Draft revision to the approved baseline and monitoring methodology AM0031

"~~Baseline Methodology for~~ Bus Rapid Transit Projects"

I. SOURCE, DEFINITIONS AND APPLICABILITY

Sources

This baseline methodology is based on the proposals from the following proposed methodology:

- NM0105-rev "Baseline Methodology for Bus Rapid Transit Projects," whose baseline methodology was developed by Gruetter consulting.

This methodology also refers to the latest approved version of the following tool(s):

- "Tool for the demonstration and assessment of additionality";
- "Tool to calculate project, baseline and/or leakage emissions from electricity consumption".

For more information regarding the proposed new methodologies and the tools as well as their consideration by the Executive Board please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

Selected approach from paragraph 48 of the CDM modalities and procedures

Existing actual or historical emissions, as applicable.

Definitions

For the purpose of this methodology, the following definitions apply:

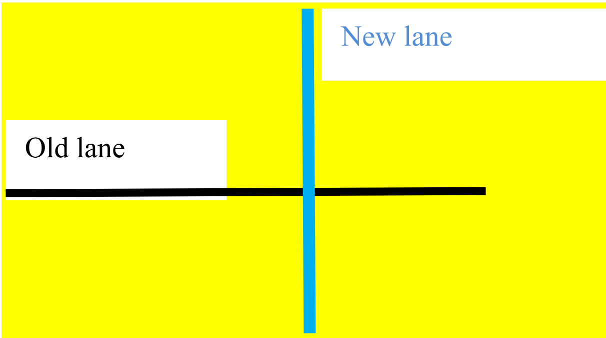
Mass Rapid Transit Systems (MRTS or MRT systems) are collective urban or suburban passenger services operating at high levels of performance, especially with regard to travel times and passenger carrying capacity. They can be based on elevated, surface level or underground roads or rail systems. MRTS can be rail-based systems such as subways/metros, Light Rail Transit (LRTs) systems, including trams, or suburban heavy duty rail systems or road-based bus systems. For the purpose of this methodology road-based MRTS are bus systems using bus-lanes (see below the definition of a bus lane), which can also be called Bus Rapid Transit (BRT) systems.

Bus rapid transit (BRT) system is a collective urban or sub-urban passenger transit service system that is bus-based, uses bus lanes for trunk routes, and operates at high levels of performance, especially with regard to travel times and passenger carrying capacity.

Bus lane (or trunk route) refers to a segregated lane, where only buses are allowed to operate. Private vehicles are not allowed to use the bus lane. Exceptions, such as emergency vehicles can apply. Bus lanes need not necessarily be physically separated from other traffic lanes. If no physical separation is realized then it must be ensured that enforcement takes place to prevent the usage of the bus lane by other vehicles. It is not a requirement that 100% of the route is a bus-only lane as buses might share part of the lanes with other modes of transport e.g. at traffic crossings, bridges, tunnels, in narrow parts or on roads with limited traffic e.g. in suburban parts of the city. However to qualify for this methodology more than half of the included bus route must be a bus-only lane.

Extensions of bus lanes refers to situations where the same bus operates on the previously existing lane and the extended lane, i.e. passengers do not need to change from one bus to another bus to use the extended bus lane. The entire bus lane is thus composed of an existing or “old lane” and a “lane extension” (latter is the project activity).

New bus lanes are bus lanes on which buses are operated that are different than buses operated on the previously existing lanes. New bus lanes might share certain stations with an existing lane but passengers will have to switch buses, if their trip involves stations on the “existing” and the “new” lane.



Feeder routes refer to bus routes which have intersections with trunk routes and which “feed” passengers on the trunk routes. Feeder routes are those with less passenger demand and which operate under mixed traffic conditions.

Rebound Effect is the term used to describe the effect that the BRT has on changing ‘consumer behaviour’ leading to additional trips. The rebound effect describes the effect that consumption (i.e. in this case the number and length of trips) may increase if prices decline or the quality of the service improves. If the BRT project reduces traffic congestion or improves the quality of transportation and reduces travel time, therefore reducing opportunity costs, it tends to increase the number and/or length of trips undertaken.

City is an area of continuous urban development and includes the historical core area and the adjacent suburbs defined by its administrative boundaries

Commercial entity is a company, excluding banks, where more than 20% of equity capital is privately owned.

Applicability

The methodology is applicable to project activities that reduce emissions through the construction and operation of a ~~Bus Rapid Transit (~~BRT~~)~~ system for urban road based transport. The methodology is also applicable for extensions ~~or expansions~~ of existing BRT systems ~~(adding new routes and lines)~~.

The following applicability conditions apply:

- ~~The project has a clear plan to reduce existing public transport capacities either through scrapping, permit restrictions, economic instruments or other means and replacing them by a BRT system;~~
- ~~Local regulations do not constrain the establishment or expansion of a BRT system;~~

- Any fuels, including (liquified) gaseous fuels or biofuel blends, as well as electricity, can be used in the baseline or project case. The following conditions[1] apply:
  - In the case of biofuels, project buses must use the same biofuel blend (same percentage of biofuel) as commonly used by conventional comparable[2] urban buses in the country, i.e. the methodology is not applicable if project buses use higher or lower blends of biofuels than those used by conventional buses. In addition, the project busses shall not use a significantly higher biofuel blend than cars and taxis.[3]
- The project activity BRT system is road-based. The baseline public transport system and other public transport options are road- or rail-based (the methodology excludes air and water-based systems from analysis). However, the methodology is not applicable if the project activity BRT system replaces an urban rail-based Mass Rapid Transit System (MRTS), i.e. if the MRTS stops operating after project implementation due to the project activity;
- ~~The BRT system partially or fully replaces a traditional public transport system in a given city. The methodology cannot be used for BRT systems in areas where currently no public transport is available;~~

The methodology is applicable if the analysis of possible baseline scenario alternatives leads to the result that a continuation of the use of the current ~~public~~ modes of transport ~~system~~ is the baseline scenario ~~that reasonably represents the anthropogenic emissions by sources of greenhouse gases (GHG) that would occur in the absence of the proposed project activity (i.e. the baseline scenario).~~

~~This baseline methodology shall be used in conjunction with the approved monitoring methodology AM0031 (Monitoring methodology for Bus Rapid Transit project).~~

~~Summary description~~

~~Bus Rapid Transit (BRT) is a bus-based mass transit system that delivers fast, comfortable, and cost-effective urban mobility. A BRT system can reduce greenhouse gas emissions via:~~

- ~~Improved fuel-use efficiency through new and larger buses;~~
- ~~Mode switching due to the availability of a more efficient and attractive public transport system;~~
- ~~Load increase by having a centrally managed organisation dispatching vehicles;~~
- ~~Potentially a fuel switch to low carbon fuels.~~

~~BRT systems replace conventional public transport systems. The new bus system transports passengers who, in absence of the project, would have used the conventional public transport system or other modes of transport such as passenger cars. A reduction or retirement of some of the conventional buses through scrapping, reduction of permits[4] or market-based instruments[5] is thus an integral part of this methodology.~~

[1] No provisions to calculate upstream emissions from the production of biofuels are provided in order to keep the methodology simple. Therefore, in order to ensure that the calculated emission reductions are conservative, this applicability condition aims to limit the use of the methodology to cases where the upstream emissions under the project activity are likely to be equal or lower than in the baseline scenario. Note that other methodologies involving fuel switch situations usually require the consideration of upstream emissions.

[2] Comparable means of the same fuel type e.g. project buses using diesel are compared with conventional buses using diesel etc. The comparison is made for each year of monitoring based on official fuels sold. The term commonly used refers to the majority of units.

[3] Project proponents wishing to consider project busses with a higher biofuel blend may propose a revision of this methodology based on future EB guidance on biofuels use.

[4] Permits to operate certain routes given by the corresponding authority.

II. BASELINE METHODOLOGY PROCEDURE

Project Boundary

The project boundary is defined by the passenger trips completed on the BRT project that is part of the public and private road-based passenger transport sector of the city in which the project is realized. The physical delineation is determined by the outreach of the new BRT or public or private urban passenger transport project.

In case of using electricity from an interconnected grid or captive power plant for the propulsion of the transport systems included in the project boundary, the project boundary also includes the power plants connected physically to the electricity system that supply power to those transport systems. Please refer to the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

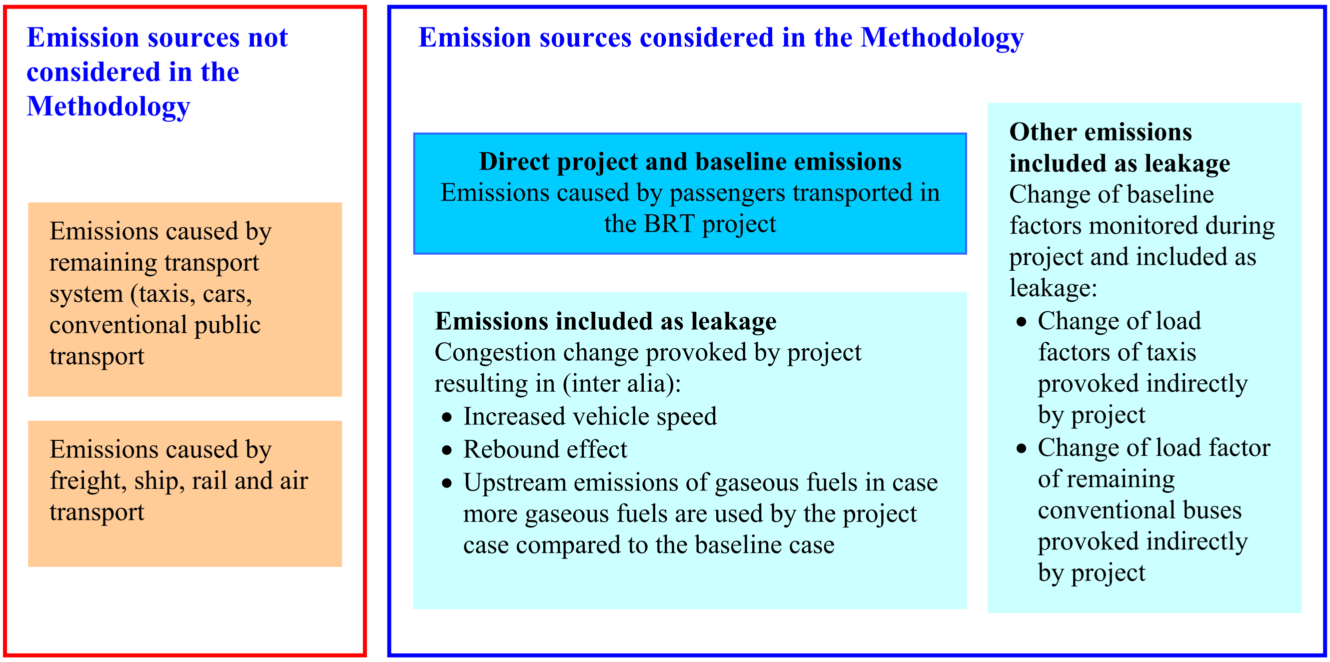


Figure 1: Project Boundary

[5] Incentives or disincentives; A market based strategy is also to simply let the rule of supply and demand work i.e., the reduced demand for conventional non-BRT bus transport will automatically lead to a reduced supply through less passengers i.e., less income and thus a drop in the profit rate for operating buses.

Table 1: Emissions sources included in or excluded from the project boundary

	Source	Gas	Included?	Justification / Explanation
Baseline	Mobile source emissions of different modes of road transport for passengers which use BRT system (buses, passenger cars, motorcycles, taxis)	CO_2	Yes	~~Main~~ Major emission source
		CH_4	Yes	Included only if gaseous fuels are used and excluded for liquid fuels CH_4 emissions are a minor emission source of the total CO_2e emissions in diesel/gasoline vehicles. Neglecting these emissions in baseline as well as project emissions is conservative as fuel consumption and thus also CH_4 emissions are reduced through the project
		N_2O	~~Yes~~ No	N_2O emissions are a minor source of the total CO_2e emissions in diesel/gasoline vehicles. Neglecting these emissions in baseline as well as project emissions is conservative as fuel consumption and thus also N_2O emissions are reduced through the project
Project Activity	BRT bus emissions (feeder and trunk routes)	CO_2	Yes	~~Main~~ Major emission source
		CH_4	Yes	Included only if gaseous fuels are used. See explanation above
		N_2O	~~Yes~~ No	See explanation above

~~**Identification of the Baseline Scenario**~~

~~***Step 1: Identify all options available that meet the same requirement as the proposed project activity***~~

~~Alternatives assessed include, but not limited to:~~

- ~~A continuation of the current public transport system;~~
- ~~The project proposal (BRT system) not implemented as a CDM project activity;~~
- ~~Rail or water-based systems;~~
- ~~Comprehensive re-organization of the transport system.~~

~~***Step 2: Analyze all options identified in Step 1 using the latest version of the "Tool for the demonstration and assessment of additionality"***~~

~~***Step3: If Step 2 results in more than one possible alternative baseline scenario, the most likely baseline scenario is the scenario with the lowest baseline emissions***~~

This methodology is only applicable if the identified baseline scenario is continuation of the current public transport system up to the end of the crediting period. Baseline emissions are those corresponding to existing actual or historical emissions by sources in the baseline scenario and are calculated *ex post*. The parameter "emissions per passenger per trip" (or per passenger per km) is taken to measure the efficiency of the current system in respect to GHG emissions.

Additionality

The additionality of the project is determined using the latest approved version of the "Tool for the demonstration and assessment of additionality".

The following steps are used without repeating the details described in the above mentioned tool:

Step 1: Identification of alternatives to the project activity consistent with current laws and regulations. Alternatives included are at minimum a continuation of the current public transport system and the BRT system proposed as project. All alternatives, which are potentially viable, are included in the further steps and may represent the baseline scenario.

Step 2: In cases where the BRT project is fully privately financed (including roads, infrastructure etc) or where the public financed component is fully repaid on commercial terms through tariffs charged to system users the financial analysis as described in the tool under Step 2 can be used.

If the BRT project is financed partially through public funding, the cost-benefit calculations of the public sector should include external costs and benefits such as the macroeconomic impact of reduced congestion or reduced health costs due to reduced air pollution. The relative comparison shall be made to other transport investment opportunities.

Step 3: Barrier analysis including typical barriers in public transport projects:

- Financial or investment barriers due to resource constraints of public bodies while having many potential investment opportunities aside from transport such as investment in health, education, social welfare etc;
- Prevailing practice barriers if such projects are first in its kind in the region or country;
- Resistance to change from the existing transport operators and resistance to change from an informal to a formal transport system. Transport operators in many countries are a powerful body and fear reduced profits;
- Political resistance or political risk to implement continuously such projects. Urban public transport projects are in general realized in phases. Public authorities however change office and often projects are abandoned after one phase as the political benefit of additional phases is limited and new administrations tend to prefer new projects to reap the related publicity benefits;
- Technological or organizational barriers e.g., if buses with new technologies (e.g., CNG) are introduced or latter require special fuel (e.g., low-sulphur diesel) or the new transport system requires sophisticated management not available currently.

Depending on the project either Step 3 (barrier analysis) or a combination of Step 2 and 3 is undertaken. Where the BRT project is fully privately financed (including roads, infrastructure etc) or where the publicly financed component is fully repaid on commercial terms through tariffs charged to system users, the project proponent should use both investment analysis and barrier analysis. If the infrastructure is fully publicly financed or not being repaid on commercial terms, project proponents may use a barrier analysis only.

~~In many BRT systems only operational costs excluding infrastructure costs are taken as a basis when calculating the tariffs while the infrastructure is paid through other means (e.g. general government revenues or special fuel taxes). The PDD should indicate the sources of financing for the investment, and whether or not these are repaid on commercial terms.~~

~~***Step 4: Common practice analysis assessing the number of similar projects that exist in comparable project contexts without the CDM.***~~

~~***Step 5: Impact of CDM registration***~~

BRT projects implemented in least developed countries (LDC) are deemed to be automatically additional.

If BRT projects are implemented in non-LDCs and face the first-if-its-kind barrier, the latest version of the EB 'Guidelines on additionality of first-of-its-kind project activities' shall be followed to demonstrate the additionality of these project activities.

For MRTS projects, which are implemented in non-LDCs and which are not first-of-its-kind, the following procedure illustrated in Figure 1 and described below shall be applied.

When validating the application of the additionality demonstration, Designated Operation Entities (DOEs) shall carefully assess and verify the reliability and credibility of all data, rationales, assumptions, justifications and documentation provided by project participants to support the demonstration of additionality. The elements and data checked during this assessment and the conclusions shall be documented transparently in the validation report.

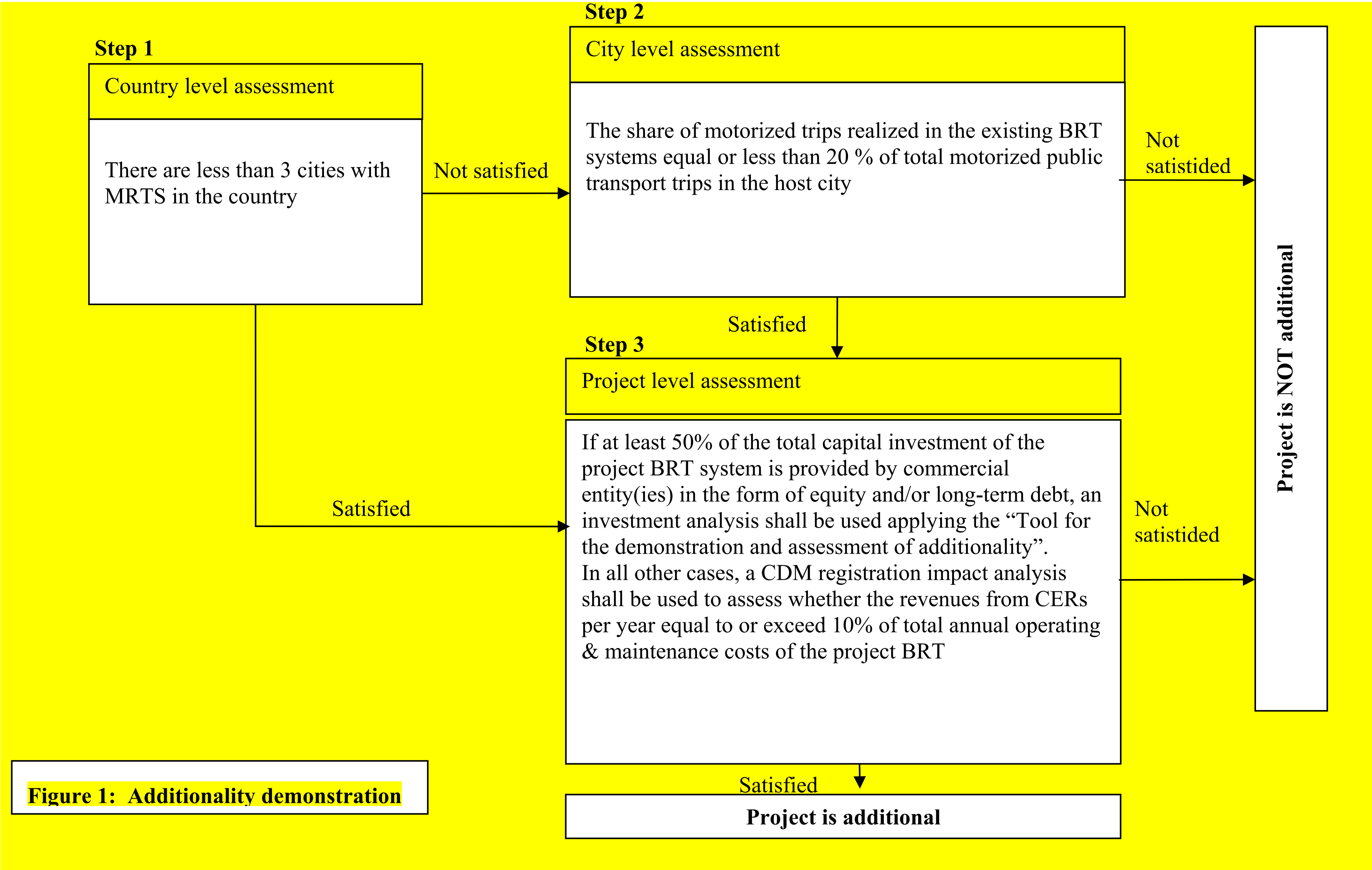


Figure 1: Additionality demonstration

Step 1: Country level assessment

This step aims to determine whether the proposed CDM project activity is common practice in the host country where the project is proposed to be implemented. For this purpose, project participants shall assess whether there are less than 3 cities with MRT systems that started commercial operation in the host country of the proposed CDM project activity prior to the start of the CDM project activity.

The project participants shall:

- Identify all cities with MRTS that have started commercial operation in the host country prior to the start of the CDM project activity. Project participants shall include a brief description of each system in the CDM-PDD;
- Identify which MRT systems were developed as CDM project activities in the host country (registered project activities and project activities which have been published on the UNFCCC website for global stakeholder consultation as part of the validation process) and exclude all[6] MRT systems developed as CDM project activities from the assessment of common practice in this step.

If the number of cities with MRTS (excluding systems developed as CDM project activities) is equal to or exceeds 3 cities, then projects participants should proceed to Step 2, otherwise project participants should proceed to Step 3 (see Figure 1***).***

Step 2: City level assessment

This step aims to determine whether the proposed project activity is common practice in the host city where the proposed CDM project activity is intended to be implemented. For this purpose, project participants shall assess whether the share of trips realized on the existing public transport system(s) in the host city, which belong to the same public transport category as the proposed CDM project activity, is equal or less than 20% of total public transport trips in the host city.

The project participants shall:

- Provide a breakdown of the total public transport trips realized in the host city by the shares of trips realized on different public transport categories, distinguishing between the following public transport categories:
    - Metro;
    - Sub-urban rail;
    - Light rail transit including trams;
    - Conventional bus system;
    - BRTs.
- Describe in the CDM-PDD the existing public transport systems and identify to which of the public transport categories they belong. Identify also to which public transport category the proposed project activity belongs. Determine and document in the CDM-PDD the shares of trips realized on each relevant public transport system and on each public transport category, expressed

[6] This is subject to further decisions by the Executive Board.

in percentages of the total public transport trips realized on all public transport systems in the host city.

If the share of motorized trips realized on the existing BRTs exceeds 20% of total motorized public transport trips in the host city, then the proposed CDM project activity is not additional. If the share of trips is equal or below 20%, then project participants should proceed to Step 3.

Step 3. Project level assessment

Two procedures are provided to demonstrate the additionality of the proposed project activity, depending on whether a commercial entity(ies) covers at least 50% of total capital investment in the project BRT system.

- If at least 50% of the total capital investment in the project BRT system is provided by commercial entity(ies) in the form of equity and/or long-term debt, an investment analysis shall be conducted, following procedure A below;
- In all other cases, an impact assessment of CDM project registration shall be conducted, following procedure B below.

Procedure A: Investment analysis

The aim of this analysis is to determine whether the proposed project activity is not economically or financially feasible using "Option III. Benchmark analysis", including the sensitivity analysis, provided in the "Tool for the demonstration and assessment of additionality".

The investment analysis should be undertaken from the perspective of the private sector operator/investor of the public transportation system of the city or urban area, reflecting the costs and revenues from the perspective of the operator/investor. If the project is subsidized through public authorities and institutions (e.g. local or central government, international donor organizations), e.g. through grants which do not need to be repaid, soft loans or contributions to operating and maintenance costs, or deficit guarantees, the financial assessment is made, taking into account these subsidies, including as investment the total system costs minus any such public subsidies. Any capital that needs to be repaid should be included in the calculations, e.g. loans by the municipality or city authority should be considered as a capital investment by the project operator and not be subtracted from the total system costs.

In applying the investment analysis, cost overruns of former investments in BRTs or reduced revenues of former BRTs investments compared to original projections, which make new investments less viable and riskier, can be considered in the investment analysis. In this case, project participants should evaluate the cost overruns or reduced revenues of former BRTs that were implemented in the same host country in the last 20 years. Information on originally projected and actually observed costs/revenues should be based on official and public data. As a conservative approach, the lower end of the range of cost-overruns or reduced revenues observed over this period should be assumed for the project BRT.

If the sensitivity analysis is not conclusive, then the project activity is not additional. If the sensitivity analysis confirms the proposed project activity is not economically attractive, then the proposed project activity is additional.

Procedure B: Analysis of the impact of CDM registration

The aim of this step is to determine whether the annual revenues from CERs constitute a significant proportion of the total annual operating and maintenance costs of the project BRT. For this purpose, the project participants shall assess whether the annual revenues from CERs are equal to or exceed 10% of the total annual operating and maintenance costs of the project BRT. For the purpose of this analysis, project participants should use the amount of operating and maintenance costs and the amount of CERs that are expected to be reached when the project BRT system will reach its planned capacity. This analysis shall be conducted one time *ex-ante* for the additionality demonstration purpose only. All assumptions used in calculations need to be documented and substantiated in the CDM-PDD. The input values and data used to conduct the analysis of the impact of CDM registration shall comply with the same requirements as the input values and data used to conduct the investment analysis specified in the "Tool for the demonstration and assessment of additionality".

The project participants shall:

- Provide an *ex-ante* assessment of the revenues from CERs per year expected to be generated by the proposed project activity. For this assessment, operating and maintenance costs as well as passenger demand shall be estimated for the year when the BRT system is expected to reach its planned stable operation. The price of CERs should be taken as the average secondary CER price for the full year prior to the submission of the CDM-PDD for validation. In case the project participants signed an emission reduction purchase agreement with a buyer, the CER price from this purchase agreement can be used for the calculations;
- Document and describe transparently the operational and maintenance cost components that are taken into account and provide an estimate of the total expected operating and maintenance costs of the proposed project activity per year, justifying relevant assumptions.

An indicative list of operational and maintenance cost categories that project proponents should include in the analysis is presented in **Error! Reference source not found.** below. Depending on the specific circumstances of the proposed project activity, operational and maintenance cost components of a particular BRT may differ from those listed in Table 1, which is provided as an example.

Table 1: Operational and maintenance cost components of BRTs

Item	**Unit of accounting in cost calculations**
Fixed operating costs	
Driver salaries	Employees/vehicle
Salaries of mechanics	Employees/vehicle
Salaries of administrative personnel and supervisors	Employees/vehicle
Other administrative expenses	% of variable costs + maintenance + personnel
Fleet issuance	% of value of vehicle/year
Variable operating costs	
Fuel	Liters/ 100 km m^3 of natural gas/100 km
Tires • New tires • Retreading	 Units/ 100,000 km Units/ 100,000 km

Item	Unit of accounting in cost calculations
Lubricants • Motor • Transmission • Differential • Grease	 Liters /10,000 km Liters /10,000 km Liters /10,000 km Kilograms/10,000 km
Maintenance	% value of vehicle/year

Source: GTZ 2005. Mass transit options.

If the annual revenues from CERs are equal to or exceed 10% of the total annual operating and maintenance costs of the BRT proposed as CDM project activity, then the proposed CDM project activity is additional. Otherwise, the proposed CDM project activity is not deemed additional.

If the project activity is deemed to be additional, then the baseline scenario is assumed to be the continuation of the use of current modes of transport provided that the project participants can provide an explanation showing that the existing transport system would be sufficient to meet the transportation demand that will be met by the project system.

Baseline emissions

Baseline emissions are estimated using two main steps:

(1) Determination of emissions per passenger transported per vehicle category: This is calculated *ex ante*, including the usage of a fixed technology change factor. The baseline emission factor is adapted to potential changes in trip distance and type of fuel used by passenger cars if the surveys indicate that changes in trip distance or fuel type used would lead to lower baseline emission factors;

(2) Baseline emissions: are estimated *ex post* based on the passengers transported by the project and their modal split. Core baseline parameters used for calculating the baseline emission factors are reviewed through an annual survey, with changes only being applied if the baseline emissions factors would be lower than the original factor. The system operator records passenger numbers.

Note: If the project does not generate credits for the modal ~~switch~~ shift, it need not determine emissions per passenger using passenger cars, taxis or motorcycles. The annual modal survey will also not include these categories or questions related directly to these categories (change of trip distance of passenger cars or fuel type of passenger cars). The survey will, however, include the categories of public transport, non-motorised transport (NMT), and induced traffic (i.e. categories with emission factors lower than the project, to ensure that emission reductions are not overstated).

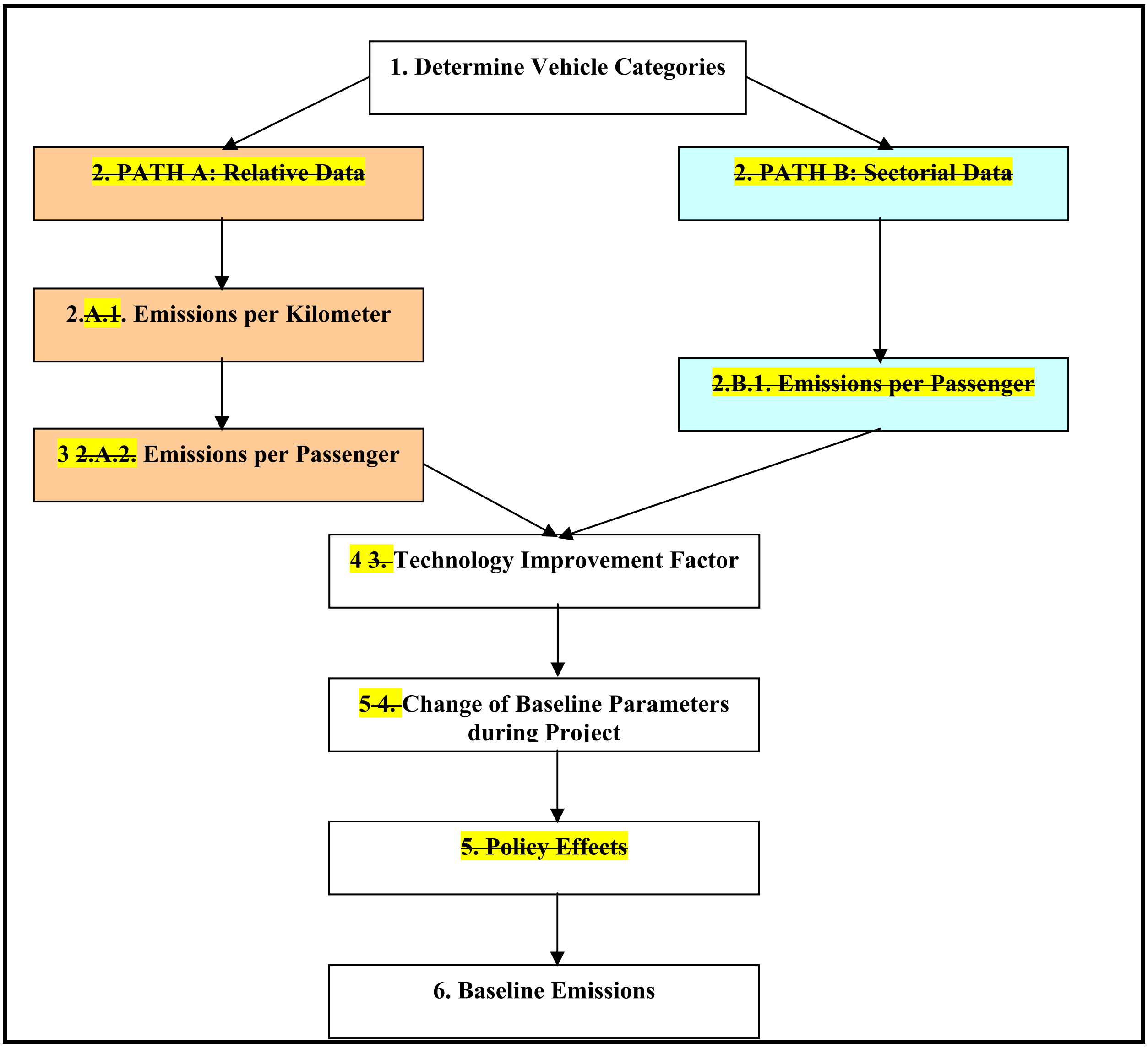


Figure 2: Determination of Baseline Emissions

~~Two methodological alternatives or paths can be used to determine the baseline emission per passenger transported:~~

~~(A) As a function of emissions per kilometre and passengers per kilometre;~~

~~(B) As a function of sectoral fuel consumptions per vehicle category and passengers transported.~~

~~A mixed approach can also be used i.e., approach A for certain vehicle categories and approach B for others. The criteria for selecting of the approach are data availability and data quality.~~

~~Note: Alternative B should only be chosen if the project proponent can ascertain that full consumption data as well as total passenger transported data are consistent (spatial, and vintage) and complete. This shall be verified by the DOE at validation.~~

Baseline emissions are determined through a sequence of the following steps:

1. Determine Vehicle Categories

Identify relevant vehicle categories, which include:

- Buses, differentiating large, medium and small buses, if appropriate;
- Passenger cars;
- Taxis;
- Motorcycles.

Criteria for identifying the categories are as follows:

- At a minimum, public transport, non-motorised transport and induced traffic have to be included;
- Conditions to include categories ~~are that there are~~ with reliable data on fuel consumption and load factors;
- Only include categories that are relevant for the BRT project. If the project will only generate credits from public transport without modal ~~switch~~ shift, then passenger cars, taxis and motorcycles need not be included;
- Differentiate relevant fuel types for each category. Diesel, gasoline and gas (CNG or LPG) are listed separately if a minimum of 10% of vehicles of the respective category use such a fuel, while the threshold for zero-emission[7] fuels is minimum 1%. The 10% threshold is justified, as GHG emission differentials between diesel, gasoline and gaseous fuels are less than 20%;
- In case of a system extension, the currently operating system is not included as a vehicle category.

~~2.A. Calculate Emissions Per Passenger Based on Relative Data~~

2.~~A.1.~~ Determine Emissions per Kilometre for Vehicle Categories

CO_2e emissions per kilometre are calculated, fixed *ex ante* for the project period, based on the consumption of each fuel type, the CO_2e emissions per litre of fuel and the fraction of vehicles using the specific fuel type.

- CO_2 emissions are ~~developed~~ estimated on the basis of the carbon content of the fuel;
- CH_4 and N_2O emission factors: CH_4 emissions are a function of the fuel and engine type, and any post-combustion controls. N_2O emissions are technology based for each fuel type, vehicle category, installed control technologies and local data such as average driving speeds, temperatures, and altitude. The emission factors are transformed into CO_{2eq} using GWP factors approved by the Conference of the Parties to the UNFCCC. CH_4 and N_2O emissions from gaseous fuels shall be accounted for. They can be ignored for liquid fuels, such as diesel and gasoline, as CH_4 and N_2O emissions constitute a minor emission source for liquid fuels.

[7] Zero-emission in the context of operating emissions and not well-to-wheel or life-cycle emissions; this includes hydrogen.

Two methods are possible to determine the relevant CH_4 and N_2O emission factors of gaseous fuels:

(1) Local measured emission factors based on a reliable data source to be detailed in the PDD;

(2) The pre-determined default value per vehicle category is used (described later in this section). The default value per vehicle category is the technology with the lowest sum of CO_{2eq} emissions of N_2O and CH_4. This ensures a conservative approach.

Alternative 1 is preferred. However, using the default value is a conservative approach. ~~Using fixed and average values is also justified as CH_4 as well as N_2O emissions in vehicles account, on average, for less than 1-2% of total CO_2e emissions.~~

~~The default parameters per vehicle category for CH_4 and N_2O are presented in the Appendix in gCO_2e per litre of fuel consumed.~~

If electricity is used by vehicles the emissions are calculated based on the latest approved version of the "Tool to calculate project, baseline and or leakage emissions from electricity consumption".

In case biofuel blends are used the biofuel share is calculated with a CO_2eq emission factor equal to zero.

This equation calculates emissions per km for vehicles of different vehicle categories.

$$EF_{KM,i} = \sum_x \left[SEC_{x,i} \times \left(EF_{CO2,x} + EF_{CH4,x} + EF_{N2O,x} \right) \times \left(\frac{N_{i,x}}{N_i} \right) \right] \quad (1)$$

Where:

$EF_{KM,i}$	=	Transport emissions factor per distance of vehicle category i (gCO_2e per kilometer driven)
$SEC_{x,i}$	=	Specific energy consumption of fuel type x in vehicle category i (litre ~~per~~ / kilometer, kWh/km, kg/km, m^3/km)
$EF_{CO2,x}$	=	CO_2 emission factor for fuel type x (gCO_2 per litre)
$EF_{CH4,x}$	=	CH_4 emission factor for gaseous fuel type x (gCO_2e per litre, based on GWP)
$EF_{N2O,x}$	=	N_2O emission factor for gaseous fuel type x (gCO_2e per litre, based on GWP)
N_i	=	Total number of vehicles in category i
$N_{i,x}$	=	Number of vehicles in vehicle category i using fuel type x

If ~~fewer~~ less than 10% of vehicles in a specific vehicle category are gasoline, diesel, CNG or LPG powered then this respective fuel can be omitted for simplicity purposes. In alternative vehicles the threshold value is ~~less than~~ 1%.

Two methodological alternatives are proposed for the fuel consumption data (in order of preference):

- Alternative 1: Measurement of fuel consumption data using a representative sample for the respective category and fuel type. To ensure a conservative approach the ~~top 20% of the sample is not included in calculations~~ lower 95% confidence level of the sample measurement shall be taken;
- Alternative 2: Use of fixed values based on the national or international literature. The literature data can either be based on measurements of similar vehicles in comparable surroundings (e.g. from comparable cities of other countries) or may include identifying the vehicle age and technology of average vehicles circulating in the project region and then

matching this with the most appropriate IPCC default values. The most important proxy to identify vehicle technologies is the average age of vehicles used in the area of influence of the project. To determine if either US or European default factors apply either local vehicle manufacturer information can be used (in the case of having a substantial domestic vehicle motor industry) or a source of origin of vehicle imports.

A technical improvement factor is thereafter introduced. The technology improvement factor results in dynamic emission factors for the different units. See Step 3.

3 ~~2.A.2~~.Calculate Emissions per Passenger per vehicle Category

This step calculates emission factors showing the emissions per passenger per average trip for each vehicle category.

This equation is used to determine the emissions per passenger transported for passenger cars, taxis or motorcycles. All data used is determined *ex ante* ~~project~~. A change in the occupancy rate of taxis is registered as leakage of the project.

$$EF_{P,i} = \frac{EF_{KM,i} \times TD_i}{OC_i} \tag{2}$$

Where:

$EF_{P,i}$	=	~~Transport~~ emissions factor per passenger before project start, where $i = C$ (passenger cars), M (motorcycles) or T (taxis) (grams per passenger)
$EF_{KM,i}$	=	~~Transport~~ emissions factor per distance of category i (gCO_2e per kilometer driven)
OC_i	=	Average vehicle occupancy rate of vehicle category i[8] (passengers)
TD_i	=	Average trip distance for vehicle category i (kilometers)

The formula below shall be used in case fuel consumption data is based on specific fuel consumption (SFC) values obtained through sampling or from literature:

~~$$EF_{P,Z} = \frac{EF_{KM,Z,S} \times DD_{Z,S} + EF_{KM,Z,M} \times DD_{Z,M} + EF_{KM,Z,L} \times DD_{Z,L}}{P_Z} \quad (3)$$~~

$$EF_{P,i} = \frac{EF_{KM,i,S} \times DD_{i,S} + EF_{KM,i,M} \times DD_{i,M} + EF_{KM,i,L} \times DD_{i,L}}{P_i} \tag{3}$$

Where:

~~$EF_{P,Z}$~~ $EF_{P,i}$	=	~~Transport~~ emissions factor ~~in~~ for buses for before ~~the~~ project start (~~grams~~ gCO_2e per passenger)
~~$EF_{KM,Z,S}$~~ $EF_{KM,i,S}$	=	Emissions from small buses (gCO_2e per kilometer)
~~$DD_{Z,S}$~~ $DD_{i,S}$	=	Total distance driven by small buses (kilometer)

[8] In the case of taxis the driver is not counted and only passengers are included in the occupancy rate.

$EF_{KM,Z,M}$ $EF_{KM,i,M}$ = Emissions from medium buses (gCO_2e per kilometer)

$DD_{Z,M}$ $DD_{i,M}$ = Total distance driven by medium buses (kilometer)

$EF_{KM,Z,L}$ $EF_{KM,i,L}$ = Emissions from large buses (gCO_2e per kilometer)

$DD_{Z,L}$ $DD_{i,L}$ = Total distance driven by large buses (kilometer)

P_Z P_i = Passengers transported by buses in the baseline

The time period for the number of passengers and the distance they travel must be equal (e.g. one year or one month). All data used is determined *ex ante* project. A change in the occupancy rate of buses is registered as leakage of the project.

In case the fuel consumption of buses is based on total fuel consumed by the baseline bus system, no differentiation between bus size shall be made and the following formula shall be used:

$$EF_{P,i} = \frac{\sum_x FC_x \times NCV_x \times EF_x \times IR}{P_i} \quad (4)$$

Where:

$EF_{P,i}$	=	Emissions factor for buses for before the project start (gCO_2e per passenger)
FC_x	=	Total fuel type x consumed by the baseline bus system prior to the project start
NCV_x	=	Net calorific value of fuel type x consumed by the baseline bus system prior to the project start (J/mass or volume unit)
EF_x	=	Emission factor of fuel type x consumed by the baseline bus system prior to the project start
IR	=	Technology improvement factor
P_i	=	Passengers transported by buses in the baseline

2.B. Calculate Emission Factor Based on Sector Data

This approach is based on sector fuel consumption data and differentiates fuel consumption per fuel type for all different vehicle categories such as identified in the first step.

Following conditions apply to using this alternative:

- A study on sector fuel consumption separating the vehicle categories is available with a confidence interval of minimum 95% (i.e., maximum error margin of 5%);
- The geographic region of the project can be separated well;
- Data for fuel consumption must have the same year/time period and the same geographic boundaries as data of passengers transported;
- Data must be cross-checked with total fuel consumption of the region.

Calculates the emission factor per passenger for different vehicle categories.

$$EF_{P,i} = \frac{\sum_{x}\left[TC_{x,i} \times \left(EF_{CO2,x} + EF_{CH4,x} + EF_{N2O,x}\right)\right]}{P_i} \quad (5)$$

Where:

$EF_{P,i}$	=	Transport emissions factor in vehicle category *i* before project start (grams per passenger)
$TC_{x,i}$	=	Total consumption of fuel type *x* by vehicle category *i* (litres)
$EF_{CO2,x}$	=	CO_2 emission factor for fuel type *x* (gCO_2 per litre)
$EF_{CH4,x}$	=	CH_4 emission factor for fuel type *x* (gCO_2e per litre, based on GWP)
$EF_{N2O,x}$	=	N_2O emission factor for fuel type *x* (gCO_2e per litre, based on GWP)
P_i	=	Passengers transported by category *i* in the baseline

3. Technological Change

Under business as usual conditions emission factors per vehicle category per fuel type may change due to:

- Vehicles are replaced with more efficient ones;
- Vehicles in stock tend to increase emissions based on wear and tear.

For simplicity purposes, a constant average improvement rate per annum is established per vehicle category. The improvement rate is applied to each calendar year. The Yyear 0 is the year for which specific or sector fuel consumption data was collected or determined. Emissions per vehicle category are multiplied with the corresponding technology improvement factor. The default technology improvement factors per vehicle category are included in the appendix A.

4. Change of Baseline Parameters during the Pproject crediting period

The change of baseline parameters is only necessary if the project includes a modal-switch shift (change from passenger cars, motorcycles or taxis to BRT). In this case, some parameters used for calculating the baseline emission factors could change over time:

- The load factor or the number of passengers per vehicle. The load factor is potentially influenced indirectly by the project. This factor is included in the monitoring of leakage of the project and thus not included in the baseline calculations;
- The distance driven by passengers using the BRT system might change or not be equivalent to the average distance driven used to calculate the baseline emission parameter. This factor is monitored through the annually conducted survey conducted annually of passengers using the project system (see corresponding monitoring methodology);
- Type of fuel used by passenger cars. This factor is only relevant for people who have switched from cars to public transport. The annual passenger survey monitors the fuel used by passengers switching from passenger cars to the BRT system and adjusts the corresponding baseline emission factor for passenger cars.

The methodology only takes into account those changes in passenger emission factors ~~into account if these are reduced~~ that lead to a reduction in baseline emissions.
Details of the survey ~~used for data on~~ to be conducted to monitor the changes ~~of~~ in trip distances ~~as well as for~~ and the changes ~~of~~ in the fuel types used by passenger cars are included in the monitoring methodology section.

The baseline emissions per passenger trip for taxis, passenger cars and motorcycles are adjusted annually with a correction factor for changing trip distances.

$$CD_{i,y} = \frac{TD_{i,y}}{TD_i} \quad \textbf{(5)}$$

Where:

$CD_{i,y}$	=	Correction factor for changing trip distance in category i for the year y, where $i = T$ (taxis), C (passenger cars) or M (motorcycles)
TD_i	=	Average trip distance in kilometers in category i before the project start
$TD_{i,y}$	=	Average trip distance in kilometers in category in year y

Note: The adjustment is only made if $TD_{i,y} < TD_i$ to ensure a conservative approach.[9]

4.1. Change of Fuel Used by Passenger Cars

For passengers that, in absence of the project, would have used a passenger car, the type of fuel used by their cars is determined via a survey (see Monitoring Methodology). Equation (1) is used to re-calculate the new emission factors for passenger cars. The same threshold values for fuel types apply as described in Step 1 (determination of vehicle categories).

The applicability condition for applying this change in fuel type used for passenger cars is: $EF_{KM,C,y} < EF_{KM,C}$. In other words, the baseline emission factor is only changed, if the new emission factor is lower than the original emission factor.

Note: This question, and the corresponding adjustment in the emissions factor estimation, is only included in the survey, if modal ~~switch~~ shift from passenger cars and the associated emission reductions are included in the project.

[9] Larger distances would increase baseline emissions per passenger trip. The project emissions ~~of~~ resulted from larger trip distances are however fully recorded as project emissions are based on total fuel consumed.

5. Policy Effects

Only policies with a measurable impact on GHG emissions shall be considered. Project participants need to assess if policies might have effects on various parameters. To remain conservative the full impact monitored is attributed to the policy.[10] All relevant policies and their impact are included in the baseline from the date of their planned implementation.[11] However, broad development strategies and concepts are not considered if they do not have a legally binding character including as minimum an implementation date, enforcement procedures and clear activities.

The project proponent shall analyse all policies following these steps:

(1) Identification of policies with a potential impact on GHG emissions of the current transport system;

(2) Has the policy been legally adopted with a clear implementation date? If no implementation date is given then the policy is not further considered. If the date is fixed and within the time frame of the project proposed then the policy is included in the analysis;

(3) Assess the potential impact of the policy on any of the baseline parameters listed above;

(4) Introduce a correction factor if required. The correction factor must be determined to achieve a conservative result.

A general equation for introducing policy aspects cannot be stated at the level of a methodology as this element is project specific.

Policies and their implementation data are assessed *ex ante*. Monitoring shall be carried out on a regular basis for policies affecting parameters of the baseline. This involves:

(1) Assessing new and enforced policies, which could significantly affect the modal split of passengers in the project area. This is defined here as policies which expect to change the modal split by 5% or more towards public transport. If several policies, which change the modal split, are enforced during the project's crediting period then the cumulative effect of these policies must be superior to 5 percentage points. This threshold value only applies to policies affecting the modal split. The expected modal split change is based on calculation or targets realized by the policy proponents (i.e., the ministry or governmental authority in charge of the policy). If such a policy has been enforced in year *x*, a year where no survey has been carried out, the modal split of the most recent year prior to that no survey is realized, and the modal split of the year x-1 is applied to all passengers using the system;

(2) Assessing new and enforced policies that change the fuel usage of vehicles (either fuel type or regulations concerning maximum fuel usage). This potentially changes the emission factor per distance driven of vehicles;

(3) Assessing any other policy which results in a measurable and verifiable manner in a change of a parameter used for calculating baseline emissions such as a compulsory technology change by establishing and enforcing maximum vehicle ages.

[10] E.g. a new policy to reduce private vehicles will potentially have an impact on the modal split. The full change of the modal split will be accounted as a result of the policy even though this could also be influenced by other factors e.g. improved supply of public transport.

[11] Policies, which potentially have an impact, include mainly fuel policies (e.g. compulsory usage of bio-fuel blends), fiscal policies (e.g. differential fuel taxes according to carbon contents), and transport policies (e.g. promotion of Non-Motorized Transport or car restriction policies).

Determination of Baseline Emissions

The baseline emissions for all passengers transported are calculated. This is differentiated according to the mode of transport, which the person would have used in absence of the project. Passengers transported are determined through the project (activity level of the project). The system operator shall report the total amount of passengers transported by the project.

$$BE_y = \sum_i \left(EF_{P,i,y} \times P_{i,y} \right)$$

$$BE_y = \sum_i \left(EF_{P,i,y} \times P_{i,y} \right) \times 10^{-6} \quad (6)$$

Where:

BE_y	=	Baseline emissions in year y (tCO_2e)
$EF_{P,i,y}$	=	Transport emissions factor per passenger in vehicle category i in year y (grams per passenger)
$P_{i,y}$	=	Passengers transported by the project (BRT) in year y that without the project activity would have used category i, where i = Z (buses, public transport), T (taxis), C (passenger cars), rail-based urban mass transit (R) or M (motorcycles)[12] (millions of passengers)

$$EF_{P,i,y} = EF_{P,i} \times IR_{i,t} \times CD_{i,y} \quad (7)$$

Where:

$EF_{P,i,y}$	=	Transport emissions factor per passenger in vehicle category i in year y (grams gCO_2e per passenger)
$EF_{P,i}$	=	Transport emissions factor per passenger before the project start, where $i = T$ (taxis), C (passenger cars) or M (motorcycles) (grams gCO_2e per passenger)
$CD_{i,y}$	=	Correction factor for changing trip distance in category i for the year y, where $i = T$ (taxis), C (passenger cars) or M (motorcycles)
$IR_{i,t}$	=	Technology improvement factor at year t for vehicle category i
t	=	Age Vintage in years of fuel consumption data (in years) used for calculating the emission factor in year y[13]

See applicability condition for $CD_{i,y}$ (Equation 5: The adjustment is only made if $TD_{i,y} < TD_i$). For passenger cars, $EF_{KM,C,y}$ is annually adjusted as described under heading in Section 4.1 above, considering the applicability condition of reduced emissions per kilometer.

Emissions from passengers which who in absence of the project would have used rail-based mass transit systems (R) are counted as $EF_{P,R,y} = 0$ grams per passenger.

$$P_{i,y} = P_y \times S_{i,y} \quad (8)$$

[12] NMT and induced transport (IT) are not included as emissions are 0 for this category in the baseline.
[13] E.g. “t=7” for the year 2007 if the fuel data is from the year 2000.

Where:

$P_{i,y}$	=	Passengers transported by the project which in absence of the latter would have used transport type *i*, where *i* = *Z* (buses, public transport), *T* (taxis), *C* (passenger cars), *M* (motorcycles), *NMT* (non-motorized transport), *R* (rail-based urban mass transit) and *IT* (induced transport, i.e., would not have traveled in absence of project) (millions)
P_y	=	Total passengers transported by the project monitored in year *y* (millions)
$S_{i,y}$	=	Share of passengers transported by the project ~~which~~ who in absence of the latter would have used transport type *i*, where *i* = *Z* (buses, public transport), *T* (taxis), *C* (passenger cars), *M* (motorcycles), *NMT* (non-motorized transport), *R* (rail-based urban mass transit) and *IT* (induced transport, i.e., would not have traveled in absence of project) (%)

If the project does not include an estimate of credits for modal shift then the survey only includes the categories of public transport, NMT, rail-based urban mass transit and induced traffic. Details of the survey are found in the appendix B.

Induced travel is included in leakage calculations (induced travel in passenger cars) as well as in the baseline (induced travel in public transport).

~~**Sensitivity Analysis**~~

~~A sensitivity analysis is carried out for data and parameters, which are used to calculate baseline as well as project emissions (at minimum where uncertainty level of data is considered moderate or high). The PDD shall identify data with this level of uncertainty. The sensitivity analysis shall also identify potential critical parameters and to further discuss these in the PDD.~~

~~The sensitivity analysis made shall be based on calculating the change of the data parameter that would be required to reduce emission reductions by 5%. This value gives an indication of the magnitude of change of the data parameter required to significantly change calculated emission reductions. A sensitivity analysis shall be undertaken at a minimum for the load factor and for the modal distribution.~~

~~Steps to carry out the sensitivity analysis include:~~

~~(1) Identify all data with moderate or high uncertainty levels;~~

~~(2) Carry out a sensitivity analysis on these parameters calculating the level of change of the parameter required to reduce emission reductions by 5% below that originally estimated;~~

~~(3) Assess the result in light of possible data uncertainty:~~

- ~~The parameter change required is considered as highly improbable. The PDD needs to deliver the arguments why this is considered improbable;~~
- ~~The parameter change is considered as plausible. In this case the maximum plausible change must be incorporated in the parameter to assure for a conservative calculation of emission reductions e.g. if fuel consumption values for the baseline could also be 20% lower and would change the emission reductions by more than 5% then the PDD must use a parameter for fuel consumption which is 20% lower than the original data indicates.~~

Project emissions

The project emissions are only from the new project transport system. All emissions from trips undertaken in the new system need to be included (i.e., both on trunk routes and feeder lines).

Total emissions can be calculated in one of the two ways, depending on data availability. If records exist, the data quality of both alternatives is equal. Reliable data are, e.g. based on electronic measurement of fuel consumption or data monitored by the bus company managing the units. For both alternatives, specific fuel consumption data (i.e., consumption per distance driven) needs to be crosschecked in the QA system. Cross-checks include a comparison over time within the same company, as well as a comparison with, e.g. other companies operating ~~in the~~ BRT systems using the same type of buses.

Alternative A: Use of Fuel Consumption Data

This alternative is based on the total fuel consumed. For BRTs using liquid fossil fuels, the project emissions from fossil fuel consumption shall be estimated using the latest version of the 'Tool to calculate project or leakage CO_2 emissions from fossil fuel consumption.' The following guidance is provided for applying the tool:

- The parameter $PE_{FC,j,y}$ in the tool corresponds to the project emissions from the project transport system that uses fossil fuels in year *y*; and
- Element process *j* corresponds to the combustion of fuel type *x* in the project vehicles.

For BRTs using gaseous fossil fuels, the project emissions from fossil fuel consumption shall be estimated according to the following equation:

~~$$PE_y = \sum_x \left[TC_{PJ,x,y} \times (EF_{CO2,x} + EF_{CH4,x} + EF_{N2O,x})\right] \quad (9)$$~~

$$PE_y = \sum_x \left[FC_{PJ,x,y} \times (EF_{CO2,x} + EF_{CH4,x} + EF_{N2O,x})\right] \quad (9)$$

Where:

PE_y	=	Project emissions in year *y* (tCO_2e)
~~T~~$FC_{PJ,x,y}$	=	Total consumption of fuel type *x* in year *y* by the project (million litres)
$EF_{CO2,x}$	=	CO_2 emission factor for fuel type *x* (gCO_2 per litre)
$EF_{CH4,x}$	=	CH_4 emission factor for gaseous fuel type *x* (gCO_2e per litre, based on GWP)
$EF_{N2O,x}$	=	N_2O emission factor for gaseous fuel type *x* (gCO_2e per litre, based on GWP)

For BRTs using electricity, the emissions from electricity consumption are based on the latest approved version "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".[14]

Alternative B: Use of Specific Fuel Consumption and Distance Data

This alternative uses as a basis fuel efficiency data (i.e. consumption per kilometre driven).

$$EF_{KM,j,y} = \sum_x \left[SEC_{j,x,y} \times \left(EF_{CO2,x} + EF_{CH4,x} + EF_{N2O,x}\right)\right] \quad (10)$$

Where:

$EF_{KM,j,y}$	=	~~Transport~~ emissions factor per distance for project bus category *j* in year *y* (gCO_2e per kilometer)
$SEC_{j,x,y}$	=	Specific energy consumption of fuel type *x* in project bus category *j* in year *y* (litre per kilometer)
$EF_{CO2,x}$	=	CO_2 emission factor for fuel type *x* (gCO_2 per litre)
$EF_{CH4,x}$	=	CH_4 emission factor for gaseous fuel type *x* (gCO_2e per litre, based on GWP)
$EF_{N2O,x}$	=	N_2O emission factor for gaseous fuel type *x* (gCO_2e per litre, based on GWP)

Fuel-efficiency data is derived from annual data reported by the bus companies operating the units either of all units or of a representative sample of comparable units (comparable technology, vintage and size). To ensure a conservative approach, ~~all data with specific fuel consumption values which are more than 20% lower than the average specific fuel consumption of comparable units are omitted from calculations~~ the specific fuel consumption of comparable vehicles, if based on sample measurement, should be taken as the upper 95% confidence level of the sample measurement conducted. This ensures a conservative approach, ~~as~~ providing that project emissions are ~~potentially~~ not overstated.

If the CDM project includes only parts of a larger activity, the fuel used for the CDM project is separated from the total fuel used. The separation is done (in order of preference) by the following means:

- By operators: This method is used if certain operators are assigned to certain parts of the project;
- By distance driven: The fuel share for each part of the project is based on the share of kilometers per project part;
- By passengers: The fuel share for each part of the project is based on the share of passengers per part of the project (based on the entry points of passengers).

Total project emissions are calculated from the following equation.

~~$$PE_y = [(EF_{KM,TB,y} \times DD_{TB,y}) + (EF_{KM,FB,y} \times DD_{FB,y})] \quad (11)$$~~

$$PE_y = [(EF_{KM,TB,y} \times DD_{TB,y}) + (EF_{KM,FB,y} \times DD_{FB,y})] \times 10^{-6} \quad (11)$$

Where:

PE_y	=	Project emissions in year *y* (tCO_2e)
$EF_{KM,TB,y}$	=	~~Transport~~ emissions factor per distance for trunk buses in year *y* (gCO_2e per kilometer)
$DD_{TB,y}$	=	Total distance driven by trunk buses in year *y* (million kilometers)
$EF_{KM,FB,y}$	=	~~Transport~~ emissions factor per distance for feeder buses in year *y* (gCO_2e per kilometer)
$DD_{FB,y}$	=	Total distance driven by feeder buses in year *y* (million kilometers)

Leakage

The following leakage sources are addressed:

(1) Change ~~of~~ in load factor of the baseline transport system due to the project, i.e., the project potentially influences the occupancy rate of the remaining vehicles. This is monitored ~~on a regular basis during project execution~~ in the year 1 and 4 of the crediting period;

(2) Reduced congestion in remaining roads, provoking higher average vehicle speed, plus a rebound effect. The total impact of congestion is ~~calculated ex ante~~ monitored in the year 1 and 4 of the crediting period, in case the implementation of the project activity leads to a reduction of road space (e.g. the project utilises an existing road by separating one of its lanes to be exclusively used by the project BRT), and not monitored, in case the implementation of the project activity does not lead to a reduction of road space (e.g. the project provides a new road infrastructure);

(3) In case of more gaseous fuel are used in the project than in the baseline case, the upstream emissions of gaseous fuels should be included. No leakage emissions should be included if in the baseline more or an equal amount of gaseous fuel are used than in the project as this would lead to negative leakage (conservative approach).

For the sake of a conservative approach, leakage is only considered if the total annual effect is to reduce estimated emission reductions.

1. Change ~~of~~ in Load Factor

The project could have a negative impact on the load factor of taxis or the remaining conventional bus fleet. Load factor changes ~~in the baseline public transport system~~ of taxis and buses are thus monitored in the year 1 and 4 of the crediting period. Leakage is only included if the load factor changes by more than 10 percentage points, as certain variations in the load factor caused by external circumstances are normal. The methodology also considers load factor changes in taxis if they are included as vehicle category by the project, thus claiming credits from a modal shift from taxis to the BRT system. In the case of lower load factors, it is assumed that this change has occurred immediately after the last measurement, and the leakage calculation for this year includes the sum of load-factor leakage of all years since the last monitoring. This ensures a conservative approach. To avoid the risk of having to include *ex post* leakage from former years, the project proponent can monitor the load factor annually.

$$ROC_{i,y} = \frac{OC_{i,y}}{CV_{i,y}} \qquad (12)$$

Where:

$ROC_{i,y}$	=	Average occupancy rate relative to capacity in category i in year y, where i = Z (buses) or T (taxis)
$OC_{i,y}$	=	Average occupancy of vehicle in category i in year y (persons)
$CV_{i,y}$	=	Average capacity of vehicle i in year y (persons)

In the case of public transport, the occupancy rate is measured in relation to the bus capacity, as bus sizes may change over time or before/after project. $ROC_{i,y}$ shall be monitored directly through visual surveys.

This equation determines leakage emissions from change of load factors in buses.

~~$$LE_{LF,Z,y} = EF_{KM,Z} \times VD_Z \times N_{Z,y} \times \left(1 - \frac{ROC_{Z,y}}{ROC_{Z,0}}\right) \quad (13)$$~~

$$LE_{LF,Z,y} = EF_{KM,Z} \times VD_Z \times N_{Z,y} \times \left(1 - \frac{ROC_{Z,y}}{ROC_{Z,0}}\right) \times 10^{-6} \quad (13)$$

Where:

$LE_{LF,Z,y}$	=	Leakage emissions from change of load factor in buses in year *y* (tCO_2e)
$EF_{KM,Z}$	=	Baseline transport emissions factor per distance for buses (gCO_2e per kilometer)
VD_Z	=	Annual distance driven per vehicle for buses before the project start, determined *ex ante* (kilometres)
$N_{Z,y}$	=	Number of buses in the conventional transport system operating in year *y*
$ROC_{Z,y}$	=	Average occupancy rate relative to capacity of conventional buses in year *y*, based on the most recent study of occupancy rates
$ROC_{Z,0}$	=	Average occupancy rate relative to capacity of buses before start of project

~~$$VD_Z = \frac{\sum_{k=S,M,L} DD_{Z,k}}{\sum_{k=S,M,L} N_{Z,k}} \quad (14)$$~~

$$VD_Z = \frac{\sum_{k=S,Md,L} DD_{Z,k}}{\sum_{k=S,Md,L} N_{Z,k}} \quad (14)$$

Where:

VD_Z	=	Distance driven per bus before the project start (kilometers)
$DD_{Z,k}$	=	Total distance driven by buses of size *k* (kilometers)
$N_{Z,k}$	=	Number of buses in the conventional transport system of size *k*, where *S, Md* and *L* stands for small, medium and large buses, respectively

Note: If $ROC_{Z,0} - ROC_{Z,y} \leq 0.1$ then $LE_{LF,Z,y} = 0$, i.e., if the occupancy rate of buses is not reduced by more than 0.1 then the project has had no negative effect (leakage).

This equation determines leakage emissions from a change ~~of~~ in load factors ~~in~~ of taxis.

$$LE_{LF,T,y} = EF_{KM,T} \times VD_T \times N_{T,y} \times \left(1 - \frac{OC_{T,y}}{OC_{T,0}}\right) \quad (15)$$

Where:

$LE_{LF,T,y}$	=	Leakage emissions from change of load factor in taxis in year *y* (tCO_2e)
$EF_{KM,T}$	=	Transport emissions factor per distance kilometre of for taxi baseline (gCO_2e per kilometer)
VD_T	=	Average Ddistance driven per by taxi on average before the project starts (kilometres)
$N_{T,y}$	=	Number of taxis operating in year *y*
$OC_{T,y}$	=	Average occupancy rate of taxi for the in year *y* (passengers only: Driver not counted)
$OC_{T,0}$	=	Average occupancy rate of taxi before the project start (passengers only: Driver not counted)

Note: If $OC_{T,0} - OC_{T,y} \leq 0.1$ then $LE_{LF,T,y} = 0$, i.e. if the occupancy rate of taxis is not reduced by more than 0.1 then the project has had no negative effect (leakage).

The measurement of the occupancy rate is based on representative surveys, which register all taxis passing the survey points. Taxis without passengers are counted as "0" occupancy rate. Only circulating taxis are counted.

2. Impact of Reduced Congestion on Remaining Roads

An implementation of a BRT project may have differing overall impacts on congestion. On the one hand, a project BRT system may be implemented on an exiting road by dedicating one or more of the lanes of the road to be exclusively used by the project BRT (with an exception of emergency vehicles). This will result in a reduced road capacity available to the vehicles operating on that road prior to the project activity, which, in turn, may increase the congestion on that reduced road capacity and, therefore, lead to higher emissions. On the other hand, an implementation of the project BRT may provide a new road infrastructure. In this case, the project BRT will likely attract passengers from conventional modes of transport and reduce the number of vehicles on the affected roads and, therefore reduce congestion. A BRT project reduces buses on the road and thus potentially reduces congestion. In this case, Rreduced congestion has may have the following impacts relevant for GHG emissions:

- "Rebound effect" leading to additional trips and thus higher emissions;
- Higher average speeds and less stop-and-go traffic leading to lower emissions.

If a project leads to increased congestion, then all equations presented can be used equally. The effects will simply be reversed, i.e., the lower average speed and increased stop-and-go traffic will lead to increased emissions while the rebound effect will lead to less induced traffic than under BAU.

In the case that the implementation of the project activity leads to a reduction of road capacity available for individual motorised transport modes, the impact of changes in congestion shall be monitored in the year 1 and 4 of the crediting period. In other cases (e.g. the project provides a new road infrastructure not taken from the existing road space in the city), monitoring of these changes is not required.[15] This change in road capacity available for individual motorised transport modes may result from the reduction of road space due to the implementation of MRTS and/or a potential reduction of traffic flow due to the withdrawal of conventional public transport units as a result of the project activity.

[15] Emission reductions due to the speed increase of the traffic flow generally overweights the increase in emissions resulting from the traffic induction of passenger cars as a result of reduced congestion.

To determine whether road capacity is reduced the following procedure shall be applied:

Step a): Determination of the additional road capacity available to motorised transport modes

The following equation determines the additional road capacity, available to the transport modes remaining in operation, as a result of the implementation of project activity in the year when the project MRT system is intended to reach its planned capacity:

Steps to Address Congestion Impact

Two elements need to be considered:

- Trunk roads can potentially reduce the space of remaining roads. The proportion of reduced road space available to passenger cars has to be calculated;
- Conventional buses are retired thus freeing road space. The proportion of retired buses and the proportion of public transport in road space have to be determined.

The additional impact of new and longer trips shall be assessed via the direct application of a "capacity elasticity", i.e., percentage additional cars resulting from a percentage change in road capacity.

Step 1: Calculate additional road-space available

This equation determines the additional road space available in year y if good quality data is available.

$$ARS_y = \sum_{w=1...y} \frac{BSCR_w}{N_Z} \times SRS - \frac{RSB - RSP}{RSB} \quad (16)$$

$$ARS_y = \sum_{y} \frac{BSCR_y}{N_B} \times SRS - \frac{RS_{BL} - RS_{PJ}}{RS_{BL}} \quad (16)$$

Where:

ARS_y	=	Additional road space available in year y (in percentage)
$BSCR_w$ $BSCR_y$	=	Bus units scrapped by project in year w, where w = 1 to y (NB: if buses are not scrapped the estimated amount of retired buses is taken) Bus units retired as a result of the project in year y
N_Z N_B	=	Number of buses in use in the baseline (units)
SRS	=	Share of road space used by public transport in the baseline (in percentage)
RSB RS_{BL}	=	Total road space available in the baseline (lane-kilometers)
RSP RS_{PJ}	=	Total available road space in the project (= RSB minus kilometre of lanes that where reduced due to dedicated bus lanes) (lane-kilometers)

If $ARS_y < 0$, then we have a reduced road space in that year, and thus increased emissions due to reduced vehicle speed, but reduced emissions due to a negative "rebound effect".

This equation is required to determine SRS if no recent and good quality study is available which has calculated this parameter.

$$SRS = \frac{DD_Z}{DD_Z + DD_T + DD_C} \quad (17)$$

$$SRS = \frac{TD_B \times 2.5}{TD_B \times 2.5 + TD_T + TD_C} \quad (17)$$

Where:

SRS	=	Share of road space used by public transport in the baseline (in percentage)
DD_Z	=	Total distance driven by public transport buses baseline (kilometers)
DD_T	=	Total distance driven in kilometers by taxis baseline (kilometers)
DD_C	=	Total distance driven in by passenger cars baseline (kilometers)

It is assumed that one bus occupies 2.5 times more road space than a personal car or a taxi.

For all distance variables the same vintage of data, the same spatial scope and the same time-span (e.g. one month or one year) is required.

If ARS_y is negative, leakage emissions due to increased congestion as a result of the reduced road capacity due to the project activity shall be quantified as per Step b) below. If ARSy is positive, $LE_{CON,y}$ is assumed to be zero and no monitoring is required in this case.

Step b) Calculation of $LE_{CON,y}$.

The corresponding emissions $LE_{CON,y}$ are calculated as follows:

$$LE_{CON,y} = \max\{LE_{REB,y} + LE_{SP,y};0\} \quad \textbf{(18)}$$

Where:

$LE_{CON,y}$	=	Leakage emissions from reduced congestion in year *y* (tCO_{2e})
$LE_{REB,y}$	=	Leakage emissions due to induced traffic / rebound effect in year *y* (tCO_{2e})
$LE_{SP,y}$	=	Leakage emissions due to change in vehicle speed in year *y* (tCO_{2e})

c) Determination of emissions due to induced traffic/rebound effect ($LE_{REB,y}$)

The concept to capture emissions from induced traffic (or rebound effect) includes the following assumptions (induced traffic is measured for passenger cars and taxis):

- The distance driven on the affected roads by all additional cars/taxis is considered as additional trip distance, i.e. it is assumed that formerly used alternative routes are shorter, which is a conservative assumption;
- All additional cars/taxis on the affected roads are considered to be induced by the project and not by external effects such as general traffic growth, which again is a conservative assumption.

The monitoring is realized through measurements of traffic flows and distance driven by passenger cars and taxis on the affected roads. Monitoring is realized in the years 1 and 4 of the crediting period.

As a first step the "affected roads" are identified and clearly listed in the PDD including a map. The procedure to identify the "affected roads" is described in the definition section of the methodology under the term "affected roads".

A negative rebound effect based on additional congestion is expected in this situation. As prior condition to measuring the negative rebound effect thus for each affected road the average speed of cars/taxis is monitored and compared with the baseline one.

Vehicle speed refers to the average speed, i.e. total distance divided by total time, on the affected road. Taxis and passenger cars are treated identical. This condition should be monitored for each affected road.

The rebound effect for the affected roads is calculated as follows:

$$LE_{REB,y} = \frac{1}{10^6} \cdot \sum_i \left(TD_{i,y} \cdot EF_{KM,i,y} \cdot \left(N_{i,y} - N_{i,BL} + N_{i,S,y} \right) \right) \quad (19)$$

Where:

$LE_{REB,y}$	=	Leakage emissions due to rebound effect in year *y* (tCO_2)
$TD_{i,y}$	=	Average trip distance driven by cars/taxis in year *y* (km)
$EF_{KM,i,y}$	=	Emission factor per kilometre for cars and taxis in year *y* (gCO_2/km)
$N_{i,y}$	=	Number of cars/taxis per annum using in the project boundary in year *y* (cars, taxis)
$N_{i,BL}$	=	Number of cars/taxis per annum using in the project boundary in the baseline (cars, taxis)
$N_{i,,P,y}$	=	Number of cars/taxis per annum not used anymore due to mode shift to the BRT in year *y* (cars, taxis)
i	=	Cars, taxis

The number of cars and taxis per annum not used anymore due to mode shift to the MRTS in year *y* is calculated as:

$$N_{i,S,y} = \frac{S_{i,y} \cdot P_y}{OC_i} \quad (20)$$

Where:

$N_{i,S,y}$	=	Number of cars/taxis per annum not used anymore due to mode shift to the MRTS in year *y* (cars, taxis)
$S_{i,y}$	=	Net share of passengers using the BRT which would have used mode *i* in year *y* (%)
P_y	=	Passengers transported by the project in year *y* (passengers)
OC_i	=	Average occupancy rate of vehicle category *i* prior to the project start (passengers)
i	=	Cars, taxis

The net share of passengers that shifted from car/taxi to the BRT is based on the percentage of passengers which would have used in the baseline cars/taxis at least partially for their trip minus the share of passengers of the MRTS which use cars/taxis partially for their trip (to and/or from the MRTS).

Step c) Determination of emissions due to changes in vehicle speed ($LE_{SP,y}$)

Leakage emissions due to changes in vehicle speed are determined only for cars and taxis, as presented below:

$$LE_{SP,y} = \frac{1}{10^6} \cdot \sum_i \left(N_{i,y} \cdot TD_{i,y} \cdot \left(EF_{KM,VP,i,y} - EF_{KM,VB,i} \right) \right) \quad (21)$$

Where:

$LE_{SP,y}$	=	Leakage emissions due to changes in vehicle speed of cars and taxis in year *y* (tCO_2)
$N_{i,y}$	=	Number of cars/taxis using the project boundary in year *y* (cars, taxis)
$TD_{i,y}$	=	Average trip distance made by cars/taxis in the project boundary in year *y* (km)
$EF_{KM,VP,i,y}$	=	Emission factor per kilometre for cars/taxis at the project speed in year *y* (gCO_2/km)

$EF_{KM,VB,i}$ = Emission factor per kilometre for cars/taxis at the baseline speed (gCO_2/km)
i = Cars, taxis

The project speed on the affected roads is monitored in the years 1 and 4 of the crediting period. Vehicle speed is monitored under moving conditions. The same method should be used for determining the baseline and project speed.

The number of cars and taxis on the affected roads are monitored through visual or electronic counting.

To determine the emission factor per kilometre of cars/taxis at the project speed and baseline speed, project proponents can either use a speed dependency factor developed with an officially recognized methodology for the project region with the corresponding documentation to ensure a good quality (this is the preferred option) or use as a default relationship between the speed dependency factor and emissions for passenger cars developed by CORINAIR. The same vehicle speed is used for passenger cars and taxis.

$$\frac{EF_{KM,VP,i,y}}{EF_{KM,VB,i}} = \left(\frac{V_{P,y}}{V_B}\right)^{-0.7} \quad (22)$$

Where:
$EF_{KM,VB,i}$ = Emission factor per kilometre for cars/taxis at the baseline speed (gCO_2/km)
$EF_{KM,VP,i,y}$ = Emission factor per kilometre for cars/taxis at the project speed in year *y* (gCO_2/km)
V_B = Average speed of cars/taxis prior to the project start (km/h)
$V_{P,,y}$ = Average speed of cars/taxis in year *y* (km/h)

V_B and V_P in this case refer to moving speed, i.e. the speed of the vehicle under moving conditions.

~~Step 2: Assess the rebound impact of the additional road space~~

~~This equation calculates leakage emissions from additional/longer trips (“rebound effect”).~~

$$LE_{TRIPS,y} = ITR \times ARS_y \times TR_C \times TD_C \times EF_{KM,C} \times D_y \quad (18)$$

~~Where:~~
~~$LE_{TRIPS,y}$ = Leakage emissions from additional and/or longer trips in year *y* (tCO_2e)~~
~~ITR = Elasticity factor for additional and/or longer trips: the factor is fixed at 0.1~~
~~ARS_y = Additional road space available (percentage)~~
~~TR_C = Number of daily trips realized by passenger cars baseline (number)~~
~~TD_C = Average trip distance for passenger cars (kilometers)~~
~~$EF_{KM,C}$ = Transport emissions factor per distance of passenger cars before the project start (gCO_2e per kilometer) (see Equation 2)~~
~~D_y = Number of days buses operate in year *y*~~

The impact is calculated as immediately although the short-term reaction of induced traffic is significantly lower than the long-term (3 years+) reaction.

Step 3: Assess the impact of changing vehicle speed from passenger cars

$$LE_{SP,y} = TR_C \times TD_C \times \left[EF_{KM,VP,C} - EF_{KM,VB,C} \right] \times DW_y \quad (19)$$

Where:

$LE_{SP,y}$	=	Leakage emissions from change in vehicle speed in year *y* (tCO_2e)
TR_C	=	Number of daily trips realized by passenger cars baseline (number)
TD_C	=	Average trip distance driven by passenger cars (kilometers)
$EF_{KM,VP,C}$	=	Transport emissions factor per distance for passenger cars at project speed (gCO_2 per km)
$EF_{KM,VB,C}$	=	Transport emissions factor per distance for passenger cars at baseline speed (gCO_2 per km)
DW_y	=	Number of days per year in year *y*

The new vehicle speed is calculated based on the number of retired vehicles or additional available road space. The project proponent can either use a speed dependency factor developed with an officially recognized methodology for the project region (with the corresponding documentation to ensure a good quality; if latter is available this would be the first preference) or use as default relation the speed dependency factor Passenger Cars (gCO_2 per km) developed by CORINAR. If the project has no data on speed changes or current speed, then it is assumed that the speed impact is equal to 0.

CORINAR speed emission factor equation:

$$EF_{KM,m,C} = 135.44 - 2.314 \times V + 0.0144 \times V^2 \quad (20)$$

Where:

$EF_{KM,m,C}$	=	Transport emissions factor per distance for passenger cars traveling at speed *m* (gCO_2 per km)
V	=	Vehicle speed (km/h); calculated both for the project speed (VP) and baseline speed (VB)

Step 4: Sum of Congestion Impacts and Determination of Leakage Factor

The sum of the rebound and the speed impact is included as leakage. The congestion impact is only calculated *ex ante* .

$$LE_{CONG,y} = LE_{TRIPS,y} + LE_{SP,y} \quad (21)$$

Where:

$LE_{CONG,y}$	=	Leakage emissions from reduced congestion in year *y* (tCO_2e)
$LE_{TRIPS,y}$	=	Leakage emissions from additional and/or longer trips in year *y* (tCO_2e)
$LE_{SP,y}$	=	Leakage emissions from change in vehicle speed in year *y* (tCO_2e)

3. Upstream Emissions of Gaseous Fuels

Upstream leakage of gaseous fuels is only included if project vehicles consume more gaseous fuels than baseline vehicles. In this case and to simplify calculations the upstream leakage included is based only on project gaseous fuels used. The following leakage emission sources shall be considered:

- Fugitive CH_4 emissions associated with fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of natural gas used in the project plant and fossil fuels used in the grid in the absence of the project activity;
- In the case LNG is used in the project plant: CO_2 emissions from fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression into a natural gas transmission or distribution system.

Thus, leakage emissions are calculated as follows:

$$LE_{UP,y} = LE_{CH4,y} + LE_{LNG,CO2,y} \quad \textbf{(23)}$$

Where:

$LE_{UP,y}$	=	Leakage upstream emissions of gaseous fuels during the year *y* in t CO_2e
$LE_{CH4,y}$	=	Leakage emissions due to fugitive upstream CH_4 emissions in the year *y* in t CO_2e
$LE_{LNG,CO2,y}$	=	Leakage emissions due to fossil fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system during the year *y* in t CO_2e

Emissions due to fugitive upstream CH_4 emissions

$$LE_{CH4,y} = TC_{PJ,NG,y} \times NCV_{NG,y} \times EF_{NG,upstream,CH4} \times GWP_{CH4} \quad \textbf{(24)}$$

Where:

$L_{CH4,y}$	=	Leakage emissions due to upstream fugitive CH_4 emissions in the year *y* in tCO_2e
$TC_{PJ,NG,y}$	=	Quantity of natural gas used by project units in the year *y* in m³
$NCV_{NG,y}$	=	Net calorific value of the natural gas used by the project during the year *y* in GJ/m³
$EF_{NG,upstream,CH4}$	=	Emission factor for upstream fugitive methane emissions from production, transportation and distribution of natural gas in tCH_4/GJ
GWP_{CH4}	=	Global warming potential of methane valid for the relevant commitment period

Where reliable and accurate national data on fugitive CH_4 emissions associated with the production, transportation and distribution of NG is available, project participants should use this data. Where such data is not available, project participants may use the default values provided by IPCC (latest version). The NCV is based on local, regional or national data or on IPCC default values.

CO2 emissions from LNG

Where applicable, CO_2 emissions from fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system ($LE_{LNG,CO2,y}$) should be estimated by multiplying the quantity of natural gas combusted in the project system with an appropriate emission factor, as follows:

$$LE_{LNG,CO2,y} = TC_{PJ,NG,y} \cdot EF_{CO2,upstream,LNG} \quad \textbf{(25)}$$

Where:

$LE_{LNG,CO2,y}$	=	Leakage emissions due to fossil fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system during the year y in t CO_2e
$TC_{PJ,NGy}$	=	Quantity of natural gas used by project units during the year y in TJ
$EF_{CO2,upstream,LNG}$	=	Emission factor for upstream CO_2 emissions due to fossil fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system in t CO_2/TJ

Where reliable and accurate national data on fugitive CH_4 emissions associated with the production, transportation and distribution of LNG is available, project participants should use this data. Where such data is not available, project participants may use the default values provided by IPCC (latest version).

Total Leakage

$$LE_y = LE_{UP,y} + LE_{LF,Z,y} + LE_{LF,T,y} + LE_{CONG,y} \quad \textbf{(26)}$$

Where:

LE_y	=	Leakage ~~E~~emissions ~~leakage~~ in year y (tCO_2e)
$LE_{UP,y}$	=	Leakage upstream emissions of gaseous fuels during the year y (tCO_2e)
$LE_{LF,Z,y}$	=	Leakage emissions from change of load factor in buses in year y (tCO_2e)
$LE_{LF,T,y}$	=	Leakage emissions from change of load factor in taxis in year y (tCO_2e)
$LE_{CONG,y}$	=	Leakage emissions from reduced congestion in year y (tCO_2e)

If $LE_y < 0$, then leakage is not included;
If $LE_y > 0$, then leakage is included.

The impact of induced traffic (additional trips) provoked through the new transport system is addressed directly in the project emissions and is not part of the leakage. This is addressed by including as project emissions the trips of passengers, ~~which~~ who, in absence of the BRT project, would not have realized the trip.

Emission reductions

$$ER_y = BE_y - PE_y - LE_y \quad \textbf{(27)}$$

Where:

ER_y	=	Emission reductions in year y (tCO_2e)
BE_y	=	Baseline emissions in year y (tCO_2e)
PE_y	=	Project emissions in year y (tCO_2e)
LE_y	=	Leakage emissions in year y (tCO_{2e})

~~Changes required for methodology implementation in 2nd and 3rd crediting periods~~

~~The revision at the end of the first crediting period in preparation for the next crediting period shall include an assessment of:~~

- ~~The applicability conditions for the approved methodology shall still be valid at the time of the revision;~~
- ~~Project participants shall evaluate the institutional and legal conditions, particularly related with environmental and fuel regulations governing the project, to determine whether original baseline conditions still apply.~~

Crediting period

The implementation of the methodology is limited to a 10 year crediting period.

Data and Parameters not monitored

In addition to the parameters listed in the tables below, the procedures contained in the tools referred to in this methodology also apply.

Data / Parameter:	$SEC_{x,i}$
Data Unit	litres/km, kWh/km, kg/km, m^3/km
Description	Specific energy consumption of fuel type x in vehicle category i
Source of Data	Specific studies conducted by the project proponent, IPCC or international literature
Measurement Procedure	The result should be checked for consistency against manufacturer data and default IPPC values (alternative for baseline estimation; see baseline methodology)
Comments	For vehicle categories. Based either on local measurements or international data from comparable regions or IPCC values adapted to local circumstances. In case of bio-fuel blends being used, the biofuel share must be transparently recorded and emissions are only calculated on the fossil share of the blend

Data / Parameter:	$DD_{Z,S}$, $DD_{Z,M}$, $DD_{Z,L}$, DD_T
Data Unit	km
Description	Total distance driven by all vehicles in category
Source of Data	Official statistics
Measurement Procedure	In general various official sources are available (vehicle registration data; transportation statistics). For QA it is important to have the same data source for items $N_{i,x}$, $SEC_{x,i}$ and P_i if calculations are related

Comments	Statistics is based, in general, on samples. Required for all sub-categories of baseline buses and taxis and potentially other categories. To ensure consistency, it is important to have the same data source for distance driven and passengers for public transport. Data can be either with or without the informal sector as long as above mentioned parameters are from the same data source. In general, data including only the formal sector is of a better data quality and should thus be taken

Data / Parameter:	P_i
Data Unit	Passengers
Description	Passengers transported by buses in the baseline
Source of Data	Official statistics. Vintage maximum 3 years
Measurement Procedure	In general various official sources are available (vehicle registration data; transportation statistics). The same data source should be taken as for $DD_{i,S}$, $DD_{i,M}$, $DD_{i,L}$, $DD_{i,T}$ to ensure data consistency
Comments	This is for the calculation of the emission factor for the baseline and is not for calculating the total baseline emissions. The latter are calculated based on the passengers transported by the project. It is important to have the same data source for distance driven ($DD_{i,S}$, $DD_{i,M}$, $DD_{i,L}$, $DD_{i,T}$) and passengers (P_i) to ensure consistency. Data can be either with or without the informal sector as long as above-mentioned parameters are from the same data source. In general data including only the formal sector is of better data quality and should thus be taken

Data / Parameter:	SRS
Data Unit	%
Description	Share of road space used by public transport baseline
Source of Data	Official statistics or studies conducted by the project proponent or a third party
Measurement Procedure	Based on calculations made for urban infrastructure and transport scenarios or on the calculation method provided using data on the distance driven by various vehicle categories
Comments	Used for urban transport and infrastructure models; see baseline equations for the calculation of SRS if the data is not available from reports. The share of road space used by public transport is a figure often calculated in transport studies. If no reliable data is available as proxy the relative distance driven per different vehicles can also be taken. SRS would then be the distance driven by the public transport (baseline) divided by the total distance of all vehicles driven (baseline). This would be a conservative factor as buses are larger than private cars and thus occupy a larger share of road space per kilometre driven

Data / Parameter:	RS_{BL}, RS_{PJ}
Data Unit	km
Description	Road space baseline and project
Source of Data	Official statistics or studies conducted by the project proponent or a third party
Measurement Procedure	Based on calculation (RSP) and infrastructure statistics

Comments	Road space baseline based on official information. Reduced road space based on construction plans (reduced road space is lanes which where eliminated due to dedicated bus lanes). Road space project = road space baseline – eliminated lanes

Data / Parameter:	V_B
Data Unit	km/h
Description	Average speed passenger car in the baseline
Source of Data	Based on transport models
Measurement Procedure	Traffic models use such data and have verified them.
Comments	The average speed of passenger cars before the project start

Data / Parameter:	$EF_{CO2,upstream,CH4}$
Data unit:	tCH_4/GJ
Description:	Emission factor for upstream fugitive methane emissions of natural gas from production, transportation, distribution, and, in the case of LNG, liquefaction, transportation, re-gasification and compression into a transmission or distribution system
Source of data:	Where reliable and accurate national data on fugitive CH_4 emissions associated with the production, and in case of natural gas, the transportation and distribution of the fuels is available, project participants should use this data to determine average emission factors by dividing the total quantity of CH_4 emissions by the quantity of fuel produced or supplied respectively. Where such data is not available, project participants may use the default values provided in the table below. Note that the emission factor for fugitive upstream emissions for natural gas should include fugitive emissions from production, processing, transport and distribution of natural gas, as indicated in the table below. Where default values from this table are used, the natural gas emission factors for the location of the project activity should be used. The US/Canada values may be used in cases where it can be shown that the relevant system element (gas production and/or processing/transmission/ distribution) is predominantly of recent vintage and built and operated to international standards

Activity	Unit	Default emission factor	Reference for the underlying emission factor range in Volume 3 of the *1996 Revised IPCC Guidelines*
USA and Canada			
Production	t CH4 / PJ	72	Table 1-60, p. 1.129
Processing, transport and distribution	t CH4 / PJ	88	Table 1-60, p. 1.129
Total	t CH4 / PJ	160	
Eastern Europe and former USSR			
Production	t CH4 / PJ	393	Table 1-61, p. 1.129
Processing, transport and distribution	t CH4 / PJ	528	Table 1-61, p. 1.129
Total	t CH4 / PJ	921	
Western Europe			
Production	t CH4 / PJ	21	Table 1-62, p. 1.130
Processing, transport and distribution	t CH4 / PJ	85	Table 1-62, p. 1.130
Total	t CH4 / PJ	105	
Other oil exporting countries / Rest of world			
Production	t CH4 / PJ	68	Table 1-63 and 1-64, p. 1.130 and 1.131
Processing, transport and distribution	t CH4 / PJ	228	Table 1-63 and 1-64, p. 1.130 and 1.131
Total	t CH4 / PJ	296	

Note: The emission factors in this table have been derived from IPCC default Tier 1 emission factors provided in Volume 3 of the 1996 Revised IPCC Guidelines, by calculating the average of the provided default emission factor range.

Measurement procedures (if any):	-
Any comment:	-

Data / Parameter:	$EF_{CO2,upstream,LNG}$
Data unit:	tCO_2e/TJ
Description:	Emission factor for upstream CO_2 emissions due to fossil fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system
Source of data:	Where reliable and accurate data on upstream CO_2 emissions due to fossil fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system is available, project participants should use this data to determine an average emission factor. Where such data is not available, project participants may use the default value of 6 tCO2e/TJ
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter:	FC_x
Data Unit	Mass or volume units of fuel
Description	Total fuel of type *x* consumed by the baseline bus system prior to the project start
Source of Data	Fuel records of bus operator(s)
Measurement Procedure	Based on fuelling station reports
Monitoring frequency	Continuously, aggregated at least annually
QA/QC procedures	Control with fuel invoices
Comments	

III. MONITORING METHODOLOGY

Monitoring procedures

BRT systems have as core environmental aspect that the resource efficiency of transporting passengers in a city shall be improved i.e. fuel consumption and emissions per passenger trip shall be reduced compared to the situation without the project. The methodology directly addresses the objective of increased resource efficiency and is thus based upon emissions per transported passenger.

The monitoring methodology for the baseline has *ex ante* determined emission factors per passenger transported for all modes of transport. These factors are fixed, but not constant. For passengers using the project, ~~which~~ who in absence would have used taxis, passenger cars or motorcycles, the change in distance travelled and in the fuel-mix is monitored based on a questionnaire. To ensure a conservative approach the baseline emission factors are only changed if the monitoring results show that the new factors would be lower than the ones originally used.

The total baseline emissions are derived by applying to these emission factors the activity level (passengers per mode transported) of the project. Data sources are either from recent statistics or measurements made or are based on fixed default values taken from the international literature, primarily IPCC. Preference is for local data. Default values are the last options in case of non-availability of more precise data. The project proponents can choose to either invest resources to carry out measurements or opt for the simpler and less expensive alternative of using default values with the ~~drawback~~ trade-off of claiming less emission reductions as the default values of the baseline methodology are very conservative. All the data used to calculate the baseline emission factors are ~~monitored~~ collected *ex ante*. For calculating the total baseline emissions, the number of passengers using the project and the traffic mode they would have used in absence of the new transport system needs to be monitored (public transport, taxis, passenger cars, motorcycles, Non-Motorized Transport or induced traffic). Baseline emissions can thus only be calculated *ex post*.

The monitoring methodology for the project is based on measuring the total fuel consumption and thus emissions of the new transport system. From a methodological viewpoint, data is derived from measurements. Data reliability is very high due to having exact measurements and established control procedures for the data required. Default values for fuel consumption cannot be used for project emissions.

~~The monitoring methodology for leakage depends basically on elements calculated *ex ante* based on pre-established factors and, to a minor degree, on measurements during project execution implementation.~~

~~Congestion leakage is calculated *ex ante* for the project period and not monitored. Data is derived basically from planning sources, fixed parameters derived from the international literature and from periodic surveys.~~

QA and QC is assured by having a monitoring manual containing *inter alia* how to proceed with key measurements and survey, how to screen data for quality and potential errors and by training the staff in charge of monitoring. ~~Also f~~For the periodic survey of passengers and ~~for~~ the surveys monitoring the load factor, the core outline ~~is~~ shall be included in this methodology and the PDD shall contain~~s~~ a detailed design of both instruments.

Table B1: Main Points of Monitoring Methodology

Element	Monitoring Methodology
Core data for determining baseline emissions: ➢ ~~Alternative A based on relative data~~ ~~(~~fuel consumption and distance driven per vehicle category and fuel type~~)~~; ~~➢ Alternative B: sectoral fuel consumption;~~ ➢ Technology improvement factor; ➢ Passengers per transport mode using ~~new~~ the project transport system after the project start (relative distribution and absolute numbers).	➢ ~~Alternative A:~~ fuel consumption based on measurement of a representative sample, international literature, IPCC values related to local circumstances and distance driven based on official statistics; ~~➢ Alternative B: Based on representative surveys;~~ ➢ Default value based on international literature; ➢ Monitored ~~annually~~ in the year 1 and 4 of the crediting period by the project proponent based on surveys plus registration of total passengers transported by the system.
Core data for determining project emissions: ➢ Fuel consumption of the project system; *or* ➢ Fuel efficiency and distance driven by project units .	➢ Measured annually by the project proponent based on company accounts and measurements; *or* ➢ Distance driven measured annually by GPS; fuel efficiency based on measurement.
Core data for determining leakage: ➢ Change ~~of~~ in load factor; ➢ Congestion impact (rebound effect and change in vehicle speed).	➢ Measured regularly by the project proponent based on representative samples; ➢ Based on transport models, local statistics and default values from international literature sources; ~~value is calculated *ex ante*~~ Congestion impact shall be monitored in the years 1 and 4 of the crediting period in case the implementation of the project BRT reduces road space.

Describe and specify in the CDM-PDD all monitoring procedures, including the type of measurement instrumentation used, the responsibilities for monitoring and QA/QC procedures that will be applied. Where the methodology provides different options (e.g. use of default values or on-site measurements), specify which option will be used. All meters and instruments should be calibrated regularly as per industry practices.

~~All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data should be monitored if not indicated differently in the comments in the tables below.~~

Data and parameters - Project Emissions

~~*Alternative A: Use of Fuel Consumption Data*~~

~~This alternative is based on the total fuel consumed by the project activity, and uses Equation (9).~~

~~The emission factor electricity is calculated in accordance with the latest approved version "Tool to calculate baseline, project and/or leakage emissions from electricity consumption."~~

~~*Alternative B: Use of Specific Fuel Consumption and Distance Data*~~

~~This alternative uses as a basis fuel efficiency data (i.e. consumption per kilometre driven), and uses Equation (10).~~

Fuel-efficiency data is derived from annual data reported by the bus companies operating the units either of all units or of a representative sample of comparable units (comparable technology, vintage and size). To ensure a conservative approach, the lower 95% confidence level is taken if ~~all~~ data ~~with~~ for specific fuel consumption is based on sampling ~~values which are more than 20% lower than the average specific fuel consumption of comparable units are omitted from calculations~~. This ~~ensures~~ is a conservative approach, ~~as~~ ensuring that project emissions are ~~potentially~~ not overstated.

If the CDM project includes only parts of a larger activity, the fuel used for the CDM project is separated from the total fuel used. The separation is done (in order of preference) by the following means:

- By operators: This method is used if certain operators are assigned to certain parts of the project;
- By distance driven: the fuel share for each part of the project is based on the share of kilometers per project part;
- By passengers: the fuel share for each part of the project is based on the share of passengers per part of the project (based on the entry points of passengers).

ID number	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1. $TC_{PJ,x,i}$	Total fuel consumption	Proprietary	Litre kWh kg m^3	M	Annual	100%	Electronic	Required if alternative A is chosen for as described in baseline methodology (for total project or only for trunk lanes); Based in general on company records. In case of bio-fuel blends being used the biofuel share must be transparently recorded and emissions are only calculated on the fossil share; It must be shown that conventional comparable urban buses use the same biofuel blend as project buses In case of usage of electricity based on kWh
2. $SEC_{j,x,y}$	Fuel efficiency	Proprietary	l/km kWh/km kg m^3/km	M	Annual	100% or sample	Electronic	Required if alternative B is chosen as described in baseline methodology for total or part of the project; required for trunk and for feeder buses separately. In case of bio-fuel blends being used the biofuel share must be transparently recorded and emissions are only calculated on the fossil share; It must be shown that conventional comparable urban buses use the same biofuel blend as project buses In case of usage of electricity based on kWh
3. $DD_{TB,y}$ $DD_{FB,y}$	Distance	Proprietary	million km	M	Annual	100%	Electronic	Required for alternative B baseline (see above); required for trunk and for feeder buses separately; based in general on GPS (at minimum for trunk buses) and/or reports checked by the operator of the BRT system as payments are based *inter alia* on distance driven

Data and parameters - Baseline Emissions

Details of Data on Fuel Consumption Baseline (ID 5)

Two methodological alternatives are proposed for the fuel consumption data (in order of preference):

- Alternative 1: Measurement of fuel consumption data using a representative sample for the respective category and fuel type. Factors such as the specific urban driving conditions (drive-cycle, average speed etc), vehicle maintenance and geographical conditions (altitude, road gradients, etc.) are thus included. The sample must be large enough to be representative.[16] To ensure a conservative approach the top 20% of the sample is not included in calculations the lower 95% confidence level of the sample measurement to be taken. This ensures a conservative approach. Such surveys are potentially conducted by international organizations or by local transit or environmental authorities. As such surveys are, however, costly they are only available in few cities;
- Alternative 2: Use of fixed values based on the national or international literature. The literature data can either be based on measurements of similar vehicles in comparable surroundings (e.g., from comparable cities of other countries) or may include identifying the vehicle age and technology of average vehicles circulating in the project region and then matching this with the most appropriate IPCC values. The most important proxy to identify vehicle technologies is the average age of vehicles used in the area of influence of the project. To determine if either US or European default factors apply either local vehicle manufacturer information can be used (in the case of having a substantial domestic vehicle motor industry) or source of origin of vehicle imports.

Note that a technical improvement factor is also considered (see equation in Annex to the Baseline methodology).

Details of Survey to Identify Mode of Transport (ID 12 and 9)

The survey is used to distribute the electronically or mechanically registered total number of passengers to different transport modes that they would have used in absence of the project. The basic goal of this survey is to identify the mode of transport used in absence of the project. Additionally the survey is also used to track any changes in distance driven of by passengers (which in absence would have used passenger cars, motorcycles or taxis) as well as the fuel type used in passenger cars for passengers using the project system which who an absence of the latter would have used passenger cars. The precise survey methodology to be used will vary with each individual project.

The PDD must contain an elaborated version of such a survey. Also a sensitivity analysis shall be made in the PDD to assess the sensitivity of emission reductions to changes in the recorded shares of passengers towards different modes of transport, change of distance driven per mode of transport and change of fuel type used by passenger cars.

The survey is conducted annually during project duration based on a representative survey of all passengers. The categories of transport modes include public transport (buses and, if applicable, rail-based urban MRTS), taxis, passenger cars, motorcycles, non-motorized transport and induced traffic (i.e., passenger would not have realized the trip in absence of the project). The relative distribution is measured and the absolute numbers are calculated based on total passengers transported. Additionally, per specific transport mode the users are asked for their trip origin and destination to calculate distance driven. Users

[16] Variances of fuel consumption will result due to different routes, load factors, engine and vehicle types, driver, driving conditions, ambient conditions etc.

of the project system that would have used passenger cars in absence of the BRT system are additionally asked what fuel type their passenger car uses.

The following survey principles shall be followed:

- The survey must be realized with maximum 5% error margin and a 95% confidence interval. This confidence interval corresponds to the guidelines issued by the EB in its 22nd meeting Annex 2 (EB 22 report Annex 2, D, page 3): "Methodologies employing sampling to derive parameters in estimating emissions reductions shall quantify these parameter uncertainties at the 95% confidence level";
- The sampling size is determined by the 95% confidence interval and the 5% maximum error margin;
- Sampling must be statistically robust and relevant i.e. the survey has a random distribution and is representative of the persons using the BRT system;
- The methodology to select persons for interviews is based on a systematic random sampling based on the flow of passengers per station per day per hour (i.e., the number of persons to be interviewed randomly per bus station and per hour per day is based on the total flow of passengers per station-day-hour to have a representative sample);
- Only persons over age 12 are interviewed;
- Minimum bi-monthly and preferably monthly surveys are to be realized to avoid any problems due to varying usage dependent on month of use (e.g. vacations);
- The survey shall be executed by an external organization with specialized knowledge on survey and survey techniques;
- Training of the people conducting the ~~questionnaire~~ survey must be made by the organization performing the latter to ensure good quality. The training must be based on standard questionnaire techniques and quality assurance;
- Before starting the official monitoring a test-run using the same questionnaire should be realized. This to ensure that the questions and multiple-choice answers are correctly understood by the passengers;
- The PDD must contain the design details of the survey. Relevant for the PDD is that the design can guarantee a representative survey with the targeted confidence interval. The same question should be used throughout the crediting period to ensure consistency;
- The survey must allow for a clear separation of modes of transport which the passenger would have used in absence of the project;
- The survey should include control questions to assure a conservative approach;
- ~~A sensitivity analysis of the share of passengers that would have taken a given transport mode in absence of the project needs to be carried out showing the percentage change in the modal split required to change emission reductions by 5%;~~
- ~~A sensitivity analysis is realized to calculate the impact of lower than baseline trip distances and of changing fuel types in passenger cars;~~
- ~~The relative modal distribution is maintained constant for the year after a policy affecting potentially the modal distribution has been enforced. The emission reductions due to the policy change are thus fully accounted for in the baseline in a conservative manner (100% is attributed to the policy change);~~

- BRT projects are in general implemented gradually. The questions asked by surveys can thus compare a still existing public transport system with the project situation;
- If a passenger is not sure how he would have made a trip he is assigned to induced transport. This ensures a conservative approach.

The default questionnaire to be used is included in Appendix A below. This questionnaire should be used by all projects except if valid arguments exist to change the questionnaire and to adapt it to local circumstances. The questionnaire must be realized in the local language.

Equation (1) is used to calculate transport emissions factor per distance of vehicle category.

If ~~fewer~~ less than 10% of vehicles in a specific vehicle category are gasoline, diesel, CNG or LPG powered, then this respective fuel can be omitted for simplicity purposes. ~~In~~ For alternative vehicles the threshold value is less than 1%.

Two methodological alternatives are proposed for the fuel consumption data (in order of preference)

- Alternative 1: Measurement of fuel consumption data using a representative sample for the respective category and fuel type. To ensure a conservative approach the ~~top 20%~~ the lower 95% confidence level of the sample ~~is not included in~~ shall be taken for calculations;
- Alternative 2: Use of fixed values based on the national or international literature. The literature data can either be based on measurements of similar vehicles in comparable surroundings (e.g. from comparable cities of other countries) or may include identifying the vehicle age and technology of average vehicles circulating in the project region and then matching this with the most appropriate IPCC default values. The most important proxy to identify vehicle technologies is the average age of vehicles used in the area of influence of the project. To determine if either US or European default factors apply either local vehicle manufacturer information can be used (in the case of having a substantial domestic vehicle motor industry) or source of origin of vehicle imports.

A technical improvement factor is thereafter introduced. The technology improvement factor results in dynamic emission factors for the different units. See Step 3.

Calculate Emissions per Passenger per vehicle Category

This step calculates emission factors showing the emissions per passenger per average trip for each vehicle category and uses Equations (2) (for buses) and (3) (for passenger cars, taxis and motorcycles).

The time period for passengers and distance must be equal (e.g. one year or one month). All data used is determined *ex ante* project. A change in the occupancy rate of buses is registered as leakage of the project.

~~*Calculate Emission Factor Based on Sector Data*~~

~~This approach is based on sector fuel consumption data and differentiates fuel consumption per fuel type for all different vehicle categories such as identified in the first step.~~

~~Following conditions apply to using this alternative:~~

- ~~A study on sector fuel consumption separating the vehicle categories is available with a confidence interval of minimum 95% (i.e., error margin maximum 5%);~~
- ~~The geographic region of the project can be separated well;~~

- ~~Data for fuel consumption must have the same year/time period and the same geographic boundaries as data of passengers transported;~~
- ~~Data must be crosschecked with total fuel consumption of the region.~~

~~Emissions per passenger are calculated by taking the sector consumption and the passengers transported per vehicle category, and uses Equation (4). Fuel consumption data is transformed to CO_2e emissions. This is calculated for all relevant vehicle categories. If alternative fuels such as gas (CNG or LNG) are used they are included in the calculations using the appropriate default values for CO_2, CH_4 and N_2O.~~

Change of Baseline Parameters during Project crediting period

The baseline emissions per passenger trip for taxis, passenger cars and motorcycles are adjusted annually with a correction factor to changing trip distances, and uses Equation (5).

Note: The adjustment is only made if $TD_{i,y} < TD_i$ to ensure a conservative approach.[17]

The baseline emissions for all passengers transported are calculated. This is differentiated according to the mode of transport, which the person would have used in absence of the project. Passengers transported are determined through the project (activity level of the project). The total amount of passengers transported by the project shall be reported by the system operator.

Total baseline emissions. These are calculated using Equations (6), (7), (8).

[17] Larger distances would increase baseline emissions per passenger trip. The project emissions of larger trip distances are however fully recorded as project emissions are based on total fuel consumed.

ID number	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
4. $N_{i,x}$	Number of vehicles	Official statistics and proprietary	Vehicles	m	Before project start and annually (in the case of modal shift for passenger cars)	100% and annually based on a survey of passengers using the new system	Electronic	Per vehicle category the amount of vehicles per relevant fuel type (gasoline, diesel, LNG, CNG or electric vehicles) needs to be identified. Only categories are included where modal shift is expected (next to public transport) – see NMB. Annual recording of fuel type used from passengers using the new system which in absence of the project would have used a passenger car (only required if a modal shift of passenger cars is included in the project)
5. $SEC_{x,i}$	Fuel efficiency	Proprietary, IPCC or international literature	litres/km kWh/km kg/km m^3/km	m	Before project start	Sample	Electronic	Per vehicle category required; Based either on local measurements or international data from comparable regions or IPCC values adapted to local circumstances. In case of bio-fuel blends being used the biofuel share must be transparently recorded and emissions are only calculated on the fossil share; In case of usage of electricity based on kWh
6. $DD_{Z,S}$ $DD_{Z,M}$ $DD_{Z,L}$ DD_T	Total distance driven by all vehicles in category	Official statistics	km	m	Before project start and partially annually	Sample	Electronic	Statistics are based in general on samples. Required for all sub-categories of buses baseline and for taxis and potentially other categories. Important is to have the same data source for distance driven and passengers for public transport to ensure consistency. Data can be either with or without the informal sector as long as above mentioned parameters are from the same data source. In general data including only the formal sector is of better data quality and should thus be taken

ID number	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
7. P_i	Passengers transported baseline by vehicle category *i*	Official statistics	Passengers	m	Before project start	100%	Electronic	This is for calculation the emission factor for the baseline and is not for calculating the total baseline emissions. Latter are calculated based on the passengers transported by the project. It is important to have the same data source for distance driven (ID 6) and passengers (ID 7) to ensure consistency. Data can be either with or without the informal sector as long as above-mentioned parameters are from the same data source. In general data including only the formal sector is of better data quality and should thus be taken
8. OC_i $OC_{i,y}$	Average occupancy rate baseline of vehicle category *i*	Official statistics or proprietary	Passengers	m	Before project start and for buses and taxis minimum year 3, 6 and 10	Sample	Electronic	Required for all categories of vehicles baseline if passenger-km is calculated based on occupancy rate and trip distance and for leakage taxis and buses. For buses, monitoring required at a minimum in years 3, 6 and 10 as part of leakage. For taxis also if this vehicle category is included in the project. Need to have explanation of how this survey is done
9. TD_i $TD_{i,y}$	Average trip distance baseline for vehicle category *i*	Official statistics or proprietary	Km	m	Before project start and annually (in the case of modal shift for passenger cars)	Sample and sample survey	Electronic	Required for all categories of vehicles baseline if passenger-km is calculated based on occupancy rate and trip distance. Average trip distances of passengers using the new system are recorded through surveys based on the mode of transport they would have used in absence of the project (for users which would have used passenger cars, taxis or motorcycle; only required if modal shift effects are demanded by the project)

ID number	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
10. $TC_{x,i}$	Total fuel consumption per vehicle category	Official statistics or proprietary	Litres	m	Before project start	Sample	Electronic	Required if calculations are based on sectoral fuel consumption data
11. P_y	Passengers transported by project	Proprietary	Passengers	m	Annually	100%	Electronic	Statistics of transit management unit show the number of passengers transported by the project in total. This is based on electronic or mechanical measurement of all passengers using the system. Used to calculate ex-post the baseline emissions and to fulfil the applicability conditions
11bis. S_i	Share of passengers that would have taken transport mode *i*	Proprietary	%	m				The project monitors what transport mode passengers would have used in absence of the project. See paragraph below for details on the survey. The survey is also required if no modal shift is included in the project. In this case the modes of transport are only public transport, NMT, rail based urban transit and induced traffic
12. $P_{i,y}$	Passengers transported by project who would have used transport mode *i*	Proprietary	Passengers	e	Bi-monthly	Sample survey	Electronic	

~~ID number~~	~~Data variable~~	~~Source of data~~	~~Data unit~~	~~Measured (m), calculated (c), estimated (e)~~	~~Recording frequency~~	~~Proportion of data to be monitored~~	~~How will the data be archived? (electronic/ paper)~~	~~Comment~~
~~13. Policies~~	~~Policies that affect baseline~~	~~Proprietary~~	~~None~~	~~E~~	~~Before project start and annually~~	~~100%~~	~~Electronic~~	~~Transport policies, which affect the baseline emissions, are identified and their impact on any of the baseline factors is estimated. This is done ex-ante to project start.~~ ~~Annually the project assesses if a new policy has been implemented which changes in a measurable manner a baseline parameter.~~ ~~Project participants need to assess if policies might have effects on various parameters.~~

Data and parameters - Leakage

Details of Load Factor Study

~~The frequency of the road load study is:~~

- ~~If 100% of the project is implemented at the start: Year 2 to monitor short-term response of remaining bus fleet to project and years 5 and 10 to monitor medium-term response. Data of year 2 is used for years 3-5 and data of year 5 for rest of crediting period. To monitor the occupancy rate of the remaining buses every year is not considered as necessary, as changes are expected either in the first years (short-term response) or then in the medium-term. In between only incremental annual changes are expected which would not justify the considerable expenses for realizing such surveys;~~
- ~~With gradual project implementation monitoring years may vary. It is proposed to monitor at a minimum every 3 years e.g. year 3, 6 and 10.~~

Changes in load factor of the remaining conventional buses and taxis shall be monitored in the years 1 and 4 of the crediting period. If the load factor reduces less than 10 percentage points no leakage is included. If the load factor reduces by more than 10 percentage points relative to the measurement before project start (benchmark) then leakage is calculated and included. In this case the amount of leakage is the cumulative sum of all years since the last load factor survey was realized assuming that the reduction of the load factor occurred immediately since the last survey.

Guideline for the establishment of load factor studies for buses

Load factor surveys shall be based on "Visual Occupation Studies". The procedures to establish visual occupation are as follows:

(1) Vehicle categories are defined according to the characteristics of the fleet and types of services (e.g. with or without standing passengers);

(2) Occupation categories are defined (usually 5 or 6), for instance <50% occupied, 50-100% seats occupied, 100% seats occupied, <50% space for standing passengers occupied, 50-100% of standing space occupied, overload (>100% of legally permitted space occupied);

(3) The number of passengers corresponding to each vehicle category and type of service is defined. A pilot study could be completed to calibrate the levels of occupation with actual in vehicle counts;

(4) Formats for field study are prepared;

(5) Field data collectors are trained;

(6) Locations, days and times for field study are defined. Points are strategically located to cover all the routes with the minimum of points. Suggested days are Tuesday to Thursday, avoiding days immediately after or before a holiday. A typical seasons (school or university vacations) should be avoided. The recommended time period for the study is 6AM-9PM. More important is, however, that the same days and time periods are chosen for the baseline as well as for the monitoring studies to ensure data comparability;

(7) Field data is collected. Coverage of the occupation counts should be higher than 95% of the number of buses that cross the checkpoint. 100% coverage is desired. To control this outcome, a separate vehicle count is advised. Data can be adjusted with the actual count;

(8) Data is digitized and its quality is controlled. In case of mistakes in data collection, counts should be repeated;

(9) The total number of vehicles, number of available spaces (vehicle capacity) and the total number of passengers is reported. Occupation is the number of passengers divided by the vehicle capacity.

The average load factor is equal to the average load factor of each route multiplied by the total number of passengers in the route, divided by the total passengers in the network.

Guideline for the establishment of load factor studies for taxis

This study is only conducted if modal shift is claimed from former taxi passengers. The actual number of passengers excluding the driver of taxis is counted in a given point within a given time period. The counting is based on visual occupation counting the number of passengers occupying the taxi. Procedures to establish visual occupation:

(1) Locations, days and times for field study are defined. Suggested days are Monday to Friday, avoiding days immediately after or before a holiday. Atypical seasons (school or university vacations) should be avoided. The recommended time period for the study is 6AM-9PM. More important is, however, that the same days and time periods are chosen for the baseline as well as for the monitoring studies to ensure data comparability;

(2) Field data is collected. Coverage of the occupation counts should be higher than 95% of the number of taxis that cross the checkpoint. 100% coverage is desired. To control this outcome a separate vehicle count is advised. Data can be adjusted with the actual count;

(3) Data is digitized and its quality is controlled. In case of mistakes in data collection counts should be repeated;

(4) Occupation is the number of passengers using the taxi. The driver is not counted. Taxis without passengers are counted as 0 occupation;

(5) The total number of taxis and the total number of passengers is reported. The average occupation rate of taxis is the total number of passengers divided by the total number of taxis in which counts were performed;

(6) The study is realized in different locations of the city during minimum 5 days;

(7) The same methodology is used for the load study performed prior to the project as during the monitoring. Locations of monitoring can however change as traffic flows in cities change over time. Other parameters of the study (duration, sample size, counting method etc) however should remain constant to ensure consistency and comparability of studies.

Data and Parameters Monitored

All data collected as part of monitoring should be archived electronically and be kept at least for two years after the end of the last crediting period. 100% of the data should be monitored if not indicated otherwise in the tables below. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

In addition to the parameters listed in the tables below, the procedures contained in the tools referred to in this methodology also apply.

Data / Parameter:	$FC_{PJ,x,y}$
Data Unit	Litre
Description	Total consumption of fuel type x in year y by the project
Source of Data	Based on company records.
Measurement Procedure	
Monitoring frequency	Annual
QA/QC procedures	Data of measurements can be cross-checked against specific fuel consumption data. Variations in the specific fuel consumption from the average factor need to be controlled. Variations are possible due to different bus models used, variations resulting from routes and frequency, load factor variances and driver variances.
Comments	In case of bio-fuel blends being used, the biofuel share must be transparently recorded and emissions are only calculated for the fossil fuel share of the blend. It must be shown that conventional comparable urban buses use the same biofuel blend as project buses

Data / Parameter:	TD_i, $TD_{i,y}$
Data Unit	Km
Description	Average trip distance driven by vehicle category *i*
Source of Data	Official statistics or specific studies conducted by the project proponent. Vintage maximum 3 years.
Measurement Procedure	
Monitoring frequency	
QA/QC procedures	Data is based on origin-trip survey used to design the project including the QA procedures involved in such studies The same data source should be taken as for OC_i and $OC_{i,y}$ to ensure data consistency. The annual survey is based on a questionnaire, which is representative. Data from the annual survey is however only used if this results in lower baseline emissions (i.e. lower trip distances are monitored than the original baseline data)
Comments	Required for categories of baseline vehicles (taxis, personal cars and motorcycles) if passenger-km is calculated based on occupancy rate and trip distance. Average trip distances for passengers using the project system are recorded through surveys based on the mode of transport they would have used in absence of the project (for users which would have used a passenger cars, taxis or motorcycle; only required if modal shift effects are accounted for in emissions reductions attributed to the project)

Data / Parameter:	$S_{i,y}$
Data Unit	%
Description	Share of passengers transported by the project who in absence of the latter would have used transport type *i*
Source of Data	Survey conducted by an external survey company
Measurement Procedure	Based on survey
Monitoring frequency	The year 1 and 4 and the test-retest survey in the year 1 only

QA/QC procedures	See Annex for the survey design. Statistics on the total number of passengers of the project system is based on electronic or mechanic measurements and is cross-checked against financial receipts from the sale of tickets
Comments	The project monitors via a survey which transport mode passengers would have used in absence of the project. The survey is also required if no modal shift is included in the project. In this case the modes of transport are only public transport, NMT, rail based urban transit and induced traffic

Data / Parameter:	P_y
Data Unit	Passengers
Description	Passengers transported by the project
Source of Data	Municipal transit authorities or specific studies done by the project proponent or a third party. Data vintage maximum 3 years
Measurement Procedure	Statistics is based on electronic or mechanic measurements and is cross-checked against financial receipts from the sale of tickets
Comments	Statistics of transit management unit show the number of passengers transported by the project in total. This is based on electronic or mechanical measurement of all passengers using the system. Used to calculate ex-post the baseline emissions and to fulfil the applicability conditions

Data / Parameter:	OC_i
Data Unit	passengers
Description	Occupancy of baseline vehicle category *i*
Source of Data	Official statistics or survey conducted by an external survey company
Measurement Procedure	Based on survey
Monitoring frequency	Before the project start and for buses and taxis and in the year 1 and 4
QA/QC procedures	See Annex for the survey design. The same data source should be taken as forTD_i and $TD_{i,y}$ to ensure data consistency.
Comments	Required for all categories of vehicles baseline if passenger-km is calculated based on occupancy rate and trip distance and for leakage taxis and buses. For buses, monitoring required in the year 1 and 4 of the crediting period as part of leakage. The same requirement is for taxis if this vehicle category is included in the project. Need to have explanation of how this survey is done

Data / Parameter:	$ROC_{i,y}$, $OC_{i,y}$
Data Unit	
Description	Occupancy rate of vehicle category *i* relative to its capacity; occupancy of vehicle category *i* in year *y*
Source of Data	Survey conducted by an external survey company
Measurement Procedure	Based on survey
Monitoring frequency	The year 1 and 4 of the crediting period

QA/QC procedures	See Annex for the survey design Important is that the same methodology is used to measure the occupancy rate thus ensuring data consistency. For QA a precise and transparent data collection protocol is thus established detailing methodology and operational issues (including frequency, location, time, duration of measurement). The data is only required at a medium level as only changes >10 percentage points will be registered
Comments	The occupancy rate of taxis and the remaining bus fleet is monitored through representative samples. If results show negative changes > 10 % in the load factor, this change is included in the leakage calculation for all years since the last monitoring of the load factor

Data / Parameter:	$N_{Z,y}$, $N_{T,y}$
Data Unit	
Description	Number of conventional buses and taxis remaining in operation
Source of Data	Official registration statistics or survey conducted by an external survey company
Measurement Procedure	Based on survey
Monitoring frequency	The year 1 and 4 of the crediting period
QA/QC procedures	See Annex for the survey design In general various official sources are available (vehicle registration data; transportation statistics). Important is to ensure that over time the same source or the same calculation method (e.g. average of sources) is applied. The same data source should be taken as for $ROC_{i,y}$ and $OC_{i,y}$ to ensure data consistency
Comments	

Data / Parameter:	$N_{i,x}$
Data Unit	Vehicles
Description	Number of vehicles
Source of Data	Official statistics or specific studies done by the project proponent or a third party. Vintage maximum 3 years
Measurement Procedure	
Monitoring frequency	Before project start and in the year 1 and 4 (in the case of modal shift for passenger cars)
QA/QC procedures	In general various official sources are available (vehicle registration data; transportation statistics). Important is to have the same data source for distance driven and passengers for public transport to ensure consistency. Data can be either with or without the informal sector as long as above-mentioned parameters are from the same data source. In general data including only the formal sector is of better data quality and should thus be taken. To ensure quality, the data source and calculation method need to be stated. With the survey data on the fuel type of passenger cars used by passengers now using the BRT system is recorded. Changes to the baseline emission factor for passenger cars are only made if the monitored data results in lower emission factors, not so however if the data results in higher emission factors

Comments	Per vehicle category the amount of vehicles per relevant fuel type (gasoline, diesel, LNG, CNG or electric vehicles) needs to be identified. Only categories are included where modal shift is expected (next to public transport). Recording of fuel type used by passengers using the project system who in absence of the project would have used a passenger car (only required if a modal shift of passenger cars is included in the project) shall be conducted in the year 1 and 4 of the crediting period

Data / Parameter:	NCV_x
Data Unit	J/mass or volume units of fuel
Description	Net calorific value of fuel type *x*
Source of Data	The following data sources may be used if the relevant conditions apply: <table><tr><th>Data source</th><th>Conditions for using the data source</th></tr><tr><td>(a) Values provided by the fuel supplier in invoices taken from a sample of fuel stations in the larger urban zone of the city</td><td>This is the preferred source if the carbon fraction of the fuel is not provided</td></tr><tr><td>(b) Measurements by the project participants taken from a sample of fuel stations in the larger urban zone of the city</td><td>If (a) is not available</td></tr><tr><td>(c) Regional or national default values</td><td>If (a) is not available This source can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances)</td></tr><tr><td>(d) IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td></td></tr></table>
Measurement Procedure	For (a) and (b): measurements should be undertaken in line with national or international fuel standards

Monitoring frequency	For (a) and (b): the NCV should be obtained for each fuel delivery, from which weighted average annual values should be calculated.
	For (c): review the appropriateness of the values annually
	For (d): any future revision of the IPCC Guidelines should be taken into account

QA/QC procedures	Verify if the values under (a), (b) and (c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range, collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in (a), (b) or (c) should have ISO17025 accreditation or justify that they can comply with similar quality standards

Comments	The parameter is used for baseline as well as project emissions and vehicle owners or operators can buy fuel from a variety of sources (fuel stations). In practice therefore it is considered to be simpler to determine the parameter using options (c) or (d)

Data / Parameter:	$NCV_{NG,y}$
Data Unit	GJ/m³
Description	Net calorific value of the natural gas used by the project during the year y
Source of Data	Local, regional, national data or IPCC
Measurement Procedure	annually
Comments	In case of IPCC default values, the upper limit of the uncertainty at a 95% confidence interval should be taken

Data / Parameter:	$EF_{CO2,x}$
Data Unit	gCO_2/J
Description	CO_2 emission factor for fuel type *x*
Source of Data	The following data sources may be used, if the relevant conditions apply: **Data source** — **Conditions for using the data source** (a) Values provided by the fuel supplier in invoices taken from a sample of fuel stations in the larger urban zone of the city — This is the preferred source (b) Measurements by the project participants taken from a sample of fuel stations in the project boundary — If (a) is not available (c) Regional or national default values — If (a) is not available. This source can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances) (d) IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories —
Measurement Procedure	For (a) and (b): measurements should be undertaken in line with national or international fuel standards. For (a): if fuel suppliers provide the NCV value and the CO_2 emission factor on the invoices and these two values are based on measurements for this specific fuel, this CO_2 factor should be used. If another source for the CO_2 emission factor is used or no CO_2 emission factor is provided, options (b), (c) or (d) should be used

Monitoring frequency	For (a) and (b): the CO_2 emission factor should be obtained for each fuel delivery, from which weighted average annual values should be calculated.
	For (c): review the appropriateness of the values annually
	For (d): any future revision of the IPCC Guidelines should be taken into account

QA/QC procedures	
Comments	The parameter is used for baseline as well as project emissions and vehicle owners or operators can buy fuel from a variety of sources (fuel stations). In practice therefore it is considered to be simpler to determine the parameter using options (c) or (d)

Data / Parameter:	$EF_{CH4,x}$
Data Unit	gCO_{2e}/litre
Description	CH_4 emission factor for gaseous fuel type *x*
Source of Data	The source of data should be the following, in order of preference: project specific data, country specific data or IPCC default values. As per guidance from the Board, IPCC default values should be used only when country or project specific data are not available or difficult to obtain.
Measurement Procedure	
Monitoring frequency	
QA/QC procedures	
Comments	The default value of 21 shall be used as the global warming potential (GWP) of methane for the first commitment period under the Kyoto Protocol.

Data / Parameter:	$EF_{N2O,x}$
Data Unit	gCO_{2e}/litre
Description	CH_4 emission factor for gaseous fuel type *x*
Source of Data	The source of data should be the following, in order of preference: project specific data, country specific data or IPCC default values. As per guidance from the Board, IPCC default values should be used only when country or project specific data are not available or difficult to obtain.
Measurement Procedure	
Monitoring frequency	
QA/QC procedures	
Comments	The default value of 310 shall be used as the global warming potential (GWP) of methane for the first commitment period under the Kyoto Protocol.

Data / Parameter:	$V_{P,y}$
Data Unit	km/h
Description	Average project speed of passenger cars on remaining roads in the project boundary in year *y*
Source of Data	Municipal transit authorities or studies ordered by project proponent
Measurement Procedure	On-board measurements determining the total average speed and the average moving speed (when circulating) on the remaining roads based, e.g. on GPS measuring This parameter should be monitored for each affected road in the project boundary

Monitoring frequency	Once in the years 1 and 4 of the crediting period
QA/QC procedures	-
Comments	

ID number	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic / paper)	Comment
20. $ROC_{i,y}$ $OC_{i,y}$	Occupancy rate of vehicle category *i* relative to capacity; occupancy of vehicle category *i*	Proprietary	%	C,M	Before project start plus regular intervals thereafter	Sample	Electronic	The occupancy rate of taxis and the remaining bus fleet is monitored through representative samples. If results show negative changes > 10 % in the load factor, this change is attributed and included in the leakage calculation for all years since the last monitoring of the load factor. Recommended interval: year 3, 6 and 10 for 10 year crediting period; year 3 and 7 for 7 year crediting period See details below
21. $N_{Z,y}$, $N_{T,y}$	Number of conventional buses and taxis still operating	Official statistics or proprietary	Units	M	Before project start plus regular intervals thereafter	100%	Electronic	Registration statistics. Same years to be monitored as in Item 20

ID number	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic / paper)	Comment
22. SRS	Share of road space used by public transport baseline	Official statistics or proprietary	Percentage	E, c	Before project		Electronic	Used for urban transport and infrastructure models; see baseline euqations for calculation of SRS if the data is not available from reports: The share of road space used by public transport is a figure often calculated in transport studies. If no reliable data is available as proxy the relative distance driven per different vehicles can also be taken. SRS would then be the distance driven by the public transport (baseline) divided by the total distance of all vehicles driven (baseline). This would be a conservative factor as buses are larger than private cars and thus occupy a larger share of road space per kilometre driven
23. RSP, RSB	Road space baseline and project	Official statistics and proprietary	Index, km	E	Before project start	100%	Electronic	Road space baseline based on official information. Reduced road space based on construction plans (reduced road space is lanes which where eliminated due to dedicated bus lanes). Road space project = road space baseline – eliminated lanes
24. TR_C	Number of daily trips undertaken by passenger cars	Official statistics or proprietary	Unit	m	Before project start	Sample	Electronic	Based on surveys. Used for urban transport and infrastructure models
25. V_{PJ}, V_{BL}	Average speed passenger car in baseline and project	Proprietary	km/h	m/e	Before project start	100%	Electronic	Based on transport models. The average speed of passenger cars before project start and the expected speed after decongestion is calculated

~~ID number~~	~~Data variable~~	~~Source of data~~	~~Data unit~~	~~Measured (m), calculated (c), estimated (e)~~	~~Recording frequency~~	~~Proportion of data to be monitored~~	~~How will the data be archived? (electronic / paper)~~	~~Comment~~
~~26. $NCV_{NG,y}$~~	~~Net calorific value of the natural gas used by the project during the year y~~	~~Local, regional, national data or IPCC~~	~~GJ/m³~~	~~m~~	~~annually~~	~~100%~~	~~electronic~~	~~If IPCC default values at the upper limit of the uncertainty at a 95% confidence interval~~
~~27. $EF_{CO2,upstream,CH4}$~~	~~Emission factor for upstream fugitive methane emissions from production, transportation and distribution of natural gas~~	~~National or IPCC~~	~~tCH4/GJ~~	~~m~~	~~Prior project start~~	~~100%~~	~~electronic~~	
~~28. $EF_{CO2,upstream,LNG}$~~	~~Emission factor for upstream CO_2 emissions due to fossil fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system~~	~~National or IPCC~~	~~tCO2/TJ~~	~~m~~	~~Prior project start~~	~~100%~~	~~electronic~~	

~~**Quality control (QC) and quality assurance (QA) procedures**~~		
~~**Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)***~~	~~**Uncertainty level of data (High/Medium/Low)**~~	~~**Explain QA/QC procedures planned for these data, or why such procedures are not necessary.**~~
~~*Fuel consumption project 2-1; 1*~~	~~*Low*~~	~~*Data of measurements can be cross-checked against specific fuel consumption data. Variations in the specific fuel consumption from the average factor need to be controlled. Variations are possible due to different bus models used, variations resulting from routes and frequency, load factor variances and driver variances*~~
~~*Fuel efficiency project 2-1; 2*~~	~~*Low*~~	~~*Operators record fuel consumption data. Distance driven based in general on GPS. Thus precise results for project data. Variations in the specific fuel consumption in a specific enterprise and between enterprises need to be controlled. Variations are possible due to different bus models used, variations resulting from routes and frequency, load factor variances and driver variances. Controls are based on checking data with the operators including checks of bills issued by fuel companies. If project fuel emissions are based on specific fuel consumption values of not the total fleet but only a representative sample then all data with specific fuel consumptions more than 20% lower than the average specific fuel consumption of comparable units is omitted to ensure a conservative approach*~~
~~*Distance driven project 2-1; 3*~~	~~*Low*~~	~~*Based in general on GPS; Kilometres driven is the base for paying bus operators. This data is thus well checked and verified by the transit operator*~~
~~*Number of vehicles baseline 2-3; 4*~~	~~*Low*~~	~~*In general various official sources are available (vehicle registration data; transportation statistics). Important is to have the same data source for distance driven and passengers for public transport to ensure consistency. Data can be either with or without the informal sector as long as above-mentioned parameters are from the same data source. In general data including only the formal sector is of better data quality and should thus be taken. To ensure quality the data source and calculation method need to be stated. With the annual survey data on the fuel type of passenger cars used by passengers now using the BRT system is recorded. Changes to the baseline emission factor for passenger cars are only made if the monitored data results in lower emission factors, not so however if the data results in higher emission factors*~~
~~*Fuel efficiency vehicles baseline 2-3; 5*~~	~~*Medium*~~	~~*Result is checked for consistency against manufacturer data and default IPPC values (alternative for baseline estimation; see baseline methodology)*~~
~~*Distance driven baseline buses and taxis 2-3; 6*~~	~~*Medium*~~	~~*In general various official sources are available (vehicle registration data; transportation statistics). For QA it is important to have the same data source for items 4, 5 and 7 if calculations are related*~~
~~*Passengers transported baseline 2-3; 7*~~	~~*Low*~~	~~*In general various official sources are available (vehicle registration data; transportation statistics). The same data source should be taken as for item 6 to ensure data consistency*~~

~~*Average occupancy rates vehicles baseline 2-3; 8*~~	~~*Medium*~~	~~*The same data source should be taken as for item 9 to ensure data consistency*~~
~~*Average trip distance baseline -2-3; 9*~~	~~*Low*~~	~~*Data is based on origin-trip survey used to design the project including the QA procedures involved in such studies The same data source should be taken as for item 8 to ensure data consistency. The annual survey is based on a questionnaire, which is representative. Data from the annual survey is however only used if this results in lower baseline emissions (i.e. lower trip distances are monitored than the original baseline data)*~~
~~*Total fuel consumption per vehicle category 2-3; 10*~~	~~*Low*~~	~~*Data is based on sector surveys of fuel consumption per category and can be checked against statistics of total fuel consumption; The study should have a 95% confidence interval with a 5% error margin*~~
~~*Passengers transported by project 2-3; 11*~~	~~*Low*~~	~~*Statistics are based on electronic or mechanic measurements and are cross-checked against financial receipts from the sale of tickets*~~
~~*Passengers transported by the project which in absence of latter would have used other transport modes 2-3; 12*~~	~~*Low*~~	~~*Important is that the same methodology is used to estimate transport modes over the whole crediting period. For QA a precise and transparent data collection protocol is established detailing methodology and operational issues (including frequency, location, time, duration of measurement). The sample size is determined to ensure a 90% confidence interval using statistical techniques for random surveys. The PDD must contain a survey format as well as the survey methodology to be used. A sensitivity analysis of this parameter must be realized*~~
~~*Policies which affect baseline 2-3; 13*~~	~~*Moderate*~~	~~*Policies are assessed. Their potential impact on the modal split and on other relevant parameters affecting baseline emissions is assessed based on information or studies realized by the policy promoter. If the impact in modal switch is significant it is assumed that the full modal switch of the implementation year is attributable to the policy and not the project. If a measurable impact exists on any baseline parameter the respective baseline emission factors are changed*~~
~~*Average occupancy rates of remaining taxis and conventional buses (relative to capacity in buses) 4-1; 20*~~	~~*Medium*~~	~~*Important is that the same methodology is used to measure the occupancy rate thus ensuring data consistency. For QA a precise and transparent data collection protocol is thus established detailing methodology and operational issues (including frequency, location, time, duration of measurement). The data is only required at a medium level as only changes >10 percentage points will be registered. The same data source should be taken as for item 19 to ensure data consistency*~~
~~*Number of conventional buses and taxis still operating 4-1; 21*~~	~~*Low*~~	~~*In general various official sources are available (vehicle registration data; transportation statistics). Important is to ensure that over time the same source or the same calculation method (e.g. average of sources) is applied. The same data source should be taken as for item 20 to ensure data consistency*~~
~~*Share of road space used by public transport 4-1; 22*~~	~~*Medium*~~	~~*Based on calculations made for urban infrastructure and transport scenarios or on the calculation method provided using data on the distance driven of various vehicle categories*~~

~~Road space baseline and project 4-1; 23~~	*~~Low~~*	*~~Based on calculation (RSP) and infrastructure statistics~~*
~~Number of daily trips realized by passenger cars 4-1; 24~~	*~~Low~~*	*~~Based on calculations made for urban infrastructure and transport scenarios; based on sample countings in general~~*
~~Average speed passenger car baseline and project 4-1; 25~~	*~~Medium~~*	*~~Traffic models use such data and have verified them. The data accuracy is not very important as data is only used to estimate roughly leakage based on change of vehicle speed and induced traffic. Both elements in it have a moderate accuracy~~*

IV. REFERENCES AND ANY OTHER INFORMATION

Not applicable.

Appendix A: Parameters Used in Baseline Methodology

BASELINE AND PROJECT EMISSIONS PARAMETERS (fixed ex-ante, including potential default parameters):[18]

1. Fuel emissions factors

CO_2 emissions factors are a fixed value per litre of fuel is used, on the basis of the carbon content of the fuel. The calculation is based on the carbon content of the fuel, the net calorific value of the fuel, and the oxidation of the fuel during combustion. ~~CH_4 and N_2O emissions factors depend on vehicle type~~.

Table A.1: Default Emission Factors for all Vehicle Categories and Fuel Types (gCO_2e/litre)

Vehicle category	CO_2 emission factors		~~CH_4 emission factors~~		~~N_2O emission factors~~	
	Gasoline	Diesel	~~Gasoline~~	~~Diesel~~	~~Gasoline~~	~~Diesel~~
Bus large	2 313	2 661	~~11~~	~~2~~	~~9~~	~~21~~
Bus medium[19]	2 313	2 661	~~12~~	~~2~~	~~12~~	~~36~~
Bus small	2 313	2 661	~~13~~	~~1~~	~~14~~	~~51~~
Taxis[20]	2 313	2 661	~~11~~	~~1~~	~~14~~	~~23~~
Passenger cars	2 313	2 661	~~11~~	~~1~~	~~14~~	~~23~~
Motorcycles	2 313	2 661	~~29~~	~~—~~	~~7~~	~~—~~

~~Note: CH_4 and N_2O has been transformed in CO_2e using GWP factors; Default values represent per vehicle category the technology with the lowest sum of CO_2e emissions~~

2. Fuel consumption for vehicles

IPCC values can be used. However the project proponent must identify the average vehicle age per category and the most common technology to assess which factor is the most appropriate for the local circumstances. The most important proxy to identify vehicle technologies is the average age of vehicles used in the area of influence of the project. To determine if either US or European default factors apply either local vehicle manufacturer information can be used (in the case of having a substantial domestic vehicle motor industry) or the source of origin of vehicle imports. Data sources for IPCC values on fuel consumption are the Revised 1996 IPCC Guidelines for National GHG Inventories: Reference Manual Tables 1-27 to 1-42. If these tables are updated, the latest available version must be used.

3. Technology improvement factor: This is a fixed and constant parameter per vehicle category.

Table A.2: Technology Improvement Factor for fuel consumption

Vehicle category	Improvement Factor IR
Buses	0.99
Taxis	0.99
Passenger cars	0.99
Motorcycles	0.997

4. Upstream Emissions

The default value for UEF is 14%.

[18] Project proponents can use in many cases fixed default parameters or use local data. The different options including a preference for certain options are listed in the respective formulas.

[19] Calculated as average between small and large buses.

[20] Taken as equivalent to passenger cars.

LEAKAGE PARAMETERS (fixed *ex ante* or default values):[21]

1. Fixed elasticity factor for relation between additional road space and induced trips:

This parameter cannot be observed with a reasonable effort during the project. The default factor taken is 0.1, based on literature, taking a conservative approach.

2. Fixed relation between vehicle speed and emissions:

The relation is based upon the speed dependency factor Passenger Cars (gCO2 per km) developed by CORINAR. The category from this analysis used is 1.4l <CC<2.0l for Euro I onwards with a speed range between 13.1 and 130 km/h.

[21] Project proponents can use in many cases fixed default parameters or use local data. The different options including a preference for certain options are listed in the respective formulas.

Appendix B

Guideline for the establishment of load factor studies for buses based on visual occupation

Load factor surveys based on visual occupation studies use the following procedures:

(1) Vehicle categories are defined according to the characteristics of the fleet and types of services (e.g. with or without standing passengers);

(2) Occupation categories are defined (usually five or six), for instance <50% occupied, 50-100% seats occupied, 100% seats occupied, <50% space for standing passengers occupied, 50-100% of standing space occupied, overload (>100% of legally permitted space occupied);

(3) Formats for field study are prepared;

(4) Field data collectors are trained;

(5) Locations, days and times for field study are defined. Points are strategically located to cover all the routes with the minimum of points. Atypical seasons (school or university vacations) should be avoided. The recommended time period for the study is the entire period of operation of the selected buses. Measurements should be realized for all weekdays proportional to the number of buses displaced on these days. The same days and time periods need to be chosen for the baseline as well as for the monitoring studies to ensure data comparability;

(6) Field data is collected. Coverage of the occupation counts should be higher than 95% of the number of buses that cross the checkpoint. 100% coverage is desired. To control this outcome, a separate vehicle count is advised. Data can be adjusted with the actual count.

Appendix C

Guideline for the establishment of load factor studies for buses based on boarding-alighting surveys

Load factor surveys based on boarding-alighting studies for buses use the following procedure:

(1) Routes for the survey must be selected, weighted upon the expected number of passengers per route. Only active routes are included;

(2) The load factor (occupation rate) is defined as the average percentage of capacity of the vehicle used by passengers. The average load factor of a route is based on the average of each load factor between each station of the specified route;

(3) The common operational procedure used is to ride on the unit and count at each station the number of passengers boarding and alighting. Instead of manual controls electronic or mechanical controls can be used;

(4) Locations, days and times for the survey are defined. Atypical seasons (school or university vacations) should be avoided. The recommended time period for the study is the entire period of operation of the selected buses. Measurements should be realized for all weekdays proportional to the number of buses displaced on these days. The same days and time periods need to be chosen for the baseline as well as for the monitoring studies to ensure data comparability;

(5) The survey must be conducted during the entire operation period of buses (not only peak or off-peak hours);

(6) The units selected are clearly identified including licence plate, day monitored, number of turn-arounds, route and route distance;

(7) Data are digitized and its quality is controlled. In case of mistakes in data collection, counts should be repeated.

Boarding and alighting information can also be obtained in some cases from electronic means such as electronic ticketing, digital camera passenger identification per bus, monitoring of average bus weight per station, etc.

Appendix D

Guideline for the establishment of load factor studies for taxis/motorcycles or passenger cars

The actual number of passengers excluding the driver of taxis is counted in a given point within a given time period. The counting is based on visual occupation counting the number of passengers occupying the vehicle excluding the driver for taxis. The procedures to establish visual occupation are:

(1) Locations, days and times for field study are defined, avoiding days immediately after or before a holiday. Atypical seasons (school or university vacations) should be avoided. The same days and time periods need to be chosen for the baseline as well as for the monitoring studies to ensure data comparability;

(2) Field data is collected. Coverage of the occupation counts should be higher than 95% of the number of taxis that cross the checkpoint. One hundred per cent coverage is desired. To control this outcome a separate vehicle count is advised. Data can be adjusted with the actual count;

(3) Occupation is the number of passengers using the vehicle. The driver is not counted for taxis. Taxis without passengers are counted as no (zero) occupation;

(4) The total number of vehicles and the total number of passengers is reported. The average occupation rate of vehicles is the total number of passengers divided by the total number of vehicles in which counts were performed;

(5) The study is realized in different locations of the project boundary;

(6) The same methodology is used for the load study performed prior to the project start and during its monitoring. Locations of monitoring can, however, change as traffic flows in cities change over time. Other parameters of the study (duration, sample size, counting method, etc) however should remain constant to ensure consistency and comparability of studies.

Appendix E

Methodological design of survey BRT

The methodological design of the survey is presented in detail. The following points are discussed:

(1) Survey objective;

(2) Target population;

(3) Sample frame;

(4) Sample design;

(5) Relative error level;

(6) Geographical coverage;

(7) Sample frequency;

(8) Sample size;

(9) Size and result of the pilot test;

(10) Selection method of the sample;

(11) Methodology for information collection and estimation of the parameters;

(12) Data verification and validation including QA and QC;

(13) Survey realization;

(14) Calculation of a trip distance in the survey;

(15) Default questionnaire.

Whenever the BRT is extended, a new survey distribution is realized and data of the new survey is used for calculating emissions reductions achieved from the moment of the BRT extension.

Technical Summary Data Sheet of the Survey
Strategy and sample design in the BRT passenger survey

Parameter	Main parameters: • Baseline emissions; Secondary parameters and inputs: • Proportion of passengers using each mode of transport, with the project and in absence of the project; • The average distance travelled by these modes with the project and in absence of the project
Target population	Passengers over 12 years using the BRT
Sample frame	Passenger flow in all the stations of the BRT

Sample design	Two staged probabilistic design: • First stage: stratified – simple random sampling (SRS); • Second stage: systematic sampling based on passengers flow per station. Stratum: Stations. Sub stratum: Days in a week and hours
Relative error level (CV)[22]	For the survey a global desired level of precision (relative standard error or coefficient of variation – CV) between 5% and 10% for the parameters of interest, which also implies that having precision levels of 90/10, is required. Results obtained are based on a 95% confidence level using the more conservative boundary
Coverage	The project boundary where the BRT operates
Size of Universe	Generally, in one day an BRTmobilizes between 100,000 and 3,000,000 passengers, depending on the type of transport system
Sample size	The sample size ranges from 6,000 to 8,000 surveys in the measuring week with a re-test sample size of around 50% of the original sample[23]. The final sample size determination depends on the transport system characteristics regarding daily passenger flow and number of stations. The sample size indicated is an estimate and needs to be determined per project type (see corresponding chapter)
Sample frequency	Once in the years 1 and 4 of the crediting period during an entire week plus one re-test in the year 1 only
Method of information collection	The information will be obtained through the face-to-face application of the established questionnaire on a random base
Consistency of the survey results	The internal consistency of the results of the survey must be carefully checked. The reliability will be measured using the Cronbach's alpha. A coefficient of over 0.7 has to be reached, values over 0.9 shall be re-checked to avoid redundancy of data. In case the survey does not demonstrate internal consistency in their results, it will be rejected and another survey could be arranged

1. Survey Objective

The survey objective is to determine:

- The baseline emissions caused by passengers which use the BRT and in absence of the latter would have used other modes of transport to realize their trip;

2. Target Population

The target population are all passengers over 12 years of age. Smaller children are excluded due to problems in answering the questions. Also smaller children, in general, are accompanied by their parents or an adult and thus have the same trip sequence as the adult person.

3. Sample Frame

The sample frame is the passenger flow in all the stations of the BRT. Data for the passenger frame is obtained from the system manager.

[22] Relative error level refers to the coefficient of variation (CV), which is calculated as the ratio between the standard deviation of the average and the population average.

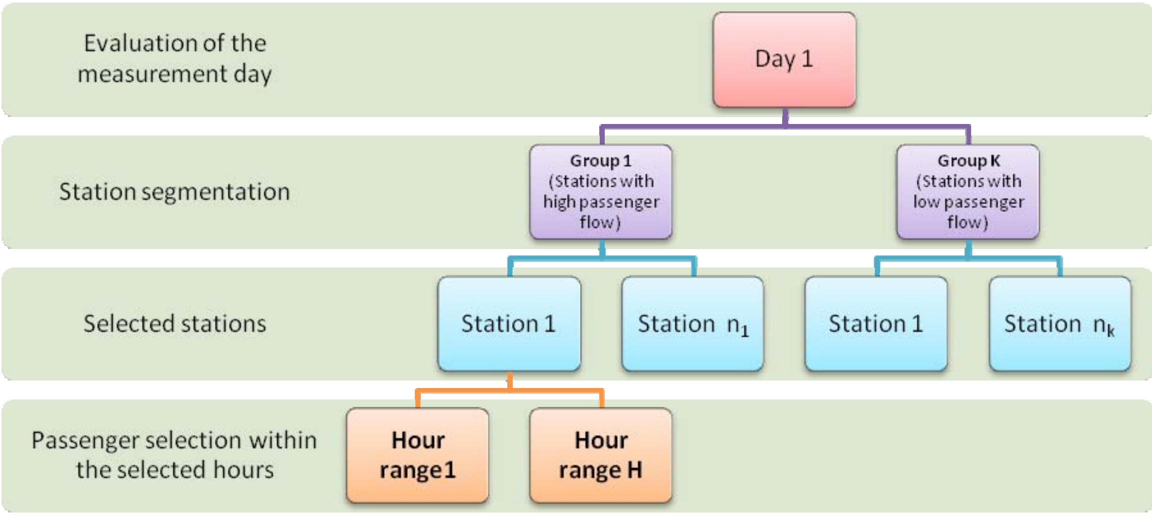
[23] The re-test sample size is determined based on the variances encountered in the original sample.

4. Sample Design

A two staged probabilistic design is applied:

- First stage: Stratified – Simple Random Sampling (SRS);
- Second stage: Systematic sampling based on passengers flow per station.

The stratification model used is represented by the following scheme, where the process for a specific day is shown, applies routinely for the seven measurement days.



Main strata (Stations): First a cluster analysis is performed that groups the stations depending on the passenger flow per station to provide information for busier stations and less frequented stations. In practical terms, three groups of stations are created: stations with a high, medium and low passenger volume. In the case of large heterogeneity of passenger flows an additional group is included to control this variability.

Sub strata: Sub strata are built from the passenger flow information reported per day and hour. Sub strata are formed in such a manner that information is taken for the seven days of a week, and within each day, hours ranges are arranged according to the passenger flow.

In BRTs, there are generally predefined hourly passenger flow ranges (peak/off-peak hours) through which the fixed hours when passengers are surveyed during the seven week days are defined taking into account that peak hours have to be included i.e. in each of these hours information is collected and off-peak hours are partially included.

The sample is to be distributed in each day according to the average passenger flow per day and within the day, as per the users per day or hour range. Within each day, a random station selection process is to be carried out within the defined strata, in such a way that during the evaluation week the possibility for all stations to be visited is created. The station grouping is carried out according to a multi-variant cluster analysis, using as a classification variable the passenger flow reported daily by station.

5. Relative Error Level

For the survey, a global desired level of precision (relative standard error or coefficient of variation – CV) between 5% and 10% for the parameters of interest is required, which also implies having precision levels of 90/10.

It is considered that the result of an estimate is:

- Statistically robust if its coefficient of variation is less than 5%;
- Practically acceptable if its coefficient of variation is between 5% and 10%;
- Of low precision if its coefficient of variation is higher than 10% and less than 15%;
- It is not considered as robust if its coefficient of variation is higher than 15%.

For the results obtained, a 95% confidence level is calculated taking the (conservative) lower boundary for baseline emissions. The parameters determined in the survey are thus quantified at the 95% confidence level following the Annex 2 (EB 22 report, Annex 2, D, page 3): "Methodologies employing sampling to derive parameters in estimating emissions reductions shall quantify these parameter uncertainties at the 95% confidence level".

6. Geographical Coverage

The geographical coverage is the area where the BRT operates (project boundary).

7. Sample Frequency

The survey is realized minimum once during the year 1 and 4 of the crediting period plus an re-test survey realized in the year 1 only, thus achieving two samples in the year 1, and one sample per the year 4 of the crediting period. The survey shall take place during an entire week. The selected week shall not correspond to a public holiday and shall be representative for the average demand for transport services in the considered year.

To guarantee that there is no seasonality, and if there was, the way in which it would be approached, the following steps are taken:

(a) In the first year and while the system is stabilized, a single measurement is taken and a second measurement is carried out in a later period (test-retest method), with a sample size of less than half of the initial survey;

(b) With the passenger flows data of the first year, and with the comparison between the first survey and the test-retest, it is defined if there is any seasonality degree in the year. If there is an evidence of seasonality, within each period where there are apparent differences, independent surveys are performed and at the end, the results are compared regarding the emissions difference and the parameters on the use of modes of transport and the average travel distance;

(c) If there are no significant differences between the analysis periods, the measurements of later years shall be done only once a year, on the contrary, they shall be carried out in the periods in which seasonality is identified;

(d) Independent from the result, at least one measurement in a whole week will always be performed in the year 4 of the crediting period, and the application of the test-retest method in the year 1. The two measurements in the year 1 are done in different periods, one in the first semester of the year and the other in the second semester.

The criteria for identifying if there is any seasonality are the following one:

- A test of mean comparison is carried out between the data reported on the flow of passengers between months, and in the same way, within the weeks of each month;
- A further test consists in the application of a times series model SARIMA, where it is estimated if there is any seasonality degree in the passengers flows, either weekly or monthly. Through the functions of auto-correlation and partial auto-correlation, it is identified if there is any pattern in the data.

8. *Sample Size*

For the calculation of the sample size, a global level of precision (relative standard error or coefficient of variation – CV) between 5% and 10% for the parameters of interest has to be met. This implies at the same time having precision levels of 90/10, i.e. a minimum confidence level of 90% and a maximum precision level of 10%.

In general, determining the sample size is done by simulation following the Särndal methodology (1992), in which a CV is fixed and the sample size is found by solving *n* of the formula of the estimator variance according to the design used in each case.

$$CV = \left(\frac{\sqrt{V(\hat{t}_y)}}{\hat{t}_y} \right) \cdot 100$$

Where $\hat{t}_y$ is the estimate of the average for parameter of interest *y* and $V(\hat{t}_y)$ is the variance of this estimate.

The stratification structure complies with the principles of independence and invariance, reason for which in the formula for the CV in this study, the estimated variance of the estimator results from adding those obtained in each stratum (see section 10 which provides formulas for the calculation of the variance in case of multi-stage designs).

The main parameter of interest is the distance per mode of transport for each passenger. The distance per mode is one parameter, i.e. D(i) indicating distance travelled by passengers using mode *i* .

However, an important parameter to determine the sample size is the percentage of passengers which use mode *i*. This is relevant as only few passengers of the new system would have used certain modes such as passenger cars (the large majority of users come from conventional public transport). However, even if their share is low they could still have an impact on emission reduction calculations due to their high emission factor. For the survey to be reliable, it needs a sufficient number of respondents also in modes used less frequently. The sample size determination is thus influenced strongly by the share of passengers per mode to have the desired precision level for this variable and therefore also for the main parameter of interest being the distance per mode. To determine the sample size *ex ante* therefore a pre-survey is conducted and/or data from other comparable-projects are taken.

In practical terms, the procedure for determining the sample size is:

(a) The results of the pilot test are taken as reference for the simulation (mean and standard deviation); This is especially important concerning share of modes for passengers as this determines the sample size to a considerable extent as some modes have a low frequency (e.g. passenger cars, potentially taxis and motorcycles);

(b) Simulation is subject to the modification of standard deviations larger than the one found in the pilot test, with the objective of obtaining an optimum sample size even under high variability conditions (limitation of the maximum variability level);

(c) The simulation process is first done using the results of the pilot survey under a SRS design (Simple Random Sampling), and under the multistage design (see the formulae described in section 10) and thereafter the design effect (Deff) is determined corresponding to the ratio between the variance of the multi-stage design, and the variance of a SRS design;

(d) Finally, based on the simulation and the presentation of different scenarios corresponding to different sampling sizes and various assumptions about the standard deviations of parameters of interest (for instance by using a deff factor between 2 and 3), the sample size that best adjusts to the expected error levels is taken.

The DOE shall verify that the procedures used to derive the sample size will lead to the level of precision for the parameters of interest stipulated above.

Design Effect (Deff)
The ratio between the variance of the particular design and the variance under a SRS design, is called the design effect (Deff). In this way, when Deff is less than 1 it implies that the selected design has more precision than the SRS one, and when it is larger than 1, the proposed design is less efficient than the SRS one.

9. Size and Result of Pilot Test

The data obtained for a similar transport system will be used as a reference and pilot result. In case the BRT is already operating, it is recommended to realize a pilot sample which can be of a smaller sample size and simplified concerning stratification, etc. In cases where the BRT is not operating, results from comparable surveys from comparable BRTs from other cities can be used as a reference.

10. Selection method of the sample

Stations, hours and passengers must be selected for the sample. The selection method has to demonstrate that it guarantees a random and non-biased selection process, which is especially important in face-to-face interviews. The random distribution allows that the sample mirrors the total population in any other non-observed variables such as age, gender, religion, personal preferences, etc. A control is realized if the sample matches the total population in several of these parameters to ascertain that the sample reflects truly the population with all its characteristics.

(a) Selection of stations and evaluation hours

Given that there is a complete list of stations that are part of each established group (stratum), the selection of stations is carried out according to a SRS design, through the negative coordinated algorithm.

The same happens for the defined hour ranges: within each range a specific hour is selected under this method for the sample selection.

Algorithm of the Negative Coordinated Method

N: Universe size

n: Sample size to be selected.

A value 0<π<1 is fixed and for each one of the universe elements random events $\xi_1, \ldots, \xi_N$ are carried out uniformly distributed (0,1). Which ones belong to the sample is decided as follows:

- If $\xi_k < \pi$ then k belongs to the sample;
- If $\xi_k \geq \pi$ then k does not belong to the sample.

In this way the probabilities of being part of the sample of the first and second order are:

$$\pi_k = \pi, \pi_{kl} = \pi^2$$

Since the expectation of the sample size is equal to $\sum_U \pi_k$ in the SRS design, it complies with $E(n_s) = \sum_U \pi_k = n$ therefore the departure point is from an expected sample size equal to n, further it is said that $\pi_k = \pi = n / N$ and from that value, the selection is carried out.

(b) Selection of Passengers

Given that there is no reference frame or list frame for the identification of BRT users, the selection of the sample in the last stage shall be performed according to the systematic sampling design, replicated identically for each stratum and considering the following steps:

(i) A random starting point is generated according to the statistics tables of uniform distribution between 1 and the average flow of passengers in the evaluation hour;

(ii) Systematic selection of passengers: every nth passenger entering the station, starting with the random number. In this way, if the random number is 20, the first passenger selected is the 20th that enters the station, the 2nd n+20 and thus successively every nth passenger. The number n, called selection interval, will be determined based on the passenger flow per hour and the sample distribution of the specific measurement day.

11. Methodology for information collection and estimation of the parameters

(a) General considerations on information collection

The information will be obtained through the face-to-face application of the established questionnaire.

According to the selected days and hour range, each survey interviewer shall carry out the number of established surveys. Given that the selection of people is done randomly in a time range, the start point, that is, the person number from which the contact begins is random and is defined by the appointed pollster supervisor.

The random selection of individuals, as well as the sufficiency in the sample size, enables obtaining dispersion and representation of the study population through the sample. Further, it allows controlling factors that may affect the user type, in terms of use of modes of transport and distance in these travels. Some of these such as the social-economic level, the residence zone, vehicle ownership, among others, shall be represented within the selected sample.

It is recommended that, in addition to the surveyors, other personnel systematically and in parallel to the information collection asks about and registers the system users' social-economic level, gender (observable) and age, with the purpose that these data guarantee that people included in the sample correspond to the general demographic characteristics of the system users.

The age ranges recommended are:

1. From 12 to 17 years

2. From 18 to 25 years

3. From 26 to 35 years

4. From 36 to 45 years

5. From 46 to 55 years

6. From 56 to 65 years

7. More than 65 years old.

If a surveyed person is not willing to answer the question, the interviewer shall locate the person in the range according to his/her appearance.

For socio economic levels the ranges recommended are 5 different ranges of minimum salary. This needs to be adapted to the country circumstances, so that a representative stratification is reached.

n measurements of later years, when any of the modes of transport to which the survey refers, are extinct at the moment of applying the survey or simply to clarify the issue or modes of transport to which the question refers to, photos or graphs with an amplified size can be used, to guarantee the correct interpretation of the question.

(b) Method of estimation and expansion factors

In accordance with the sample strategy and with the sample design specified in Section 4 there exist two stages in the method of estimation and selection of sampling observation units:

(1) Selection of stations (SRS design);

(2) Selection of passengers in accordance with the systematic design taking as auxiliary information the flow of passengers in the range of hours defined.

Having in mind that the design used in each stratum is identical, the probabilities of inclusion shall be calculated on an equivalent basis in each stratum.

First stage:

$$\pi_{Ii} = \frac{n_{Ihsp}}{N_{Ihsp}},$$

π_{Ii}: Probability of inclusion in the sample in the first stage (1).

n_{Ihsp} : Number of stations *sp* selected in the stratum *h* (3 stratus are created i.e. high, medium and low passenger flow)

N_{Ihsp} : Total number of *stations* sp in the stratum *h.*

sp: stations of the system

Second stage:

$$\pi_{k/i} = \frac{n_{ihsp}}{N_{ihsp}},$$

$\pi_{k/i}$: Probability of inclusion of the individual passenger *k* in the sample in the second stage (i), given the selection of the first stage (I).

n_{ihsp} : Number of passengers selected in the station s*p,* in stratum *h.*

N_{ihsp} : Total number of passengers in the station s*p,* in stratum *h*

The general formula to calculate the expansion factor is:

$$f_I = \frac{1}{\pi_k}$$, where k indicates the k^th^ element of the sample.

Thus the expansion factors are:

First stage:

$$f_I = \frac{N_{Ihsp}}{n_{Ihsp}},$$

Where n_{Ihsp} and N_{Ihsp} are as previously defined.

Second stage:

$$f_i = \frac{N_{ihsp}}{n_{ihsp}},$$

Where n_{ihsp} and N_{ihsp} are established according to the total flow of passengers in the station *sp* during the day.

Estimator of the total for the variable of interest[24]:

$$\hat{t}_\pi = \sum_h \frac{N_{Ihsp}}{n_{Ihsp}} \sum_{s_I} \hat{t}_{i\pi}$$

$\hat{t}_\pi$ corresponds to π Estimator of sample designs without replacing sample units, see Särndal et al. (1992)

[24] The variables of interest used to calculate totals correspond to the trip distances per mode of passengers of the BRT (the parameter is not distance alone it is trip distance per mode) in the baseline situation (for BE).

Where:

$$\hat{t}_{i\pi} = \frac{N_{ihsp}}{n_{ihsp}} \sum_{s_i} y_{ksp}$$

Where "s_i" represents the sample of passengers in the second phase and "*k*" the information of the k[th] individual selected

Estimator of the variance:

$$\hat{V}(\hat{t}_\pi) = \sum_h \left[\frac{N_{Ihsp}}{n_{Ihsp}} (n_{Ihsp} - N_{Ihsp}) S^2_{\hat{t}s_I} + \frac{N_{Ihsp}}{n_{Ihsp}} \left(\sum_{s_I} \frac{N_{ihsp}}{n_{ihsp}} (n_{ihsp} - N_{ihsp}) S^2_{s_i} \right) \right]$$

Where:

$$S^2_{\hat{t}s_I} = \frac{1}{n_{Ihsp} - 1} \sum_{s_I} \left[\hat{t}_{i\pi} - \left(\sum_{s_I} \hat{t}_{i\pi} / n_{Ihsp} \right) \right]^2 \text{ and } S^2_{ys_I} = \frac{1}{n_{ihsp} - 1} \sum_{s_i} \left(y_{ksp} - \bar{y}_{ksp} \right)^2$$

The parameter (R) is not used to calculate directly BE or the distance per mode of transport which is the main parameter and the one required for calculating BE. It is however fundamental to determine the required simple size as proportions of passengers using various transport modes are required for the simple size determination. (R) is also required for various other parameters where proportions are determined in the survey (e.g. income category). These other parameters are not used directly to determine BE, but are important information sources to assess if the survey has any bias or if other factors such as gender or income influence the outcome. The parameter (R) is therefore used for survey information gathered based on proportions.

Estimator for the variable of interest:

$$\hat{R} = \frac{\hat{t}_{y\pi}}{\hat{t}_{z\pi}},$$

Where $\hat{t}_{y\pi}$ and $\hat{t}_{z\pi}$ are totals.

R represents the relation between two variables, which in the particular case is a proportion, where $\hat{t}_{z\pi}$ estimates the universe of the study (N).

The parameter (R) is not used to calculate directly BE or the distance per mode of transport which is the main parameter and the one required for calculating BE. It is however fundamental to determine the required simple size as proportions of passengers using various transport modes are required for the sample size determination as well as eventually for leakage calculations. (R) is also required for various other parameters where proportions are determined in the survey (e.g. income category). These other parameters are important information sources to assess if the survey has any bias or if other factors such as gender or income influence the outcome. The parameter (R) is therefore used for survey information gathered based on proportions.

Example: To calculate the proportion of users per mode of transport "X"a *R* ratio has to be calculated, taking into consideration as variable *y*: "Users can use the mode X" and as variable *z* "surveyed users". Thereafter ty and tz represent the estimators associated to the total of the two variables.

Variance Estimator:

$$\hat{V}(\hat{R}) = \sum_h \left[\frac{N_{Ihsp}}{n_{Ihsp}} \left(n_{Ihsp} - N_{Ihsp}\right) S^2_{\hat{t}us_I} + \frac{N_{Ihsp}}{n_{Ihsp}} \left(\sum_{s_I} \frac{N_{ihsp}}{n_{ihsp}} \left(n_{ihsp} - N_{ihsp}\right) S^2_{u_{ki}} \right) \right]$$

Where:

$$u_{kshp} = \frac{y_{ksp} - \hat{R} z_{ksp}}{\hat{t}_{z\pi}},$$

Thus it is established that:

$$S^2_{\hat{t}us_I} = \frac{1}{n_{Ihsp} - 1} \sum_{s_I} \left[\hat{t}_{ui} - \left(\sum_{s_I} \hat{t}_{ui} / n_{Ihsp} \right) \right]^2 \text{ and } S^2_{u_k} = \frac{1}{n_{ihsp} - 1} \sum_{s_i} \left(u_{ksp} - \bar{u}_{ksp} \right)^2$$

Other alternative methods to estimate the variance, especially helpful in multi-staged designs of complex samples can be used such as Jacknife or Bootstrap.

Based on the formerly described formulas and based upon if it is a total or a proportion the parameter $\hat{t}_\pi$ and associated the variance $\hat{V}(\hat{t}_\pi)$ is determined.

To calculate the confidence interval, a normal distribution is assumed (large sample size) using the formula for a 95% confidence interval:

$$\hat{t}_\pi \pm Z_{0.975} * \sqrt{\hat{V}(\hat{t}_\pi)}$$

$\hat{t}_\pi$ represents BE. For BE the lower confidence interval is taken.

The DOE shall verify the validity of the statistical procedures used and the assumptions made to determine the total baseline emissions including the determination of their respective 95% confidence intervals.

Summarized to calculate the expansion factor the following data is required next to the data resultant from the survey:

- Number of stations;
- Passenger flow per station per hour, day and week;
- Selection rate of passengers surveyed per hour per station (i.e. each *n* passenger was selected for an interview).

Based on this information the total baseline for the BRT for the survey week can be calculated with a confidence interval of 95%. For the total baseline emissions the lower 95% boundary is taken to have a conservative calculation of emission reductions. For total annual or period baseline emissions, the baseline emission per passenger of the survey week is calculated and thereafter multiplied with the total passengers transported by the BRT per annum or period.

12. Data verification and validation including QA and QC

(a) Criteria for evaluating data consistency

Considering that in the year 1 there should be at least two measurements (the weekly measurement and the test-retest) and in the year 4 at least one measurement, through these the consistency on information collection is to be guaranteed.

The assessment of consistency can be carried out by three supplementary statistical methods:

(i) A mean difference test is performed through a t – Student test, where the differences presented between both measurements are evaluated, for: 1. Proportion of users that use each type of modes of transport and 2. Average trip travel distance;

To perform the mean difference test, it is necessary to determine beforehand, if the two samples come from the same population. Thereafter a F-test is carried out to determine the variability difference between one and the other. To assess that data used to estimate the study parameters follow the same distribution the Mann Whitney non-parametric U test and the Wilcoxon T test can be used.

(ii) To evaluate the users proportion per modes of transport, the Pearson's Chi Square can be used, where categories are defined for each mode of transport;

(iii) Globally and internally in each survey realized, consistency of data reported in the survey should be assessed through the Cronbach alpha coefficient. In practice a value higher than 0.7 in the coefficient has to be reached. Values over 0.9 shall be rechecked to avoid redundancy of data.

For the internal consistency the Cronbach alpha coefficient is to be used whilst to test for consistency between different periods of measurement the first two options of testing are used.

The Cronbach alpha coefficient shall be calculated for each stratum established as these *a priori* control the variations in the responses and therefore the control eliminates biases which could be generated due to heterogeneity and inconsistency in information.

13. Survey realization

The survey must be conducted by a company with minimum 3 years of experience in comparable surveys in the respective country to ensure a professional survey implementation. The following principles are to be followed in the survey realization:

- Non-responses should be recorded;
- Record and store all original surveys;
- Surveys are conducted at MRTS stations when people wait for MRTS-boarding. It should be avoided to realize the survey with people de-boarding the MRTS as the latter will not want to invest time in a survey thus potentially giving wrong answers.

(a) Preparation phase

This phase is characterized by the development of all the activities previous to the implementation of the field operation and it is divided in:

(1) Drafting of a manual on information collection and basic concepts. The manual on information collection and basic concepts covers in general terms the profile of the field personnel, the questionnaire structure, the instructions and specifications for filling in the questionnaire, the definitions and basic concepts of the study and the instructions and formats used;

(2) Selection and training of field personnel. The selection and training of the field personnel is performed on the concepts of filling in questionnaires, in order to select the most adequate survey interviewers for the development of the field work.

A pre-test is performed with the aim of familiarizing the supervisors with the instrument of information collection and establishing in general terms the acceptance degree of the population facing the instrument's application. The pre-test is also to assure that respondents understand what the MRTS is as they might not have taken a similar system before, to ensure that all the concepts are clearly defined and the questions are not ambiguously phrased and avoid interviewer errors. Interviewers may misread the question or twist the answers in their own words and thereby introduce bias. The pre-test has to detect and minimize this potential error.

The results of the pre-test shall be documented and shall be taken into consideration for the modification of the final instrument and for the preparation of the model of information collection.

(b) Validation process of the information

A supervisor should be used in the field to carry out the field verifications, guaranteeing the validity of the gathered information as well as the attained coverage.

14. Calculation of trip distance in the survey

Trip distances need to be determined for each surveyed passenger. The following procedures are applied:

- For NMT, others and induced traffic this is not required as the applied EF is "0";
- For users of buses either:
  - The shortest possible geographical distance based on electronic maps or measuring the distance between the two points with GPS or a comparable mean or through distance measurement on maps; or
  - Measuring the actual distance from the bus entry station to the bus exit station based on (electronic) route maps of the bus operators with official distances or measuring e.g. with GPS the distances between the involved stations.
- For users of passenger cars, taxis, motorcycles, motorized rickshaws and other modes of motorized transport except buses based on the shortest possible geographical distance based on electronic maps or measuring the distance between the two points with GPS or a comparable mean or through distance measurement on maps;

A default questionnaire to be used is included below. This questionnaire should be used by all projects except if valid arguments exist to change the questionnaire and to adapt it to local circumstances. The questionnaire must be realized in the local language. The questionnaire needs to be adapted to national or local circumstances, the wording needs to be checked locally and local test-runs should be performed to ensure that the questions are simple, easily understood, cannot be misinterpreted and lead to reliable results. The survey is reviewed in the language of users of the project, not translated directly from the CDM methodology

References for survey design:

[1] Bautista, L. (1998). "*Diseños de Muestreo Estadístico*". Publication of the Universidad Nacional de Colombia.

[2] Cochran, W.G. 1977, Sampling Techniques, 3d ed, Wiley, New York

[3] Särndal, C-E., Swensson, B., Wretman, J. (1992). "*Model Assisted Survey Sampling*". Springer – Verlag, New York.

Appendix ~~B~~ F

DEFAULT QUESTIONNAIRE FOR MODAL SPLIT SURVEY (ID 12, partially 4 and 9)

Interviewer:……………………………
Date:..………………………………….
Time:…………………………………….
Bus identification (line):………………………………

"Assuming that the bus system you are currently using would not exist: What mode of transport would you have used for this specific trip you are doing currently".

For the interviewer:

- *The question is related to this specific trip and not to the trips realized by the person during the year in general;*
- *To clarify mention that you are comparing the system he/she is using currently to the one which existed formerly respectively (according to project) continues to exist in other parts of the city not served by the BRT system;*
- *Persons which cannot relate it to any mode of transport are taken as induced traffic (conservative default parameter).*

Multiple-choice **answers**
(Only tick one; if the passenger would have used more than one transport mode for the trip he/she is realizing currently then tick the mode, which involves the longest distance):

1. Conventional bus based public transport (this exists normally still as BRT systems are implemented gradually; otherwise a description can be given of the former existing system including photos of former buses);
2. Passenger car → please go to 2A;
3. Taxi (if relevant in the project) → please go to 3A;
4. Motorcycle (if relevant in the project) → please go to 4A;
5. Rail-based urban transit;
6. NMT (per foot or bicycle);
7. I would not have made the trip (induced traffic).

If the passenger responds with the answer 2 then ask:

2A. Do you or your family own a car or do you have access to a car (e.g. car-sharing)?

☐ NO ☐ YES

If the passenger responds with NO this specific questionnaire is deemed as non-consistent and removed from the final counting

2B. What fuel type does the car use to which you have access?

☐ gasoline ☐ diesel ☐ gas (CNG or LPG) ☐ electric ☐ I don't know ☐ other: which:………………………………………….

2C. What is the starting point of your trip (origin) and which is the final (destination) point? Please name the station or location where you first boarded a bus and where you will make the final stop?

For the interviewer: Please advise the passenger that the original departing and final point is required. This may include bus transboarding such as first using a feeder line and then a main line. It is thus the origin and final destination of the passenger trip and not of the ride on this specific bus-line.

Origin (departing point): …………………………………………………
Destination (final point): …………………………………………………

If the passenger responds with the answer 3 then ask:

3A. Have you used in the last 12 months a taxi ?

☐ NO ☐ YES

If the passenger responds with NO this specific questionnaire is deemed as non-consistent and removed from the final counting

3B. What is the starting point of your trip (origin) and which is the final (destination) point? Please name the station or location where you first boarded a bus and where you will make the final stop?

For the interviewer: Please advise the passenger that the original departing and final point is required. This may include bus transbording such as first using a feeder line and then a main line. It is thus the origin and final destination of the passengers trip and not of the ride on this specific bus-line.

Origin (departing point): …………………………………………………
Destination (final point): …………………………………………………

If the passenger responds with the answer 4 then ask:

4A. Do you or your family own a motorcycle or do you have access to a motorcycle ?

☐ NO ☐ YES

If the passenger responds with NO this specific questionnaire is deemed as non-consistent and removed from the final counting

4B. What is the starting point of your trip (origin) and which is the final (destination) point? Please name the station or location where you first boarded a bus and where you will make the final stop?

For the interviewer: Please advise the passenger that the original departing and final point is required. This may include bus transbording such as first using a feeder line and then a main line. It is thus the origin and final destination of the passengers trip and not of the ride on this specific bus-line.

Origin (departing point): …………………………………………………
Destination (final point): …………………………………………………

The project proponent must include the questionnaire as annex to the PDD. The questionnaire is to be reviewed by the DOE. The DOE assesses if the questionnaire is in accordance with the principles (core elements of survey) specified above.

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History of the document

Version	Date	Nature of revision(s)
04.0.0	EB 65, Annex # 25 November 2011	• Introduces an innovative approach to additionality demonstration; • Limits the crediting period to 10 years; • Introduces additional formula to calculate the emission factor for the baseline bus system based on its total fuel consumption; • Reduces monitoring requirements set in the monitoring survey from annual monitoring to monitoring in the years 1 and 4; • Reduces monitoring requirements for leakage. For leakage from changes in load factor of buses and taxes, the frequency of monitoring is reduced from every 3 years to the years 1 and 4. For leakage from reduced congestion, the requirement to estimate it ex ante is replaced with the requirement of (1) not to conduct monitoring, in case the implementation of the project activity does not lead to a reduction of road space; and (2) to monitor in the year 1 and 4, in case the implementation of the project activity leads to a reduction on road space; • Removes an applicability condition requiring to prove that the local regulations do not constrain the establishment or expansion of a BRT system; • Removes an applicability condition requiring that the BRT system partially or fully replaces a traditional public transport system in a given city and stating that the methodology cannot be used for BRT systems in areas where currently no public transport is available; • Removes the option to determine baseline emissions using sectoral data (Path B); • Removes the requirement to conduct the policy effects on emission reductions; • Removes the requirement to conduct the sensitivity analysis; • Improves the requirements on measurement of specific fuel consumption in the baseline and project to use the lower and upper 95% confidence levels in case of sample measurement, respectively; • Removes the requirement to account for CH_4 and N_2O emissions from gasoline and diesel, requiring to account for these emissions for gaseous fuels only; • Introduces the Tool to calculate project and leakage emissions from fossil fuel consumption; • Introduces more guidance on conducting the survey; • Improves the format of the methodology to be in line with the current template for CDM large scale methodologies; • Improves the language, readability and clarity.
03.1.0	EB 58, Annex 2 26 November 2010	The methodology was revised to include project activities that use more gaseous fuels in the project activity than in the baseline scenario
03	EB 50, Annex 5 16 October 2009	The methodology was revised in response to AM_REV_0160. The revision expanded the applicability of the methodology to situations in which electricity is used in the transport systems included in the project boundary; and removed, from the applicability conditions, the restriction imposed in the use of biofuels,

		whose use was limited to a 3% blend with fossil fuels in the previous versions of the methodology.
02	EB 48, Annex 6 17 July 2009	The methodology was revised in response to AM_REV_0142. The revision expanded the applicability of the methodology to include situations in which the baseline public transport system and other public transport options include rail-based systems.
01.1	EB 44, Annex 9 28 November 2008	Editorial revision to introduce the parameter TRC which was missing in Equation 22.
01	EB 25, Annex 1 28 July 2006	Initial adoption.
Decision Class: Regulatory **Document Type**: Standard **Business Function**: Methodology		