URBAN MOBILITY
A SOURCE OF SOLUTIONS AGAINST CLIMATE CHANGE

November 2015

This document was compiled by CODATU association under the supervision of the Agence Française de Développement (AFD). Julien Allaire coordinated its edition in close collaboration with Reda Sourgi and Lise Breuil (AFD). Julien Allaire, Maël Martinie, Lorenza Tomasoni, Marion Hoyez (CODATU) and Reda Souirgi (AFD) have contributed to the present document.

AFD, the *Agence Française de Développement*, is a public development-finance institution that has worked for seventy years to alleviate poverty and foster sustainable development in the developing world and in the French Overseas Provinces. AFD executes the French government's development aid policies. Working on four continents, AFD provides financing and support for projects that improve living conditions, promote economic growth, and protect the planet.

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CODATU gathers the different stakeholders of transport and urban mobility: local authorities and government departments, universities and research institutes, private companies and individual consultants. The association was founded in 1980, following the World Conference on Urban Transport in Dakar. It aims to stimulate the exchange of knowledge and know-how to promote the implementation of sustainable urban mobility policies in developing countries. It organizes international conferences, offers trainings to the leaders of the South and regularly publishes books on this topic. Moreover, CODATU support cooperation between local governments in the field of transport and urban mobility.

For more information: www.codatu.org

_List of Acronyms

ADB	Asian Development Bank
ASI	Avoid Shift Improve
AFD	Agence Française de Dévelopment
BRT	Bus Rapid Transit
CDM	Clean Development Mechanism
CTF	Clean Technology Fund
CMP	Comprehensive Mobility Plan
EASI	Enable-Avoid-Shift-Improve
EIA	Energy International Agency
FGEF	French Global Environment Facility
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	greenhouse gas
INDCs	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
ITDP	Institute for Transportation and Development Policy
ITF	International Transport Forum
MRV	Measure, Report, Verify
NAMA	Nationally Appropriate Mitigation Actions

NUTP	National Urban Transport Policies
PCTI	Integrated Territorial Climate Plan
PDU	Plan des Déplacements Urbains
SUMP	Sustainable Urban Mobility Plan
TOD	Transit Oriented Development
UCD	University of California Davis
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organization

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_Introduction

The transport sector produces 15% of the world's greenhouse gas (GHG) emissions, or 7 Gt CO_2eq, three-quarters of which is generated by road transport, both urban and long distance. The transport sector alone generates more than 23% of CO_2 emissions from fossil fuel burning. According to the Intergovernmental Panel on Climate Change (IPCC), "*without aggressive and sustained GHG mitigation policies being implemented, transport emissions could increase at a faster rate than emissions from any other energy end-use sector, rising from 7 to 12 gigatons of CO_2equivalent per year by 2050.*"[1] The transport sector would thus be the biggest emitter of GHGs.

Given this outlook, more and more political leaders are observing that it will not be possible to meet the 2°C[2] target without an in-depth transformation of the transport sector. The challenge of low-carbon mobility has thus become a major climate issue. Central to this issue is urban mobility, as it accounts for more than one-third of transport sector emissions. In 2010, according to the Institute for Transportation and Development Policy (ITDP) and University of California Davis (UCD), people's urban journeys worldwide represented 2.3 gigatonnes of CO_2 per year, and this figure, given the rapid urbanisation in developing countries, is set to double by 2050, in a business-as-usual scenario.

Besides its impact in reducing GHG emissions, the transformation of urban transport systems responds to local needs that are powerful drivers of change. The idea is to ensure "livable" cities despite their very fast development and the growing flow of cars and motorbikes that is degrading people's living environment and particularly that of the most disadvantaged. The challenge is thus to limit the congestion of road infrastructure, which paralyses cities and reduces their economic growth potential; to limit air pollution, which has become a real public health challenge in metropolises; and lastly, to improve road safety.

1. According to chapter 8 of the IPCC's fifth assessment report

2. The target to limit the average global temperature increase to 2°C by 2100 relative to the pre-industrial age is a decision taken by the United Nations Framework Convention on Climate Change (UNFCCC) during COP15 in 2009 in Copenhagen. This figure is based on the scientific work of the IPCC, whose scenarios for climate change greater than 2°C predict dramatic and irreversible impacts.

Solutions do exist to resolve these local problems while fighting climate change: at global level, sustainable urban mobility policies have high mitigation potential. For instance, the "High Shift Scenario" proposed by the ITDP and UCD envisages a potential 40% reduction in GHG emissions due to personal people's urban mobility by 2050, by combining various levers with short-, medium- and long-term impacts. These measures include actions designed to avoid motorised travel; actions designed to shift users to more low-carbon modes; and lastly, actions to improve the energy efficiency and carbon footprint of vehicles and fuels. A broad array of measures classified under these three headings, Avoid Shift Improve (ASI), is presented in this study in order to show the issues relating to each component in the ASI approach.

However, the efficient implementation of these measures would require integrated governance of urban transport modes and of long term funding mechanisms. It is thus essential to add an "Enable" pillar – and thus move from ASI to EASI. This fourth pillar consists of *"establish[ing] an efficient and responsible governance system, capable of anticipating needs, guiding action and ensuring integrated management and development of urban transport systems".*[3]

The idea is thus to manage urban mobility challenges on the right scale, integrating all components of the transport system, by establishing or strengthening competent institutions; defining urban mobility policies that are sustainable, consistent and integrated; planning corresponding actions at the right territorial scale; implementing appropriate funding schemes, etc. In order to have efficient levers able to bring about an in-depth transformation of the urban transport sector, the various components of the Enable pillar must give rise to concurrent actions at local and national levels.

Various instruments are available to territorial stakeholders, at these two local and national levels, with the aim of implementing sustainable urban mobility policies: planning programmes and tools, monitoring and evaluation tools, appropriate funding models, etc.

At local level, a Sustainable Urban Mobility Plan (SUMP) makes it possible to develop an integrated multimodal policy that is articulated with urban planning; and to define an action plan over a period of 10-15 years, as part of an inclusive multi-stakeholder programme and with comprehensive GHG reduction targets (this is now a major issue).

At national level, the defining of National Urban Transport Policies (NUTP) must: offer a suitable institutional framework, secure funding over the long term, build a system to support local strategies and encourage the creation of SUMPs, provide the resources to build capacity of local bodies, etc. The regulatory, normative and tax frameworks that impact the use of motor vehicles and of fuels also derive, very often, from national policies and are a major lever for controlling GHG emissions.

3. SSATP (2015), Policies for Sustainable Accessibility and Mobility in Urban Areas of Africa, Working Paper No. 106.

It is also at two scales – national and local – that resources can be defined to help fund urban mobility policies: national or local budgetary funding, dedicated resources, private finance, international funding, etc. The rollout of strategic frameworks and of local and national planning documents must, in this respect, facilitate access to funding from international donors for projects or actions identified within the scope of SUMPs; or even, later on, access to additional "climate" funds.

However, a difficult issue remains for the urban transport sector: measurement and accountability regarding GHG emission reduction targets. Unlike other sectors (energy, in particular), measuring the impact of the urban transport system on GHG emissions is highly complex, because it involves conducting complicated and costly user surveys in order to inform a comprehensive model on a city-wide scale, not just for a single project.

Urban transport is mentioned in roughly one-third of the Intended Nationally Determined Contributions (INDCs) sent by countries ahead of COP21. These national targets must clearly set out in the coming years. Systems for evaluating urban transport policies and projects, whether to track these contributions or give access to "climate" funds, will play an essential role.

The merging of systems for evaluating sustainable urban mobility plans (SUMPs) with the MRV (Measure, Report, Verify) systems proposed as part of the climate negotiations should, in this respect, provide a reference frame suited to monitoring the impacts of urban mobility policies. On the one hand, evaluation will be conducted on the correct scale, i.e. metropolitan area scale. On the other hand, this will make it possible to record – as with Nationally Appropriate Mitigation Actions (NAMAs) – the benefits that align with development objectives (road safety gains, air quality improvement, better accessibility, etc.).

_Chapter 1

Low-carbon urban mobility: a challenge both local and global

1.1 The expected explosion of mobility needs in the cities of the Global South and associated GHG emissions

Several dynamics are at work in the expected explosion of emissions due to mobility in cities of the Global South:

- On the one hand, fast-paced urbanisation will be concentrated in developing countries: the United Nations forecast that, in 2050, 75% of the world's population will live in urban areas. And of the 2.7 billion extra urban inhabitants expected by 2050, 92% will live in developing countries. Behind these figures, the issue is the shape of the future million-inhabitant cities, with urban development of varying compactness. In any event, longer travel times are expected.
- On the other hand, economic growth increases mobility needs, expressed in the number of daily trips per inhabitant. This then raises the issue of using motorised and carbon-emitting modes to meet this growing demand for travel, which can be measured by the rate of ownership of private cars and of motorised two-wheelers.

Combining these dynamics will result in strong growth of mobility needs, expressed in passenger-kilometres (as illustrated in Figure 1), essentially in developing countries.

Depending on how the shape of the urban areas, population-mobility levels, modal split and types of motorised and carbon-emitting vehicles are combined, emissions per inhabitant due to urban transport vary hugely at present. Figure 2 shows levels of emissions for urban transport higher than 2 t CO_2eq/inhabitant in North American and Australian cities, whereas European cities, which are more compact, emit between 0.5 t and 2 t CO_2eq/inhabitant. With a few exceptions, developed cities in Asia have emission levels lower than 1 t CO_2eq/inhabitant.

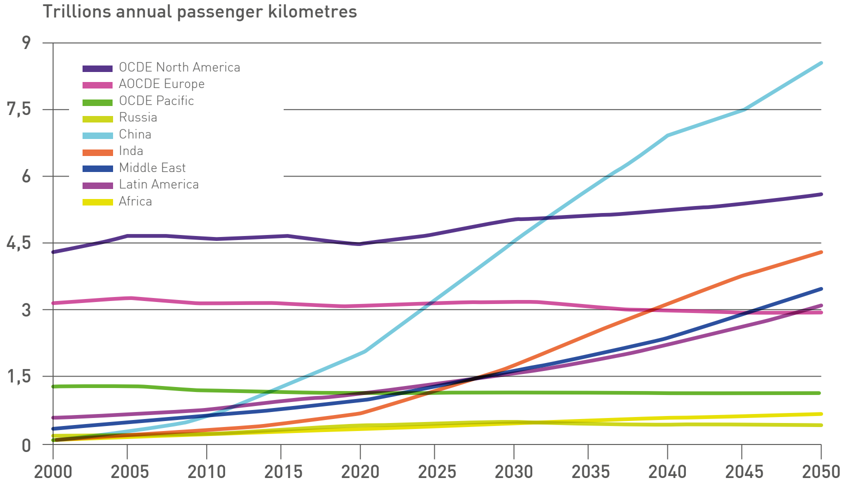


***Figure 1: Forecasts of private motorised travel in urban areas*[4]**

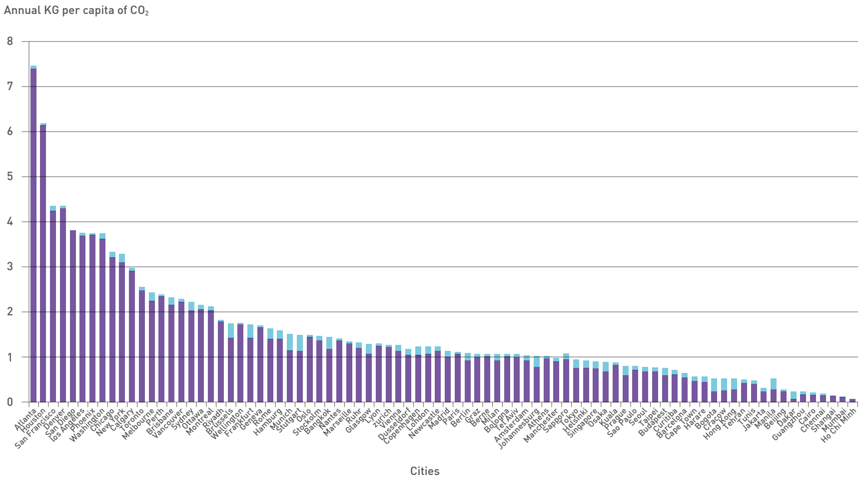


***Figure 2: CO_2 emissions per inhabitant for urban transport in 84 cities worldwide (2003)*[5]**

In absolute terms, CO_2 emissions per inhabitant due to urban mobility in developing countries are currently far lower than those in developed countries.

4. Source : IEA, 2013

5. Source : Kenworthy, J. R. (2003). Transport energy use and greenhouse gases in urban passenger transport systems: a study of 84 global cities. http://researchrepository.murdoch.edu.au/21463/1/transport_energy_use_and_greenhouse_gases.pdf

Accordingly, in the Sub Saharan cities of Africa, where walking is the dominant travel mode – between 50% and 80% of the trips5 – the volume of CO_2 emissions attributable to urban travel is particularly low. However, as observed in other emerging countries, travel demand rises quickly, travel distances lengthen and populations turn to motorised modes to meet their growing travel needs: motorbikes and paratransit offset the absence of structured, efficient public transport provision. Which raises the question: in terms of mobility behaviours, what will be the trajectory of these future million-inhabitant cities in developing countries? What role will motorised personal vehicles have?

Analysis of historic trends and current disparities between the world's regions shows that various trajectories are possible, leading to different social models of travel organisation and of mobility behaviours.

The use of motorised vehicles can vary greatly between models[6]. Some countries have far higher car ownership rates than others with comparable incomes: this is true of the United States, compared to Canada; and of Italy, to Germany. As shown in Figure 3, South Korea has a far lower ownership rate with equivalent income. The countries of Southeast Asia, but also Latin American countries such as Brazil, display high ownership rate trajectories relative to income.

The countries of Southeast Asia have experienced an original trajectory for motor-vehicle ownership by developing national industries for motorbikes, which are now widely represented there. India appears to be following this trend, while China has seen lower growth in recent years. In Latin America, the two-wheeler fleet is also expanding strongly.

The use of motorised modes is far from the only distinguishing factor between the various urban mobility models encountered in metropolises worldwide.

In relative terms, the share of urban transport emissions at city level can vary depending on mobility-specific factors (frequency and proportion of use of the various transport modes), but also on factors related to other sectors: compactness of urban development, level of industrial development, need for heating or air-conditioning. In European cities, the movement of goods and people is responsible, on average, for 30% of GHG emissions in urban areas.[7] In Beijing and Shanghai, urban transport represents 11% of GHG emissions. In New York and London, 20%; 35% in Rio de Janeiro and Mexico City; 45% in Houston and Atlanta, and even 60% in Sao Paulo.[8]

6. The ownership rate is an important indicator for evaluating the transport system development model of a country and its GHG emissions profile. However, the various types of vehicle do not all emit the same amounts: their technical characteristics and how they are used must also be considered in a broader analysis. The ASIF (Activity Structure Intensity Fuel) methodology provides a general framework for calculating transport emissions that has now achieved a consensus. It is described later in this document.

7. The Covenant of Mayors in Figures and Performance Indicators: 6-year Assessment, 2015

8. UN-Habitat. (2013). Trends and conditions in transport-oriented mobility systems in Planning and design for sustainable urban mobility, Global report on human settlements 2013

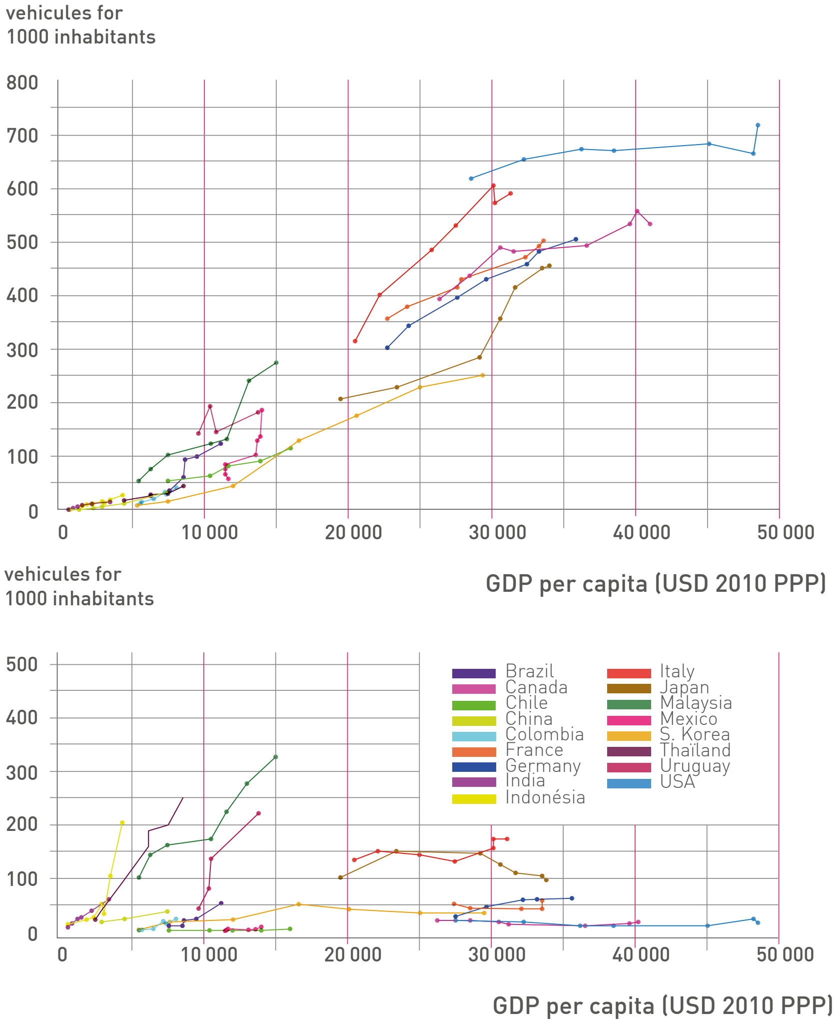


Figure 3: Four-wheeler then Two-wheeler ownership relative to per capita income, selected countries-[9]

In 2010, people's urban journeys worldwide represented 2.3 Gt of CO_2, i.e. one-third of all transport sector emissions. Given the various trajectories described above, this volume of emissions, under a business-as-usual scenario, is expected to double by 2050 owing to the rapid urbanisation and motorisation of developing countries,

9. Source : ITF (2015), ITF Transport Outlook 2015, Chapter 4, OECD/ITF 2015.

particularly China and India.[10] In this case, it would represent nearly 10% of current global emissions…

To fit a trajectory compatible with the 2°C scenario, it is thus essential to guide and transform urban mobility habits, in both hemispheres, towards more sustainable and low-carbon models. But is this achievable? And sufficient?

1.2 Mitigation potential of low-carbon urban mobility: the Global High Shift Scenario projections

In September 2014, the ITDP and UCD published a report evaluating the potential reduction in CO_2 emissions worldwide by 2050, under the hypothesis that cities will invest massively in multimodal transport systems combining public transport, active modes and low-emission personal vehicles. Using the forecasts of the International Energy Agency (IEA), the authors modelled the mitigation policies and measures aimed at reducing the need to travel (Avoid), at modal transfer (Shift) and at making travel more efficient (Improve). They adopted the IEA's mobility model (MoMo), which is traditionally used at national level, and supplemented the range of urban modes in order to refine the urban mobility results.

This report, titled A *Global High Shift Scenario* and looking ahead to 2050, tests the hypothesis that sustainable urban mobility policies will become commonplace worldwide. The consequences would be a sharp dip in the growth of car and 2-wheeler ownership and of distance travelled, compared to the business-as-usual scenario; and very high modal shift to public transport and active modes.

The High Shift Scenario forecasts demand for travel equivalent to the baseline scenario, but including modal shift to public transport and active modes. This scenario is based on the idea that all countries worldwide will implement policies and make investments equivalent to what has been done in the countries with the most efficient urban mobility systems.

This scenario, based on strong development of public transport and on urban development built round this infrastructure, forecasts a drop in the number of passenger-kilometres in cars due to: massive use of public transport, an optimised rate of vehicle occupancy, and increased use of non-motorised transport modes. With, in addition, an improvement in vehicle energy performance.

10. Replogle M. & Fulton L. (2014), A Global High Shift Scenario, Impacts And Potential For More Public Transport, Walking, And Cycling With Lower Car Use, ITDP & UC DAVIS, November 2014, https://www.itdp.org/wp-content/uploads/2014/09/A-Global-High-Shift-Scenario_V2_WEB.pdf

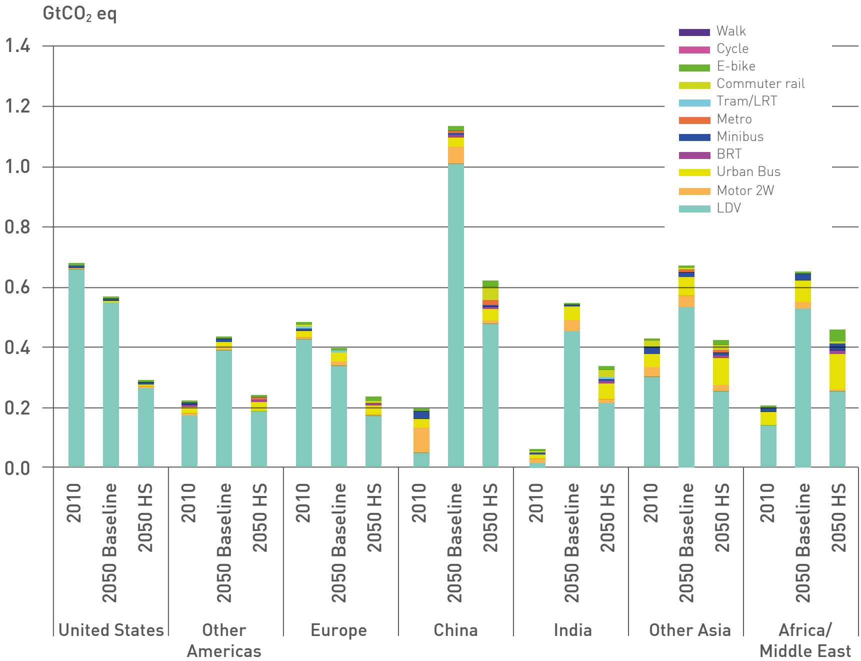


Figure 4: Emissions outlook in the High Shift Scenario[11]

By way of example, the number of kilometres travelled in cars is 42% lower in North America and 45% lower in China than under the baseline scenario. Consequently, GHG emissions in these two regions are reduced proportionately. In Africa, the Middle East and Asia (excluding India and China), however, the High Shift Scenario projects a rise in kilometres travelled compared to the baseline scenario (+40-45% depending on the region) whereas the GHG emission projections are only half those in the business-as-usual scenario.

Whereas the business-as-usual scenario forecasts global annual emissions in the order of 4.4 gigatonnes of CO_2 for urban mobility in 2050, the results of the study show that the massive development of mitigation policies in urban transport could entail a 40% drop in CO_2 emissions, i.e. nearly 1.7 gigatonnes.

Another recent study, published by the International Transport Forum, focuses on the large emerging regions and evaluates the difference in GHG emissions by urban transport in China, India and Latin America by 2050, depending on the urban development model adopted. Figure 5 shows the modal mix in these three regions depending on whether policies are oriented to private motorised transport or to public transport.

11. Source : ITDP & UC DAVIS (2014)

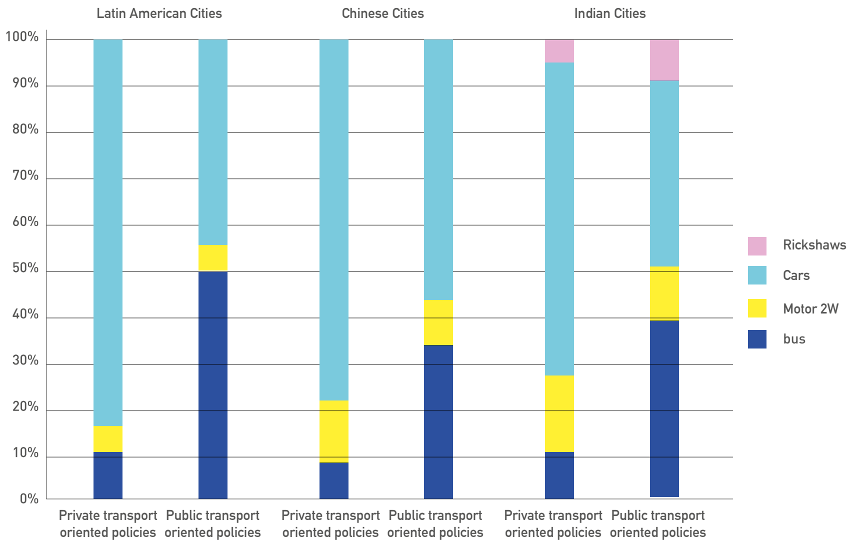


Figure 5: Modal shares (in passenger-km) depending on urban development scenarios[12]

A policy promoting private motorised transport could cause a rise in GHG emissions of 19% in China, 47% in India and 35% in Latin America compared to the baseline scenario. Conversely, urban planning policies combined with high fuel prices and public transport infrastructure development would reduce emissions by 26%, 31% and 37% respectively.

There is thus real potential for reducing GHG emissions in the area of urban mobility. However, the advent of a sustainable, low-carbon type of urban mobility would involve a paradigm shift of global scale: moving from a travel model guided by the development of road infrastructure and private cars to a multimodal and integrated model that is built around public transport, gives active modes (cycling and walking) their full role, and considers cars – whose emissions must be substantially reduced – as an alternative mainly suited to relatively long journeys in low-density areas. To ensure a good level of access, urban development, land use and public transport provision must thus be considered in an integrated way.

Although this paradigm shift seems far from obvious, given the substantial changes it would entail in our personal and collective behaviours, it has a major factor in its favour: the introduction of low-carbon urban mobility policies intrinsically delivers large local benefits: improved living conditions, conservation of the natural environment, health benefits, favourable conditions for economic development, better access, greater social fairness, etc.

12. Source : ITF (2014)

1.3 Local benefits of sustainable urban mobility policies, which are change drivers

Low-carbon urban mobility policies are associated with high local benefits. They contribute to in-depth transformation of cities and to substantial reduction in negative externalities related to private car-oriented urban mobility.

Access and social inclusion

The majority of the global population today has no access to private cars; and, according to the business-as-usual scenario, this will still be true in 2050.[13] In fundamental terms, an urban mobility policy oriented towards the use of private cars is therefore non-egalitarian because, in the absence of investment in public transport infrastructure, the lowest-income categories cannot travel in conditions of acceptable quality and/or safety. In cities of the Global South, they are even forced to use informal transport systems that are often unreliable, unsafe and also very expensive: in Nairobi (Kenya) or Pretoria (South Africa), the cost of urban transport can represent up to 30% of users' daily resources.[14]

By promoting the development of public transport and of active modes, low-carbon urban mobility policies promote the requirements of social inclusion often highlighted when transport policy is discussed. They offer the largest number of people cheaper, quality access to employment areas, education and healthcare, and are thus a factor that fosters social inclusion. For instance, the *High Shift Scenario* is the one which, among the alternatives examined in this study, presents the greatest social fairness: the gap in distances travelled in cities per inhabitant in high- and low-income households is heavily reduced.

Road congestion

Road congestion plagues all metropolises – in industrialised countries but also in developing countries, and especially cities experiencing high demographic growth. In countries like India and China, in particular, the combination of a fast-growing car population and an uncontrolled urban sprawl is paralysing cities, which are paying a high price for the worrying rise in traffic congestion in terms of wasted time, fuel waste, air pollution, noise pollution, etc., and ultimately in economic growth and prosperity[15]. For example, in Cairo, productivity loss alone is estimated at more than

13. Replogle M. & Fulton L. (2014), A Global High Shift Scenario, Impacts And Potential For More Public Transport , Walking, And Cycling With Lower Car Use, ITDP & UC DAVIS, November 2014, https://www.itdp.org/wp-content/uploads/2014/09/A-Global-High-Shift-Scenario_V2_WEB.pdf

14. UN-Habitat. (2013). Sustainability challenges for urban mobility in *Planning and design for sustainable urban mobility, Global report on human settlements 2013.*

15. UN-Habitat (2013), Trends and conditions in transport-oriented mobility systems in *Planning and design for sustainable urban mobility, Global report on human settlements 2013.*

1.7 billion dollars per year[16].

Because a low-carbon urban mobility policy induces a fall in the number of private vehicles on the roads, in favour of the use of public transport and active modes, but also because it promotes – via an integrated approach to transport and urban planning – a reduction in journey distances, also helps to reduce road congestion and the negative externalities associated with it.

Air quality

Current levels of air pollution are a major health risk. In urban areas, exhaust fumes from vehicles with internal combustion engines are a big factor in deteriorating air quality. Air pollution causes various cardiovascular diseases such as stroke, heart disease, chronic and acute respiratory diseases, and lung cancer.

According to the World Health Organization (WHO), outdoor air pollution in urban and rural areas caused 3.7 million premature deaths worldwide in 2012. Some 85% of these deaths occurred in low- or mid-income countries, particularly in the western Pacific and Southeast Asia. The trend is for very high growth, as the number of premature deaths was estimated at 0.8 million per year in the 2000s[17]. It is thus urgent to act, especially as these deaths have considerable financial consequences. In OECD countries, induced spending on healthcare systems is estimated at 3.5 trillion dollars per year. The cost is put at roughly 1.4 trillion dollars for China, and 500 billion for India[18].

The implementation of a low-carbon urban mobility policy automatically entails a substantial reduction in air pollutants such as fine particulate matter and nitrogen and (NO_x), sulphur (SO_x) oxides. Table 1 shows the impact of measures to reduce CO_2 emissions on pollutant levels in China.

In *A Global High Shift Scenario*, the authors estimate that a measure such as adopting the Euro 6 standard worldwide would likely prevent 1.36 million deaths per year, i.e. a 40%-plus improvement on the current situation.

16. Hamed, et al. (2012), For Better or for Worse: Air Pollution in Greater Cairo. A Sector Note. June 2012

17. UN-Habitat, (2013), Urban mobility and the environment in *Planning and design for sustainable urban mobility, Global report on human settlements 2013*

18 17 OCDE (2014), *The Cost of Air Pollution: Health impacts of Road Transport, ODCE*, http://www.oecd.org/newsroom/rising-air-pollution-related-deaths-taking-heavy-toll-on-society.htm

Reducing NO_x through CO_2 reduction (China)				
	10%	25%	50%	75%
2015	5%	12%	28%	49%
2020	4%	11%	26%	46%
2050	3%	8%	19%	31%
Reducing SO_x through CO_2 reduction (China)				
	10%	25%	50%	75%
2015	6%	16%	34%	56%
2020	5%	14%	31%	53%
2050	3%	10%	24%	37%

Table 1: Reduction of air pollution associated with a reduction in CO_2 emissions[19]

Road safety

According to WHO studies, road accidents cause 1.24 million deaths and 20-50 million injured per year. So-called "vulnerable" road users pay the highest price, as 50% of people killed are pedestrians (22%), cyclists (5%) and motorcyclists (23%). More than 92% of deaths occur on the roads of developing or emerging countries, although these have only 53% of the car population.

These premature deaths particularly affect young men aged 15 to 29, who are the main breadwinners in households, especially those with the lowest incomes. Besides the human and family tragedy of such deaths, they have a considerable economic impact: this is estimated at 518 billion dollars per year, i.e. 1-3% of annual GDP in some countries.[20]

Measures designed to reduce GHG emissions from urban mobility tend also to reduce road traffic deaths. According to the WHO, only 59 countries worldwide have introduced urban area speed limits equal to or lower than 50 km/h, and allow the local authorities to further lower this limit. Yet a 5% drop in average speed may reduce the number of fatal accidents by up to 30%.

The promotion of active modes by implementing dedicated infrastructure and/or mixed traffic with calming measures helps to improve user safety, and thus reduces the number of road traffic casualties.

19. Challenge Michelin Bibendum (2013), *Livre vert*, Challenge Michelin Bibendum, http://www.michelin.com/fre/content/download/13394/154535/version/4/file/VF.pdf

20. http://www.un.org/en/roadsafety/

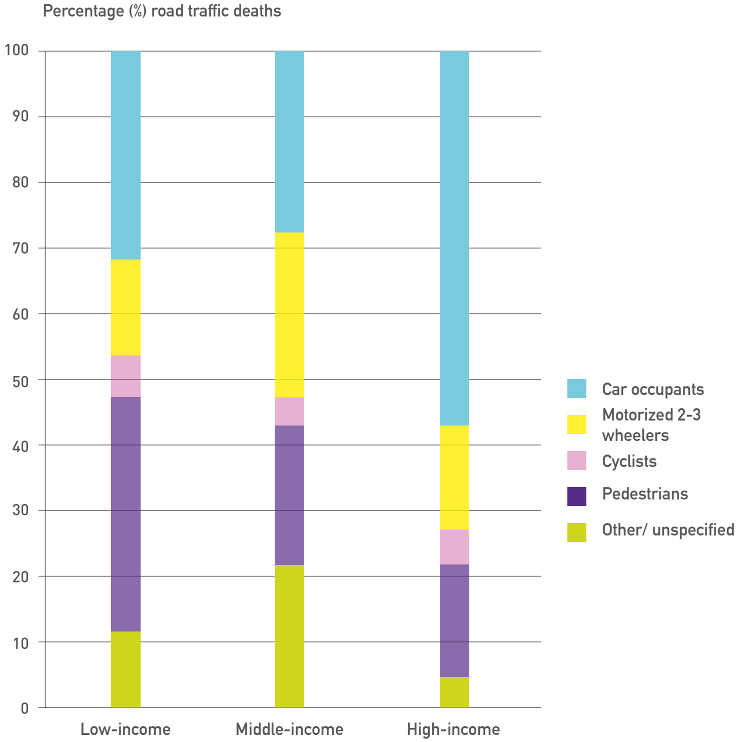


Figure 6: Proportion of road traffic deaths among road user types, by country income status[21]

Reduction in spending

The IEA estimates that travel control and modal shift policies can reduce transport sector spending (vehicles, fuel and infrastructure) by 30 trillion dollars by 2050 compared to the business-as-usual scenario, and even by 70 trillion if policies to improve vehicle energy performance are added. The authors of the High Shift Scenario go even further, showing that it yields large savings, particularly in road infrastructure and parking provision. Some 100 trillion dollars of spending is thus avoided by 2050, 60% of it in non-OECD countries.

Table 2 lists the global costings for all the benefits mentioned above. While these values cannot be deemed orders of magnitude, they show the total sums spent or wasted annually because of the main negative externalities of the transport system.

21. Source : WHO (2013)

Air Pollution	> 5.4 trillion
Road traffic deaths	500 billion
Congestion[22]	850 billion
Spending (infrastructure, fuel)[23]	2 500 billion

Table 2: Orders of magnitude of total costs associated with urban mobility based on motorised vehicle ownership (in US dollars per year)

In the field of urban mobility, climate change mitigation and developmental benefits are thus intrinsically linked. This is an opportunity not necessarily found in other sectors[24], and must be a powerful argument made to local and national political decision makers.

22. Conservative estimate. Extrapolation to global scale of EU figures (1% of GDP/yr) http://ec.europa.eu/transport/themes/strategies/doc/2011_white_paper/white_paper_2011_ia_full_en.pdf. Global GDP 2013

23. Calculated on the basis of 100 trillion dollars by 2050

24. In the energy industry, for example, the installation of solar farms or wind farms can be perceived as degrading the environment.

_Chapter 2 Sustainable-mobility policies to promote a reduction in GHG emissions in urban transport: EASI !

Improving the energy efficiency and carbon footprint of vehicles (especially cars) by technology alone, which is too often cited as the miracle solution for reducing GHG emissions in the transport sector, is certainly necessary but not sufficient to meet the 2°C scenario and fully address the challenges of the explosion in urban mobility, especially in the cities of the Global South, and in emissions caused by a business-as-usual scenario.

A 2012 study by the IEA showed that even if technologies such as the plug-in hybrid electric vehicle (PHEV), the battery electric vehicle (BEV) and the fuel cell electric vehicle (FCEV) reached a 30% market share per year in global sales of light vehicles by 2030, actions to control demand and to deliver modal shift would be necessary[25].

Moreover, improving the carbon footprint of vehicles through technology cannot resolve problems to do with congestion and living environment.

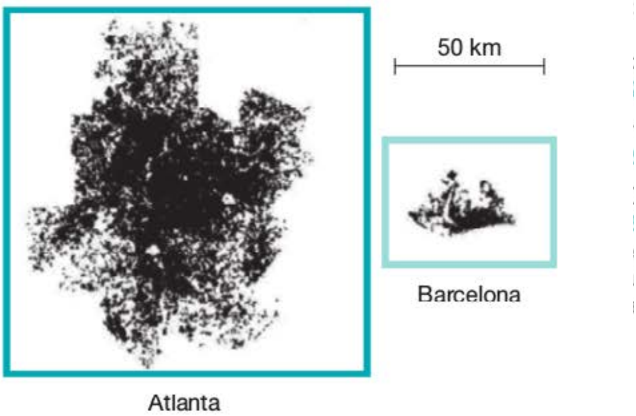
The "Avoid, Shift, Improve" (ASI) approach, which goes beyond these limitations, aims to be holistic and pragmatic, by combining actions over different timescales. Urban-planning actions are indeed a long-term challenge: rooting urban development in a model that depends to varying degrees on private transport, while facilitating a shift to active and collective modes.

25. IEA (2012), Energy Technology Perspectives: Tracking Clean Energy Progress, OECD/IEA, Paris.

2.1 Avoid – Control growth in the number of kilometres travelled

The economic prosperity of a metropolitan area does not necessarily depend on its car ownership rate or on the number of kilometres travelled daily by its residents. Metropolitan areas with equivalent GDP levels may have economies that vary in intensity of journeys, which may in turn, depending on transport modes, be high GHG emitters.

Newman & Kenworthy (1989) proposed a comparison of urban forms in North America, Europe and Asia to describe car dependence. This seminal work highlighted the link in metropolitan areas between population density and energy consumption. On this theme, one of the most representative images is the comparison of the metropolitan areas of Atlanta and Barcelona. With an equivalent population, Atlanta's metropolitan area is 26 times larger than that of Barcelona. The Georgia state capital, which is heavily car-dependent, shows a level of CO_2 emissions from travel 10 times higher than in the capital of Catalonia.



ATLANTA	BARCELONE
Population 5.25 million	Population 5,33 million
Urban area 4280 km^2	Urban area 162 km^2
CO_2 emissions 7.5 tonnes per hectare per year (public+private transport)	CO_2 emissions 0.7 tonnes per hectare per year (public+private transport)

Figure 7: Comparison of the urban forms of Atlanta and Barcelona [26]

26. Source: Bertaud, A. (2004). The spatial organization of cities: Deliberate outcome or unforeseen consequence?

Urban forms related to the history of cities

Urban forms result from a long history, during which phases of demographic and economic growth give structure to metropolitan areas. Transport-system infrastructure plays an essential role in this dynamic.

European cities developed from a pedestrian model inherited from the Middle Ages, then along railway routes in the 19th century, and in the 20th century around roads developed for car traffic. Accordingly, they are often built around a dense centre with a pedestrian core, surrounded by an inner ring served by public transport networks, which is itself surrounded by a low-density periphery devoted to cars. Given the star structure of rail networks, some areas of the outer ring may also have good public transport provision. In the city centre of these metropolitan areas, walking and public transport may have very high modal shares; but the further you go from the centre, the greater the share of car journeys.

North American cities, with their more recent urban legacy, have developed more quickly around motorised transport modes that give easy access to the periphery. More than elsewhere, the increase in travel speeds has caused a constant fall in city density and a dependence on cars. Moreover, these cities often have a concentration of jobs in the central business district, whereas the population lives on the periphery. In these cities, the car is the dominant transport mode and many people use it to travel more than 60 km per day. High geographic scatter of businesses prevents the use of slower transport modes – so much so that public transport provision is very often unsatisfactory in service terms, or even non-existent. Public transport is marginalised and, ultimately, intended only for people who cannot drive or afford to drive (the elderly, children, deprived people).

Cities in developed Asia have even higher density levels than in European metropolises, but their GHG emissions are even lower. They are built around efficient public transport systems, which historically have sought to optimise land use near stations in order to make investments profitable. In Hong Kong and Japan, metro networks have given structure to cities. Development of the road network has been highly constrained, and does not have the same capillarity as in Western cities.

Cities in developing countries are evolving in ways that differ greatly from the types of city mentioned above. Although there is no standard profile, these cities have certain common characteristics: high demographic and economic growth entailing often uncontrolled urban development. Transport systems, which in many cases did not exist several decades ago, are trying to achieve structure but are often outstripped by the pace of transformation that their cities face.

BOX 1

Growth of CO_2 emissions in Chinese cities

During the past three decades, metropolitan areas in China have developed very quickly, albeit without identical urban growth. The urban forms and mobility systems of Shanghai and Beijing have followed very different trajectories.

In the late 1980s, car ownership was very low in both metropolitan areas, and most journeys were made on foot or bicycle. Beijing, whose metropolitan area is laid out in concentric circles, embraced China's industrial policy of car promotion in the mid-1990s. Conversely, Shanghai, which had an urban legacy of much higher density and a polycentric development model, sought very early on to develop its public transport while discouraging people from buying cars, by making them more expensive[27]. In 2013, Beijing and Shanghai had 250 and 100 cars per 1000 inhabitants respectively.

Their urban forms have evolved accordingly. During the 2000s, Beijing built a sixth ring road 15-20 km from the city centre. This road is already congested, but has had the effect of fostering the urbanisation of farmland on the periphery. Journey distances in the Chinese capital are thus longer than in Shanghai, whose population density is nearly twice that of Beijing.

The figure below shows the consequences in terms of GHG emissions in the transport sector. Beijing has seen a very large rise in private car use, causing very rapid growth in CO_2 emissions per resident. From 1993 to 2006, the level of emissions per resident more than doubled in the capital. However, in 2006, Shanghai had a level of emissions per resident equivalent to that of 2002… which was roughly Beijing's 1993 level!

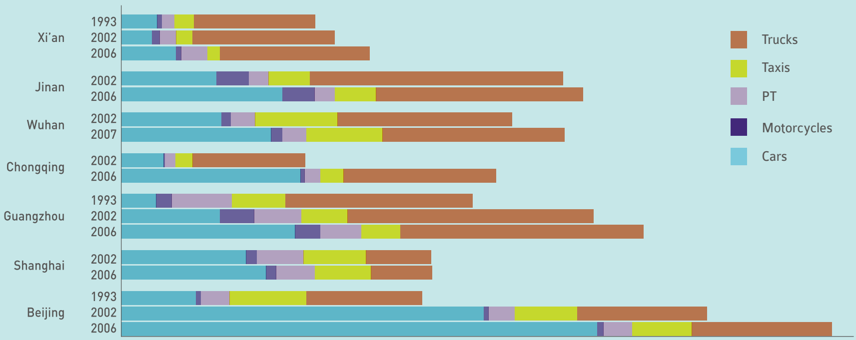


Figure 8: Annual per capita CO_2 emissions in urban areas[28]

27. In 1986, Shanghai introduced a registration-plate auction system based on the Singaporean model. Involving very high prices until the late '80s, the system was then reformed under central-government pressure to lower the asking price; as a result, more cars were sold in one year than in the previous 15 years.

28. Source: Darido and al. (2009)

Levers for action to shape the urban form

Urban forms are defined by various elements that are determining factors in the energy intensity of the transport system. The mobility of people in urban areas is one way to access urban functions (housing, jobs, shops, businesses, etc.), and urban form directly influences access to these functions. If we characterise it by its "3 Ds" - density, diversity, design[29] - we see that, by acting on each component, it is possible to substantially transform urban-mobility practices and to facilitate the use of a given transport mode.

In order to promote a city that is more economically and environmentally efficient and socially fairer, the challenge is thus to implement integrated planning of city and transport so as to control and guide urban mobility on three scales:

- **At living-area level,** i.e. on long-distance journey scale, spatial planning seeks to promote a mix of uses. To do this, it creates a hierarchy of transport networks (road or rail), and controls land use in order to control urban development.
- **At the level of the existing public transport network**, i.e. on medium-distance journey scale, Transit Oriented Development (TOD) seeks to influence urban density. It chiefly works by urbanising along lines and around stations, in order to facilitate the use of public transport and to limit car use.
- **At neighbourhood level**, on short-distance journey scale, the idea is to improve city design. By judiciously planning public space along main arteries and around the existing network of public transport stations, walking and cycling is made easier and the need for car travel is reduced. In Mexico, this approach is preferred for redeveloping districts around public transport stations (*Desarollo orientado al transporte sustentable*).

However, these approaches to multi-scale integrated planning encounter numerous barriers, such as institutional fragmentation and separate "urban planning" and "transport" cultures. The challenge is thus to blend these cultures, in order to develop and share the core vision of a sustainable future urban structure.

Other possible measures to reduce the number and distance of journeys

Shorter-term measures may be taken to reduce both the number and distance of daily journeys. Employees' lunch potentially generates extra journeys. If companies run a workplace catering service, this can avoid the need to drive home to eat. Likewise, running school transport both ensures safe travel for children and reduces the number of journeys made by parents and the number of kilometres travelled by private cars.

29. Ewing, R., & Cervero, R. (2010). Travel and the built environment: a meta-analysis. *Journal of the American Planning Association*, *76*(3), 265-294.

In some business activities, teleworking reduces travel. By working from home or in a shared office space in their neighbourhood, an employee saves time by cutting daily travel distances. Information and communication technology can also offer many prospects in this area. Mobile telephones and online services can reduce the need for mobility, especially in less advanced countries where transport provision is limited, or in cities with congested roads. However, due consideration must be given to the impact of a person not travelling. This may sometimes generate other transport activities, particularly involving good delivery, and which use more energy.

2.2 Shift / Maintain – Promote the use of transport modes that consume less energy

The share of each transport mode depends on a large number of metropolitan-area parameters including size, geography, density, spatial organisation, development level and car ownership; quality of road infrastructure, spatial coverage, levels of public transport coverage and service quality, etc. Modal shares often reflect the long-term policies conducted in metropolitan areas.

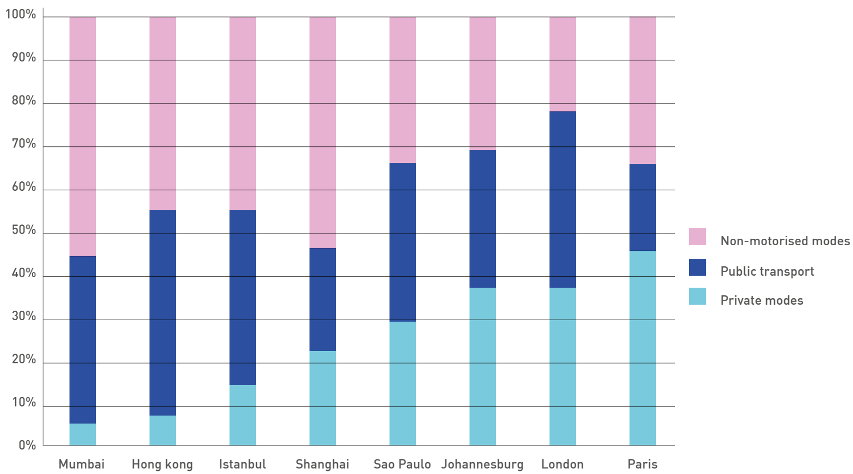


Figure 9: Modal shares in various metropolitan areas[30]

Moreover, modal shares can vary greatly between parts of a metropolitan area. As shown in Figure 10, in Paris the use of active modes and of public transport is far higher in the centre of the metropolitan area than on the periphery. Analysis of travel in the Ile-de-France region shows that journeys to Paris from the inner and outer rings are made mostly on public transport (71%), while a majority of periphery-to-periphery journeys (about 60%) are made by private vehicle.

30. Source: Enquête nationale transports et déplacements (2008). Note: the Paris data are those for the Ile-de-France region, where the city is located; the Shanghai modal shares are those for the city. Data compiled by LTA Academy in the Journeys journal, Issue 7, November 2014 http://lta.gov.sg/ltaacademy/doc/J11Nov-p60PassengerTransportModeShares.pdf

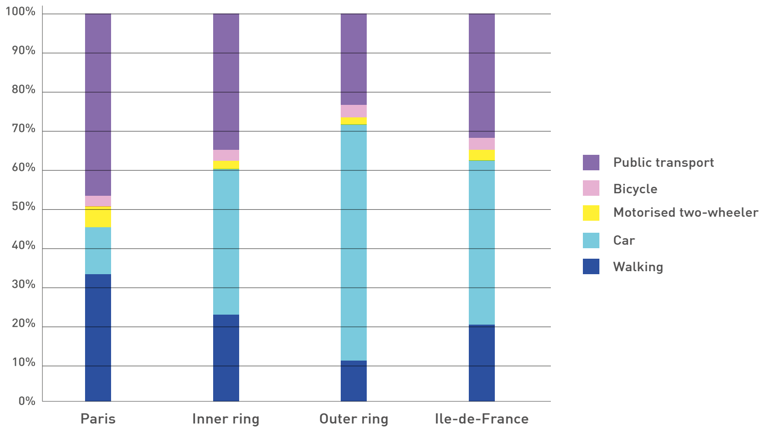


Figure 10: Modal shares in the Paris metropolitan region, by area of residence[31]

In order to develop modal-shift policies through tailored measures, it is thus important to properly understand mobility behaviours across the region.

The policies in the "Shift" section aim to shift journeys made using private motorised modes to public transport and active modes (the so-called "modal shift"). For countries where the car ownership rate is still low, and where public transport and walking still comfortably hold a majority share, the idea is to maintain use of transport and to promote alternative modes instead of cars and motorised two-wheelers, while restricting use of these latter two categories. To help achieve this, various measures can be taken:

- incentive measures: these aim to attract users (or potential future users) to public and active transport modes by offering them a credible alternative, through reliable, competitive public transport services and good facilities for cycling, walking, etc.
- coercive measures: these discourage the use of private cars and motorbikes.

Incentive measures: investing in low-carbon modes (public or active)

The purpose of these measures is to make the transport modes that use the least energy and emit the least GHGs more attractive to residents. As shown in Figure 11, the main idea is to promote use of public transport and active modes, which also take up the least space.

31. Source: Caenen et al. (2010)

	Mixed Traffic	Regular Bus**	Cyclists	BRT single lane	Pedestrians	Light Rail	Suburban Rail
Corridor capacity (people/hr)*	2 000	9 000	14 000	17 000	19 000	22 000	80 000
Energy intensity (MJ/p.km)	1.65-2.45	0.32-0.91	0.1	0.24	0.2	0.53-0.65	0.15-0.35
Fuel	Fossil	Fossil	Food	Fossil	Food	Electricity	Electricity

* on 3.5m wide lane in the city

** Regular bus lower values correspond to Austrian busses, upper values correspond to diesel busses in Mexico City before introduction of BRT system.

Figure 11: Corridor capacity of transport modes, and energy consumption per user[32]

To develop the use of active modes, it is advisable to offer travelling conditions that ensure a good level of safety and comfort. In many developing cities, the absence of pavements, or their poor quality and use for functions other than pedestrian travel (parking, shops, etc.) actually encourages the use of motor vehicles, even for short journeys. Cyclists are rarely considered, and find themselves in traffic. Likewise, complicated crossing of road infrastructure can strongly deter people from walking and cycling. The absence of suitable facilities makes these transport modes dangerous and encourages the use of cars and motorbikes.

To attract people to public transport, the idea is to offer spatial coverage of the metropolitan area (line routes and density) and an adequate level of provision (frequency, capacity) to ensure good quality of service (comfort, user safety, commercial speed, timetable reliability), and to charge affordable fares.

In large metropolitan areas, the development of networks of high-capacity public transport infrastructure, whether rail transport (urban/suburban trains, metro, light rail), public transport corridors on dedicated lanes (tramways, Bus Rapid Transit - BRT), or even cable-operated urban transport, is viewed everywhere as a necessary, efficient means of offering a credible alternative to private motorised modes.

In industrialised countries, such networks historically predated the advent of the private car: suburban railways developed in the 19th century, soon followed, in the early 20th century, by the first underground metros[33]. In the emerging and developing worlds, the first metros appeared in large metropolitan areas during the 1970s-'80s, but this mode has really taken off since the late '90s, with many projects in Latin America, Asia and the Middle East. In parallel, dedicated lane public transport networks have become commonplace: modern tramways and BRT in the mid-sized

32. Source: Asian Development Bank

33. In London (1863), Paris (1900), New York (1904), Tokyo (1927), Moscow (1935).

cities and suburbs of Western Europe, but also BRT in the big cities of the Global South.

All these projects help to promote public transport use and to shift people from private cars, and thus to reduce GHG emissions. The inclusion of some of these projects in the Kyoto Protocol's Clean Development Mechanism (CDM) provides visibility on the GHG emissions avoided by this infrastructure[34]. Figure 13 shows the direct impact in tons of CO_2 of the BRT projects in Latin American and Chinese cities. There is great variety in terms of infrastructure length and user numbers. This estimate of the CO_2 impact of these projects depends on BRT capacity and user numbers, but also on the origin of modal shift (this could be from walking, existing public transport modes, or private vehicles with low occupancy). The BRT projects under consideration allow savings of between 30,000 and 150,000 tCO_2eq with the latter order of magnitude corresponding to very high-capacity systems (China, Bogota…).

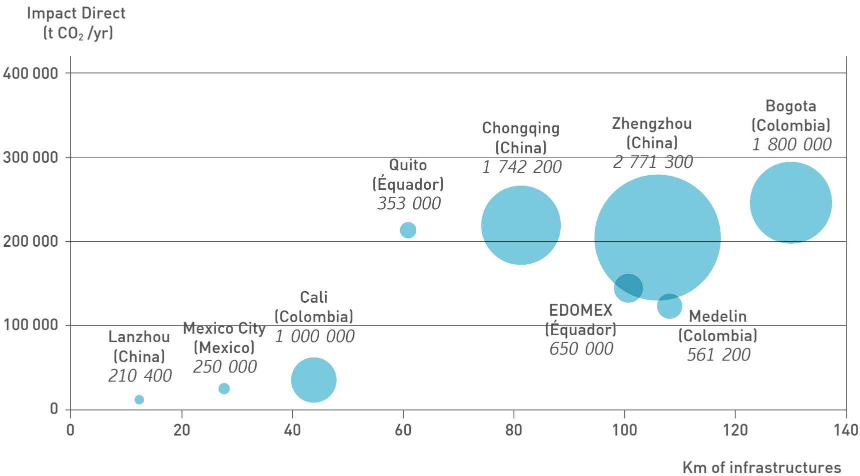


Figure 12: Annual reduction in CO_2 emissions for a selection of projects included in the CDM[35]

To promote modal shift, it is important for users to have good quality of service a along the trips made. Mass transport alone cannot provide an efficient, complete system of public transport, able to offer a credible alternative to the car on metropolitan-area scale. The overall efficiency of a public transport system also depends on the level of service provided by lower-capacity modes (buses, minibuses, taxis), and how they mesh with the high-capacity modes.

34. The CDM methodology for these pieces of infrastructure takes account of mobile-source emissions. It does not include emissions due to infrastructure construction, unlike Life Cycle Analysis.

35. Source: TEEMP

It is thus essential – for buses, paratransit minibuses, and taxis – to provide attractive provision (geographic coverage, frequency), quality of service (safe, comfortable, modern rolling stock) and fares. This demands spatial planning and effective regulation of transport provision; adequate funding for rolling-stock operation, maintenance and renewal; and thus a suitable institutional framework.

It is also essential to organise the system to inter-connections, by means of station design and fare integration. This presupposes close co-operation among operators and transport authorities; and that the authorities are capable of planning provision of the various modes in an integrated way.

BOX 2

The building of public transport infrastructure generates emissions

Civil-engineering work and the production, transport and installation of the equipment needed to build a piece of transport infrastructure naturally emit GHGs. GHG emission savings during the operating phase must be able to offset emissions released during the build phase, and actually achieve net savings.

The methodology developed by the Global Environment Facility (GEF) – Transportation Emissions Evaluation Model for Projects (TEEMP) – proposes values of tons of CO_2 per kilometre of infrastructure built (see Table 3).

	Tons of CO_2/km
BRT system	1 390 - 3 475
Metro (assumption: 80% over-, 20% underground)	7 119 – 19 487
Railways (metal and concrete only)	875 – 1 500
Roads (4 lanes)	1 100 - 2 400
Cycling lane	Approx. 20

Table 3: CO_2 emissions due to infrastructure building[36]

However, these data remain highly dependent on the maintenance and renewal required by these types of infrastructure. Although heavier modes (metro, in particular) are the highest emitters during construction, they have a longer life expectancy and their cost, in terms of emissions, can be spread over more years.

36. Source: TEEMP

BOX 3

The metro in Santo Domingo, a means for wider change

The city of Santo Domingo (population: 2.5 million) is facing acute problems of road-network congestion, aggravated by a car population that is largely old (75% are more than 15 years old) and thus highly polluting; insufficient parking; and many defects in the water-removal system, in a country regularly subject to heavy rainfall.

To meet these challenges, the Dominican Republic's capital equipped itself in 2008 with a first metro line, 14.5 km long. The second line (12.8 km, underground, 14 stations) opened in April 2013. Costing $830 million in total, the project was part-funded by the AFD with a $230 million loan. The metro network offers quality service, running every three minutes at peak times. In 2014, this second line had an average 210,000 passengers per day. Over the project lifetime, modal shift from cars, but also from buses, to the metro will deliver savings of 32,000 tCO_2eq per year.

This project, however, is part of a wider policy to integrate the public transport system with urban-development policy, which should further reduce mobility-related GHG emissions. The Dominican authorities plan to extend metro line 2 by four kilometres, as well as building a line of urban cablecars and clearing a slum in the area. They have begun a study to capture increased property values and to design the public spaces around the stations.

Through its funding, the AFD is a partner in these various initiatives, which confirm Santo Domingo's proactive policy of developing mobility and urban-development models that are credible alternatives to carbon-emitting modes.

Figure 13: Santo Domingo metro

BOX 4

Lagos BRT: an integrated approach

With more than 21 million residents, Lagos metropolitan area is now the biggest city in Sub Saharan Africa and Nigeria's business capital. In 2008, demand for motorised urban transport (excluding the port and airport, which handle more than 70% of the country's goods) was provided by private minibuses (75%), buses (10%), private vehicles (5%), taxis (5%) and two-wheelers (5%). Over the years, urban congestion has become a major issue, affecting the cost of product manufacturing and distribution as well as residents' quality of life. Under the impetus of a very dynamic governor, the Lagos Metropolitan Area Transport Authority (LAMATA) was set up in 2002. Within a few years, LAMATA was able to draw up a comprehensive strategic vision and to take the right steps to address the city's real transport needs and coordinate the activities of the various entities in charge. LAMATA thus began the preparation of a long-term transport master plan, which includes BRT corridors and two urban heavy metro lines. Moreover, LAMATA has rationalised the management of a motor-vehicle tax; upgraded more than 600 km of roads and four ferry jetties; implemented a BRT pilot project called "BRT-Lite" by mobilising the national drivers' federation; and, lastly, helped bring about real change in users' behaviour and their opinion of bus transport.

Phase one of BRT-Lite is the first operational example in Sub Saharan Africa of an integrated approach to improving public transport and has been a technical, economic and social success: 30% shorter journey times, 50% reduction in accidents, and a reduction in CO_2 emissions and pollution. This first phase, in terms of infrastructure, involved building work for a dedicated, lower-cost 23 km BRT line.

The AFD and the World Bank are co-funding the extension of the BRT line, with a total of $235 million. The extension project (+13.5 km) includes more substantial structures than in phase one (road structures and footbridges). Its entry into service, scheduled for summer 2015, should ultimately allow nearly 300,000 passengers per day to be carried; increase the modal share of buses to 20%; reduce minibus congestion; and lastly, avoid about 20,000 t CO_2eq per year upon entry into service, and ultimately almost 50,000 t CO_2eq per year.

Figure 14: The BRT-Lite system in Lagos

BOX 5

The Rabat-Salé tramway network

The construction of the Rabat-Salé tramway was part of a programme of sustainable urban-transport development in the metropolitan area, which has a population of 1.9 million residents, and also of a comprehensive programme to develop the Bouregreg river valley separating Rabat and Salé. In May 2011, two tramway lines entered service: a piece of infrastructure 20 km long with 31 stations and a new bridge over the Bouregreg, costing €343 million in total. The project was 50% self-funded by the Société de Tramway de Rabat-Salé (STRS), together with funds from Rabat municipality and a contribution from donors (the AFD with a €45 million loan, but also the French government, the European Investment Bank, and the European Union). With a frequency of about eight minutes and a commercial speed of 17.4 km/h (versus an initial target of 19 km/h), line 1 now offers users an appreciable level of service.

In 2014, the two lines reached 130,000 passengers/day, i.e. 33 million passengers over the year. Thanks to this high traffic, project revenues covered operational exenditures, but challenges remain: use, though growing, is still too concentrated on certain sections and on peak times; and coordination with buses and taxis must be improved. Projects to extend the network and improve operations will help to remedy these issues.

The carbon balance of the project, upon entry into service, had been estimated in advance at 23,000 t CO_2 eq/year. However, given that user numbers are still 40% below initial forecasts, the impact is very likely lower. In the long term, the order of magnitude of 30,000 t CO_2eq/year avoided looks achievable.

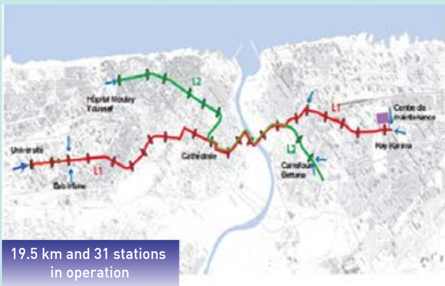


Figure 15: Map and photo of Rabat-Salé tramway

Coercive measures: regulating and limiting private-car use

Coercive measures, intended to reduce the appeal of private transport modes, are driven by a desire to fight congestion, improve quality of life, and limit GHG and pollutant emissions. Local and national governments can use regulatory, planning and tax instruments to deter the use of private motorised modes.

Regulatory measures may be very useful in controlling car use. Some examples:

- **Reducing speeds** in urban areas can have a direct impact on GHG emissions. It can also reduce the appeal of cars, by increasing journey time compared to other modes.
- **Introducing low-emission zones**, i.e. limiting, by regulatory means, access to certain districts to vehicles that emit low levels of GHG emissions and air pollutants, as in some German and Swedish cities, for example. Such zones have a clear impact on emissions, but the gradual renewal of the vehicle population tends to limit the effect of this measure over time.
- **The introduction of road-space rationing** is another existing measure, originally devised as an occasional solution to deal with pollution spikes in highly polluted cities. But some cities, such as Mexico City and Sao Paulo, where authorised pollution thresholds are repeatedly exceeded, have deployed the measure on a permanent basis.
- **Congestion pricing** in London, Singapore and Milan. In the case of Milan, implementation of the Area C urban toll caused a drop in traffic that yielded a reduction in air-pollutant and CO_2 emissions of 20-30% between 2010 and 2013. This change was also recorded in the city's other districts, showing that a fall in car travel affects the whole city, and that there is no mass shift in car travel to other parts of the city.
- **Registration licences:** in China, a growing number of cities are opting to control the number of private cars (lottery system, auctioning-off "motoring permits", mixed system) to fight air pollution and congestion. These measures are helping indirectly to mitigate GHG emissions and air pollutants[37].

Parking policies are an important modal shift lever. Car use depends heavily on the ease of finding a parking space, at journey start and end points.

- **The effect on car ownership:** in Paris, low parking capacity in the city centre may reduce ownership by 10-30%, since there is efficient public transport provision[38]. Planning documents can thus opt to limit parking in certain urban areas in order to restrict car use. In Tokyo, the link between car ownership and parking is even closer: owning a car is prohibited if one cannot prove that a parking space is available.

37. More further details, see OECD Transport Outlook 2015.

38. Rennes G., & Orfeuil J. P. (1997), Les pratiques de stationnement au domicile, au travail et dans la journée. *Recherche, transports, sécurité*, (57), 21-35.

- **Price of parking based on the level of emissions:** Between 2007 and 2010, in the municipality of Richmond, southwest London, a residential parking-permit system was introduced, based on CO_2 emission levels of vehicles. Within a few years, the proportion of permits issued to the most emission-intensive vehicles fell (from 16% to 13%) and that of the lowest-emission vehicles rose (25% to 32%). This type of policy remains in force in other parts of London, but Richmond's new municipal council has, since the local elections, abolished the scheme[39].
- **Valuing parking space:** the "cash-out" system in California involves giving employees the choice between a sum of money and a parking space. According to a study, the demand for commuting-related parking was reduced by 11%, resulting in a 12% drop in CO_2 emissions[40].

Taxation policies are used in many countries to discourage the use and/or purchase of private vehicles. Through taxes on fuel, and on buying or owning vehicles, etc., the authorities can raise the cost of car and/or motorbike use.

- **Fuel taxation:** countries where fuel is strongly subsidised encourage car use and do not promote the development of alternative provision. In countries on the right-hand side of Figure 17, taxation deters the use of private motorised-transport modes. It should be emphasised that some countries directly allocate tax revenues to help fund public transport. In Colombia, for example, motorists pay an extra tax of up to 25% for petrol and up to 8% for diesel. This resource, intended mainly for local-level funding, earned the Colombian authorities nearly €250 million in 2012. This extra tax on fuel financed 20% of investment in the first three TransMilenio lines.
- Ma**king vehicle ownership more costly:** in Japan, car owners must pay an annual tax of €75-€385. The amount depends on the power of the vehicle. The same applies in Denmark, where owners must also pay a tax when buying a new vehicle. Congestion charges and registration permits (covered above) also help to raise the cost of using or buying vehicles, in order to deter motorists.

It is essential to link coercive and incentive measures in order to maximise efficiency. These must allow the creation of a multimodal transport system that meets residents' mobility needs. Making private-car use more difficult and costly will only be effective and accepted by the population if reliable, efficient alternatives are available. Moreover, public communication campaigns are necessary when introducing such policies in order to foster understanding and acceptance of the measures.

39. Kodransky M. & Hermann G. (2011), Europe's parking U-Turn: from accommodation to regulation. *Institute for Transportation and Development Policy*. http://dcba.ie/wp-content/uploads/temp/2012/04/European_Parking_U-Turn.pdf

40. Shoup D. (1997), Evaluating the effects of parking cash out: eight case studies, Transport Policy, Vol.4, No.4, pp. 201-216, 1997.

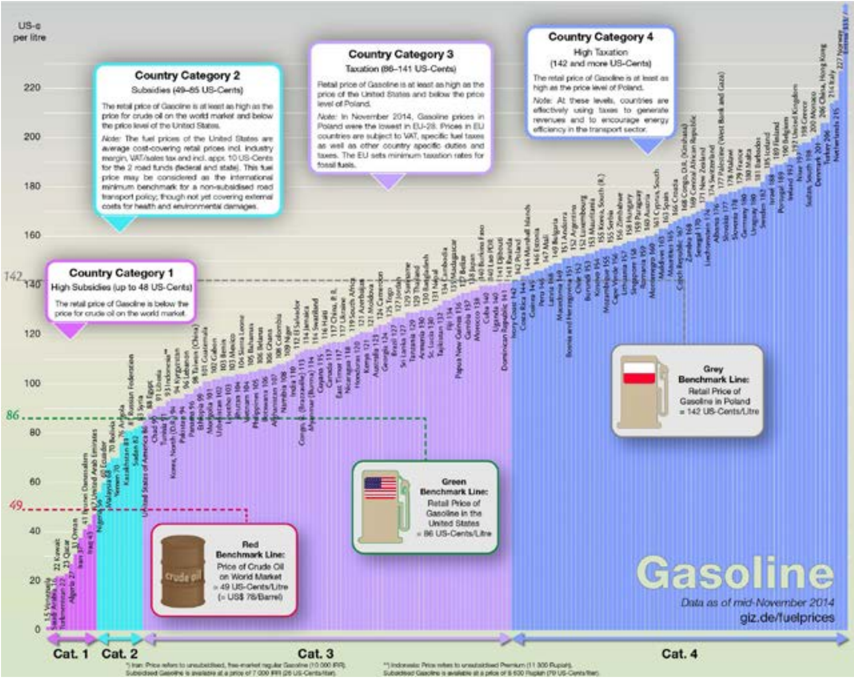


Figure 16: Global comparison of the price of petrol per litre[41]

BOX 6

The TransMilenio BRT in Bogotá: an illustration of Shift through a mix of coercive and incentive measures which led to a reduction in GHG emissions

Opened in 2000, the TransMilenio in Bogotá has integrated into the city's transport system and now totals nearly 110 km of lines operated by nearly 2,200 buses carrying 2.2 million passengers per day. This Bus Rapid Transit – high-capacity buses running in dedicated lanes – was introduced to address high congestion, air pollution well above WHO-issued maximum thresholds, and recurrent safety problems.

The BRT network now allows travellers, for a reasonable price, to save nearly 40 minutes per journey compared to travel time in a private car. As an integral part of a Shift policy, the network was created to reduce private-car use and to shift travel to public transport and active modes. The introduction of this BRT network was accompanied by a set of coercive and incentive measures. The coercive measures include road-space rationing at peak times, a scheme introduced in 1998 (*pico y*

41. Source: GIZ - International Fuel Prices 2014, www.giz.de/fuelprices

placa); an extra tax on fuel that helps fund public transport; and one car free day per week, following public consultation. Though symbolic, this latter measure is important in gaining user acceptance, and raising citizen awareness, of problems related to urban mobility.

Among the incentive measures that supported execution of the project, it is worth mentioning the construction of 350 km of cycling lanes and nearly 1,500 bicycle parks, which helped dramatically boost the modal share of bicycles (from 1% to 7% between 1995 and 2010). Moreover, the project was supported by a policy of building many parks and spaces devoted to active modes, designed to green the urban environment and return it to pedestrians and cyclists.

Awareness-raising campaigns were run to promote BRT acceptance by the population, with the creation of the *Ciclovia* programme: every Sunday during the day, 120 km of streets are closed and given over to active modes.

Although critics have pointed out the large area of land occupied by the network, its poor coverage of more deprived areas, and the time taken to connect between the BRT and the traditional bus lines, the fact remains that the BRT and all the measures in support of its introduction have played a big role in cutting road congestion and reducing GHG emissions (by nearly 250 kt CO_2eq per year) and air pollutants (more than 60 kt of nitrogen/sulphur oxides and fine particulate matter), according to measurements done between 2006 and 2009. Other local benefits are also worth noting: the creation of jobs, the improvement of gender equality in access to employment, a rise in road safety, and a drop in noise pollution in the city.

Bogotá is maintaining its efforts to make a cleaner, lower-carbon city, and recently announced its intention to replace all its diesel buses by hybrid and electric models by 2024; and to launch a pilot project on electric taxis.

2.3 Improve – Enhance trip efficiency

Improving the energy efficiency of trips involves various components: **travel management, improving occupancy rates, and improving the energy performance of vehicles**. The latter point covers incremental technological advances as well as step-change scenarios based on new energy vectors.

Traffic conditions and occupancy rate

According to the Asian Development Bank[42], **traffic management** can reduce GHG emissions by 20%. Through techniques to make traffic more fluid and to reduce congestion, energy consumption can thus be greatly cut.

Occupancy rate is a major issue for private cars. In most countries with a high car-ownership rate, car journeys are made by one person. The average occupancy rate in Europe is 1.2 people per vehicle. Increasing the number of passengers would thus heavily reduce the energy footprint of trips. That is the objective of policies to encourage ride-sharing. We can cite the High Occupancy Vehicle (HOV) lanes in the United States, reserved for vehicles shared by two or three occupants; parking areas to promote ride-sharing; and online platforms to match drivers and passengers.

Occupancy rate is also crucial for public transport and goods transport. Regarding public transport, the idea is to adapt vehicle size to mobility demand. If, on the periphery of a metropolitan area at off-peak times, a standard bus runs with fewer than eight passengers, the level of emissions per kilometre per person is higher than that of a lone motorist in a small car. Integration of the public transport system is thus also an energy-efficiency issue.

Urban goods transport is probably the least-documented topic, yet accounts for no less than one-quarter of CO_2 emissions across all urban traffic[43]. In the city of Paris, emissions from goods transport are as high as those from passenger transport (1.75 $MtCO_2$ per year). According to a study done in Dijon, France, consumption of fuel by goods transporters is particularly high during the morning rush hour, representing 25% of vehicle-kilometres but 36% of fuel use[44]. Better traffic management, with goods-traffic regulation in particular, is thought to help reduce GHG emissions and pollutants from urban logistics. Some cities are also seeking to promote pooling of goods flows by setting up urban logistics hubs, which act as interfaces between inter- and intra-urban operations, thus optimising vehicle loads.

42. ADB (2010), Reducing Carbon Emissions from Transport Projects, ADB Evaluation Study, Reference Number: EKB: REG 2010-16, July 2010.

43. Dablanc, L. (2009), Freight Transport for Development: Toolkit: Urban Freight, Transport Research Support, 57 p.

44. Dablanc, L. (2007). La notion de développement urbain durable appliquée au transport des marchandises. *Les Cahiers scientifiques du transport*, 51, 97-126.

Improving the energy performance of vehicles

In the IEA's view, the biggest contribution to GHG reduction in the transport sector (both urban and long-distance transport) must come from this component, thanks to technological advances in vehicles and the development of new industries. Cars are central to all strategies designed to improve the energy efficiency of transport. However, there is also potential for improvement in public transport fleets (hybrid and electric buses), goods-transport vehicles, and development of motorised two- and three-wheelers (electric scooters and E-bikes).

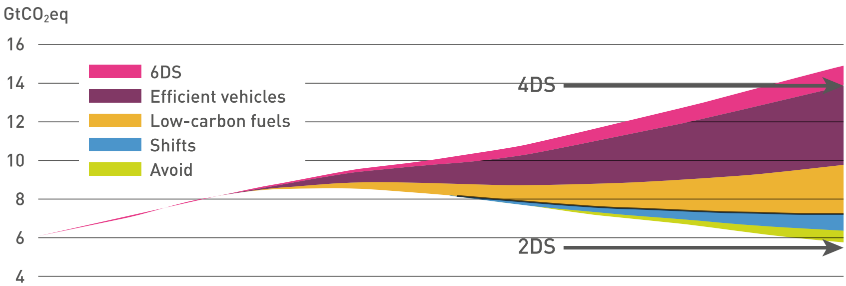


Figure 17: The IEA's scenario to switch from the 4°C scenario to the 2°C scenario[45]

Realisable potential for fossil-fuel vehicles

Non-OECD countries, where the vehicle population is growing very quickly, rarely have national emissions standards that allow vehicle energy use to be limited or regulated. The GFEI (Global Fuel Economy Initiative), which proposes to halve the unit consumption of cars by 2050, offers support in drawing up such regulations. Current trends show a 2% annual improvement in vehicle efficiency between 2005 and 2013. This progress remains well below the 2.7% annual improvement required to meet the GFEI-proposed target.

However, it is especially difficult to renew the oldest vehicles, which are often owned by the lowest-income motorists. In developing countries, in particular, the vehicle population may be especially old and very high-energy consuming. Some countries are taking drastic measures to reduce imports of second-hand vehicles. Take Gabon, where in 2014 the government banned imports of vehicles more than three years old. The introduction of this restriction was not very well received by the population and second-hand car dealers: only 5,000 new vehicles used to be sold annually, versus 15,000 to 20,000 imported second-hand vehicles.

45. Source: International Energy Agency (2012). Energy Technology Perspectives 2012; IEA: Paris, France, 2012.

Renewal programmes may also be conducted for public transport vehicles[46], taxis, etc. In Cairo, owners of taxis more than 20 years old who pledged to send their old vehicle for scrap enjoyed reductions of 25%-30% on the price of a new vehicle. Some 17,000 taxis were replaced in 2009, thus avoiding 57,000 tons of CO_2eq[47].

European standards have sometimes been adopted by other countries. These standards set pollutant-emission caps for the vehicle population, but do not directly concern emissions. These are covered by a programme that monitors average specific emissions of CO_2 by new private vehicles[48].

In the United States, the CAFE (Corporate Average Fuel Economy) standards were introduced in 1975 to reduce consumption by vehicles sold on the American market. These standards impose an average consumption level for all the vehicles that carmakers sell.

Although these standards changed the vehicles sold in the United States[49], the fact remains that average consumption per vehicle in Europe and Japan is far lower. This is due primarily to the price of fuel, which is much higher than in the United States. The CAFE standards evolved recently, now requiring carmakers to achieve an average of 4.36 l /100km in 2025, i.e. about half the current level.

In France, a bonus/penalty system was introduced in January 2008 to quicken market penetration of lower-energy-consuming vehicles. Buyers of the higher-consuming new vehicles must pay a charge (penalty), which enables a bonus to be paid to buyers of lower-consuming vehicles. This mechanism, which was meant to be financially neutral, has actually cost the French government €1.4 billion. However, as shown in Figure 18, it has changed the characteristics of new vehicles sold. Owing to the budgetary imbalance of this measure, the thresholds were changed in 2014 and an annual penalty was created for vehicles bought after 2009 and which emit more than 250gCO_2 /km.

Reducing unit consumption of vehicles is thus within reach, if only by making vehicles smaller and lighter. In Europe, where vehicles are already smaller than in the United States, the view is that the fall in fuel consumption can be quickened by reducing the average weight of vehicles. A drop of about 10% in the weight of fossil-fuelled vehicles would achieve a 7% fuel saving (EEA, 2006). Reducing vehicle power may also give highly encouraging results.

46. One example is the Cars Rapides minibuses in Dakar, in 2003.

47. ESMAP, Cairo Case Study: Cairo, Arab Republic of Egypt - Taxi Scrapping and Recycling Project, May 2010.

48. Decision No. 1753/2000/CE of the European Parliament and of the Council of 22 June 2000.

49. Assuming carmakers do not cheat in the anti-pollution tests. (cf. Volkswagen scandal)

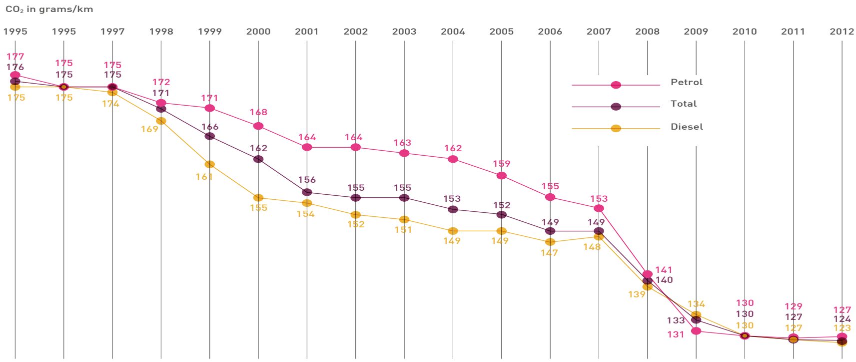


Figure 18: Average CO_2 emission rates of new vehicles sold in France from 1995 to 2012[50]

Promoting new industries

In Brazil, **agro-fuels** are massively used, whereas in other countries this avenue has been abandoned. Some studies show that the potential reduction in GHG emissions per kilometre travelled is high: between 30% and 90% compared to conventional fossil fuels (petrol and diesel). However, if the indirect emissions attributable to some agro-fuels are considered, their overall efficiency is sometimes lower than that of fossil-derived products. This avenue for improvement is therefore highly uncertain for first-generation agro-fuels[51].

Japan has adopted policies in favour of **hybrid vehicles**, taking the view that these allow fuel savings in the region of 35% relative to similar non-hybrid vehicles. More than 2 million such vehicles were sold in the country in 2012[52].

In China, the government is seeking to position the country as an **electric vehicle** leader. It is subsidising the industry to drive a technological revolution, and also offering car-buyers bonuses that vary according to battery capacity (from $440/kWh up to $8,800). To quicken the switch to electric, some local authorities are doubling the central-government subsidy offered to buyers.

50. Source: Ademe

51. Sims R., R. Schaeffer, F. Creutzig, X. Cruz-Núñez, M. D'Agosto, D. Dimitriu, M. J. Figueroa Meza, L. Fulton, S. Kobayashi, O. Lah, A. McKinnon, P. Newman, M. Ouyang, J. J. Schauer, D. Sperling, and G. Tiwari, 2014: Transport. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

52. International Energy Agency (2012). Energy Technology Perspectives 2012; IEA: Paris, France, 2012.

To measure relevance from energy and climate perspectives, it is necessary to use approaches such as "well to wheel", which, besides emissions from vehicle use, takes account of emissions from extracting and transporting the fuel that vehicles run on. In the case of electric vehicles, the national "electric mix" has a substantial impact on CO_2 emissions.

In France, due to the large share of nuclear in the energy mix, production of 1 kWh emits 110 g CO_2eq /kWh compared to 623 g CO_2eq /kWh in Germany[53], 771g CO_2eq / kWh in China and 912g CO_2eq /kWh in India[54]. The development of electric vehicles relative to fossil-fuel vehicles in China and India is not therefore necessarily yielding reductions in GHG emissions, at least while the electric mix in these countries has not been heavily rebalanced in favour of lower-carbon energy sources.

Hydrogen fuel is also heavily dependent on the energy mix, in the well-to-wheel approach. Studies have shown that, with the European energy mix, CO_2 emission levels were higher than for standard vehicles. By contrast, renewable natural gas shows a gain of 97%[55]. RNG is produced by processing gas derived from the degradation of organic matter (farm effluent, farming waste and coproducts, food waste, water-treatment sludge, etc.). The methane is isolated from the other components of the recovered gas, and can be used in vehicles.

Lastly, it is noteworthy that the use of purely technological solutions included in strategies to improve the energy performance of vehicles does not address all the challenges of sustainable urban mobility: road safety, fight against congestion, fair access to mobility, accessibility for deprived or isolated urban areas, etc.

53. Figures for 2012. WARBURG, Niels, et al. "Élaboration selon les principes des ACV des bilans énergétiques, des emissions de gaz à effet de serre et des autres impacts environnementaux induits par l'ensemble des filières de véhicules électriques et de véhicules thermiques, VP de segment B (citadine polyvalente) et VUL à l'horizon 2012 et 2020 [en ligne]." *Sl Agence de l'Environnement et de la Maîtrise de l'Energie. Available here: http://www2. ademe. fr/servlet/getDoc* (2013).

54. World Resources Institute (2015). GHG Protocol. Version 2.6.

55. ATEE (2014), Livre Blanc du BioGNV, http://atee.fr/sites/default/files/2014-06_livreblanc_biognv_0.pdf

BOX 7

The impact of changing fuel and technologies for auto-rickshaws (India)[56]

Auto-rickshaws, the three-wheel vehicles used daily by Indians for short journeys, have since the late 1950s compensated for inadequate public transport provision and also supplied the existing public transport system. Rickshaws often cover "the last kilometre" for bus and metro users. They are thus an essential part of urban-transport provision in India, and their manufacture has more than tripled in 10 years[57].

They now represent 80% of the total number of vehicles in circulation in India, and are thus chiefly responsible for emissions of hydrocarbons (HCs), fine particulate matters (PMs) and nitrogen oxide (NO_x), with a catastrophic effect on public health. Until 2001, most auto-rickshaws in service were vehicles with two-stroke engines: cheap and easy to repair, but known for their high HC and PM emissions.

In 2001, the Supreme Court in New Delhi required all auto-rickshaws to convert to compressed natural gas (CNG) or liquefied petroleum gas (LPG), and to install four-stroke engines. Four-stroke engines running on CNG make a substantial fuel saving and significantly reduce emissions of PM[58] and HCs. Moreover, CNG is 30% cheaper than petrol. These vehicles are recognisable by their green-and-white livery, as opposed to the black-and-yellow petrol-driven vehicles.

In the 2000s, stricter emission standards were added to the obligation to use CNG or LPG. In particular, these new standards required vehicles with two-stroke engines to be fitted with catalytic converters, to reduce CO_2 and HC emissions.

The imposition of CNG and LPG significantly reduced urban pollution, but is not however a sustainable option: CNG and LPG stations are expensive to roll out, and are limited to big cities. There are 527 across India, spread between 41 cities; Delhi has 188.

The latest innovation in reducing rickshaw pollutants comes from the manufacturer Bajaj, which has adapted direct injection to the two-stroke engine. Its vehicle design delivers a 30% increase in energy efficiency, while retaining a mechanically simple engine.

Lastly, in recent years electric rickshaws (e-rickshaws) have entered service in several Indian cities; nearly 40,000 are estimated to run in New Delhi. But these vehicles were banned in August 2014 by the Supreme Court in New Delhi, as there was no law covering their use. Once their use is regulated, e-rickshaws may be a useful alternative to fossil-fuelled rickshaws and make a significant contribution to reducing urban pollution levels, but their impact in terms of GHG emissions may be negative, given India's energy mix.

56. "Improving and upgrading IPT vehicles and services: a study", July 2014, IUT Delhi.

57. Annual production rose from 200,000 in 1999 to 610,000 in 2009 (ACMA 2011).

58. 0.015 g/km, i.e. three times less than vehicles with two-stroke petrol-driven engines (ARAI 2007).

2.4 Enable – An integrated, tailored framework for intervention

The mitigation prospects presented above are conditioned by the execution capability of national and local governments. Building a responsible urban-governance system is a prerequisite for implementing a sustainable urban-mobility policy able to integrate all the components set out above.

A recent study of policies for access and sustainable urban mobility in African cities[59] showed the link between the governance and performance of urban transport systems. It proposed to add the "Enable" dimension to the ASI concept, thus turning it into EASI: "Enable" addresses issues of efficiency in urban-mobility governance.

To ensure the implementation of urban-mobility measures able to promote control of GHG emissions, it is advisable to have a clearly established institutional framework, competent human resources, and appropriate funding models. This study made seven recommendations to address these challenges:

➤ **Define, adopt and implement at central-government level a national urban transport policy in order to ensure the sustainable development of mobility systems in metropolitan areas and to drive transformational projects at local level.**

The deployment of such a policy requires a strengthening of local-level decision-making, based on the principle of subsidiarity and proximity. By clearly defining objectives, responsibilities and the resources available to each stakeholder, this national strategy must guide public action in order to ensure coherence across urban and economic development and transport. It must also give private stakeholders a certain visibility, to promote initiative-taking. It may support the development of manufacturing sectors through a regulatory framework, strategic investment, or by offering market opportunities to these sectors. Central government must also encourage data collection and analysis in order to evaluate the results obtained.

➤ **Assign the main mandates between the various city-level stakeholders.**

A regulatory framework states who takes decisions, with what resources and what level of autonomy. These decisions include:

- urban and mobility planning, land use, and the oversight of regulatory constraints enabling development of an Avoid-type policy.
- development and management of roads and transport infrastructure, regulation and oversight of transport services, enabling development of a Shift-type policy.

59. This study was done by Transitec Ingénieurs Conseils, ODA, CODATU and Urbaplan for the SSATP (Sub Saharian Africa Transport Policy Program). http://www.ssatp.org/sites/ssatp/files/publications/SSATPWP106-Urban%20Mobility-Fin.pdf

• technical regulation and oversight of vehicles in circulation, enabling development of an Improve-type policy, but one which also improves road safety.
• provision of information on how the urban transport network is organised and works, in order to inform discussion with users, the private sector and other stakeholders. This information must also inform the urban-transport evaluation system (especially with regard to reducing GHG emissions).

➤ **Create an entity in charge of planning urban mobility, and of conducting and coordinating public action, guarantees the implementation of an efficient multimodal transport system suited to the population's needs.**

The role of this entity, typically called a Public (or Metropolitan) Transport Authority, is to drive the vision of a coherent, mutimodal transport organisation and to coordinate public action for the development and management of the urban transport network. This entity must have decision-making power over its territory and in the mandates assigned to it (network planning, management and regulation; fare policy, public transport project ownership, etc.). They preferably have autonomy over their financial development.

The Transport Authority must have the requisite technical expertise to execute its missions. At administrative level, it may be a local authority, a public agency, or any other administrative form allowing proper governance by the stakeholders of the territory in question. Most of the actions proposed in the Avoid and Shift sections depend on the capability of this entity to deliver projects and to coordinate with those in charge of other sectors (urban planning, land management, etc.), but also on central government's willingness and capability to provide the Transport Authority with appropriate human and financial resources.

➤ **Ensure competent human resources in the entities in charge of planning and managing urban mobility and public transport.**

Urban mobility is a cross-functional discipline that requires political and technical skills in order to understand the issues and to take decisions based on sound knowledge. Training programmes at various levels (master's degrees, vocational training, etc.) must be put in place, and it is essential to promote knowledge sharing through national and international exchange schemes. Training programmes must be suitable, and must open doors to the different types of roles in the sector. Funding must thus be allocated to national and local training actions.

➤ **Provide long-term financial resources devoted to transport and urban mobility.**

An effective governance system requires long-term funding models. Proper funding mechanisms strengthen public action in building, operating and maintaining a sustainable urban-mobility system. There are multiple possible funding sources, including local taxes, state subsidies, private investment and loans (chiefly from financial institutions), and international funds[60].

60. CODATU, Who Pays What for Urban Transport? Handbook of good practices, 2014 edition.

	Enable (Establishing an institutional and funding framework. Building capacity)	Avoid (Reducing the need for mobility and/or distances travelled)
Regulatory and institutional framework	National Urban Transport Policy, institutional setup (Transport Authority...)	Introducing speed limits, limiting goods traffic and controlling car ownership
Taxation and funding mechanisms	Creating sustainable funding mechanisms	Capture property value along transport corridors; manage land use to ensure the feasibility of future projects
Planning	SUMP process, Surveys, data collection	Densification along transport corridors; mixed use of land; limit the urbanisation of agricultural land
Social and/or technological innovations	Consultation process, participatory budget, support for the development of the industrial sector	New lifestyles (home working, etc.) ; promote less mobile lifestyles

Figure 19: The EASI grid

Shift ((Discourage car use and offer qualitative alternatives)	Improve (Improve the energy efficiency of transport modes and promote the use of new technologies)
Parking management, urban toll, etc. Contribution to the cost of public transport passes	Adopt emission standards for fossil fuelled vehicle; Set up low emission zones
Investment in public transport infrastructure; Integrated fare in public transport; tax on private vehicles, and fuels…	Taxation on high energy consuming vehicles ; Incentives to buy less energy intensive vehicles;Renewal of public transport vehicle fleets
Increase the size of cycling and public transport networks and develop Park & Ride solutions	Traffic management; Low emission zones; …
Car sharing and car pooling systems, promote the use of navigation systems, etc.; Promotion of intermodality and mulitimodality	Improve vehicles' energy efficiency; promote electric mobility; gain user acceptance

➤ **Consultation with, and participation of, civil society in order to establish a productive dialogue.**

Public opinion must be given greater consideration. To this end, it is advisable to deploy programmes to raise awareness and educate about urban-mobility issues with the aim of strengthening citizens' skills and making their involvement in the decision-making process more rewarding and constructive. It is thus necessary to envisage changing the national and local regulatory framework in order to introduce public consultation in transport projects, and processes for designing mobility plans.

➤ **The private sector's contribution in developing infrastructure and mobility services.**

Private-sector support within the scope of business activities with a high financial risk is beneficial for public authorities. This intervention must be correctly managed in line with principles of transparency and general interest; and must be contractually framed in order to define conditions of recruitment, of responsibility-sharing, and of financial risk inherent to the operation.

*****

The EASI methodology (Enable-Avoid-Shift-Improve) describes the authorities' various fields of action for conducting a coherent policy. This is why it is essential to consider the various levers available: regulation, funding, planning, and the promotion of social and technological innovations. These levers will be all the more effective if combined to achieve greater economic, social and environmental efficiency.

_Chapter 3

Instruments to support sustainable mobility and mitigation policies

3.1 Sustainable Urban Mobility Plans: metropolitan planning tools to transform mobility

■ A national framework to promote local planning

Traditional planning tools such as master plans generally include the planning of urban transport infrastructure. But these documents, besides a stated intent to structure urban development in a low-regulation environment, often struggle to attain an operational dimension. They often focus on infrastructure development, and set aside the institutional, organisational, fare, economic, financial and social dimensions of urban mobility policies. Through a lack of political backing, of cross-sector vision, or simply of execution strategy, these plans frequently become obsolete before they are implemented.

To achieve greater efficiency in transport planning, many countries have sought to develop a strategic approach that integrates all transport modes, with proven monitoring methods and design processes.

France and the United Kingdom were among the first countries to propose this direction, with the *Plan de Déplacements Urbains* (PDU) and the Local Transport Plan (LTP), which for nearly 30 years have defined local urban mobility policies. Drawing inspiration primarily from these experiences, the European Union in 2013 published guidelines for developing and implementing Sustainable Urban Mobility Plans[61] (SUMPs). This publication encouraged several European countries (particularly in the east: Romania, Slovenia, etc.) to undertake massive efforts to design mobility plans.

In recent years, national programmes encouraging the development of urban mobility plans have appeared in Morocco, India, South Africa and Brazil. These

61. Commonly known in French as a *Plan des Déplacements Urbains* (PDU), or “urban travels plan”.

countries have drawn up a national regulatory framework that promotes local-level SUMP deployment. Depending on the case, a SUMP may be drawn up voluntarily, but is often required by national regulations, especially in the biggest cities. Central government contributions to infrastructure funding may even impose the creation of a SUMP.

The European Union guidelines define a SUMP as "*a strategic plan designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life. It should build on existing planning practices and take due consideration of integration, participation and evaluation principles*"[62].

A SUMP thus structures a strategy for a metropolitan area in a document that presents an analysis of mobility issues, considering current practices and anticipating future needs. The document also defines public policy challenges and objectives with regard to transport and mobility, and proposes scenarios geared to achieving these objectives. After a comparative evaluation of the impact of each scenario, the SUMP defines an action plan and concrete measures as well as a monitoring and evaluation system.

A SUMP is an approach that adds value to a long-term vision of the mobility project within a pre-defined perimeter, which is generally that of the entity responsible for urban transport. It is based on a participatory approach involving all transport sector actors (political decision-makers, public institutions, and private players, especially those from the informal economy) and stakeholders (civil society, etc.).

This approach provides an overview of mobility needs with the purpose of addressing all urban transport problems. Although it primarily takes into account the specific features of each territory and context, a SUMP typically aims to:

- Offer the conditions of urban mobility for all by strengthening, access to services, jobs, leisure, etc. across the territory;
- Improve the efficiency of the passenger and goods transport system;
- Improve road safety;
- Reduce all types of pollution and nuisance (noise, air, GHGs, etc.) and energy consumption caused by urban transport;
- Reduce social segregation and inequalities;
- Enhance the appeal and quality of the urban environment for the benefit of citizens, the economy, and society in general.

A SUMP must be based on a solid evaluation of the state of the art, of future mobility needs and of the system's positive and negative externalities. Within a SUMP, it is essential to set up a system of indicators to allow regular monitoring of the plan's objectives and performance.

62. Wefering F., Rupprecht S., Bührmann S., Böhler-Baedeke S. (2014), Guidelines Developing and Implementing a Sustainable Urban Mobility Plan, European Platform on Sustainable Urban Mobility Plans, http://www.eltis.org/sites/eltis/files/sump_guidelines_en.pdf

BOX 8

Urban Mobility Plans in Brazil

In 2012, Brazil's federal government adopted the National Law on Urban Mobility, which required municipalities with more than 20,000 residents to adopt a *plano de mobilidade urbana* (or PMU, the Brazilian equivalent of the SUMP) by April 2015. The law concerned more than 3,000 municipalities. The PMU had to be aligned with their urban development master plan, and had to include motorised transport, public transport and active modes. The SUMPs will be reviewed every 10 years. Access to federal funding for the construction of transport infrastructure was subject to the creation of a SUMP by the towns and cities in question.

The SUMPs must adhere to the following guidelines:

- promote modal shift from private cars to public transport and active modes; towns with no public transport system must prioritise active modes;
- reduce energy consumption by urban transport, as well as the associated emissions of GHGs and air pollutants;
- improve road safety, particularly for the most vulnerable populations (children, the elderly, and more generally users of active modes).

The following key aspects must be considered: targets for modal split, emissions reduction, integration policy; planned improvements in public transport; collaborative planning approaches; implementation times; and monitoring and evaluation tools.

Belo Horizonte is one of the rare cities that already had a SUMP, dating from 2010. The city is thus preparing to review it in order to meet federal requirements. Generally speaking, only a few Brazilian cities have the capability and expertise to submit a coherent SUMP that fully meets the federal government's expectations. An ample share of the 3,000 towns and cities concerned by the law, due to a lack of financial and/or human resources, and sometimes to a lack of political willpower to complete such a project, will submit a document which will not actually make it possible to implement sustainable urban transport planning.

A cyclical approach to strengthen actions over time

To give impetus to change, a SUMP process must by nature be cyclical: a new-generation SUMP is prepared on the basis of the previous one, after the latter has undergone its implementation phase (10 years). It must also be incremental: preparation of the new-generation SUMP is based on the progress of the previous generation – and provides for remedies to any shortcomings. The various stakeholders involved thus follow a learning curve enabling them to acquire experience and improve the quality of the successive SUMPs, and thus to raise objectives (or adjust them, as necessary) and requirements from one generation to the next, particularly with regard to reducing GHG emissions.

The SUMP approach is represented by a virtuous circle (SUMP cycle, see Figure 20) intended for planners and local decision-makers, which defines a technical-institutional approach to urban mobility planning that combines decision-taking, consultation and technical expertise.

Figure 20: SUMP approach[63]

Implementation of a SUMP approach begins with the evaluation of its potential for success. This prior analysis helps, if necessary, to stimulate reforms at local or national level, but also the (re)structuring of the urban mobility governance and funding system, in order to build the conditions required for the plan to succeed.

Two phases must then be considered within a SUMP:

- **The SUMP elaboration phase** which refers to the work from the analysis through to defining the action plan. This first phase lasts two to three years, depending on the need for surveys, political maturation, and periods of consultation.

63. Source: Wefering et al. (2014).

- **The SUMP implementation phase**, i.e. the concrete execution of an action plan yielded by the SUMP elaboration process.

BOX 9

The Low-carbon Comprehensive Mobility Plan in Vishakhapatnam, India

Vishakhapatnam, the second most populous metropolitan area (1.7 million inhabitants) in the state of Andhra Pradesh, adopted in late 2014 a Low-carbon Comprehensive Mobility Plan with backing from the United Nations Environment Programme (UNEP).

In the city, 52% of trips are made on foot, 18% by bus, and 17% with private motorised vehicles (cars and two-wheelers). Business-as-usual projections, based on the doubling of the population by 2030) forecast a 32% rise in GHG emissions (from 5.3 to 7 Mt CO_2eq), due to a massive modal shift to private cars and motorised two-wheelers.

Given the disastrous effects of such a scenario on climate change, congestion, road traffic deaths and air pollution, the municipality wants to take action in four areas: land management, public transport, active modes and technology transfer.

In concrete terms, the municipality wants to structure its urban form around the public transport system (bus and BRT) in order to limit trip length. It also wants to double the bus fleet by 2030 by introducing cleaner buses, extending the BRT network, increasing frequency, and giving everyone access to public transport (thanks to low-floor buses and station access in particular).

For active modes, the idea is to secure dedicated pedestrian areas, increase the number of bicycle paths and secure them, (cycling currently accounts for 3% of trips, with 7% estimated by 2030), particularly by lowering the speed limit on a number of roads. There are also plans to build a network of shared bicycles. In technology terms, the municipality wants to raise standards regarding fuel and to grow the share of agro-fuels in the urban transport energy mix.

Through implementing its Low-carbon Comprehensive Mobility Plan, the Greater Vishakhapatnam Municipal Corporation hopes to divide GHG emissions by three by 2030, compared to the business-as-usual scenario, i.e. a drop of 2.84 Mt CO_2eq per year; and halve road traffic deaths in the conurbation.

In practice, a SUMP is generally valid for 10 years, with regular monitoring of objectives and a review after five years.

The elaboration and the implementation of a SUMP makes it possible, through coordinated policies that address all transport modes and the various ASI pillars (Avoid, Shift, Improve), to increase the volume of GHG emissions avoided, particularly compared to more segmented transport policies. Although the additionality of a SUMP in mitigation terms is inherently hard to measure, and of course depends on each urban context, we can however cite a comparative study done for four European cities (Barcelona, Freiburg, Malmö and Sofia), which studied the introduction of policies for energy efficiency of vehicles; incentive and coercive measures; and long-term policies on land use. The authors found that by 2040, for the scenario in which a SUMP is adopted and implemented, the potential reduction in CO_2 emissions is between 35% and 70% compared to the business-as-usual scenario[64].

3.2 Tools and methods for measuring and evaluating avoided GHG emissions

Methods for evaluating, accounting for and measuring GHG emissions may vary greatly, depending chiefly on objectives. Before choosing an accounting method, it is thus advisable to consider the numerous parameters below:

Geographic and functional scope of the evaluation:

The task may be to account for emissions related to a territory (a city, region or country), to the work of one or more people, or to the production and use of a product (for example, an electric or fossil fuelled car) or a service (ride-sharing, for example). It may also involve measuring the impact of executing a precise project / investment (a metro line, for instance) or a complete policy (the implementation of a SUMP, for example).

The evaluation period:

The evaluation may aim to capture a "snapshot" of emissions at a given moment (or, more typically, over a given year); or to measure the impact of a measurement over a long period (several years), or even of a product or piece of infrastructure over its life cycle.

The timing of the evaluation:

The evaluation may be a forecast of the impact on GHG emissions of a measure, a project or a product, based on assumptions. The task may also be to measure and account for GHG emissions in real time, or even ex-post.

64. Creutzig, F., Mühlhoff, R., & Römer, J. (2012). Decarbonizing urban transport in European cities: four cases show possibly high co-benefits. *Environmental Research Letters*, *7*(4), 044042.

The GHG accounting method:

There are various methodologies that refer to different accounting philosophies. There are "tank to wheel" methodologies, which only include emissions of vehicles when they are in circulation; and there are "well to wheel" methodologies, which are a life-cycle analysis of products and account for the "grey energy" of vehicles, infrastructure, fuel, etc.

The "tank to wheel" method covers direct emissions (also called Scope 1). With various methodologies (carbon balance study[65], Global Protocol for Community-Scale GHG Emission Inventories[66]) it is possible to distinguish two types of direct emissions which can also be considered in order to estimate emissions throughout the value chain:

- consumption of electricity, heat and cooling (Scope 2), which can, as we saw above in the Improve section, substantially influence investment decisions.
- Activities upstream and downstream of transport (Scope 3), such as building transport infrastructure, manufacturing and recycling vehicles, which are also accounted for in other sectors: construction, industry, recycling activities, etc.

Integrating the three Scopes mentioned above fits the rationale of a life-cycle analysis of a product (or, in this case, of a transport system), which involves listing and quantifying the material and energy flows associated with the manufacture of a product – from extraction of the energy and non-energy raw materials, via distribution (including transport phases) and use, to its end-of-life elimination.

Choosing an emissions accounting method thus depends on the intended type of analysis: the evaluation of current emissions or of future projections, of investment decisions (infrastructure projects or technology industries, etc.), or a more general evaluation on mitigation policies.

However, such a decision must also be informed by the available data (number of trips, kilometres per trip, mode, type of vehicle, type of fuel, etc.). Reliable data makes it possible to conduct a proper evaluation and guide the implementation of urban transport policies.

Moreover, within the scope of prior evaluation of projects or public policies, defining the business-as-usual scenario may be a complex exercise, especially when data are rare and the context is changing quickly. It is essential to combine prior evaluations with a system for real-time or "ex-post" emissions monitoring.

65. http://associationbilancarbone.fr

66. http://www.ghgprotocol.org

■ MRV systems: a rigorous approach to emissions monitoring

MRV systems are monitoring tools that allow evaluation of the impacts of policies conducted on the basis of field measurements.

Since 1992, countries have committed, under the United Nations Framework Convention on Climate Change (UNFCCC), to report information on anthropogenic emission inventories. The international monitoring framework has since been strengthened to allow countries to meet requirements of consistency, transparency, accuracy and completeness.

The term MRV[67] – Measure, Report, Verify – is thus used to describe all emissions data collection measures and mitigation actions intended for compilation, in order to produce an emissions inventory; and to measure reduction potential compared to business-as-usual, as well as actual reductions of emissions caused by a concrete project, an action plan or a policy:

- **Measure:** this involves monitoring GHGs (emitted, reduced or avoided thanks to conducted actions), but also measuring the impact of mitigation policies or mitigation related support (be it financial, capacity-building, or technological).
- **Report:** stakeholders undertake to report progress made during climate actions. There are several reporting levels, at various intervals.
- **Verify:** this is checking that the reported information on mitigation actions deriving from the "Measure" section is correct. These verifications may involve independent experts who analyse the reports produced and the methodologies used. The Verify section may yield improvements in the quality of the information produced, and the preparation of recommendations; and promote exchanges of best practices.

These three components of MRV systems must ensure transparency, accuracy and comparability, in order to attribute the quantified impacts to the policies conducted by national or local governments; to measure progress achieved over time versus a baseline scenario; and to promote access to international funding.

■ The ASIF methodology: a standard for calculating direct emissions

The ASI methodology provides a general framework for calculating emissions "from tank to wheel" in transport, which has now achieved a consensus. It follows the equation presented in Figure 7.

67. See the MRV system manual: http://mitigationpartnership.net/sites/default/files/mrv_tool_4_0_fr.pdf

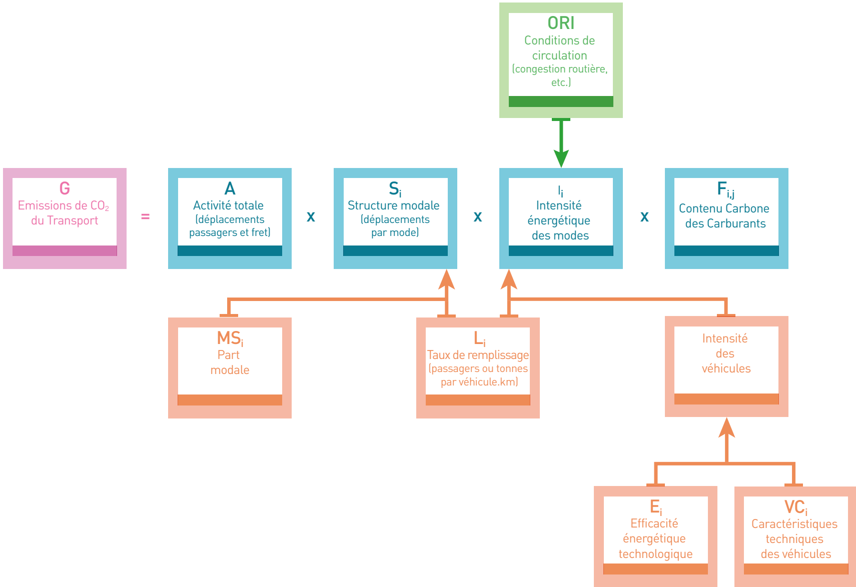


Figure 21: Principle for calculating GHG emissions in transport[68]

E is the volume of emissions in tons of CO_2 expressed as a function of:

- A, transport activity (in passenger-km or ton-km);
- S, modal structure of travel;
- I, energy intensity of each mode;
- F, type of fuel used for each mode.

The transport activity (A) and the modal structure (S) are ideally calculated by travel surveys which evaluate the number of kilometres travelled by people and goods, and the share of each transport mode in these trips. If precise data are not available, vehicle registrations and an estimate of kilometres travelled in a given period may offer an approximation.

Energy intensity (I) is the energy consumed to travel one kilometre with a given vehicle. It depends on the vehicle (type of vehicle, type of engine, age, etc.), its characteristics (occupancy and load) and driving conditions.

Lastly, the fuels used (F) will each have emission factors that are a function of their carbon intensity.

The ASIF methodology is thus a calculation of tank-to-wheel emissions.

For the metro in Kochi, India, the AFD evaluated the reduction in emissions at 2.3 Mt CO_2 over 30 years thanks to modal shift. In a life-cycle analysis, emissions from building the metro (0.34 $MtCO_2$) and operating it for 30 years (0.66 $MtCO_2$) must be deducted from this result.

68. Source: Schipper et al. 2000

Calculating GHG emissions for territories

It is necessary to define the perimeter of the emissions being studied. By definition, an urban area is a surface area that should be determined prior to any measurement. The perimeter may be administrative (municipality, district, etc.) but, in reality, the urban area often goes beyond institutional boundaries. It is thus essential to select a perimeter that matches the mobility behaviours being observed.

The next step is to determine the types of trips included in the study. If a portion of trips is made within the perimeter, it is necessary to know how to account for trips where only the start or end point is within the calculation perimeter, and for trips that only cross the perimeter. Various approaches are used for the territorial calculation of emissions (see below). An approach must be selected on the basis of the available data:

- **Geographic approach:** this was the approach selected to quantify GHG emissions at national level under the UNFCCC. It covers all transport-related emissions within a defined perimeter, irrespective of where they originate and terminate. It is the approach used by many European cities.
- **Induced-activity approach:** the purpose of this approach is to account for emissions induced by transport activity in the urban area, and to account for 50% of trips that only originate or terminate in the urban area. This is the methodology most used by American cities.
- **Resident-activity approach:** involves only accounting for emissions from residents in the defined urban area.
- **Fuel sales accounting:** involves accounting for fuel sales within the perimeter, as a transport activity proxy.

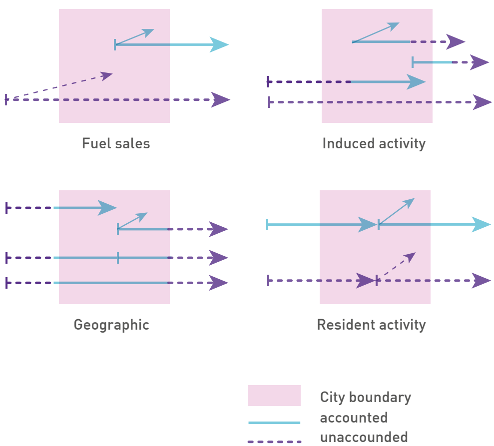


Figure 22: Different approaches to calculating GHG emissions from urban transport[69]

69. Source: GHG Protocol

BOX 10

Energy diagnosis and GHG emissions report as part of the Integrated Territorial Climate Plan (PCTI) in Dakar[70]

The Metropolitan Area of Dakar had 3.2 million residents in 2015, and the National Agency of Statistics and Demography (ANSD Senegal) forecasts that its population will rise to 5 million in 2025. Despite various attempts to decentralise development opportunities, the production of national wealth is still concentrated in the Dakar area. Although it covers only 0.28% of the country, Dakar has 24% of Senegal's population and still contains more than 80% of the country's permanent jobs across all sectors.

In 2012, Dakar adopted an Integrated Territorial Climate Plan (PCTI), i.e. a long-term project that promotes a comprehensive approach to the metropolitan area. The city wants to deploy a multi-stakeholder and multi-sector development strategy based on a better understanding of the area, its problems and weaknesses, in order to draw up an effective medium- and long-term action plan.

The Bilan Carbone® (carbon balance study) of the Dakar area, conducted in partnership with the Ile-de-France regional agency for the environment and new energies (ARENE), has provided a tool to support territorial forecasting; shed fresh light on "greenhouse" and "fossil energy" perspectives; and guides the city towards anticipating and taking action, in the face of new challenges.

The scope of the study includes all direct and indirect emissions generated by the Dakar Metropolitan Area – its stakeholders, residents and visitors. In total, the study accounted for 15.8 million tons CO_2 for all emitting sectors: industry, energy production, housing, secondary and tertiary activities, passenger and goods transport, waste management and the construction sector.

	Thousands of tons of CO_2
Residents' trips by car	716.5
Residents' trips by bus and car	85.7
Residents' trips by air	53.1
Trips by boat (Gorée island)	8.0
Visitor air traffic	1 237.8
Transport total	**2 579.3**

Table 4: GHG emissions from passenger transport[71]

70. Diagne M et al. (2013), Note de synthèse, Réalisation d'un diagnostic énergétique et bilan des émissions de gaz à effet de serre du Plan Climat Territorial Intégré de Dakar PCTI Région Dakar, Région de Dakar, ARENE Ile-de-France.

71. Source: Diagne M et al. (2013)

BOX 10 (CONTINUED)

Passenger trips (by land and air routes) account for 16.3% of emissions and rank second in terms of emissions after energy production, which in Dakar is wholly fossil-based. With this method of calculation, including indirect emissions, urban transport (with 0.81 Mt CO_2) represents 4.3% of all emissions in the area, across all sectors. Some 88.4% of these emissions are due to car trips and 10.6% to trips on public transport, although this is the most-used mode of motorised transport.

3.3 NAMAs: tools to add value to a sustainable-mobility policy

The **NAMA (Nationally Appropriate Mitigation Action)** concept first appeared in December 2007 during the 13th session of the Conference of the Parties in Bali (COP13) and was clarified in the Cancun Agreements in 2010. NAMAs are voluntary measures taken by developing countries to reduce their GHG emissions (and concern "non-Annex 1 countries"). They are voluntarily registered with the UNFCCC.

They are not restricted to investment activities enabling direct reductions in GHG emissions. They may equally pertain to an investment project or programme or to sector-specific or national policies that lead to reductions in emissions in the short or medium-to-long term. A NAMA may thus consist of a project or of precise measures with the objective of reducing CO_2 emissions in the short term, but may also consist of implementing research policies, strategies and programmes that fit a rationale of reducing emissions over the longer term.

NAMAs must:

- fit into a national sustainable development policy, help to reduce GHG emissions and deliver co-benefits, i.e. benefits not wholly related to reducing GHG emissions, for instance a better quality of life, a drop in environmental pollution, an improvement in democratic or governance practices, etc.
- refer to a business-as-usual situation, in order to show the expected reductions in emissions, by using an MRV methodology to quantify the impacts of the conducted measures[72];
- be registered with the UNFCCC by the country developing them.

In the urban-transport sector, the co-benefits associated with deploying a Transport NAMA (or T-NAMA) generally include a fall in congestion, higher energy security, better quality of life, economic development, a rise in air quality, a fall in environmental impacts, a improvement in road safety, etc.

72. The International Partnership on Mitigation and MRV offers detailed documentation on the topic (available in several languages): http://mitigationpartnership.net/sites/default/files/mrv_tool_4_0_fr.pdf

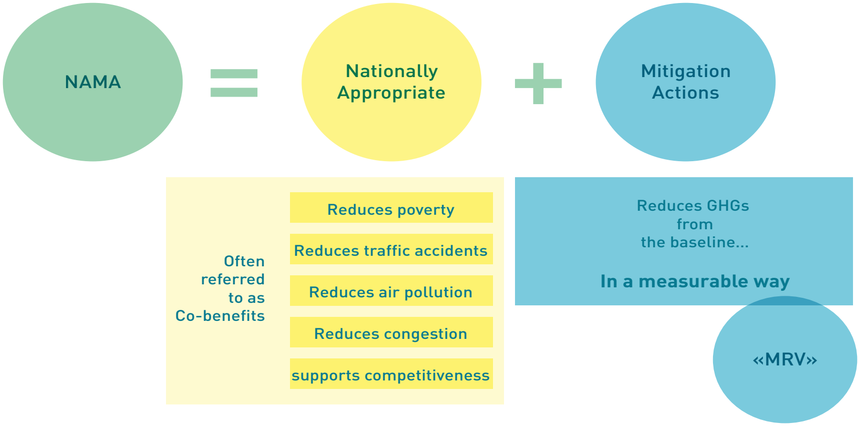


Figure 23: Illustration of the NAMA concept for the transport sector[73]

Three types of NAMA have been defined. "Unilateral NAMAs" bring together voluntary actions taken by developing countries without external support. "Supported NAMAs" solicit other countries or international partners to receive technological, financial or technical support. Lastly, "credited NAMAs" give developing countries the possibility to trade emission-reduction credits on the market in financial instruments, in a way similar to the Clean Development Mechanism[74].

In 2015, 151 NAMAs were registered with the UNFCCC, 16% of them in the transport sector[75]. Only 11 were in the implementation phase, including three in transport (Transit Oriented Development in Colombia, NAMA SUTRI in Indonesia, and T-NAMA in Peru: see boxes). The others are seeking funding for the preparation phase or for implementation.

Under the Bali action plan, NAMAs were intended to run until 2020, but they are expected to remain as an implementation mechanism that allows funding to be channelled. NAMAs could thus become tools for implementing Intended Nationally Determined Contributions (INDCs) and to provide climate funding.

73. Sakamoto, K. 2012, http://cleanairinitiative.org/portal/sites/default/files/presentations/Sakamoto_ADB_Tip_of_the_Iceberg_0.pdf

74. To date, there is no MRV methodology for this type of NAMA.

75. Van Tilburg X., Cameron L, Harms N., Esser L., Afanador A. (2015), Status Report on Nationally Appropriate Mitigation Actions (NAMAs) - Mid-year update 2015 - ECN & ECOFYS.

BOX 11

The Sustainable Urban Transport Programme in Indonesia (T-NAMA SUTRI)[76]

In 2005, the transport sector in Indonesia accounted for 68 $MtCO_2eq$, i.e. 23% of energy-production emissions. From 2005 to 2030, in a business-as-usual scenario, motorised vehicle ownership is forecast to double owing to an expected tripling of living standards. Car ownership is expected to rise from 115 to 312 vehicles per 1000 inhabitants. Fuels are still subsidised by the Indonesian government. Even recently, only 13% of the transport sector budget was allocated to infrastructure development, versus 61% for fuel subsidies. In 2013, the share of subsidies fell by 13%, and part of the €2.8 billion saving was earmarked for infrastructure funding.

The NAMA SUTRI, as registered with the UNFCCC, involves transforming urban transport through a national programme that combines capacity building with investment in transport modes other than private motorised vehicles. The project is transformational insofar as it aims to strengthen capacity at local and national levels; to bring about a change in thinking on urban transport in Indonesia; and to reverse the current paradigm by cutting fuel subsidies to invest in transport infrastructure.

It consists of two phases, 2015-2019 and 2020-2030, and aims to develop a programme of capacity-building at local and national levels, as well as mechanisms to co-fund transport infrastructure and to manage demand; to implement projects by targeting seven pilot cities (with the phase-one scope); and to implement a MRV system that must meet the urgent need for a decision-making support tool at local level.

The direct impact of the demonstration projects is a reduction of 0.7 to 1.8 $MtCO_2$ per year by 2030. Indirectly, considering that these experiments will be replicated in other metropolitan areas in the country, the mitigation potential is thought to be between 18.6 and 72.9 $MtCO_2$ from 2020 to 2030.

76. http://transport-namas.org/projects/transfer-partner-countries/indonesia/

BOX 12

NAMA for sustainable urban transport in Peru (T-NAMA TRANSPERU)[77]

Besides reducing GHG emissions in urban transport, this NAMA aims to reverse the trend towards car-centric urban mobility by proposing a new matrix of transport policies at national level, with local applications in the cities of Lima and Callao.

Main actions conducted:

- At national level, strengthening the institutional framework and building capacity to support local governments; technical assistance to overcome project barriers and deploy the MRV system.
- At local level, implementing appropriate infrastructure (metro and BRT network extensions, modernisation of the bus fleet, development of active modes) and development of a single Transport Authority for Lima and Callao.

The development of these various measures should yield a reduction of 5.6 to 9.9 $MtCO_2$ over the period 2015-2025. The Peruvian government is heavily contributing to funding (about $7 billion). Additional funding has been provided by development partners (CAF, IADB, KFW), and technical cooperation agencies have expressed an interest in helping fund the mass transport projects (metro line 2) and the national programme.

3.4 Tools for funding sustainable urban mobility

Varied funding sources

In 2012, the IEA estimated that $2.5 trillion per year of transport infrastructure spending would be required between 2010 and 2050 to stay below the 2°C target[78]. These resources must necessarily be mobilised at local and national levels. GIZ estimates that domestic finance represents nearly two-thirds of this funding, the remainder being split between foreign direct funding and international debt. Less than 5% of the total is from development finance institutions, even though they pledged at Rio+20 to release $175 billion by 2020 for sustainable transport. "Climate finance", meanwhile, represents a tiny share of the total[79].

77. http://transport-namas.org/wp-content/uploads/2014/04/Overview_PERU_TRANSPeru.pdf

78. IEA (2012), Plugging the Energy Efficiency Gap with Climate Finance, OECD/IEA, 2012. http://www.iea.org/publications/insights/insightpublications/PluggingEnergyEfficiencyGapwithClimateFinance.pdf

79. GIZ (2012), Urban Transport and Climate Change, Sustainable Transport : A Sourcebook for Policy-makers in Developing Cities, Module 5e, GIZ. http://sutp.org/files/contents/documents/resources/A_Sourcebook/SB5_Environment%20and%20Health/GIZ_SUTP_SB5e_Transport-and-Climate-Change_EN.pdf

In order to fund sustainable urban mobility policies, it is thus essential to mobilise local and national, and public and private resources, by harnessing a variety of conventional and innovative funding schemes that mobilise public funds but also contributions from beneficiaries, both direct (transport users) and indirect (employers, landowners, retailers), to the urban transport budget. It is therefore important to evaluate the possibility of transferring funding from less efficient transport sub-sectors to sustainable transport (see Figure 24).

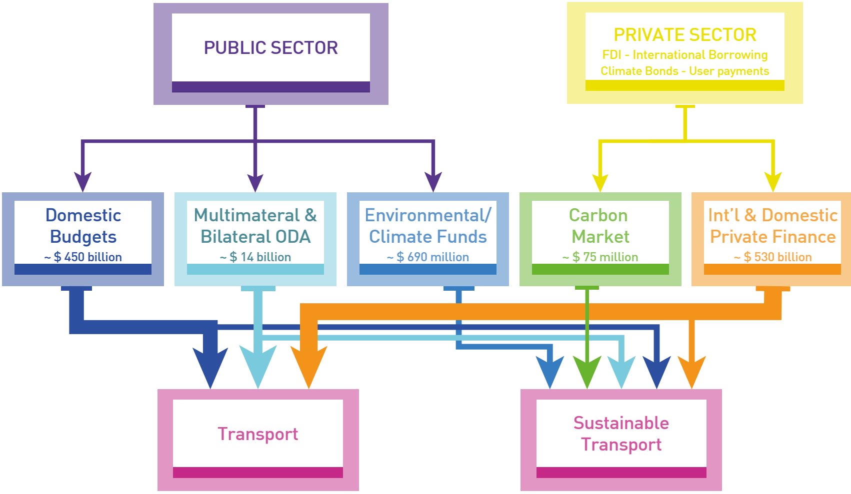


Figure 24: Estimated annual financial flows in the transport sector

Though representing less than half the total, international public funding – through official development assistance, international financial institutions and climate finance – must play their full role as catalysts in order to achieve the desired leverage for mobilising domestic or private funds to promote sustainable urban transport, and to guide investment towards the solutions with the lowest GHG emissions.

This is one of the major issues for COP21 and the cycles of negotiations under the UNFCCC.

In response to this leverage, financial resources intended for urban transport projects can be mobilised at local and national level by public partners through taxation and approaching private-sector banks. It is thus essential for decision-makers to draw inspiration from proven solutions in other countries (see the handbook of good practices "Who Pays What") or to develop novel mechanisms.

A challenge: mobilising climate finance to promote sustainable urban mobility

Climate funds, in particular, must play their full role as catalysts. But at present, they make only a very limited contribution to urban-transport funding.

The SLoCaT partnership[80] has collected data on transport projects funded by the main climate finance instruments[81]. Of the international funding sources, from 2010 to 2013 the Global Environment Facility (31 projects) and the Clean Development Mechanism (24 projects) were the main transport sector "windows". The Clean Technology Fund (CTF), meanwhile, has only registered eight projects. NAMAs have been used far more widely over time (22 projects) but less funding is available and projects are still struggling to reach the operational phase.

SLoCaT points out that projects are primarily focused on "Shift" (57%) and "Improve" (31%) actions, owing in particular to the fact that public transport projects are among the priorities in GEF programmes. Lastly, the amounts at stake are relatively low (roughly one billion euros over four years), whereas the needs amount to trillions.

Given the high stakes in the mitigation of GHG emissions, as outlined for example in the High Shift Scenario (see part C), climate funds need to be mobilised more widely in order to fund sustainable urban mobility policies.

Preparing a coherent policy within the scope of a SUMP; establishing tools for monitoring and evaluating GHG emissions via an MRV system; and the implementation of measures to strengthen institutions under the "Enable" pillar, must make it possible for local authorities, countries, and their technical and financial partners (international financial institutions, etc.) to mobilise climate finance more efficiently.

80. See : http://slocat.net/news/1447

81. The Clean Development Mechanism (CDM), the Clean Technology Fund (CTF), the Global Environment Facility (GEF), the International Climate Initiative (IKI), the Joint Crediting Mechanism (JCM), Nationally Appropriate Mitigation Actions (NAMAs), and the Nordic Development Fund (NDF).

BOX 13

The major "climate" funds

The Global Environment Facility (GEF) was created in 1991 to protect the global environment and promote sustainable development. It now brings together 183 countries in partnership with international institutions, nongovernmental organisations and the private sector.

As an independent financial organisation, the GEF helps developing and transitioning countries, through subsidies, to protect biodiversity, fight climate change and manage natural resources.

Since it was created, the GEF has supported 50 urban transport projects, for a total aggregate amount of $292.5 million. Although initially, the GEF primarily supported projects that BOXed on technological solutions, the scope has broadened since 2007, leaving room for non-technological solutions, modal shift, good management of public transport systems and planning. The GEF supports projects that promote low-carbon modes of transport. This concerns both public transport and non-motorised modes of transportation. However, priority is given to countries with small and medium-size cities experiencing rapid growth.

A very wide variety of projects are fundable by the GEF. Candidates can apply for a subsidy of up to $25,000, to prepare a project. The candidate may be a public administration, a transport operator, a bilateral partnership between development agencies or an NGO. Right from the start, it is important to contact the national office of the GEF, which approves the initial project. In most countries, the office is set up within the Ministry of the Environment or the national environmental agency.

The French Global Environment Facility (FGEF) is a bilateral counterpart of the GEF. The FGEF was established in 1994 to partially subsidise global environmental protection projects in developing countries, in connection with the multilateral environmental agreements signed by France. Sustainable urban areas are one of the five priority sectors of activity of the FGEF. Regarding urban transport systems, the FGEF has supported projects to build underground systems in Cairo and Hanoi.

The Clean Technology Fund (CTF) was created in 2008, and forms with the Strategic Climate Fund (SCF) what are called the Climate Investment Funds (CIFs). The role of the CTF is to help middle-income countries fight climate change, by funding major projects. Fifteen countries are eligible to receive CTF funding: South Africa, Chile, Colombia, Egypt, India, Indonesia, Kazakhstan, Mexico, Morocco, Nigeria, Philippines, Thailand, Turkey, Ukraine and Vietnam. The funding is planned by the countries in agreement with the multilateral development banks which must co-finance the projects. They are presented to the CTF in a regularly updated plan. There are also regional plans for North Africa and the Middle East.

The CTF provides (heavily) subsidised loans, or subsidies for project preparation, and its funds transit through the five multilateral development banks. The energy efficiency of vehicles, modal shift and mass transit are major areas of BOX for the CTF in the urban transport sector. Over 14% of the CTF's funds are currently allocated to urban transport, for a total budget of $728 million.

The Green Climate Fund (GCF) was established by the Cancun Climate Conference in 2010. It is a funding mechanism of the United Nations, attached to the UN framework convention on climate change (UNFCCC). This fund, officially launched at the Durban conference in 2011, and which is still in the process of development, could eventually become the main international fund devoted to fighting climate change.

It must of course meet the needs of the developing countries which are seeking a funding instrument to implement policies for mitigating and adapting to climate change. To meet the high demand for funding, developed countries have agreed to mobilise $100 billion by 2020.

Other "climate" funding agencies exist, which finance urban transport to a lesser degree: the Clean Energy Financing Partnership Facility (Asian Development Bank), Fast Start Finance (Japan), International Climate Initiative (Germany), etc.

_Conclusion

The development of low-carbon urban mobility may also address the issues of sustainable development on a local scale, in its economic, social and environmental dimensions. The transformation of mobility systems may thus be viewed as a policy that pays multiple dividends. Many solutions exist and have already been proven worldwide; their technical challenges are not insurmountable, and they are less costly than car-centric solutions.

To ensure the transition to sustainable mobility, institutional and economic systems must above all be changed, in order to ensure, in particular, the coordination of stakeholders, the consistency of policies, the integration of transport modes and the implementation of long-term funding models. Policies must be coordinated and integrated both vertically (between local, national and international tiers) and horizontally (between the various stakeholders involved at metropolitan or national level) to meet the challenges of urban mobility and, at the same time, achieve the objectives set in the Intended Nationally Determined Contributions registered with a view to the COP21 Conference.

Tools for public policy planning and evaluation, and funding mechanisms, must be the pillars of urban mobility policies in order to achieve objectives for controlling GHG emissions and promoting sustainable development. It is essential for developing countries and cities, which are experiencing very rapid growth, to equip themselves as soon as possible with tools of this type, then to improve them through their own experience while enriching them with international experience. And it is essential for this ownership to be encouraged immediately by development assistance and climate finance actors.

The transport sector produces 15% of the world's greenhouse gas (GHG) emissions, or 7 Gt CO_2eq, three-quarters of which is generated by road transport, both urban and long distance. The transport sector alone generates more than 23% of CO_2 emissions from fossil fuel burning. According to the Intergovernmental Panel on Climate Change (IPCC), "without aggressive and sustained GHG mitigation policies being implemented, transport emissions could increase at a faster rate than emissions from any other energy end-use sector, rising from 7 to 12 gigatons of CO_2 equivalent per year by 2050." The transport sector would thus be the biggest emitter of GHGs.

Given this outlook, more and more political leaders are observing that it will not be possible to meet the 2°C target without an in-depth transformation of the transport sector. The challenge of low-carbon mobility has thus become a major climate issue. Central to this issue is urban mobility, as it accounts for more than one-third of transport sector emissions.

Besides its impact in reducing GHG emissions, the transformation of urban transport systems responds to local needs that are powerful drivers of change. The idea is to ensure "livable" cities despite their very fast development and the growing flow of cars and motorbikes that is degrading people's living environment and particularly that of the most disadvantaged. The challenge is thus to limit the congestion of road infrastructure, which paralyses cities and reduces their economic growth potential; to limit air pollution, which has become a real public health challenge in metropolises; and lastly, to improve road safety.

Solutions do exist to resolve these local problems while fighting climate change. The present document aims at presenting the different levers for actions and the tools that can be used by local and national decision makers. It underlines the challenges of the coordination of stakeholders, the consistency of policies, the integration of transport modes and the implementation of long-term funding models.

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