Division 44
Environment and Infrastructure

Transport and Climate Change

Module 5e

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

gtz
Sector project
Transport Policy Advisory Service

commissioned by
Federal Ministry
for Economic Cooperation
and Development

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 more than 25 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. GTZ is 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 constant 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.

Any questions regarding the use of the modules can be directed to sutp@sutp.org or transport@gtz.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@gtz.de, or by surface mail to:

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Further modules and resources

Further modules are anticipated in the areas of *Financing Urban Transport*, *Reftrofit,* and *Induced Travel* (among others). 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)

Land use planning and demand management

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

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

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. *Eco Driving* (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/TRL)

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)

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Module 5e

Transport and Climate Change

Findings, interpretations, and conclusions expressed in this document are based on information gathered by GTZ and its consultants, partners, and contributors from reliable sources. GTZ does not, however, guarantee the accuracy or completeness of information in this document, and cannot be held responsible for any errors, omissions, or losses which emerge from its use.

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1. Climate change: challenges for the transport sector

Greenhouse gas emissions from transport are a key contributor to global climate change. In addressing the impacts of climate change through sustainable transport instruments, cities are also able to benefit from a range of co-benefits, including improved air quality, reduced noise from traffic, increased road safety, and a range of social and economic benefits. This *Sourcebook* module focuses on the sustainable transport instruments available that will help achieve both reductions in greenhouse gas emissions and co-benefits. The module will discuss how decision-maker and administrations may implement and finance these instruments.

1.1 Man-made emissions are changing our climate

Climate change is one of the major challenges for mankind in the 21st century. Human activity has lead to wide-spread increases in global atmospheric concentrations of 'greenhouse gases', including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)[1] . The human activities primarily responsible for these increases include the use of fossil fuels, changes in land use such as deforestation, and agriculture. Greenhouse gas emissions are very likely to be the main cause of current and future climate change.

The effects of climate change include wide-spread melting of glaciers and ice caps, rising sea levels and changes in rainfall patterns that are likely to lead to increased drought in some regions. Heat-waves and extreme high temperatures are also very likely to become more common. Extreme weather events, including hurricanes and typhoons, may become more intense, although it is not yet clear as to whether or not the frequency of these events will increase. It is expected that these trends will continue over the coming decades. Due to the relatively long period of time between emission and the effects in the atmosphere, there are no easy solutions. However, if action is taken now, there is still a chance to limit the worst effects beyond the middle of the century.

Effects will vary greatly in different areas of the world. It is expected that effects will be stronger in the south, in developing countries, whose geography and lack of resources to adapt make them more vulnerable. Recent examples include the increase in flooding in Bangladesh and the desertification in China (see Boxes 1 and 2).

Fig. 1
Emissions from an old school bus.
Photo courtesy of Allan Quimby (TRL), India, 2004

Box 1: Climate change effects – Bangladesh

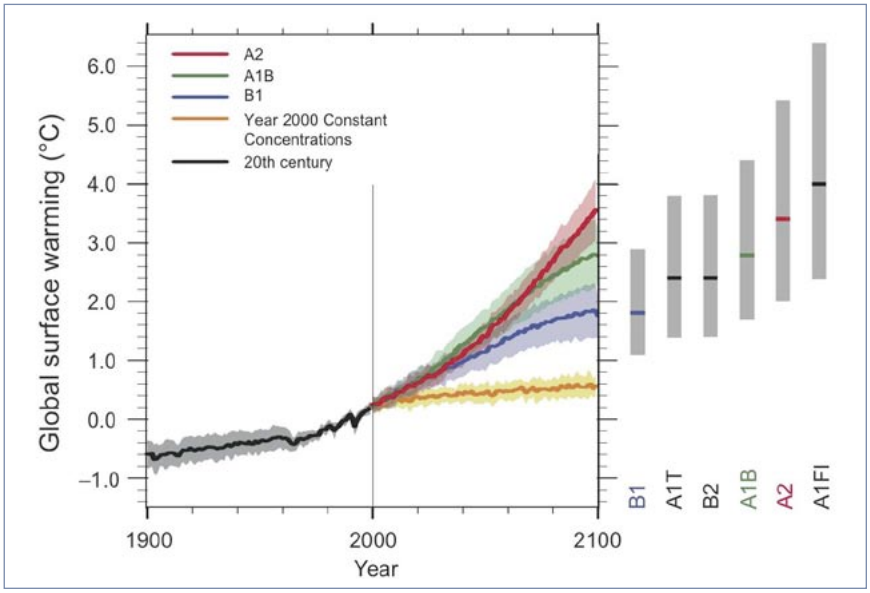
- Bangladesh is vulnerable due to low lying land, high risk of cyclones, dependency on agriculture and the poverty of its inhabitants.
- Severe floods used to occur once every twenty years. They are now occurring every five to seven years, taking place in 1987, 1988, 1995, 1998, 2004, and 2007.
- Floods in 2004 were some of the most severe in decades, leaving 1,000 people dead and 30 million people homeless. It is estimated that the floods caused £4 billion of damage.
- A 45cm sea level rise would reduce Bangladesh's land area by 11% and force 5.5 million people to migrate. A 100 cm rise would remove 20% of the land area, causing 15 million people to migrate. Rainfall is predicted to increase by 10 to 15% by 2030 and the higher temperatures increase the frequency and intensity of cyclones (WDM, 2006).

[1] The full basket of greenhouse gases covered by the Kyoto protocol includes carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydro fluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6).

The Intergovernmental Panel on Climate Change (IPCC) regularly publishes reports on climate change predictions. Table 1 summarises the impacts that climate change is projected to have on developing nations as estimated by the IPCC in its 4th Assessment Report 2007 (IPCC, 2007a).

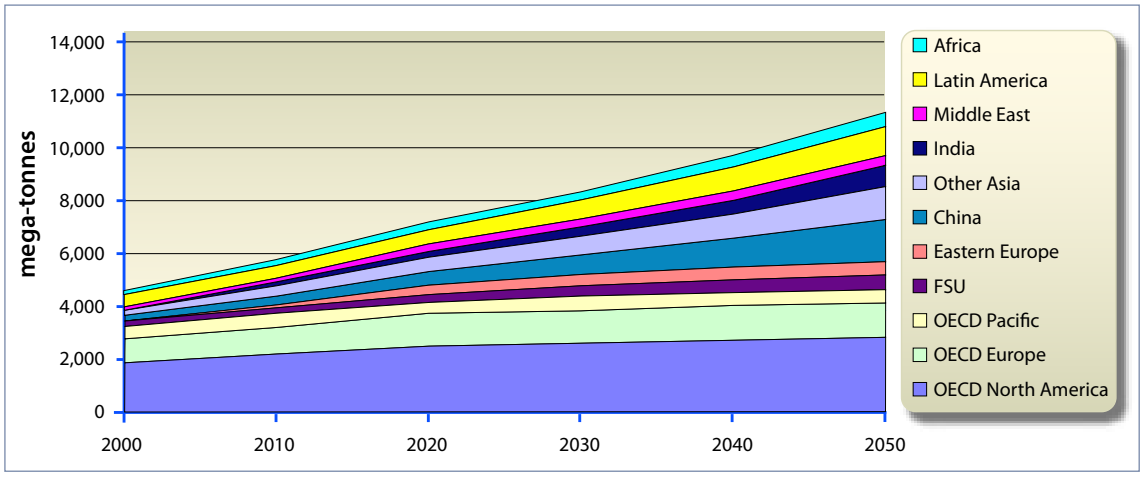
Figure 2 shows the projected temperature change over the next century (IPCC, 2007b). Depending on the simulation assumptions, global average temperature will increase by between 1°C and 4°C until 2100. There will be significant regional variations in temperature increase. More detailed data can be found on the IPCC website (http://www.ipcc.ch).

Fig. 2: Multi-model averages and assessed ranges for surface warming



Source: IPCC, 2007b

Fig. 3: Transportation vehicle CO_2 emissions by regions



Source: World Business Committee for Sustainable Development, WBCSD, 2004

Box 2: Climate change effects – China

- Extreme droughts currently cover about 2% of the world's land area and this is expected to increase to about 10% by 2050.
- From 1950 to 1975 China lost an average of 1,560 square kilometres of land to desert each year. By 2000, nearly 3,625 square kilometres were going to desert annually. Soon 40% of China could turn into scrubland.
- The Gobi desert in central China has expanded by about 64,750 square kilometres since 1994 and its sands are now within 160 kilometres of Beijing. This has resulted in the capital being subjected to severe sand storms effecting human health.
- The growth in desert has meant villages being buried under sand and the loss of agricultural land has decreased food production. Official reports also warning that China is losing about US$7.7 billion a year because of desertification (Pocha, 2006).

1.2 Transport's contribution to man-made emissions

Carbon dioxide (CO_2) represents the largest proportion of the basket of greenhouse gas emissions covered by the Kyoto protocol. Over the past three decades, carbon dioxide emissions from transport have risen faster than those from all other sectors and are projected to rise more rapidly in the future. From 1990 to 2004, the carbon dioxide emissions from the world's transport sector have risen by 36,5%. For the same period, road transport emissions have risen by 29% in industrialised countries and 61% in the other countries (mainly developing countries or countries in transition, IEA, 2006). Figure 3 shows the projected increase in transportation CO_2 emissions by world region for 2050.

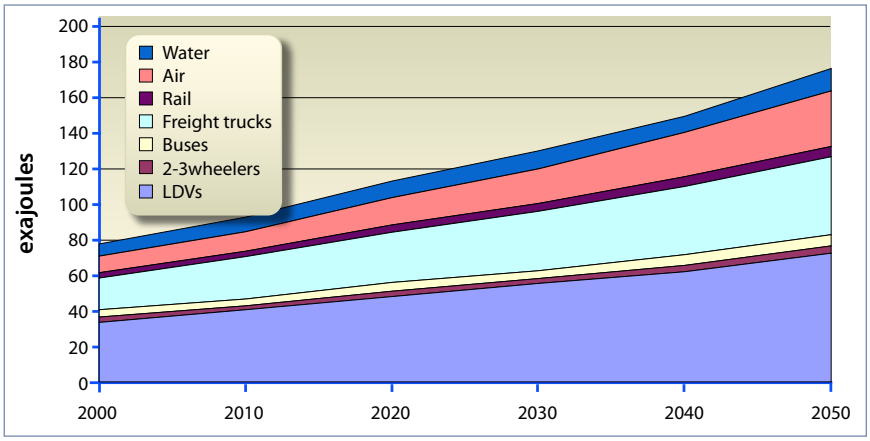
At present industrialised countries are the main sources of transport emissions. However, the proportion of emissions being produced in developing countries is increasing rapidly, particularly in countries such as China, India, and

Table 1: Projected effects of climate change on developing nations

Region	Projected effects of climate change
Africa	■ By 2020, projected that between 75 and 250 million people will be exposed to an increase of water stress. If this stress is coupled with increased demand, livelihoods will be adversely affected and water-related problems will be exacerbated. ■ Area suitable for agriculture, the length of growing seasons and yield potential are expected to decrease, further adversely affecting food security and malnutrition in the continent. ■ Decreasing fisheries resources in large lakes may lead to negative effects on local food supply as a result of rising water temperatures. ■ Sea level rise may affect low-lying coastal areas with large populations by the end of the 21st century, and Mangroves and coral reefs are projected to be further degraded. This is likely to have further consequences for fisheries and tourism.
Asia	■ An increase in flooding, rock avalanches and effects on water resources are likely to be experienced in the next two to three decades as a result of glacier melt in the Himalayas. Following this, river flows are projected to decrease as the glaciers recede. ■ Freshwater availability is likely to decrease, particularly in large river basins, in Central, South, East and Southeast Asia as a result of climate change. This could potentially adversely affect more than a billion people by the 2050s through population growth and increasing demand from higher standards of living. ■ Coastal regions will be at risk due to increased flooding from the sea and some mega-deltas flooding from the rivers. Effects will be experienced particularly in the heavily populated mega-delta regions in the South, East and Southeast Asia. ■ Pressure on natural resources and the environment associated with rapid urbanisation, industrialisation and economic development could be compounded with the effects of climate change to impinge on sustainable development of most developing countries in Asia. ■ Effects on agriculture include increased crop yields of up to 20% in East and Southeast Asia, and decreases of up to 30% in Central and South Asia by the mid 21st century. These effects coupled with rapid population growth and urbanisation, are likely to lead the risk of hunger remaining high in several developing countries. ■ Adverse health effects are projected to increase, including endemic morbidity and mortality due to diarrhoeal disease (associated with floods and droughts) in East, South and Southeast Asia, and the abundance and/or toxicity of cholera in South East Asia due to increases in coastal water temperature.
Latin America	■ Tropical forest is projected to be gradually replaced by savanna in eastern Amazonia through increases in temperature and associated decreases in soil water. Biodiversity loss through species extinction in many areas of tropical Latin America is a risk. ■ Salinisation and desertification of agricultural land may occur in drier areas as a result of climate change. This could lead to reduced productivity of certain crops and livestock productivity could decline with adverse effects for food security. Soybean yields could increase in temperate zones. ■ Low-lying areas may experience increased flood-risk due to projected sea-level rise. Sea surface temperature increases are likely to have an adverse effect on Mesoamerican coral reefs, causing shifts in the location of south-east Pacific fish stocks. ■ Water availability for human consumption, agriculture and energy generation are projected to be significantly affected by changes in precipitation patterns and the disappearance of glaciers.
Small Islands	■ Small island display characteristics that make them particularly vulnerable to the effects of climate change, sea-level rise and extreme events (both the Tropics and higher latitudes). ■ Coastal conditions are projected to deteriorate, including erosion of beaches and coral bleaching. These effects could affect local resources, such as fisheries and reduce the value of these destinations for tourism. ■ Sea-level rise can exacerbate certain problems including inundation, storm surge, erosion and other coastal hazards. These effects can threaten vital infrastructure, settlements and facilities that support the livelihood of island communities. ■ Water resources in many small islands are projected to be affected by climate change. They may become insufficient to meet demand during low rainfall periods. ■ Non-native species invasion may be increased as a result of higher temperatures, particularly on middle and high latitude islands.

Source: adapted from IPCC, 2007a

Fig. 4: Global transport fuel use by mode



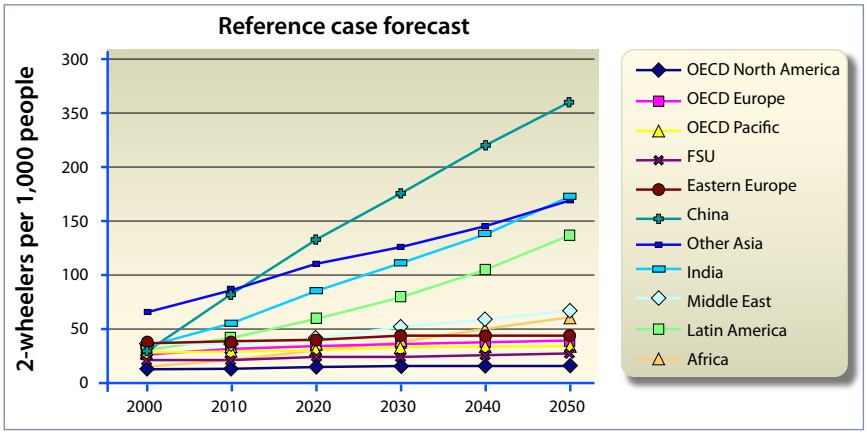
Source: WBCSD, 2004

Indonesia. World CO_2 emissions from the transport sector are projected to increase by 140% from 2000 to 2050, with the biggest increase in developing countries. Figure 4 shows the increase in world fuel use by transport mode. The majority of transport fuel emissions (76%) are from road transport. Light Duty Vehicles (LDVs)—*i.e.,* four-wheeled vehicles, including cars, sports utility vehicles (SUVs), small passenger vans (up to 8 seats), and personal pickup trucks—are the most important source.

Air travel produces around 12% of transport CO_2 emissions and its share is growing rapidly. Various transport modes contribute to global warming by more than their direct emissions of CO_2, *e.g.,* via the upstream CO_2 emissions from oil refineries, electricity used by electric trains, and for aviation the enhanced climate forcing as a result of contrails and other effects.

In developing countries, particularly China, India, Latin America, and other Asian countries, a rapid rise in two-wheeled vehicles is predicted. Between 2000 and 2050, two-wheeler fuel consumption is projected to increase by more than eight times, this increases the proportion of road vehicle fuel use attributed to two-wheelers from 2% to 3%. This rise is demonstrated in Figure 6.

Fig. 6: Predicted growth in two-sheeled vehicle use by world region



Source: WBCSD, 2004

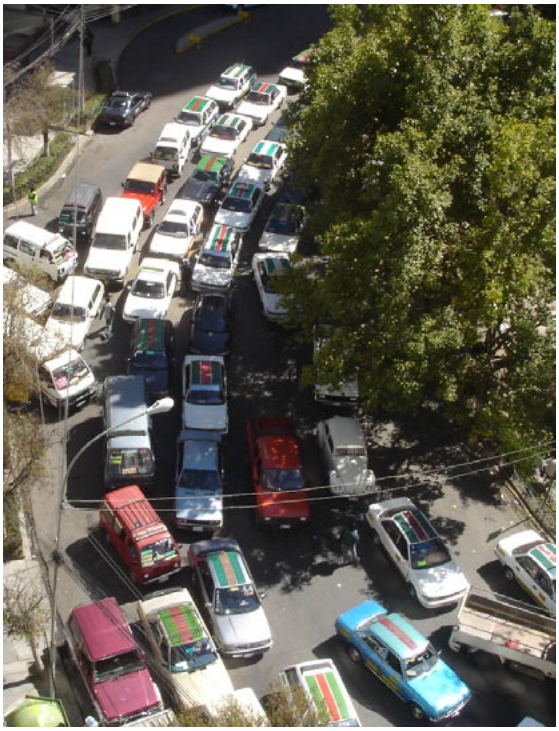


Fig. 5
Traffic jam in the centre of La Paz.
Photo by Gerhard Menckhoff, La Paz, 2005

1.3 Opportunities to reduce emissions from the transport sector

With the signing of the Kyoto Protocol in 1997, the first legally binding international agreement to reduce greenhouse gas emissions was established. As of May 2007, a total of 175 parties have ratified the agreement, covering over 60% of global emissions.

The industrialised countries who sign up to the treaty are legally bound to reduce worldwide emissions of six greenhouse gases by an average of 5,2% below their 1990 levels by the period 2008 to 2012. The Kyoto Protocol also includes mechanisms which allow industrialised countries to meet their targets by reducing emissions elsewhere, either through purchasing carbon credits as in the EU Emissions Trading Scheme or by funding projects in developing countries using the Clean Development Mechanism (CDM) or Joint Implementation (JI).

There are three primary ways to reduce greenhouse gas emissions from transport:

- ***Avoid*** (*i.e.,* avoid travel or avoid travel by motorised modes);
- ***Shift*** (*i.e.,* shift to more environmentally friendly modes); and
- ***Improve*** (*i.e.,* improve the energy efficiency of transport modes and vehicle technology).

Action in any of these areas could receive support from funding mechanisms such as the CDM, JI, or the Global Environmental Facility (GEF). These mechanisms are described in more detail in Section 3. See Box 3 for an overview of these funding mechanisms.

Transport is proving to be one of the most difficult sectors in which to reduce greenhouse gas emissions as there are numerous small emission sources (*i.e.,* vehicles) and, additionally, there is a seemingly close relationship with economic development.

Leapfrogging may be a particularly important element of reducing greenhouse gases from transport in developing countries, *i.e.,* bypassing the use of inferior, less efficient, more expensive or more polluting technologies and moving to more advanced ones.

This *Sourcebook* module is primarily focused on urban passenger and private transport. However, other sectors should not be neglected when aiming to reduce greenhouse gas emissions from transport, particularly freight and commercial transport, and aviation.

This *Sourcebook* module is divided into two major sections:

- ***Tackling the problem: Sustainable Transport Instruments***: An overview of the sustainable transport instruments available to decision-makers, strategies to reduce greenhouse gas emissions and likely effects, and factors contributing to the success of sustainable transport instrument implementation.
- ***Financial Mechanisms***: An overview of the financial mechanisms available to aid the implementation of sustainable transport schemes to reduce greenhouse gas emissions, focusing on Clean Development Mechanism (CDM) and Global Environment Facility (GEF).

Fig. 7
In Hanoi two-wheelers represent the major motorised transport mode.
Photo by Manfred Breithaupt, Hanoi, 2006

Fig. 8
In Delhi cars are increasingly replacing two-wheelers in the modal mix.
Photo by Abhay Negi, Delhi, 2005

Box 3: Funding mechanisms

CDM: The Clean Development Mechanism (CDM) allows industrialised countries with a greenhouse gas reduction commitment under the Kyoto Protocol to invest in emission reduction projects in developing countries.

JI: Similar to CDM, Joint Implementation (JI) again allows industrialised countries with greenhouse gas reduction commitments to invest in emission reducing projects in other industrialised countries.

GEF: The Global Environment Facility (GEF) was set up to fund projects and programmes aimed to protect the global environment in beneficiary nations. Projects can include biodiversity, climate change, international waters, land degradation, the ozone layer and persistent organic pollutants.

For more information see Chapter 3 of this module.

2. Tackling the problem: sustainable transport instruments

Instruments to promote sustainable transport are a key element in the response to tackling increases in greenhouse gas emissions and their contribution to climate change.

A sustainable transportation system is one that:

- allows individuals, companies, and societies to meet their basic mobility needs in a way that preserves human and ecosystem health, and promotes equity within and between successive generations,
- is affordable, efficient, offers a choice of transport mode, and supports a competitive economy, as well as balanced regional development, and
- limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes, while minimising the impact on the use of land and the generation of noise" (ECMT, 2004).

For developing countries the implementation of sustainable transport systems is particularly important as the large-scale investment that will be necessary in the years to come will shape transport for future decades. To avoid a bias in favour of the automobile, an integrated transportation

Fig. 9
Public transportation: buses and vans accessing the roadside market place in Ghana.
Photo courtesy of Allan Quimby (TRL), Ghana, 2004

Box 4: GTZ's Sustainable Transport Sourcebook for Policy-Makers in Developing Cities

GTZ's Sourcebook modules cover a wide range of sub-topics of sustainable urban transport. Many of the policy issues discussed in these modules have direct implications for GHG emissions, *e.g.,* the promotion of non-motorised transport (Module 3d) will help reduce CO_2 emissions. As of August 2007, the full range of Sourcebook modules are as follows:

- 1a: The Role of Transport in Urban Development Policy
- 1b: Urban Transport Institutions
- 1c: Private Sector Participation in Urban Transport Infrastructure Provision
- 1d: Economic Instruments
- 1e: Raising Public Awareness about Sustainable Urban Transport
- 2a: Land Use Planning and Urban Transport
- 2b: Mobility Management
- 3a: Mass Transit Options
- 3b: Bus Rapid Transit
- 3c: Bus Regulation and Planning
- 3d: Preserving and Expanding the Role of Non-motorised Transport
- 3e: Car Free Development
- 4a: Cleaner Fuels and Vehicle Technologies
- 4b: Inspection and Maintenance and Roadworthiness
- 4c: Two and Three Wheelers
- 4d: Natural Gas Vehicles
- 4e: Intelligent Transport Systems
- 4f: Eco Driving
- 5a: Air Quality
- 5b: Urban Road Safety
- 5c: Noise and its Abatement
- 5d: The CDM in the Transport Sector
- 5e: Transport and Climate Change
- 7a: Gender and Urban Transport: Smart and Affordable

All Sourcebook modules are available to download from http://www.sutp.org. For Chinese users a special website is available (http://www.sutp.cn). All are available in English, whilst most of the Sourcebook modules are also available in Chinese and Spanish, and some in Romanian, Indonesian, Vietnamese, Thai, and French.

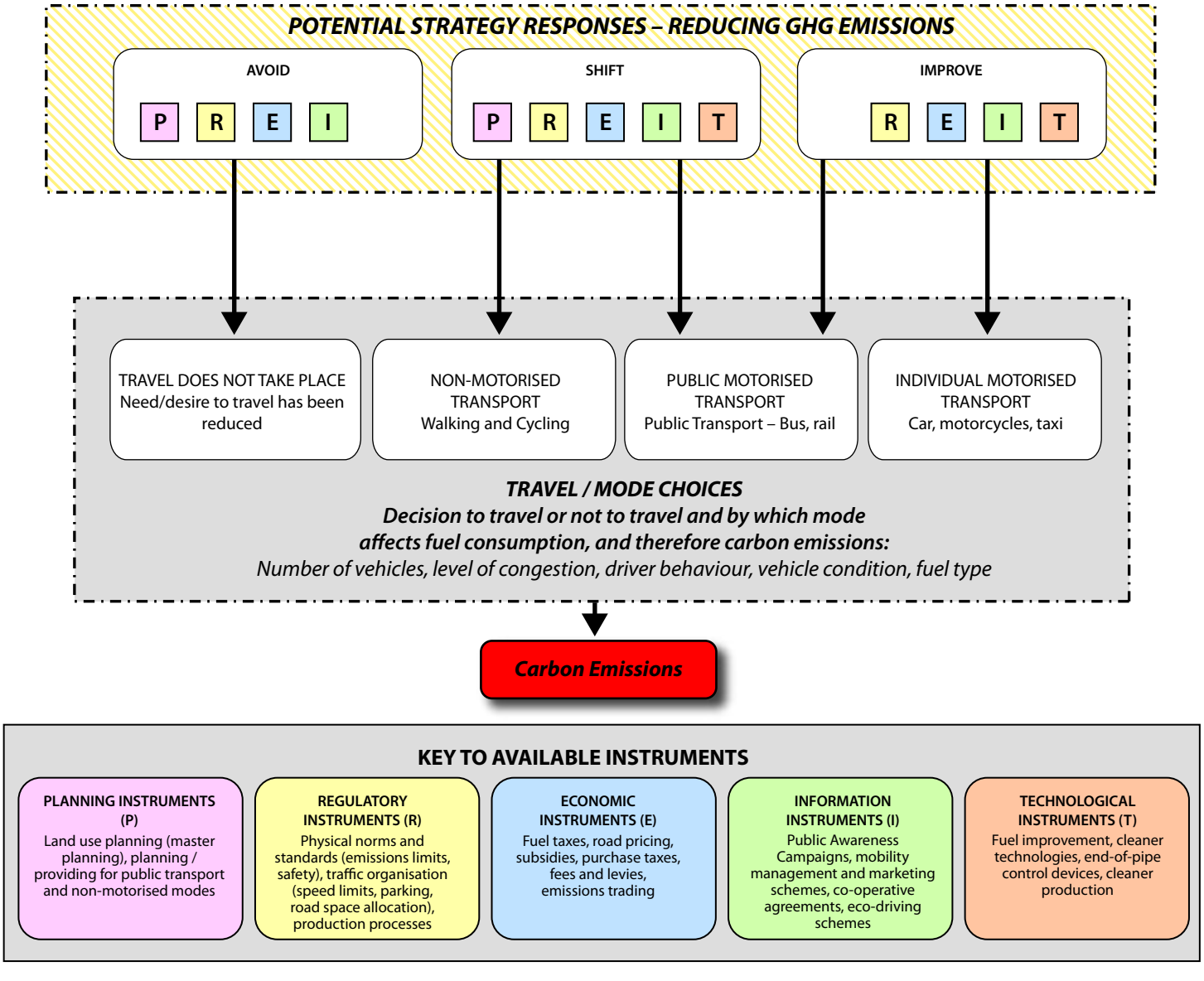
planning approach should be taken. This should include efficient transport modes, leapfrogging technological development, and smart infrastructure designs that reduce the need for transportation. In addition, the limited availability of financial resources and the importance of alternative travel modes make the need for sustainable transport policies even more obvious.

There are numerous modules of GTZ's Sustainable Transport Sourcebook for Policymakers in Developing Cities that are of relevance to transport and climate change. These modules discuss in more detail many of the principles mentioned here, and therefore should be referred to by the reader. Where appropriate, the most relevant modules have been identified throughout the text. Published GTZ *Sourcebook* modules are listed in Box 4.

Factors affecting mode choice can be influenced by a variety of instruments, spanning from planning to technological improvements. The interaction of policy instruments and key factors will eventually influence mode choices and travel options which—in the end—will determine carbon emissions in the transport sector (see Section 2.2).

Figure 10 summarises the key strategy responses to reduce greenhouse gas emissions, available sustainable transport instruments, key decisions individuals make regarding mode choice as a result of strategy implementation, and the resulting impact on carbon emissions.

Fig. 10: Sustainable transport instruments and their impact on carbon emissions



As identified in Section 1, the three primary strategy responses to reduce greenhouse gas emissions from vehicle travel are:

- ***Avoid*** (*i.e.,* avoid or reduce travel or the need to travel);
- ***Shift*** (*i.e.,* shift to more environmentally friendly modes); and
- ***Improve*** (*i.e.,* improve the energy efficiency of transport modes and vehicle technology).

A variety of sustainable transport instruments can be incorporated within these strategies. They can be categorised into planning, regulatory, economic, information, and technology instruments. There are four main outcomes related to strategy implementation that will determine the effect on carbon emissions:

- ***Travel does not take place***: As a result of sustainable transport measures implemented, the decision is taken not to travel for certain trips. In this case, emissions for a trip that would have been made previously are reduced to zero. This is achieved through the '***avoid***' strategy.
- ***Non-motorised transport is increased***: Strategies to encourage ***mode-shift*** can result in a higher proportion of trips being made by walking or cycling.
- ***Public motorised transport is increased and/or made more efficient***: A second outcome of ***mode-shift*** strategies is to achieve a shift to public transport vehicles, such as buses or rail. Although there are emissions associated with both bus and rail, the high occupancy levels that can be achieved means that the emissions of greenhouse gases per passenger km is less than being the sole occupant of a private vehicle. Strategies to ***improve*** the energy efficiency and technology of vehicles also apply to public transport vehicles, so emissions can be reduced further.
- ***Individual motorised transport is made more efficient***: Where private cars and other low occupancy vehicles continue to be used, the strategy to improve energy efficiency and technology of vehicles can help to reduce emissions.

Fig. 11
Broad bike and pedestrian lanes encourage people to shift to non-motorised traffic modes.
Photo by Sheyra Gadepalli, Bogotá, 2005

Fig. 12
Busses stuck in traffic jams are not attractive for passengers.
Photo by Manfred Breithaupt, Hanoi, 2006

The outcome and scale of these travel decisions will ultimately affect carbon emissions from transport, based on the effect they have on the following:

- Number of vehicles;
- Level of congestion;
- Driver behaviour (including speed);
- Vehicle condition; and
- Fuel type.

Figure 13 provides an overview of various sustainable transport instruments and their potential contributions to reducing greenhouse gas emissions.

2.1 Overview of sustainable transport instruments

Sections 2.1.1 to 2.1.5 provide an overview of the sustainable transport instruments available (planning, regulatory, economic and information instruments, and technological instruments/improvements) and their potential contribution to reducing greenhouse gas emissions from transport. The described instruments aim at both behavioural and technological changes.

At the end of each sub-section, two tables are provided detailing the instruments' contribution to greenhouse gas reductions, the estimated costs, co-benefits, implementation considerations of instruments, level of implementation and responsible/interested stakeholders. A checklist for successful implementation is also provided.

2.1.1 Planning instruments

Planning instruments include all measures that focus on "smarter" planning of infrastructure, *i.e.,* planning that helps reduce or optimise transport, encompassing both public transport and non-motorised modes such as cycling and walking.

Land use planning

Smart infrastructure design will influence both the demand for and the efficiency of transport. The need to travel can be reduced when the various forms of land use (such as residential houses, offices, shops, public services, etc.) are not separated in different city quarters but mixed within close proximity of one another—a strategy termed "mixed land use". A smart mixture can significantly reduce the need to travel (or distances travelled)—and thus energy consumption and emissions. In addition, smart infrastructure design will also include non-motorised

Fig. 13: Sustainable transport instruments and potential contribution to the reduction of greenhouse gas emissions

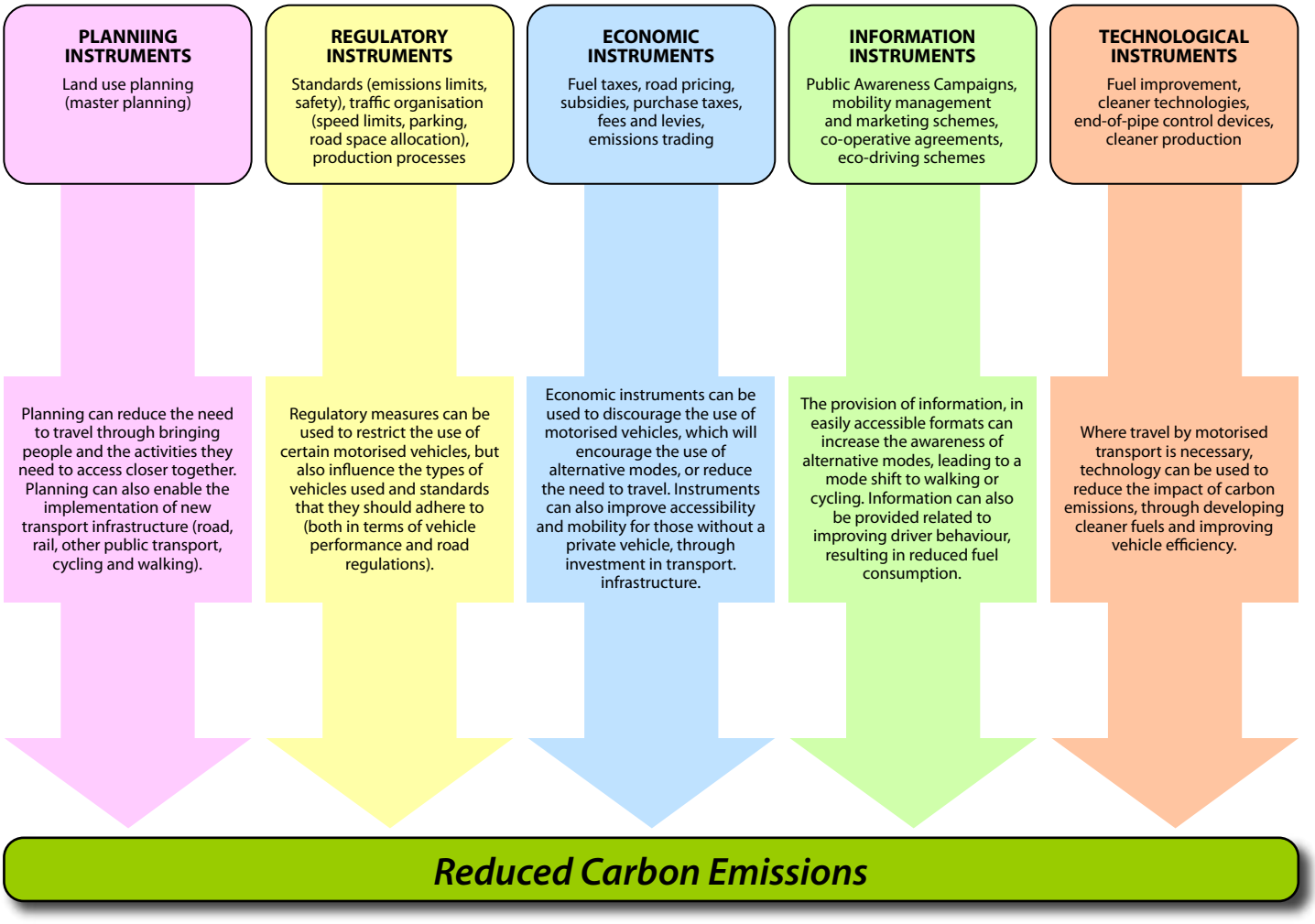


Fig. 14
Useless sidewalk.
Photo by Carlos F. Pardo, Pattaya, 2005

transport modes like walking and cycling right from the beginning, *e.g.,* by including pedestrian footways and areas or cycle paths in the infrastructure design. Good access to public transport can be a major contributor to cutting emissions as public transport is, in most cases, much more energy efficient and thus will have lower energy consumption and emissions per kilometre travelled.

Taking a more general perspective, the density of an area (*i.e.,* number of people and businesses per square kilometre) will be a crucial factor affecting energy consumption and emissions. Low density development where places of employment, residential areas and key services are separated can lead to a strong reliance on motorised private vehicles, and consequently high transport energy demand. Concentrated city designs, on the other hand, that work towards higher densities, with a variety of land uses and services within close proximity, will reduce travel needs and emissions.

Fig. 15
Uncoordinated public transport can cause congestion: traffic jam in a central business district.
Photo by Hans-Jörg Sommer, Delhi, 2005

In addition, public transport will be more efficient in densified cities. When major activity centres are concentrated locally, there will be a high demand for transport between these centres which can be served by efficient and—due to high demand—frequent public transport services. It has been estimated that benefits or savings from effective land use planning, combined with various traffic management schemes can create energy savings of 20 to 30% for bus operators (Martin *et al.,* 1995; in Karekezi *et al.,* 2003), not forgetting additional savings for other road users.

Parking management within a city or region can affect the relative price and convenience of driving. It can also affect land use density, accessibility, and walkability. As another example, traffic calming measures can affect the relative speed, convenience and safety of non-motorised transport (VTPI, 2005). Some of these issues are discussed further in the section on regulatory and economic instruments.

▸▸ Please see GTZ *Sourcebook* Module 2a: *Land Use Planning and Urban Transport* for further information.

Box 5: Land use planning

Land banking (where land is reserved for specific development uses) has been implemented in various cities including Singapore, Hong Kong and Curitiba alongside public transport corridors. The use of this mechanism has enabled the provision of low-income housing in transit friendly locations (Hook and Wright, 2002).

Planning for public transport modes

The provision of new and improved public transport is essential to reduce emissions of greenhouse gases. 'Public transport' can include buses, rail, light rail, metro, and underground systems. Attractive, accessible and reliable public transport systems can provide the basis for alternative mode use in cities.

The two key options to improve public transport are the expansion of systems or services and improvements to the operation of systems and services. The expansion of services can include fixed guideways, express bus services, local bus services, or services which extend the geographical coverage of bus network. System/service and operational improvements may include splitting routes, transfer improvements, co-ordination of schedules, through ticketing, and increased vehicle frequency. Services may also be improved through the provision of passenger amenities (*e.g.,* bus shelters, station improvements, safety and security enhancements, vehicle comfort improvements, signage and elderly/mobility impaired access) as well as full integration of public (and other) transport systems, both regarding physical infrastructure and fare systems.

However, in order to really reduce greenhouse gas emissions, sufficient ridership is required to avoid transit vehicles running at half occupancy. At the same time, consideration should be given to the possibility that public transport systems which manage to induce mode shifts away from the private car, will reduced congestion on roads—which may ultimately encourage additional drivers. This potential "rebound effect" must not be neglected.

Public transport improvements in developing cities are considered to be important supporting measures for a variety of transportation control measures (including road and fuel pricing). FHA (1998) identifies the following factors as being instrumental in the effectiveness of transit investment in reducing emissions of greenhouse gases:

- The level of improvement in transit frequency, coverage or amenities;
- The extent to which increased transit investment reduces motor vehicle fuel consumption (which depends on the extent to which transit causes shifts in mode of travel, improvements in traffic flow, and any offsetting increases in travel due to improved traffic flow); and
- The extent to which any increases in transit fuel consumption offset these reductions.

One option to improve public transport is the implementation of 'Bus Rapid Transit' (BRT) systems. BRT systems have most notably been implemented in Bogotá (Colombia) and Curitiba (Brazil), with others including Beijing (China), Jakarta (Indonesia), León (Mexico), and Seoul (South Korea), with projects underway in cities like Cape Town (South Africa), Dar es Salaam (Tanzania), Hanoi (Vietnam), Lima (Peru), Mexico City (Mexico), and Johannesburg (South Africa). The key features of BRT systems are outlined in Box 6.

Box 6: Key features of BRT systems

- Segregated busways;
- Rapid boarding and alighting;
- Clean, secure and comfortable stations and terminals;
- Efficient pre-board fare collection/ verification;
- Free transfers between routes;
- Clear and prominent signage and real-time information displays;
- Transit prioritisation at intersections;
- Modal integration at stations and terminals;
- Clean bus technologies;
- Sophisticated marketing identity; and
- Excellence in customer service (Hook and Wright, 2002; Wright and Fulton, 2005).

Experience with BRT systems shows that they can contribute to reducing emissions. Congestion problems are reduced substantially through increases in patronage (mode shift from private vehicles), and increasing fuel economy when efficient buses are used. Additional co-benefits are likely, such as improved local air quality (reductions of SO_X, NO_X, PM, and CO emissions), and improved public transport.

Fig. 16
Exclusive bus lanes for the BRT line in Quito.
Photo by Klaus Banse, Quito, 2002

Fig. 17
Bus stop at a station of the BRT corridor in Kunming.
Photo by Karl Fellstrom, Kunming, 2003

Box 7: Bus Rapid Transit

Columbia: Bogotá's TransMilenio BRT system was launched in 2000. As of August 2007 it consisted of 84 km of busway, 515 km of feeder routes, and carried 1,400,000 passengers a day. Its success has been helped by a range of complementary measures including new cycleways (increasing mode share from 0.58% to over 4%), pedestrian upgrades and car-free events. Every Sunday 120 km of arterial roadways are closed to private motorised vehicles from 7:00 to 14:00h. Car restriction measures have also been implemented, including restricting access to 40% of motorised vehicles on weekdays during peak periods (between 6:00 and 9:00h, and 16:00 and 19:00h). On-street parking has been eliminated from many streets (Wright and Fulton, 2005 and http://www.transmilenio.gov.co).

Brazil: In Curitiba, Brazil, BRT implementation achieved an increase in patronage by 2.36% a year for over two decades. This increase in ridership year on year was enough to secure public transport mode share when it was recorded to be declining in other Brazilian cities (Rabinovitch and Hoen, 1995 in Hook and Wright, 2002). In addition, public space within the city has been improved through converting parking bays into pedestrianised areas. The city's pedestrian zones also act as feeder services to the BRT by easing pedestrian movements towards stations (Wright and Fulton, 2005).

China: Beijing's first exclusive BRT line became operational on 30th December 2005. It is 16 km in length and has 17 stops along the route, linking a number of residential areas with four commercial circles in the city's southern districts. In the first two months of operation it attracted average daily passenger flows of 80,000 commuters.

▸▸ For more detailed information, please see GTZ *Sourcebook* Modules 3a: *Mass Transit Options*; 3b: *Bus Rapid Transit*; and 3c: *Bus Regulation and Planning* as well as the comprehensive *BRT Planning Guide*. In addition, the *Sourcebook* Module 5d: *The CDM in the Transport Sector* has a strong focus on BRT projects.

Box 8: Non-motorised modes

China: In China, bike mode share increased in cities until the early 1990s, accounting for nearly 30 to 70% of all trips. However, bike use fell sharply in Southern and Eastern provinces in the late 1990s. Wealthier residents have upgraded to taxis, mopeds or motorcycles. Bicycle use has declined largely due to public policies banning their use on major arterials, and upgrading major-urban arterials to high speeds. Bicycle lanes have also been removed (Hook and Wright, 2002). Road safety is another important barrier to increasing cycle use in China. Cyclists are often forced out of or on to the road by cars parked or driving in cycleways. Traffic deaths have doubled between 1990 and 2000, with cyclists accounting for 38% of fatalities (approximately 38,000) (Karekezi *et al.,* 2003).

Colombia: Bogotá has been successful in increasing bike use from 0.58 to 4.0 % of all trips through improvements to cycling infrastructure. 330 km of new fully grade-separated bicycle lanes were constructed over three years, coupled with other complimentary bicycle measures (Hook and Wright, 2002). Following the implementation of cycling and other mode improvements, a study was undertaken in Bogotá involving interviews with 12,000 homes. Respondents were asked which works had improved the family's quality of life during the previous 5 years. The responses were as follows: parks (73.4%), bicycle paths (68.6%), pedestrian overpasses (67.8%), roads (66.1%), the TransMilenio BRT (64.8%), sidewalks (64.5%), public libraries (55.5%) and public schools (37.9%) (I-CE, 2007).

Chile: Experience in Santiago with a cycling project revealed that a 3% decrease in car and taxi travel as a result of modal shift to bicycle is expected to reduce CO_2 emissions by 126,000 tonnes a year (approximately 1.15%) (World Bank, 2006).

Africa: The implementation of 60 km of bikeways as part of a network in Tamale, Ghana, accounted for 65% of transport trips. The network was fully integrated with the town and with other transport modes, such as taxis, and lorries, which are used for long-distance travel (CIDA, 2002).

Case Study 1: Access Africa Programme

The Access Africa Programme, initiated by the American Institute for Transportation and Development Policy (ITDP), aims at the promotion of clean, healthy and liveable cities by the deployment of a custom-tailored transportation system. The programme, implemented in Ghana, Senegal, South Africa and Tanzania, includes the encouragement of Bus Rapid Transit (BRT) Systems by facilitating exchange of information and the provision of technical or legal assistance.

As part of the programme, the California Bike Coalition (CBC), a growing network of small African bicycle retailers, was founded in 2003. The commercial partnership was established to produce good-quality bicycles that are available to the African market by using economies of scale. The member retailers receive support in repair and customer services. Moreover ITDP is working to enable ownership for locals who cannot afford new bicycles.

Another element of the Access Africa programme is the improvement of safety for cyclists and pedestrians. Beginning in 2000, the aim is to work directly on the planning and implementation of non-motorised transport (NMT) infrastructure. In cooperation with municipal authorities, ITDP is developing master plans, "Safe Routes to School" programmes and securing access to public transport routes.

Due to its extensive and multi-level approach, the Access Africa Programme improves both mobility and air quality. By making a high contribution to the promotion of NMT and modal shift, CO2 emissions are reduced to a great extend without high expense.

Fig. 18
Wall of ideas on the car free day in Bogotá: people are being involved by sharing their ideas about mobility.
Photo by Manfred Breithaupt, Bogotá, 2002

Case Study 2: Carsharing in Singapore (Car Clubs)

Shared-use vehicle systems such as carsharing have become more and more popular in recent years. Carsharing makes a fleet of vehicles available for use by the members of the carsharing group, while the fleet management is transferred to a central organiser. Users access the vehicles from shared-use lots such as transit stations, neighbourhoods or employment centres. This increases public transport ridership and decreases parking demand. In many cities, carsharing has become a rewarding alternative to buying an own vehicle, as members can use a car whenever they need one. Within a few minutes of booking, members can use their personal card to unlock the car from where it is parked.

After positive experiences mainly in Europe and North America, the former Communications Minister of Singapore, Mah Bow Tan, first mentioned carsharing as a promising endorsement for Singapore's transport system in the mid-1990s. Only short time later, in 1997, the first carsharing company in Singapore, Car Co-Op, was launched by NTUC Income, a Singapore insurance company. Since then, three further carsharing projects were established. CitySpeed, the second carsharing operator in Singapore, was launched in 2002, as well as Honda Diracc, which is part of Honda´s Intelligent Community Vehicle System (ICVS). A year after, WhizzCar started its operations. Among these four companies, Car Co-Op is the only cooperative (non-profit) carsharing operator with the largest fleet. Together, they provide approximately 430 vehicles for 12,200 members (2006 Figures). One of the reasons for the carsharing success in Singapore is the high cost of private vehicle ownership there.

A first pilot carsharing project to replicate the good experiences in Singapore was launched in Malaysia in Spring 2006. Kar Club, which is supported by Income Car Co-Op, started operating with an initial fleet of about 10 vehicles in Kuala Lumpur.

(Further details on car-sharing can be accessed online at http://www.carsharing.net; http://www.ecoplan.org/carshare/cs_index.htm.)

Planning for non-motorised modes

The encouragement and facilitation of increased levels of walking and cycling is essential in any successful sustainable transport strategy. Cycling and walking as modes do not produce any direct emissions. As emissions from motorised transport are highest at cold start of the engine, short trips are disproportionately polluting. These shorter trips are most suitable for non-motorised modes.

Transport authorities face difficulties when trying to achieve a mode shift to cycling and walking, as they are often viewed as unattractive alternatives to motorised transport, primarily due to the inconvenience and safety concerns experienced in developing country cities (World Bank, 2004). Lack of protection from the weather, the topography in some cities/countries, the health and physical fitness of the intended cyclists, and road safety and security

Table 2: Planning instruments – Level of implementation and responsible/interested stakeholders

Type of instrument		Level of implementation			Responsible / interested stakeholder									
		National	Regional	City	Mayor/Equivalent	Transport Authorities (including public works)	Land use/planning authorities	City Administration (treasury/finance/taxation)	Public relations, Press, and Media	Enforcement Authorities (police, others)	Non-Governmental Organisations (NGOs)	Private Sector (Industry/commercial)	Private sector – Public Transport Operators	Private Sector – Employers
Planning	Land Use Planning		✔	✔	✔		✔						✔	✔
	Public Transport		✔	✔	✔	✔	✔		✔		✔		✔	✔
	Non-Motorised Modes			✔	✔	✔	✔		✔		✔			✔

✔ = indicates level of implementation and responsible/interested stakeholders

Table 3: Planning instruments – Contribution to greenhouse gas reductions, estimated costs, co-benefits benefits, and implementation considerations of instruments

Type of instrument		Contribution to reduce greenhouse gas emissions	Potential cost of Implementation	Co-benefits / negative (+ ? –)	Implementation considerations for responsible authorities
Planning	Land Use Planning	##	$	+ accessibility, social inclusion, air pollution	
	Public Transport	# – ###	$$	+ accessibility, mobility, economy	Service coverage/ frequency, cost
	Non-Motorised Modes	# – ###	$ – $$	+ Safety, accessibility, mobility, social inclusion, economy, air pollution	Safety

\# = Small contribution
= Medium contribution
= High contribution

$ = Low cost
$$ = Medium cost
$$$ = High cost

\+ = positive
? = unclear
– = negative

(*e.g.,* fear of bicycle theft) in general also add to the perceived unattractiveness of walking and cycling.

There are a number of improvements that can be made to encourage cycling and walking. These include the creation of continuous cycle networks, possibly featuring separate cycle lanes, or integration with other transport modes. Employers and educational facilities also have a role to play in encouraging walking and cycling, and may wish to consider the provision of facilities such as lockers (for storing cycling/walking equipment), bicycle racks, and showers.

A key instrument in encouraging a mode shift to walking and cycling is the use of awareness campaigns and information (see Section 2.1.4), which may also include the development of cycling and walking routes and maps (Sloman, 2003; Hook and Wright, 2002).

▸▸ Please see GTZ *Sourcebook* Module 3d: *Preserving and Expanding the Role of Non-motorised Transport* as well as the GTZ NMT training document for more information.

Planning instrument implementation – impacts and consideration

Table 2 shows the level of implementation of each of the planning instruments and potential responsible or interested stakeholders. Planning instruments, including the provision of public transport or non-motorised modes, are generally implemented on a regional or local level. Transport and land use authorities will typically act as the implementing authorities for such instruments, but will require assistance from non-governmental organisations (such as those interested in public transport and non-motorised modes, environmental or social issues), and public relations, to increase public awareness and acceptance.

Table 3 focuses on the contribution that planning instruments could make to reducing greenhouse gas emissions, and indication of likely implementation costs, the co-benefits that could be achieved through implementation of the instruments, and any further considerations for responsible authorities. Although relatively low cost, planning instruments may contribute significantly to reducing greenhouse gas emissions and achieving a variety of co-benefits.

CHECKLIST A: Successful implementation of planning measures

- ☑ Ensure that new developments include **mixed land uses** (employment, residential, amenities) to reduce the need to travel.
- ☑ Ensure that **cyclist and pedestrian facilities** are attractive to existing and potential users. This includes considering safety (adequate lighting, separate from traffic where necessary), and accessibility (direct routes, connectivity).
- ☑ Aim to create **partnerships with local employers and businesses**, encouraging the implementation of additional ancillary facilities for cyclists and pedestrians, such as lockers/storage facilities, showers, bicycle racks, etc.
- ☑ Consider **integration with other modes**, *e.g.,* integration between rail and bus (*e.g.,* common fare, timetable), bus and cycling (allow transport of cycles, provide parking infrastructure) to encourage their use.
- ☑ Ensure **public transport vehicles and associated infrastructure** (public transport stations/hubs) are accessible (low floor vehicles, step-free buildings), and attractive (safe, lighting, waiting areas, information provision, etc.).
- ☑ Ensure that **public transport provision** has the appropriate level of service and coverage to meet potential user demand.
- ☑ Use appropriate **fare structures** to ensure adequate levels of patronage.
- ☑ Ensure **appropriate priority measures for public transport, cyclists, and pedestrians**.
- ☑ Ensure provision of relevant **passenger travel information** (timetables, format of information, advertising).
- ☑ Integrate **stakeholders** from the public to increase awareness and acceptance of the measures.

Fig. 19
Passenger friendly bus station.
Photo by Gerhard Menckhoff, Curitiba, 2004

Planning instruments – relevant GTZ SUTP Sourcebook modules:

- Module 1a: Sustainable Transport and Urban Development
- Module 1b: Sustainable Transport Institutions
- Module 2a: Land Use Planning and Urban Transport
- Module 2b: Mobility Management
- Module 3a: Mass Transit Options
- Module 3b: Bus Rapid Transit
- Module 3c: Bus Regulations
- Module 3d: Preserving and Expanding the role of Non Motorised Transport
- Module 3e: Car Free Development

Other relevant GTZ publications:

- Planning Guide: Bus Rapid Transit
- Training Course: Bus Regulation and Planning – Bus Sector Reform
- Training Course: Mass Transit
- Training Course: Non-Motorised Transport

2.1.2 Regulatory instruments

Regulatory instruments can be implemented by the public administration or the political bodies at the national, regional/provincial or local level and include fuel consumption regulation, physical restraint measures, traffic management measures, regulation of parking, and limitations placed on speed. Measures aim to either discourage travel, or deny access completely to certain traffic/vehicles.

Fig. 20
Car free zone in the historical centre of Bogotá.
Photo by Sheyra Gandepalli, Bogotá, 2004

Physical restraint measures

In order to achieve a 'quick-win' in reducing emissions from vehicles, city authorities can implement measures that physically restrict access for certain motorised vehicles. When implemented successfully, such measures can be effective in reducing traffic volumes and associated greenhouse gas emissions. Furthermore, it can increase the attractiveness of public transport, improve the quality of public space and thus the quality of life in cities.

One such measure that has been implemented in many cities is the restriction of vehicles on certain days depending on their registration plate number. This type of scheme has been widely implemented, including Athens, Bogotá, Lagos, Manila, Mexico City, Santiago, Sao Paulo, and Seoul. Short-term benefits of the measure include a reduction in congestion and increases in vehicle speeds. In Bogotá, average travel speeds were reported to increase by 20%. Implementing authorities should be aware that some people will be encouraged to purchase a second car, or retain older, more polluting vehicles that may have otherwise been scrapped, thus negating any benefits achieved. To avoid this problem, schemes should be well-designed and limited to restricting vehicles just during peak periods and having the proportion of non-use days sufficiently large (World Bank, 2004) (see Section 2.1.4 and Box 10 for more information on car free days).

Low emission zones

Low emission zones (LEZs) are areas into which access is permitted only to vehicles or classes of vehicles meeting a prescribed standard of emissions. Local transport and planning authorities can determine an area within a city from which certain vehicles (usually older, more polluting vehicles) will be banned from entering. Such restrictions have obvious benefits for local air quality improvements, but could also reduce greenhouse gas emissions if the area is large enough and can encourage people to use alternative modes. However, this instrument assumes that emission standards are evident for vehicles being used within the city, and will require a high level of administration and technology to set up and enforce the restrictions.

▸▸ Please see GTZ *Sourcebook* Module 5a: *Air Quality* for more information.

Traffic management measures

Where the implementation of physical restraint measures is difficult, transport authorities may wish to use traffic management measures in order to smooth traffic flows. This helps ease congestion, and therefore improves fuel efficiency and reduces emissions.

Traffic signal systems aim to secure a steady traffic flow. The most efficient of these systems is area traffic control systems, where signals are linked across a whole network. However, careful design and committed institutional co-ordination is required in order to make the use of traffic signals a success. Traffic control systems can also be quite costly to run and maintain. 'Cell Systems' can be introduced to inner city areas which use physical restrictions on cross-centre movements to keep through-traffic of private vehicles (not buses) from central areas. At the same time it should be noted that improved traffic flows may encourage people to increase their travel—thus nullifying the achieved emission reductions.

In developed countries, traffic management has been estimated to reduce emissions by 2% to 5% overall (greater proportions in specific corridors or areas) through increasing fuel efficiency. There is potential for similar, if not greater, benefits in developing cities due to the poor initial traffic considerations, where the implementation of traffic management instruments can aid in the reduction of fuel consumption (World Bank, 2004).

Regulation of parking supply

As with road space, the provision of parking is closely linked to demand. Parking in developing cities is a particular problem, where highways and walkways are often littered with parked vehicles. Parking supply restrictions can make car use unattractive and thus contribute to mode shift. These restrictions are often implemented alongside parking pricing measures (see Section 2.1.3).

To ensure the successful implementation of this measure, illegal parking elsewhere must be avoided, *e.g.,* by providing bollards on pavements. Where possible, developing cities should avoid publicly-funded free car parking and try to ensure strong regulation to limit on-street parking where it can have adverse effects (World Bank, 2004).

Transport authorities should also work in partnership with employers and other commercial businesses, which have a role to play in reducing private parking allocations reserved for employees or customers. City-wide initiatives are likely to be more successful compared to solely applying restrictions to publicly-provided parking.

Fig. 21
Huge parking demand in the centre of Delhi.
Photo by Abhy Negi, Delhi, 2005

Table 4: Regulatory instruments – Level of implementation and responsible/interested stakeholders

Type of instrument		Level of implementation			Responsible / interested stakeholder									
		National	Regional	City	Mayor/Equivalent	Transport Authorities (including public works)	Land use/planning authorities	City Administration (treasury/finance/taxation)	Public relations, Press, and Media	Enforcement Authorities (police, others)	Non-Governmental Organisations (NGOs)	Private Sector (Industry/commercial)	Private sector – Public Transport Operators	Private Sector – Employers
Regulatory	**Physical Restraint Measures**			✔	✔	✔	✔		✔	✔			✔	
	Traffic management Measures			✔		✔	✔		✔	✔			✔	
	Regulation of Parking Supply		✔	✔		✔			✔	✔				✔
	Low Emission Zone		✔	✔	✔	✔			✔	✔	✔	✔	✔	
	Speed Restrictions	✔		✔		✔			✔	✔				

✔ = indicates level of implementation and responsible/interested stakeholders

Table 5: Regulatory instruments – Contribution to greenhouse gas reductions, estimated costs, co-benefits, and implementation considerations of instruments

Type of instrument		Contribution to reduce greenhouse gas emissions	Potential cost of Implementation	Co-benefits / negative (+ ? –)	Implementation considerations for responsible authorities
Regulatory	Physical Restraint Measures	## - ###	$ - $$$	+ safety, air pollution, noise ? accessibility, mobility, social inclusion, economy	Traffic displacement, restricted access/mobility, alternative modes provision, enforcement
	Traffic management Measures	## - ###	$ - $$$	+ safety ? accessibility, mobility, social inclusion, economy, air pollution	Traffic displacement, restricted access/mobility, alternative mode provision, enforcement
	Regulation of Parking Supply	# - ##	$ - $$	+ air pollution ? accessibility, mobility, social inclusion, economy	Traffic displacement, restricted access/mobility, alternative mode provision, illegal parking/ obstructions, enforcement
	Low Emission Zone	# - ##	$$ - $$$	+ Safety, local air pollution, noise ? accessibility, mobility, social inclusion, economy	Traffic displacement, restricted access/mobility, alternative mode provision, enforcement
	Speed Restrictions	# - ##	$ - $$	+ safety, air pollution, noise ? accessibility, mobility, social inclusion, economy	Enforcement

\# = Small contribution
= Medium contribution
= High contribution

$ = Low cost
$$ = Medium cost
$$$ = High cost

\+ = positive
? = unclear
– = negative

CHECKLIST B: Successful implementation of planning measures

Regulatory instruments place restrictions on personal travel and may conflict with other objectives such as access to employment, education and healthcare. They may also lead to increases in vehicle kilometres travelled as people search for parking spaces. To minimise these potential negative effects, a full sustainable transport strategy should be implemented by the local authority, including the provision of viable and attractive alternatives (public transport, cycling, and walking), and awareness campaigns.

- ☑ Ensure adequate provision of **alternative modes** (public transport, walking, cycling) to maintain access to key services and activities where restrictions are in place.
- ☑ Raise **public awareness** of changes in regulations regarding transport restrictions, and the alternatives available.
- ☑ Create **partnership with neighbouring districts/municipalities** when implementing regulatory measures to ensure that unwanted traffic is not shifted to another part of the road network.
- ☑ Ensure the support of relevant authorities to guarantee **enforcement** of restrictive measures (access restraint, parking control, speed).

Regulatory instruments – Relevant GTZ SUTP Sourcebook modules:

- Module 2b: Mobility Management
- Module 3e: Car-free development

Speed restrictions

At higher speeds (generally above 55 km/h) fuel consumption is often an increasing function of speed for cars and trucks. In order to reduce emissions of greenhouse gases from vehicles, the implementation of lower speed limits should be considered.

Regulation instrument implementation – impacts and considerations

Table 4 shows the level of implementation of each of the regulatory instruments, and potential responsible or interested stakeholders. Regulatory instruments, including physical restraint measures, traffic management measures, regulation of parking supply, low emission zones and speed restrictions are usually implemented on the city or regional level. Some measures work particularly well when implemented on the regional level as it reduces the likelihood of traffic problems moving to alternative routes/areas. Transport authorities are most likely to be responsible for implementation of the measures, whilst enforcement authorities will be responsible for ensuring adherence to regulations. Awareness raising of measures to be implemented and reasons for their implementation is crucial for success, and the mayor, the public relations office or the media may play an important role in this respect.

Table 5 assesses the contribution that the implementation of regulatory instruments could make to the reduction of greenhouse gas emissions, estimated costs, co-benefits and considerations linked to the implementation of such instruments. Instruments that are likely to have the greatest contribution to reducing greenhouse gas emissions include physical restraint and traffic management measures. Costs of implementation and operation vary greatly, but can depend on the level and method of enforcement. The main consideration for implementation authorities with the majority of regulatory measures is the displacement of traffic to alternative routes and areas, and ensuring that key services and facilities are still accessible despite restrictions. In order to avoid these problems, regulation measures should be implemented alongside others, such as the provision of public transport.

2.1.3 Economic instruments

Whilst economic instruments have often been used for financing infrastructure costs in the past, one of the key aims of economic instruments as they are currently used is to discourage the use of private vehicles (or others) or encourage more (energy-) efficient use of transport through the implementation of charges or taxes on transport. The use of these economic instruments often aims to internalize external costs, such as taking into account the effects of greenhouse gas emissions. The instruments discussed here include road pricing, fuel taxation, vehicle taxation, and parking pricing.

Road pricing

The motivations for road pricing are various. They include raising revenue to pay for infrastructure, reducing congestion, and reducing emissions. In general, road pricing increases the cost of running a vehicle thus encouraging the use of alternative modes.

There are a number of key factors that affect the effectiveness of road pricing including: the level of fee charged; the current cost of driving per kilometre; the responsiveness of travellers to the price of travel (measured in terms of price elasticity); and the nature and extent of pricing. When implementing pricing schemes, decision-makers should always consider the costs and technology required in enforcing the road pricing, collecting tolls etc., which can be potentially expensive to implement and run. Public acceptance is also a major issue when dealing with pricing schemes, as they are likely to have a disproportionate effect on low-income drivers.

Where revenue generation is the key objective, rates are set to maximise the revenues or to recover costs incurred. The revenue generated is often used for other roadway projects. However, in order to meet the key objectives, shifts to alternative routes or modes are undesirable as revenues would be reduced.

The two main road pricing options are: national road pricing schemes, where charges are applied to long-distance highway use; and local road pricing schemes, which typically cover city centre areas (often referred to as 'congestion charging' schemes).

To reduce peak-period vehicle traffic, road pricing rates can be variable (higher during periods of congestion), following the principle of congestion management. Where congestion management is a key objective of road pricing schemes, reductions in greenhouse gas emissions are more likely to be achieved.

There are four main effects resulting from the implementation of road pricing schemes:

- Those drivers with flexibility in their travel will find an alternative route to avoid paying the charge;
- The charge will discourage some drivers from travelling;
- Some drivers will switch to an alternative transport mode to undertake their journey; or
- Driver will choose to continue with their originally planned journey and pay the charge.

In the first three cases, emissions may be reduced: by reduced congestion; by reduced travel; or by mode shift to (potentially) less emission intensive modes.

An important consideration for decision-makers is the displacement of vehicles on the road network to surrounding routes covered by road pricing, particularly when implemented locally. Traffic diversions may occur, with more vehicles seeking alternative routes, possibly using secondary or more environmentally sensitive routes to avoid the charge. Where possible, surrounding roads should also be included within the charging scheme to avoid this transference of vehicles. This effect should be a key factor when considering the boundary of the scheme.

Equity and public acceptability are always issues when implementing charge-based measures, and this is particularly so for road pricing schemes. Those benefiting from such schemes include the users of the improved public transport system—but also the drivers paying the charge, who may experience reduced congestion, higher speeds and shortened journey times. However, other low-income drivers are likely to experience disproportionate effects as they are unable to afford the charge, and possibly the cost (if available) of alternative transport. These low-income drivers can therefore become isolated as access is restricted. To overcome these disproportionate effects, implementing authorities may wish to consider supporting measures in tackling equity issues and increasing public acceptance, such as:

- Providing a direct rebate to low-income groups;
- Providing public transport subsidies for low income users; or
- Increasing the supply of public transport, including subsidised public transport fees.

Negative effects may also be experienced by businesses located within a cordon area or along a road pricing route. Similar supporting measures may need to be implemented, including reduced charges for certain businesses/fleets within the city charging area.

Fuel taxation

Political administrations may consider the use of taxes on fuel at the national level. Fuel taxes

Box 9: Road pricing and congestion charging

Singapore: Singapore's cordon pricing measure, an Area Licensing Scheme (ASL), covers a 7.5 square km restricted zone in downtown Singapore. The restrictions are applied during the morning peak, between 7:30 and 10:30h. Access to the restricted zone is made possible through the purchase of daily or monthly licenses at post offices and kiosks outside of the zone. Since 1989, the access restrictions have been extended to include carpools and trucks (which were previously exempt under the scheme). Singapore's ASL has been successful in reducing motorised traffic within the zone by 50%, and private car travel by 75%. The speed of the traffic has also been increased from approximately 18 to 30 km/h. The scheme was complimented by the doubling of parking charges (Hook and Wright, 2002).

South Korea: Road pricing was introduced to the #1 and #3 Tunnels linking downtown Seoul (South Korea) to the southern part of the city. Both corridors experienced high volumes of private vehicle traffic, leading to heavy congestion. Private cars with three or more passenger, buses, vans and trucks were exempt from the 2,000 won charge (US$2.20), as was all traffic on Sundays and national holidays. The road pricing schemes resulted in a 34% reduction in peak period passenger vehicle volumes in the two years following implementation. Average travel speeds also increased by 50%, from 20 km/h to 30 km/h. As it was not an area-wide charging scheme, traffic volumes increased on alternative routes up to 15%. However, average travel speeds also increased as a result of improved flows at signalled intersections and increased enforcement of on-street parking rules on alternative routes (World Bank, 2002).

London: The London Congestion Charge came into effect in February 2003. The Charging Zone covers an area in Central London (which was extended in 2007), and drivers of non-exempt vehicles must pay a charge of £8 (US$16) per day to enter and travel within this zone. The scheme is enforced by a network of Automatic Number Plate Recognition (ANPR) cameras that monitor vehicles entering and circulating within the Charging Zone. The scheme has resulted in an estimated 19% reduction in traffic related CO_2 and a 20% reduction in fuel consumption (Jones, G. *et al.,* 2005).

increase the price of travelling and thus have an indirect effect on individual travel behaviour and decisions. Fuel taxes are a way of charging the users of transport infrastructure relative to individual use. Implementing or increasing taxes on fuel can have two main effects:

- Fuel taxation raises the price of travel per km. This action can lead to drivers trying to reduce the number of vehicle kilometres travelled.
- Fuel taxation is directly proportional to fuel consumption. This could be an incentive to purchase fuel efficient vehicles.

Both effects can contribute to reducing greenhouse gas emissions. The effectiveness of fuel taxation depends on the consumers' response to price increases. The implementation of fuel taxation is relatively simple as tax collection only needs to be done at a few refineries or wholesalers.

Implementing fuel tax measures will not address the issue of congestion, which is often a localised problem. It may also be the cause of disproportionate effects on low-income drivers who are affected by the tax. However, in many developing countries it is the wealthier part of the population, *i.e.,* those who can afford a car, that benefits most from low fuel prices.

Where the tax is implemented in smaller countries, there may be an issue regarding tax evasion, where drivers living close to borders can fill up abroad or smuggle in fuel, leading

Fig. 22
A three-wheeler refuels at gas station in Kolkata.
Photo by Gerhard Metschies, Kolkata, 2004

Fig. 23
Old parking meter in Mexico City.
Photo by Klaus Banse, Mexico, 2002

to revenues not being collected in the country where the vehicle is mainly driven.

⏩ For more information on fuel taxation and an international comparison of fuel prices in more than 170 countries see the publication GTZ *International Fuel Prices*, available on the GTZ website http://www.gtz.de/fuelprices.

Vehicle taxation

The main principle behind vehicle taxation is to charge vehicle ownership. Vehicle taxes are often regarded as an "access fee" to use the road network, and they are also important source of tax revenues. There are two key forms of vehicle taxation:

- Sales taxes are charged when the vehicle is purchased, sometimes contributing significantly to the overall cost of the vehicle. This form of taxation may discourage potential owners from buying a vehicle.
- Annual vehicle taxes/registration fees which may have similar effects, but are a continuous financial burden rather than a one-off tax. They also apply to all vehicles rather than just new ones.

Vehicle taxes can be differentiated according to vehicle type, vehicle size or emissions, and noise levels. However, it is essential that central administration bodies exist for vehicle taxation schemes to be successful.

In terms of reducing greenhouse gas emissions, drivers may be encouraged to buy more fuel-efficient vehicles if tax rates are differentiated according to fuel consumption. However, vehicle taxation does not encourage them to use their vehicles efficiently. Therefore additional measures should be implemented to promote energy efficient transport, *e.g.,* via fuel taxation.

Parking pricing

This instrument increases the cost of using a vehicle by raising the cost of parking. To increase the effectiveness of parking pricing, it should be coupled with limits to the physical availability of parking spaces, and it is recommended to introduce it on a region-wide basis. Parking pricing can be expected to typically reduce parking demand by 10%–30% compared with unpriced parking (VTPI, 2006).

Implementing authorities should be aware of a number of considerations concerning parking pricing and availability measures. Where pricing is introduced or increased within urban centres, there is a risk of urban sprawl. Through-traffic may also increase as it is less desirable to stop within the central areas. In areas where parking is only partly under public control, it can be extremely difficult to implement. Finally, enforcement of parking charges is essential if the scheme is to be successful.

Economic instrument implementation – impacts and considerations

Table 6 shows the level of implementation of each of the economic instruments, and potential responsible or interested stakeholders. Economic instruments, including road pricing, fuel tax implementation/increases and vehicle taxation are generally measures implemented at the national level, whereas parking pricing (like the regulation of parking) and congestion charging schemes are regionally and city level implemented instruments. Stakeholders that will be responsible for implementation and operation include the transport authorities and city administration (including treasury, finance and taxation departments). Enforcement authorities will also be important for the operation and success of instruments.

Table 7 assesses the contribution that the implementation of economic instruments could make to the reduction of greenhouse gas emissions, estimated costs, co-benefits and considerations linked to the implementation of such instruments. The instrument that is most likely to have the greatest contribution to reducing greenhouse gas emissions is road pricing, which is also likely to incur the highest implementation costs. Implementation costs for fuel and vehicle taxation instruments will depend on the extent of coverage and enforcement. The main consideration for implementation authorities with road pricing instruments is the displacement of traffic to alternative routes and areas, and ensuring that key services and facilities are still accessible despite restrictions. In order to avoid these problems, regulation measures should be implemented alongside others, such as the provision of public transport.

⏩ For more information, please see GTZ *Sourcebook* Module 1d: *Economic Instruments* as well as Schwaab / Thielmann (2001).

Table 6: Economic instruments – Level of implementation and responsible/interested stakeholders

	Type of instrument	Level of implementation			Responsible / interested stakeholder										
		National	Regional	City	Mayor/Equivalent	Transport Authorities (including public works)	Land use/planning authorities	City Administration (treasury/finance/taxation)	Public relations, Press, and Media	Enforcement Authorities (police, others)	Non-Governmental Organisations (NGOs)	Private Sector (Industry/commercial)	Private sector – Public Transport Operators	Private Sector – Employers
Economic Instruments	**Road Pricing**	✔	✔	✔	✔	✔		✔	✔	✔	✔		✔	
	Fuel Tax Implementation / Increases	✔						✔		✔				
	Vehicle Taxation	✔						✔		✔				
	Parking Pricing		✔	✔				✔	✔	✔				

✔ = indicates level of implementation and responsible/interested stakeholders

Table 7: Economic instruments – Contribution to greenhouse gas reductions, estimated costs, co-benefits, and implementation considerations of instruments

	Type of instrument	Contribution to reduce greenhouse gas emissions	Potential cost of Implementation	Co-benefits / negative (+ ? –)	Implementation considerations for responsible authorities
Economic Instruments	Road Pricing	# - ##	$$-$$$	+ safety ? accessibility, mobility, social inclusion, economy	Traffic displacement, restricted access/mobility, equity impacts, enforcement, cost
	Fuel Tax Implementation / Increases	#	$$	– mobility, equity	Level of tax, enforcement
	Vehicle Taxation	#	$$	– mobility, equity	Level of tax, enforcement
	Parking Pricing	# - ##	$ - $$	+ safety ? accessibility, mobility, social inclusion, economy	Traffic displacement, restricted access/mobility, alternative mode provision, illegal parking/ obstructions, enforcement, cost

\# = Small contribution
= Medium contribution
= High contribution

$ = Low cost
$$ = Medium cost
$$$ = High cost

\+ = positive
? = unclear
– = negative

CHECKLIST C: Successful implementation of economic measures

Economic instruments can play an important part in both promoting energy efficiency in the transport sector and discouraging individual car use. Economic instruments can also help create revenues that may be used, *e.g.,* to fund environmentally friendly public transport or to promote cycling.

- ☑ Ensure the adequate provision of **alternative modes** (public transport, walking, cycling):
  - Level of service
  - Service coverage
  - Cost
- ☑ Consider the **cost-benefit** of the economic instruments being implemented. Always adopt appropriate approaches (*e.g.,* low tech versus high tech).
- ☑ Ensure that the necessary **administrative bodies** have been set up to oversee vehicle tax implementation and regulation.
- ☑ Raise **public awareness** of the economic instruments being implemented, reasons behind implementation, and the likely benefits. This will increase public acceptance.
- ☑ Create **partnerships with neighbouring districts/municipalities** when implementing certain economic measures—*e.g.,* area-wide parking charges.
- ☑ Employ the services and support of relevant **enforcement authorities** to regulate the restrictive measures (road pricing/congestion charging, parking pricing).

Fig. 24
Bicycles conquer the lanes: Initiative to encourage people to use other transport modes.
Photo by Shreya Gadepalli, Bogotá, 2003

Economic instruments – Relevant GTZ SUTP Sourcebook modules:

- Module 1d: Economic Instruments

Other relevant GTZ publications:

- GTZ International Fuel Prices
- Economic Instruments for Sustainable Road Transport: An Overview for Policy Makers in Developing Countries, GTZ / UNESCAP

2.1.4 Information instruments

There are a number of information instruments available to decision makers to complement—or act as an alternative—to more resource intensive instruments. These 'soft' measures may induce behavioural changes of transport users through raising awareness of alternatives modes. Typical examples are public awareness campaigns, mobility management and driver education.

Public awareness campaigns and mobility management

Public awareness campaigns can take many forms. Most often they are used to inform the public about the travel alternatives available to them or about the environmental, economic and social impacts of (motorised) transport. Marketing of sustainable transport solutions is essential when attempting to secure public acceptance, and therefore should always be taken into consideration when promoting sustainable transport policies.

Some larger cities have implemented 'car-free' days, banning cars from entering the city centre area on certain days. This can be combined with the promotion of alternative mode choices (public transport, cycling, and walking). Information on public transport services may be distributed through 'mobility centres', set up in city centres as information and sales points.

The provision of education through schools or places of employment can also be beneficial in raising awareness, or through the provision of cycle training.

⏩ For more information, please refer to GTZ *Sourcebook* Module 1e: *Raising Public Awareness about Sustainable Urban Transport* and the GTZ training document on *Public*

Awareness and Behaviour Change on Sustainable Urban Transport.

Driver behaviour training and education / eco-driving

The way in which a vehicle is driven or maintained has a direct impact on fuel consumption, and subsequently operating costs and emissions. Through the provision of 'Eco-Driving' education and training, driver behaviour may be altered to achieve greater fuel efficiencies. Estimates show that average fuel savings (and emission reductions) are in the range of 10% to 15%. Individual fuel saving potential may be even up to 25%. Key methods of improving fuel efficiency can relate to driving style/behaviour (speed, braking and acceleration, engine idling, carrying capacity and cold starts) and vehicle condition (maintenance-engine, tyres, oil and air filter, and vehicle age).

Driver training is particularly effective when commercial vehicles, such as bus, taxi or freight fleets, are included. The potential fuel savings can significantly contribute to (fuel) cost savings and constitute a strong incentive for eco-driving.

▸▸ For more information, please see GTZ *Sourcebook* Module 4f: *Eco Driving*.

Information instrument implementation – impacts and considerations

Table 8 shows the level of implementation of each of the information instruments, and potential responsible or interested stakeholders. Information instruments, including public awareness campaigns and driver behaviour training/ecodriving can be implemented at all levels; national, regional and city level. Responsible stakeholders are likely to include the transport authorities, public relations, press and media, non-governmental organisations and private sectors.

Table 9 assesses the contribution that the implementation of information instruments could make to the reduction of greenhouse gas emissions, estimated costs, co-benefits and considerations linked to the implementation of such instruments. Both information instruments are likely to have small to medium contributions to reducing greenhouse gas emissions and similar levels of costs.

Fig. 25
Congestion on a market day.
Photo by Gerhard Menckhoff, La Paz, 2005

Box 10: Public awareness campaigns

Columbia: Bogotá's' first 'Car Free Day' was implemented in 2000. Between 6:30 and 19:30h no vehicles were allowed to circulate within the entire urban area. This led to several million people travelling about the city by public transport, bicycle, roller blades, taxis and by foot (ITDP, 2001). Car free days have since been used within Bogotá to promote the city's bike and bus network.

Mexico: Through providing one car-free day per week in Mexico, reductions were realised in private car use, with mode share decreasing from 25% to 17% (Prointec Inocsa Stereocarto, 2001).

Further information on Car-Free campaigns can be found in the GTZ *Sourcebook* Module 3e: *Carfree Development* as well as online at: http://www.worldcarfree.net/wcfd

Fig. 26
Increase public awareness: Drawing competition for children on a car free day in Surabaya.
Photo courtesy of Reinhard Kolke, Surabaya, 2001

Box 11: Vehicle maintenance and driver behaviour

Vehicle maintenance

- **Engine** – the engine should be tuned regularly as a poorly tuned engine can increase fuel consumption up to 10 to 20% (depending on the condition of the car).
- **Tyres** – vehicle tyres should be properly inflated and aligned to avoid increased fuel consumption, up to 6%. For example tyres that are:
  - 0.2 bar under-inflated can lead to a 1% increase in fuel consumption;
  - 0.4 bar under-inflated can lead to a minimum 2% increase in fuel consumption; and
  - 0.6 bar under-inflated can lead to a minimum 4% increase in fuel consumption.
- **Oil** – Oil should be changed regularly, as clean oil reduces wear caused by friction between moving parts and removes harmful substances from the engine. Replacing traditional lube oils with modern low friction lube oils can lead to additional reductions in fuel consumption in the range of 5%.
- **Air filters** – Air filters should be checked and replaced regularly, as they keep impurities in the air from damaging internal engine components. Not only will replacing a dirty air filter improve your fuel economy, but it also will protect the engine. Clogged filters can cause up to a 10% increase in fuel consumption (FTC, 2006).

Driver behaviour

- **Speed** – the faster a vehicle is driven, the more fuel is consumed. For example, driving at 105 kilometres per hour (km/h), rather than 90 km/h, increases fuel consumption by approximately 20%. Driving at 120 km/h, rather than 105 km/h, increases fuel consumption by another 25%. Maintaining a constant speed can also help to reduce fuel consumption.
- **Braking and acceleration** – Breaking and acceleration use a large proportion of the energy that is needed to power vehicles. It is estimated that nearly 50% of energy needed to power a vehicle can go into acceleration. Therefore, drivers should anticipate driving situations if they are to reduce unnecessary breaking and accelerating.
- **Engine idling** – In situations where a vehicle is stationary with the engine running, fuel is wasted. Where lengthy waits (*e.g.,* during periods of congestion) are anticipated, drivers should turn off their engines.
- **Carrying capacity** – Increasing the weight of a vehicle (through additional passengers, carrying items) can also decrease fuel efficiency. It is estimated that an additional 50 kg carried by a vehicle can reduce a typical vehicle's fuel economy by 1 to 2%.
- **Cold starts** – To avoid a number of cold starts, and high fuel usage/emissions, drivers should try to combine trips where possible. Several short trips taken from a cold start can use twice as much fuel as one trip covering the same distance when the engine is warm (FTC, 2006).

CHECKLIST D: Successful implementation of information measures

Public Transport Authorities

☑ Ensure that **service and timetable information** is provided in a variety of media, considering newspapers, booklets, posters, and formats (language, text size, etc.).

Public Authorities

☑ Early provision of **cycle training** (for children) may encourage long term travel behaviour change towards more sustainable modes.

☑ Ensure information provided is in a **variety of media** (personal, newspaper, booklets (timetable), and formats (consider language, font, size, etc.).

☑ Highlight the **wider benefits** of schemes beyond greenhouse gas emission reduction (so-called co-benefits), including: Local air quality, health, safety, access, mobility, noise, economy.

Table 8: Information instruments – Level of implementation and responsible/interested stakeholders

Type of instrument		Level of implementation			Responsible / interested stakeholder									
		National	Regional	City	Mayor/Equivalent	Transport Authorities (including public works)	Land use/planning authorities	City Administration (treasury/finance/taxation)	Public relations, Press, and Media	Enforcement Authorities (police, others)	Non-Governmental Organisations (NGOs)	Private Sector (Industry/ commercial)	Private sector – Public Transport Operators	Private Sector – Employers
Information	**Public Awareness Campaigns**	✔	✔	✔	✔	✔			✔		✔		✔	✔
Information	**Driver Behaviour Training and Education / Eco-Driving**	✔	✔	✔		✔			✔		✔		✔	✔

✔ = indicates level of implementation and responsible/interested stakeholders

Table 9: Information instruments – Contribution to greenhouse gas reductions, estimated costs, co-benefits, and implementation considerations of instruments

Type of instrument		Contribution to reduce greenhouse gas emissions	Potential cost of Implementation	Co-benefits / negative (+ ? –)	Implementation considerations for responsible authorities
Information	Public Awareness Campaigns	# - ##	$ - $$	+ accessibility, mobility, air pollution	
Information	Driver Behaviour Training and Education / Eco-Driving	# - ##	$ - $$	+ safety, air pollution	

# = Small contribution	$ = Low cost	+ = positive
## = Medium contribution	$$ = Medium cost	? = unclear
### = High contribution	$$$ = High cost	– = negative

Information instruments – Relevant GTZ SUTP Sourcebook modules:

- Module 1e: Raising Public Awareness about Sustainable Urban Transport
- Module 4f: Eco Driving

Other relevant GTZ publications:

- Training Course: Public Awareness and Behaviour Change in Sustainable Urban Transport

2.1.5 Technology improvements and instruments

The key aims in order to achieve reduced greenhouse gas emissions from transport are to change travel behaviour and/or the technology used. Planning, regulatory, economic and information instruments can be used to achieve behavioural change and/or technological change. For example, the use of fuel efficiency standards is a regulatory approach aiming at technological change.

Technological improvements may sometimes seem to be easier to implement than policies that may restrain vehicle demand and use, primarily as they require less behavioural and lifestyle change. However, technology improvements are most effective when implemented in conjunction with other instruments within a larger strategy. Technology improvements often focus on fuels, propulsion technology, other vehicle attributes, and use of communication and information technologies (Sperling and Salon, 2002).

Switching to fuels with reduced carbon contents provides the opportunity to reduce greenhouse gas emissions from transport, without having to achieve a dramatic reduction in the number of vehicles. Fuels as alternatives to the use of gasoline and diesel include methanol, natural gas, liquid petroleum gas (LPG), ethanol, hydrogen, and electricity. However, it should be noted that whilst these alternative fuels have a lower carbon-content compared with gasoline, they may not reduce greenhouse gas emissions when the complete life-cycle is considered. Where alternatives are considered such as biofuels, their production can pose additional conflicts in developing countries, such as the land used to grow biofuel crops, which could be used for food protection. Therefore, it is always important to consider the full life cycle when the CO_2 emissions of alternative fuels are compared.

Fig. 27
Rickshaw drivers waiting for customers.
Photo by Manfred Breithaupt, Hanoi, 2003

Greenhouse gas emissions vary greatly depending on the fuels and technologies used in transport. Table 11 shows the greenhouse gas emissions for various travel modes and fuels/technologies.

In the past, traditional methods of attempting to clean the environment have tended to focus on 'end-of-pipe' technologies. These are technologies which are added to existing production processes with the aim of controlling or reducing pollution. In terms of the transport sector, this has involved the use of 'end-of-pipe' technology and control devices (UNEP, 2001). However, the use of these 'end-of-pipe' devices usually aim to reduce/clean the emissions of local air pollutants, such as nitrous oxides and particulates, but can in some cases increase greenhouse gas emissions.

'Clean' technologies are an alternative to the use of end-of-pipe' technologies. They aim to alter the production processes, inputs to the process and products themselves so that they are more

Table 10: GHG emissions from vehicles and transportation modes in developing countries

	Load factor (average occupancy)	CO_2 equivalent emissions per passenger km (full energy cycle)
Car (gasoline)	2.5	130–170
Car (diesel)	2.5	85–120
Car (natural gas)	2.5	100–135
Car (electric)*	2.0	30–100
Scooter (two-stroke)	1.5	69–90
Scooter (four stroke)	1.5	40–60
Minibus (gasoline)	12.0	50–70
Minibus (diesel)	12.0	40–60
Bus (diesel)	40.0	20–30
Bus (natural gas)	40.0	25–35
Rail Transit**	75% full	20–50

All numbers in this table are estimates and approximations, and are best treated as illustrative.

* Ranges are due largely to varying mixes of carbon and non-carbon energy sources (ranging from about 20% to80% coal), and also the assumption that the battery electric vehicle will tend to be somewhat smaller than conventional cars.

** Assumes heavy urban rail technology ("Metro") powered by electricity generated from a mix of coal, natural gas, and hydropower, with high passenger use (75% of seats filled on average).

Source: Sperling and Salon, 2002

Case Study 3: Indian Cycle Rickshaw Modernisation Project

In close cooperation with members of the Indian bicyclgy ine and tourism industry, the American Institute for Transportation and Development Policy (ITDP) launched the “Cycle Rickshaw Modernisation Project" in 1999. The main driver behind this project was the massive pollution caused by exhaust gases, which has lead to increasing damage to the World Heritage monument Taj Mahal in the city of Agra, India.

Rickshaws have always played a fundamental role in Asia. However, over time more and more governments in Asia banned their traditional vehicle because of the perception of Rickshaws being obsolete. Furthermore, the traditional rickshaws weigh about 80 kg, making driving a highly exertive activity. Therefore, the use of motorised wheelers, and thus, the environmental pollution, increased dramatically in Asia over the last years.

With this background, the primary aim of the project was to design an efficient but simple rickshaw that reduces atmospheric greenhouse gases and protects the health of its driver. Using an appropriate technology, American and Indian engineers created a lighter, more comfortable and modern vehicle at a similar cost as the traditional ones, thus, these modern vehicles were affordable to their intended drivers.

The implementation of the project achieved not only an important improvement of air quality, but increasing levels of employment and income among the poor. Surveys demonstrated that earnings increased by 20% to 50% as drivers were able to work longer and gain new passengers. Additionally, the modernised wheeler attracted 19% of its ridership from highly polluting two-stroke engine vehicles. Due to the substantial change of image, rickshaw drivers now enjoy a new economic status.

By 2005, over 100,000 modern cycle rickshaws have been manufactured by over 20 small businesses and sold in Delhi, Agra, Bharatpur, Brindavan, Mathura, and Jaipur. The modernisation of cycle rickshaw technology in India has proven to be a cost effective way of reducing CO_2 emissions.

Based on these successes in India, ITDP is now replicating the project in Yogyakarta, Indonesia, in partnership with the Centre for Tourism Research and Development and Gadjah Mada University.

environmentally-friendly. These technologies avoid the need to extract and concentrate toxic material from the waste stream and their use is therefore preferable to end-of-pipe technologies (UNEP, 2001).

Despite these benefits, cleaner technologies are not always available, and where they are, companies tend to use their old technologies until they have run their useful life before switching. An OECD investigation found that the majority of investment in pollution control was related to end-of-pipe technology, with only 20% being used for cleaner production.

Technology instrument implementation – impacts and considerations

Technological instruments are usually initially implemented at the national or international level, with perhaps pilots or demonstration projects at the regional or local level, particularly when dealing with alternative fuels. Key stakeholders include national ministries, the private sector and non-governmental organisations.

▸▸ For more information, please see GTZ *Sourcebook* Modules 4a: *Cleaner Fuels and Vehicle Technology*, 4c: *Two and Three-Wheelers* and 4e: *Intelligent Transport Systems*.

Technological improvements to motorised vehicles are likely (in most cases) to have significant benefits for reducing emissions of greenhouse gases (see Table 12). However, in order to tap the full potential and also achieve

Fig. 28

Congested but emission-free: bicycles and rickshaws in Pingyao/China.

Photo by Armin Wagner, Pingyao, 2006

Table 11: Technlology instruments – Level of implementation and responsible/interested stakeholders

Type of instrument		Level of implementation			Responsible / interested stakeholder									
		National	Regional	City	Mayor/Equivalent	Transport Authorities (including public works)	Land use/planning authorities	City Administration (treasury/finance/taxation)	Public relations, Press, and Media	Enforcement Authorities (police, others)	Non-Governmental Organisations (NGOs)	Private Sector (Industry/commercial)	Private sector – Public Transport Operators	Private Sector – Employers
Technology	Cleaner Production	✔				✔			✔		✔	✔	✔	
	Cleaner Technology	✔				✔			✔		✔	✔	✔	

✔ = indicates level of implementation and responsible/interested stakeholders

Table 12: Technology instruments – Contribution to greenhouse gas reductions, estimated costs, co-benefits, and implementation considerations of instruments

Type of instrument		Contribution to reduce greenhouse gas emissions	Potential cost of Implementation	Co-benefits / negative (+ ? –)	Implementation considerations for responsible authorities
Technology	Cleaner Production	## - ###	$$$	+ air pollution	To achieve other co-benefits, needs to be implemented alongside instruments that aim to promote mode shift or reduce travel.
	Cleaner Technology	## - ###	$$$	+ air pollution, noise	

\# = Small contribution
= Medium contribution
= High contribution

$ = Low cost
$$ = Medium cost
$$$ = High cost

\+ = positive
? = unclear
– = negative

CHECKLIST E: Successful implementation of technology improvements

Technology improvements can often be indirectly influenced by public decision-makers (through regulations and funding). The funding of technological options is often cost-intensive and in competition with other expenses. Therefore a regulatory framework which enables the market forces seems to be the most efficient one. Local decision-makers could set incentives through specific regulations (like vehicle restrictions).

☑ Ensure that **planning, regulatory, economic and information instruments** are also implemented to complement the emission reducing benefits of technological improvements, through reducing traffic/congestion and realising wider benefits of air quality, increased accessibility and mobility, noise reduction, and safety and economic benefits.

☑ Raise **awareness** through the use of information instruments of the benefits of cleaner fuel use.

☑ Consider the **adverse effects** of new technologies (such as when implementing bio-fuels).

Technology instruments – Relevant GTZ SUTP Sourcebook modules:

- Module 4a: Cleaner Fuels and Vehicle Technology
- Module 4c: Two and Three-Wheelers
- Module 4e: Intelligent Transport Systems

the co-benefits (such as safety, accessibility etc.), technological improvements should in most cases be coupled with other transport policy instruments that aim to promote mode shift and reduce travel overall.

2.2 Strategies to reduce emissions of greenhouse gases and potential effects

The policy instruments presented in the previous section are most successful in reducing greenhouse gas emissions and achieving other co-benefits, when implemented as a package of measures. This section focuses on the various combinations of measures and a more comprehensive approach.

2.2.1 A comprehensive approach

Evidence suggests that a comprehensive sustainable urban transport approach that takes advantage of a variety of instruments will have a larger impact on emission reductions and will result in more co-benefits through the improvement of local transport systems. Taking a comprehensive approach will typically include, *e.g.,* the provision of cycling and walking facilities, attractive and reliable alternatives to the private vehicle; it will make use of measures that restrict the use of the car; it will help establish of good land use planning practices; it will promote technological improvements such as cleaner fuels; and it will set (monetary) incentives by applying appropriate economic instruments.

The level and intensity of intervention will differ from instrument to instrument. Some will be voluntary, some will work on an incentive basis, others will establish binding legal restrictions. Figure 29 outlines the spectrum of instruments that can be taken by decision-makers when implementing a comprehensive approach for greenhouse gas emissions reduction from transport.

Fig. 29: Strategy approaches

A successful policy mix or package for passenger transport is aimed at the three primary means to reduce greenhouse gas emissions from transport presented in Section 1: Avoid, Shift, and Improve.

2.2.2 Potential strategy outcomes – greenhouse gas emission reductions and co-benefits

A key objective of many sustainable transport strategies is to achieve a high proportion of public transport and non-motorised mode use. The majority of developing cities still have a high mode share of public transport or non-motorised modes[2)]. Therefore, retaining this mode share of alternative modes (public transport, cycling and walking) in developing cities can be one method of working towards stabilising greenhouse gas emissions.

The level of greenhouse gas reduction that could be achieved as a result of individual instruments is difficult to predict. Reductions are most likely to be achieved where a higher share of public transport or non-motorised modes is attained, but this is often due to the implementation of a variety of complementary measures as presented above.

As a guideline, Table 13 considers the greenhouse gas emissions of various transport modes. It highlights that although some of the larger higher capacity vehicles produce higher emissions per vehicle kilometre (as would be expected), they also tend to have the lowest greenhouse gas emissions per average passenger kilometre. In this particular case, it is the diesel

[2)] For example; in 1998, Havana (Cuba) had 57% non-motorised transport and 12% public transport mode share. Cairo in Egypt (1998) had a non-motorised transport mode share of 36% and public transport share of 47%, and Sao Paulo in Brazil (1997) had a non-motorised transport mode share of 35% and public transport share of 33% (Wright and Fulton, 2005).

Table 13: Greenhouse Gas (GHG) emissions of selected transport systems[1)]

Mode of transport	Maximum capacity (passengers per vehicle)	Average capacity (passengers per vehicle)	GHG emissions per vehicle-kilometre	GHG emissions per average passenger-kilometre
Pedestrian	1	1.0	0	0
Bicycle	2	1.1	0	0
Gasoline Scooter (two-stroke)	2	1.2	118	98
Gasoline Scooter (four-stroke)	2	1.2	70	64
Gasoline Car	5	1.2	293	244
Diesel Car	5	1.2	172	143
Diesel Minibus	20	15.0	750	50
Diesel Bus	80	65.0	963	15
Compressed Natural Gas Bus	80	65.0	1,050	16
Diesel Articulated Bus	80	160.0	1,000	7

Source: Hook and Wright, 2002

[1)] Values are derived from a variety of sources and are intended to provide a relative comparison for discussion purposes. It is recognised that a more rigorous definition of emission factors would need to include analysis of actual driving practices, vehicle models, local traffic conditions, local fuel types, and vehicle maintenance practices.

articulated bus that has the lowest GHG emissions per average passenger kilometre. However, average occupation rates, *i.e.,* the number of passengers actually using the vehicles, is crucial for emissions per passenger.

As mentioned earlier, taking a comprehensive strategy approach and implementing a range of sustainable transport instruments can help to achieve a reduction or stabilisation in the level of greenhouse gas emissions and other co-benefits. The table also shows that achieving a greater shift to public transport or non-motorised modes can bring greater benefits in terms if CO_2 and other greenhouse gas reductions.

Table 14 looks at a variety of mode shift scenarios and the potential emission reductions for an exemplary city. The scenarios developed by Wright/Fulton are based on the key assumptions that in the city some 10 million passenger trips per day take place and that the average distance per non-walk trip is 10 km (these assumptions are valid for a city like Bogotá with a population of 7.2 million inhabitants). The scenarios also include estimates for likely abatement costs per tonne of CO_2.

The largest CO_2 reduction from the baseline[3)] can be achieved by the implementation of a package of measures, including BRT, pedestrian upgrades and cycleways (highlighted). This is estimated to result in a reduction of more than 12 million tonnes of CO_2 from the baseline at mitigation costs of US$30 per tonne of CO_2.

Fig. 30
TransMilenio bus lane next to a wide sidewalk in the centre of Bogotá.
Photo by Shreya Gadepalli, Bogotá, 2003

[3)] The baseline calculations were developed in a simple manner—no assumed growth in private motorised vehicles over the 20 year analysis.

Table 14: Impact of mode shifts on carbon dioxide emission reductions

Scenario name	Mode shares	CO_2 over 20 years (million tonnes)	CO_2 reduced from the baseline (million tonnes)	Cost of infrastructure	Cost per tonne of CO_2 (US$)
BRT mode share increases from 0 to 5%	Automobiles 19% Motorcycle 4% Taxi 4% Mini-bus 48% BRT 5% Walking 19% Bicycle 1%	47.4	1.9	US$125m (59 km of BRT at US$2.5m/km)	66
BRT mode share increases from 0 to 10%	Automobile 18% Motorcycle 4% Taxi 3% Mini-bus 45% BRT 10% Walking 19% Bicycle 1%	45.1	4.2	US$250m (100 km of BRT at US$2.5m/km)	59
Walking mode share increases from 20 to 25%	Automobile 19% Motorcycle 4% Taxi 4% Mini-bus 47% BRT 0% Walking 25% Bicycle1%	45.9	3.4	US$60m (400 km of pedestrian upgrades at US$150,000/km)	17
Bicycle mode share increases from 1 to 5%	Automobile 19% Motorcycle 4% Taxi 5% Mini-bus 48% BRT 0% Walking 19% Bicycle 5%	47.4	1.9	US$30m (9,300 km of cycleways at US$100,000/km)	15
Bicycle mode share increases from 1 to 10%	Automobile 18% Motorcycle 3% Taxi 5% Mini-bus 46% BRT 0% Walking 18% Bicycle 10%	45.2	4.2	US$60m (500 km of cycleways at US$100,000/km, plus US$10m promotional campaign)	14
Package: BRT, Pedestrian upgrades, cycleways	Automobile 15% Motorcycle 3% Taxi 3% Mini-bus 34% BRT 10% Walking 25% Bicycle 10%	37.0	12.4	US$370m (BRT US$250m; footpaths US$60m; cycleways US$60m)	30

Source: Wright and Fulton, 2005

Table 15 displays a range of sustainable transport instruments and identifies their co-benefits, and synergies and conflicts with greenhouse gas reduction and global concerns.

Reducing greenhouse gas emissions may not be high on the local agenda of priorities for citizens. However, a range of co-benefits can be achieved through the implementation of sustainable transport instruments, helping to meet local priorities. Co-benefits include health and safety, the economy, accessibility to key services and activities and air pollution. It may therefore be beneficial to focus on the wider benefits that sustainable transport instruments (aimed at reducing greenhouse gases from transport) may bring. Table 16 looks at each of the sustainable transport instruments and their potential effects on a range of co-benefits.

Table 15: Sustainable transport instruments: co-benefits, synergies, and conflicts with global concerns

Local instruments	Type of instrument	Co-benefits	Synergy with global concerns	Conflict with global concerns
Promoting mass transport and discouraging private cars	Planning, Regulatory, Information, Economic	Measures can reduce local air pollutant emissions, noise from traffic, increase safety and improve accessibility. There may also be additional social inclusion benefits as a result of increased public transport services.	Such measures can often reduce CO_2 emissions as they improve overall energy performance and reduce gasoline use. This further reduces congestion and associated CO_2 penalties from vehicles.	Inefficiency in operation of mass transport systems may tend to reduce their occupancy and promote private modes of transport and the gain may be less than expected.
Congestion pricing and traffic management	Economic, Regulatory	Measures can reduce congestion, leading to reductions in local air pollutant emissions, noise from traffic.	Instruments can reduce congestion, discourage car use, and result in fuel savings.	However the exact impact on CO_2 emissions depends on various factors.
Inspection and maintenance systems	Regulatory, Information	Changing driving conditions and driver behaviour may reduce air pollutant emissions.	Changing driving conditions and driver behaviour may improve fuel efficiency and thereby reduce CO_2 emissions.	However, effects need to be monitored.
Introducing category-based emissions/fuel-efficiency standards for vehicles	Technology		Such standards help to reduce local air pollutants and CO_2 emissions per vehicle km for particular vehicle categories (type or size).	If distance travelled by individual vehicles increases or if people switch to vehicles with bigger engines, the total volume of CO_2 might increase even if the standard are met.
Use and development of alternative fuels (*e.g.,* CNG or Propane fuels, Low-sulphur diesel, reformulated gasoline, biofuels (ethanol blended gasoline or biodiesel)	Technology		Depending on the fuel used, both positive and negative effects can be achieved for various pollutant emissions. Whilst generally alternative fuels may reduce CO_2 emissions, they may also contribute to them and increase emissions of other pollutants, including CO_2, NO_X, VOC, CH_4	

Source: adapted from Dhakal, 2006

Table 16: Sustainable transport instruments: meeting local priorities

Instrument Type	Sustainable Transport Instrument	Meeting Local Priorities							
		Safety	Accessibility	Mobility	Social inclusion	Economy	Local Air Pollution	Equity	Noise
Planning	Land Use Planning	O	+	–	+	O	+	O	O
	Public Transport	O	+	+		+	O	O	O
	Non-Motorised Modes	+	+	+	+	+	+/?	O	O
Regulatory	Physical Restraint Measures	+	?	?	?	?	+	O	+
	Low Emission Zone	+	?	?	?	?	+	O	+
	Traffic management Measures	+	?	?	?	?	+	O	+/?
	Regulation of Parking Supply	O	?	?	?	?	+	O	O
	Speed Restrictions	+	?	?	?	?	+		+
Economic	Road Pricing	+	?	?	?	?	O	?	O
	Fuel Tax Implementation / Increases	O	O	–	O	O	O	–	O
	Vehicle Taxation			–			O	–	O
	Parking Pricing	+	?	?	?	?	O	O	O
Information	Public Awareness Campaigns	O	+	+	O	O	+	O	O
	Driver Behaviour Training and Education / Eco-Driving	+	O	O	O	O	+	O	+
	Individualised Marketing	O	+	+	O	O		O	O
Technology	End of Pipe Devices	O	O	O	O	O	?	O	O
	Cleaner Production	O	O	O	O	O	+	O	O
	Cleaner Technology	O	O	O	O	O	+	O	+

+ = Instrument is predicted to have a positive effect on meeting priority
– = Instrument is predicted to have a negative effect on meeting priority
? = Instrument could have both positive and negative effects on meeting priority
O = Instrument is not predicted to have an effect on meeting priority

Fig. 31
High emissions due to an increasing rate of individual motorisation: The majority in Hanoi uses two-wheelers.
Photo by Manfred Breithaupt, Hanoi, 2003

Table 17: Sustainable transport instruments and their impacts on pollutant emissions and greenhouse gas emissions

	Local Air Pollution	Greenhouse Gas Emissions
Reduce motorised travel	↓	↓
Modal shift from cars/motorbikes to buses/rail	↓	↓
Improve vehicle efficiency	↓	↓
Improve fuel quality (*e.g.,* lower sulphur)	↓	↑
Add oxidation or 3-way catalyst	↓	↑
Improve vehicle maintenance	↓	↓
Switch to CNG	↓ to ↓	↓ to ↑
Blend ethanol	↓ to ↑	↓ to ↑

Source: Fulton, 2006

Legend: ↓ Green arrow: positive change, reduction in emissions. ↑ Red arrow: negative change, increase in emissions.

Case Study 4: Estimated greenhouse gas emission impacts BRT, TDM, and NMT measures in Bogotá

Two lines of a planned 22 corridor Bus Rapid Transit (BRT) system had opened in Bogotá, alongside 200 km of bike lanes and expansion of numerous sidewalks, 1,100 new parks, shaded promenades and 17 km pedestrian zone. This was complemented by a number of TDM measures, including restrictions on vehicle use (cars with license plates ending with one of four numbers not allowed to operate during the morning or evening peak, restricting 35% of vehicle fleet), increases in parking fees by 100%, increases in gasoline taxes by 20%, and physical measures to prevent illegal parking on the sidewalk (bollards). Additional promotional measures were also implemented, including a full various car free days.

Over a four year period, the percentage of trips made by private cars and taxies decreased by 2.2% (from 19.7% to 17.5%). Public transit passenger trips increased by 1% (from 67% to 68%), and bike trips increased by 3.5% (from 0.5% to 4%). It has been estimated that the implementation of the combined measures has resulted in a reduction of CO_2 emissions by 318 metric tons per day from 1997 levels in absolute terms.

Approximately 90% of these reductions can be attributed to mode shift and 10% from efficiency gains within the public transit system. The CO_2 emissions benefit has been measured against the JICA (projected modal split for 2001) which has shown that the combined measures lead to a benefit of 694 metric tonnes of CO_2. It is estimated that the projected benefits per day of the change in mode split will rise to 5,688 metric tonnes per day by 2015 if projected impacts of the current plans for Bogotá's transport system are realised (Hook and Wright, 2002).

Table 17 attempts to identify the effects of various sustainable transport instruments on local air pollution and greenhouse gas emissions. It shows that whilst most instruments can be beneficial to reduce local air pollution, they may be less beneficial or even counter productive for greenhouse gas emissions. Those instruments that demonstrate clear benefits for the reduction of greenhouse gas emissions include the reduction of motorised travel and generating a mode shift from private motorised travel (cars, motorbikes) to public transport modes such as bus and rail. However, the instruments with perhaps the most mixed response to pollutant emission and greenhouse gas emission reductions are those relating to cleaner or alternative fuels, where GHG emissions can actually increase.

Case Study 4 demonstrates the estimated greenhouse gas emission reductions achieved through the implementation of Bus Rapid Transit, transport development measures and non-motorised transport measures in Bogotá.

2.3 Factors contributing to the success of sustainable transport instrument implementation

The following section presents additional considerations for responsible authorities when contemplating the implementation of sustainable urban transport policies within cities.

2.3.1 Institutional arrangements and key stakeholders

The majority of sustainable transport instruments are implemented at the municipal level, often requiring the involvement of multiple municipal and national level agencies. Authorities may lack skilled personnel, and be dependent on central government funds, international grants, technical support, legal approval, and policy support. The organisation at the city and municipal level may also hinder smooth implementation of schemes (*i.e.,* where cities are divided into districts). The implementation of sustainable urban transport schemes can involve a great many number of stakeholders. The way in which these stakeholders are involved in the planning and implementation process may be instrumental to the subsequent success. For strategies to be successful, it is important that the implementing authority is able to form and maintain viable relationships and partnership with these stakeholders. Potential stakeholders include:

- ***Public Authorities***: A wide-variety of public authority departments and offices may be involved or at least interested in the planning, implementation and regulation of sustainable transport initiatives. Potential departments and offices may include: road transport office; legal office; public works office; press/public relations office; treasury/finance office; taxation office; parking office; traffic office; planning boards; environmental officers; and parliamentary offices.
- ***Transport Market Participants***: In addition to the public authorities, successful implementation will also rely on the involvement of transport market participants, such as industry partners, private transport users and public transport institutions, operators and promoters.
- ***Non-Governmental Organisations (NGOs)***: Interested NGOs may include those involved in social and environmental issues (including international donors and agencies). The involvement of NGOs can provide additional benefits to project implementation, particularly if they have the relevant skills and technical knowledge to help guide implementation.
- ***Press and Media***: Support from the press and media will help to raise awareness amongst the public.

2.3.2 Financial feasibility

It is essential that the instruments and measures implemented in order to promote sustainable urban transport schemes take into account the funds available. The instruments chosen must always be appropriate for the specific local conditions. However, many of the instruments described in this module have the advantage of being relatively low-cost. For example, smart land-use planning does not involve a lot of costs; BRT systems are much cheaper than any other mass transport option like metro systems, and economic instruments can even mobilise revenues.

However, it is always necessary to thoroughly assess the costs of policy measures and make

them transparent in the decision-making process and to design the chosen instruments in a way that reflects the local financial capacities.

2.3.3 Political support/will

Political support is essential when implementing and subsequently enforcing sustainable transport measures. Controversial measures may result in (political) decision-makers coming under attack from the press and public—putting successful implementation at risk. It is thus crucial to secure public (and political) support as early as possible.

Many examples of successful sustainable transport projects implemented in developing cities have had the necessary strong political support, such as in Bogotá and Curitiba. Often good practice examples help to gain understanding and acceptance. International partnerships between cities could also help in the promotion of sustainable solutions. Once gained, this support needs to be maintained across a number of administrations.

There are varying levels of political support, ranging from simple support of a scheme or implementation of an instrument (allowing/letting it happen) up to strong leadership leading to the implementation of an instrument, despite public opposition.

Fig. 32
The BRT in Kunming: BRT lanes are being painted red.
Photo by Karl Fjellstrom, Kunming, 2003

Box 12:
Political support in Kunming, China

The city of Kunming, China, is twinned with Zurich in Switzerland. The partnership was formed to increase development co-operation. Kunming has benefited from the experiences and knowledge of Swiss partners in relation to local transport planning, particularly as they are recognised for demonstrating best practice in urban development throughout the world. The partnership has focused on capacity building rather than technological transfer, and local planning and management authorities have been trained, and a dialogue established between political decision makers and experts from both cities. The successful formation of this partnership, partly through continued political support, has led to the development of a new master plan for urban transport in 1996, which incorporated the new skills obtained during the cooperation. Successful outcomes of the plan included the design and implementation of a Bus Rapid Transit (BRT) system in the city, including public transport priority.

Factors contributing to the success of Sustainable Transport Instrument Implementation – Relevant GTZ SUTP Sourcebook modules:

- Module 1c: Private Sector Participation in Urban Transport Infrastructure Provision
- Module 1e: Raising Public Awareness about Sustainable Urban Transport
- Module 7a: Gender and Urban Transport

2.3.4 Other considerations

There are other elements of sustainable transport that are beyond the scope of this *Sourcebook* module but must not be neglected when looking at greenhouse gas reduction from the transport sector:

- **Road Freight**: This *Sourcebook* module has mainly focused on reducing emissions from urban transport use, more specifically in urban passenger transport. Freight transport is a significant source of greenhouse gas emissions. In urban areas freight transport can contribute to congestion, poor safety, and damage of infrastructure (*e.g.,* road surfaces). However, a number of instruments presented in this module have an impact on freight transport as well (*e.g.,* fuel taxation, more energy-efficient vehicles, the cleaner fuels, eco-driving).
- **Aviation**: Aviation is a major source of CO_2 emissions and affects both passenger and freight transport. It is the fastest growing transport sub-sector, and emissions have far greater impacts on climate change. Emissions from aviation have to be tackled on a national and international level.
- **Ports and Shipping**: Many large cities incorporate ports and therefore may be concerned with emissions from port and shipping activities. This, however, is also beyond the scope of this module.

3. Financial mechanisms to tackle climate change: CDM and GEF

Many of the instruments presented in this module do not require large-scale investment; they can be implemented at relatively low cost and often provide economic benefits in the long run due to improved transport, reduced negative impacts such as congestion and air pollution, health benefits, etc.

Some improvements, however, require significant amounts of investment which cannot always be met by municipal authorities or governments in developing countries. Extensions of public transport services are a typical example of such investments.

In some cases funds may be provided by international donors such as the World Bank, regional development banks or bilateral development cooperation either as loans or on a grant basis. If the investment yields a high return on investment, the private sector may also be interested in project finance. BRT systems may constitute such a case if adequate framework conditions are in place.

In addition to these funding options, climate change funding mechanisms exist which can

Fig. 33
Daily traffic in Hanoi: motorist and cyclists take precautions.
Photo by Karin Roßmark and Torsten Derstroff, Hanoi, 2003

provide additional funding if the planned investment will help mitigate greenhouse gas emissions.

This section presents two major financial mechanism that support climate change mitigation projects: the Clean Development Mechanism (CDM) and the Global Environment Facility (GEF).

3.1 Clean Development Mechanism (CDM)

GTZ has published a separate *Sourcebook* module dedicated to the Clean Development Mechanism. This section therefore only provides a brief overview of some of the key elements of the mechanism.

▸▸ For more information on the CDM in the transport sector, please refer to the GTZ *Sourcebook* Module 5d: *The CDM in the Transport Sector*.

What is the CDM?

The CDM allows industrialised countries with a greenhouse gas reduction commitment under the Kyoto Protocol to invest in emission reducing projects in developing countries. These are usually alternatives to what is considered to be more costly emission reductions in their own country. While CDM is becoming a popular tool in other sectors like renewable energy and energy efficiency, there are only two transport projects in the pipeline. One key bottleneck is the need for a reliable method to prove a reduction in CO_2. Table 20 provides an overview of the proposed methodologies. So far, methodology (NM 0105) for the BRT project in Bogotá has been accepted and can therefore be used in other cases.

It is anticipated that new CDM methodologies will be approved in 2007, including those in the following areas: Biofuel production; efficient bus fleets; Metro or LDR methodology; and freight mode-switch methodology.

What are the benefits for developing countries / cities?

CDM projects provide additional funds for investment in developing countries and can lead to better infrastructure and technology. Investment using this mechanism should lead to sustainable development as projects are assessed for their impact on reducing greenhouse gas emissions. For developed countries the benefits of getting involved in the CDM is that they will be able to implement greenhouse gas emissions at lower costs than in their own countries. For the host country (*i.e.,* a developing country), benefits include financial assistance in the implementation of sustainable transport projects, and realisation of the associated wider co-benefits (safety, accessibility, mobility etc.).

Table 18: Proposed CDM transport methodologies

Fuel Switch	Efficiency Improvement	Modal Shift
Switching fossil fuels from petro-diesel to biodiesel in transport sector (NM0069, NM0108)	Emission reductions by low-greenhouse gas emitting vehicles (AMS-III C) (Small Scale)	Change from road to sea transport (NM0128)
Transportation bio-fuel production with life-cycle assessment (LCA) (NM0109, NM0185)	TransMilenio – urban mass transportation system (NM0052, NM0105) Including modal shift elements	Change from road to pipeline transport (SSC58) (Small Scale)
Khon Kaen fuel ethanol project (NM0082, NM0185)	BRT project Mexico (NM0158) Including modal shift elements	Cosipar Transport Modal Shift Project (NM0201)
Palm methyl ester biodiesel fuel production for transport using LCA (NM0142)	Behaviour-oriented demand-side enery efficiency program (SSC41) (Small Scale)	
LPG retail outlets for cars (NM0083)		
Biolux Benji Biodiesel Project (NM0180)		

Source: Baatz and Sterk, 2007

In the case of the Bogotá TransMilenio project, the revenues from the CDM represent 10% of the total infrastructure costs.

What is the process and how can funds be obtained for projects?

The CDM project cycle can be seen in Figure 34.

Table 19 provides an overview of the steps that have to be taken to receive Certified Emission Reduction (CERs). The table also provides an example of the stakeholders that were involved in the Bogotá TransMilenio scheme.

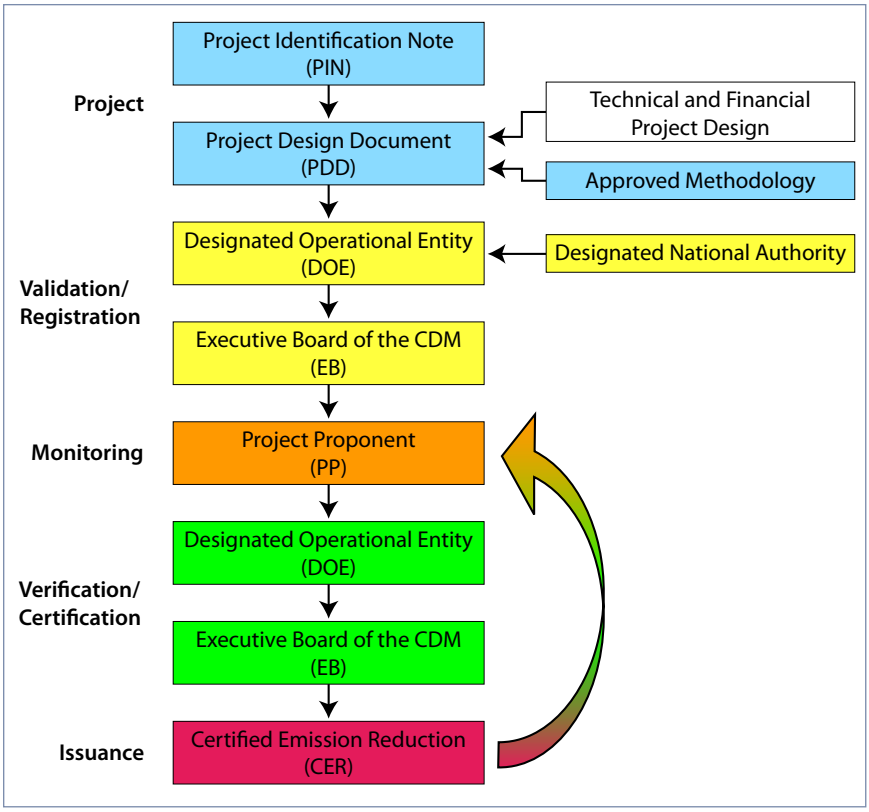
For a project to be eligible it has to reduce net greenhouse gas emissions, either through reduction of emissions or sequestration. This reduction has to be 'real, measurable and additional'. There are a variety of requirements that projects should adhere to, and processes to be undertaken in order to gain funding.

Additionality: For a project to be considered for CDM funding, 'additionality' should be proved. This means that the emissions reductions achieved are proved to be in addition to any that would occur in the absence of the certified project activity, *e.g.,* with and without Bus Rapid Transit. Additionality can be proved by applicant through the use of the additionality tool provided for by the Executive Board of the CDM.

Baseline: The baseline for CDM projects must be calculated. The baseline refers to the scenario representing the greenhouse gas emissions that would occur in the absence of the proposed project activity. In doing so, the possible alternatives to the project should be identified and discussed.

Leakage: Transport projects are particularly susceptible to 'leakage'. Leakage can be described as the net change of greenhouse gas emissions which occurs outside the project boundary, and which is measurable and attributable to the CDM project activity. An example of leakage in the transport sector is where increased investment is put into transport infrastructure, which could lead to reductions in the level of congestion, increases in vehicle speeds, and then reduced emissions. However, the investment could also lead to the generation of additional trips and a shift to private vehicle use as a result of reduced journey times. The latter effect is called leakage and has to be taken into account.

Fig. 34: Clean Development Mechanism project cycle



Emission reductions: The emission reductions from a project can be calculated as the baseline, minus the project, minus the leakage emissions. In other words, the emission reductions are only those reductions that can be directly attributed to the project.

Further guidance on completing the project design documents for CDM is available online at:

Fig. 35
Segregated bus lanes and rapid boarding facilities at bus stations make the TransMilenio BRT system attractive.
Photo by Shreya Gadepalli, Bogotá, 2004

http://cdm.unfccc.int/Reference/Guidclarif/index.html. The document "Guidelines for completing CDM-PDD, CDM-NM" guides the applicant through the project development stages required for financial funding.

Table 19: CDM steps to achieve Certified Emission Reduction (CER)

Step	Task	Stakeholder	Example
Project Identification Phase	Identify potential project. Prepare Project Identification Note (PIN) (often formulated by a specialised CDM project developer using a standard format, *e.g.,* World Bank). Inform UNFCCC.	City Administration/ Project Developer. Non-Governmental Organisations (NGOs).	Suggestions for BRT TransMilenio Project (Public-private partnership).
Project Design Phase	Formulate project into specific format provided by UNFCCC using a UNFCCC approved methodology. Prepare the Project Design Document (PDD).	Project Owner, project proponent, *e.g.,* municipality for BRT. Specialised CDM project developer.	Methodology developed by a consultant (AM 0031); approved by UNFCCC; Application by TransMilenio.
Validation	Select, contract and pay the UNFCCC approved Designated Operational Entity DOE (see list of approved DOEs at UNFCCC website) for validation of project.	Project Owner. Designated Operational Entity (DOE).	CO_2 reduction approved through: ■ bus fleet renewal; ■ increased capacity; ■ mode shift.
	Respond to public enquiries and comments.	Project Owner (city, administration, project developer).	Public enquiry including representatives from transport sector, affected public; published on UNFCCC website.
	Receive approval from host country.	Designated National Authority (DNA).	Ministry of the Environment, Housing and Territorial Development (Columbian DNA) and Ministry of Housing, Spatial Planning and the Environment (DNA of Netherlands).
	Request for registration for proposed CDM project.	Designated Operational Entity (DOE).	
Registration	Formal acceptance of registration, therefore a validated project as a CDM project activity and prerequisite for the issuance of CERs related to project activity.	Executive Board (EB) of the UNFCCC.	
Monitoring	Monitor the emission reductions achieved by the project. Summarise emission reductions achieved during the period in a monitoring report.	Project Owner.	Monitoring of: ■ fuel consumption; ■ distance driven; ■ passengers transported; ■ travel choice survey.
Verification	Get DOE to verify emissions reductions.	Designated Operational Entity (DOE).	1.7 million t CO_2 *e.g.,* = US$20m until 2012 (estimated).
Certification		Executive Board (EB) of the UNFCCC.	

Box 13: CDM and BRT in Bogotá – TransMilenio

The TransMilenio BRT project in Bogotá is the only transport project currently registered under CDM. The project objective is the establishment of a mass urban transport system based on a Bus Rapid Transit (BRT) system. The TransMilenio project extends from Phase II to Phase IV activities and starts in 2012. Phase I is not part of the CDM project. The project involves constructing new trunk route dedicated bus lanes and bus stations, and replacing current buses which are 15 years or older with more fuel efficient Euro 2 and 3 buses. By 2012 it is expected that TransMilenio will consist of:

- 130 km of new dedicated lanes (trunk routes) including new bus-stations;
- Around 1,200 new articulated buses with a capacity of 160 passengers, operating on trunk routes; and
- 500 new large buses operating on feeder lines;
- 1.8 million passengers transported per day.

It is estimated this will save an average of 246,563 tonnes of CO_2 equivalent emissions per year during the 7 year crediting period.

CHECKLIST F: Clean Development Mechanism (CDM)

Steps to be taken by developing countries/cities in order to host CDM projects:

- ☑ Voluntarily participate in the CDM;
- ☑ Ratify the Kyoto Protocol; and
- ☑ Set up a Designated National Authority to approve and facilitate investment in projects.

Steps to be taken by the applicant/Project Owner (*e.g.,* municipal authority, public transport operator):

- ☑ **Identify project** – If project has been assessed to have the potential to reduce GHG emissions, they can be identified as a potential CDM project.
- ☑ **Prepare a Project Identification Note** (PIN), indicating the magnitude of potential GHG emission reductions, potential risks and benefits of the project.
- ☑ **Prove additionality** – showing that the emissions reductions achieved are in addition to any that would occur in the absence of the certified project activity.
- ☑ **Establish a baseline** that represents the greenhouse gases that would occur in the absence of the proposed project activity.
- ☑ **Identify any potential leakage** from the project – the net change of greenhouse gas emissions which occurs outside the project boundary, and which is measurable and attributable to the CDM project activity.
- ☑ **Prepare a Project Design Document** (PDD) using an approved UNFCCC methodology.
- ☑ **Get PDD verified** by an UNFCCC approved Designated Operational Entity (DOE).
- ☑ **Receive approval** from the Designated National Authority (DNA).
- ☑ Following the approval and registration of the project, the project owner is then responsible for **monitoring** the emission reductions achieved by the project.
- ☑ The **monitoring report should then be verified** by a DOE.

Clean Development Mechanism – Relevant GTZ SUTP Sourcebook modules:

- Module 5d: The CDM in the Transport Sector

3.2 Global Environment Facility (GEF)

What is the GEF?

The Global Environment Facility (GEF) was set up to fund projects and programmes aimed to protect the global environment. In principle, the GEF only provides co-funding, *i.e.,* a significant contribution to the financing of the project needs to come from other sources. Such financing can either come from the national government or from other donor agencies. The financing may be also done by providing 'in-kind' work resources (*e. g.,* preparation of the transport planning administration), credits, and loans.

Projects can include biodiversity, climate change, international waters, land degradation, the ozone layer and persistent organic pollutants. The GEF is directly linked to the relevant environmental conventions. With regard to climate change, the United Nations Framework Convention on Climate Change (UNFCCC) is the relevant international convention, and GEF co-funding is available for developing countries which have ratified the UNFCCC and want to promote climate change mitigation projects. Eligible areas of activity are: renewable energy, energy efficiency, and sustainable transport.

The projects that are funded under the GEF programme can vary greatly in size (from project development funds of US$25,000 and medium-size projects worth up to US$1 million, to full-size projects worth well in excess of US$1 million, averaging about US$6 million each).

Fig. 36

Congested narrow road in Bangkok.

Photo courtesy of John Fletcher (TRL), Bangalore, 2007

What are the benefits for developing countries / cities?

By using the GEF developing countries and cities can mobilise additional funding to implement projects that are their core interest. In the transport sector, co-funding from the GEF can, *e.g.,* be used to improve public transport or promote non-motorised transport. To be eligible for GEF funding, projects must have a benefit for the global environment and fulfil specific formal criteria.

What kind of projects could be financed via GEF?

In 2007. new policies have been introduced for the GEF and have been submitted to the GEF council in June 2007. As a result of this process, the focus and some modalities have been adjusted. This is also relevant for transport sector projects. While initially GEF mainly supported technological solutions, the new strategic programme (called *Promoting Sustainable Innovative Systems for Urban Transport*) will have a stronger focus on 'non-technology' options such as planning, modal shift and the promotion of better managed public transport systems. GEF support can be given to promote transport modes with lower carbon intensity. This covers public transport, public rapid transit (including bus-rapid transit) as well as non-motorized transport. Priority will be given to countries with rapidly growing small and medium cities.

Who is able to apply for the GEF funding (Climate Change)?

The pre-conditions for eligibility in applying for GEF funding are:

- The applicant country has ratified the relevant treaty (Kyoto Protocol);
- The applicant is eligible to borrow from the WB or receive technical assistance grants from UNDP;
- The individuals or groups (such as city government, transport operators etc.) have proposed a project that will improve the global environment; and
- The proposed project reflects national or regional priorities.

The application process relates to the specific type of funding. Generally speaking, the applicant should be a public administration, a transport operator/company, a bilateral development cooperation agencies or a NGO. Often project preparation is supported by a consultancy, and cooperation with international partners is common. From the beginning, it is crucial to establish a contact with the national Focal Point for the GEF, as they have to approve the initial project. In most of the cases the focal point has been established in the ministries for environment or the national environmental agencies. A list of all national Focal Points is available at the GEF website (http://www.gefweb.org/interior.aspx?id=16818).

What kind of funding is available?

There are a great variety of projects that can be financed by GEF, and the application process differs depending on the type of project. The most work intensive preparation is needed for full-sized projects, which include projects in excess of US$1 million. Other options include enabling activity or medium-sized projects. For all type of projects it is possible to apply first for an project preparation grant (PPG) to get initial funding (up to US$25,000) to prepare the project proposal (see http://www.gefweb.org/interior.aspx?id=16674&terms=ppg). This includes holding workshops to increase stakeholder participation within the project and to strengthen the focus of the proposal. Table 20 provide an overview on former GEF projects in the transport sector.

What is the process and how can funds be obtained for projects?

The proposal should be submitted via the national focal point to the implementing agency (IA), which is the World Bank, UNEP or UNDP (contact details of the IAs can be found at http://www.gefweb.org/interior.aspx?id=16832). As an alternative, the proposal can be submitted from the focal point to an executing agency (such as Regional Development Banks *e.g.,* ADB; or other UN organisations like UNIDO and UN-Habitat). The latter options were added to spread the responsibility between the agencies and to enable more GEF activities to take place. There are no specific criteria to which agency a proposal should be submitted

Table 20: GEF grants, purpose, and key documents

	Grant ($)	Key Documents
Enabling Activities	GEF grant < US$0.5 million The GEF currently finances enabling activities related to the conventions on biodiversity, climate change, and persistent organic pollutants. There is no limited amount identified, funding is flexible.	Operation guidance for Enabling Activities is available at: http://www.gefweb.org/interior.aspx?id=17572 Preparation guidelines and required formats are available at: http://www.gefweb.org/interior.aspx?id=16674 Initial Document (Project Identification Form): http://www.gefweb.org/uploadedFiles/Projects/Templates_and_Guidelines/PIF%20Template-8-30-07.doc
Medium-Sized	GEF grant < US$1 million	Preparation guidelines and required formats are available at (Medium-Sized Projects): http://www.gefweb.org/interior.aspx?id=16674 Medium-Sized Project Proposal: http://www.gefweb.org/uploadedFiles/Projects/Templates_and_Guidelines/MSPProjectTemplateRev2-23-07R.doc
Full-Sized	GEF grant > US$1 million	Each project needs to go through the GEF project cycle available at: http://gefweb.org/Documents/Council_Documents/GEF_C22/Project_Cycle_Update__FINAL__Nov_5_2003.pdf Initial Document (Project Identification Form): http://www.gefweb.org/uploadedFiles/Projects/Templates_and_Guidelines/PIF%20Template-8-30-07.doc Preparation guidelines and required formats are available at: http://www.gefweb.org/interior.aspx?id=16674

to. Therefore, it is good practise for a project developer to get in touch with the national focal point in advance and decide, based on the recommendation of the focal point, which agency to choose. One of the aims of the agencies is to increase the number of proposals and they therefore provide advice for the application.

The application process differs between enabling activities (PDF), medium-sized projects and full-sized projects (see table above). The main difference is related to the approval process.

Box 14: Key stages of the GEF application process for large and medium-sized projects

Project Identification Form (PIF) – Initial four page document to hand over from the project developer (public administration, a transport operator/company, a bilateral development co-operation agencies or a NGO) to the national focal point to start the GEF application process (Stage 1 project cycle). After acceptance by the focal point they will submit it to the Implementing Agency/Executing Agency.

Main content of the document: Project summary, objective, threats/root causes and barriers to be addressed, global environmental benefits expected or adaptation benefits, fit with local area strategy, potential risk and mitigation. Preparation of a financing plan (large and medium-sized projects).

Prepare medium-sized project proposal – After approval (Stage 2 project cycle) the project developer has to submit a full proposal to the IA/EA.

Main content of the document: Project summary, country ownership, program and policy conformity, financing, institutional co-ordination and support. Report on the use of project preparation grant, co-financiers commitment letters, agency notification template on major project amendment where applicable. Research hypothesis, contribution to objectives of existing or new operational programs, incrementality (medium-sized projects).

Prepare Project Executive Summary – Separate document to prepare and submit together with the project proposal develop by the project developer and submitted to the IA/EA.

Main content of the document: Project summary, country ownership, program and policy conformity, financing, institutional co-ordination and support. Incremental costs analysis and project logical framework (large-sized projects).

The key steps and the main references for the application process for a full-sized project are outlined in more detail below. The process is divided into two perspectives: the project cycle describes the whole process from the GEF perspective; while Box 14 highlights the main activities from a project developer's point of view (*e.g.,* public administration, transport operators/companies, bilateral development cooperation agencies or a NGO). According to recently updated rules, the process should now last a maximum of 22 months.

Four-Step GEF Project Cycle:

1. Submission of Project Identification Form (PIF) and review by GEF Secretariat:
   - A Project Identification Form is submitted to the GEF Secretariat by the project developer;
   - The PIF is reviewed by the GEF Secretariat;
   - The Chief Executive Officer (CEO) of the GEF considers the PIF for inclusion in a work programme;
   - If necessary, Project Preparation Grants (PPG) can be granted (based on preparation budget request);
2. The work program is approved by the GEF Council:
   - The work program lists all the accepted PIFs and enables the project developers to submit a full proposal.
   - Project developers submit a full proposal.
3. GEF CEO's endorsements of the projects:
   - Project proposals are reviewed by the Secretariat for compliance with conditions for endorsement (high likelihood to deliver and provide global environmental benefit, cost effective use of the grant, explanation of changes to the PIF documents, if any);
   - Secretariat will then circulate to Council Members the draft final project document;
   - Council members can transmit to the CEO any concerns related to technical, procedural, policy issues or inconsistency with the GEF instrument;
   - Concerns are posted on the GEF website, along with an updated status of the projects;
   - The project is eventually endorsed;
   - The final project document of the endored projects is posted on the GEF website.

Table 21:
Examples of GEF sustainable transport projects under the climate change Programme OP 11

Country	Project Name	Implementing Agency	Project Type	GEF Grant (US$m)
Botswana	Incorporating Non-Motorised (NMT) Transport Facilities in the City of Gaborone	UNDP	Medium Size	0.917
China	Demonstration of Fuel Cell Bus Commercialisation in China, Phase 2	UNDP	Full Size	5.767
Egypt	Sustainable Transport	UNDP	Full Size	7.175
Ghana	Ghana Urban Transport (resubmission from Feb 2006 IWP)	IBRD	Full Size	7.350
India	Electric 3-Wheeler Market Launch Phase	UNDP	Medium Size	0.998
Indonesia	Bus Rapid Transit and Pedestrian Improvements in Jakarta	UNEP	Full Size	6.160
Nicaragua	Promotion of Environmentally Sustainable Transport in Metropolitan Managua	UNDP	Full Size	4.225
Venezuela	Promotion of Environmentally Sustainable Transport in the City of Valencia	UNDP	Medium Size	1.000
Vietnam	Hanoi Urban Transport Development	IBRD	Full Size	10.150
Regional	Regional Sustainable Transport Project	IBRD	Full Size	21.175
Regional	Promoting Sustainable Transport in Latin America (NESTLAC)	UNEP	Medium Size	0.986
Global	Reducing Greenhouse Gas Emissions with Bus Rapid Transit	UNEP	Medium Size	0.750

4. Implementation supervision, monitoring and final evaluation.

Box 14 provides a brief overview of the application process stages/tasks for GEF from the applicant's perspective for both large and medium-sized projects. For more detailed information, please see http://www.gefweb.org/interior.aspx?id=16674

GEF Project Examples: A variety of sustainable transport-related projects have been funded through GEF in many developing cities. An overview of those projects funded through GEF in 2005 is displayed in Table 21.

Fig. 37
Cyclists on bike lane on Dai Co Viet.
Photo by Gerhard Menckhoff, Hanoi, 2005

GEF Case Study 5: Promotion of environmentally sustainable transport for the capital City of Managua, Nicaragua

Managua, the capital city of Nicaragua with an estimated population of 1.4 million inhabitants and an annual population growth rate of 2.8%, is afflicted with an anarchic public transport system. There are fundamental problems in daily transportation. As a consequence, the city has undergone a reduction of its modal split and air quality is degrading rapidly. Without intervention, the total CO_2 emissions are estimated to double over the next 25 years (from 0.89 to 1.82 million tons per year).

Therefore, the main aim of the UNDP-GEF Project is the mitigation of greenhouse gas emissions by promoting a sustainable urban transport system in the City of Managua. The project is based on cooperation at the municipal as well as the national level. Key stakeholders are the Municipal Government of Managua, its Institute for the Regulation of Transport, the Ministry of Environment and Natural Resources, the National Committee on Climate Change, the National Engineering University and the Inter American Development Bank.

The execution of this project includes the implementation of a new legal and operational framework for public transportation, implementation of a Bus Rapid Transport (BRT) system, improvement of land-use planning and traffic management, development of a Cycling Paths Network Construction Programme as well as capacity building, knowledge management and monitoring of impacts.

The project is expected to reduce CO_2 emissions from public transport by 35% (from 2005 level) in 2030, while the target modal shift to NMT is estimated to abate about 4% of the prospective CO_2 emissions (without the GEF intervention). This will at last lead to a total mitigation up to 40,000 tons CO_2 annually at the end of the execution (by 2011) and raise up to 146,000 tons per year in 2030.

Source: GEF (2006a)

GEF Case Study 6: Hanoi Urban Transport Development Project (HUTDP), Vietnam

With a focus on the promotion of public transport, this IBRD-GEF Full Size Project in cooperation with the Hanoi People's Committee and the Ministry of Transport is designed to assist Hanoi in implementing a sustainable strategy of city development and transport improvement.

HUTDP will encourage modal shift in urban transport through emphasis on BRT, non-motorised transport (such as bicycle and pedestrian areas) as well as non-technology measures like traffic demand management and economic incentives. There will also be a key focus on institutional and technical capacity building at the local level and the support of public outreach initiatives.

More precisely, this project will support the establishment of high capacity busways on major corridors, by integrating investments in road infrastructure with land-use plans. This will lead to a transit-friendly urban landscape development. Through enhancing the attractiveness of the public transport service and encouraging and sustaining bicycle use and walking and activities, a modal shift is promoted additionally.

The reduction of greenhouse gas (GHG) emissions in the course of the project implementation is expected to be significant, but difficult to quantify. Nevertheless, there is an initial estimate of the anticipated GHG emissions reductions limited to the BRT component of the programme. Hence, approximately 1.70 to 2.23 million tons of CO_2-equivalent emissions will be reduced by the establishment of BRT in Hanoi over the 15 year period from 2005 to 2020.

Source: GEF (2006b)

CHECKLIST G: Global Environment Facility (GEF)

Proposed projects under GEF must meet the following criteria:

- ☑ The project should reflect **national or regional priorities** and have the support of the country or countries involved.
- ☑ The project should **improve the global environment** or advance the prospect of reducing risks to it.

Country eligibility to receive funding for proposed projects:

- ☑ **Developing countries** that have ratified the relevant treaty (*i.e.,* the UN Framework Convention on Climate Change) are eligible to propose climate change projects, or
- ☑ **Other countries**, primarily those with economies in transition, are eligible if the country is a party to the appropriate treaty and is eligible to borrow from the World Bank or receive technical assistance grants from UNDP.

Scope of transport projects covered within the programme includes (ground transport):

- ☑ Non-motorised transport;
- ☑ Transport planning;
- ☑ Modal shift;
- ☑ Promotion of better managed public transport systems.

4. Summary

Climate change is projected to have major effects for the world. The consequences of climate change are predicted to be particularly severe for developing nations which often already face more extreme climatic conditions and in many cases will not have the means to adapt to the predicted climatic changes.

Transport is one of the key sources of greenhouse gas emissions. In order to effectively reduce global emissions of greenhouse gases, developing cities with dramatically increasing populations and emissions will—sooner or later—have to address climate change issues and contribute to its mitigation.

However, implementing climate change mitigation should not exclusively be viewed as a burden but it can also be an opportunity to promote sustainable urban transport solutions. Sustainable urban transport will help reduce greenhouse gas emissions but it also has a significant potential to improve the urban living conditions.

There are a variety of instruments available to tackle climate change, many of which have been presented in this *Sourcebook* module. In view of the large number of instruments and approaches covered, the presentations had to be brief. More detailed information on individual instruments can be found in other *Sourcebook* modules and cross-references have been provided throughout the text. All GTZ material is available for download from http://www.sutp.org (in China: http://www.sutp.cn).

Fig. 38
Midday in Santiago: Air pollution during a clear day.
Photo by Jan Schwaab, Santiago, 2004

Table 22: Sustainable transport instrument overview 1 – Level of implementation and responsible/interested stakeholders

Type of instrument		Level of implementation			Responsible / interested stakeholder									
		National	Regional	City	Mayor/Equivalent	Transport Authorities (including public works)	Land use/planning authorities	City Administration (treasury/finance/taxation)	Public relations, Press, and Media	Enforcement Authorities (police, others)	Non-Governmental Organisations (NGOs)	Private Sector (Industry/ commercial)	Private sector – Public Transport Operators	Private Sector – Employers
Planning	Land Use Planning		✔	✔	✔		✔						✔	✔
	Public Transport		✔	✔	✔	✔	✔		✔		✔		✔	✔
	Non-Motorised Modes			✔	✔	✔	✔		✔		✔			✔
Regulatory	Physical Restraint Measures			✔	✔	✔	✔		✔	✔			✔	
	Traffic management Measures			✔		✔	✔		✔	✔			✔	
	Regulation of Parking Supply		✔	✔		✔			✔	✔				✔
	Low Emission Zone		✔	✔	✔	✔			✔	✔	✔	✔	✔	
	Speed Restrictions	✔		✔		✔			✔	✔				
Economic Instruments	Road Pricing	✔	✔	✔	✔	✔		✔	✔	✔	✔		✔	
	Fuel Tax Implementation / Increases	✔						✔		✔				
	Vehicle Taxation	✔						✔		✔				
	Parking Pricing		✔	✔				✔	✔	✔				
Information	Public Awareness Campaigns	✔	✔	✔	✔	✔			✔		✔		✔	✔
	Driver Behaviour Training and Education / Eco-Driving	✔	✔	✔		✔			✔		✔		✔	✔
Technology	Cleaner Production	✔				✔			✔		✔	✔	✔	
	Cleaner Technology	✔				✔			✔		✔	✔	✔	

✔ = indicates level of implementation and responsible/interested stakeholders

Table 23: Sustainable transport instrument overview 2 – Contribution to greenhouse gas reductions, estimated costs, co-benefits, and implementation considerations of instruments

Type of instrument		Contribution to reduce greenhouse gas emissions	Potential cost of Implementation	Co-benefits / negative (+ ? –)	Implementation considerations for responsible authorities
Planning	Land Use Planning	##	$	+ Accessibility, social inclusion, air pollution	
	Public Transport	# - ###	$$	+ Accessibility, mobility, economy	Service coverage/ frequency, cost
	Non-Motorised Modes	# - ###	$ - $$	+ Safety, accessibility, mobility, social inclusion, economy, air pollution	Safety
Regulatory	Physical Restraint Measures	## - ###	$ - $$$	+ Safety, air pollution, noise ? accessibility, mobility, social inclusion, economy	Traffic displacement, restricted access/mobility, alternative modes provision, enforcement
	Traffic management Measures	## - ###	$ - $$$	+ Safety ? accessibility, mobility, social inclusion, economy, air pollution	Traffic displacement, restricted access/mobility, alternative mode provision, enforcement
	Regulation of Parking Supply	# - ##	$ - $$	+ Air pollution ? accessibility, mobility, social inclusion, economy	Traffic displacement, restricted access/mobility, alternative mode provision, illegal parking/ obstructions, enforcement
	Low Emission Zone	# - ##	$$ - $$$	+ Safety, local air pollution, noise ? accessibility, mobility, social inclusion, economy	Traffic displacement, restricted access/mobility, alternative mode provision, enforcement
	Speed Restrictions	# - ##	$ - $$	+ Safety, air pollution, noise ? accessibility, mobility, social inclusion, economy	Enforcement
Economic Instruments	Road Pricing	# - ##	$$-$$$	+ Safety ? accessibility, mobility, social inclusion, economy	Traffic displacement, restricted access/mobility, equity impacts, enforcement, cost
	Fuel Tax Implementation/ Increases	#	$$	– Mobility, equity	Level of tax, enforcement
	Vehicle Taxation	#	$$	– Mobility, equity	Level of tax, enforcement
	Parking Pricing	# - ##	$ - $$	+ Safety ? Accessibility, mobility, social inclusion, economy	Traffic displacement, restricted access/mobility, alternative mode provision, illegal parking/ obstructions, enforcement, cost
Information	Public Awareness Campaigns	# - ##	$ - $$	+ Accessibility, mobility, air pollution	
	Driver Behaviour Training and Education/ Eco-Driving	# - ##	$ - $$	+ Safety, air pollution	
Technology	Cleaner Production	## - ###	$$$	+ Air pollution	
	Cleaner Technology	## - ###	$$$	+ Air pollution, noise	

\# = Small contribution
= Medium contribution
= High contribution

$ = Low cost
$$ = Medium cost
$$$ = High cost

\+ = positive
? = unclear
– = negative

Table 22 summarises the sustainable transport instruments discussed in this *Sourcebook* module. The table indicates the level at which the instruments should be implemented and the key stakeholders that need to be involved.

Table 23 compiles the potential greenhouse gas emission reductions and the cost implications when applying the instruments. The table also presents the co-benefits, potential negative effects and some implementation issues to be considered by the relevant authorities.

At present, climate change mitigation may not have a high priority in many developing cities as day-to-day problems seem to be much more pressing for many municipal authorities.

Fig. 39
The sun setting over Washington, DC.
Photo by Armin Wagner, Washington, 2007

Climate change mitigation in the transport sector may appear to be particularly burdensome as it is closely related with economic activities and personal mobility.

However, meeting the transport needs for ever growing populations is getting more and more difficult in many developing cities. Some municipal authorities have started to realize that the reliance on the individual car cannot be the solution in the long run. The comprehensive approach that sustainable urban transport policies offer is a way forward to meet the needs for transport and mobility in an environmentally, socially and economically sustainable way.

Decision-makers and city administrations may have concerns regarding the impact of reducing the level of motorised transport on the economy. These concerns may not be well-founded. There is evidence to suggest that by encouraging travel by sustainable transport modes GDP can continue to grow and economies can continue to develop. Sustainable urban transport can improve the local environment, reduce local air pollution and congestion levels—and thus make cities more desirable places to live, work, and visit.

But sustainable urban transport policies will not only improve local transport and quality of life. They also help reduce greenhouse gas emissions and thus contribute to addressing climate change. A win-win solution is thus possible for the transport sector—a win-win solution that should be backed and promoted by the policy-makers in the developing cities of the world.

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Abbreviations

BRT	Bus Rapid Transit
CDM	Clean Development Mechanism
CEO	Chief Executive Officer
CER	Certified Emission Reduction
CH_4	Methane
CO_2	Carbon Dioxide
CO	Carbon Monoxide
DNA	Designated National Authority
DOE	Designated Operational Entity
EB	Executive Board of the CDM
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (German Technical Cooperation)
HFCs	Hydro Fluorocarbons
ITDP	Institute for Transportation and Development
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
LDV	Light Duty Vehicles
LEZ	Low Emission Zone
N_2O	Nitrous Oxide
NGO	Non-Governmental Organisation
NO_X	Nitrogen Oxides
NMT	Non-Motorised Transport
OECD	Organisation for Economic Co-operation and Development
PDD	Project Design Document
PFCs	Perfluorocarbons
PIN	Project Identification Note
PM	Particulate Matter
PP	Project Proponent
PT	Public Transport
SF_6	Sulphur Hexafluoride
SUTP	GTZ Sustainable Urban Transport Project
SUV	Sports Utility Vehicle
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

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