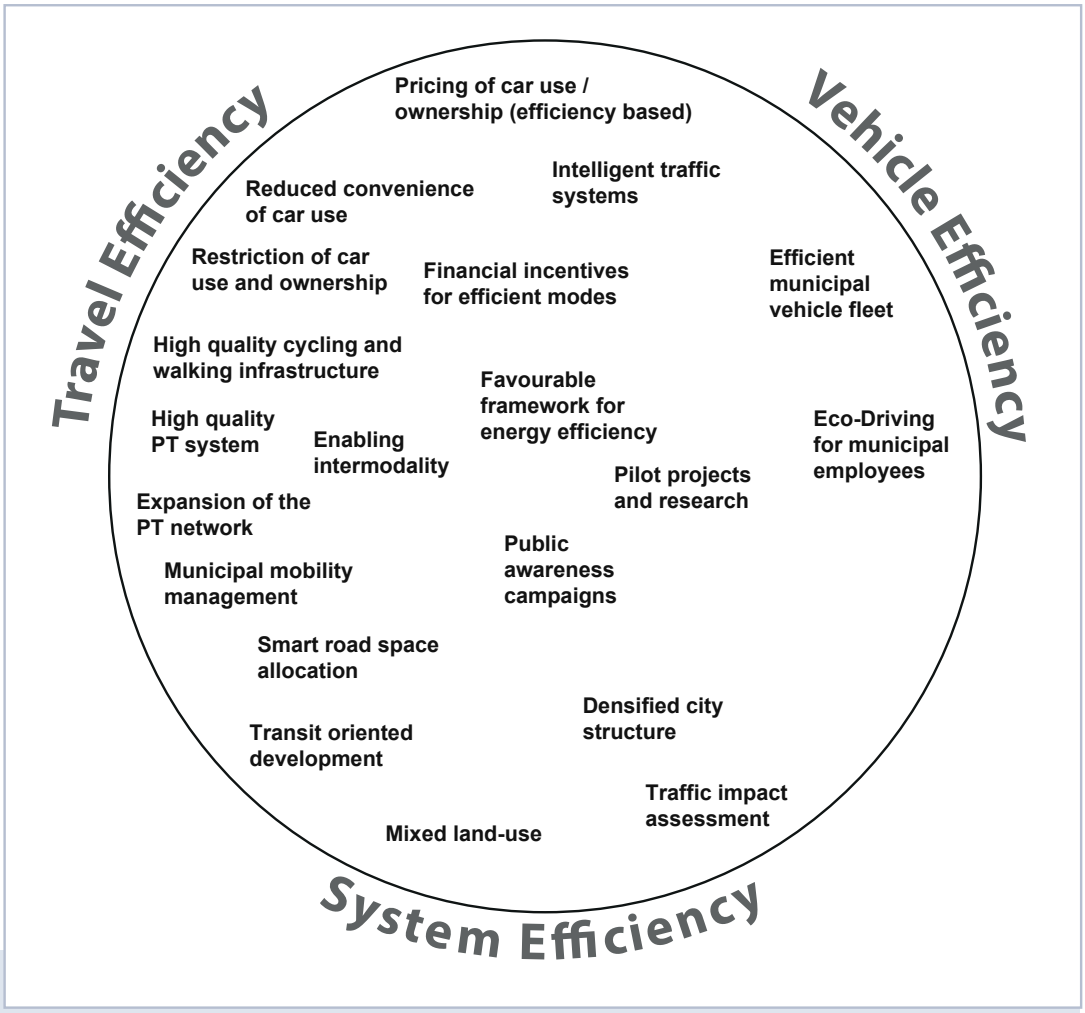

Figure 19: Energy Efficiency Navigator for local authorities and cities (measures grouped into fields of activity).

3.1.1 Mayors and city governments

Table 3: Energy efficiency agenda for mayors and city governments

Implementation	**Mayors do not implement most policies and measures directly, but are responsible for a favourable citywide framework for energy efficiency initiatives.** **Exceptions in which a mayor is mainly responsible for energy efficiency measures include:** ■ **Training in eco-driving techniques for municipal employees** ■ **Municipal mobility management (*e.g.* job tickets, teleworking)** ■ **Green procurement policy for municipal vehicles** ■ **Pilot projects and research**
Involvement	**Mayors and city governments have important functions in agenda setting and coordination:** **a) Political leadership** **b) Initiation and approval of measures** **c) Exertion of political influence on the regional and national level**

Coordinated political support and political commitment are necessary for the successful establishment of an energy-efficient transport system. The political will for change and strong leadership are crucial, as is the continuity of political decision making, even beyond legislative periods.

Mayors and city governments have to set the overall agenda. They outline quantitative and qualitative targets, and they establish and promote common objectives that reach beyond the local government and administration. The media and the public are important stakeholders in this context.

Mayors and city governments should ensure that their local energy efficiency concepts not only solve their particular urban development problems, but also provide multiple benefits:

- Better transportation system and more comfortable forms of travel;
- Reductions in air pollution and noise, with a positive impact on human health and city liveability;
- Reduction of environmental damage, both locally and on a global scale;
- Reduction of urban sprawl by promoting dense structures and mixed land use;

Figure 20:
Antanas Mockus, Mayor of Bogotá (1995–97; 2001–03).
Source: Karl Fjellstrom, 2002

- Increased competiveness and attractiveness of the city (including for foreign investors), which attracts companies and highly qualified employees;
- Additional revenue for the city that could be invested in new transport infrastructure and contribute to the reduction of external transport costs.

Urban planning, the design of infrastructure, traffic management, and enforcement by the traffic police are usually the responsibility of separate divisions. It is therefore important for a city government to maintain a holistic view of its energy efficiency measures, and that it identifies and solves any conflicts that arise between the different divisions. It can be helpful to establish a multidisciplinary organisational unit or to launch thematic working groups.

The executive authority can also support research into energy efficiency by allowing ***pilot projects*** to run in the city. For a city to become a pioneer in energy-efficient transport, the mayor or local government must cooperate with national authorities, research institutions and private companies.

Last but not least, city councils can encourage more efficient transport through the way they manage their own municipal mobility. Similar to a private enterprise, a municipality can improve its own efficiency with the following measures (see Section 3.2.2 for further details):

- **Municipal mobility management;**
- **Green procurement policy for municipal vehicles;**
- **Eco-driving training for municipal employees.**

Thus, city administrations can serve as role models for the use of cleaner technologies, and they can encourage private companies in the city to follow their example.

Table 4: Relevant GIZ publications on sustainable urban transport

FURTHER READING
■ Module 1b: Urban Transport Institutions ■ Module 2b: Mobility Management ■ Module 4a: Cleaner Fuels and Vehicle Technologies ■ Module 4f: Eco Driving ■ Case Studies in Sustainable Urban Transport #5: Mobility management & commuting: inputs and examples of best practice in German firms

3.1.2 Transport planning divisions

Table 5: Energy efficiency agenda for local transport planning divisions

Implementation

- **Bicycle lanes**
- **Bicycle parking**
- **Bicycle route signage and maps**
- **Bike and ride facilities**
- **Bus lanes**
- **Bus priority**
- **Bus Rapid Transit**
- **Car-free days**
- **Comfortable stations and vehicles**
- **Continuous cycle network**
- **Cycle highways and green wave for cyclists**
- **Intelligent traffic systems**
- **Environmental zone**
- **Expansion of the public transport network Integration of NMT into public transport**
- **Integration of public transport infrastructure**
- **Intelligent traffic systems**
- **Park and ride facilities**
- **Parking restrictions**
- **Pedestrian zones**
- **Plate restrictions**
- **Safe sidewalks and crossings**
- **Separate crossing times for NMT**
- **Shared bicycle services**
- **Speed restrictions**
- **Traffic cells and diverters**
- **Transportation access guides**
- **Vehicle quota**

Involvement

Put on the agenda ...

- Campaigns for energy-efficient modes of transport (3.2.3)
- Car sharing (Section 3.2.2)
- Car-free travel packages (3.1.5)
- Congestion charge (3.1.5)
- Customer user groups (3.2.3)
- Demand-oriented public transport system (3.2.1)
- Denser city planning (3.1.3)
- Green procurement of energy-efficient vehicles for public transport (3.2.1)
- Improved rider information (3.2.1)
- Integration of public transport services (3.2.1)
- Mandatory eco-driving training for public transport operators (3.2.1)
- Maximum parking requirements (3.1.3)
- Parking pricing (3.1.5)
- Pay-at-the-pump surcharges (3.1.5)
- Pilot projects and research (3.3.5)
- PPP to improve the public transport network (3.2.2)
- Road pricing (3.1.5)
- Road space reallocation (3.1.3)
- Subsidised public transport fares (3.1.5)
- Traffic impact assessment (3.1.4)
- Transit-oriented development (3.1.3)
- Transportation access guide (3.2.2)

Be available for consultation on, and provide data for ...

The local transport planning divisions consult with other actors about all transport-related measures implemented at the local level.

Transport planning divisions are usually responsible for planning and managing transport systems. They are key actors for supporting local governments in their strategy development and for the coordination of various activities.

In terms of implementation, they are especially important for travel efficiency and the associated SHIFT strategies. They plan the public transport network, arrange transport services and are responsible for the network of pedestrian and cycle paths. Transport planning divisions can enhance their cities' energy efficiency significantly, if they succeed in promoting public transport and non-motorised modes of transport. The divisions are also responsible for roads and parking spaces for private motor vehicles. These require careful management, as an approach that favours such vehicles will be less energy-efficient. Strategic planning by the authorities addresses all modes of transport. As such, it can significantly influence the modal distribution.

3.1.2.1 Expanding the role of public transport

Improvements in the public transport system can induce a modal shift, leading to increased energy efficiency. A good public transport system is attractive, accessible and reliable. ***Expanding the public transport network*** – enhancing the frequency of services and improving its operation – is important for promoting the use of public transport. A powerful public transport system can include different types of public transport. Which kind of system is appropriate for a city or a specific route depends on several factors, including the costs, construction time, passenger capacity and the city structure. Possible options are commuter rail systems, metros, light rail transit systems, trams and bus rapid transit systems. Regional transport systems can be connected to city systems, which, in turn, are linked to neighbourhood systems. This establishes a dense network, and the size and type of vehicles used can be varied to meet specific requirements.

Figure 21:
BRT with segregated bus lane in Bangkok, Thailand.
Source: Santhosh Kodukula, 2010

Bus rapid transit (BRT) systems have been introduced in several cities as an alternative to rail systems, because the construction costs are lower and they require less time to build; they also offer greater flexibility (see Case Study 2 on p. 26). BRT systems are characterised by bus corridors with designated lanes, high travel speeds and quick boarding systems. They are designed to provide comfortable public transport with high quality vehicles and stations as well as excellent customer services and integrated fare systems.

Existing public transport systems can be improved with a number of different measures, such as using separate ***bus lanes*** or giving ***buses priority*** at intersections to help them travel faster and improve their reliability.

Reliability and high standards of design for vehicles and stations contribute a lot to passenger comfort, which in turn helps to make public transport attractive to the citizens. Features to improve the ***comfort of stations and vehicles*** (*e.g.* bus shelters, boarding islands and improved lighting) could be provided, at least at major stations.

An important measure to improve public transport services is the ***integration of different public transport infrastructure***. The physical infrastructure and route networks could be adjusted and coordinated so that passengers can transfer easily between the different services. The transport planning divisions should cooperate closely with public transport operators, which have to adjust their schedules to provide a fully integrated system (for more details on integrated public transport services, see Section 3.2.1).

Public transport systems are often not publicly regulated, and multiple public transport operators form an uncoordinated system. In this case, it may be necessary to set up a central public transport authority. The local transport planning division can initiate the development of such an authority and improve the regulatory framework for public transport operation. Controlled competition might be the most promising organisational approach for regulating a system that has various public transport providers (see Box 7).

Box 7: Public transport regulation

Proper regulation of public transport is important to ensure that the formal system meets transport demands. If the local government does not administer regulation effectively, paratransit services are likely to emerge (*i.e.* informal public transport with small vehicles). Paratransit is often inefficient and not subject to governmental control.

The local transport authorities could implement a coherent set of policies to ensure proper regulation of public transport. The regulatory framework determines the amount of influence the local government can exert. It is important that the local government is able to control the level of services, so that it can make sure demand is met and that energy efficiency standards are implemented. Ideally, public transport can be sustained by the passenger fares. In many cases, however, governmental subsidies are necessary to keep prices low and ensure public transport is accessible for the urban poor.

In regulating public transport systems, three types of organisational arrangement are common:

Monopoly: In a monopoly one private company or public agency directly controls and regulates either one transport mode (*e.g.* buses), or all public transport activities in a city, and there is no competition.

Controlled competition: In this system, a transportation authority exists to manage the competition process. This is a particularly common form of regulation in developed cities that have the experience and the financial resources to carry it out.

Open competition: With open competition, there is no regulation of players' entrance into the market. To the customers' benefit, the competition can lead to lower prices and better service. However, the lack of regulation can also result in an inefficient system and may mean some areas are not served by public transport if they are not profitable.

Traditionally, governments in developing countries provide public transport through publicly-owned companies. These are under governmental control, but usually have inadequate financial resources. Public funding is generally used to make up deficits incurred. There is a policy dilemma between ensuring low-cost public services and earning a return on the resources invested. However, if private operators dominate under open competition, the narrow focus on profitability can adversely affect passenger safety and comfort.

Source: Meakin 2004c – SUTP *Sourcebook Module* 3c; Sohail *et al.*, 2004

Figure 22: Uncoordinated conventional public transport system, Delhi, India. Source: Abhay Negi, 2005

3.1.2.2 Enabling intermodality

To achieve a shift in the modes of transport used, it is important to support intermodality. Transport planning divisions can provide ***park and ride facilities***, especially at the outskirts of the city to enable an easy switch from private cars to public transport. Furthermore, high connectivity between public transport and non-motorised modes of transport is also important. Adequate pedestrian and cycling infrastructure improves access around transit stops, and proper bicycle stands at railway and subway stations encourage ***bike and ride***. Allowing passengers to take bicycles with them on public transport adds even more flexibility. The ***integration of non-motorised modes and public transport*** can increase the use of both. The local transport planning divisions can encourage the use of energy-efficient travel by making available ***transportation access guides*** showing convenient routes to and from public buildings, using public and non-motorised transport.

These measures all require close cooperation between the local transport planning divisions and public transport operators.

Figures 23a, b: (Segregated) bicycle lanes in Rio, Brazil (top) and Copenhagen, Denmark (above).
Sources: Carlos Pardo, 2007 (top) and Broaddus, 2008 (above)

3.1.2.3 Pedestrian and bicycle-friendly infrastructure

Non-motorised transport modes must be included in any transport strategy right from the beginning. Numerous improvements can be made to encourage cycling and walking. These include the creation of ***continuous cycle networks***, possibly featuring separate ***bicycle lanes*** or even so-called ***cycle highways***. ***Shared bicycle services***, which provide free or low-cost bicycles for public use, are a useful addition to the usual public transport system, and increase visibility.

Furthermore, sufficient ***bicycle parking*** facilities should be provided throughout cities. Often, places that are already used for parking can be upgraded by installing guarded bicycle stands. Other measures include ***route signage and maps*** designed to meet the special needs of pedestrians or cyclists.

Cities can be improved as places for walking through the provision of ***safe sidewalks and pedestrian crossings***. In areas where foot traffic is very high, vehicle access can be restricted to create ***pedestrian zones***. Intersections must be designed to be as safe as possible for non-motorised traffic. For example, ***separate crossing times*** for pedestrians and cyclists can be beneficial. To bundle activities, many cities have set up local cycle plans (see Case Study 15 on p. 104) or even a pedestrian strategy.

It is important to raise public awareness about energy-efficient mobility. Local transport planning divisions should

Figure 24: Pedestrian crossing in Tokyo, Japan.
Source: Gaz Errant, 2006

Figure 25: Cycling campaign in Bogotá, Colombia.
Source: Karl Fjellstrom, 2002

Figure 26: 'Ecopass' in Milan, Italy. The scheme has recently been replaced by the Area C, which covers the same area and requires drivers entering the city centre to pay a congestion charge regardless of the vehicle pollution level.
Source: Jonathan Gómez, 2011

Case Study 9

Bike-to-work programme in Buenos Aires

The Buenos Aires city government recently initiated a bike-to-work programme, its latest effort to get residents on bikes and out of their cars. The government held a conference with business leaders to outline various ways in which they could encourage their employees to commute by bicycle, and to explain the associated advantages for the companies, employees, and environment. Shortly thereafter, a number of participating companies signed an agreement with the city in which they committed themselves to encouraging sustainable mobility among their employees.

Other aspects of the city's bicycle programme include the construction of 100 kilometres (62 miles) of protected bicycle lanes, the installation of 1 000 bike parking racks around the city, and a new law requiring commercial car parks to accept bicycles for a charge of no more than 10 % of their fee for cars.

With planning, financing and information tools such as these, Buenos Aires has created a comprehensive policy package to promote bicycles as an energy-efficient means of transport.

Source: Holub 2010

disseminate information on sustainable transport and educate the public. Public awareness campaigns can be organised, such as cycle rallies or other communication measures. Many cities around the world have introduced ***car-free days***, when they are closed to cars, and cyclists and pedestrians can take over the streets (see Case Study 7 on p. 28).

3.1.2.4 System management

Transport planning divisions can implement measures that reduce the speed or the quantity of motorised vehicles travelling in the city. One such measure that has been widely implemented in many cities is the ***license plate restriction concept***, in which vehicles are restricted on certain days, depending on their registration plate number (see Case Study 4 on p. 27). Implementing authorities should be aware that this might encourage households to purchase a second vehicle, or to retain an older, less efficient one that would otherwise have been scrapped. This could counteract energy efficiency benefits or even

lead to increased energy consumption. Decision makers and stakeholders should seek local concepts to avoid these perverse incentives, *e.g.* through a sufficiently large proportion of non-use days.

Another approach to limiting growth in car use is to set a cap on the number of cars registered in a given year. Such a ***vehicle quota*** can be implemented through a licensing scheme for cars, and permits can be linked to a pricing system (see Case Study 6 on p. 28).

Environmental zones are areas which only vehicles, or classes of vehicle, that meet a prescribed emission standard are allowed to enter. Usually, such zones are intended to improve the local air quality, but the requirement could also be used to encourage more energy-efficient vehicles. Local transport and planning authorities define the area within a city where substandard vehicles are banned.

Road design has an important influence on the efficient use of the road network and transport demand management. ***Traffic cells and diverters*** are used to reduce speed and convenience for cars. A traffic cell can be created within a city district making it impossible for cars to cut though an area between arterial roads. Cars are only allowed to travel within each traffic cell. Traffic diverter structures can be built to block streets at intersections to divert the traffic away from direct routes. Cells and diverters make it less attractive to use a car, but they can also increase the distance travelled. Before implementing such a measure it is essential to assess whether the net effects will be positive.

Speed restrictions can have multiple benefits for a city and increase energy efficiency in two ways. Firstly, fuel consumption increases at higher speeds so a speed limit reduces consumption. Secondly, an increase in travel time makes car use less attractive. On some roads, speed restrictions can also improve safety levels for non-motorised modes of transport.

A constant traffic flow is also beneficial, as stop-and-go traffic results in much higher fuel consumption. In addition to good road design, ***intelligent traffic systems*** can help avoid congestion and thus improve energy efficiency. In order to avoid induced traffic, this measure needs to be combined with other measures that discourage car-use.

A supply of parking that is readily available and free of charge can increase vehicle use and ownership. Proper parking management is therefore an important task for local transport planning divisions. Parking management measures, such as ***parking supply restrictions***, can make car use unattractive and thus prompt a modal shift. Cities could avoid public-funded free parking and also find a good balance for on-street parking (see Case Study 3 on p. 26). To ensure successful implementation of parking management measures, illegal parking must be discouraged. Some of the space freed up by limiting the parking supply can be reallocated for non-motorised transport. Additional parking management strategies will be outlined in sections 3.1.3 and 3.1.5, in the context of land-use planning and pricing measures.

Figure 27: Maximum speed sign in Las Palmas, Spain.
Source: Klaus Neumann, 2006

Figures 28a, b:
Parking lots in Delhi, India (top) and Bangkok, Thailand (above).
Source: Abhay Negi, 2006 (top) and
Carlos Pardo, unknown (above)

Table 6: Relevant GIZ publications on sustainable urban transport

FURTHER READING	
■ Module 1b: Urban Transport Institutions ■ Module 2a: Land Use Planning and Urban Transport ■ Module 2b: Mobility Management ■ Module 2c: Parking Management ■ Module 3a: Mass Transit options ■ Module 3b: Bus Rapid Transit ■ Module 3d: Preserving and Expanding the Role of Non-motorised Transport ■ Module 3e: Car Free Development ■ Module 4e: Intelligent Transport Systems ■ Module 5e: Transport and Climate Change ■ Planning Guide: Bus Rapid Transit ■ TDM Training Document	■ Technical Document #3: Public Bicycle Schemes: Applying the concept in developing cities (examples from India) ■ Technical Document #4: Transport Alliances – Promoting Cooperation and Integration to offer a more attractive and efficient Public Transport ■ NMT-Training Document ■ Training Course Non-motorised Transport ■ Handbook: Cycling-Inclusive Policy Development ■ Case Studies in Sustainable Urban Transport #1: Bangkok Rapid Transit: BRT System of Bangkok, Thailand ■ Fact Sheet: Speeding up cycling

3.1.3 Land use planning divisions

Table 7: Energy efficiency agenda for local land use planning divisions

Implementation T7	
■ **Planning for denser cities** ■ **Maximum parking requirement (and revision of minimum parking requirement standards)**	■ **Mixed land use** ■ **Road space reallocation** ■ **Transit-oriented development**
Involvement	
Put on the agenda ...	
■ Intelligent traffic systems (3.1.2)	■ Park and ride facilities (3.1.2)
Be available for consultation on, and provide data for...	
■ Bicycle lanes (3.1.2) ■ Bicycle parking (3.1.2) ■ Bicycle route signage and maps (3.1.2) ■ Bike and ride facilities (3.1.2) ■ Bus lanes (3.1.2) ■ Bus rapid transit (3.1.2) ■ Congestion charge (3.1.5) ■ Continuous cycle network (3.1.2) ■ Cycle highways and green wave (3.1.2) ■ Demand-oriented public transport system (3.2.1) ■ Environmental zone (3.1.2) ■ Expansion of the public transport network (3.1.2) ■ Integration of NMT into public transport (3.1.2)	■ Integration of public transport services (3.1.2) ■ Intelligent traffic systems (3.1.2) ■ Parking supply restrictions (3.1.2) ■ Park and ride facilities (3.1.2) ■ Parking pricing (3.1.5) ■ Pedestrian zones (3.1.2) ■ Pilot projects and research ■ Public transport integration (3.2.1) ■ Safe sidewalks and crossings (3.1.2) ■ Speed restrictions (3.1.2) ■ Traffic cells and diverters (3.1.2) ■ Traffic impact assessment (3.1.4) ■ Transportation access guide (3.1.2)

Land use has a substantial effect on travel demand and travel patterns. Smart land use policies could be designed to minimise the need for travel and reduce people's dependency on cars for transportation.

A key characteristic of smart land use planning is ***mixed land use***. If residential houses, offices, shops and public services are built in close proximity of one another, the need to travel by car, or the distances to be travelled are significantly reduced.

The density of people and businesses within an area is another crucial factor influencing its energy efficiency. Low densities correspond to higher travel distances, higher car dependency, and consequently to higher transport energy demand. By contrast, ***more densely populated cities*** equate to shorter travel distances and greater efficiency of public transport, since the demand is locally concentrated, and public transport is also more profitable.

A varied set of smart land use measures can be combined in the concept of ***transit-oriented development*** (TOD). TOD aims to increase the density of commercial and residential development alongside public transport corridors and near stations. Transit stations are supported as centres of local commercial activity. These centres are surrounded by high-density residential structures, in walking distance. Places of work and services such as health care are also close to the transit stations. This pattern results in a structure in which many facilities are within walking distance, and where longer distances can be travelled easily using public transport (see Case Study 14 on p. 104). Proper connection to the public transport infrastructure increases the site's attractiveness and enhances its financial value. The city can profit from this development by raising building and land taxes, or leasing rates in this area, to reflect its enhanced value.

Traditional planning has tended to prioritise roads for private motorised vehicles. ***Reallocation of road space*** could benefit public transport or non-motorised modes of travel. To cap the expansion in traffic, land use planning divisions should set ***maximum parking allowances*** for new residential and commercial areas rather than minimum parking supply requirements.

Figure 30: Road network in Beijing, China.
Source: Manfred Breithaupt, 2006

Figure 29: Curitiba, Brazil, has followed the principles of transit-oriented development since the 1960s.
Source: Otta 2005

Table 8: Relevant GIZ publications on sustainable urban transport

FURTHER READING
■ Module 2a: Land Use Planning and Urban Transport
■ Module 2c: Parking Management
■ Module 3e: Car Free Development
■ Module 5e: Transport and Climate Change
■ TDM Training Document

3.1.4 Economic development divisions

Table 9: Energy Efficiency Agenda for the local economic development divisions

Implementation	
■ Traffic impact assessments	
Involvement	**Put on the agenda ...**
	■ Changing facilities and bicycle stands at workplaces (3.2.2) ■ Transit-oriented development (3.1.3)
	Be available for consultation on and provide data for ...
	■ Transit-oriented development (3.1.3)

Careful selection of locations for business and residential developments is a precondition for energy-efficient mobility of commuters and business partners. Economic development divisions can support urban density improvements and transit-oriented development by guiding companies on their property investment decisions. If they provide land for business development, they should carry out ***traffic impact assessments*** as well as a traffic impact control. A traffic impact assessment is an analysis of the traffic likely to be generated by a proposed development. It can be used to propose traffic mitigation measures, which should be implemented if necessary.

Table 10: Relevant GIZ publications on sustainable urban transport

FURTHER READING
■ Module 2a: Land Use Planning and Urban Transport

Figure 31: BRT and real estate advertisement in Jinan, China. Source: Carlos Pardo, 2008

3.1.5 Financial divisions (treasury/finance/taxation)

Table 11: Energy Efficiency Agenda for the local financial divisions

Implementation

- **Car-free travel packages**
- **Financial incentives**
- **Congestion charge**
- **Parking pricing**
- **Pay-at-the-pump surcharges**
- **Road pricing**
- **Subsidised public transport fares**

Involvement

Put on the agenda ...

- Green procurement policy for municipal vehicles (3.1.1)

Be available for consultation on, and provide data for ...

- Bicycle lanes (3.1.2)
- Bicycle parking (3.1.2)
- Bicycle route signage and maps (3.1.2)
- Bicycle sharing systems (3.1.2)
- Bike and ride facilities (3.1.2)
- Bus lanes (3.1.2)
- Bus rapid transit (3.1.2)
- Comfortable stations and vehicles (3.1.2)
- Continuous cycle network (3.1.2)
- Cycle highways and green waves (3.1.2)
- Expansion of the public transport network (3.1.2)
- Park and ride facilities (3.1.2)
- PPP to improve the public transport network (3.2.2)
- Separate crossing signals for NMT (3.1.2)
- Vehicle quota (3.1.2)

All transport programmes and measures have to be evaluated with regard to their financial viability, and some measures will require additional investments in infrastructure and personnel. Financial divisions have to provide the necessary funds to invest in suitable measures. Expenses for urban transport are generally high. Maintenance, operation and administration involve recurrent expenditures, and capital investment is necessary to provide new infrastructure or technology.

Financial divisions can introduce local road pricing schemes as a disincentive from using private motorised transport. Schemes of this kind would create additional revenue for the local authorities, which could be used to pay for expensive measures, such as energy-efficient transport infrastructure. Knowing that the additional revenues are earmarked for this purpose would also raise the public acceptance of them. Ideally, therefore, policy packages should be developed that include revenue generating economic instruments as well as the expensive infrastructural measures.

Parking pricing

Parking fees encourage commuters to use alternative modes of transport and can lead to reduced vehicle ownership among urban residents. However, a pricing scheme for parking will only be successful if alternatives to private vehicles are available. Parking pricing can reduce the total vehicle traffic, bringing benefits like lower fuel consumption and reduced environmental pollution. Moreover, parking fees are usually politically easier to introduce than road tolls, since they are already very common and can be gradually expanded. The implementation and enforcement of parking pricing is also cheaper and usually less complicated. On the other hand, pricing is most effective if it is introduced citywide, which means it requires the participation of the various different stakeholders who provide parking space.

Road pricing

Urban road pricing can be implemented for the whole city (city toll), for certain roads (toll roads) or facilities (bridge tolls) (see Case Study 5 on p. 27). In some cities the pricing scheme is limited to peak hours (***congestion charge***). Road pricing allocates the cost of road use to individual users, thereby encouraging vehicle owners to switch to other modes of transport or to drive less frequently.

In general, three different categories of road pricing can be distinguished: licence-based pricing, zone-based pricing and proportional pricing. The last category presents the most sophisticated road pricing system, as it takes the actual distance driven by each road user into account, no matter which route the driver takes. Consequently, this

category is most effective in discouraging car use. However, proportional pricing requires considerable technical investment, as each vehicle's position must be constantly tracked. Regardless of which form of road pricing is used, or the size of area covered, the design of the pricing scheme could include differentiated fees for various types of vehicle (*e.g.* according to their energy efficiency).

This measure has some weaknesses. Comprehensive road pricing is quite complex and costly. Investments in technology, infrastructure and personnel are required to collect tolls and monitor compliance. Public-private partnerships can be useful to overcome this challenge (see Box 8). Planning authorities should be aware that road tolls can encourage vehicle owners to switch to cheaper routes, with a consequent increase in travel distance.

Figure 32: Electronic road pricing in Singapore.
Source: Carlos Pardo, 2008

Box 8: Public-private partnerships

A public-private partnership (PPP) is an agreement between a private and a public party for the common funding of a transport measure. This concept is often used for expensive infrastructure investments. Its advantages are:

- The combination of practical experience on the part of the private sector partner, and the financial security of the public sector can improve the chances of a project's success.
- Risks can be shared between the parties according to which is better equipped to cope with them, and the commercial expertise of the private sector can help secure financial success.

Risks associated with PPPs are mostly on the public side. The public sector therefore has to make sure that financial risks are not only carried by them, and that exploding costs or bankruptcy of the private investor are not borne by the taxpayers.

One example of a PPP is the road pricing scheme on State Route 91 in Orange County, California. This has 10 miles of express toll lanes constructed by the California Private Transportation Company and funded by various tolls. The public partners provide maintenance and highway patrol.

Sources: Sakamoto and Belka 2010 – GTZ sourcebook 1f, VTPI 2010

Further financial instruments

Local governments can also establish ***pay-at-the-pump surcharges*** to supplement national fuel taxation (see Section 3.3.3). The customers have to pay the additional charge for gasoline at petrol stations in the municipal area.

Figure 33:
Parking meters in London, UK (left) and Brasov, Romania (right).
Source: Manfred Breithaupt, 2006 (left) and Rossmark, 2006 (right)

Additional revenues created by the above mentioned financial disincentives could be used to ***subsidise public transport fares***. Lower fares not only make the public transport system more attractive, but they also open the system to low-income families.

Cities frequently visited by tourists could also provide special financial incentives for their guests. One option for encouraging energy-efficient tourist mobility is to provide and promote ***car-free travel packages***. Guests get low-cost or free public transport tickets with their accommodation.

Similar to private companies, the financial division can also offer ***financial incentives*** to municipal employees who ***commute***, which are tied to energy-efficient modes of transport.

Table 12: Relevant GIZ publications on sustainable urban transport

FURTHER READING
■ Module 1e: Economic Instruments ■ Module 1f: Financing Sustainable Urban Transport

3.1.6 Other relevant local institutions

In addition to the divisions already mentioned, there are other local actors who play a key role in achieving energy-efficient local transport, even though they have no direct political decision-making power. These stakeholders act mainly in support of measures implemented by other actors.

Public relations divisions

For many measures, success depends on the general public paying attention. An improved and extended public transport system will only be accepted if the residents are aware of its renewal and the associated benefits. Marketing a new transit service is an important step to increase the number of people using it.

Public awareness campaigns and events are important to inform the public about the economic, environmental and social impacts of motorised transport and to promote alternative choices. A municipality can commission an agency to carry out its public awareness campaigns. To do this, it is worth considering relevant non-governmental organisations, as they often have a long record of experience with public relations.

Figure 34: PR mobility campaign in Surabaya, Indonesia (left) and Car-Free Day in Jakarta, Indonesia (right).
Source: GIZ, 2001 (left) and An Seika, 2010 (right)

Enforcement authorities

Disincentives (*i.e.* 'push' measures) are strongly linked to proper enforcement. Interventions such as parking restrictions or speed limits are meaningless if they are not enforced effectively. The police and associated institutions are the enforcing bodies, responsible for all regulatory measures to monitor compliance of road users.

The enforcing authorities are subject to the directives of the policy making body. If new traffic laws are introduced, education and training might be necessary. Campaigns could be used to inform the public that the laws will be strictly enforced. New technologies, such as licence plate video recording, could be used to support the police in their efforts.

Since enforcement is an essential requirement for the success of measures like road pricing or parking restrictions, it is important to evaluate the institutional capacity to enforce before any such measures are implemented. It is also necessary to prevent the rules being bypassed, for instance through bribery.

Often, concerns about personal security discourage people from using public or non-motorised transport, and they would rather take a taxi or use a private car if they can afford it. It is very important that the police and related institutions not only ensure road safety, but also protect the personal security of people using public transport and areas reserved for non-motorised transport (see Box 9).

Figure 35: Wheel clamp in Bogotá, Colombia.
Source: Carlos Pardo, 2006

Box 9: The importance of personal security in transport

In many cities public and non-motorised transport is perceived to be unsafe due to frequent personal attacks. Thieves take advantage of crowded public vehicles to steal passengers' valuables. Even more traumatic are cases of mugging, physical attack or verbal abuse in less crowded locations such as on board public transport during the evening hours, or in pedestrian underpasses. In several regions, the public perception of personal security is one of the main driving factors for automobile use.

Women feel particularly vulnerable in public spaces, and they face the additional threat of sexual harassment. In 2004, in a survey of 18 000 people in New Delhi, 90 % of the respondents felt that public transport was not safe for women. Attacks and harassment in public spaces and in public transport have an impact on women's travel behaviour and patterns.

To ensure the success of energy-efficient transport, it is essential to raise the level of personal security and, in so doing, to alter people's perceptions of public transport and non-motorised travel. Introducing police bicycle patrols and increasing the number of female police officers can help to reduce violence, theft and harassment. Besides increasing the police presence, deploying security personnel on board public transport or at stations can help to reduce crime rates and enhance the passengers' feeling of security. Some cities have also introduced women-only carriages to reduce sexual harassment. Better lighting and good landscaping can also improve security in public spaces. Electronic surveillance might help to reduce crime in remote places. However, increasing personal security often calls for bigger changes in the social system, and significant improvement takes time. It therefore remains a challenge for local authorities to reduce the threats to personal security as a driving factor of automobile use.

Source: World Bank 2002, Kunieda and Gauthier 2007 – GTZ *Sourcebook Module* 7a, UN-Habitat and UNESCAP 2009

3.2 Local companies and organisations

Even though stakeholders from the private sector have no direct political decision making power, their role in improving energy efficiency must not be neglected. The private sector is indeed highly significant, and city authorities need to be in close contact with local companies. If the local public transport system is operated by private companies, it is essential that the city authorities cooperate closely with them.

Other private companies can also support local efficiency strategies. For instance, retailers can help discourage vehicle use by reducing the amount of parking space they provide, or by charging for the spaces provided. Local NGOs are also key actors, since they can exert political pressure and put energy efficiency measures on the agenda.

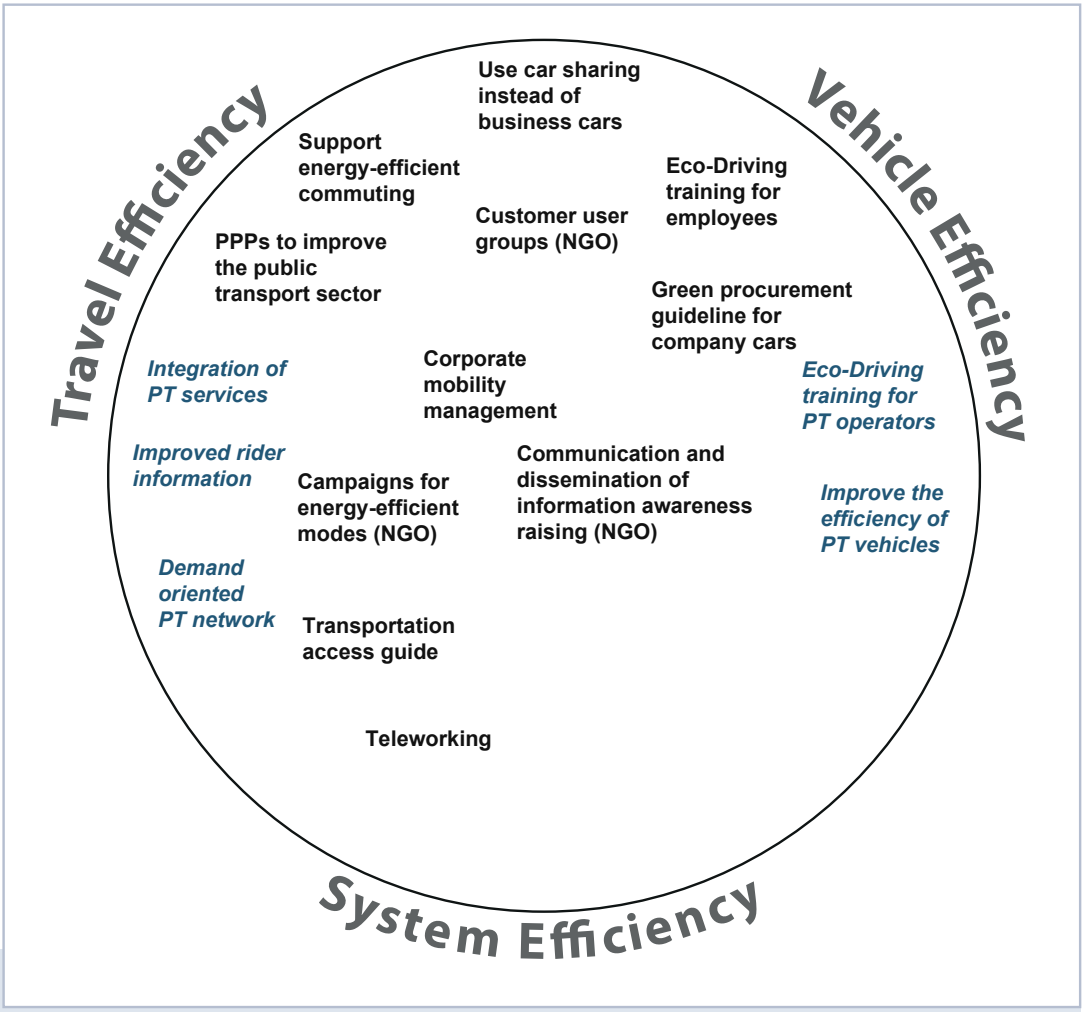

Figure 36: Energy Efficiency Navigator for local companies and organisations (*several measures grouped into fields of activity*).

3.2.1 Public transport operators

Table 13: Energy Efficiency Agenda for public transport operators

Implementation		
	■ **Demand-oriented public transport system** ■ **Improved passenger information systems** ■ **Integration of public transport services**	■ **Mandatory eco-driving for public transport operators** ■ **Procurement of energy-efficient vehicles for public transport**
Involvement	**Put on the agenda ...**	
	■ Bus lanes (3.1.2) ■ Bus priority (3.1.2) ■ Comfortable stations and vehicles (3.1.2) ■ Expansion of the public transport network (3.1.2) ■ Integration of public transport infrastructure (3.1.2)	■ Park and ride facilities (3.1.2) ■ PPPs to improve the public transport network (3.2.2) ■ Subsidised public transport fares (3.1.5) ■ Transit-oriented development (3.1.3)
	Be available for consultation on, and provide data for ...	
	■ Bus lanes (3.1.2) ■ Bus priorities (3.1.2) ■ Bus rapid transit (3.1.2) ■ Car-free travel packages (3.1.5) ■ Comfortable stations and vehicles (3.1.2) ■ Expansion of the public transport network (3.1.2) ■ Integration of NMT info public transport (3.1.2)	■ Integration of public transport infrastructure (3.1.2) ■ Job tickets (3.2.2) ■ Park and ride facilities (3.1.2) ■ PPPs to improve the public transport network (3.2.2) ■ Subsidised public transport fares (3.1.5) ■ Transportation access guides (3.1.2), (3.2.2)

In many cities, urban rail and bus systems are run by different operators. Uncoordinated networks and schedules lead to long waiting times for passengers transferring from one mode of transport to another. Different fare systems force users to buy separate tickets for each leg of their journey.

To address such shortcomings, the various local operators can be encouraged to cooperate in a single public transport network. The ***integration of public transport services*** makes the system more attractive to new users. Schedules could be adjusted to allow easy transfers between operators (see Case Study 10). A harmonised system also reduces the duplication of routes. To help users to find their way, ***improved passenger information*** could be made available at stations and inside vehicles. Information panels should display all bus routes or train lines. In addition, a common ticketing system could be implemented. Integrating services requires greater planning and communication among the operators, but it attracts new customers.

Figure 37:
Bus with advertising for a local company in Lucerne, Switzerland.
Source: GIZ Photo Album DVD, 2004

Case Study 10

Singapore's bus system – from disparate local providers to an integrated system

There are two multimodal private operators in Singapore, both of which run bus lines and a commuter rail service. In an effort to integrate their trains and buses to act as a single, comprehensive public transport network, they have set up a service company, Transit Link Pte Ltd. Transit Link facilitates fare integration, information integration and network integration.

- ***Fare integration*** is done through a common ticketing system using a contactless smart card, called the 'ez-link card', for payments. The greatest benefit is that passengers purchase a common fare-card for use on all forms of public transport. When commuters receive cash rebates for making transfers between modes, within prescribed times, it lowers their misgivings about making transfers.
- ***Information integration*** is achieved through the publication of the Transit Link Guide, which lists information on all the bus routes and train lines; Furthermore, at major bus stops information panels are installed explaining the bus services available there.
- ***Network integration*** is achieved through centralised rationalisation of bus services whenever a new train line is introduced. This reduces the wasteful duplication of bus and train services. Transit Link uses a computer model (TRIPS) that can forecast changes in commuter demand and passenger numbers when new train lines and new bus routes are added.

By integrating mobility management systems, synergies are achieved and energy-efficient transport solutions can be promoted more easily.

Source: Broaddus 2009 – GIZ TDM Training Document

Public transport companies should make sure they have a ***demand-oriented public transport system*** that targets particular travel needs. Articulated buses with large capacities and faster travel times could operate on trunk routes with large passenger volumes. Small busses making more frequent stops could connect smaller and less frequently used stations. Well-designed transport hubs could be developed, in which distances for interchange are small and users can switch more easily between different vehicles. A demand-oriented system is not only more comfortable for the passenger, it can also enhance the profitability of the network.

Figures 38a, b: '*Rendez-vous*' stops for changing between buses and trams in Basel; Switzerland (left) and Kassel, Germany (right). Source: Kuehn, 2007 (left) and 2006 (right)

Eco-driving training can help save energy and reduce fuel expenditure for the operating company. The purpose of the training is to alter drivers' driving style in order to achieve greater fuel efficiency. Key factors that influence fuel efficiency are speed, engine idling, braking, acceleration and cold starts. The average fuel savings achieved as a result of training courses in eco-driving are between 10 and 17% (Dalkmann and Brannigan 2007), which represents a significant cost reduction. However, the effects of eco-driving tend to wane after a while, if no continuous training or incentives are provided to sustain the new driving style. Eco-driving is particularly effective for professional drivers employed for bus, taxi or freight delivery fleets. As well as driving behaviour, the condition of vehicles also influences their fuel consumption. If the engine, tyres, oil, and air filters are regularly maintained, a vehicle can operate more economically.

Figure 39: Eco-friendly bus in Santa Monica, USA.
Source: Chris Wat, 2008

In developing cities public transport often relies on old buses with high fuel consumption. ***Procuring new energy-efficient vehicles*** can reduce fuel consumption as well as operating costs.

Figure 40: A CNG bus in Bangkok.
Source: Dominik Schmid, 2010

Technological improvements have enabled more fuel-efficient vehicles to be developed in recent years. Some modern vehicles use conventional fuels more economically, but alternative fuels are also available (see Box 10). These include methanol, natural gas, liquid petroleum gas (LPG), ethanol, hydrogen and electricity. Technological improvements often lead to co-benefits like emission reduction.

Box 10: Efficient vehicles for urban public transport

Hybrid propulsion is a promising technology for achieving fuel savings in urban buses. Hybrid electric-diesel vehicles combine diesel combustion engines with an electric propulsion system. The electric motor is used to accelerate the vehicle before the petroleum engine takes over. Hybrids often also use additional efficiency-improving technologies like the recovery of braking energy. The same strategy can be applied in urban rail transit. The drive motor can be used as a generator in order to feed braking energy back into the system. Due to the large number of stops in local transport, recovery of braking energy can cut electricity consumption by over 20 %.

Natural gas vehicles are a good alternative to urban buses running on diesel. Even though the vehicle efficiency is lower, the overall efficiency ('well-to-wheel') is the same as for diesel buses. However, natural gas vehicles produce lower emissions locally, which makes them preferable, especially for urban transport. Natural gas can also be replaced by biogas produced from organic waste.

Electric vehicles can be categorised according to their power supply, with some depending solely on on-board batteries, some using hydrogen-powered fuel cells, and others dependent on a grid connection. The last of these is especially useful for urban transport, as trolley buses, metros, trams and trains can all take their energy from overhead lines or third rails.

Sources: DeCicco *et al.*, 2001, BMWi 2010, Walsh and Kolke 2005 – GTZ *Sourcebook Module* 4a, MVV InnoTec – GIZ *Sourcebook Module* and 4d

Table 14: Relevant GIZ publications on sustainable urban transport

FURTHER READING
■ Module 3a: Mass Transit Options ■ Module 4a: Cleaner Vehicles and Fuels ■ Module 4e: Natural Gas Vehicles ■ Module 4f: Eco Driving ■ TDM Training Document ■ Technical Document #4: Transport alliances – promoting cooperation and integration to offer more attractive and efficient public transport

3.2.2 Other companies

Table 15: Energy Efficiency Agenda for local companies

Implementation		
	■ **Car sharing**	■ **Green procurement policy for company vehicles**
	■ **Changing facilities and bicycle parking at the workplace**	■ **Job tickets**
	■ **Commuter financial incentives**	■ **PPP to improve the public transport network**
	■ **Corporate travel policy**	■ **Rideshare matching**
	■ **Eco-driving training for employees**	■ **Teleworking**
		■ **Transportation access guide**
Involvement	**Put on the agenda ...**	
	■ Expansion of the public transport network (3.1.2)	
	Be available for consultation on, and provide data for ...	
	■ Mixed land-uses (3.1.3)	■ Transit-oriented development (3.1.3)
	■ Traffic impact assessment (3.1.4)	

Private companies and organisations generate traffic through their business activities and the daily commuting of their employees. Therefore, the location of the company is the defining factor in its transport-related energy consumption. Energy-efficient company sites are those that are well served by public transport and which can easily be accessed by bike or on foot. This is more likely to occur in areas of denser land use where people can live in close proximity to their workplace. To reflect this fact, the inherent transport cost could be included as part of the evaluation of a location.

Offices and shops could be located close to public transport stations. Through denser settlement around existing stations, companies can support transit-oriented development (see Section 3.1.3). If public transport is not accessible from a preferred location, the company could cooperate with the local land use planning authorities to develop a sustainable mobility solution.

Public-private partnerships to improve the public transport network bring benefits, both to the company involved and to the city administration (see Box 8). Paying to extend the network can help the company connect to the public transport system. Alternatively, a company might support public transport by sponsoring vehicles in return for advertising rights. The company could also build or maintain bus shelters on a similar basis.

Figure 41: Sponsored tram in Budapest, Hungary.
Source: Rossmark, 2006

To reduce the amount of transport energy directly consumed by a company or its employees, the company can develop a mobility management strategy to make its business trips and commuter traffic more efficient. To implement this, a ***corporate travel policy*** can be introduced that encourages employees to use energy-efficient travel for business trips whenever possible. Moreover, there are

also a number of possible ways in which to encourage more efficiency among commuting employees:

1. Instead of providing them with free parking, a company can give its employees ***financial incentives to commute*** using only energy-efficient modes of transport. Alternatively, it can reduce the number of parking spaces and charge for parking.
2. Large companies or groups of individual firms can negotiate with the local transport operator to introduce a ***job ticket system*** that reduces the cost for employees to come to work by public transport.
3. For employees without proper access to public transport, a ***car sharing programme*** can be set up, which helps them organise carpools or vanpools. For measures such as these, it helps if working hours are flexible, as employees can then adjust to carpool and public transport schedules.
4. To encourage people to cycle to work, a company can provide appropriate infrastructure, such as ***changing facilities***, showers and ***bicycle stands***.
5. Another way of reducing a company's transport demand is ***teleworking***, which enables employees to work at home.
6. If its premises are very large, a company can provide bicycles or operate a company bus to move workers around.

A company can provide a ***transportation access guide*** for its customers and business partners, which describes how to reach it using non-motorised or public transport.

A ***green procurement policy for company vehicles*** could be integrated as standard, under the corporate philosophy. This would require that energy efficiency and environmental performance are considered for vehicle purchases. A fleet management programme ensures that the vehicles are properly maintained and that vehicles of an appropriate size are used for each trip. Rental cars or ***car sharing*** – a kind of neighbourhood rental service that hires out cars on an hourly basis – can be used to complement or replace a company-owned fleet. A company can also provide training for its drivers in ***eco-driving*** techniques.

Besides passenger transport, freight transport could also be incorporated into the mobility management strategy. By improving scheduling and routing, freight vehicle mileage can be reduced and load factors increased. Some of the larger private carriers can often deliver goods more efficiently than company fleets, as they can combine different loads and avoid travelling empty on return trips. Companies can also stipulate that their goods are transported using efficient modes of transport. For instance, as with passenger travel, rail transport or shipping is more energy-efficient than road transport.

Figure 42: Large companies served by public transport in Frankfurt, Germany.
Source: Jonathan Gomez, 2011

Figure 43: Company bikes located at the P+R station in Eschborn Süd, Germany.
Source: Jonathan Gomez, 2011

Table 16: Relevant GIZ publications on sustainable urban transport

FURTHER READING
■ Module 1c: Private Sector Participation in Urban Transport Infrastructure Provision ■ Module 1g: Urban Freight in Developing Cities ■ Module 2b: Mobility Management ■ Module 3d: Preserving and Expanding the Role of Non-motorised Transport ■ Module 4a: Cleaner Fuels and Vehicle Technology ■ Module 4f: Eco Driving ■ TDM Training Document ■ Mobility management & commuting: inputs and examples of best practice in German firms (Case Studies in Sustainable Urban Transport #5)

3.2.3 Non-governmental organisations

Table 17: Energy Efficiency Agenda for non-governmental organisations

Implementation		
	■ **Campaigns for energy efficient modes of transport**	■ **Customer user groups**
Involvement	**Put on the agenda ...**	
	■ Bicycle lanes (3.1.2) ■ Bicycle parking (3.1.2) ■ Bicycle parking and changing facilities at workplaces (3.2.2) ■ Bicycle route signage and maps (3.1.2) ■ Bike and ride facilities (3.1.2) ■ Car free days (3.1.2) ■ Commuter financial incentives (3.2.2) ■ Continuous cycle network (3.1.2) ■ Green procurement of energy-efficient vehicles for public transport (3.2.1)	■ Integration of NMT into public transport (3.1.2) ■ Job tickets (3.2.2) ■ National cycling plan ■ Pedestrian zones (3.1.2) ■ Rideshare matching (3.2.2) ■ Safe sidewalks and crossings for NMT (3.1.2) ■ Separate crossing signals for NMT (3.1.2) ■ Teleworking (3.2.2)
	Be available for consultation on, and provide data for ...	
	■ Bicycle route signage and maps (3.1.2) ■ Car free days (3.1.2)	■ Corporate travel policy (3.2.2)

Non-governmental organisations (NGOs) can play an important role in adjusting services and infrastructure to the needs of the users, if local administrations involve them in the decision making process. Transport and environmental organisations, for instance, can contribute to strategy formulation. Participation increases public acceptance, and at the same time imparts in-depth knowledge of people's needs. Customer user groups can identify weaknesses in the local transport system, *e.g.* barriers to cycling and walking in the existing infrastructure (see Case Study 11). NGOs could also act as advisors on improving the public transport services.

It can also be useful to cooperate with NGOs when organising campaigns such as bike-to-work programmes,

community cycling events or car-free days. Other NGO-based campaigns might include awareness raising activities to inform the public about the advantages of energy-efficient modes of transport.

Figure 44: NGO action 'Cyclists' Solidarity Ride' in Johannesburg, South Africa. Source: GIZ Photo Album, 2004

Case Study 11

Urban Cyclist Association of Buenos Aires

A bicycle user group (BUG) is an organisation set up by cyclists with the aim of improving cycling conditions in their local area. BUGs vary in size and purpose. They may meet on a regular basis to consider strategies to improve cycling in their community, in their building or on their university campus. BUGs also get involved in transport planning where they can advocate positive changes to the physical infrastructure as well as policy changes. BUGs encourage local governments to provide better facilities and safer routes for commuter cyclists, for children riding to schools and for recreational cyclists. An excellent example of an active BUG is the Urban Cyclists' Association (ACU) of Buenos Aires, which conducts rallies, seminars, forums, and special events. It organises social rides, publishes a newsletter and a bicycle manual, and makes presentations at schools. ACU also carries out studies on issues such as bicycle parking and the integration of cycling with commuter rail services, and it provides detailed recommendations to the municipal government. The main function of an urban BUG is to be a focus for bicycle advocacy at the local level, making sure that discussions address detailed proposals. However, the roles of BUGs are more varied than that.

- They can provide a forum for cyclists to meet, discuss local bicycle issues, and hold social events;
- They work with the city government to improve conditions for cycling;
- They help other people to start cycling (neighbours, friends, work colleagues, fellow students);
- They arrange social rides in their city, and participate in local festivals and community events.

Source: Fjellstrom and Pardo 2006 – GTZ *Sourcebook Module 1e: Raising Public Awareness about Sustainable Urban Transport*

Table 18: Relevant GIZ publications on sustainable urban transport

FURTHER READING
■ Module 1e: Raising Public Awareness about Sustainable Urban Transport
■ Module 3e: Car-Free Development

3.3 National governments

National governments play an important role in urban transport. For the countrywide establishment of energy-efficient transport, national governments have to create favourable conditions and support local initiatives. The commitment of national governments is essential, because it is the national strategies, programmes and legislation that underpin local policies.

To start with, national authorities can influence local budgets for the transport system. They administer national taxes and decide on the disbursement of grants and subsidies to local governments, and they are usually also responsible for supporting research and development, and pilot projects.

Furthermore, national taxation schemes or financial incentives can influence how citizens choose their means of transport. Fuel prices, which are regulated by the national government, shape the country's transport structure. If the national government subsidises fuel or does not implement proper fuel taxation, private motorised vehicles will dominate the transport system and in many cases the government will lack the necessary financial resources to provide a high quality transport infrastructure.

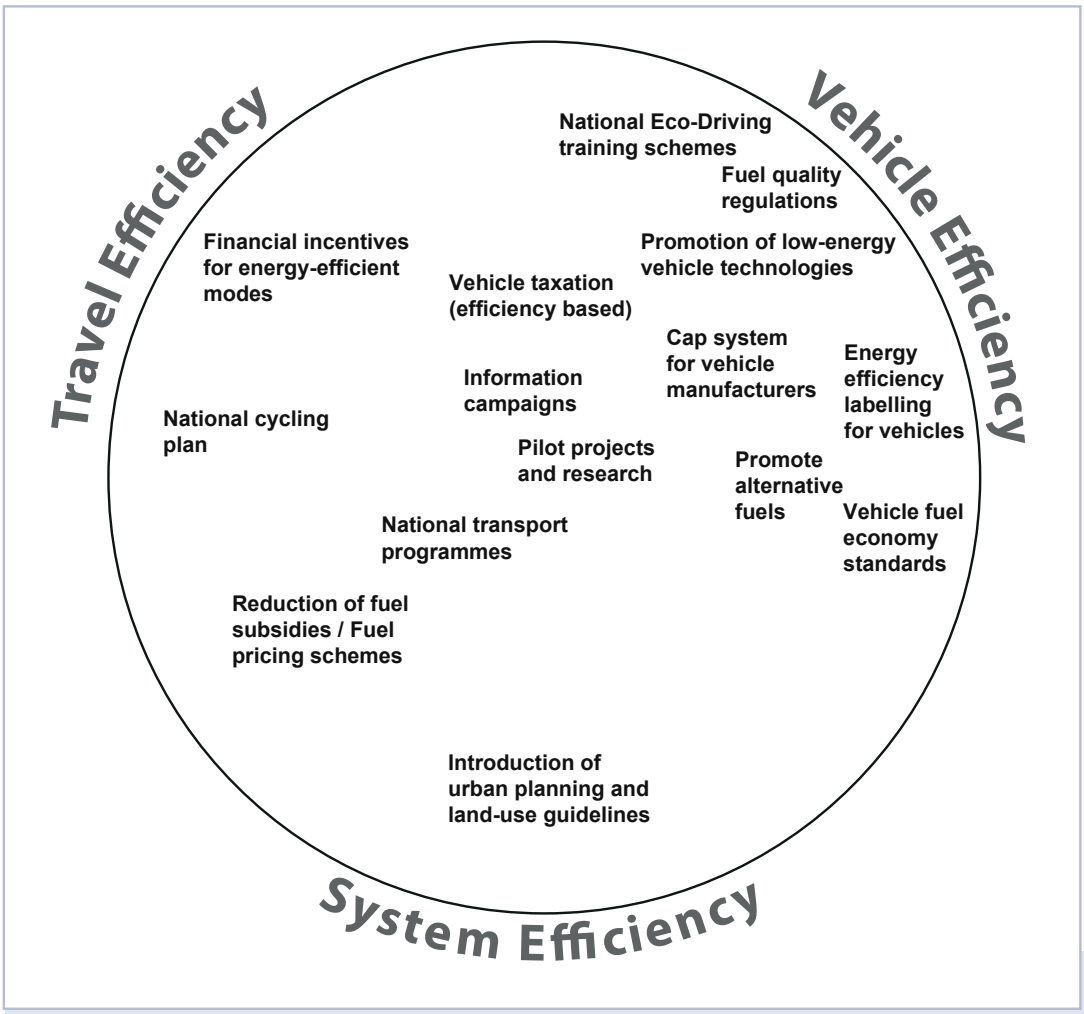

Figure 45: Energy Efficiency Navigator for national governments (*several measures grouped into fields of activity*).

3.3.1 Transport ministries

Table 19: Energy Efficiency Agenda for transport ministries

Implementation		
	■ **National transport programme** ■ **National eco-driving training schemes**	■ **National cycling plan** ■ **Urban planning guidelines**
Involvement	**Put on the agenda ...**	
	■ Alternative fuels (3.3.4) ■ Annual vehicle registration tax (3.3.3) ■ Electricity from renewables (3.3.4) ■ Energy-saving vehicle components and accessories (3.3.5) ■ Expansion of the public transport network (3.1.2) ■ Financial incentives for energy-efficient modes (3.3.3)	■ Fuel taxation (3.3.3) ■ Sales tax (3.3.3) ■ Pilot projects and research (3.3.5) ■ Reduction of fuel subsidies (3.3.3) ■ Vehicle fuel economy standards (3.3.2)
	Be available for consultation on, and provide data for ...	
	■ Annual vehicle registration tax (3.3.3) ■ Bus rapid transit (3.1.2) ■ Financial incentives for energy-efficient modes (3.3.3) ■ Fuel taxation (3.3.3) ■ Innovative technologies and design of vehicles (3.3.5)	■ Pilot project and research (3.3.5) ■ Sales tax (3.3.3) ■ Vehicle fuel economy standards (3.3.2)
	Create a legislative framework for ...	
	■ Car-free days (3.1.2) ■ Congestion charges (3.1.3) ■ Environmental zones (3.1.2) ■ Parking pricing (3.1.3)	■ Plate restrictions (3.1.2) ■ Road pricing (3.1.3) ■ Speed restrictions (3.1.2) ■ Vehicle quota (3.1.2)

Transport ministries usually develop the national transportation policy and organise public transport, being responsible for the construction and maintenance of the necessary infrastructure. They have a key role as they allocate financial resources to the different modes of transport. Many countries spend a large portion of their budget on expanding their automotive infrastructure, leaving few resources for public transport, or for cycling and walking infrastructure. Reversing this trend in national transport planning is an essential first step.

Like local transport authorities, transport ministries have an important part to play in strategy development and coordination. They can help local actors to identify and establish suitable policies and measures to promote energy-efficient transport, and they can publish country-specific ***urban planning guidelines*** that encourage the efficient management of transport.

Any comprehensive strategy or plan for an energy-efficient transport has have to be developed at the national level.

One key policy can be a ***national transport programme*** that provides financial support to cities which set up their own local strategies for energy-efficient transport, in order to help them implement those strategies. India's Jawaharlal Nehru National Urban Renewal Mission (JNNURM) is an impressive example (for details, see Case Study 12 in Section 4). Another example is Germany's *Gemeindeverkehrsfinanzierungsgesetz* (GVFG), a law that provides for the financing of municipal transport. In both cases, financial support for public transport is linked to specific quality and environmental standards as well as the development of comprehensive local transport plans.

A ***national cycling plan*** can support and promote cycling in urban areas. In Europe there are many examples of this, for instance in the Netherlands, Germany and Finland. These national plans define objectives and set targets. They may also outline a set of activities that can be carried out at national and local levels. A national cycling plan demonstrates political will and commitment, and it raises awareness of cycling as an energy-efficient and sustainable mode of transport.

Figure 46: People riding bikes in Beijing, China.
Source: Manfred Breithaupt, 2006

Training in eco-driving techniques can reduce fuel consumption for just a small investment (see Section 3.2.1). The advantage of eco-driving over technological improvements is that energy savings can be achieved in both new and old cars. Several countries have eco-driving programmes at the national level (*e.g.* Netherlands and Austria). National governments can support eco-driving by promoting the training courses and encouraging the deployment of in-car feedback instruments. Transport ministries can introduce national eco-driving training schemes, and could also make eco-driving education a mandatory part of obtaining a driver's license. Under European Union regulations, for instance, it is already compulsory to teach eco-driving to learner drivers (Kojima and Ryan 2010). As well as mandatory training, awareness campaigns can also influence driving behaviour very successful. Communication campaigns backed up with information material can achieve fuel savings of around 5 % among individuals who respond to them (Kojima and Ryan 2010). However, experience shows that the effects of eco-driving training wane after a certain time if there are no further incentives to drive economically.

Table 20: Relevant GIZ publications on sustainable urban transport

FURTHER READING
■ Module 1f: Financing Sustainable Urban Transport
■ Module 2a: Land Use Planning and Urban Transport
■ Module 3d: Preserving and Expanding the Role of Non-motorised Transport
■ Module 4f: Eco Driving
■ TDM Training document

3.3.2 Environment ministries

Table 21: Energy Efficiency Agenda for environment ministries

Implementation		
	■ **Caps for vehicle manufacturers**	■ **Vehicle fuel economy standards**
	■ **Energy efficiency labelling for vehicles**	
Involvement	**Put on the agenda ...**	
	■ Annual vehicle registration tax (3.3.3)	■ Fuel quality regulations (3.3.4)
	■ Campaigns for energy-efficient modes of transport (3.2.3)	■ Innovative technologies and design of vehicles (3.3.5)
	■ Electricity from renewables (3.3.4)	■ National eco-driving training schemes (3.3.1)
	■ Energy-saving vehicle components and accessories (3.3.5)	■ Reduction of fuel subsidies (3.3.3)
	■ Fiscal incentives for energy-efficient modes of transport (3.3.3)	■ Sales tax (3.3.3)
	Be available for consultation on, and provide data for...	
	■ Alternative fuels (3.3.4)	■ Fuel taxation (3.3.3)
	■ Annual vehicle registration tax (3.3.3)	■ Pilot projects and research (3.3.5)
	■ Electricity from renewables (3.3.4)	■ Urban planning guidelines (3.3.1)
	■ Financial incentives for energy-efficient modes of transport (3.3.3)	
	Create a legislative framework for ...	
	■ Alternative fuels (3.3.4)	■ Denser development of cities (3.1.3)

National environment ministries are key players in support of energy efficiency, because it is in their interest to promote sustainable and environmentally friendly transport systems. Either directly or through support for local initiatives, environment ministries can help reduce the fuel consumption of entire national vehicle fleets.

Vehicle fuel economy standards are an important tool for reducing fuel consumption in the long run, as they induce positive changes in the ratio between distance travelled and fuel consumed. Usually, fuel economy standards address new vehicles and encourage the automotive industry to invest in technological improvements. Fuel economy standards have been implemented in several countries (*e.g.* South Korea, China, Japan, the United States, and the European Union). Some of the standards are mandatory, some are voluntary. In a review of fuel economy policies in selected countries, the IEA (2009b) found that tight mandatory fuel efficiency standards are instrumental in achieving rapid technology adoption and avoiding increases in vehicle size, weight and power. Due to the slow rate of vehicle replacement, tighter vehicle standards can easily take ten years or more to have their full effect.

Figure 47: Cars in Bucharest, Romania.
Source: GIZ Photo Album, 2004

Similar to fuel economy standards for specific vehicle classes are ***capping systems applied to vehicle manufacturers***. Vehicle manufacturers are targeted directly if minimum values are set for the energy efficiency of their overall fleets, *i.e.* by capping the permissible average CO_2 emissions or energy consumption. A dynamic threshold for emissions can be introduced for the whole fleet of a single manufacturer. An example of this is the European Union's regulation on CO_2 emissions for new cars. If a manufacturer exceeds the limit for the fleet average, it has to pay a fine.

Even if a mandatory standard is not implemented, a national database for the fuel economy of all registered vehicles can be introduced to allow local and national authorities to promote cleaner vehicles. This includes the definition of a driving cycle that allows vehicles to be compared, and provides data for other regulations such as environmental zones (see Section 3.2.1.4). Road pricing or taxation can also be differentiated according to the fuel economy of the vehicles.

A simple fuel economy rating system for vehicles is a good way of keeping car-buyers informed. ***Vehicle labelling***, also for customer information, can be a useful instrument to push vehicle manufacturers to produce more energy-efficient vehicles. Such rating systems encourage customers to take efficiency characteristics into account when they buy a new car.

Box 11: Labelling – an option for promoting efficient vehicles?

Eco-labelling, which has become increasingly popular for food products and consumer electronics, is mutually beneficial, as customers can (in theory) be confident they are buying environmentally friendly products while, at the same time, a label makes a product more attractive, which is beneficial for the producing company. On the down side, it is possible for companies to practise 'greenwashing', to invent their own new labels, or to lower the standard of the awarding organisation.

More recently the concept of labelling has been introduced for private motorised vehicles, especially passenger cars. Here, the labels are awarded according to the cars' fuel efficiency. This approach has been taken in the USA, where the labels are graded from A+ to D, and in the European Union, where Directive 1999/94/EC promotes the use of the eco-label shown here.

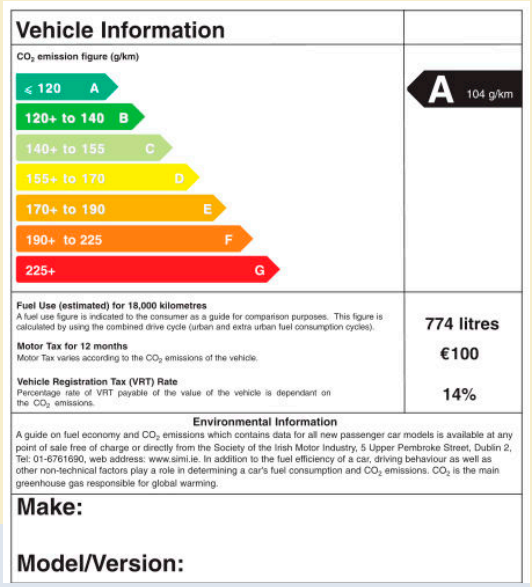

Figure 48: Irish car label.
Sources: EC 2009

Table 22: Relevant GIZ publications on sustainable urban transport

FURTHER READING
■ Module 4a: Cleaner Fuels and Vehicle Technology ■ TDM training document

3.3.3 Treasuries and ministries for financial affairs

Table 23: Energy Efficiency Agenda for ministries of finance

Implementation	
■ **Annual vehicle registration tax** ■ **Financial incentives for energy-efficient modes** ■ **Fuel taxation**	■ **Reduction of fuel subsidies** ■ **Sales tax**
Involvement	
Put on the agenda ...	
■ National transport programmes (3.3.1)	
Be available for consultation on and provide data for ...	
No activities identified	
Create a legislative framework for ...	
■ Expansion of the public transport network (3.1.2) ■ National transport programmes (3.3.1)	■ Pay-at-the-pump surcharges (3.1.5)

Treasuries and ministries of finance can introduce tax regimes which support the use of energy-efficient vehicles or modes of transport. Such a measure could do more than just create additional revenue, as energy efficiency measures also induce other financial co-benefits associated with energy savings. Finance ministries can take these long-term cost savings into consideration when a transport measure is being discussed. Traffic reduction, modal shifts towards energy-efficient travel, and higher vehicle efficiency all help to reduce the external costs of inefficient transport, such as congestion, accidents, infrastructure wear, air pollution, noise and climate change. Fuel or vehicle taxes help to internalise these external costs by linking them directly to the cost of a vehicle.

An important measure for slowing down the rate of motorisation, where applicable, is the ***reduction of fuel subsidies***. Fuel subsidies are a key incentive for any one to drive a motorised vehicle, and they can become a huge financial burden on a state's budget. If such subsidies are in place, finance ministries are well advised to reduce them as soon as possible. In doing so, they will eliminate the misguided incentives and avert the many adverse consequences described in Box 12.

Box 12: Arguments against fuel subsidies

Governments in developing countries argue that fuel prices have to be low to promote economic growth and social equity. Consequently, many developing countries lack a proper fuel taxation policy, or they have subsidised fuel prices. However, there are disadvantages to such policies:

1. Low fuel prices result in higher fuel consumption due to growth in vehicle travel and trend for larger vehicles.
2. Fuel taxation is essential if a state is to expand and maintain a nationwide infrastructure network. In the long run, subsidised fuel prices hamper economic growth.
3. Middle- and high-income motorists profit from fuel subsidies, not the poor. The lowest-income groups account for just a very small proportion of the total fuel consumed.
4. Low fuel prices lead to more traffic, with knock-on effects such as land use dispersion, pollution, congestion and accidents.

To conclude, it is far better to reduce overall fuel costs by increasing the efficiency of vehicles, and to establish affordable public transport options which provide poor people with the transport services they need.

Fuel taxation is another key step in discouraging the use of private cars. Since additional costs are directly proportional to a car's fuel economy, such a tax favours the use of more efficient vehicles, as well as economical driving behaviour. Fuel taxes are a reliable source of revenue for the country and provide financial resources that can be invested in sustainable transport projects. The taxes are usually easy to collect, since they only need to be levied at a few refineries or fuel distribution centres.

To make vehicle ownership less attractive, ***sales taxes*** or annual registration taxes can be increased. By including rebates for cars with greater fuel economy, this measure can be designed in such a way that it speeds up the replacement of the national fleet with more efficient cars (see Case Study 8 on p. 31). With ***annual vehicle registration taxes*** the existing fleet of motorised vehicles can be addressed. The tax is often levied as a road tax that contributes to the construction and maintenance of road infrastructure. If the tax is differentiated based on engine size, type of vehicle, and overall fuel consumption, it can encourage the use of energy-efficient vehicles and prompt fleet turnover.

Figure 49:
'Telepass' electronic toll collection in Lombardy, Italy.
Source: Jonathan Gomez, 2011

The national tax scheme should not only provide disincentives for inefficient mobility, but should also encourage a switch to public or non-motorised transport by providing ***financial incentives***. One option is to make public transport expenses tax deductible. Another is to provide subsidies that lower the cost of certain modes of transport. Financial support from the national government for the public transport network and its operation mean that customers can profit indirectly from the resulting network expansion, higher frequency of services or renewal of infrastructure.

Many local governments face the challenge of simultaneous motorisation and urbanisation. This leads to a huge financial burden. Therefore, it is essential that cities get support from the national level, for example through national transport policies (see Section 3.3.1). The financial division could provide financial support for local urban infrastructure projects. For instance, under the Indian JNNURM programme (see Case Study 12 Section 4.1.1) cities can request grants in order to purchase buses for city operators. Another approach is to use tax relief to increase external investments in the transport system by attracting foreign investors or promoting public-private partnerships. Moreover, international funds exist to support sustainable, climate friendly transport. Since most energy efficiency projects also reduce CO_2 emissions, additional financial resources can be tapped.

Figure 50: Prices of conventional gasoline and ethanol at a gas station in Rio, Brazil.
Source: Manfred Breithaupt, 2011

Table 24: Relevant GIZ publications on sustainable urban transport

FURTHER READING
■ Module 1d: Economic Instruments ■ Module 1f: Financing Sustainable Urban Transport ■ Technical Document No. 5: Accessing climate finance for sustainable transport: a practical overview ■ GIZ Fuel prices series

3.3.4 Ministries of energy

Table 25: Energy Efficiency Agenda for ministries of energy

Implementation		
	■ **Alternative fuels** ■ **Electricity from renewables**	■ **Fuel quality regulations**
Involvement	**Put on the agenda ...**	
	■ Fuel taxation (3.3.3) ■ Innovative technologies and design of vehicles (3.3.5)	■ Pilot projects and research (3.3.5) ■ Reduction of fuel subsidies (3.3.3)
	Be available for consultation on, and provide data for ...	
	■ Annual vehicle registration tax (3.3.3) ■ Cap system for vehicle manufacturers ■ Fuel taxation (3.3.3)	■ Innovative technologies and design of vehicles (3.3.5) ■ Pay-at-the-pump surcharges (3.1.5) ■ Vehicle fuel economy standards (3.3.2)
	Create a legislative framework for ...	
	■ Pay-at-the-pump surcharges (3.1.5)	■ Pilot projects and research (3.3.5)

Ministries of energy should strive for energy savings and promote the use of alternative fuels to enhance national energy security. ***Fuel quality regulations*** can be used to ensure optimal fuel use, and they are essential to promote the adoption of ***alternative fuels***. Cars are usually designed to use fuel of a certain quality, and deviation from that can reduce engine performance. Advanced engine technologies often have particularly tight fuel composition constrains. To enable market penetration of alternative fuels, it is essential that each fuel type meets the predefined specifications, to ensure their compatibility with the respective engine technologies.

A national strategy could be developed that clearly facilitates greater use of alternative, low-carbon fuels as a substitute for petroleum wherever possible. Ministries of energy have the expertise to evaluate different types of fuel and to give advice on fuel preferences. Methanol, natural gas, liquid petroleum gas, ethanol, biodiesel, hydrogen and electricity are all currently discussed as alternatives for gasoline and diesel. However, while the total oil consumption might be reduced, introducing alternative fuels does not necessarily mean that vehicles will operate more energy-efficiently.

Using liquid petroleum gas (LPG) for transport does result in higher energy efficiency, because it is usually otherwise burned off as a waste gas at oil fields or refineries. Compressed natural gas (CNG) is widely used in the transport sector and provides benefits in comparison to gasoline driven vehicles because of the lower carbon content. Some governments in Asian and Latin American countries have already promoted the use of CNG in urban transport to reduce air pollution and energy dependence (Vossenaar 2010). However, if CNG is used to replace diesel, or if there are any gas leakages, the benefits are less significant. Finally, the sustainability of electric vehicles using battery technology depends to a great extent on the way a country generates its electricity (see Box 13).

Box 13: Electric vehicles

Electric trains, light rail systems, trams and trolleybuses are already in common use in Europe and Asia. For a few years now, many countries have been trying to promote the use of electric motors in private vehicles as well. Battery electric vehicles (BEVs) take all their energy from rechargeable battery packs, whereas plug-in hybrid vehicles (PHEV) have an internal combustion engine as well, with only some of their power provided from an external electricity supply.

During operation, the energy efficiency of electric vehicles is much higher than that of conventional cars and they do not emit any CO_2 or other pollutants while driving. At the local level, improved air quality and reduced noise are major advantages of electricity as a fuel.

For the evaluation of the overall efficiency, a life-cycle-analysis has to be conducted.

Firstly, the extraction of raw materials such as lithium for the batteries requires enormous amounts of energy and causes pollution, mainly in developing countries. Recycling the batteries is a challenge as well.

Secondly, the efficiency and the environmental performance of electricity generation and distribution vary from country to country, so the overall advantage of electric vehicles has to be assessed carefully. In terms of greenhouse gases, their potential to reduce emissions also depends to a large extent on that electricity mix.

Even if there are environmental advantages associated with electric vehicles, there are challenges involved in managing the shift. Electric propulsion using batteries as the power source is still hampered by the problem of storing sufficient on-board energy. With the existing battery technology, the range of such cars is at present mainly limited to urban areas. To promote electric cars, Beijing, Shanghai and Tianjin have recently introduced charging stations. Another disadvantage of electric vehicles, is the need for a proper, ubiquitous electricity grid.

With the current state of the electricity supply and available technologies, electric cars can still only make a limited contribution of to energy-efficient urban transport. However, it might be technology for the future. Already today, electric scooters and bikes are an option in urban areas. For example, there are already more than 120 million electric two-wheelers in China. Especially in large cities the number of electric bicycles has increased tremendously in recent years.

Source: Associated Press 2009; Cherry *et al.*, 2007; Financial Times Deutschland 2009

In general, the complete life cycle should be considered when alternative fuels are compared. These fuels and the associated technologies are at various stages of development. Their availability and competitiveness, both now and in the future, have to be evaluated carefully. Each country has to consider its own environmental challenges, financial resources, technical capabilities, oil import costs and natural resources when selecting promising alternative fuels. The energy ministries can promote alternative fuels by providing incentives for the necessary infrastructure investments (*e.g.* refuelling stations, pipelines). Furthermore, market-creation measures can be used to support the success of new engine and fuel technologies.

Another major responsibility for ministries of energy is to manage the mix of electricity generation. The national energy strategy could be designed in a way that promotes ***electricity generation from renewable energy***. This affects the transport sector in terms of railway electrification and future electrification of private vehicles. In many countries, the railway system already uses electric locomotives, at least on the main lines. The advantages of electric motors are not only their high efficiency, but also the fact they produce fewer emissions and less noise.

Figure 51: Electricity generated by coal power plants significantly reduces the climate benefits of electric vehicles: A coal power plant near Hanau, Germany.
Source: Dominik Schmid, 2009

Table 26: Relevant GIZ publications on sustainable urban transport

FURTHER READING
■ Module 1f: Financing Sustainable Urban Transport
■ Module 4a: Cleaner Fuel and Vehicle Technologies
■ Module 4d: Natural Gas Vehicles

3.3.5 Ministries of economic affairs and technology

Table 27: Energy Efficiency Agenda for ministries of economic affairs and technology

Implementation	
■ **Energy-saving vehicle components and accessories** ■ **Innovative technologies and design of vehicles**	■ **Pilot projects and research**
Involvement	
Put on the agenda ...	
■ Cap system for vehicle manufacturers (3.3.2) ■ Fuel quality regulations	■ Vehicle fuel economy standards (3.3.2)
Be available for consultation on, and provide data for ...	
■ Cap system for vehicle manufactures (3.3.2) ■ Fuel quality regulations (3.3.4)	■ Vehicle fuel economy standards (3.3.2)
Create a legislative framework for ...	
No activities identified	

Ministries of economic affairs and technology can lead efforts to promote an energy-efficient or low-fossil-fuel economy, and they should not neglect the transport sector as part of this strategy. To open the way to further progress in alternative transport, ministries of economic affairs could provide special support for research into energy efficiency technologies in the vehicle industry.

For countries with a significant automotive industry, public support for ***innovative technologies and vehicle design*** offers potential for energy savings. Lightweight construction, downsizing and aerodynamic improvements are all areas of research that can help reduce vehicle fuel consumption. Economic and technology ministries can also encourage progress in developing ***energy-saving vehicle components*** and accessories such as:

- Low-friction engine lubricants;
- Automatic engine idle;
- Gear shift indicators, which ensure drivers use the ideal gear at each speed;
- Tyres with low rolling resistance (about 20% of vehicle fuel consumption is used to overcome the rolling resistance of the tyres);
- Tyre pressure monitoring systems (when tyres are soft, a lowering of 5 bar results in 2 to 5% increase in fuel consumption – Álvarez 2008).

These ministries can also initiate and support ***pilot projects and research***, which are necessary for identifying promising measures and possible barriers to implementation. The results can then be shared with local authorities.

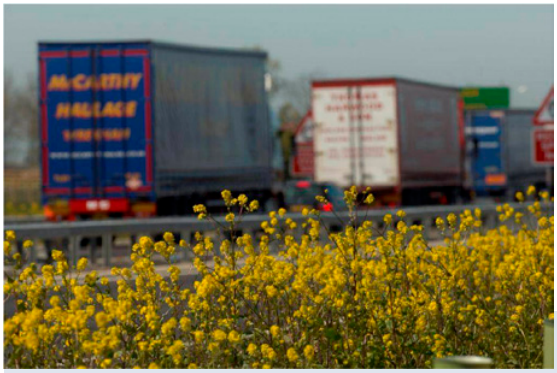

Figure 52: Heavy trucks on the M1, UK.
Source: Highways Agency, unknown date

Table 28: Relevant GIZ publications on sustainable urban transport

FURTHER READING
■ Module 4a: Cleaner Fuel and Vehicle Technologies

3.4 Joining forces

Local decision makers and stakeholders are key actors in the improvement of energy efficiency in urban transport. Local transport authorities play a key role in strategy development and coordination. At the same time, an appropriate national framework and supportive national measures – again coordinated by transport ministries – can inspire more successful approaches to energy efficiency. The conclusion must be, therefore, that local and national actors should join forces. This can be achieved, for example, through round table discussions.

The examples presented throughout this document give just a small taste of the knowledge and experience that are available from other cities. There should be even more opportunities to pursue exchanges of ideas and innovative approaches:

- Local authorities could exchange their experiences and their ideas for enhancing energy efficiency, and national authorities can support these exchanges.
- National programmes or partnerships across national borders can be helpful. The European CIVITAS Initiative is a programme promoting cooperation between cities in Europe on innovative approaches for urban transport (http://www.civitas-initiative.org).
- National or international associations such as the UITP – the *International Association for Public Transport* – can facilitate communication across cities and borders.

By way of a conclusion to the presentation of policies and measures given here, the next section will highlight the importance of policy packages. Strategies and planning can result in policy packages that combine several of the measures discussed above. However, developing and implementing such packages calls for close cooperation between the key actors that have been mentioned. The next section will therefore focus on the questions: How do we take the first steps? How can policies be bundled? And how should we develop guidelines on increasing energy efficiency?

4 Policy packages for energy-efficient urban transport – exploiting synergies

To achieve the full potential of energy efficiency policies and measures, it is important to appreciate the complexity of the transport sector. Single, uncoordinated measures can have only limited success. A proper policy to enhance energy efficiency in the urban transport system must address all three levels of energy-efficient transport: system efficiency, travel efficiency and vehicle efficiency. Strategies and policy packages deliver that kind of mixed approach. Ideally, positive incentives ('pull' measures) need to be supported by disincentives ('push' measures).

A well developed and convenient public transport infrastructure can attract more passengers, but that is often not enough, in itself, to inspire a major shift from private car use to public transport. Underlying factors that sustain car use, such as convenience and status, continue to prevent people who can afford cars from using public transport. Therefore, steps have to be taken to overcome these factors, such as pricing measures that increase the cost of car use, or parking restrictions that reduce the convenience. These steps will prompt a more rapid shift towards energy-efficient modes of transport (see Case Study 14 on p. 104).

Measures with push- and pull-effects
Redistribution of carriageway space to provide cycle lanes, broader sidewalks, planting strips, bus lanes..., redistribution of time-cycles at traffic lights in favour of public transport and non-motorised modes, public-awareness-concepts, citizens' participation and marketing, enforcement and penalizing...

Source: Müller *et al.*, (1992)

Figure 53: The push–pull approach.

Policy packages of varying complexity can be introduced. It is important to involve a number of different actors, and the different organisations must cooperate effectively if they are to achieve any positive multiplier effect from the complex policy packages. A successful example is the Indian Jawaharlal Nehru National Urban Renewal Mission (JNNURM, see Case Study 12 p. 96), which has managed to initiate comprehensive strategies across different levels.

Case Study 12

Jawaharlal Nehru National Urban Renewal Mission (JNNURM), India

In India, strong economic growth coupled with a rapidly growing urban population has prompted increased demand for individual housing. This has caused urban sprawl and an ever-increasing demand for mobility.

As a result, huge pressure has been placed on the resources available to Indian cities, and their development patterns have become unsustainable. The introduction of innovative financing concepts is necessary to start projects for energy-efficient transport.

The Jawaharlal Nehru National Urban Renewal Mission (JNNURM) is a financial project that is being used to improve the overall situation and provide adequate infrastructure in the cities. It provides a platform on which to coordinate the significant amounts of financial support being delivered by the central government to selected cities in India for urban infrastructure projects from.

Cities identified by the Mission are expected to formulate comprehensive city development plans (CDPs) for a period of 20 to 25 years, indicating policies, programmes, strategies and financial plans. Based on the CDPs, more detailed project reports are to be developed related to land use, environmental management and urban transport initiatives. At present, 112 transport and transport related projects are receiving USD 2 billion in financial support – some 23 % of the total 478 approved infrastructure projects.

Examples of sustainable urban mobility projects supported under the JNNURM are the various bus rapid transit systems (BRTS) that are being developed. There are currently BRTS proposals at various stages of appraisal and implementation. Such systems have already been implemented successfully in a number of Indian cities, including Ahmedabad, Pune, Bhopal or Jaipur.

Through the JNNURM, cities are now also able to request grants in order to purchase buses for city bus operations. In this context, support has been granted for a total of 15 260 buses in 61 cities across the country.

Source: Bongardt *et al.*, 2010

4.1 Step by step towards an energy-efficient transport system

This section describes a step by step approach to policy packages. The underlying idea is that cities are different, and at different stages of development. However, they can choose their optimal policy mix from a policy toolbox. The policy packages presented here build on each other and plot an approximate course towards achieving an energy-efficient transport system. For instance, having an appropriate public transport system in place is a precondition for introducing restrictive pricing mechanisms to reduce car use.

Three steps (or packages) are described.

- ***Basic package*** – The basic package includes measures that remove factors which trigger inefficient transport. The measures mentioned here are essential for enabling a transition towards energy-efficient transport.
- ***Advanced package*** – The advanced package leads to further increases in transport efficiency. The measures address additional fields of action or support the success of the basic package.
- ***Complementary package*** – The complementary package includes additional measures to improve energy efficiency in urban transport. These measures can complement the basic and advanced packages. Even though their additional effect might by smaller than with the other packages, the measures nevertheless promote further reductions in energy consumption or lead to innovations in energy efficiency. As with the advanced packages, only example measures are listed here.

The mix of appropriate measures depends on the circumstances in each individual country and city. Some need to start with the basic package, whereas other, more advanced countries or cities can already begin to implement advanced measures. However, some measures (*e.g.* proper public transport infrastructure, fuel taxation) need continuous adaptation and development.

Case Study 13

Improving energy efficiency in the transport sector – The case of Germany

The transport volume in Germany has been growing for decades. From 1990 to 2007, the passenger transport volume increased by 52 %. During the same period, the goods transport volume rose by 132 %, with international shipping and road transport responsible for much of the increase (BMVBS 2008).

Despite this growth of the overall transport volume, energy consumption and related GHG emissions remained stable and have even begun to decrease during recent years. From 1990 to 2008, transport-related CO_2 emissions rose by only 0.4 % (Figure 53). According to the latest figures available, emissions decreased by 10 % during the period 2000 to 2010.

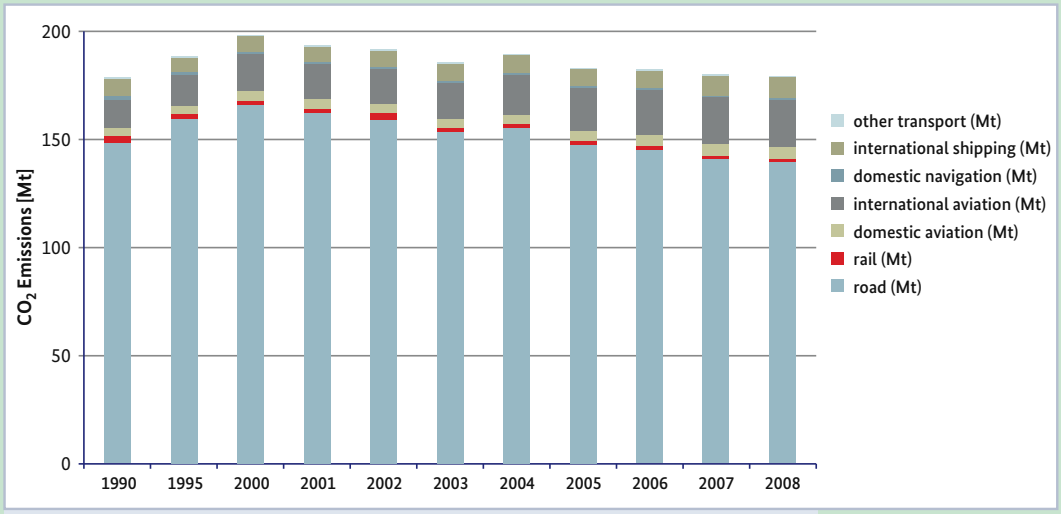

Figure 54: Development of transport-related CO_2 emissions in Germany, 1990–2008.
Source: ITF/OECD 2010

This development may be attributed to a combination of different policies. Push-measures, such as high taxation of fuels, the introduction of emission limits and a toll system for lorries on highways and major federal roads, have certainly played a key role. In addition, pull-measures, such as making public transport more attractive, have helped stabilise or even increase the modal share of energy-efficient means of transport, especially in major urban areas.

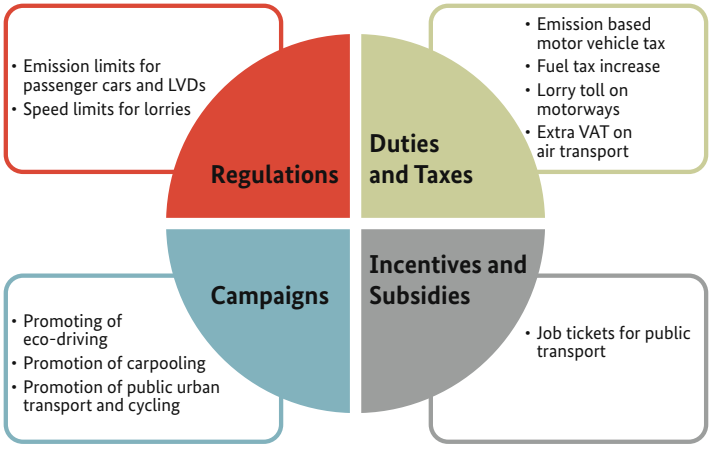

Figure 55: Overview of measures adopted to increase energy efficiency and reduce GHG emissions in the German transport sector.
Source: Christine Weiß, GIZ, 2011.

4.1.1 Setting a framework at national level

The national government is responsible for the framework that influences many transport issues at the local level. Removing fuel subsidies and implementing a proper fuel taxation scheme, for instance, prompt behavioural change away from cars and towards more efficient forms of mobility. Transport funds are allocated at the national level, and to reduce the demand for private vehicle ownership and use, the central authorities must allocate sufficient financial resources to the development of public transport infrastructure and non-motorised modes of transport. Urban planning guidelines that limit urban sprawl and stipulate transit-oriented development and dense city structures give rise to the kind of framework that is essential for a future development towards greater energy efficiency.

These basic measures can be supported by further 'push' measures in the advanced package, such as the new concept of public transport-oriented development. Efficient vehicle types can be used to achieve additional improvements in transport efficiency. Research and pilot projects can complement these efforts by spawning new innovative ideas and technologies that further enhance energy efficiency in transport.

1. Basic package

- Removal of fuel subsidies;
- Additional fuel taxation;
- Improve infrastructure for energy-efficient transport modes;
- Urban planning guidelines.

2. Advanced package

- Vehicle fuel economy standards;
- Financial incentives for the use of energy-efficient modes;
- Annual vehicle registration tax.

3. Complementary package

- Promote research and pilot projects (of new technologies and concepts such as car-sharing);
- Vehicle labelling;
- Cap system for vehicle manufacturers;
- National cycling plan;
- National eco-driving training schemes.

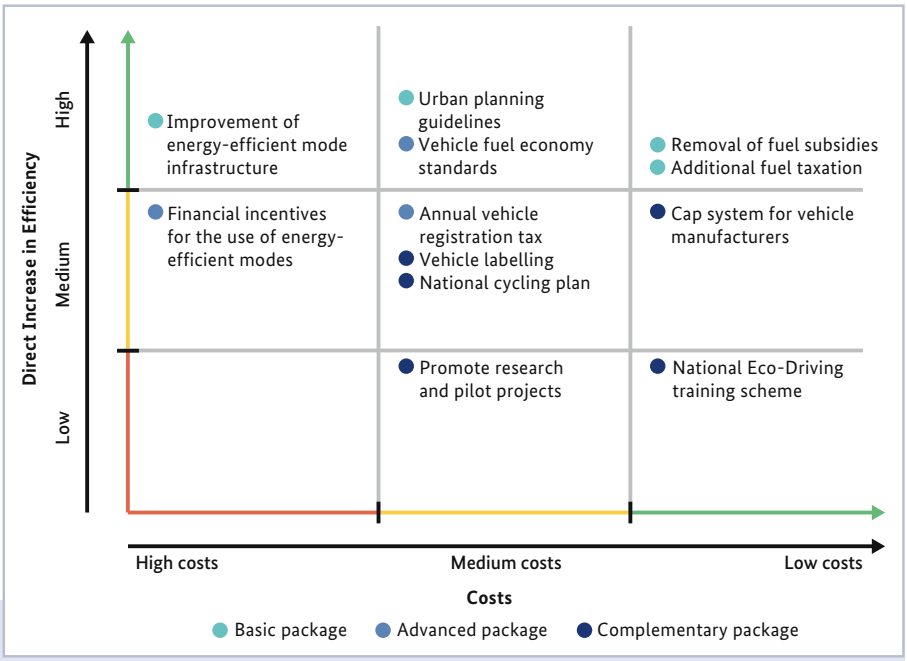

Figure 56: Effects and costs*) of national energy efficiency measures in the different packages (authors' own assessment).

*) = *Icluding monetary, organisational, staff costs and expenditure of time*

Figure 56 provides a first assessment of the costs and potential efficiency improvements associated with the measures in the different packages. The actual costs and efficiency gains vary, depending on the economic and structural circumstances in each country. Usually, removing fuel subsidies and imposing additional fuel taxation are low-cost means of raising energy efficiency. By contrast, it requires large financial investments to expand and improve energy-efficient infrastructure. However, it is essential that the policy makers consider the interdependencies and synergies among the measures, and communicate these to the public. In this respect, comprehensive and clear mid- to long-term strategies are essential if they are to gain acceptance for their policies.

Box 14: Smart pricing – a must for energy efficiency strategies

Pricing is an important instrument, not only for financing the urban transport system, but also for promoting energy-efficient transport. High prices trigger demand for energy saving technologies and behaviour, because with the right pricing strategies it is possible to allocate the full costs of car use to the individual car owners ('polluter pays' principle). Underestimating costs such as air pollution, congestion, road infrastructure and global warming leads to hidden subsidies for car users.

Reduction of fuel subsidies, a certain level of taxation, parking fees, congestion charges, and other levies or taxes also help to reduce the phenomenon of the rebound effect, in which actions to increase efficiency and reduce consumer costs can result in higher consumption. Fuel efficiency programmes tend to have significant rebound effects. For example, strategies like surcharges on inefficient vehicles or vehicle standards encourage the development of more fuel-efficient vehicles. However, efficiency gains reduce running costs, which in turn encourages more vehicle usage or faster driving styles, or frees up income for other energy consumption outside the transport sector. The rebound effect can be seen an increase in the per-vehicle annual travel distance. Consequently, vehicles that are 10 % more fuel-efficient do not result in 10 % fuel savings. The effect can negate one to three percentage points in a 10 % fuel efficiency gain, although there is still a net reduction in fuel consumption of seven or eight per cent (UKERC 2007, p. 31; VTPI 2010). Pricing is therefore an important tool for reducing the rebound effect, as the costs saved are offset by the increasing prices.

Source: UKERC 2007, VTPI 2010

Figure 57: Prices at a gas station in Rio, Brazil.
Source: Manfred Breithaupt, 2011

4.1.2 Make use of local potential

It is essential to evaluate the status of the transport system at the local level and to identify its weaknesses. Without a proper public transport network, or pedestrian and bicycle-friendly infrastructure, a shift in transport mode cannot be achieved, even if disincentives for car-use are implemented. Citizens need an alternative to the private car. Instead of extending the road network, it would be possible to address the future increase in demand for transport in growing and developing cities by reducing the distances travelled and promoting efficient modes of transport. Thus, a dense city structure with mixed land-use and transit-oriented development is a key part of the basic package. In the advanced and complementary package, measures can be implemented that persuade more people to switch from cars to public transport or non-motorised modes.

1. Basic package

- Extension of the public transport network
- Pedestrian and bicycle-friendly infrastructure
- Dense city structure
- Transit-oriented development
- Mixed land use
- Car-free days

2. Advanced package

- Parking/road pricing
- License plate restrictions
- Bus priority
- Intelligent traffic management
- Extensive cycle network
- Cycling highways and green wave
- High quality public transport network (public transport integration, comfortable stations and vehicles, improved information for passengers)

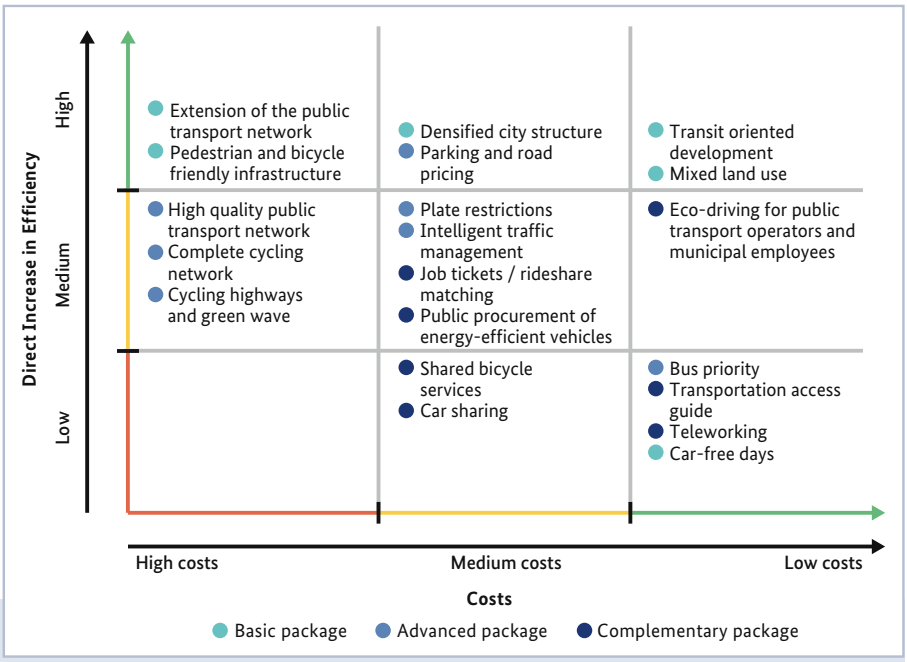

Figure 58: Effect and cost*) of local energy efficiency measures in the different packages (authors' own assessment).

*) = *Icluding monetary, organisational, staff costs and expenditure of time*

3. Complementary package

- Transportation access guide
- Job tickets and rideshare matching
- Teleworking
- Shared bicycle services
- Car sharing
- Eco-driving for public transport operators and municipal employees
- Public procurement of energy-efficient vehicles

Figure 58 shows that large investments are necessary to obtain substantial efficiency gains at the local level. Most measures in the basic packages, which provide the basis for an energy-efficient urban transport system, are associated with high or medium costs. But these instruments can result in great efficiency improvements by reducing the transport demand or by shifting travel to more efficient modes.

Several measures at the local level only produce small gains in energy efficiency. However, since most of these can be executed at a low cost and within a short time period, the measures are useful additions to a sustainable transport system. Within policy packages, they play an important role to support the key components, such as the high quality of public transport.

Case Study 14

Energy-efficient transport in Curitiba

Curitiba is the seventh largest city in Brazil, with a population of approximately 1.8 million, and ranks fourth in terms of GDP. Curitiba presents a striking example of how a coherent set of policies can transform a city by encouraging the development of an impressive and economically successful low-carbon, energy-efficient transport system. Since the 1960s, the city has been pursuing transit-oriented development. By developing the city linearly along its arteries, the downtown area ceased to be the primary focus of everyday transport activity. This helped to avoid peak hour commuter congestion. Employers offer transport subsidies for their low-skilled and low-paid workers.

Car-oriented development has not occurred, and there is only limited parking in the city centre, which discourages drivers from clogging the area. The last, and perhaps most eye-catching element of Curitiba's development is a highly efficient bus rapid transit system along the arterial roads, which has ushered in a modal shift from car travel to bus travel. Compared to the people of other Brazilian cities of comparable size, Curitibans consume 30 % less transport fuel. Overall, the policy package for energy-efficient transport has proved very successful in Curitiba.

Source: Bongardt, Breithaupt and Creutzig 2010

Case Study 15

Bicycle planning in Mexico City

The administration of Mexico City developed a Bicycle Master Plan – a policy package to promote cycling as a safe, attractive, healthy and convenient travel option for city residents. This was intended to increase bicycle travel as a proportion of all journeys to 2 % by 2010 and 5 % by 2012. To achieve its goal, the Master Plan project involves a number of activities:

- Mobility: designing bicycle path networks with a focus on safety, attractiveness, and convenient access to more popular destinations and mass transit services; implementing measures to reduce automobile traffic;
- Universal access: facilitation of door-to-door journeys by strengthening connections between travel modes (*e.g.* bike parking at transit stations);
- Promotion: carrying out public campaigns that encourage bike use and raise its social status; promoting bike sharing at 85 stations;
- Managing travel demand: providing disincentives for excessive car travel, such as congestion charges and parking fees;
- Application of laws: enforcing laws related to urban transport.

Source: ITDP 2010, Ellingwood 2010

Figure 59: Mexico City is improving cycling infrastructure to support this energy efficient mode of transport.
Source: Manfred Breithaupt, 2010

5 The path to an energy-efficient transport system

A wide variety of potential policies and measures exits to increase energy efficiency in local transport. In order to achieve the maximum benefits, there is a need to coordinate the various political levels and actors. It is also necessary to bundle these measures into comprehensive packages (plans or strategies). Such packages could run in phases, with a step by step approach, but they also need continuity and long-term strategies.

The aim of this *Sourcebook Module* is to raise awareness about how it is possible to achieve more energy-efficient transport. As it does this, it also demonstrates the benefits of energy-efficiency in the transport sector. Energy-efficient transport is the basis for a competitive economy, and it brings social as well as ecologic benefits. In order to make energy-efficient transport policies and measures a success, policy makers should work together to foster a common vision for transport. It is important to identify the benefits to the main interest groups and to get their support for collective action.

In many regions, institutional, economic and social barriers inhibit the use of certain instruments. Political decision makers and other key actors need to consider these obstacles in order to identify a path to sustainable and energy-efficient transport.

Institutional barriers constitute a major challenge in many countries. They might cause weaknesses in the vertical or horizontal coordination of efforts, *i.e.* in relations between the different government levels, and in relations between different national or local authorities. To help develop energy-efficient structures, it is a good idea to set up a local, integrated urban and transport planning authority.

In many developing and emerging countries ***financial barriers*** hamper the development of an energy-efficient transport system. The budget is often insufficient, especially for more expensive extensions to the public transport infrastructure. The flexibility of budget allocation needs to be increased. A sustainable transport fund might be a promising solution (see GIZ *Sourcebook Module* 1f: Financing Sustainable Urban Transport).

Cultural or social barriers can impede the implementation of measures. For example, conflicts may arise between car owners and lower-income people, who rely on the public transport system. Therefore it is crucial to also integrate all citizens into the planning processes as early as possible. A number of public participation and mediation methods are available for this.

The case studies throughout this document show that sustainable urban transport is necessary, and that it is possible, affordable and beneficial for citizens, companies and public authorities. With vision and leadership, the barriers described here can be overcome. The actors addressed in this module can create a transport system that is not only energy-efficient but which also improves the city's appearance and the quality of life of its residents.

Box 15: Low hanging fruits for improved energy efficiency

'Low hanging fruits' refers to those improvements that are most easily achievable and that do not require many resources and time. With a minimum of effort, it is possible to have a considerable impact on the efficiency of the local transport system.

To identify the low hanging fruits in the context of energy efficiency, key actors in the local transport system must work together to identify potential areas of activity. To find the easier interventions in specific local contexts, the local actors can ask the following key questions.

Basic questions

- What financial and personnel resources are available?
- Who is responsible for implementation?
- Where is the largest potential for energy efficiency measures?
- What measures can be implemented within the next twelve months?

Identifying suitable measures

- Is the city's public transport system working at full capacity?
  - ➔ ***Yes:*** How can the city provide additional public transport?
    Example measures:
    - ❖ Short term supply of new bus services
    - ❖ Increase speed and efficiency of existing public transport operations
    - ❖ Make use of public-private partnerships to provide public transport
  - ➔ ***No:*** How can we induce a shift towards public transport?
    Example measures:
    - ❖ Introduce car-free days
    - ❖ Restrict free parking supply
    - ❖ Introduce pricing of roads or parking
- Does the city have a sufficient infrastructure for non-motorised transport?
  - ➔ ***Yes***, but it is not being used: How can we induce a shift towards non-motorised modes of transport?
    Example measures:
    - ❖ Public awareness campaigns
    - ❖ Provide bicycle facilities
  - ➔ ***No:*** How can we provide additional infrastructure in a short time and at low cost?
    Example measures:
    - ❖ Reallocate existing road space (*e.g.* parts of the traffic lanes along Broadway in New York were replaced by sidewalk benches and bicycle lanes)
- How is the commuter behaviour in the city?
  - ➔ Many commuters come by car from outside the city.
    Example measures:
    - ❖ Provide park and ride facilities at traffic axes
    - ❖ Support rideshare matching
    - ❖ Introduce and promote job tickets
  - ➔ Many commuters use their cars even for short distances.
    Example measures:
    - ❖ Bike-to-work programmes
    - ❖ Provide changing facilities at workplaces
- Is your own vehicle fleet energy-efficient?
  - ➔ ***Yes:*** Use your experiences to set an example for others.
  - ➔ ***No:*** Improve the energy efficiency of your own fleet.
    Example measures:
    - ❖ Eco-driving
    - ❖ Low rolling resistance tires
    - ❖ High-lubricity oil for vehicles

6 References

6.1 Non-GIZ references

- **Álvarez, E.C. (2008)**: Type Approval Requirements for the General Safety of Motor Vehicles. Policy Department Economic and Scientific Policy. Available online http://www.endseurope.com/docs/81128a.pdf
- **Associated Press (2009)**: China Drives Electric Bike, Scooter Boom. Available online http://www.msnbc.msn.com/id/32172301/ns/world_news-world_environment
- **Beijing Traffic Management Bureau (2010)**: 2009 Sees a Surge of Vehicle and Driver Population in China. Available online http://www.bjjtgl.gov.cn/publish/portal1/tab165/info16307.htm
- **BMWi – Federal Ministry of Economics and Technology (2010)**: Energy Efficiency – Made in Germany. Energy Efficiency in Industry, Building Service Technology and Transport. BMWi, Berlin. Available online http://www.efficiency-from-germany.info/EIE/Navigation/EN/root.html
- **BMVBS (Ed)** (2008): Verkehr in Zahlen. Hamburg, Eurailpress
- **Böhler, S. (2010)**: Nachhaltig mobil. Eine Untersuchung von Mobilitätsdienstleistungen in deutschen Großstädten. IRPUD – Institut für Raumplanung Fakultät Raumplanung, Technical University of Dortmund
- **Cherry, C., Weinert, J. and Ma, C. (2007)**: The Environmental Impacts of E-bikes in Chinese Cities. Available online http://www.its.berkeley.edu/publications/UCB/2007/VWP/UCB-ITS-VWP-2007-2.pdf
- **City of Vancouver (2008)**: Vancouver EcoDensity Charter – How Density, Design, and Land Use Will Contribute to Environmental Sustainability, Affordability, and Livability. Available online http://vancouver.ca/commsvcs/ecocity/pdf/ecodensity-charter-low.pdf
- **Cracknell, John A (2000)**: Experience in Urban Traffic Management and Demand Management in Developing Countries. World Bank Urban Transport Strategy Review Background Paper
- **Creutzig, F., McGlynn, E., Minx, J. and Edenhofer, O. (2011)**: Climate policies for road transport revisited (I): Evaluation of the current framework. Energy Policy, 39, 2396-2406
- **Davis, L. (2008)**: Driving Restrictions and Air Quality in Mexico City. In: Resources for the Future, August, 18, 2008. Available online http://www.rff.org/Publications/WPC/Pages/08_15_08_Driving%20Restrictions%20and%20Air%20Quality%20in%20Mexico%20City.aspx
- **DeCicco, J., An, F. and Ross, M. (2001)**: Technical Options for Improving the Fuel Economy of U.S. Cars and Light Trucks by 2010–2015. American Council for Energy-Efficient Economy
- **Díaz, O. (undated)**: Car Free Bogotá: the response to the transportation challenge. Available online http://www.newcolonist.com/bogota.html
- **EC – European Commission (2009)**: Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009: Setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO_2 emissions from light-duty vehicles, Art. 6/7/8. Available online http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0001:0015:EN:PDF
- **Ellingwood, K. (2010)**: Mexico City Bicycle Program Pedals Uphill. In: LA Times March 30, 2010. Available online http://articles.latimes.com/keyword/news
- **EPA – Environmental Protection Agency (2010)**: Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards. Final Rule. In: Federal Register/Vol. 75, No. 88/Friday, May 7
- **Financial Times Deutschland (2009)**: Ausgebremste E-Bikes. Available online at http://www.ftd.de/politik/international/:china-ausgebremste-e-bikes/50051696.html
- **Holub, A. (2010)**: Buenos Aires Launches Bike-to-work Programme. ITDP. Available online http://www.itdp.org/index.php/news_events/news_detail/buenos_aires_launches_bike-to-work_program

- **ICCT – The International Council on Clean Transportation (2007)**: Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update. Washington. Available online http://www.lowcvp.org.uk/assets/reports/ICCT_GlobalStandards_2007.pdf
- **IEA – International Energy Agency (2009a)**: Key World Energy Statistics. IEA/OECD, Paris. Available online http://www.iea.org/textbase/nppdf/free/2009/key_stats_2009.pdf
- **IEA – International Energy Agency (2009b)**: Transport, Energy and CO_2 – Moving Toward Sustainability. IEA/OECD, Paris
- **IEA – International Energy Agency (2009c)**: World Energy Outlook 2009. IEA/OECD, Paris
- **IFEU – Institut für Energie- und Umweltforschung Heidelberg GmbH (2008)**: Transport in China: Energy Consumption and Emissions of Different Transport Modes. Heidelberg. Available online http://www.kfw-entwicklungsbank.de/.../Transport/IFEU-KfW-transport_in_China_May_2008.pdf
- **ITDP – Institute for Transportation and Development Policy (2010)**: Buenos Aires Launches Bike-to-Work Program. Available online http://www.itdp.org/index.php/news_events/news_detail/buenos_aires_launches_bike-to-work_program
- **ITF/OECD (2010)**: Transport Greenhouse Gas Emissions – Country Data 2010. Available online http://www.internationaltransportforum.org/Pub/pdf/10GHGCountry.pdf
- **Kenworthy, J. (2003)**: Transport Energy Use and Greenhouse Gases in Urban Passenger Transport Systems: A Study of 84 Global Cities. Proceedings of the International Third Conference of the Regional Government Network for Sustainable Development, Notre Dame University, Fremantle, Western Australia, 2003. http://cst.uwinnipeg.ca/documents/Transport_Greenhouse.pdf
- **Kojima, K. and Ryan, L. (2010)**: Transport Energy Efficiency. Implementation of IEA Recommendations since 2009 and next steps. IEA Energy Efficiency Series. Available online http://www.iea.org/papers/2010/transport_energy_efficiency.pdf
- **Mueller, P., Schleicher-Jester, F., Schmidt, M-P and Topp, H.H. (1992)**: Area-wide concept of traffic calming in 16 cities. University of Kaiserslautern, Department of Transportation, Green Series Number 24
- **Newman, P. W. G. and Kenworthy, J. R. (1989)**: Cities and Automobile Dependence: An International Sourcebook. Aldershot, UK: Gower
- **OECD/IEA/Eurostat (2005)**: Energy Statistics Manual, Paris, 2005. Available online http://www.iea.org/stats/docs/statistics_manual.pdf
- **Oliver, H. H., Gallagher, K. S., Tian, D. and Zhang, J. (2009)**: China's Fuel Economy Standards for Passenger Vehicles: Rationale, Policy Process, and Impacts. Discussion Paper 2009–03, Cambridge, Mass.: Belfer Center for Science and International Affairs
- **Sohail, M., Maunder, D. and Miles, D. (2004)**: Managing Public Transport in Developing Countries: Stakeholder Perspectives in Dar es Salaam and Faisalabad. In: International Journal of Transport Management, 2 (3–4), pp. 149–160
- **Taylor, N. (2006)**: The Urban Transport Benchmarking Initiative – year three final report. Available online http://www.transportbenchmarks.eu/pdf/final-reports/UTB3-A0-FINAL-REPORT.pdf
- **UKERC – UK Energy Research Centre (2007)**: The Rebound Effect: An Assessment of the Evidence for Economy-wide Energy Savings From Improved Energy Efficiency. Available online http://www.ukerc.ac.uk/Downloads/PDF/07/0710ReboundEffect/0710ReboundEffectReport.pdf
- **UN-Habitat and UNESCAP (2009)**: Urban Safety and Poverty in Asia and the Pacific. Key findings from sub-regional studies on South-Asia, South-East Asia and the Pacific. Available online: http://asiapacific-safecity.org/files/UN-HABITAT_Urban_Safety_and_Poverty_in_Asia_and_the_Pacific.pdf
- **Vossenaar, R. (2010)**: Deploying Climate-Related Technologies in the Transport Sector: Exploring Trade Links, ICTSD Issue Paper No. 15, ICTSD Programme on Trade and Environment, International Centre for Trade and Sustainable Development, Geneva, Switzerland. Available online: http://ictsd.org/downloads/2010/11/rene_vossenaar_web3gp.pdf
- **VTPI – Victoria Transport and Policy Institute (2010)**: TDM Encyclopaedia. Available online http://www.vtpi.org/tdm
- **World Bank (2002)**: Urban Transport Safety and Security in Cities on the Move: A World Bank Urban Transport Strategy Review. World Bank. Available online: http://siteresources.worldbank.org/INTURBANTRANSPORT/Resources/chapter5.pdf

6.2 Further reading and information

- **ACEA (2010)**: Reducing CO_2 emissions: Progress and Constraints". Available online http://www.acea.be/index.php/news/news_detail/reducing_co2_emissions
- **An, F. and Sauer, A. (2004)**: Comparison of Passenger Vehicle Fuel Economy and Greenhouse Gas Emission Standards Around the World. Pew Center on Global Climate Change. Available online http://www.pewclimate.org/docUploads/FuelEconomyandGHGStandards_010605_110719.pdf
- **BESTTRANS – Benchmarking of Energy and Emission Performance in Urban Public Transport Operations ()** http://www.tis.pt/proj/bestrans
- **Chang, S.K. and Gou, Y.J. (2005)**: Trip Cost Analysis of Bus Rapid Transit. Available online http://www.easts.info/on-line/proceedings_05/2195.pdf
- **ECMT – European Conference of Ministers of Transport (2004)**: National Policies to Promote Cycling. Available online http://www.internationaltransportforum.org/europe/ecmt/pubpdf/04Cycling.pdf
- **EIA – Energy Information Administration (2010)**: International Energy Outlook 2010. U.S. Energy Information Administration, Washington. Available online http://www.eia.doe.gov/oiaf/ieo/pdf/0484(2010).pdf
- **Hartmann, S. and Kitaska, K. (2004)**: Vancouver, British Columbia's High Tech Bus Rapid Transit Achieves Mode Shift From Private Vehicles Surpassing. Available online http://www.llbc.leg.bc.ca/public/pubdocs/bcdocs/405927/high_tech_bus_rapid_transit.pdf
- **Helms, H., Pehnt, M., Lambrecht, U. and Liebich, A. (2010)**: Electric Vehicle and Plug-in Hybrid Energy Efficiency and Life Cycle Emissions. Available online http://www.ifeu.org
- **IEA – International Energy Agency (2008)**: Worldwide Trends in Energy Use and Efficiency Key Insights from IEA Indicator Analysis. IEA/OECD, Paris
- **IEA – International Energy Agency (2010)**: World Energy Outlook 2010. IEA/OECD, Paris
- **ITF – International Transport Forum (2010a)**: Reducing Transport Greenhouse Gas Emissions – Trends and Data. OECD/ITF
- **ITF – International Transport Forum (2010b)**: Transport Outlook 2010 – The Potential for Innovation. OECD/ITF
- **Kejun J. (2010)**. Mapping Climate-Mitigation Technologies/Goods within the Transport Sector. Study prepared for ICTSD by Jiang Kejun, Energy Research Institute, China. http://ictsd.org/downloads/2010/11/mapping-climate-change-mitigation-technologies-and-associated-goods-within-the-transport-sector-jm.pdf
- **Litman, T. (2008)**: Win-Win Transportation Solutions – Mobility Management Strategies That Provide Economic, Social and Environmental Benefits. Available online http://www.vtpi.org/winwind.pdf
- **Litman, T. (2009)**: Transportation Cost and Benefit Analysis – Techniques, Estimates and Implications. Available online http://www.vtpi.org/tca
- **Litman, T. (2010)**: Appropriate Response to Rising Fuel Prices – Citizens Should Demand, "Raise My Prices Now!". Available online http://www.vtpi.org/tdm/tdm45.htm
- **Manville, M. and Shoup, D. (2005)**: People, Parking, and Cities, In: Journal of Urban Planning and Development, December, 2005, pp. 233–245
- **May, A. D. (2003)**: Developing Sustainable Urban Land Use and Transport Strategies. A Decision Makers' Guidebook. Available online: http://www.polisnetwork.eu/uploads/Modules/PublicDocuments/decision%20makers%20guidebook_prospects.pdf
- **Olli-Pekka H. (2011)**: Benchmarking efficiency of public passenger transport in larger cities, Benchmarking: An International Journal, Vol. 18 Issue: 1, pp. 23 – 41
- **Padeco (2000)**: Study on Urban Transport Development. Available online http://siteresources.worldbank.org/INTURBANTRANSPORT/Resources/ut_development_padeco.pdf
- **Pew Center on Global Climate Change (2010)**: Comparison of Actual and Projected Fuel Economy for New Passenger Vehicles. Available online http://www.pewclimate.org/federal/executive/vehicle-standards/fuel-economy-comparison
- **The Urban Transport Benchmarking Initiative (2003–2004)** http://www.transportbenchmarks.eu
- **Vincent W. and Jerram, L.C. (2006)**: The Potential for Bus Rapid Transit to Reduce Transportation-Related CO_2 Emissions. Available online http://www.indiaenvironmentportal.org.in/files/BTI_BRT_CO2_Journal_2006.pdf
- **World Bank and AusAid (2010)**: Winds of Change. East Asia's Sustainable Energy Future. Available online http://siteresources.worldbank.org/INTEASTASIAPACIFIC/Resources/226262-1271320774648/windsofchange_fullreport.pdf

6.3 GIZ Sourcebook and other material references

- **Binsted, A., Bongardt, D., Dalkmann, H. and Sakamoto, K. (2010)**: Accessing Climate Finance for Sustainable Transport: A practical overview, Sustainable Urban Transport Technical Document No. 5, GTZ, Eschborn.
- **Bongardt, D., Breithaupt, M., and Creutzig, F. (2010)**: Beyond the Fossil City: Towards low Carbon Transport and Green Growth, GTZ, Eschborn.
- **Breithaupt, M. (2004)**: Sourcebook Module 1d: Economic Instruments, GTZ, Eschborn.
- **Breithaupt, M. and Eberz, O. (2005)**: Sourcebook Module 4f: EcoDriving, GTZ, Eschborn.
- **Broaddus, A., Litman, T. and Menon, G. (2009)**: Transportation Demand Management Training Document, GTZ, Eschborn.
- **Civic Exchange Hong Kong, GTZ, and UBA (2004)**: Sourcebook Module 5c: Noise and its Abatement, GTZ, Eschborn.
- **Dalkmann, H. and Brannigan, C. (2007)**: Sourcebook Module 5e: Transport and Climate Change, GTZ, Eschborn.
- **Dhingra, C. and Kodukula, S. (2010)**: Public Bicycle Schemes: Applying the Concept in Developing Cities Examples from India Sustainable Urban Transport Technical Document #3. GTZ, Eschborn.
- **Dora, C., Hosking, J., Mudu, P. and Fletcher, E. R. (2010)**: Sourcebook Module 5g: Urban Transport and Health, GIZ, Eschborn.
- **Eichhorst, U. (2009)**: Sourcebook Module 5f: Adapting Urban Transport to Climate Change, GTZ, Eschborn.
- **Godefrooij, T., Pardo, C. and Sagaris, L. (2009)**: Cycling-Inclusive Policy Development: A Handbook, GTZ, Eschborn.
- **Gorham, R. (2009)**: Demystifying Induced Travel Demand. Sustainable Urban Transport Technical Document, GTZ, Eschborn.
- **Grütter, J. (2007)**: Sourcebook Module 5d: The CDM in the Transport Sector, GTZ, Eschborn.
- **GIZ (ed.)** 2011: How far can I travel on one ton of CO_2. Available online: http://www.transport2012.org/bridging/ressources/documents/2/1079,One-ton-of-CO2.pdf
- **GTZ (ed.)** (2007): International Fuel Prices 2007. 5th edition, GTZ, Eschborn, available online: http://www.sutp.org/fuelprices
- **GTZ (ed.)** (2009): International Fuel Prices 2009. 6th edition, GTZ, Eschborn, available online: http://www.sutp.org/fuelprices
- **GTZ (ed.)** (2010): Transport Alliances Promoting Cooperation and Integration to offer a more attractive and efficient Public Transport. Sustainable Urban Transport Technical Document #4. GTZ, Eschborn.
- **Herzog, B. O. (2010)**: Sourcebook Module 1g: Urban Freight in Developing Cities, GTZ, Eschborn.
- **Hook, W. (2005)**: Sourcebook Module 3d: Preserving and Expanding the Role of Non-motorised Transport, GTZ, Eschborn.
- **Hook, W. (2005)**: Training Course: Non-Motorised Transport, GTZ Eschborn.
- **Kodukula, S. (2010)**: Bangkok Rapid Transit – BRT System of Bangkok, Thailand. – A Short Survey. Case Studies in Sustainable Urban Transport #1. GTZ, Eschborn.
- **Kolke, R. (2005)**: Sourcebook Module 4b: Inspection & Maintenance and Roadworthiness, GTZ, Eschborn.
- **Kunieda, M. and Gauthier, A. (2007)**: Sourcebook Module 7a: Gender and Urban Transport: Smart and Affordable, GTZ, Eschborn.
- **Lacroix, J. and Silcock, D. (2004)**: Sourcebook Module 5b: Urban Road Safety, GTZ, Eschborn.
- **Litman, T. (2004)**: Sourcebook Module 2b: Mobility Management, GTZ, Eschborn.
- **Meaking, R. (2004a)**: Sourcebook Module 1b: Urban Transport Institutions, GTZ, Eschborn.
- **Meaking, R. (2004b)**: Sourcebook Module 3c: Bus Regulation and Planning, GTZ, Eschborn.
- **MVV InnoTec (2005)**: Sourcebook Module 4d: Natural Gas Vehicles, GTZ, Eschborn.
- **Pardo, C. (2006)**: Sourcebook Module 1e: Raising Public Awareness about Sustainable Urban Transport, GTZ, Eschborn.
- **Pardo, C. (2006)**: Training Course: Public Awareness and Behavioural Change in Sustainable Transport, GTZ, Eschborn.
- **Peñalosa, E. (2005)**: Sourcebook Module 1a: The Role of Transport in Urban Development Policy, GTZ, Eschborn.
- **Petersen, R. (2004)**: Sourcebook Module 2a: Land Use Planning and Urban Transport, GTZ, Eschborn.
- **Rye, T. (2010)**: Sourcebook Module 2c: Parking Management, GTZ, Eschborn.
- **Sakamoto, K. and Belka, S. (2010)**: Sourcebook Module 1f: Financing Sustainable Urban Transport, GTZ Eschborn.
- **Sayeg, P. and Charles, P. (2009)**: Sourcebook Module 4e: Intelligent Transport Systems, GTZ, Eschborn.

- **Schwela, D. (2009)**: Sourcebook Module 5a: Air Quality Management, GTZ, Eschborn.
- **Shah, J. and Iyer, N. (2009)**: Sourcebook Module 4c: Two- and Three-Wheelers, GTZ, Eschborn.
- **Vilchez, J. G. (2011)**: Mobility Management & Commuting: Inputs and Examples of Best Practice in German Firms, A Short Survey. Case Studies in Sustainable Urban Transport #5, GIZ, Eschborn.
- **Walsh, M. and Kolke, R. (2005)**: Sourcebook Module 4a: Cleaner Fuels and Vehicle Technologies, GTZ, Eschborn.
- **Wright, L. (2005)**: Sourcebook Module 3b: Bus Rapid Transit, GTZ, Eschborn.
- **Wright, L. (2006)**: Sourcebook Module 3e: Car Free Development, GTZ, Eschborn.
- **Wright, L. and Fjellstrom, K. (2004)**: Sourcebook Module 3a: Mass Transit Options, GTZ, Eschborn.
- **Zegras, C. (2006)**: Sourcebook Module 1c: Private Sector Participation in Urban Transport Infrastructure Provision, GTZ, Eschborn.

7 Abbreviations

ACU	Urban Cyclists' Association
ASI	approach that combines the avoid, shift and improve strategies
BEV	battery electric vehicle
BRT	bus rapid transit
BRTS	bus rapid transit system
BUG	bicycle user group
CAFE	corporate average fuel economy
CDP	city development plan
CIVITAS	City-Vitality-Sustainability (Initiative for cleaner and better transport in cities)
CNG	compressed natural gas
CO_2	carbon dioxide
COE	certificate of Entitlement
CPTC	California Private Transportation Company
EC	European Commission
FDI	foreign direct investments
FRT	first registration tax
GDP	gross domestic product
GHG	greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
GVFG	Gemeindeverkehrsfinanzierungsgesetz (German municipal transport-financing act)
HC	hydrocarbons
IEA	International Energy Agency
J	joule
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
km/l	kilometres per litre
ktoe	kilotonnes of oil equivalent
LDV	light duty vehicle
LPG	liquefied petroleum gas
mb/d	million barrels per day
MJ	mega joule
mpg	miles per gallon
NGL	natural gas liquids
NGO	non-governmental organisation
NMT	non-motorised transport
NO_x	nitrogen oxide
OECD	Organisation for Economic Co-operation and Development
PHEV	plug-in hybrid vehicle
pkm	passenger-kilometre
ppm	parts per million
PPP	public-private partnership
PT	public transport
RZ	restricted zone
TDM	transport demand management
tkm	tonne-kilometre
TOD	transit-oriented development
UITP	International Association for Public Transport
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
VQS	vehicle quota system
WEO	World Energy Outlook

8 Appendix – Overview of measures and responsibilities

The following tables list all the measures described in Section 3. The tables are divided according to (1) push (2) pull and (3) general measures. Within each table, the measures are sorted according to the actor responsible for their implementation. For each measure the implementation task is marked with a bold, red 'X', and actors that are involved in the measure are denoted with a small, black "x". The tables also provide information on the efficiency level that each measure addresses. You can find more information about the measures in Section 4 under to the respective key actors.

Table 29: Push measures for higher energy efficiency in urban transport

(X = responsible actor, x = involvement, S = system efficiency, T = travel efficiency, V = vehicle efficiency)

Policy and Measures	Description	Local Authorities and Cities					Organisations			National Governments					Efficiency Level	
		Mayor and city government	Transport planning departments	Land use planning departments	Economic development departments	Financial departments	Public transport operators	Companies	Non-governmental organisations	Transport ministries	Environmental ministries	Ministries for financial affairs and treasury	Ministries of energy	Ministries of economic affairs and technology	Strongest impact efficiency level	Additional impact efficiency level
Push Measures																
Eco Driving for municipal employees	Mandatory training to optimise fuel consumption for municipal employees	X													V	
Green procurement policy for municipal vehicles	Purchase policy for vehicles used for public services	X				x									V	
Environmental Zone	Limit access to cars of a certain low emission class.	The Mayor and City government have a comprehensive function: a) political leadership b) initiation and approval of measures c) exertion of political influence on the regional and national level	X	x						x					T	V
Plate Restrictions	Vehicles are restricted from driving in an area on certain days, based on their registration plate		X							x					T	
Vehicle quota	Limits the number of cars which may be registered in a given year		X			x				x					T	S
Traffic cells and diverters	Design features (e.g. traffic cells and diverters) to reduce speed and convenience for cars		X	x											T	
Speed Restrictions	Lower speed limits reduce attractiveness and fuel consumption of private motorized modes		X	x						x					T	V
Car Free Days	City streets are closed to cars and freed for NMT		X						x	x					T	
Parking Supply Restrictions	Making car use less attractive by avoiding free car parking or on-street parking		X	x											T	
Maximum parking requirements	Setting maximums for new parking supply for new housing areas		x	X											T	
Road Space Reallocation	Road Space should be allocated to more energy-efficient modes		x	X											T	
Parking Pricing	A price for parking is set or increased.		x			X				x					T	
Road Pricing	Drivers are charged a direct fee for road space.		x			X				x					T	
Congestion Charge	Congestion charging is a type of road pricing with higher fee under congested conditions		x	x		X				x					T	
Pay-at-the-pump surcharges	Local surcharge on national measures to adapt transport policy to the need at local levels		x			X						x	x		T	V, S
Green procurement of energy-efficient vehicles for public transport	Use of energy-efficient vehicles in public transport (purchase policy)		x				X		x						V	
Mandatory Eco-Driving training for public transport operators	Programmes that teach drivers how to optimise fuel consumption		x				X								V	
Eco-Driving	Training to optimise fuel consumption for employees in the private sector		x					X							V	
Green procurement policy for company vehicles	Purchase policy for vehicles in private companies		x					X							V	
Corporate travel policy	A set of rules which require employees to use energy-efficient modes for business trips		x					X	x						T	
Car Sharing	Use car sharing instead of company or private cars for business trips		x					X							T	V
National Eco-Driving training schemes	Mandatory Eco Driving lessons in driving schools									X	x				V	
Vehicle fuel economy standard	National standards that limit the vehicles fuel consumption per distance travelled									x	X		x	x	V	
Cap system for vehicle manufacturers	Limiting the energy consumption or CO_2-emissions of the vehicle fleet of national manufacturers										X		x	x	V	
Reduction of fuel subsidies	To low fuel prices encourage car use and lead to numerous negative effects.									x		X	x		T	V, S
Fuel taxation	To reduce car use by fuel taxation the tax level has to be sufficient									x	x	X	x		T	V,S
Sales tax	Can be designed to suppress vehicle purchase									x	x	X			T	S
Annual vehicle registration tax	Charge vehicle ownership (can be differentiated according to energy efficiency)									x	x	X	x		T	V
Fuel quality regulations	Tight fuel composition regulations to ensure optimal engine performance and to support the uptake of alternative fuels										x		X	x	V	

[1] Since the mayor and city government are nearly involved in all measures (due to police approval), only measures are listed in this category, which address municipal employees/departments or research

Table 30: Pull measures for higher energy efficiency in urban transport

(X = responsible actor, x = involvement, S = system efficiency, T = travel efficiency, V = vehicle efficiency)

Policy and Measures	Description	Local Authorities and Cities					Organisations			National Governments					Efficiency Level	
		Mayor and city government	Transport planning departments	Land use planning departments	Economic development departments	Financial departments	Public transport operators	Companies	Non-governmental organisations	Transport ministries	Environmental ministries	Ministries for financial affairs and treasury	Ministries of energy	Ministries of economic affairs and technology	Strongest impact efficiency level	Additional impact efficiency level
Pull Measures																
Expansion of the public transport network	More people have the opportunity to travel by public transport.	The Mayor and City government have a comprehensive function: a) political leadership b) initiation and approval of measures c) exertion of political influence on the regional and national level	X	x		x	x	x		x		x			T	S
Park and Ride facilities	Car parks with connection to public transport		X	x		x	x								T	
Bus Rapid Transit	High quality bus service with greater frequency and higher travel speeds in dedicated corridors		X	x		x	x			x					T	
Bus priority	Intersection priority helps buses to travel faster and improves reliability.		X				x								T	
Bus lanes	Allowing buses to move separately from congested traffic		X	x		x	x								T	V
Comfortable stations and vehicles	For instance, provide bus shelters, better seats and sufficient lighting at stations		X			x	x								T	
Integration of public transport infrastructure	Coordination of route networks enable easy transfer between public transport services		X	x			x								T	
Bicycle lanes	Areas designated for cyclists to promote safety and comfort.		X	x		x			x						T	
Bicycle parking	Provision of convenient and secure bicycle parking		X	x		x			x						T	
Bicycle route signage and maps	Provide information for cyclists		X	x		x			x						T	
Continuous cycle network	A safe and comfortable cycling network throughout the city		X	x		x			x						T	
Cycle highways and green wave	Direct routes for cyclists and improved traffic signals reduce the travel time for cyclists and increase safety		X	x		x									T	
Bike and Ride facilities	Bicycle shelter facilities with connection to public transport		X	x		x			x						T	
Shared bicycle services	Providing free or low-cost bicycles for public use		X			x									T	
Pedestrian zones	Areas where vehicle travel is prohibited		X	x					x						T	S
Safe sidewalks and crosswalks	Safe areas for walking should be provided		X	x					x						T	S
Separate crossing times for NMT	This allows NMT prioritisation and can enhance safety		X			x			x						T	
Integration of NMT into public transport	Facilitate easy access to public transport		X	x			x		x						T	S
Transportation access guide	Describes how public buildings can be reached by energy-efficient modes		X				x								T	S
Commuter financial incentives	Municipal employees receive a benefit if they commute by alternative modes		x			X									T	
Subsidised public transport fares	Provide cost-attractive fares		x			X	x								T	
Car-free travel packages	Provide subsidised public transport tickets for tourists		x			X	x								T	
Integration of public transport services	Integration of public transpot schedules and coordinaion of fares		x				X								T	S
Demand oriented public transport system	The public transport network and the size of associated vehicles should be adjusted to the demand		x	x			X								T	S
Improved rider information	Provide real-time information on arrival time and proper timetable information		x				X								T	
PPP to improve the public transport network	Close cooperation between city administration and local companies to fund public transport improvements		x			x	x	X							T	
Commuter financial incentives	Employees who commute by alternative modes receive a benefit							X	x						T	
Job tickets	Companies offer their employees cost attractive public transport tickets						x	X	x						T	
Rideshare matching	Help employees to start carpooling							X	x						T	
Changing facilities and bicycle stands at workplace	Encourage employees to travel to work by bicycle		x		x			X	x						T	
Transportation access guide	Describes how a certain location (company, office) can be reached by energy-efficient modes		x	x			x	X							T	S
Customer user groups	Local groups that aim at improving the conditions for cycling, walking or public transport use		x						X						T	
Campaigns for energy-efficient modes	Campaigns that inform the public about sustainable energy-efficient transport and drive behaviour change		x						X		x				T	
National cycling plan	A national strategy that promotes a transregional cycling network		x						x	X	x				T	
National transport programmes	National programmes to support cities in developing and implementing energy-efficient local transport systems									X		x			T	V
Energy efficiency labelling for vehicles	Energy efficiency performance certification									x	X				V	
Financial incentives for energy-efficient modes	Fiscal incentives or subsidies for the use of energy-efficient modes									x	x	X			T	
Electricity from renewables	Promote the use of renewable energy for electric vehicles									x	x		X		V	
Energy-saving vehicle components and accessories	Reduced fuel consumption due to advanced vehicle components or due to driver assistance									x	x			X	V	
Innovative technologies and design of vehicles	Support the development and construction of vehicles with design features that increase efficiency									x	x		x	X	V	

[1] Since the mayor and city government are nearly involved in all measures (due to police approval), only measures are listed in this category, which address municipal employees/departments or research

Table 31: General measures for higher energy efficiency in urban transport

(X = responsible actor, x = involvement, S = system efficiency, T = travel efficiency, V = vehicle efficiency)

Policy and Measures	Description	Local Authorities and Cities					Organisations			National Governments					Efficiency Level	
		Mayor and city government	Transport planning departments	Land use planning departments	Economic development departments	Financial departments	Public transport operators	Companies	Non-governmental organisations	Transport ministries	Environmental ministries	Ministries for financial affairs and treasury	Ministries of energy	Ministries of economic affairs and technology	Strongest impact efficiency level	Additional impact efficiency level
General measures																
Municipal mobility management	Set of measures to improve efficiency of employee travel (e.g. job tickets, teleworking)	X													T	S
Pilot projects and research	Implementation and evaluation of new energy efficiency approaches on local level	X	x	x											general	
Intelligent traffic systems	Telematics can be used to guide the traffic flow and avoid congestion	The Mayor and city government have a comprehensive function	X	x											T	S
Densified cities	Concentrated city design will reduce travel needs.		x	X							x				S	T
Transit oriented development	Increase the density of commercial and residential development along public transport corridors		x	X	x		x	x							S	T
Mixed land-uses	By locating different activities together the need to travel is minimized		x	X				x							S	
Traffic impact assessment	Evaluate the traffic volume that can be induced by new business centres or companies		x	x	X			x							S	T
Teleworking	Allowing employees to work at home							X	x						S	
Urban planning guidelines	National guidelines that require energy-efficient urban planning									X	x				S	T
Alternative fuels	Evaluation and promotion of alternative fuels as substitute for petroleum									x	x		X		V	
Pilot projects and research	National research strategies to support innovative ideas for energy-efficient transport									x	x		x	X	general	

[1] Since the mayor and city government are nearly involved in all measures (due to police approval), only measures are listed in this category, which address municipal employees/departments or research

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