NAMAs in the transport sector – a case study for Mexico

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1. Introduction

Nationally appropriate mitigation actions (NAMAs) are still a vague concept in international climate negotiations. NAMAs are normally distinguished by three categories

- Unilateral NAMAs (mitigation action undertaken by the developing countries on their own)
- (Directly) supported NAMAs (mitigation actions in developing country supported by climate finance provided from Annex I countries)
- Credited NAMAs (mitigation actions in developing countries supported by generating credits which are fungible in the international carbon market)

In this study, we are only focusing on (directly) supported NAMAs. Such NAMAs are considered for transport as they might comprise some promising aspects, which are:

- Scaled-up and long-term finance provided at the international level
- Possibility to lead to transformational changes due to a more programmatic approach (holistic program with interdependent, complementary measures based on national strategies)
- Monitoring reporting and verification (MRV) of emissions is less demanding (no crediting), performance-based MRV can be based on indicators which fit to the respective program and are easier to measure
- Co-benefits other than CO_2 reductions can be drivers for implementation

This case study is part of a set of four case studies elaborated within the so-called CITS project[1]. In selecting and elaborating one NAMA example for Mexico, we aim at answering conceptual questions with regard to NAMAs in general as well as some more specific questions with regard to their application to the transport sector. The main goal of this example is thus not to develop a fully-fleshed NAMA and provide accurate data and information, but to reflect about the general concept, data and methodological questions that are relevant when developing a NAMA for the transport sector.

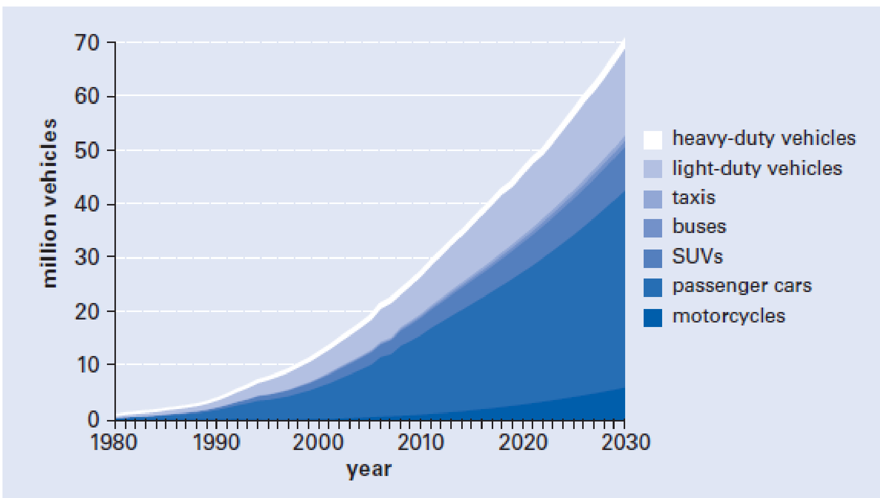
[1] The CITS project (abbreviation for Climate Instruments in the Transport Sector) is implemented by the Asian Development Bank (ADB), in cooperation with the Inter-American Development Bank (IDB) and is a first step to help ensure that the transport sector can benefit from the revised/new climate change mitigation instruments under a post-2012 Climate Change Agreement. The CITS project is a contribution to the Partnership on Sustainable, Low Carbon Transport.

2. Transport in Mexico

Transport is the largest and fastest-growing sector in Mexico with regard to energy consumption and greenhouse gas emissions. The overall transport sector is responsible for around 18 % of total GHG emissions in the country, with road-transport making-up the majority (90%) of emissions from the sector (Johnson et al. 2009).

Growth rates of road-transport energy use lie significantly above growth rates of other sectors. One important factor for this is the increase in the vehicle fleet which almost tripled in ten years (from 1996 to 2006). The increase in the motorization rate has several reasons, among which are low fuel prices, bad quality of public transportation, and the availability of inexpensive vehicles on the market (Johnson et al. 2009).

Recently, the World Bank has published the MEDEC study (Johnson et al. 2009) which includes a baseline scenario for the transport sector (see Figure 1 on the trend and projections of the vehicle fleet in Mexico) and identifies a range of low-carbon interventions which have the potential to decrease Mexico's transport-related emissions.



Source: Johnson et al. 2009

Figure 1: Transportation Fleet: Historical trend and projected growth under the baseline scenario, 1980 – 2030

Interventions included in the MEDEC study (see also Figure 2), comprise:

1) Modal shift and urban development
    a. Urban densification
    b. Bus Rapid Transit systems,
    c. Bus system optimization
    d. Non-motorized transport
2) Technology and Demand management
    a. Border vehicle inspection
    b. Inspection and maintenance

c. Fuel economy standards

3) Freight

    a. Road freight logistics

    b. Railway freight

In the MEDEC study (Johnson et al. 2009), overall baseline emissions in Mexico by 2030 are estimated to be 1137 Mt CO_2e. The above 9 transport interventions could reduce emissions in the Mexican transport sector by 131 Mt CO_2e by 2030 (around 11.5 % of overall emissions in 2030). The bus system optimization measure is estimated to contribute to this with a maximum annual emission reduction of 31.5 Mt CO_2e/year[2], while introduction and expansion of Bus Rapid Transit Systems (BRT) could lead to maximum 4.2 Mt CO_2/year. As Figure 2 demonstrates, optimizing the conventional bus systems has the highest GHG reduction potential of all the intervention analyzed in the MEDEC studies.

[2] Assumption made for the bus optimization intervention in the MEDEC study are:
Project definition: Redesign lines and make institutional changes in operation of 100 minibuses

- Project duration: 24 years
- Program definition: Redesign all feeder mass transit lines in Mexico (main axis lines are covered by the BRT intervention)
- Minibus (small passenger bus) mileage: 73,000 km/year/bus
- Redundancy percentage without project: 34 percent (according to transit plan for city of Querétaro, see also (Cordeiro et al. 2008)
- Minibus (small passenger bus) efficiency: 2.9 km/l
- Minibus (small passenger bus) lifetime: 12 years
- Minibus (small passenger bus) cost: $40,000/minibus
- Annual maintenance costs per minibus: $1,034
- Driver salary (two drivers per bus): $556/month
- The intervention assumes no new investment costs, only forgone investments
- Baseline assumption for number of minibuses in 2030: 1.1 million

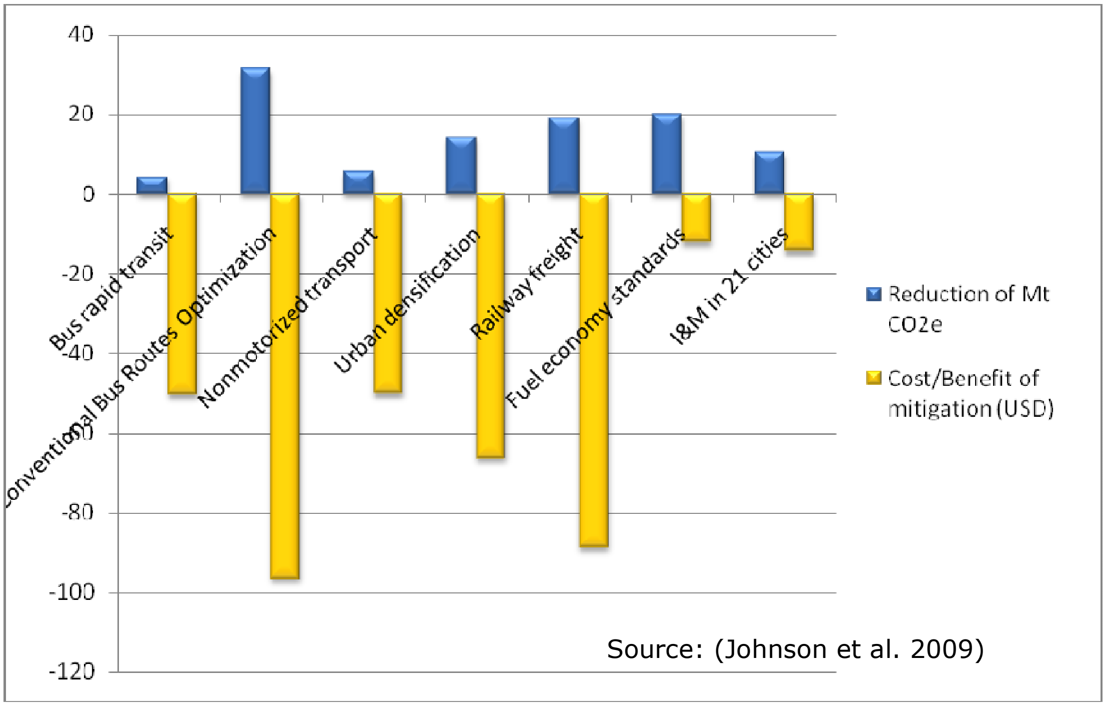


Figure 2: Reduction potential of Mt CO2e in the Mexican Transport sector and Cost/Benefit of mitigation

In the MEDEC study, the 31.5 Mt CO_2e/year reduction potential in the optimization of conventional bus routes is based on a scenario for all Mexican cities with more than 400.000 inhabitants. According to the Mexican National Institute of Statistics and Geography (INEGI for its acronym in Spanish) in 2005, about 60 million people were living in metropolitan areas with more than 400.000 inhabitants. Assuming that reduction potentials are proportional to the number of inhabitants, 32% of these 31.5 Mt CO_2e/year or in absolute terms about 10.08 Mt CO_2e/year are the potential reduction of GHG emissions in the Metropolitan area of Mexico City.

Figure 2 also illustrates that the optimization of the conventional bus system in Mexico is not only the highest in terms of GHG reduction potential, but also with regard to the cost-benefit relationship. When considering travel time saving, health effects due to reduced air pollution etc., the overall benefits of this measure outweighs the costs by far.[3]

3. Transport in the Mexican national climate plan

Mexico has published a national climate plan, called 'Programa Especial de Cambio Climático 2009-2012' (in the following called PECC, SEMARNAT 2009) in which it specifies objectives and goals (actions) to achieve in the different sectors. The PECC states 8 transport-related objectives which are estimated to achieve emission reductions of 5.74 Mt CO_2e in 2012 (more than 10% of overall emission reductions of the PECC in 2012).

[3] For details on the calculation of cost-benefits, see (Johnson et al. 2009)

Table 1: PECC transport measures (objectives and goals/actions)

Obj. number	Objective	Goal	Goal unilateral
2.2.1	Energy savings in transport by enhancement of better practices and application of energy efficiency standards	Standard for fuel use and CO2 emissions for new, light duty vehicles in 2010	**Yes**
		16 PJ of annual savings in consumption of diesel and gasoline due to transport program of Conuee	**Yes**
2.2.2	Reduction of energy consumption in freight and passenger transport	Inclusion of relevant stakeholders in Clean Transport Program of SEMARNAT	**Yes**
2.2.3	Expansion and modernization of federal roads (security, accessibility, reduction in operational costs)	Construction of 38 new road 'tramos'	**Yes**
		Construction of 18 new 'libramientos'	**Yes**
2.2.4	Renewal of vehicle fleet to increase energy efficiency	Scrapping of 15.100 vehicles	**Yes**
		Develop four financing schemes for different subsectors which makes the renovation of 40 thousand vehicles annually possible	**?**
2.2.5	Rail infrastructure decreasing fossil fuel use via multimodal schemes	Increase in participation of rail transport in national freight transport (from 26% to 28.3 % in terms of ton-km)	**Yes**
2.2.6	Modern, urban public transport in cities above 100 thousand inhabitants	Increase from 36 % in 2006 to 100% in 2012, within the programs of PROTRAM and FONADIN, the percentage of metropolitan areas and cities with more than 100 thousand inhabitants with public transport modernization projects, with an emphasis on the development of bus rapid transit systems and lanes	**?**
2.2.7	Suburban passenger transport	Substitution of low capacity passenger vehicles by putting in operation Line 1, 2 and 3 of the Suburban train of the Metropolitan Area of the Mexico valley	**Yes**
2.2.8	Increase in energy efficiency in the fishery sector by substitution of motors and scrapping of old boats	Retirement of 400 shrimp fishing boats	**Yes**
		Support the substitution of 15,500 motors of fishing boats by new ones	**Yes**

Among the 8 transport-related objectives (see Table 1) mentioned in the PECC, there is one objective which is relevant for our NAMA example below:

Objective 2.2.6

> ***Build a modern, urban public transport management system which responds to sustainability criteria and implies a high (positive) social impact, in cities with more than 100 thousand inhabitants.***

For each objective, more concrete goals are formulated which specify how the objective is going to be met. The above mentioned objective is specified by the goal M.32 which states:

Goal 32:

> ***Increase from 36 % in 2006 to 100% in 2012, within the programs of PROTRAM and FONADIN[4], the percentage of metropolitan areas and cities with more than 100 thousand inhabitants with public transport modernization projects, with an emphasis on the development of bus rapid transit systems and lanes.***

Mexico City has already started and implemented different activities, among others a BRT system (Metrobus) with a first line put in operation in 2005 along Avenida de los Insurgentes in Mexico City. A second line was opened in 2008[5]. Furthermore, Mexico City has received grants from Global Environment Facility (GEF), e.g. for preparatory activities paving the way towards the implementation of a comprehensive BRT system (strategy development, creation of enabling environment including regulatory changes, testing of technology, and awareness raising activities). In December 2009, GEF co-finance was granted for studies and technical assistance for the cities Leon, Monterrey, Puebla and Ciudad Juarez that will help prepare projects in order for them to be easily eligible for funding from the National Mass Transit Program (PROTRAM) and the Urban Transport Transformation Program. [6]

The Clean Technology Fund (CTF) has recently endorsed the investment plan of Mexico (federal level).[7] A significant share (200 Million US$) of the 500 MM US$ endorsed are targeting the development and expansion of a comprehensive BRT system and light rail (including the retirement of old buses and their replacement with lower-carbon alternatives) in various Mexican cities, thus supporting the objective 2.2.6.

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[4] For more details of PROTRAM (Programa de Transporte Masivo) and FONADIN (Fondo Nacional de Infrastructura), see section 8.

[5] Other BRT systems have been implemented in other Mexican cities as well. The focus of our NAMA at this stage is however the Metropolitan Area of the valley of Mexico (ZMVM) only.

[6] See http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,,contentMDK:22427400~menuPK:5106207 7~pagePK:34370~piPK:34424~theSitePK:4607,00.html

[7] For the investment plan of Mexico, see: http://www.climateinvestmentfunds.org/cif/sites/climateinvestmentfunds.org/files/CTF_Mexico_Inv estment_Plan_01_16_09_web.pdf

4. Selection of the NAMA example

A first lesson learnt is that the selection of the NAMA is already an important part of the work in NAMA elaboration. For the selection of the NAMA, we need to have already detailed background information on the sector in the country, existing policies and programs as well as plans and strategies of the country for the sector. Against this background, the selection of the NAMA(s), to be supported by international finance, should on one hand be part of an integrated approach for the transport sector as a whole rather than being an isolated measure, while on the other hand, the NAMA should go beyond what is done domestically by the country itself. A NAMA could enhance an existing unilateral measure, add a new element or introduce a new measure. One essential decision with regard to NAMA selection is that of the NAMA scope and boundary which is further discussed in section 6.2.1

For our NAMA example, we have chosen a NAMA definition which is rather local (smaller scope), and represents one of a range of possible elements of an integral urban mobility plan of a city or metropolitan area, namely the "Optimization of the conventional bus system".

Mexico D.F. has an urban mobility plan for 2001-2006[8]. It includes improvements in the regulatory framework and governance (e.g. coordination between different government agencies) with regard to urban transport, and specifies actions with regard to improvement of the rail infrastructure and the transport system as a whole (including urban public transport). An updated, comprehensive, urban mobility plan for the whole metropolitan area is however lacking.

In theory, a NAMA could however be defined at a broader or the national level, e.g. as a program providing financial incentives to improve public urban transport in metropolitan areas of Mexico, including bus system optimization. Using the example with the smaller scope however highlights some important aspects with regard to NAMA implementation which are important for the general policy discussion.

Further reasons for selecting our NAMA example are:

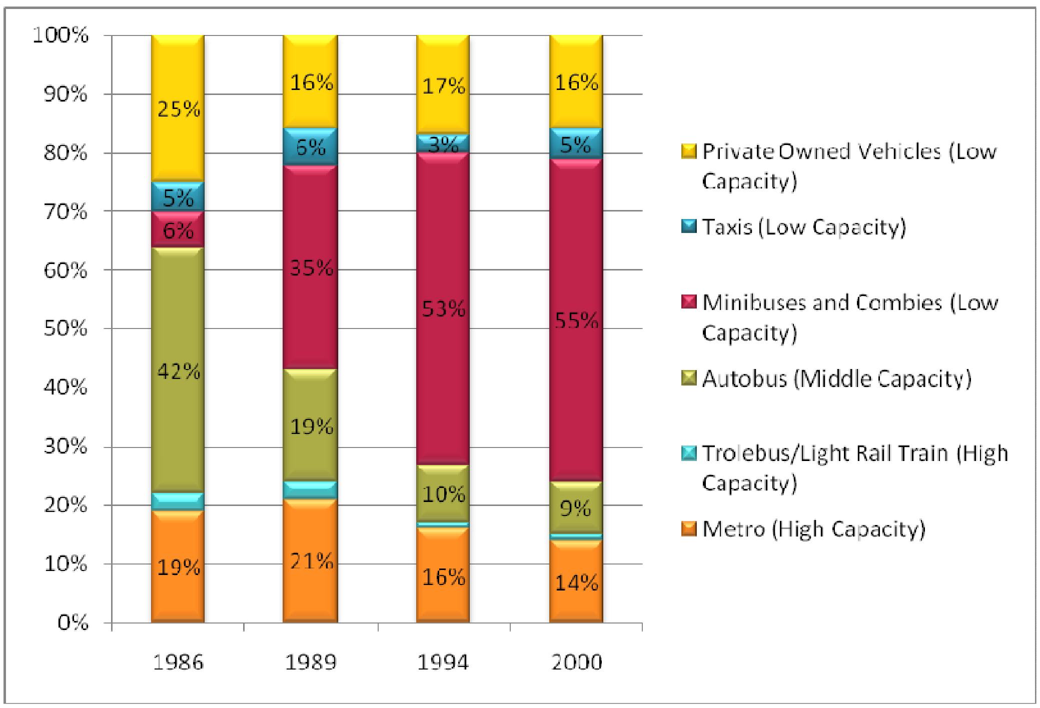
- it supports and complements objectives and goals in the national plan (see section 3),
- it is not financed or addressed by other sources yet (contrary to e.g. GEF and CTF financing provided for BRT system expansion in Mexico)
- it enhances the effect of other measures which are already under way (e.g. BRT system expansion, etc.)
- its GHG emission reduction potential is higher than of any other intervention (see Figure 2)
- its co-benefit potential is higher than of any other intervention

[8] Programa Integral de Transporte y Vialidad 2001-2006, see http://www.setravi.df.gob.mx/work/sites/stv/docs/pitv_2003.pdf

5. Case study - Bus system optimization as part of a public transport management system for Mexico City

5.1. Current situation

A big network of privately owned microbuses (peseros) operates in the valley of Mexico. In 2007 a fleet of more than 28.000 peseros transported an important part of Mexico City's public transport passengers, surpassing by far the capacity of all other public transport options - the metro of Mexico City, STE[9] trolleybuses, buses and taxis. The category includes Volkswagen (VW) Microbus, micros proper and full-length diesel buses. Peseros carry up to 60% of the city's passengers and are estimated to make more than 12.000.000 daily trips in the valley of Mexico. Even more impressive are the figures for the State of Mexico, since a large number of peseros operates there due to the lack of a concrete transport policy. During the last years the number of peseros grew at a fast pace, not just in absolute terms but also regarding their share in the transport system. This is illustrated in the following figure.



Source: CTS Mexico and et al 2010; Sheinbaum Pardo et al. 2009 Movilidad y calidad de vida: 6 estrategias de acción para la Zona Metropolitana del Valle de México.

Figure 3: Percentage of daily trips of the different means of transport in the valley of Mexico

Historic development

For a better understanding of this high growth rate, we briefly explain the history of peseros in the valley of Mexico. The development started in the 70's with so-called "taxi

[9] STE = Electric Transport System (Servicio de Transportes Eléctricos)

colectivo" (collective cabs). Collective cabs were originally large cars with more or less fixed routes which would pick-up as well as drop-off passengers at any point of the route. Passenger capacities were limited to those of a large car (usually up to six people plus a driver).

Being cheaper than a proper taxi and allowing the flexibility to cover routes that were not feasible for larger buses or other forms of public transport allowed fast growth both in numbers and in size of vehicles. By the 80's, pesero owners started using Volkswagen Microbus vehicles (known in Mexico as "combis" from its "Kombinationskraftwagen" variant). This choice enlarged their capacity to twelve passengers or even more if necessary. By the mid-to-late 80's most peseros were the even larger 'microbuses'. They are half-length passenger buses, converted to gasoline use and are larger than the VW Microbus vehicles mentioned before, although they both share the name 'microbus'. The new form of microbuses was capable of carrying between 22 and 50 sitting passengers, or in extreme cases even more. In the mid 90's an explosive growth of peseros started.

Following the bankruptcy of the government run transport company "Ruta 100" in 1995, the government largely opened the transport sector to the market. This included the outsourcing of route design. The result was that the microbus became the reigning transport mode as depicted in Figure 3. In 1986, 42% of the daily trips in Mexico City were performed by middle capacity vehicles. By 2000, this category shrunk to 9% of trips while microbuses increased to 55%. While the size of public transport vehicles used became smaller, the number of routes multiplied.

Due to the lack of government investment in public transport, in particular after the bankruptcy of Ruta 100, the fast-growing demand made the sector highly profitable. While the owners and new market participants did keep up with demand by adding more and more units and routes,[10] particularly in newly developing parts of the city such as Ecatepec, Chimalhuacán and Chalco in the East of the State of Mexico or in the West, Cuautitlán Izcalli, Tultitlán and Atizapán de Zaragoza, they did so without much order or regulation. It is beyond doubt that this scheme fosters "single man owned buses" because of the opportunity to join the market with relatively low investment and because there is hardly any advantage to exploit economies of scale. The outcome, until today, is a highly inefficient public transport system in the valley of Mexico.

The bankruptcy of "Ruta 100"

In order to explain the phenomenon of peseros, it will help to understand the history of "Ruta 100" (Autotransportes Urbanos De Pasjero Ruta 100). It was founded in 1981 and served the public during the coming 14 years. Ruta 100 operated mainly in Mexico City but also in the State of Mexico and was managed by the Government of Mexico City. In the mid 80's, it served more than 260 routes with about 7.500 autobuses. Shortly before its bankruptcy in 1995, it operated 212 different routes with about 3.500 autobuses.

After their bankruptcy, Mexico City decided to switch their approach of transport management; fostering single man owned buses, which has not changed until now.

[10] If a (new) market participant can proof that there is a demand of a new route, this person will probably receive a concession without any problems or deeper investigation by the authorities.

Existing problems

There is a wide range of problems due to the large growth and the poor regulation of peseros. Problems have arisen related to environmental and social concerns as well as regarding the overall transport system. The latter includes threats to safety, increased congestion, transparency of the system for customers and lack of proper integration of transport modes.

Environment - Peseros pollute more than other comparable public transport options both in terms of GHG emissions and emissions detrimental to public health. The reasons for this are the very old bus-technology used by the peseros and the extreme stop-and-go[11] practices.

Social concerns - Peseros' chauffeurs usually do not receive a fixed salary; rather, they are required to meet a daily quota prescribed by the owner of the vehicle. The driver is then allowed to keep the rest of fares of the day. This "penny warfare" or "war for the cent" fosters competition between drivers, as every customer is seen as valuable merchandise towards meeting the quota, and is thus increasing the driver's personal profit. The result is a way of driving which leads to a high accident rate.

Transport system – The sheer number of peseros is one element causing the extreme traffic congestion in the city. Besides, the extreme stop-and-go practice is one of the main reasons for the traffic congestion experienced in everyday life in the valley of Mexico. Lack of operators training and unit maintenance as well as the above mentioned payment system contribute to the number and severity of accidents, although the reason for this is more complex.

Routes usually begin in metro stations and end in outlying neighbourhoods of the state of Mexico. Typically, less than five pesero routes begin in a small metro station with only one metro line, but this number quickly increases depending on the number of metro lines going through a station. The terminal station of a metro line usually functions as a transport focal point and may be served by tens or more of different pesero routes. Additionally, almost every major avenue in the city is served by at least one pesero route.[12] Nevertheless, the integration of peseros to other means of transport is poor or hardly exists. One explanation for this reality is the rough struggle between each other and with other means of transport. Another reason is the stop-and-go practice, making a systematic and planned integration almost impossible.

Due to the lack of organization of the pesero system, there is no comprehensive index or guide of routes available to the passengers. Nevertheless, routes are assigned a route number in order to distinguish them from each other in license plates.[13] Individual peseros also have a sign usually affixed to the windshield indicating major points covered by the route such as metro stations, hospitals, schools, avenues, etc.

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[11] The stop-and-go is an outcome caused by their practice to pick up or to drop off passengers anywhere through the route.

[12] An exception for example is Insurgent's Avenue. Since June 2005, Metrobús operates there and pesero's transit in this avenue is completely banned.

[13] A vehicle registration plate is a metal or plastic plate attached to a motor vehicle or trailer for official identification purposes. The registration identifier is a numeric or alphanumeric code that uniquely identifies the vehicle within the issuing region's database.

However, given the lack of any real alternative until today, peseros remain in high demand throughout the valley of Mexico. Currently, peseros travel fixed routes, being able to pick up or drop off passengers anywhere through the route. The government is seeking to regulate microbus operation.[14] Efforts include reducing the number of units and replacing them with full-size diesel powered buses, which are more efficient and carry more passengers per unit. These can also be utilized for transfers and/or a unified fare-card systems, such as the system that has been implemented in the Mexican City of León (State of Guanajuato).

Unlike most other European and North American cities of similar size, it is not possible to buy a pass or fare-card either in Mexico City or in the valley of Mexico that is valid for all types of transport within the valley. Instead, each form of transport one boards requires an additional (albeit low, MXN $3) fare. There exists an official fare system where fees are supposed to be set according to distance traveled: from MXN $$3.00 for a trip of up to 5 km, MXN $3.50 for a 5-to-12 km trip, and MXN $4.50 for a trip of 12 km or more. However, this fare system is not perfectly implemented. Lack of enforcement and the high competition – or the penny warfare - between the different market participants lead to individual solutions.

A central element in the optimization of public transport in Mexico City is the development of a new regulatory approach to transport planning. To achieve this, a solid institutional framework must be developed that can efficiently provide planning, regulation, management and monitoring of the whole system.

[14] Since paratransit systems in many parts of the world are often operated by individuals and small business, they are harder to control than traditional public transport operators. Often is a fair amount of tension between the operators and the public sector authorities. In the last decades, and in many of the developing countries today, there has been a trend to try to ban paratransit operators (on the grounds of combinations of poor vehicle maintenance, unsafe driving, various forms of illegality, practices that undercut the public carriers, etc…).

NAMA structure

Actual situation

1. Lack of regulation fosters single man owned buses
2. Design of routes (lack of system planning)
3. Business model fosters a scheme "War for the Cent" (small buses, accidents, etc)
4. Inefficient system monitoring, regulation and management
5. Lack of physical integration with other transport modes

Optimised system

1. Institutional Structure
    - Regulatory organ (Government)
    - Operation and management entity
2. Planning (regulatory organ)
    - Route design (physical integration)
    - Concessions management (bus size)
    - Operational design (recognize the needs)
3. Implementation
    - Optimization of routes and buses (size, technology)
    - Physical and financial integration of infrastructure
    - Monitoring system, etc.

5.2. Description of the NAMA

The main objective of the action is to foster the improvement of the public transport system in the valley of Mexico [15] by **optimizing conventional bus routes**. The execution of the program aims at increasing the efficiency of the system in order to allow for regional, social and economic development while at the same time reducing GHG and other emissions. The NAMA includes the following components:

1. The establishment of the necessary institutional structure (e.g. reorganisation of regulatory entities)
2. Planning of the necessary changes of the bus system (e.g. route planning, concession management)
3. Implementation of the bus optimization (e.g. bus route changes, public awareness campaign, implementation of a monitoring system).

In the following section we describe the NAMA in further detail and provide background on the context.

The way cities are built affects to a large degree how inhabitants live. The development of cities´ transport system has great influence in shaping the spatial, economic and social relations among the city inhabitants and thus contributes (to a great extend) to the way cities are formed. While shaping these relations, the urban mobility system decreases transfer costs (travel time) and thus has the possibility to increase the economic competitiveness of the region.

To decrease the transfer costs, it is necessary to improve the efficiency of the public transport system in the valley of Mexico. One opportunity to do this is to optimize the conventional bus system. Studies performed in the city of Querétaro (Cordeiro et al. 2008) **[16]** (Central Mexico) show that it is possible to reduce 64% of public transport kilometers for the customers' daily travel while keeping/improving the service quality. Provided that Mexico City's transport system is by far more complex due to the enormous variety of suppliers, among other factors, the efficiency potential in the valley of Mexico could get as high as the result of the Queretaro study.

Mainly influenced by insufficient transport regulation that fosters competition, the public transport system in most of the Mexican cities has followed a system for determining routes which generates plenty of system inefficiencies. These include route redundancy, small, old and inefficient vehicles, and a "penny warfare" which generates higher levels of traffic accidents and fatalities.

The optimization of conventional bus system represents a major window of opportunity to reduce GHG emissions within the transport sector in terms of a cost/effective policy. As a result of improved route planning and management, a substantial reduction in emissions may be achieved (see Figure 2). Most importantly, in the long run, the optimization of routes and the better service that accompanies the policy may enhance the use of public transport. The influence on modal split or percentage of people

[15] Mexico City and the State of Mexico are located in the Valley of Mexico (ZMVM), a large valley in the high plateaus at the center of Mexico, at an altitude higher than 2.200 meters.

[16] The case of Querétaro (Cordeiro et al. 2008) showed a reduction potential in the public transport fleet of around 44%.

travelling by public and private transport modes, which the policy may have, increases the policy's outreach.

We recognize three main components for the routes optimization measure to be effective:

1. The ***institutional structure*** is essential for the success of the activity. The institutional structure is key in developing an efficient business model, creating the appropriate regulatory framework and in order to enable and administer the actual operations.
2. The proposed action requires mainly non-infrastructure system modifications like an improved design of the public transport network, an optimized operation and a new business mode. These system modifications require not only a good regulatory framework, but also ***adequate planning*** from the regulatory institutions. Once a strong institution is generated, it must recognize the system needs, manage public transport concessions and develop the plan for an effective network and operational design.
3. While the first two components concentrate on the appropriate design and enabling institutional setup, the third component aims at the ***implementation*** of the design. In this phase, all the agreed measures are implemented in the mobility system, considering physical integration with other transport modes, a range of complementary measures (e.g. public awareness raising) and sufficient equipment for data collection to allow for system monitoring and operation.

This policy aims to change the overall scheme and business model of the whole conventional bus transit system in order to generate a more cost efficient and sustainable setup. While a range of benefits can be expected to arise from this measure, it requires a greater involvement from the government in planning and regulation.

5.3. Components and Actions

In this chapter we describe components and actions that are suggested as part of the NAMA and which are needed to ensure successful implementation.

5.3.1. Institutional and Regulatory Framework

Proper regulation and the development of the right institutions are at the centre of any solution to optimise the conventional bus´ transport system. This is the reason why the first set of activities is related to the implementation of the institutional and regulatory framework needed for the adequate functioning of the bus system.

The institutions that manage, regulate and monitor the operation of the transport system shall provide a sufficient regulatory framework with the right set of incentives and sanctions.

We will expand on a possible institutional arrangement with the following entities:

- regulatory,
- operation & management entity

In the next sections, we will expand on the further characteristics that these public transport institutions must have and the functions they should fulfil.

5.3.1.1. Regulatory entity

The regulatory institution needs to identify societal needs, conduct the public transport planning and finally monitor and regulate that the service provided by the operation and management entity meets the identified needs. This entity must be financially and politically independent in order to be able to represent society's requirements and enforce regulation.

The regulatory entity must have a solid understanding of society's transportation requirements. This requires substantial data gathering and capacity building to perform, for example, demand and origin/destination studies. This information will then allow an optimized route and system design.

Once sufficient information is known about the needs, the regulatory entity must be entitled to change the current business model by setting-up certain requirements for the providers of services (e.g. of the service providers to be part of a company responsible for operation and management of the bus system). In order to perform its functions, the regulatory body should have the right attributes in order to be strong enough to enforce the planned quality of service. In order to do so, the regulatory body must have jurisdiction to administer sanctions and incentives to the operation and management entity. The regulatory entity is the institution in charge of approving payments and concessions for service to new routes. The concessions are used more as a managerial and incentive tool in order to enforce fulfilment of service contracts. The regulatory body should have the ability to remove/provide concessions at its own discretion according to the operation and management entity´s performance.

5.3.1.2. Operation & management institution

The operation and management entity may be privately or publicly owned, and its main objective is to provide the transportation service. The operation & management entity should be driven by an efficient set of incentives, this way providing that it acts in its own interest to achieve a high quality of service.

The operating institution must work closely with the regulators to achieve the desired service level and to receive and provide feedback to improve the operation of the system. The monitoring system may be operated by the operational entity and supervised by the regulatory authority.

5.3.2. Planning

As soon as the regulatory institution is operational and has analysed the needs, it should start rapidly with the planning process. The planning process can be divided into three different main elements:

- Route Design (Origin and Destination Study, Planning Process of optimizing conventional bus routes, etc.),
- Concessions Management (Bus Technology, Bus Size) and
- Operational Design (Quality of Service, Security, etc.).

Figure 4 illustrates the main substances and the interconnection of the different planning processes.

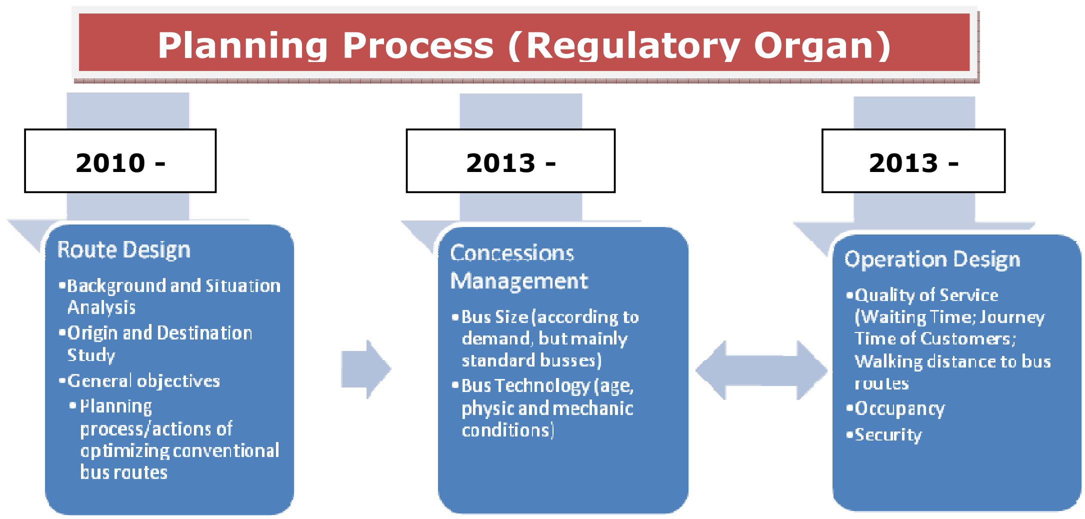

Figure 4: The planning process

5.3.2.1. Route design

Bus routes and service planning need not be sophisticated or require large resources, but they should be progressive, systematic and realistic. In the last decades, in the Valley of Mexico, the different agencies, institutions, etc. hardly undertook simple systematic planning processes to optimize conventional bus routes. In particular, the demand of customers was completely ignored. Therefore, it will be necessary to start monitoring and recognizing the needs of customers. The following general points must be considered in order to establish a new route design:

a. the social, economic and environmental context of the region
b. the contribution of the plan to meet social, economic and environmental needs
c. the legal system, regulatory policy and resource framework of the region
d. the commercial and economic aspects and consequences of operating transport systems and services
e. the origin and destination of the trips taking place in the area

The basis for all activities will be a background and situation analysis. It will help to characterize the existing situation, which will also help to provide a baseline of data for later comparison with the new system. Once the basic studies are performed, the regulatory body can determine indicators to monitor the optimized routes and check quality of services. These criteria could be, for example, waiting time for passengers, journey time and capacity of the buses. With the information on the demand indicated in the O/D study and the defined indicators, the regulatory entity can start the planning process. The optimization of bus routes is similar to "process management"[17]. To explain what we mean by optimizing conventional bus routes, the following examples can help:

[17] Process management is the ensemble of activities of planning and monitoring the performance of a process. Especially, in the sense of business process, often confused with reengineering.

- Corridors where two or more routes overlap can be optimized by replacing buses with bigger ones, eliminating routes and improving the regularity of the operation.
- In the Valley of Mexico, it can be the case that "peseros" are joining the same route 50 – 90% of their way and just differ in the final destination. A unit pricing system may allow a feeder-trunk system where transfers are cheaper and the service is offered with less buses and routes.
- Decreasing route length while still covering the origin and the destination points of the route and by shortening the travel time for the passengers is another possibility to optimize bus routes.
- Finally, a crucial point in the route design planning process is the integration of the bus routes with other means of transport such as non-motorized transport, mass rapid transit, and private vehicles.

However, the horizon for planning should not be more than three years for the first changes, such as rebuilding the system of concession management, to be carried out.

5.3.2.2. Concession management

Concession management became completely inefficient during the last decades in the Valley of Mexico. Hence, it will be necessary to rethink and implement a new concessions management system and to reallocate the already existing concessions. Besides matching the criteria of the new "Route Design Plan", applicants for concessions have to fulfil certain requirements regarding passenger capacity and technology.

- *Passenger capacity*[18]: According to demand, but mostly standard buses (70 – 100 passengers).
- *Bus technology*[19]; Clean diesel; Compressed Natural Gas (CNG); Liquid Petroleum Gas (LPG); Hybrid-electric; Electric and Fuel cell. Bus technology also includes the age, physical and mechanical condition of buses.

The allocation process for concessions has to be fair, transparent and must be steadily controlled by an independent regulatory authority. The provision of concessions may also be used as a regulatory tool to ensure proper service quality.

5.3.2.3. Operational design

Another important task that should be carried out by the regulatory body is the operational design which includes crucial criteria for the operators, specifically regarding quality of service, occupancy and safety.

Sometimes process management includes reengineering or reengineering includes process management.

[18] The vehicle size should match the passenger demand in a manner that also provides suitable frequency of service. It is not a matter of just selecting one bus type, since feeder and trunk line vehicles will likely be quite different.

[19] The specification of bus technology will affect operational costs and environmental performance. A decision must be made on the level of detail to be prescribed for the bus technology. A description of performance characteristics of the bus should be given by the regulatory organ, but the authority should leave it to the private sector bus operators to decide upon the technology and manufacturer.

The regulatory institution is not providing the service. However, it determines these indicators and enforces them through fines and incentives. Fines and incentives should be easily understandable and clear in formulation. Operators should have the opportunity to know exactly under which circumstances they risk to get fines and how they can achieve incentives.

Some parts of the planning have to be constantly revised. Parts which should be updated every one or two years are:

- a statement of how well demand is being met
- proposed new routes and changes to existing services: the network, capacity, service quality, and fares by mode, by operator, or by area and by route
- a statement of the financial performance of different sectors in the industry, with an indication of the timing and scale of any forecast fare increases

5.3.3. Implementation

Once the regulatory body is established and the first steps of planning have been completed, the implementation process can start. Implementation consists of four major actions:

- communication strategies that raise public awareness and the acceptance of the new system
- physical implementation of the new route system
- Replacement of bus units, including a support scheme to foster the scrapping of old peseros
- implementation of a public transport monitoring system that will enable to increase the effectiveness of the new system.

The monitoring system affects public acceptance because it fosters the quality of service of the public transport system. A good quality of service[20] increases the public acceptance, decrease emissions and raises benefits[21] for society. A more environmentally friendly transport system has positive effects on public acceptance and is necessary for a sustainable development. Regional development depends on a well working (public) transport system and this also influences public acceptance.

Public awareness actions do not only target existing and potentially new customers of the public transport system. Strategies need to include all stakeholders, e.g. also private vehicle owners that will be affected by changes in the system. Changes in a large system like public transport almost always face strong opposition. A good communication campaign can help smooth implementation.

The **physical implementation** of the new routes, bus stops and time tables will require a sound implementation planning. Implementation will need to be phased by re-organising specific areas and routes at a time to avoid chaos. It needs to be closely linked to the information campaign to ensure that customers are informed about changes

[20] See chapter 1.5 (The Planning Process).

[21] For emission reduction and benefits see chapter 1.3.2 (Emission and reduction potential).

that affect them directly. Not only the new buses must be supplied in time, also time tables, fare information and bus stop infrastructure need to be in place.

A support scheme needs to ensure that the thousands of peseros that will no longer be used in the valley of Mexico due to the program are removed from the road. A substantial amount of funding must be provided to be able to compensate pesero owners for scrapping their vehicles.

Bus optimisation and employment

By optimizing the conventional bus routes in the valley of Mexico an enormous amount of peseros will be eliminated.

Every pesero (more than 28.000 alone in Mexico City) means at least two working places, in most cases three or even more if we add service, maintenance and other factors. Only between 30% and 50% of these drivers will be directly relocated by the optimized system.

In 2005, when Metrobús was implemented on Insurgentes Avenue in Mexico City the same discussion engaged the politicians. The city's success in convincing minibus owners and operators to become part of the solution rather than part of the problem was one of the greatest achievements of Mexico City government in order to get the new system up and running. As a matter of fact, minibus owners and operators joined a public-private consortium that now owns and runs the Metrobús system. Furthermore, Metrobús brought and established a lot of new and social valuable employments – the new jobs created outnumbered the loss of working places. These experiences could be used to tackle arising problems through the bus optimisation as well.

The implementation of a public **transport monitoring system** is essential for the success of the activities. As with fare collection and fare verification technologies, the cost of central control technologies has steadily decreased over the years. Several options exist to link buses and stations with a central control office. The system for the valley of Mexico should be easily manageable and fulfil ISO-norms. An appropriate communication system for voice and data transmission will be needed. Bi-directional communication with mobile units' stations and control operation staff on the street has to be supported by the system.

The market offers several opportunities. Geographical Positioning Satellite (GPS) technology is increasingly providing an effective communications link. GPS technology allows for real-time information on bus location and status. This information can be utilized for a variety of purposes including system safety and control. Control centers allow for a high degree of system management and control.

Table 2: Summary of components and actions

NAMA component	Action(s)	Phase	Responsible institution(s)
Institutional Structure	• Establish regulatory entity	2010 - 2012	Ministry of Transport of D.F. (SETRAVI), (Ministry of the State of Mexico)
	• Create operation & management entity	2011 – 2015	Ministry of Transport of D.F. (SETRAVI), (Ministry of the State of Mexico)
Planning	• Stakeholder and situation analysis • Needs assessment	2010 – 2012	Ministry of Transport of D.F. (SETRAVI), (Ministry of the State of Mexico)
	• Route planning • Concession management • Operational design	2012 – 2015	Ministry of Transport of D.F. (SETRAVI), (Ministry of the State of Mexico)
Implementation	• Public awareness campaign • Physical implementation of new routes, etc. • Bus replacement and support scheme for scrapping old peseros • Implement transport monitoring system	2010 – 2020	Ministry of Transport of D.F. (SETRAVI), (Ministry of the State of Mexico), Ministry of Enviroment D.F., Ministry of Finance

6. Estimating the effects of the NAMA

6.1. Ex ante estimation vs. ex post MRV

Emission reductions and non-GHG effects of directly supported NAMAs will have to be quantified within the NAMA proposal to give an indication of the magnitude of expected impacts. The GHG and non-GHG impacts can be easily estimated for certain NAMAs, while for others quantification is more complex and uncertain. Contrary to CDM and credited NAMAs, emission reductions deriving from directly supported NAMAs *are not sold* on the carbon market and do not offset other emissions in Annex I countries. Therefore, it can be argued that the estimation of emission reductions of NAMAs does not have to be as accurate with regard to GHG emissions as in the case of carbon offsetting mechanisms.

While it is essential that all NAMA proposals include an estimation of expected GHG and non-GHG impacts, the monitoring, reporting and verification must not necessarily be based on emissions. In theory, the MRV methodology should provide the certainty that:

- A certain magnitude of GHG emission reductions is achieved[22]
- The developing country uses the financing for the stated purpose;
- The proposed actions are actually undertaken,
- The implementation is done effectively.

In the following, we elaborate an approach for the estimation of GHG and non-GHG impacts and MRV which is fulfilling the above criteria.

6.2. Methodology for estimating GHG reductions

A whole set of tools for estimating the GHG effects (as well as co-benefits) can be developed and used in standard planning processes (see De Dios Ortuzar and Willumsen 2001 for details). A complete set of such planning tools has however not been developed for the Metropolitan Area of Mexico yet, and are thus not available for ex ante estimation of the GHG effects of the bus optimization NAMA. Therefore, we recommend including a very simple calculation. Here it is very important that assumptions made and default factors used are made very transparent.

The most important aspect to consider with regard to the estimation of the impacts is that calculations are reliable, conservative and transparent, meaning that they can be reviewed and judged by the international institution examining the NAMA proposal. We propose a methodology based on the ASIF framework (see Figure 5) of Schipper et al. 2000 for the estimation of emission reductions of the NAMA. Figure 5 includes the relevant variables (total transport activity, modal split, modal energy intensity and fuel type) by which the emissions from transport can be influenced.

[22] These GHG impacts might however rather be in the mid- to long-term in some cases.

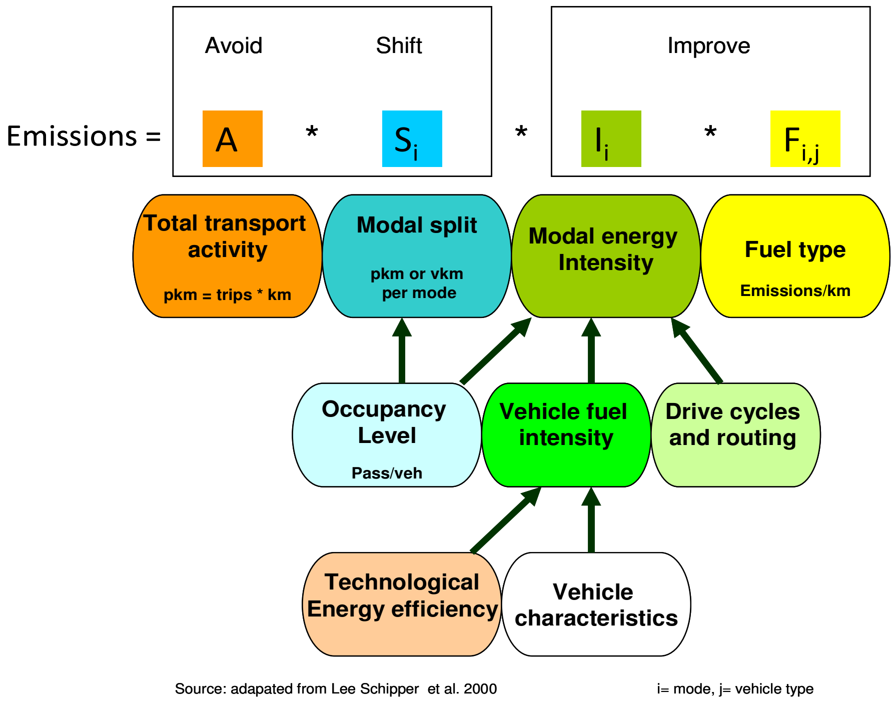

Figure 5: The ASIF concept

When optimizing conventional bus systems based on 'Peseros' as in the case of Mexico City, GHG emissions are reduced:

- directly by

  a) Decreasing the overall number of buses due to retirement (and scrapping) of redundant units[23], and

  b) Decreasing the overall km travelled by buses serving the system due to optimized routes and occupancy levels

- indirectly by

  c) Increasing the share of person-km travelled with buses (modal split) due to improvements in the bus system (shorter travel time, etc.)

The ASIF framework applied to our NAMA can be summarized as follows: Decreasing the overall number of buses (a) together with the km travelled due to optimized routes (b) lead to a decrease in the total km travelled (Avoid). An improved occupancy due to the optimization affects the modal split (Shift) as well as the modal energy intensity (Improve). [24] The improvement of the bus systems increases the share of pkm-travelled by buses (c), and thus the modal share (Shift).

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[23] Due to replacement of old buses, an improvement of the fuel efficiency of the conventional bus system can also be expected. We neglect this here for reasons of simplicity.

[24] Rebound effects (induced demand, e.g. increase in overall km-travelled by bus due to improved conditions) and changes in origin-destination patterns are possible effects of a bus system optimization. They should be considered in the MRV approach.

For using the ASIF concept for estimating the GHG impact of the bus optimization, we are assuming that there is a clear causal relationship between the above mentioned variables and the measures of the NAMA. While for a) and b), this causal relationship can be shown relatively easily, it is more difficult to do so for c). This is because changes in the modal split might also be influenced by other measures (e.g. the expansion of the BRT system in Mexico City).

In order to estimate the emission reduction effect of the NAMA, a three-step process based on the ASIF approach has to be applied:

- First the historical emissions need to be calculated
- Second the baseline emissions need to be estimated. Assumptions need to be made on how the individual variables develop under a business-as-usual scenario. Such scenario is always of hypothetical nature and includes assumptions on the socio-economic system such as the GDP. Most likely a range of baseline scenarios will have to be created to reflect the multiple possible development paths of the future.
- Third, the effect of the NAMA needs to be estimated by altering the parameters affected by the bus system optimization.

A descriptive illustration of this three step approach is given below:

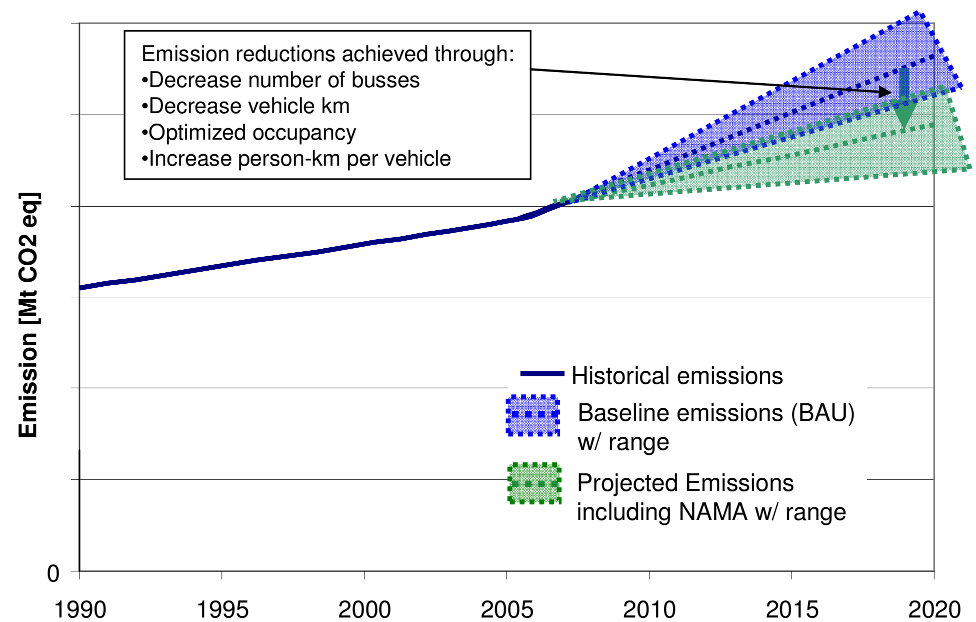

Figure 6: Three steps in estimating GHG emissions

6.2.1. Data availability and quality

When using the ASIF framework for estimating the GHG impact of the NAMA, we need to have data for all three steps mentioned above (past, baseline and the case with the measure). In the following, we provide an overview of availability and quality of relevant data.

An O/D matrix as well as GIS-based network characteristics are pre-conditions for transport modeling. An origin destination survey (O/D) for Mexico City is available for the year 1994, while an O/D-survey for the year 2007 has been carried out for the Metropolitan Area of Mexico City. [25] While modal split data of the O/D study for 2007 is quoted in some studies (e.g. Sheinbaum Pardo et al. 2009), we were however not able to get hold of the original O/D study for 2007. An O/D matrix for 2007 is generally available within the responsible government entity[26], but would need some calibrations before being able to use it in a transport model.[27] Furthermore, up-to date, detailed GIS-based data for the road and public transport network, including the bus routes are not available.[28]

A network model for Mexico City has been developed by a private consultancy firm. The model is programmed in the open-source software Tranus. The model itself is however not public. The interface of the model is not easy to use and the model is thus, of limited use for planning purposes.[29]

Due to the lack of integral transport planning tools, no model results (e.g. vehicle kilometers by mode, travel time) are available for the evaluation of the impact of the bus optimization NAMA. Therefore, we have made a literature review in order to search for available data sets on transport for the Metropolitan Area of Mexico from other sources. In the following, we summarize the result of our literature review.

Number of buses (conventional bus system)

Data on the number of microbuses in Mexico D.F. is not reliable. Bus cooperatives operate the different routes and concessions for new routes are granted by the regulatory entity. However, it can be expected that there is a considerable number of illegal buses operating on these routes. Data on the number of buses is therefore likely to be subject to some uncertainties.

Overall km-travelled by buses

Information on the bus routes (and their length) is in theory available within SETRAVI. This could be used for estimating the overall km-travelled by buses. However, data is not digitalized and does not provide information on the length of routes and their redundancy in the current form. It would take a significant effort to bring this data into a digitalized format. The overall km-travelled by buses can therefore only be estimated based on assumptions.

[25]http://www.inegi.org.mx/inegi/contenidos/espanol/prensa/Boletines/Boletin/Comunicados/Especiales/2007/Mayo/comunica1.pdf

[26] The study has been conducted by INEGI.

[27] Based on a personal communication by CTS Mexico.

[28] Routes and land use information included in the available network model described below is from 2002, and do not include the metrobus lines yet.

[29] Only few persons know how to actually use the model.

Modal split

Data on modal split is available in the mentioned O/D survey for 2007. Sheinbaum Pardo et al. 2009 quote modal split based on this survey for the public transport sector for the ZMVM.

Efficiency of buses

Information on efficiency is available in different studies in different formats (l/km or km/l). The study of Sheinbaum Pardo et al. 2009 provides information on efficiency for different vehicle and fuel types including microbuses based on different data sources. Sources quoted include the emission inventory of the Metropolitan Area of Mexico City (Secretaria del Medio Ambiente del Gobierno del Distrito Federal (SMA) 2008) and the American Energy Agency[30] website. Data is also available in Johnson et al. 2009 where assumptions on fuel efficiency are made for minibuses. A report by Institute Nacional de Ecologia 2006 quotes efficiency of buses and microbuses which are derived from a CDM analysis[31]. The UNAM study based on Institute Nacional de Ecologia 2006 provides information on the relation of efficiency and vehicle speed.

Given that there is no reliable data for the fleet and the details of km-travelled for ZMVM, little is known about the real on-road efficiency.

Overall number of trips/passengers

Data on the number of trips per mode and vehicle type is available in the O/D survey 2007 which was not available for this study. Sheinbaum Pardo et al. 2009 quotes the number passenger trips based on the O/D survey as one overall number for the whole of Mexico.

Occupancy levels

No data was available for this variable. However, some studies have been performed in Mexico City that offer average occupancy. Some studies draw upon default assumptions per mode and vehicle type.

Average distance travelled:

Information on the average distance travelled is included e.g. in the MEDEC report for different cities including the Metropolitan Area of the valley of Mexico (ZMVM). The data is provided in four vehicle groups and split by two fuel types (gasoline and diesel). Different data sources are used in the MEDEC report where data is provided for four vehicle groups. Sheinbaum Pardo et al. 2009 provides information based on the emission inventory of the Metropolitan Area of Mexico City (Secretaria del Medio Ambiente del Gobierno del Distrito Federal (SMA) 2008) and includes data on the average distance travelled per vehicle type and age of the vehicle.

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[30] www.fueleconomy.gov

[31] Rogers, J.A., Clean Development Mechanism Project Design Document Form (CDM PDD). 2005, Mexico City. 103 pp.

Number of vehicles per vehicle type

There is a diversity of data available in Mexico due to the lack of a national integrated vehicle registry. States have their own estimations which are often outdated. Presence of non-registered public transport vehicles represents another challenge. Categories for vehicle types used are not always clearly defined and not consistent between different studies. E.g. the Emission Inventory of the ZMVM published in 2008 (Secretaria del Medio Ambiente del Gobierno del Distrito Federal (SMA) 2008) which provides data for 10 vehicle types for the ZMVM. Based on the emission inventory (Secretaria del Medio Ambiente del Gobierno del Distrito Federal (SMA) 2008) Sheinbaum Pardo et al. 2009 study differentiates 15 vehicle types and provides information on the age of the vehicles. The categorization is very detailed but no clear definition is available.

Travel speed: (study by SETRAVI, measurement points, but not specific for vehicle type)

Data on the speed distribution is available e.g. in Yasuaki 2004 based on modeling of O/D data from 1994 and assumptions for 2025 data. The information available is for Mexico City, but not specific for vehicle types.

A general problem with data we found on transport is that the categories used were not always clearly defined and were often not consistent between different studies, which make them difficult to use for comprehensive GHG estimations. We can therefore conclude that reliable baseline data as well as data on the estimation of the GHG impact of the NAMA are not readily available. With some additional data collection as part of NAMA development, calibration of existing data and use of default factors (e.g. for fuel efficiencies), an estimation of GHG emission reduction of the NAMA could however be conducted based on the ASIF concept.

6.3. Estimation of non-GHG benefits

Since non-GHG benefits are often significant and represent the main drivers for implementation of transport measures at the local level, estimation of non-GHG of the NAMA are also important. For our NAMA relevant non-GHG variables are:

- data on traffic accidents
- air pollution (CO, HC, NOx, particulate matter)
- travel time

An ex ante estimation of these non-GHG benefits can be done based on existing models and has been conducted before (e.g. Johnson et al. 2009).

6.4. Effect of the NAMA boundary

The choice of the NAMA boundary and scope has a considerable impact on the estimation of GHG emissions and the MRV approach chosen. NAMA proposals can range from sector strategies at national or city level (e.g. national program for public urban transport) to very concrete projects which are part of these strategies

In this case study, we have selected a NAMA with a smaller scope which can be one of various possible measures of a broader strategy for the transport sector of the Metropolitan Area of Mexico. The difficulty is that the GHG emission impact of this NAMA can however not be estimated independently, but has to take other transport measures (and their timing) into account. The GHG effect of our NAMA example is e.g. not independent of the current and future expansion of the BRT system, metro, light rail. Therefore, the GHG effect of the NAMA can only be estimated based on assumptions on the contribution of the respective NAMA, thus leading to a relatively weak causality of indicators to the actual measure.

If narrowly defined NAMAs will be proposed separately – and maybe even at different times - then it will be difficult to avoid overlaps in the GHG effects of the respective NAMAs[32] and double counting of emission reductions cannot be avoided. Choosing a broader scope of NAMAs can avoid such overlaps in the GHG calculation.

7. Monitoring, reporting and verification (MRV)

While the estimation of GHG emissions and co-benefits of the NAMA could be based on simple, but transparent assumptions, monitoring, reporting and verification has to provide the certainty that the estimated effects actually occur. As mentioned in 6.1, this certainty relates rather to the magnitude of GHG emission reductions, thus allowing some flexibility of such monitoring.

For the monitoring of the NAMA, we recommend a simple approach using a range of indictors, as described in the following section.

7.1. Monitoring

In the following, we describe a possible monitoring approach for the bus optimization NAMA.

7.1.1. GHG emissions

We propose a monitoring methodology based on measurement of indicators which are influencing GHG emissions of the transport system (as illustrated by the ASIF framework). In section 6, we have described the three most important effects of our NAMA, which are:

- a lower number of buses[33]
- a decrease in overall km-travelled (by buses of the system)
- modal shift (passengers shifting to buses from other modes)

We can use data related to these indicators to monitor progress of our NAMA. It will be important to collect and document the status of these indicators before the implementation of the NAMA in order to have a good picture of the situation in the baseline. Then, regular monitoring of the same indicators should be part of the defined monitoring protocol of the NAMA, if possible by using the same methods and processes as in the baseline. As some of the indicators will be data which a regulatory as well as a Operation and Management (O&M) entity have to collect for the fulfillment of their tasks

[32] Even more if they do not use the same methodology for estimating GHG reductions.

[33] As mentioned above, the newer buses will also be more efficient, an effect which we neglect here due to reasons of simplicity.

anyway[34], some effort should be invested into the development of the methodology for collecting this data in the first place in order to provide a good starting point for the future monitoring of the system.

Number of buses can be estimated by correcting official numbers estimated numbers of illegal buses, considering additional information and data collected within the optimization process (e.g. sample bus counts, collecting data on members of cooperatives for the establishment of the O&M entity, number of buses scrapped, etc.). Once an O&M entity exists and operates the bus system, the number of buses will have to be part of the data centrally collected in order to guarantee an effective operation of the company anyway.

Data on km travelled by buses can be collected based on representative surveys of bus drivers who are interviewed on the average distance they are travelling per day. Once an O&M entity exists which owns and operates the buses, including the planning and determination of routes and schedules, the overall km-travelled should be known by the O&M anyway as part of its planning process. Additional data on fuel use and data collected during maintenance of buses at central bus parking and maintenance stations can serve as control variables[35].

Monitoring of modal split can be done by conducting smaller household surveys (e.g. once a year) using representative samples which cover the ZMVM and are less detailed than more comprehensive transport planning studies and complete O/D surveys. Such surveys could include the number of trips, the average distance of the trips, the transport modes used, travel time per trip and general household characteristics (e.g. gender, size of household, household income, age).

However, changes in modal split over time do not necessarily have to be consequences of the bus optimization alone, but can be due to other interventions or even an combined effect of different interventions together (e.g. BRT expansion, metro expansion and bus system optimization). Surveys would therefore have to include questions on the reasons for using and/switching to the public transport system.[36]

The problem to determine which part of modal shift is actually due to the NAMA causes some uncertainties with regard to monitoring of the bus optimization NAMA, which is even aggravated by the fact that modal shift is likely to represent the majority of emission reductions of this measure. Results of the household survey could be cross-checked by information obtained from integral mobility planning (e.g. O/D survey, modeling) which is however available over longer time intervals only (e.g. an O/D survey is likely to be conducted only every 5-10 years).

7.1.2. Co-benefits

Since the bus optimization NAMA has a range of important non-GHG-related benefits monitoring should comprise collection of data on co-benefits, e.g.

- data on traffic accidents

[34] E.g. a O&M entity will have to know the number of buses, km-travelled, routes served by its buses etc. anyway in order to offer its services effectively.

[35] This assumes that the speedometers are functioning correclty.

[36] Rebound effects and induced travel demand would also have to be taken into account in such surveys.

- air pollution (CO, HC, NOx, particulate matter)
- travel time

Such co-benefits data can be quantified and monetized as it is done within the MEDEC study. The causal relationship of these indicators is probably stronger for travel time than for the other two indicators, though.

7.1.3. Process indicators

In addition to the above indicators, monitoring of the NAMA can include a range of process indicators which show that actions considered important for the success of the NAMA have actually taken place.

While these indicators do not provide information on the amount of emissions saved, they are linked to the concrete implementation of the actions of the NAMA. Furthermore, some of these process indicators can provide insights if identified barriers are actually overcome. For the bus optimization NAMA, main barriers are less financial, but mainly institutional (e.g. lack of efficient regulatory framework, perverse incentives due to the current business model of the bus system). Therefore, identifying progress towards establishing the necessary institutions within this NAMA is key to reaching the GHG emission reductions and co-benefits. Process indicators can thus show if the implementation is progressing as planned or if postponements or failures of reaching the objective of the NAMA are to be expected. Such process indicators could also be milestones which are linked to the provision of different tranches of funding.

Such indicators are e.g.

- reform of the regulatory institution(s)
- change in the business model
- establishment of the O&M entity
- the development of procedures for the operation of the O&M entity (e.g. quality criteria)
- the number of buses scrapped
- part x of the monitoring system is implemented
- optimized route x in operation since date y etc.

Development finance offers established indicators and practices for evaluation of development projects and programmes which NAMA monitoring should draw upon.

Table 3 summarizes possible indicators to be used in an MRV approach for the bus optimization NAMA

Table 3: Possible indicators

Variable	Indicator	Source
GHG emissions		
Number of buses	Number of buses	Statistical measurement methods, data collected within the process of the establishment of the O&M entity etc.; Later: Part of the data necessary for operation of the company operating the bus system
Decrease in distances travelled by buses	Km-travelled by buses	Survey of bus drivers, statistical methods; Later: part of the data necessary for operation of the company operating the bus system, cross-check with fuel-use statistics
Modal shift	Increase in modal share of buses	Household surveys
Co-benefits		
Reduced traffic accidents	Fatalities due to traffic accidents	Secondary data
Travel time savings	Reduction in travel time per trip	Household survey
Reduced congestion	Average travel speed	Measurements at sample points
Reduced air pollution (positive health effects)	Local measurements	Secondary data
Process indicators		
Regulatory framework	Reformed regulatory institution(s), O&M entity established, etc.	-
Implementation of actions	e.g. reallocation of concessions finalized, route design plan elaborated	-

7.2. Reporting

At the national level, it could either be the respective government entity (local, regional, federal) implementing the NAMA which is also conducting monitoring and reporting, or monitoring of NAMAs could be organised centrally in one federal government entity. In the case of our bus optimization NAMA, the transport ministry at the state level (SETRAVI, and in later phases, the new regulatory entity established) is most likely the responsible institution for monitoring.

The Copenhagen Accord and the current AWG-LCA text[37] include two aspects with regards to MRV of NAMAs:

- NAMAs are likely to be subject to international MRV based on guidelines to be adopted COP
- NAMAs will be communicated through biannual national communications

Independently of what the NAMA MRV guidelines will look like, we can conclude that each monitoring and reporting on NAMAs will ask for a certain level of detail and frequency in order to be useful. For the bus optimization NAMA using an MRV methodology like the one sketched above, a monitoring and reporting frequency of one year can be considered reasonable. In order to have a comprehensive picture of the implementation of the NAMA, monitoring reports would have to include:

- the indicators specified above and assumptions used in the calculations,
- the method for obtaining the data,
- the data sources as well as
- an estimate of uncertainties.

Furthermore, it would be helpful to understand how the NAMA implementation is progressing (e.g. are milestones reached? If not, which are the reasons for the delay in implementation? How does the further implementation plan deal with identified problems and risks).

Communication of NAMAs through National Communications on a biannual basis would most likely comprise a very rough description of the status of implementation of the respective NAMA.

7.3. Verification

Verification of the NAMA can take different forms, namely verification of

1. Data, assumptions and methodologies in the NAMA proposals
2. Information provided in monitoring reports

For verification of NAMA proposals (1.), a technical committee within the respective (international) institution providing climate financing (e.g. Green Fund) is likely to be

[37] *Para 5 of the Copenhagen Accord: "Mitigation actions subsequently taken and envisaged by Non-Annex I Parties, including national inventory reports, shall be communicated through national communications consistent with Article 12.1(b) every two years on the basis of guidelines to be adopted by the Conference of the Parties…..Non-Annex I Parties will communicate information on the implementation of their actions through National Communications, with provisions for international consultations and analysis under clearly defined guidelines that will ensure that national sovereignty is respected. …..These supported nationally appropriate mitigation actions will be subject to international measurement, reporting and verification in accordance with guidelines adopted by the Conference of the Parties."; in the AWG-LCA text (FCCC/AWGLCA/2010/8, 9 July 2010) para 35. [Nationally appropriate mitigation actions, enabled and supported by finance,technology and capacity-building, shall be subject to measurement, reporting and verification at the international level in accordance with guidelines to be adopted by the Conference of the Parties at its XX session.] is still bracketed.*

responsible. Since such validation of project proposals is part of the NAMA selection process, we are not going into any further details on this within this study.

Point 2 would relate to the actual verification. Based on (annual) monitoring reports of the NAMA, an independent verifier would check if the methodology is applied correctly and if the data is reliable. Site visits could be part of this exercise. In order to appropriately review single NAMAs, the verification would have to considerably go beyond the scope and depth of current practice of reviews of national inventories/communications of Annex I countries.

8. Institutional issues

The following section deals with some relevant institutional aspects which have to be considered for the implementation of our NAMA.[38]

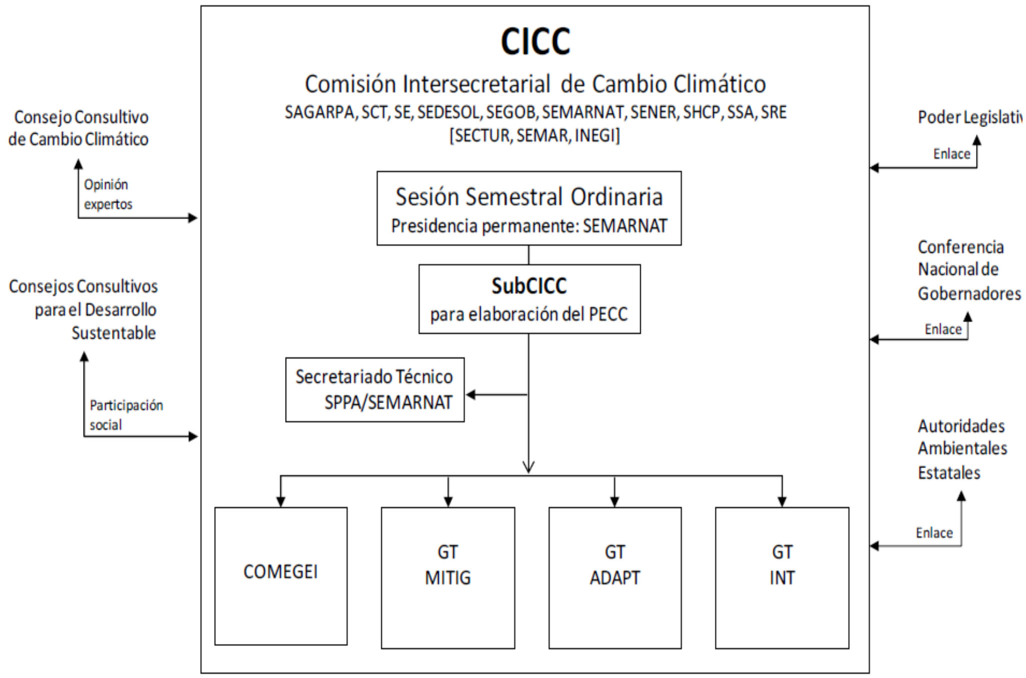
8.1. Brief description of the institutional framework

In Mexico, urban transport is mostly covered by each state separately, while the national transport ministry (SCT) is responsible for federal transport (e.g. intercity transport) only.

One important institutional issue with regard to our NAMA is related to the administrative complexities of metropolitan areas like the one of ZMVM. While the ZMVM consists of Mexico D.F., the municipalities of the State of Mexico and one municipality of the State of Hidalgo. there is no central entity for the administration at the metropolitan level. At the level of D.F., the transport ministry of D.F. (SETRAVI) is responsible for transport policy. At the State level, there is the Transport Ministry of the State of Mexico (Secretaria de Transporte). While comprehensive, integral transport policies (and thus also our NAMA as part of such a policy) should be addressed at the level of the metropolitan area, institutional complexities arise due to the different levels of government and administrative entities which have to be involved.

SEDESOL is the federal ministry responsible for urban planning and is thus the only federal ministry with responsibilities for urban transport. The environment ministry (SEMARNAT) and its implementing agency (Instituto Nacional de Ecología, INE) are the responsible entities with regard to the UNFCCC process and the elaboration of National Communications. An interministerial commission for climate change (Comisión Intersecretarial de Cambio Climático (CICC)) coordinates the formulation of climate policies at the federal level, e.g. the National Climate Strategy as well as the Special Climate Change Program (PECC). The organization structure and the participating entities in the CICC are illustrated in Figure 7.

[38] A discussion of institutional issues at the international level are beyond the scope of this study.



Source: SEMARNAT 2009, Special Climate change Program (PECC)

Figure 7: Intersecretarial Commission of Climate Change

In the context of our NAMA, it is also important to mention the PROTRAM program ("Programa de Apoyo Federal al Transporte Masivo ") of BANOBRAS (Banco Nacional de Obras y Servicios Públicos"). Banobras is the state-owned development bank of Mexico and provides project finance to municipal and state governments. FONADIN (Fondo Nacional de Infrastructura) of BANOBRAS is responsible for the PROTRAM program which supports the financing of investments in urban mass transport projects, including the strengthening of planning, regulation and administrative capacities of the urban public transport system. [39]

8.2. Different responsibilities with regard to NAMAs

Directly supported NAMAs will mainly involve the following steps:

1) Planning and implementation
2) Monitoring, reporting and verification
3) Communication with UNFCCC

In the following, we address the most important institutional issues for the three categories, and elaborate on how the interaction of the international, national and local level can be shaped most effectively with regard to NAMA implementation.

[39] For details of PROTRAM, see http://www.fonadin.gob.mx/wb/fni/programa_de_transporte_urbano

8.2.1. Planning and implementation

Planning and implementation of NAMAs relating to public urban transport are likely to be at the local or regional level. In the case of our example NAMA, the responsible institution is likely to be the respective transport ministry at city and state level. For other types of NAMAs, this might however be a national entity or other local or regional entities.

8.2.2. Monitoring and reporting

The local/state level is responsible for the monitoring and the elaboration of (annual) monitoring reports. Depending on the rules and modalities on MRV of NAMAs to be decided, these monitoring reports would be submitted to the international level (either directly or via the federal level). The federal government (INE/SEMARNAT) has the responsibility and consequently has to collect the necessary information from the entities implementing the NAMA – which in our case are at local/state level - and compile this information in the National Communication

8.2.3. Linking the national to the international level

Within the NAMA process, two main functions will be necessary to be fulfilled by the federal government:

- Function 1: Submission and management of NAMAs
- Function 2: Channeling support to lower government levels

For fulfilling function 1, the federal government will have to set-up a NAMA focal point which deals which collects and submits all NAMA proposals for Mexico [40], and is responsible for communication on NAMA issues with the international level.

With regard to the second function, existing institutions (e.g. the PROTRAM program of FONADIN) could be used.

8.3. Replicability

Replicability (implementing the same or a similar measure in selected other locations) is an important criteria especially for public urban transport measures implemented at local/regional level. Bus system optimization is a measure with high replication potential as the situation of bus systems and possible measures to optimize it are very similar in other cities of Mexico (and Latin America). A national program targeting public urban transport measures like bus system optimization could be another way to foster replication.

In Mexico, the national program PROTRAM aiming at improvement of public urban transport, with a focus on provision of infrastructure (BRT, Metro, Light rail, Suburban trains) for cities greater than 500.000 inhabitants already exists. With regard replicability of a bus optimization measure like the one described above, a NAMA could as well be defined at the national level, e.g. as a national program targeting such interventions. However, it would still have to be the local/regional entities applying for such a program, as well as planning, implementing and monitoring the measure. The main difference of

[40] This means for all sectors, and from all government levels.

such a set-up goes back to the issue on implications of NAMA scope and boundaries. If a NAMA is defined as a national program (e.g. by adding a bus optimization component to the PROTRAM program), the responsibility for the NAMA shifts to the national level (namely BANOBRAS). Components of the NAMA which are included in the NAMA proposal submitted to the international level would then relate to the establishment and implementation of the program (e.g. development of guidelines for the financing of projects, etc.). The national entity (in this case BANOBRAS/FONADIN) would then also elaborate monitoring guidelines for the financed projects.

9. Financing

The following section deals with some relevant financial aspects which have to be considered for the implementation of our NAMA. On the one hand, we give a brief overview of how the financing of the NAMA could be structured, while on the other hand we provide some general thoughts on the approach to determine financing needs of NAMAs as well as possible instruments.

9.1. Possible financing of the NAMA

The bus optimization NAMA includes a range of different elements, ranging from capacity and institution building, public awareness raising, investments in infrastructure (routes and buses) as well as NAMA-related costs for data collection and NAMA proposal preparation. Financing of the NAMA could be differentiated for the different instruments. E.g. while capacity and institution building is likely to be up-front financing based on full costs, for the replacement of old buses with newer and cleaner ones incremental costs could be financed with the O&M entity or another domestic or international entity taking over the resting part. Table 4 includes some possible financing options for the different NAMA elements.

Table 4: Possible financing for the different elements of the NAMA

NAMA component	Action(s)	Financing
Institutional structure	Establish regulatory entity Create operation & management entity	Up-front financing, maybe in tranches based on certain milestones of institution building
Planning	Stakeholder and situation analysis Needs assessment	Up-front financing
	Route planning Concession management Operational design	Up-front financing, maybe in tranches based on certain milestones (some costs to be taken over by domestic sources)
Implementation	Public awareness campaign	Up-front financing
	Physical implementation of new routes, etc.	Up-front financing, maybe in tranches based on certain milestones (some cost taken over by domestic sources)
	Bus replacement and support scheme for scrapping old peseros	Financing of incremental costs (ex post), other costs to be taken over by domestic sources (including O&M entity)
	Implement transport monitoring system	Up-front financing, maybe in tranches based on certain milestones (some cost taken over by domestic sources)
NAMA-related costs	Data collection and preparation of NAMA proposal	Up-front financing (fast-track financing)

9.2. Approach for the calculation of financing needs

As indicated above, bus system optimization involves higher benefits than costs (see Figure 2). However, the costs (e.g. cost to the operation and management entity) accrue to different stakeholders than the benefits (e.g. reduced travel time for all passengers, increased health benefits for all inhabitant). As with most no-regret measures, certain barriers inhibit the possible cost-savings from being realized. In the case of the bus system optimization, these are for example, lack of information and data on possible benefits (informational barriers), lack of the necessary institutions and regulations (institutional barriers), high up-front cost which can only be recovered over longer time horizons (financial barriers), as well as social dimensions (e.g. expected pressure from bus drivers who fear losing their jobs).

An incremental cost analysis is not appropriate for interventions with negative costs, as it is the case for the bus optimization NAMA. The only element of the NAMA for which incremental cost analysis would be easily applicable is the element of substituting old buses with more efficient bus units[41]. Another possible approach is to determine the amount of climate funds based on barrier removal costs. For certain measures, this is possible (e.g. costs for the development of a study), while for others this is more difficult (e.g. process to create an operation and management entity for the bus system). Furthermore, the removal of these barriers could as well be considered eligible for development finance. Therefore, barrier removal costs do not provide an answer to the question of how to share the costs between development and climate financing sources.

Public funds expected to be provided for climate finance are likely to be small as compared to international investment needs. Many measures eligible as NAMAs – as it is also the case for the bus optimization NAMA - have clear development benefits which make them eligible for (international) development finance as well. Therefore, climate finance could be used as an add-on to other financing where it has a potential to be most effective in triggering the desired transformational effects. This could be the case if:

- climate finance is likely to add an important component to a typical development measure (e.g. in the bus system optimization NAMA, the climate finance part might be the driving force for the intervention as without the international climate financing part, other international and domestic resources would not have been provided)[42]
- the international dimension of climate finance helps to overcome local implementation barriers and to increase public acceptance etc.

The contribution to the climate financing NAMA could be determined for single components of the overall measure. Another option to provide finance to the NAMA would be to determine which proportion of the overall measure is financed by Official Development Assistance (ODA) with an additional add-on of climate financing. The choice of the different option will have implications for how the NAMA is defined as well as how the developing country will approach possible funding institutions.

It is unlikely that the amount of climate finance to be provided to a measure can be determined by a fixed set of criteria as we are dealing with a decision process involving a range of stakeholders and political variables.

In Appendix I, we therefore only provide some first ideas on possible categorization of NAMAs as well as criteria to determine the amount of climate finance, while mainly stressing the importance of the NAMA boundary for the determination of climate funds at this point. If a NAMA is defined rather narrowly, it is a lot easier to define concrete elements, their costs and negotiate a possible distribution of funding sources for it. Governments would however have to make explicit which elements of a broader strategy (of which the NAMA is an element) are financed by which sources (domestic, ODA, climate etc.). Donor coordination becomes an important factor here. For broader NAMAs, the single actions of the NAMA will be less concrete, but the problems with interdependencies of separate measures can be avoided.

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[41] Including the compensation of bus drivers. ers.

[42] For other measures, the main reason might be the leveraging effect on private finance resources.

9.3. Financing instruments

The majority of actions of this NAMA are institutional and regulatory changes as well as changes in the way the bus system is working, while only few are related to technology or infrastructural investments. These institutional and regulatory changes pave the way to overcoming barriers inhibiting the bus system from becoming more efficient and generating cost savings.

One could therefore consider that financing granted to NAMAs can be adapted for each action depending on its characteristics. It could be argued that actions which are not directly leading to future revenue streams (e.g. capacity building, institutional and regulatory changes, and development of studies or strategies) should be financed in the form of grants, as they would otherwise increase the national debt. Financing might be in the form of soft loans where up-front financing is enabling the generation of revenues and thus costs can be recovered from increased revenue streams in the future (e.g. costs for implementing route optimization which is decreasing the cost of operation of the overall system).

FONADIN which is implementing the PROTRAM program has a range of instruments available and specifies which instruments can be applied to which type of measure (studies, investments etc.).[43]

10. Conclusion

In this study, we have chosen the optimization of the conventional bus system in the Metropolitan area of the Valley of Mexico as an example for a possible NAMA in Mexico. We describe possible elements of the NAMA, data availability and quality, a possible MRV approach, institutional aspects to be considered as well as some aspects with regard to financing of the NAMA.

One important conclusion is that the choice of the boundary and scope of the NAMA are essential with regard to the potential to estimate GHG emissions and MRV its effects. If NAMAs with a smaller scope are selected, it should be a pre-condition for financing that they are based on integral urban mobility plans. In this way, climate financing can provide incentives for improved, integral transport planning. In this study, we have selected a rather local scope of a NAMA. An alternative way for defining a NAMA targeting bus system optimization (or similar measures) could be to establish a national program (e.g. based on the existing PROTRAM program) providing support to public transport measures at the local level. In this case, the responsibility for the NAMA shifts to the national level.

The method for estimating the GHG (and other impacts) of the NAMA has to be transparent, but does not need to be as standardized as for carbon offsetting mechanisms. Transformational effect might be more important than short-term, direct GHG impact of NAMAs. However, they are more difficult to quantify. Furthermore, it is important to note that MRV for directly supported NAMAs can be based on a range of different indicators which do not necessarily have to be GHG-based. We propose an MRV

[43] For further details, see the FONADIN webpage http://www.fonadin.gob.mx/wb/fni/programa_de_transporte_urbano

approach based on simple indicators which can be collected bottom-up without having to draw upon complex tools used in transport modeling. Furthermore, complex modeling approaches can be problematic with regard to their transparency for verification of the NAMA at the international level.

Since the bus optimization NAMA has a range of important non-GHG-related benefits (e.g. travel time, health), the financing of the NAMA has a considerable overlap with development finance. Climate finance can therefore be seen as one contribution to enhance or expand actions improving public urban transport which are mainly undertaken due to their local (development) benefits.

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Annex I: Theoretical criteria for determining climate finance

Certain criteria could be used to evaluate what might be a typical distribution of climate finance for a certain category of NAMAs. When applying criteria for the amount of climate finance to be provided to a NAMA, it is useful to categorize NAMAs (or even the NAMA sub-elements) in order to be able to apply the criteria in a useful manner.

Categorization could e.g. be based on:

- Types of barriers to be removed
- Types of actions which can be part of NAMAs, e.g.
- On project/program types, e.g.
- The way the actions affects GHG emissions
- The type of country or region supported

Table 5: Criteria for determining climate finance

Types of barriers to be removed	Type of activity	Program/project type	Way actions affect GHG emissions	Type of country
• Financial • Institutional • Technical • Etc.	• Data collection, studies, research • Strategy development on national/regional and sectoral level • (Pilot-) Projects • Definition, implementation and enforcement of regulation • Capacity and institution building • Provision of financial incentives • Etc.	• Implementation of a feed-in tariff • BRT expansion • Efficient lighting program in poor households • Pilot projects for energy efficient buildings • Implementation of efficiency standard • Etc.	• Indirect vs. direct GHG effects • Short vs. long-term effects • Transformational effects • Size and type of co-benefits • Type of barrier • Etc.	• LDCs • etc

Possible benchmark values (for different NAMA categories) for the proportion or amount of climate finance could be:

- Barrier removal cost (still leaves open if rather ODA or climate finance relevant for removing this barrier)
- The relation of climate/other financing sources of past lending activities (e.g. of bilateral and multilateral financing institutions like KFW, GEF etc.)
- GHG reduction * C market price * multiplier as proposed by Embarq witin the CITS project (the multiplier could be determined for different categories as outlines above)
- Fixed total/relative amounts of climate finance ageed ex-ante for certain NAMA category (e.g. x% of costs of BRT expansion are financed by climate finance)

Furthermore, the amount of climate finance could be linked to the stringency of the MRV methodology. More stringent and accurate MRV methodologies could be compensated by additional financing resources. The stringency could be based on tier levels, similar to those used in IPCC reporting.

Annex II: Abbrevations

BANOBRAS	Banco Nacional de Obras y Servicios Públicos (Mexico's state-owned development bank)
BRT	Bus rapid transit
CDM	Clean Development Mechanism
CICC	Comisión intersecretarial de cambio climático (Interministerial commission for climate change)
CNG	Compressed Natural Gas
CO2e	Carbon Dioxide equivalents
CONAPO	Consejo Nacional de Población (Mexico Population Bureau)
CTF	Clean Technology Fund
FONADIN	Fondo Nacional de Infraestructura (Mexico's National Infrastructure Fund)
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIS	Geographic Information System
GPS	Geographical Positioning Satellite
INE	Instituto Nacional de Ecología (Mexican National Institute of Ecology)
INEGI	Instituto Nacional de Estadística y Geografía (Mexican National Institute of Statistics and Geography)
ISO	International Organization for Standardization
LPG	Liquid Petroleum Gas
MEDEC	Estudio sobre la Disminución de Emisiones de Carbono (Mexico Low-Carbon Country Case Study of the World Bank)
MRV	Monitoring, Reporting, Verification (of carbon emissions reductions)
NAMA	Nationally Appropriate Mitigation Action
O&M	Operation and Management

O/D	Origin Destination
ODA	Official Development Assistance
PECC	Programa Especial de Cambio Climático (National Climate Plan of Mexico)
PROTRAM	Programa de Apoyo Federal al Transporte Masivo (Mexico's National Mass Transit Program)
SCT	Secretaría de Comunicaciones y Transportes (Ministry of Communications and Transport)
SEDESOL	Secretaría de Desarrollo Social (Ministry of Social Development)
SEMARNAT	Secretaría del Medio Ambiente y Recursos Naturales (Ministry of Environment and Natural Resources)
SETRAVI	Secretaria de Transportes y Vialidad (Ministry of Transport of Mexico D.F.)
SMA	Secretaría de Medio Ambiente (Environment Ministry of Mexico D.F.)
STE	Servicio de Transportes Eléctricos (Electric Transport System)
UNAM	National Autonomous University of Mexico
UNFCCC	United Nations Framework Convention on Climate Change
ZMVM	Zona Metropolitana del Valle de México (Metropolitan area of the valley of Mexico)

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