CLEAN DEVELOPMENT MECHANISM

**CDM-EB110-A02**

# Large-scale Consolidated Methodology

# ACM0016: Mass rapid transit projects

Version 05.0

Sectoral scope(s): 07

United Nations
Framework Convention on
Climate Change

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# 1. Introduction

1. The following table describes the key elements of the methodology.

**Table 1. Methodology key elements**

| | |
|---|---|
| **Typical project(s)** | Establishment and operation of new rail-based or bus-based mass rapid transit systems (MRTS) in urban or suburban regions for passenger transport by replacing a traditional urban public transport system. For buses, typical projects involve the replacement, extension of bus lanes or expansion of existing BRT systems (adding new routes and lines). For trains, typical projects involve the extension of existing rail line or expansion of existing rail infra-structure (e.g. new rail lines). |
| **Type of GHG emissions mitigation action** | Energy efficiency:<br>Displacement of more-GHG intensive transport modes (e.g. an existing fleet of buses operating under mixed traffic conditions) by less-GHG-intensive ones (e.g. newly developed rail-based systems or segregated bus lanes) |

# 2. Scope, applicability, and entry into force

## 2.1. Scope

2. The scope of this methodology includes the establishment and/or expansion and operation of rail-based or bus-based mass rapid transit systems (MRTS) in urban or suburban districts of a host city.

## 2.2. Applicability

3. ~~Bus rapid transits (BRTs) without feeder lines, i.e. passengers realize their trip partially on the project system and partially on conventional buses shall use this methodology. BRTs with feeder plus trunk routes shall use the methodology “AM0031: Bus rapid transit systems” where passengers can realize their entire trip on the project system.~~

4. ~~The project constructs a new rail-based infrastructure or segregated bus lanes;~~

5. ~~For rail systems, the project needs to involve the construction of a new infrastructure (new rail lines);~~

6. ~~For BRTs, the project can be based on existing road infrastructure, but which separates physically bus lanes from mixed traffic.~~

7. The methodology is applicable for the implementation of Mass Rapid Transit Systems (MRTS), such as segregated Bus Rapid Transits (BRT) bus lanes or rail-based lines, that replaces existing bus routes operating under mixed traffic conditions.

8. The project may involve one or more of the measures listed below:

   (a) The construction of a new rail-based infrastructure (e.g. new rail lines);

(b) The expansion of an existing rail infrastructure (e.g. extension of an existing rail line);

(c) The construction of new segregated BRT bus lanes;

(d) The extension of bus lanes of existing BRT systems or expansions of existing BRT systems (i.e. adding new routes and lines).

9. For projects involving BRTs, the following specific provisions apply:

(a) Only BRT systems without feeder route are eligible under this methodology[1];

(b) The buses used in the routes that were replaced by the project MRTS can be retired or relocated to another part of the network;

(c) The project activity may be based on existing road infrastructure, but the bus lanes shall be separated physically from mixed traffic.

~~6. The methodology is applicable for the segregated BRT bus lanes or the rail-based MRTS replaces existing bus routes (e.g. through scrapping units or through closing or re-scheduling existing bus routes) operating under mixed traffic conditions.~~

7. Fuels including (liquified) gaseous fuels or biofuel blends, as well as electricity can be used in the baseline or project case. The following conditions[2] apply in case of biofuels:

(a) The project buses shall use the same biofuel blend (same percentage of biofuel) as commonly used by conventional comparable[3] 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;

(b) The project buses shall not use a significantly higher biofuel blend than cars and taxis.[4]

8. The methodology is applicable for urban or suburban trips. It is not applicable for inter-urban transport.

9. In addition, the applicability conditions included in the tools referred to below shall apply.

[1] BRTs with feeder lines plus trunk routes, where passengers can realize their entire trip in the project system, shall use methodology “AM0031: Bus rapid transit systems”.

[2] No provisions to calculate upstream emissions from the production of the fuels 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.

[3] 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.

[4] Project proponents wishing to consider project buses with a higher biofuel blend may propose a revision to this methodology.

10. The methodology is applicable if the most plausible baseline scenario is the continuation of the use of current modes of transport.

11. The methodology is not applicable for:

(a) Operational improvements (e.g. new or larger buses) of an already existing and operating bus lane or rail-based MRTS;

(b) Bus lanes replacing an existing rail-based system i.e. the existing urban or suburban rail infrastructure shall remain fully (in its full length) operational;

(c) The implementation of air- ~~and~~ or water-based transport systems.

### 2.3. Entry into force

12. The date of entry into force is the date of the publication of the EB 110 meeting report on 27 May 2021.

### 2.4. Applicability of sectoral scopes

13. For or validation and verification of CDM projects and programme of activities by a designated operational entity (DOE) using this methodology, application of sectoral scope 7 is mandatory.

## 3. Normative references

14. This consolidated baseline and monitoring methodology is based on the following proposed new methodologies:

(a) "NM0258: Methodology for Bus Lanes" developed by Grütter Consulting AG, Switzerland;

(b) "NM0266: Methodology for Rail Based Urban Mass Rapid Transit Systems (MRTS)" developed by Grütter Consulting AG, Switzerland.

15. This methodology also refers to the latest approved version of the following tools:

(a) "TOOL01: Tool for the demonstration and assessment of additionality" (hereinafter referred as "TOOL01");

(b) "TOOL03: Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion" (hereinafter referred as "TOOL03");

(c) "TOOL05: Tool to calculate baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (hereinafter referred as "TOOL05");

(d) "TOOL11: Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (hereinafter referred as "TOOL11");

(e) "TOOL15: Upstream leakage emissions associated with fossil fuel use" (hereinafter referred as "TOOL15").

(f) "TOOL18: Baseline emissions for modal shift measures in urban passenger transport" (hereinafter referred as "TOOL18");

(g) "TOOL23: Additionality of first-of-its-kind project activities" (hereinafter referred as "TOOL23");

16. For more information regarding the proposed new methodologies and the tools as well as their consideration by the Executive Board of the clean development mechanism (CDM) (hereinafter referred to as the Board) please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

### 3.1. Selected approach from paragraph 48 of the CDM modalities and procedures

17. Existing actual or historical emissions, as applicable.

# 4. Definitions

18. The definitions contained in the Glossary of CDM terms shall apply.

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

(a) **Affected roads** - ~~are~~ the roads influenced by the establishment of the MRTS. Affected roads are those inside a radius of minimum 1 kilometer running parallel to the MRTS line (roads on both sides of the MRTS line are included). Only roads with large traffic volumes are included;

(b) **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 shall be ensured that enforcement takes place to prevent the usage of the bus lane by other vehicles. The bus- lane 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, for the purpose of this methodology more than half of the included bus lane shall be a bus-only lane;

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

(d) **City** - is a~~n area of~~ continuous area on which urban settlement has occurred ~~development and~~ includinges the historical core area and the adjacent suburbs defined by its administrative boundaries;

(e) **Extensions of bus lanes** - are those where the same bus operates on the entire route i.e. passengers need not change from one bus to another bus when using

the bus lane. The entire bus lane is thus composed of an existing or “old lane” and a “lane extension” (latter is the project activity);

**Figure 1. Extension of bus lanes**


(f) **Extension of rail infrastructure** - is defined as adding additional kilometers along an existing rail-route;

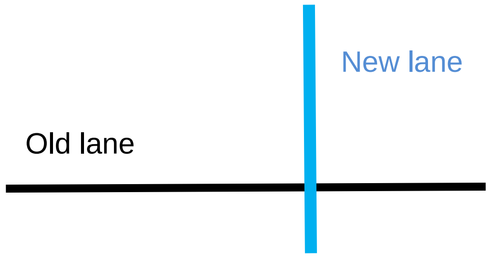
(g) **Feeder routes** - refer to bus routes which have intersections with trunk routes and which “feed” passengers on the trunk routes. Feeder routes are those with less passenger demand and operate under mixed traffic conditions;

(h) **Larger urban zone (LUZ)** - of a city covers the whole functional zone around the city (including the core city) i.e. it corresponds to the commuting ~~field~~ area around the city;

(i) **Mass Rapid Transit Systems (MRTS)** - are collective urban or suburban passenger services operating at high levels of performance, especially with regard to travel times and passenger carrying capacity and 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, which can also be called BRT systems;

(j) **New bus lanes** - are new routes operated by ~~different~~ buses. Additional bus routes might share certain stations with an existing lane but passengers will have to switch buses if their trip involves stations on the “old” and the “new” lane;

**Figure 2. New bus lanes**




(k) **Rebound effect (**or take-back effect) - the effect that the MRTS has on ~~changing~~ ‘consumer behaviour’ leading to additional trips. The rebound effect is an extension of the “Law of Demand”, a basic principle of economics, which states that if prices decline, consumption usually increases. If the MRTS 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~~total vehicle mileage~~. Generated Traffic is the additional vehicle

travel that occurs when reduced congestion increases traffic speeds and reduces travel time;

(l) **Vehicle speed** - refers to the average speed of a vehicle, which is the total distance travelled by the vehicle divided by the total time taken by the vehicle to cover this distance, on the affected road. For the purpose of this methodology taxis and passenger cars are treated identically.

# 5. Baseline methodology

## 5.1. Project boundary

20. The spatial extent of the project boundary encompasses the ~~larger~~ passenger trips completed on the MRTS system within the urban zone of the city in which the project takes place. It is based on the origins and destinations of passengers using the project system. As the project cannot control the trip origins or destinations of passengers the spatial area of the project is the entire larger urban zone of the city in which the project operates.

21. The project only includes emission reductions from the MRTS ~~lanes~~routes. The location of the MRTS lanes should be transparently outlined in the project design document (CDM-PDD). If any MRTS lane would in a later stage be extended (prolonged) beyond the originally planned route detailed in the CDM-PDD, then the project proponents shall follow the latest requirements in “CDM Project cycle procedures” in order to claim emission reductions from these additional lanes.

22. ~~In case of using electricity from an interconnected grid or captive power plant for the propulsion of the transport system~~ If the project activity involves electricity-based transport systems (e.g. electrical railway systems), the project boundary also includes the power plants connected physically to the electricity system that supply power to the project, and/or the captive power plant.

23. The greenhouse gases included in or excluded from the project boundary are shown in Table 2.

**Table 2. Emission sources included in or excluded from the project boundary**

| | Source | Gas | Included | Justification/Explanation |
|---|---|---|---|---|
| **Baseline** | Mobile source emissions of different modes of transport ~~due to the trips made by the passengers using the MRTS~~(buses, passenger cars, motorcycles, taxis), which the passengers of the MRTS system would have taken in the absence of the project MRTS | $CO_2$ | Yes | Major emission source |
| | | $CH_4$ | Yes | Included only if gaseous fuels are used and excluded for liquid fuels.<br>$CH_4$ 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 |
| | | $N_2O$ | No | $N_2O$ emissions are a minor source of the total $CO_2e$ emissions. 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** | ~~Mobile source e~~Direct emissions ~~of~~ from the operation of the project ~~transport system~~ ~~(~~MRTS~~) due to the trips made by the passengers using it~~ | $CO_2$ | Yes | Major emission source |
| | | $CH_4$ | Yes | Included only if gaseous fuels are used. See argument above |
| | | $N_2O$ | No | See ~~argument~~ explanation above |
| | ~~Mobile source emissions~~ Indirect emissions from the ~~of~~ different modes of transport used ~~due to the trips made~~ by the passengers of ~~using~~ the MRTS, from their point of ~~trip~~ origin to the MRTS entry station, and from the MRTS exit station to their ~~trip~~ final destination | $CO_2$ | Yes | Major emission source |
| | | $CH_4$ | Yes | Included only if gaseous fuels are used. See argument above |
| | | $N_2O$ | No | See ~~argument~~ explanation above |

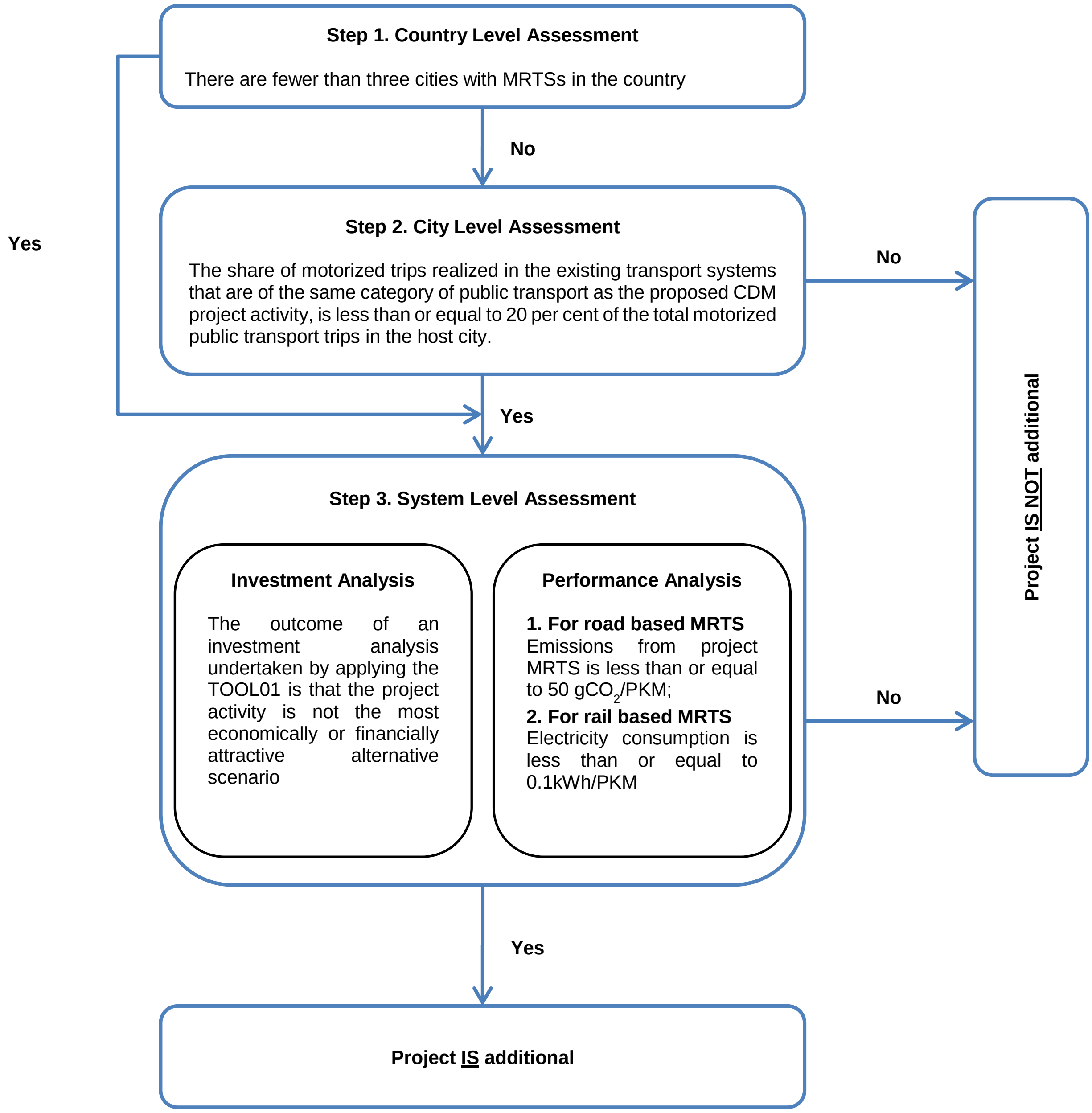
## 5.2. Additionality demonstration

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

25. If MRTS projects are implemented in countries other than ~~non-~~LDCs and face the first-if-its-kind barrier, the latest approved version of the “Additionality of first-of-its-kind project activities” shall be followed to demonstrate the additionality of these project activities.

26. For MRTS projects, which are implemented in countries other than ~~non-~~LDCs and which are not first-of-its-kind, the procedure illustrated in Figure 3 and described below shall be applied.

**Figure 3. Additionality demonstration**




### 5.2.1. Step 1: Country level assessment

25. 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 three cities with MRTS that started commercial operation in the host country of the proposed CDM project activity prior to the start of the CDM project activity.

26. The project participants shall:

(a) 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;

(b) Identify which MRTS 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[5] MRTS developed as CDM project activities from the assessment of common practice in this step.

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

### 5.2.2. Step 2: City level assessment

28. 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 less than or equal to 20 per cent of total public transport trips in the host city.

29. The project participants shall:

(a) 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:

(i) Metro;

(ii) Sub-urban rail;

(iii) Light rail transit including trams;

(iv) Conventional bus system;

(v) BRTs;

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

30. If the share of motorized trips realized on the existing systems which belong to the same public transport category as the proposed project activity exceeds 20 per cent of total motorized public transport trips in the host city, then the proposed CDM project activity is

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

not additional. If the share of trips is less than or equal to 20 per cent, then project participants should proceed to Step 3.

### 5.2.3. Step 3: System level assessment

31. Two options are provided for the system level assessment of the proposed project activity.

(a) Conduct an investment analysis following the procedure under section 5.2.3.1 below; or

(b) Conduct a performance analysis, following the procedure under section 5.2.3.2 below.

#### 5.2.3.1. Procedure for Investment analysis

32. 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 ~~“~~TOOL01~~: Tool for the demonstration and assessment of additionality”~~.

33. The investment analysis should be undertaken from the perspective of the 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.

34. In applying the investment analysis, cost overruns of former investments in MRTS or reduced revenues of former MRTS investments compared to original projections, which make new investments less viable and riskier, can be considered. In this case, project participants should evaluate the cost overruns or reduced revenues of former MRTS 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 MRTS.

35. If the results of the sensitivity analysis ~~is~~ are 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.

#### 5.2.3.2. Procedure for a performance analysis

36. The MRTS project shall demonstrate that for road-based systems, forecasted emissions from the project MRTS is less than or equal to 50 $gCO_2$/pkm[6] and, forecasted electricity

[6] Refer section 3 of “Performance benchmarks in draft revision of AM0031, AM0101 and ACM0016” available as annex 3 to 67th meeting report of Meth Panel.

consumption of the rail-based systems is less than or equal to 0.1 kWh/pkm, to demonstrate that the project is additional.

37. For this purpose the annual amount of emissions from project MRTS for road-based systems and/or annual amount of electricity consumption by the project MRTS for rail-based systems shall be based on expected efficiency and energy source of the project vehicles, annual number of passengers expected to travel in the project system and an average distance that these passengers are expected to travel in the project MRTS when the project MRTS will reach its planned capacity. A four-step model, or equivalent, of the transportation system of the project city as mentioned under section 5.7 below shall be used as the basis for forecasting the number of passengers and distance of travel on the system. This analysis shall be conducted ex ante for the purpose of additionality demonstration. All assumptions used in calculations need to be documented and substantiated in the CDM-PDD.

38. 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 (possibly expanded using additional vehicles) would be ~~ablesufficient~~ to meet the transportation demand that will be met by the project system.

### 5.3. Baseline emissions

39. Baseline emissions include the emissions that would have happened due to the transportation of the passengers who use the project activity to travel between the point of origin (O) to the final destination (D), had the project activity not been implemented. This is differentiated according to the modes of transport (relevant vehicle categories) that the passengers would have used in the absence of the project.

40. Baseline emissions are calculated ~~using the tool "Baseline emissions for modal shift measures in urban passenger transport"~~ based on the latest version of the TOOL18, and taking into account the following provisions:

(a) The core baseline parameters used for calculating baseline emission are updated through surveys conducted in year 1 and year 4 of the crediting period, and changes only apply if the baseline emissions factors would be lower than the original factors;

(b) The survey shall capture O and D of the passenger and which modes the passenger would have used and the distance it would have travelled between O and D[7];

(c) When applying equation 4 of the TOOL18, the parameter "Share of passengers who shifted from electricity-based or road based vehicle category *i* ($S_i$)" should be calculated taking into account all passengers travelling in the project transport

[7] As a rule of thumb, O and D are assumed to be equal for both baseline and project scenarios (except for induced traffic, which is included only as project but not as baseline trip). However, the trip distance and the modes used between O and D in the baseline and project scenarios are different since (i) the passenger shifts its transportation mode, e.g. from cars to the project MRTS, and (ii) some passengers using the project MRTS may be willing to make detours due to the higher speed of the MRTS versus conventional baseline mode of transport.

mode, including induced traffic (i.e. those passengers who responded in the survey that they would not have travelled in the absence of the project transport mode). In case the baseline considers the expansion of the existing system with additional vehicles, then the determination of parameter $SFC_{i,n,x}$ under TOOL18 should take into account the share of new vehicles in the respective vehicle category;

(d) If the project participants choose not to claim emission reductions for switching from passenger cars, taxis or motorcycles to the project transport, the 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);

(e) ~~per passenger surveyed. For each passenger surveyed, the individual baseline emissions are calculated and multiplied with the individual expansion factor thus getting the baseline emissions of all passengers of the specific week surveyed. These are multiplied with the total of the passengers of the period to arrive at baseline emissions. The following steps should be followed:~~

(f) ~~Step 1: Conduct a survey in years 1 and 4 of the crediting period, following the procedures presented in Appendix 4, in which for each surveyed passenger, the trip distance per transport mode that would have taken place in the baseline is determined;~~

(g) ~~Step 2: Calculate the individual baseline emissions for each surveyed passenger (equation (2) below);~~

(h) ~~Step 3: Apply an individual expansion factor to each surveyed passenger in accordance with the survey sample design (as defined in Appendix 4), and summarize these to get the total baseline emissions of the period (week) surveyed. To get the annual (or monitoring period) baseline emissions the baseline emissions of the surveyed period (week) are calculated per passenger of the period (week) and multiplied with the total passengers transported per year (or monitoring period), as per equation (1) below;~~

(i) ~~Step 4: Take the lower limit of the 95 per cent confidence interval as total baseline emissions (see Appendix 4).~~

41. ~~Baseline emissions are calculated as follows:~~

$$BE_y = \frac{P_y}{P_{SPER}} \times \sum_p \left(BE_{p,1-4y} \times FEX_{p,1-4y}\right)$$ ~~Equation (1)~~

~~Where:~~

| | | |
|---|---|---|
| $BE_y$ | = | ~~Baseline emissions in year *y* ($tCO_2$)~~ |
| $BE_{p,y1-4}$ | = | ~~Baseline emissions per surveyed passenger *p* in years 1 and 4 of the crediting period *y* ($tCO_2$)~~ |

| | | |
|---|---|---|
| $FEX_{p,y1-4}$ | = | Expansion factor for each surveyed passenger *p* surveyed in years 1 and 4 of the crediting period *y* (each surveyed passenger has a different expansion factor) |
| $P_y$ | = | Total number of passengers in year *y* |
| $P_{SPER}$ | = | Number of passengers in the time period of the survey (1 week) |
| $p$ | = | Surveyed passenger (each individual) |
| $y$ | = | Year of the crediting period |

42. The baseline emissions per surveyed passenger *p* are calculated based on the mode used, the trip distance per mode and the emission factor per mode:

$$BE_{p,1-4y} = \sum_i \left(BTD_{p,i,1-4y} \times EF_{pkm,i,1-4y} \times 10^{-6}\right)$$ Equation (2)

Where:

| | | |
|---|---|---|
| $BE_{p,1-4y}$ | = | Baseline emissions per surveyed passenger *p* in year *y* ($tCO_2$) |
| $EF_{pkm,i,1-4y}$ | = | Emission factor per passenger-kilometer of mode *i* in years 1 and 4 of the crediting period *y* ($gCO_2$/pkm), determined based on equations 2 and 3 from the "TOOL18 : Baseline emissions for modal shift measures in urban passenger transport" |
| $BTD_{p,i,1-4y}$ | = | Baseline trip distance per surveyed passenger *p* using mode *i* in years 1 and 4 of the crediting period *y* (pkm) |
| $p$ | = | Surveyed passenger (each individual) |
| $i$ | = | Relevant vehicle category |
| $y$ | = | Year of the crediting period |

(e) Criteria for identifying the vehicle categories are as follows:

(i) At a minimum, public transport, non-motorised transport and induced traffic have to be included;

(ii) Conditions to include categories with reliable data on fuel consumption and load factors;

(iii) Only include categories that are relevant for the MRTS project. If the project will only generate credits from public transport without modal shift, then passenger cars, taxis and motorcycles need not be included;

(iv) Differentiate relevant fuel types for each category. Diesel, gasoline and gas (CNG or LPG) are listed separately if a minimum of 10 per cent of vehicles of the respective category use such a fuel, while the threshold for zero-GHG-emission[8] fuels is minimum 1 per cent. The 10 per cent threshold is justified,

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

as greenhouse gas (GHG) emission differentials between diesel, gasoline and gaseous fuels are less than 20 per cent;

(v) ~~In case of a system extension, the currently operating system is not included as a vehicle category.~~ If the baseline includes the expansion of the existing public transportation system with additional vehicles, then the determination of parameter $SFC_{i,n,x}$ under the TOOL18 should take into account the share of new vehicles in the respective vehicle category.

~~43. The relevant vehicle categories should be clearly identified in the CDM-PDD.~~

~~44. If some vehicle categories are not explicitly identified or do not fit into one of the categories above, they should be subsumed in the survey as “others”. Baseline emissions of this category are counted as 0-emissions.The index i is used to identify each relevant vehicle category (mode of transport) included in the analysis.~~

### ~~5.3.1. Determination of the average occupancy rate~~

~~45. The average occupancy rate (OCi) of vehicle category i, required to calculate EFpkm,i,1-4 (emission factor per passenger-kilometer of mode i in years 1 and 4 of the crediting period), is determined based on the provisions from the “TOOL18 : Baseline emissions for modal shift measures in urban passenger transport” (please refer to the “Data / Parameter table 8” of the tool) visual occupancy studies for all vehicle categories i. For buses, besides the visual occupancy studies, the occupancy rate in buses can also be based on boarding-alighting studies or electronic smart tickets, with expansion factors for routes served to determine the average occupancy rate along the entire route. For taxis, the driver should not be included.~~

~~46. The detailed procedures concerning visual occupancy studies and boarding-alighting studies are presented in Appendices 1, 2 and 3. The detailed procedures concerning expansion factors are presented in Appendix 4.~~

~~47. For buses, as an alternative, the occupancy rate can be based on an average trip distance of bus passengers, total passengers and total distance driven by buses, using the following equation:~~

$$OC_{B,x} = \frac{PBL_{B,x} \times TDL_{P,B,x}}{DD_{B,x}}$$ ~~Equation (3)~~

~~Where:~~

| | | |
|---|---|---|
| $OC_{B,x}$ | = | ~~Average occupancy rate of buses in year xprior to the project start (passengers)~~ |
| $PBL_{B,x}$ | = | ~~Passengers transported by baseline buses prior to the project startin year x (passengers)~~ |
| $TDL_{P,B,x}$ | = | ~~Average trip distance travelled by passengers using baseline buses prior to the project start in year x (km)~~ |
| $DD_{B,x}$ | = | ~~Total distance driven by all buses prior to the project startin year x (km)~~ |

x = Most recent calendar year prior to the start of commercial operation of the project system or prior to the submission of the CDM-PDD for validation, whatever is earlier. Data not older than three years.

48. If bus lanes already exist in the baseline the relevant emission factor per kilometer is calculated as average of all bus lanes existing within the category EFkm,BBL.

49. The distance driven by buses can be based on the average annual distance and the number of units. In other cases, however, companies might have reliable records on total distance driven by units.

50. Baseline emissions cover the entire emissions which would have been caused by the project passenger in absence of the project from his trip origin to his trip destination:

(a) The origin and destination of the trip are assumed to be equal for the baseline as for the project case with an exception of induced traffic included only as project but not as baseline trips;

(b) The trip distance and the modes used between O (origin) and D (destination) are however different in the baseline than in the project case;

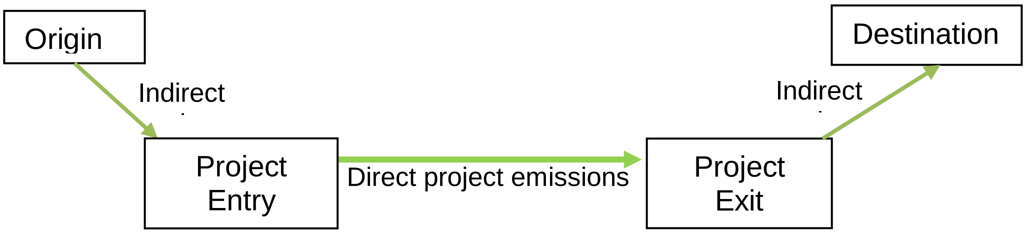
(c) The trip distance may vary as some passengers using the project MRTS may be willing to make detours due to the higher speed of the MRTS versus conventional bus transport.

51. To fully capture all potential changes the methodology compares emissions per O-D trip of the baseline with emissions per O-D trip of the project. The data to determine O-D mode(s) and distances per mode are derived from a representative survey of project passengers realized annually. Total baseline emissions are calculated thereafter annually based on these parameters, the emissions per pkm and the amount of passengers transported by the project.

## 5.4. Project emissions

52. Project emissions are based on the fuel and/or electricity consumed by the MRTS (direct project emissions) plus emissions caused by project passengers from their trip origin to the entry station of the project and from the exit station of the project to their final destination (indirect project emissions), as illustrated in Figure 4.

**Figure 4 Direct and indirect project emissions**




53. Project emissions are calculated as follows:

$$PE_y = DPE\cancel{P}_y + IPE_y \qquad \text{Equation (4)}$$

Where:

| | | |
|---|---|---|
| $PE_y$ | = | Project emissions in year *y* ($tCO_2$) |
| $DPE\cancel{P}_y$ | = | Direct project emissions in year *y* ($tCO_2$) |
| $IPE_y$ | = | Indirect project emissions in year *y* ($tCO_2$) |

### 5.4.1. Determination of direct project emissions (*DPE*$_y$)

54. Direct project emissions are determined based on the fuel and electricity consumed by the project system.

$$DPE_y = DPE_{FC,y} + DPE_{EC,y} \qquad \text{Equation (5)}$$

Where:

| | | |
|---|---|---|
| $DPE_{FC,y}$ | = | Direct project emissions from fuel consumption in year *y* ($tCO_2$) |
| $DPE_{EC,y}$ | = | Direct project emissions from electricity consumption in year *y* ($tCO_2$) |

### 5.4.2. Direct project emissions from fuel consumption

55. The methodology provides two alternatives to determine project emissions from fuel consumption, depending on data availability. If records exist, the data quality of both alternatives is equal. Reliable data are, for example, based on electronic measurement of fuel consumption or data monitored by the company managing the vehicles. 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, for example other companies operating MRTS systems using the same type of vehicles.

#### 5.4.2.1. Alternative A: Use of fuel consumption data

56. This alternative is based on the total fuel consumed by project buses. For buses using liquid fossil fuels, the project emissions from fossil fuel consumption shall be estimated

using the latest approved version of the TOOL03. The following guidance is provided for applying the tool:

(a) 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

(b) Element process *j* corresponds to the combustion of fuel type *n* in the project vehicles.

57. For buses using gaseous fossil fuels, the project emissions from fossil fuel consumption shall be estimated based in one of the following approaches:

(a) If fuel is being measured on a mass basis, the following equation shall be applied:

$$PE_{FC,y} = \sum_{n}[FC_{PJ,n,y} \times NCV_n \times (EF_{CO2,n} + GWP_{CH4} \times EF_{CH4,n})] \times 10^{-6}$$ Equation (6)

Where:

| | | |
|---|---|---|
| $PE_y$ | = | Project emissions in year *y* ($tCO_2e$) |
| $FC_{PJ,n,y}$ | = | Total consumption of fuel type *n* in year *y* by the project (t) by both trunk buses and feeder buses (tonne) |
| $NCV_n$ | = | Net calorific value of the fuel type *n* (TJ/Gg) |
| $EF_{CO2,n}$ | = | $CO_2$ emission factor for fuel type *n* ($tCO_2$/TJ) |
| $EF_{CH4,n}$ | = | $CH_4$ emission factor for gaseous fuel type *n* ($tCH_4$/TJ) |
| $GWP_{CH4}$ | = | Global warming potential of the $CH_4$ ($tCO_2e/tCH_4$) |
| n | = | Fuel type used by the project |

(b) If fuel is being measured on a volumetric basis, the following equation shall be applied:

$$PE_{FC,y} = \sum_{n}[FC_{PJ,n,y} \times NCV_n \times \rho_n \times (EF_{CO2,n} + GWP_{CH4} \times EF_{CH4,n})] \times 10^{-6}$$ Equation (7)

Where:

| | | |
|---|---|---|
| $PE_y$ | = | Project emissions in year *y* ($tCO_2e$) |
| $FC_{PJ,n,y}$ | = | Total consumption of fuel type *n* in year *y* by the project by both trunk buses and feeder buses (L) |
| $NCV_n$ | = | Net calorific value of the fuel type *n* (TJ/Gg) |
| $\rho_n$ | = | Density of the fuel type *n* (t/L) |
| $EF_{CO2,n}$ | = | $CO_2$ emission factor for fuel type *n* ($tCO_2$/TJ) |
| $EF_{CH4,n}$ | = | $CH_4$ emission factor for gaseous fuel type *n* ($tCH_4$/TJ) |
| $GWP_{CH4}$ | = | Global warming potential of the $CH_4$ ($tCO_2e/tCH_4$) |
| n | = | Fuel type used by the project |

### 5.4.2.2. Alternative B: Use of specific fuel consumption and distance data

58. Total project emissions under alternative B are calculated from the following equation.

$$PE_{FC,y} = EF_{km,Z,y} \times DD_{Z,y} \times 10^{-6}$$ Equation (8)

Where:

| | | |
|---|---|---|
| $PE_y$ | = | Project emissions in year *y* (t $CO_2$e) |
| $EF_{km,Z,y}$ | = | Emissions factor per kilometer for project buses in year *y* (g$CO_2$e/km). Calculated through equation (9) below |
| $DD_{Z,y}$ | = | Total distance driven by project buses in year *y* (km) |

59. $EF_{km,Z,y}$ is determined based on the fuel efficiency data (i.e. consumption per kilometer driven).

(a) If the specific fuel consumption is determined on a mass basis (i.e. in mass units/km), the following equation shall be applied

$$EF_{km,Z,y} = \sum_{n}\left[SFC_{Z,n,y} \times NCV_n \times \left(EF_{CO2,n} + GWP_{CH4} \times EF_{CH4,n}\right)\right] \times 10^{-3}$$ Equation (9)

Where:

| | | |
|---|---|---|
| $EF_{km,Z,y}$ | = | Emissions factor per kilometer for project bus in year *y* (g$CO_2$e/km) |
| $SFC_{j,n,y}$ | = | Specific consumption of fuel type *n* by project bus in year *y* (g/km) |
| $NCV_n$ | = | Net calorific value of the fuel type *n* (TJ/Gg) |
| $EF_{CO2,n}$ | = | $CO_2$ emission factor for fuel type *n* (t$CO_2$/TJ) |
| $EF_{CH4,n}$ | = | $CH_4$ emission factor for gaseous fuel type *n* (t$CH_4$/TJ ) |
| $GWP_{CH4}$ | = | Global warming potential of the $CH_4$ (t$CO_2$e/t$CH_4$) |
| *n* | = | Fuel type used by project bus category *j* |

(b) If the specific fuel consumption is determined on a volumetric basis (i.e. in volume units/km), the following equation shall be applied

$$EF_{km,Z,y} = \sum_{n}\left[SFC_{Z,n,y} \times NCV_n \times \rho_n \times \left(EF_{CO2,n} + GWP_{CH4} \times EF_{CH4,n}\right)\right] \times 10^{3}$$ Equation (10)

Where:

| | | |
|---|---|---|
| $EF_{km,Z,y}$ | = | Emissions factor per kilometer for project bus in year *y* (g$CO_2$e/km) |
| $SFC_{Z,n,y}$ | = | Specific consumption of fuel type *n* by project bus in year *y* (L/km) |
| $NCV_n$ | = | Net calorific value of the fuel type *n* (TJ/Gg) |
| $\rho_n$ | = | Density of the fuel type *n* (t/L) |
| $EF_{CO2,n}$ | = | $CO_2$ emission factor for fuel type *n* (t$CO_2$ /TJ) |
| $EF_{CH4,n}$ | = | $CH_4$ emission factor for gaseous fuel type *n* (t$CH_4$/TJ) |

| | | |
|---|---|---|
| $GWP_{CH4}$ | = | Global warming potential of the $CH_4$ ($tCO_2e/tCH_4$) |
| *n* | = | Fuel type used by project bus category *j* |

### 5.4.3. Direct project emissions from electricity consumption

60. The methodology also provides two alternatives to determine project emissions from electricity consumption by electric vehicles (buses or trains), depending on data availability. If records exist, the data quality of both alternatives is equal. Reliable data are, for example, based on electronic measurement of electricity consumption or data monitored by the company managing the project vehicles. For both alternatives, specific electricity 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, for example other companies operating MRTS systems using the same types of vehicles.

#### 5.4.3.1. Alternative A: Use of electricity consumption data

61. This alternative is based on the total electricity consumed by electric vehicles (buses or trains). Project emissions shall be estimated using the latest approved version of the TOOL05, where the parameter $PE_{EC,j,y}$ in Equation 1 of the tool corresponds to the project emissions from the project transport system that uses electricity in year *y*.

#### 5.4.3.2. Alternative B: Use of specific electricity consumption and distance data

62. Total project emissions under alternative B are calculated applying Equation 1 from the TOOL05, where the parameter $EC_{PJ,j,y}$ is determined as the product between the specific electricity consumed by the project vehicles and the distance driven by the project vehicles:

$$EC_{PJ,j,y} = \sum_{n} SEC_{j,n,y} \times DD_{j,n,y} \times 10^{-3} \quad \text{Equation (11)}$$

Where:

| | | |
|---|---|---|
| $EC_{PJ,j,n,y}$ | = | Electricity consumed by the project vehicle *n* from the electricity consumption source *j* in year *y* (MWh) |
| $SEC_{j,n,y}$ | = | Specific electricity consumed by the project vehicle *n* from the electricity consumption source *j* in year *y* (kWh/km) |
| $DD_{j,n,y}$ | = | Total distance driven by vehicle *n* year *y* (km) |

63. For both electric and fossil fuel vehicles, the fuel-efficiency data is derived from annual data reported by the transport companies operating the project vehicles either for all units or for a representative sample of comparable units (comparable technology, vintage and size). To ensure a conservative approach, the specific fuel and electricity consumption of comparable vehicles, if based on sample measurement, should be taken as the upper 95 per cent confidence level of the sample measurement conducted.

64. If the CDM project includes only parts of a larger activity (e.g. a certain line of a comprehensive MRTS development), the fuel used by the project vehicles shall be

separated from the total fuel used. The separation is done (in order of preference) by the following means:

(a) By operators: this method is used if certain operators are assigned to certain parts of the project;

(b) By distance driven: the fuel share for each part of the project is based on the share of kilometers per project part;

(c) 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).

### ~~5.4.3.3. Case 1: Use of fossil fuels in the project activity transport system~~

~~65. If the project transport system uses fossil fuels, the latest version of the "Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion" shall be used. The following guidance is given for applying the tool:~~

~~(a) The parameter $PE_{FC,j,y}$ in the tool corresponds to the direct project emissions from the project transport system that uses fossil fuels in year *y* ($DPE_{FC,y}$);~~

~~(b) Element process *j* corresponds to the combustion of fuel type *n* in the project vehicles.~~

~~66. If the project has no reliable records on total fuel consumed, the specific fuel consumption of a representative sample of comparable transport units (comparable technology, vintage and size) together with the total distance driven can be taken to calculate the parameter $FC_{PJ,x,y}$ in the tool. Transport units of the sample shall be project units running on project routes. The sample criteria are based on technology (e.g. Euro standard), age, and unit size. To be conservative, project fuel consumptions based on sample data shall be based on the upper limit of the uncertainty band at a 95 per cent confidence level. This means that with 95 per cent confidence it is possible to state that the actual project fuel consumption is equal to or lower than the value used by the project.~~

~~67. If the total fuel consumed is determined based on sample measurements, the following equation is used:~~

$$FC_{PJ,n,y} = \sum_i SFC_{i,n,y} \times DD_{PJ,i,n,y}$$ ~~Equation (12)~~

~~Where:~~

| | | |
|---|---|---|
| ~~$FC_{PJ,n,y}$~~ | ~~=~~ | ~~Total fuel consumed by project transport units using fuel type *n* in year *y* (mass or volume units of fuel)~~ |
| ~~$SFC_{i,n,y}$~~ | ~~=~~ | ~~Specific fuel consumption of vehicle category *i* using fuel *n* in year *y* included in the sample (mass or volume units of fuel per /km)~~ |
| ~~$DD_{PJ,n,y}$~~ | ~~=~~ | ~~Distance driven by transport unitsthe vehicle category *i* consuming fuel *n* in year y (km)~~ |

#### 5.4.3.4. Case 2: Use of electricity in the project activity transport system

68. If the project activity involves electricity-based transport systems (e.g. electrical railway systems), the emissions from electricity consumption are based on the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". The parameter $PE_{EC,y}$ in the tool corresponds to the direct project emissions from the project transport system in year *y* ($DPE_{EC,y}$). Only electricity consumed for train propulsion should be included in rail-based MRTS.

69. If the project activity involves electricity-based transport systems (e.g. electrical railway systems), the emissions from electricity consumption are based on the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". The parameter PEEC,y in the tool corresponds to the direct project emissions from the project transport system in year y (DPEEC,y). Only electricity consumed for train propulsion should be included in rail-based MRTS.

### 5.4.4. Determination of indirect project emissions (*$IPE_y$*)

70. Indirect project emissions are those caused by passengers from their trip point of origin (O) up to the project activity entry station, and from the project activity exit station up to the trip final destination (D):

(a) The survey realized identifies the originO, the project entry station, the project exit station and final destination D of the passenger, plus the modes used between the different points, (e.g. bike from origin to project entry station and taxi from project exit station to final destination);

(b) The distances between origin O and the entry, and between the exit and destination D are calculated based, e.g. on public transit routes, electronic maps and GPS (identical to baseline trip determination);

(c) The emission factors per passenger-kilometer used for indirect project emissions are identical to the baseline passenger-kilometer factors (EFpkm,i,y) determined based on equation 1 of the TOOL18.

71. Indirect project emissions are determined based on the equation below:

$$IPE_y = P_y \times \sum_i \left(D_{ind,i,1-4} \times EF_{pkm,i,1-4} \times 10^{-6}\right)$$

Equation (13)

Where:

| | | |
|---|---|---|
| $IPE_y$ | = | Indirect project emissions in year *y* ($tCO_2$) |
| $P_y$ | = | Total number of passengers transported in year *y* |
| $EF_{pkm,i,1-4}$ | = | Emission factor per passenger-kilometer of mode *i* in years 1 and 4 of the crediting period ($gCO_2$/pkm) |
| $D_{ind,i,1-4}$ | = | Average indirect project trip distance of surveyed passengers using mode *i* in years 1 and 4 of the crediting period (km) |

72. The next steps should be followed to determine indirect project emissions:

73. **Step 1**: Conduct a survey, following the procedures presented in Appendix 4, in which for each surveyed passenger the trip distance per transport mode used to/from the MRTS is determined;

74. **Step 2**: Calculate indirect project emissions for each surveyed passenger, as per equation 6 below;

75. **Step 3**: Apply to each surveyed passenger an individual expansion factor in accordance with the survey sample design (as defined in Appendix 4), and summarize these to get the total indirect project emissions for the survey period (week). To get the annual (or monitoring period) indirect project emissions the indirect project emissions of the surveyed period (week) are calculated per passenger of the survey period (week) and multiplied with the total passengers transported per year (or period), as per equation 7 below.

76. **Step 4**: Apply the upper 95 per cent confidence interval to the total indirect project emissions (see Appendix 4).

$$IPE_y = \frac{P_y}{P_{SPER}} \times \sum_p (IPE_{p,y} \times FEX_{p,y}) \times 10^{-6}$$ Equation (14)

Where:

| | | |
|---|---|---|
| $IPE_y$ | = | Indirect project emissions in year *y* ($tCO_2$) |
| $IPE_{p,y}$ | = | Indirect project emissions per surveyed passenger *p* in year *y* ($gCO_2$) |
| $FEX_{p,y}$ | = | Expansion factor for each surveyed passenger *p* in year *y* |
| $P_y$ | = | Total number of passengers in year *y* |
| $P_{SPER}$ | = | Number of passengers in the time period of the survey (one week) |
| $p$ | = | Surveyed passenger (each individual) |
| $y$ | = | Year of the crediting period |

77. The indirect project emissions per surveyed passenger are calculated based on the transport mode used, trip distance per mode and emission factor per mode.

$$IPE_y = \sum_p IPTD_{p,i,y} \times EF_{pkm,i,y}$$ Equation (15)

Where:

| | | |
|---|---|---|
| $IPE_{p,y}$ | = | Indirect project emissions of surveyed passenger *p* in year *y* ($gCO_2$) |
| $EF_{pkm,i,y}$ | = | Emission factor per passenger-kilometer of mode *i* in year *y* ($gCO_2$/pkm) |
| $IPTD_{p,i,y}$ | = | Indirect project trip distance of surveyed passenger *p* using mode *i* in year *y* (pkm) |

78. Based on the surveyed passenger and the survey design, the corresponding expansion factors are applied to calculate total indirect project emissions. Total indirect project emissions are determined based on the upper limit of the 95 per cent confidence interval as results are based on a sample/survey.

## 5.5. Leakage

~~79. Leakage emissions include the following sources:~~

~~80. Emissions due to changes of the load factor of taxis and buses of the baseline transport system due to the project (LELFB,y and LELFT,y);~~

~~81. Emissions due to reduced congestion on affected roads, provoking higher average vehicle speed, plus a rebound effect (LECON,y);~~

~~82. Upstream emissions of gaseous fuels (LEUP,y).~~

~~83. The impact on traffic (additional trips) induced by the new transport system is included as project emissions and thus is not part of leakage. This is addressed by including, as project emissions, the emissions from the trips of passengers who would not have travelled in the absence of the project.~~

84. ~~Leakage emissions are calculated as follows:~~ Potential sources of leakage emissions from a MRTS project are listed below and are calculated based on Equation 16 below:

(a) Changes in occupancy of the baseline transport system, that is, the project may potentially increase or decrease the occupancy rate of the baseline vehicles (i.e. buses and taxis); and

(b) Reduced congestion in remaining roads (because passengers shifted from cars and motorcycles to the BRT project, resulting in higher average speed of baseline vehicles), plus a rebound effect.

(c) Upstream emissions of gaseous fuels, if the project vehicles consume more gaseous fuels than baseline vehicles.

$$LE_y = LE_{LF,ZB,y} + LE_{LFT,y} + LE_{CONG,y} + LE_{UP,y}$$ Equation (16)

Where:

| | | |
|---|---|---|
| $LE_y$ | = | Leakage emissions in year *y* ($tCO_2$) |
| $LE_{LF,ZB,y}$ | = | Leakage emissions due to change of load factor of buses in year *y* ($tCO_2$) |
| $LE_{LFT,y}$ | = | Leakage emissions due to change of load factor of taxis in year *y* ($tCO_2$) |
| $LE_{CONG,y}$ | = | Leakage emissions due to change in congestion in year *y* ($tCO_2$) |
| $LE_{UP,y}$ | = | Leakage emissions due to upstream emissions of gaseous fuels in year *y* ($tCO_2$) |

85. As a conservative approach, ~~it is assumed that for each components $LE_{LFB,y}$, $LEL_{FT,y}$, $LE_{CON,y}$, and $LE_{UP,y}$, only the positive value (leading to net emissions) is considered~~ leakage is only considered if the total annual effect is to reduce estimated emission reductions and where total net leakage effects are negative ($LE_y < 0$), project participants should assume $LE_y = 0$.

86. 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, who, in absence of the MRTS project, would not have realized the trip.

### 5.5.1. ~~Determination of emissions~~ Leakage due to ~~a~~ the change in load factor of buses ($LE_{LF,BZ,y}$)

87. ~~The project could have a negative impact on the load factor of the~~ The decrease in the occupancy of baseline conventional bus fleet results in a higher $CO_2$ emission factor per passenger-kilometer. Load factor changes are monitored in years 1 and 4 of the crediting period for the entire larger urban zone of the city as the potential impact is not necessarily in the proximity of the project MRTS (buses can be used in other parts of the larger urban zone of the city). ~~Load factor changes are monitored for the entire larger urban zone of the city as the potential impact is not necessarily in the proximity of the project MRTS (buses can be used in other parts of the larger urban zone of the city). The load factor of buses is monitored in the years 1 and 4 and of the crediting period. Leakage from load factor change of buses~~

88. This leakage source is only included if the load factor of buses has decreased by more than 10 per cent~~age points~~ as certain variations in the load factor caused by external circumstances are normal and normal~~comparing the monitored value with the baseline value,~~ and are calculated as:

$$LE_{LF,BZ,y} = max\left[\frac{N_{B,yZ,1-4} \times AD_{BZ} \times EF_{km,BZ,y} \times \left(1 - \frac{ROC_{B,yZ,1-4}}{ROC_{BZ,x}}\right)}{10^6}\ ; 0\right]$$

Equation (17)

Where:

| | | |
|---|---|---|
| $N_{B,yZ,1-4}$ | = | Number of ~~baseline~~ buses in years 1 and 4 of the crediting period ~~y~~ (buses) |
| $AD_{BZ}$ | = | Average annual distance driven by baseline buses (km/bus) |
| $EF_{km,BZ,y}$ | = | Emission factor per kilometer for baseline buses in year *y* ($gCO_2$/km) |
| $ROC_{B,yZ,1-4}$ | = | Average occupancy rate relative to the capacity of baseline buses in ~~year y (passengers)~~ years 1 and 4 of the crediting period (%) |
| $ROC_{BZ,x}$ | = | Average occupancy rate relative to the capacity of baseline buses ~~prior to the project start (passengers)~~ in year *x* (%) |
| $x$ | = | Most recent calendar year prior to the start of commercial operation of the project system or prior to the submission of the CDM-PDD for validation, whichever is earlier |

89. The average annual distance driven by baseline buses ($AD_Z$) is determined based on the distance driven by the different bus sizes (small, medium, large) and the number of the different bus sizes.

$$AB_Z = \frac{\sum_i DD_{Z,s,x}}{\sum_s N_{Z,s,x}}$$ Equation (18)

Where:

| | | |
|---|---|---|
| $DD_{Z,s,x}$ | = | Total distance driven by bus size *s* in year x (km) |
| $DD_{i,L}$ | = | Total distance driven by large (L) buses *i* in year x (km) |
| $N_k$ | = | Number of buses of size *k* in year *x* |
| $s$ | = | Bus sizes: small (S), medium (M) and large (L) |
| $x$ | = | Most recent calendar year prior to the start of commercial operation of the project system or prior to the submission of the CDM-PDD for validation, whichever is earlier |

90. ~~The occupancy rate of buses is monitored through~~The average occupancy rate relative to the capacity of buses is determined through the equation below, based on boarding-alighting or through visual occupancy studies or by other means to be described in the CDM-PDD. The same monitoring method should be used for monitoring the baseline load factor before the project start and the load factor during the project execution. The detailed procedures concerning visual occupancy studies and boarding-alighting studies are presented in Appendices 1, 2 and 3.

$$ROC_Z = \frac{OC_{Z,t}}{CV_{Z,t}}$$ Equation (19)

Where:

| | | |
|---|---|---|
| $OC_{Z,t}$ | = | Average occupancy of buses in the period *t* (passengers) |
| $CV_{Z,t}$ | = | Average capacity of buses in the period *t* (passengers) |
| $t$ | = | Period of time when the parameters are measured: most recent calendar year prior to the start of commercial operation of the project system or prior to the submission of the CDM-PDD for validation, whatever is earlier (*x*) or years 1 and 4 of the crediting period (1-4) |

### 5.5.2. Determination of emissions due to a change in load factor of taxis ($LE_{LFT,y}$)

91. The project could have a negative impact on the load factor of taxis. Taxis can include cars as well as motorized rickshaws providing taxi services. If both types of services exist, the load factor change is monitored separately for these two taxi categories. Load factor changes are monitored for the entire larger urban zone of the city as taxis operate all over the larger urban zone of the city and are not confined to deliver their services in certain

areas. The load factor of taxis is monitored in the years 1 and 4 of the crediting period. This leakage is calculated as follows:

$$LE_{LFT,y} = max\left[\frac{N_{T,1-4y} \times AD_T \times EF_{km,T,y} \times \left(1 - \frac{ROC_{T,1-4y}}{ROC_{T,x}}\right)}{10^6}\ ;\ 0\right]$$ Equation (20)

Where:

| | | |
|---|---|---|
| $LE_{LFT,y}$ | = | Leakage emissions due to a change in load factor of taxis in year *y* ($tCO_2$) |
| $N_{T,y1-4}$ | = | Number of ~~baseline~~ taxis in years 1 and 4 of the crediting period ~~y~~ (taxis) |
| $AD_T$ | = | Average annual distance driven by baseline taxis (km/taxi) |
| $EF_{km,T,y}$ | = | Emission factor per kilometer for baseline taxis in year *y* ($gCO_2$/km) |
| $ROC_{T,1-4y}$ | = | Average occupancy rate relative to the capacity of baseline taxis in years 1 and 4 of the crediting period ~~y~~ (~~passengers~~%) |
| $ROC_{T,x}$ | = | Average occupancy rate relative to the capacity of baseline taxis ~~prior to the project start~~in year *x* (~~passengers~~%) |
| $x$ | = | Most recent calendar year prior to the start of commercial operation of the project system or prior to the submission of the CDM-PDD for validation, whichever is earlier |

92. The maximum change in load factor attributed to taxis is the emission reductions due to passengers switching from taxis to the project (calculated by the emission factor per passenger-kilometer for taxis, trip distance and number of passengers transported by the project, which would have used taxis in absence of the project). This maximum condition is established ~~as~~ because load factors might also worsen city-wide ~~also~~ due to factors external to the project, and the maximum leakage from a change in load factor of taxis due to the project can ~~at maximum~~ be determined according to the number of passengers transported by the project who in absence of the ~~latter~~ project would have taken a taxi.

93. The average occupancy rate relative to the capacity of taxis is determined through the equation below, based on ~~The occupancy rate of taxis is monitored through~~ visual occupancy studies counting the number of passengers. The detailed procedures concerning visual occupancy studies for taxis are presented in Appendix 3.

$$ROC_T = \frac{OC_{T,t}}{CV_{T,t}}$$ Equation (21)

Where:

| | | |
|---|---|---|
| $OC_{T,t}$ | = | Average occupancy of taxis in the period *t* (passengers) |
| $CV_{T,t}$ | = | Average capacity of taxis in the period *t* (passengers) |

| | | |
|---|---|---|
| $t$ | = | Period of time when the parameters are measured: most recent calendar year prior to the start of commercial operation of the project system or prior to the submission of the CDM-PDD for validation, whatever is earlier (x) or years 1 and 4 of the crediting period (1-4) |

94. The parameter emission factor per kilometer for baseline taxis in year $y$ ($EF_{km,T,y}$) is calculated using the equation (1) for $EF_{km,i,y}$ presented in the tool "TOOL18: Baseline emissions for modal shift measures in urban passenger transport", substituting $i$ for T (taxis).

### 5.5.3. Determination of emissions Leakage due to reduced congestion ($LE_{CONg,y}$)

95. The project activity may reduce the number of remaining buses and potentially other vehicles on roads used by mixed traffic and, thus, also reduce congestion. On the other hand, MRTS project activities may also reduce the road space available for conventional buses and individual transport modes. Therefore, two effects resulting from reduced congestion are considered:

96. The implementation of the project activity may have the following overall impacts on congestion:

(a) On the one hand, the project system may reduce the road space available for conventional buses and individual transport modes. This may 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;

(b) On the other hand, an implementation of the project system may provide a new road infrastructure. In this case, the project system will likely attract passengers from conventional modes of transport; as a consequence, the number of vehicles that will travel on the affected roads will reduce, resulting in reduced congestion. In this case, reduced congestion may have the following impacts relevant for GHG emissions:

(i) Induced traffic effect (or rebound effect), i.e. more trips of passenger cars on the "affected roads";

(ii) Changes in vehicle speed effect, i.e. change of emissions due to a reduced or increased speed of cars on "affected roads".

97. In the cases that where 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 end of years 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.[9] 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

[9] 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.

flow due to the withdrawal of conventional public transport units as a result of the project activity.

~~98. To determine whether road capacity is reduced the following procedure shall be applied:~~

~~99. Determination of the additional road capacity available to motorised transport modes~~

100. The ~~following~~ equation below shall be applied to determine~~s~~ 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 MRTS is intended to reach its planned capacity:

$$ARS_y = \sum_y \frac{BSCR_y}{N_{BZ,x}} \times SRS_x - \frac{RS_{BLx} - RS_{PJy}}{RS_{BLx}}$$ Equation (22)

Where:

| | | |
|---|---|---|
| $ARS_y$ | = | Additional road capacity available to individual motorised transport modes in year *y* when the project MRTS is intended to reach its planned capacity (in percentage) |
| $BSCR_y$ | = | Cumulative ~~B~~bus units ~~retired~~ displaced by the project on the trunk lanes as a result of the project in year *y* (number of vehicles) |
| $N_{BZ,x}$ | = | Total number of buses in the public transportation system in use in year *x* (units) |
| $SRS_x$ | = | Share of road space used by public transport in year *x* (in percentage). Calculated based on paragraph 101 below |
| $RS_{xBL}$ | = | Total road space available in year *x* (lane-kilometers) |
| $RS_{yPJ}$ | = | Total available road space in the project in year *y* ~~(=RSB minus kilometer of lanes that where reduced due to dedicating bus lanes to the project activity) (lane-kilometers)~~ |
| $x$ | = | Most recent calendar year prior to the start of commercial operation of the project system or prior to the submission of the CDM-PDD for validation, whichever is earlier~~for which data is available~~. Data not older than three years |

101. The following equation shall be used to determine SRS if no recent and good quality study is available which has calculated this parameter:

$$SRS_x = \frac{TD_{B,x} \times 2.5}{TD_{B,x} \times 2.5 + TD_{T,x} + TD_{C,x}}$$ Equation (23)

Where:

| | | |
|---|---|---|
| $SRS_x$ | = | Share of road space used by public transport in year *x* (in percentage) |
| $TD_{B,x}$ | = | Total distance driven by public transport buses in year *x* (km) |
| $TD_{T,x}$ | = | Total distance driven in kilometers by taxis in year *x* (km) |

| | | |
|---|---|---|
| $TD_{C,x}$ | = | Total distance driven in by passenger cars in year *x* (km) |
| $x$ | = | Most recent calendar year for which data is available. Data not older than three years |

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

103. 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.

104. ~~If ARSy 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 section 5.5.3.2.~~ If $ARS_y$ is negative, then the road capacity in that year was reduced and leakage emissions due to increased congestion as a result of the reduced road capacity due to the project activity ($LE_{CONG,y}$) shall be quantified based on the equation below. If $ARS_y$ is positive, $LE_{CONG,y}$ is assumed to be zero and no monitoring is required.

~~105. Calculation of $LE_{CON,y}$~~

106. The corresponding emissions $LE_{CONG,y}$ are calculated as follows:

$$LE_{CONG,y} = max\left[\left(LE_{REB,y} + LE_{SP,y}\right)\,;\ 0\right] \quad \text{Equation (24)}$$

Where:

| | | |
|---|---|---|
| $LE_{REB,y}$ | = | Leakage emissions due to induced traffic / rebound effect in year *y* ($tCO_2$) |
| $LE_{SP,y}$ | = | Leakage emissions due to change in vehicle speed in year *y* ($tCO_2$) |

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

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

(a) 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~~;

(b) 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~~.

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

109. ~~As a first step~~ Ex-ante, the “affected roads” are identified and clearly listed in the CDM-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”.

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

111. 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.~~

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

$$LE_{REB,y} = \sum_{i} \frac{\left[TD\cancel{IZ}_{i,1-4\cancel{y}} \times EF_{KM,i,1-4\cancel{y}} \times \left(N\cancel{IZ}_{i,1-4\cancel{y}} - N\cancel{IZ}_{i,x\cancel{BL}} + N\cancel{IZ}_{i,MS,y}\right)\right]}{10^6}$$ Equation (25)

Where:

| | | |
|---|---|---|
| $LE_{REB,y}$ | = | Leakage emissions due to rebound effect in year *y* ($tCO_2$) |
| $TD\cancel{IZ}_{i,\cancel{y}1-4}$ | = | Average trip distance ~~made~~ driven by vehicle category *i* ~~cars/taxis~~ on the affected roads in years 1 and 4 of the crediting period ~~y~~ (km) |
| $EF_{KM,i,y}$ | = | Emission factor per kilometer for vehicle category *i*~~cars and taxis~~ in years 1 and 4 of the crediting period ~~y~~ ($gCO_2$/km) |
| $N\cancel{IZ}_{i,1-4\cancel{y}}$ | = | Number of vehicle category *i*~~cars/taxis~~ ~~per annum~~ using the affected roads in years 1 and 4 of the crediting period ~~y~~ (cars, taxis) |
| $N\cancel{IZ}_{i,x\cancel{BL}}$ | = | Number of vehicle category *i*~~cars/taxis~~ per annum using the affected roads in year *x* (cars, taxis) |
| $N\cancel{IZ}_{i,MS,y}$ | = | Number of vehicle category *i* ~~cars/taxis~~ per annum not used anymore due to mode shift to the MRTS in year *y* (cars, taxis) |
| $i$ | = | Vehicle category: passenger cars (C) and taxis (T)~~Cars, taxis~~ |
| $x$ | = | Most recent calendar year prior to the start of commercial operation of the project system or prior to the submission of the CDM-PDD for validation, whichever is earlier~~for which data is available~~. Data not older than three years |

113. The number of cars and taxis per annum not used anymore due to mode shift to the MRTS in years 1 and 4 of the crediting period ~~y~~ is calculated as:

$$N\cancel{IZ}_{i,MS,y} = \frac{MS_{i,\cancel{y}1-4} \times P_y}{OC_{i,x}}$$ Equation (26)

Where:

| | | |
|---|---|---|
| $MS_{i,\cancel{y}1-4}$ | = | Net share of passengers using the MRTS which would have used mode *i* in years 1 and 4 of the crediting period *y* (%) |
| $P_y$ | = | Passengers transported by the project in year *y* (passengers) |
| $OC_{i,x}$ | = | Average occupancy rate of vehicle category *i* year *x* (passengers) |
| $i$ | = | Vehicle category: passenger cars (C) and taxis (T)~~Cars, taxis~~ |

| | | |
|---|---|---|
| $x$ | = | Most recent calendar year prior to the start of commercial operation of the project system or prior to the submission of the CDM-PDD for validation, whichever is earlier~~for which data is available~~. Data not older than three years |

114. The net share of passengers that shifted from car/taxi to the MRTS 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).

#### 5.5.3.2. Determination of emissions due to changes in vehicle speed (***$LE_{SP,y}$***)

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

$$LE_{SP,y} = \sum_{i} \frac{[N\cancel{IZ}_{i,1-4\cancel{y}} \times TD\cancel{IZ}_{i,1-4\cancel{y}} \times (EF_{KM,VP,i,1-4\cancel{y}} - EF_{KM,VB,i})]}{10^6}$$ Equation (27)

Where:

| | | |
|---|---|---|
| $LE_{SP,y}$ | = | Leakage emissions due to changes in vehicle speed of cars and taxis in year *y* ($tCO_2$) |
| $N\cancel{IZ}_{i,1-4\cancel{y}}$ | = | Number of cars/taxis using the affected roads in years 1 and 4 of the crediting period ~~y~~ (cars, taxis) |
| $TD\cancel{IZ}_{i,1-4\cancel{y}}$ | = | Average trip distance made by cars/taxis on the affected roads in years 1 and 4 of the crediting period ~~y~~ (km) |
| $EF_{KM,VP,i,1-4\cancel{y}}$ | = | Emission factor per kilometer for cars/taxis at the project speed in years 1 and 4 of the crediting period ~~y~~ ($gCO_2$/km) |
| $EF_{KM,VB,i}$ | = | Emission factor per kilometer for cars/taxis at the baseline speed ($gCO_2$/km) |
| $i$ | = | Vehicle category: passenger cars (C) and taxis (T)~~Cars, taxis~~ |

116. The project speed on the affected roads is monitored in the end of 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.

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

118. To determine the emission factor per kilometer 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 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.

$$\frac{EF_{km,VP,i,1-4\cancel{y}}}{EF_{km,VB,i}} = \left(\frac{V_{P,1-4\cancel{y}}}{V_B}\right)^{-0.7}$$ Equation (28)

Where:

| | | |
|---|---|---|
| $EF_{km,VB,i}$ | = | Emission factor per kilometer for cars/taxis at the baseline speed ($gCO_2/km$) |
| $EF_{km,VP,i,1-4\cancel{y}}$ | = | Emission factor per kilometer for cars/taxis at the project speed in years 1 and 4 of the crediting period ~~y~~ ($gCO_2/km$) |
| $V_B$ | = | Average speed of cars/taxis prior to the project start (km/h) |
| $V_{P,1-4\cancel{y}}$ | = | Average speed of cars/taxis on affected roads in years 1 and 4 of the crediting period ~~y~~ (km/h) |

119. $V_B$ and $V_{P,1-4}$ in this case refer to moving speed, i.e. the speed of the vehicle under moving conditions.

### 5.5.4. Upstream emissions from gaseous fuels ($LE_{UP,y}$)

120. Upstream leakage of gaseous fuels shall be only included if the project vehicles consume more gaseous fuels than baseline vehicles. In this case, and in order to simplify the calculations, the calculation of upstream leakage emissions is based only on the gaseous fuels used under the project activity. The methodological tool "Upstream leakage emissions associated with fossil fuel use" shall be used to calculate leakage. The following leakage sources shall be considered:

(a) Fugitive CH4 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;

(b) In the case more LNG is used under the project activity: CO2 emissions from fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression into a natural gas transmission or distribution system.

## 5.6. Emission reductions

96. Emissions reductions are calculated as:

$$ER_y = BE_y - PE_y \cancel{+} - LE_y$$ Equation (29)

Where:

| | | |
|---|---|---|
| $ER_y$ | = | Emissions reductions in year *y* ($tCO_2$) |
| $BE_y$ | = | Baseline emissions in year *y* ($tCO_2$) |

| | | |
|---|---|---|
| $PE_y$ | = | Project emissions in year *y* ($tCO_2$) |
| $LE_y$ | = | Leakage emissions in year *y* ($tCO_2$) |

## 5.7. Changes required for methodology implementation in 2nd and 3rd crediting periods

97. When a renewable crediting period is chosen, project participants shall use a four-step model, or equivalent, of the transportation system of the project city for the purpose of modelling relevant parameters from the TOOL18, such as the modal split, share of passengers who shifted from electricity-based or road-based vehicle category *i*, $S_i$ or share of passenger-kilometers who shifted from electricity-based or road-based vehicle category *i*, $SD_i$, and an average trip distances travelled by passengers who shifted from electricity-based or road-based vehicle category $D_i$ for the second and third crediting periods. The model should be tested and calibrated with the results of origin-destination surveys. For the determination of the baseline emissions, the most conservative value shall be used between estimates of baseline emissions based on the modelled parameters and the parameters determined via passenger surveys in the 4th year of the previous crediting period.

98. The parameters below can be based on data from municipal transit authorities on vehicle registration statistics from the respective city or data from vehicle control stations (technical and emission control stations):

(a) Percentage or share of vehicle-kilometers or vehicles in vehicle category *i* using fuel type *n* in year *y* ~~of the second or third crediting period,~~; and

(b) $N_{i,n,y}/N_{i,y}$, or parameters used to estimate this share $N_{i,y}$ and $N_{i,n,y}$, which are the number of vehicle-kilometers or vehicles in vehicle category *i*, and the number of vehicle-kilometers or vehicles in vehicle category *i* using fuel type *n* in year *y*~~, can be based on data from municipal transit authorities on vehicle registration statistics from the respective city or data from vehicle control stations (technical and emission control stations). If no city/municipal data is available, regional data (canton, state) or, as a last option, national data can be used~~.

99. Furthermore, project participants shall apply the latest approved version of the TOOL11~~tool "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period"~~.

## 5.8. Data and parameters not monitored

100. 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 table 1.**

| **Data / Parameter:** | ***PBL**$_{B,x}$* |
|---|---|
| Data unit: | Passengers |
| Description: | Passengers transported by baseline buses prior to the project starting year *x* (per day or year) |

| | |
|---|---|
| Source of data: | Municipal transit authorities or bus operators.<br><br>Data from the most recent calendar year prior to the start of commercial operation of the project system or prior to the submission of the CDM-PDD for validation, whatever is earlier.<br><br>Vintage maximum three years. Use the same vintage as for the parameter $TDBL_{P,B}$ |
| Measurement procedures (if any): | - |
| Any comment: | - |

**Data / Parameter table 2.**

| **Data / Parameter:** | $DD_{Z,s,x}$~~$_{B/DDL/DDM/DDS}$~~ |
|---|---|
| Data unit: | km |
| Description: | Total distance driven by bus size *s* in year *x*~~, Total distance driven by buses from various sub-categories prior to the project start. B stands for all buses, L for large buses, M for medium buses and S for small buses~~ |
| Source of data: | Data from bus companies (company records), municipal transit authorities or specific studies done by the project proponent or a third party.<br><br>Vintage maximum three years |
| Measurement procedures (if any): | Distance driven by buses is often recorded by bus companies based on odometer reading. Preferable is GPS or other electronic means, however this is not yet common in bus companies.<br><br>Data can also be based on sample measurements based, in general, on daily distance driven (measured by odometer or GPS) plus the average number of operation days of a bus (based on bus operator information).<br><br>The total distance driven by all buses is the multiplication of the average annual distance driven per bus and the number of registered buses operating in the larger urban zone of the city.<br><br>The data source used to monitor this parameter shall also be used to monitor parameter $N_{k,x}$, as well as $SFC_{i,n,x}$ and $P_{i,x}$ in the tool TOOL18. |
| Any comment: | Bus sizes: small (S), medium (M) and large (L).~~-~~ |

~~**Data / Parameter table 3.**~~

| ~~**Data / Parameter:**~~ | ~~$AD_B$~~ |
|---|---|
| ~~Data unit:~~ | ~~km/bus~~ |
| ~~Description:~~ | ~~Average annual distance driven by baseline buses~~ |

| | |
|---|---|
| Source of data: | Data from bus companies (company records), municipal transit authorities or specific studies done by the project proponent or a third party.<br>Vintage maximum three years |
| Measurement procedures (if any): | Distance driven by buses is often recorded by bus companies based on odometer reading. Preferable is GPS or other electronic means, however this is not yet common in bus companies.<br>Data can also be based on sample measurements based, in general, on daily distance driven (measured by odometer or GPS) plus the average number of operation days of a bus (based on bus operator information).<br>Calculated as the division of the total distance driven by all registered buses operating in the larger urban zone of the city, by the number of registered buses |
| Any comment: | - |

**Data / Parameter table 4.**

| **Data / Parameter:** | $NB_{Z,s,x}$ |
|---|---|
| Data unit: | DimensionlessNumber of buses bus size *s* in year *x* |
| Description: | Number of buses in use in the baseline |
| Source of data: | Municipal transit authorities based on vehicle registration statistics from the respective city or data from vehicle control stations (technical and emission control stations). If no city/municipal data is available, regional data (canton, state) or, as a last option, national data can be used. Vintage maximum three years |
| Measurement procedures (if any): | The data source used to monitor this parameter shall also be used to monitor parameter $DD_{i,S,x}$, $DD_{i,M,x}$, $DD_{i,L,x}$ as well as $SFC_{i,n,x}$ and $SEC_{i,x}$ in the TOOL18.- |
| Any comment: | Bus sizes: small (S), medium (M) and large (L).- |

**Data / Parameter table 5.**

| **Data / Parameter:** | $RSBL_x$ |
|---|---|
| Data unit: | km |
| Description: | Total Rroad space available in year *x*the baseline and project |
| Source of data: | Official statistics or studies conducted by the project proponent or a third party |
| Measurement procedures (if any): | -Based on infra-structure statistics |
| Any comment: | Road space baseline based on official information. Reduced road space based on construction plans (reduced road space is lanes which were eliminated due to dedicating bus lanes to the project system). Road space project = road space baseline – eliminated lanes |

**Data / Parameter table 6.**

| **Data / Parameter:** | $RS_y$ |
|---|---|
| Data unit: | km |

| | |
|---|---|
| Description: | Total road space available due to the project activity |
| Source of data: | Official statistics or studies conducted by the project proponent or a third party |
| Measurement procedures (if any): | Based on infra-structure statistics |
| Any comment: | Road space based on official information and on construction plans.<br><br>During the crediting period the actual RSy implemented should be checked against the ex ante expectation. If there are differences, the Project Proponent should demonstrate why it does not affect the project design (i.e. by applying equation 9 again), or request a Post Registration Change to incorporate or eliminate the leakage calculation |

**Data / Parameter table 7.**

| **Data / Parameter:** | ***$AD_T$*** |
|---|---|
| Data unit: | km /taxi |
| Description: | Average annual distance driven by taxis |
| Source of data: | Municipal transit authorities or taxi operators. Vintage maximum three years |
| Measurement procedures (if any): | Based on records of taxi companies or on surveys. A simple method can be odometer reading of a sample of taxis and dividing total distance driven by the vehicle age |
| Any comment: | - |

**Data / Parameter table 8.**

| **Data / Parameter:** | ***N~~IZ~~$_{i,x}$~~$_{BL/NIZC,BL/NIZT,BL}$~~*** |
|---|---|
| Data unit: | Number of vehicles |
| Description: | Number of vehicles of vehicle category *i* per annum using the affected roads in year x~~per annum in the baseline. In particular, C stands for cars, and T for taxis~~ |
| Source of data: | Municipal transit authorities or studies ordered by project proponent. Vintage maximum three years |
| Measurement procedures (if any): | Visual counting on the identified roads. Counting should be based on various parts of the road, if major roads depart from the observed road to ensure average numbers |
| Any comment: | The same method should be applied to determine number of cars and taxis in the project situation to ensure a consistent approach.<br><br>Vehicle categories: passenger cars (C) and taxis (T) |

**Data / Parameter table 9.**

| **Data / Parameter:** | ***$V_B$*** |
|---|---|
| Data unit: | km/h |
| Description: | Average total speed and average speed under circulation is measured |

| | |
|---|---|
| Source of data: | Municipal transit authorities or studies ordered by project proponent. Vintage maximum three years, if no major infrastructure or policy (e.g. licence plate scheme or new traffic signalling) changes have occurred since the last major change |
| Measurement procedures (if any): | On-board measurements determining the average speed when circulating and average total speed on the road based e.g. on GPS |
| Any comment: | Average speed required for calculation of the rebound effect refers to total distance divided by total time on the affected road.<br><br>Average moving speed required for the calculation of the speed effect refers to the speed under moving conditions i.e. total distance divided by time under movement (total time minus standstill time of vehicle), on the affected road.<br><br>Only passenger cars and 4-wheel taxis are monitored. The same speed data is taken for both vehicle types.<br><br>The same method should be applied to determine vehicle project speed thereafter to ensure a consistent approach.<br><br>Required for monitoring of the rebound effect and the speed effect on affected roads |

**Data / Parameter table 10.**

| **Data / Parameter:** | $TD\text{~~B~~}_{Z,x}$, $TD_{T,x}$, $TD_{C,x}$ |
|---|---|
| Data unit: | km |
| Description: | $TD_{Z,x}$: Total distance driven by public transport buses in year x<br>$TD_{T,x}$: Total distance driven by public transport taxis in year x<br>$TD_{C,x}$: Total distance driven by passenger cars in year x<br>~~Total distance driven by buses (B), taxis (T) and personal cars (C) in the baseline~~ |
| Source of data: | Official statistics (vehicle registration data; transportation statistics) |
| Measurement procedures (if any): | - |
| Any comment: | Data can be either with or without informal transport as long as the above mentioned parameters are from the same data source. In general, data including only formal transport is of a better data quality and should thus be taken |

# 6. Monitoring methodology

## 6.1. Data and parameters monitored

101. 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. One hundred per cent 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.

102. 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 table 11.**

| **Data / Parameter:** | $P_y$ |
|---|---|
| Data unit: | Passengers |
| Description: | Total number of passengers in year *y* |
| Source of data: | As per the "TOOL18: Baseline emissions for modal shift measures in urban passenger transport" |
| Measurement procedures (if any): | As per the "TOOL18: Baseline emissions for modal shift measures in urban passenger transport" |
| Monitoring frequency: | As per the "TOOL18: Baseline emissions for modal shift measures in urban passenger transport" |
| QA/QC procedures: | As per the "TOOL18: Baseline emissions for modal shift measures in urban passenger transport" |
| Any comment: | - |

**Data / Parameter table 12.**

| **Data / Parameter:** | $EF_{pkm,i,1-4}$ |
|---|---|
| Data unit: | $tCO_2$/pkm |
| Description: | Emission factor per passenger-kilometer of mode *i* in years 1 and 4 of the crediting period *y* ($gCO_2$/pkm) |
| Source of data: | Calculated based on equations 2 and 3 from the "TOOL18: Baseline emissions for modal shift measures in urban passenger transport". |
| Measurement procedures (if any): | As per the "TOOL18: Baseline emissions for modal shift measures in urban passenger transport". |
| Monitoring frequency: | Calculated based on the "TOOL18: Baseline emissions for modal shift measures in urban passenger transport", through surveys conducted in the end of years 1 and 4 of the crediting period,. |
| QA/QC procedures: | As per the "TOOL18: Baseline emissions for modal shift measures in urban passenger transport". |
| Any comment: | The parameter $EF_{pkm,i,x}$ in the tool corresponds to the emission factor per passenger-kilometer of mode *i* in years 1 and 4 of the crediting period *y* ($EF_{pkm,i,1-4}$).<br><br>It has to be determined separately for electricity based transport system (equation 2 of the tool) and fuel based transport system (equation 3 of the tool). |

**Data / Parameter table 13.**

| **Data / Parameter:** | $DPE_{FC,y}$ |
|---|---|
| Data unit: | $tCO_2$ |
| Description: | Direct project emissions from fuel consumption in year *y* |
| Source of data: | Calculated based on the TOOL03 |

| | |
|---|---|
| Measurement procedures (if any): | As per the TOOL03 |
| Monitoring frequency: | As per the TOOL03 |
| QA/QC procedures: | As per the TOOL03 |
| Any comment: | The parameter $PE_{FC,j,y}$ in the tool corresponds to the direct project emissions from the project transport system that uses fossil fuels in year $y$ ($DPE_y$), and the element process $j$ corresponds to the combustion of fuel type $n$ in the project vehicles.<br><br>If the project does not have reliable records on total fuel consumed, the specific fuel consumption of a representative sample of comparable transport units (comparable technology, vintage and size) and the total distance driven are used to determine the parameter $FC_{i,j,y}$, as per equation (5). |

**Data / Parameter table 14.**

| **Data / Parameter:** | $DPE_{EC,y}$ |
|---|---|
| Data unit: | $tCO_2$ |
| Description: | Direct project emissions from electricity consumption in year $y$ |
| Source of data: | Calculated based on the TOOL05 |
| Measurement procedures (if any): | As per the TOOL05 |
| Monitoring frequency: | As per the TOOL05 |
| QA/QC procedures: | As per the TOOL05 |
| Any comment: | The parameter $PE_{EC,j,y}$ in the tool corresponds to the direct project emissions from the project transport system that uses fossil fuels in year $y$ ($DPE_{FC,y}$). Only electricity consumed for train propulsion should be included in rail-based MRTS. |

**Data / Parameter table 15.**

| **Data / Parameter:** | $SFC_{i,n,y}$ |
|---|---|
| Data unit: | Mass or volume units of fuel/km |
| Description: | Specific fuel consumption of vehicle category $i$ using fuel type $n$ in year $y$ included in the sample |
| Source of data: | MRTS operator(s) or project owner |

| | |
|---|---|
| Measurement procedures (if any): | Based on specific studies or cCalculated based on total fuel consumed and total distance driven per bus size sub-category of the buses included in the sample.<br>If based on studies, tThe specific fuel consumption is taken of from a representative sample of comparable project units in terms of technology, vintage and size. Buses of the sample shall be project units running on project bus lanes. The sample criteria are based on technology (Euro standard), age, and bus size. The sample shall be representative of the route(s) serviced by the project as well as the operation frequencies during the day to account for differences of fuel consumption related to time.<br>Measurement procedures shall include distance driven (preferably recorded by GPS or other electronic means with a maximum error level of 5 per cent) and the fuel consumed monitored either through appropriate equipment installed in the units or through standard measurement procedures at a calibrated fuel station |
| Monitoring frequency: | Annually |
| QA/QC procedures: | To be conservative project fuel consumptions based on specific fuel consumption values of samples shall be based on the upper limit of the uncertainty band at a 95 per cent confidence level i.e. with 95 per cent confidence the actual average fuel consumption is equal to or lower than the value used by the project |
| Any comment: | This data is only required if total fuel consumption (TC) is not available.<br>This data is only collected if the MRTS operates with buses |

**Data / Parameter table 16.**

| **Data / Parameter:** | ***$DD_{PJ,n,y}$*** |
|---|---|
| Data unit: | km |
| Description: | Distance driven by project units using fuel type *n* in year *y* |
| Source of data: | MRTS operator(s) or system manager |
| Measurement procedures (if any): | Based on GPS (preferred), other electronic means, odometer or number of units per route and turnover per route |
| Monitoring frequency: | Continuously, aggregated at least annually |
| QA/QC procedures: | In many systems operators are paid according to distance driven. Payment of operators can thus be used to check the distance driven |
| Any comment: | Used only for QA/QC in case of bus operated MRTS to control the specific fuel consumption (fuel per distance) |

**Data / Parameter table 17.**

| **Data / Parameter:** | ***$N_{i,1-4y/NB,y/NT,y}$*** |
|---|---|
| Data unit: | Number of vehicles |
| Description: | Number of vehicles category *i* in years 1 and 4 of the crediting periodNumber of vehicles of vehicle category i circulating in the larger urban zone of the city. In particular B stands for buses, and T for taxis |
| Source of data: | Municipal transit authorities based on vehicle registration statistics from the respective city or data from vehicle control stations (technical and emission control stations) |

| | |
|---|---|
| Measurement procedures (if any): | For buses as well as for taxis informal or illegal units may operate. While estimates on the number of informal units may be available these are due to their nature not trustworthy. For both categories it is thus recommended to only include formally registered units |
| Monitoring frequency: | Studies conducted ~~in~~ at the end of years 1 and 4 of the crediting period |
| QA/QC procedures: | - |
| Any comment: | Vehicle categories: buses (B), passenger cars (C), taxis (T)~~See also the table for Ni~~ |

**Data / Parameter table 18.**

| | |
|---|---|
| **Data / Parameter:** | $EF_{km,i,1\text{-}4}$ |
| Data unit: | $gCO_2/km$ |
| Description: | Emission factor per kilometer for vehicle category *i* in years 1 and 4 of the crediting period ($gCO_2/km$) |
| Source of data: | Calculated based on equation 1 from the TOOL18 |
| Measurement procedures (if any): | As per the TOOL18 |
| Monitoring frequency: | Calculated based on surveys conducted at the end of years 1 and 4 of the crediting period, based on the TOOL18. |
| QA/QC procedures: | As per the TOOL18 |
| Any comment: | The parameter $EF_{km,i,x}$ in the tool corresponds to the emission factor per kilometer of vehicle category *i* in years 1 and 4 of the crediting period *y* ($EF_{km,i,1\text{-}4}$).<br><br>Vehicle categories: buses (Z) and taxis (T).<br><br>For taxis, a default emission factor for new vehicles can be obtained from the source provided in the table in section “Data and Parameters not monitored” of the tool. |

**Data / Parameter table 19.**

| | |
|---|---|
| **Data / Parameter:** | $OC_{i,}$~~$_{yt/OCB,y/OCT,y}$~~ |
| Data unit: | Passengers |
| Description: | Average occupancy of vehicle category *i* in the period of time *t* ~~Average occupancy rate of vehicle category i in year y. In particular, B stands for buses, and T for taxis~~ |
| Source of data: | Municipal transit authorities or ~~specific studies~~surveys ~~done~~ conducted by the project proponent or a third party |

| | |
|---|---|
| Measurement procedures (if any): | Based on visual occupancy studies for all vehicle categories.<br>For buses the occupancy rate is based on boarding-alighting studies, electronic smart tickets or on visual occupancy studies with expansion factors for routes served to determine the average occupancy rate along the entire route. As an alternative for buses, the occupancy rate can be based on average trip distance of bus passengers, total passengers and total distance driven of buses.<br>For taxis, the driver should not be counted.<br>The detailed procedures concerning visual occupancy and boarding alighting studies are presented in appendices 1, 2 and 3 |
| Monitoring frequency: | Studies/surveys conducted ~~in~~ at the end of years 1 and 4of the crediting period |
| QA/QC procedures: | - |
| Any comment: | Period of time when the parameters are measured: most recent calendar year prior to the start of commercial operation of the project system or prior to the submission of the CDM-PDD for validation, whatever is earlier (x) or years 1 and 4 of the crediting period (1-4)<br><br>Vehicle categories: buses (B), passenger cars (C), taxis (T)- |

**Data / Parameter table 20.**

| | |
|---|---|
| **Data / Parameter:** | $CV_{i,t}$ |
| Data unit: | Passengers |
| Description: | Average capacity of vehicle category *i* in the period *t* (passengers) |
| Source of data: | Official statistics |
| Measurement procedures (if any): | - |
| Monitoring frequency: | Surveys conducted at the end of years 1 and 4of the crediting period |
| QA/QC procedures: | - |
| Any comment: | Period of time when the parameters are measured: most recent calendar year prior to the start of commercial operation of the project system or prior to the submission of the CDM-PDD for validation, whatever is earlier (x) or years 1 and 4 of the crediting period (1-4)<br><br>Vehicle categories: buses (B), passenger cars (C), taxis (T)<br><br>For taxis, the average capacity shall not include the driver. |

**Data / Parameter table 21.**

| | |
|---|---|
| **Data / Parameter:** | $BSCR_y$ |
| Data unit: | Number of vehicles |
| Description: | Cumulative bus units displaced by the project on the trunk lanes as a result of the project in year *y* |
| Source of data: | Municipal transit authorities, official statistics or studies ordered by project proponent |
| Measurement procedures (if any): | - |

| | |
|---|---|
| Monitoring frequency: | Yearly |
| QA/QC procedures: | - |
| Any comment: | Used to calculate $ARS_y$.<br><br>The number of buses circulated in trunk lanes prior to the construction of the project activity that have ceased to circulate in trunk lanes due to the project activity are to be considered. These buses can be retired or used in another part of the network |

**Data / Parameter table 22.**

| | |
|---|---|
| **Data / Parameter:** | $TD$~~$IZ$~~$_{i,}$~~$_{y}$~~$_{1-4}$ |
| Data unit: | km |
| Description: | Average trip distance driven by vehicle category *i* ~~taxis and cars~~ on the affected roads in years 1 and 4 of the crediting period ~~y~~ |
| Source of data: | Municipal transit authorities or project owner |
| Measurement procedures (if any): | Electronic or visual tracking of samples of vehicles entering/exiting the affected roads registering the entry and the exit point and measuring the distance by GPS or other means |
| Monitoring frequency: | Surveys conducted ~~Once in the~~ at the end of years 1 and 4 of the crediting period |
| QA/QC procedures: | - |
| Any comment: | - |

~~**Data / Parameter table 23.**~~

| | |
|---|---|
| ~~**Data / Parameter:**~~ | ~~$NIZ_{i,y}/NIZ_{C,y}/NIZ_{T,y}$~~ |
| ~~Data unit:~~ | ~~Number of vehicles~~ |
| ~~Description:~~ | ~~Number of vehicles of vehicle category *i* using affected roads. In particular, C stands for cars, and T for taxis~~ |
| ~~Source of data:~~ | ~~Municipal transit authorities or project owner~~ |
| ~~Measurement procedures (if any):~~ | ~~Visual counting. Counting should be based on various parts of the road if major roads depart from the lane to ensure average numbers~~ |
| ~~Monitoring frequency:~~ | ~~Once in the years 1 and 4 of the crediting period~~ |
| ~~QA/QC procedures:~~ | ~~-~~ |
| ~~Any comment:~~ | ~~-~~ |

**Data / Parameter table 24.**

| | |
|---|---|
| **Data / Parameter:** | $MS_{i,1-4}$~~$_{y}$~~ |
| Data unit: | Percentage |
| Description: | Net share of passengers using the MRTS which would have used mode *i* in the years 1 and 4 of the crediting period ~~y~~ |
| Source of data: | Survey ~~realized~~ conducted by an external survey company |
| Measurement procedures (if any): | Survey. The relevant question numbers are 2 and 3 |

| | |
|---|---|
| Monitoring frequency: | The survey is realizedconducted in the at the end of years 1 and 4 of the crediting period |
| QA/QC procedures: | See Appendix 4 for the survey design |
| Any comment: | Only used for leakage calculation of rebound effect (reduced amount of cars and taxis) if required (see condition for rebound effect calculation) |

**Data / Parameter table 25.**

| **Data / Parameter:** | $V_{P,y1-4}$ |
|---|---|
| Data unit: | km/h |
| Description: | Average speed of cars and /taxis on affected roads in years 1 and 4 of the crediting period y and total average speed and average moving speed |
| Source of data: | Municipal transit authorities or studies ordered by project proponent |
| Measurement procedures (if any): | On-board measurements determining the total average speed and the average moving speed (when circulating) on the affected road based, e.g. on GPS measuring. The same methodology as for determination of $V_B$ should be used.<br>Average speed required for calculation of the rebound effect refers to total distance divided by total time, on the affected road.<br>Average moving speed required for calculation of the speed effect refers to speed under moving conditions i.e. total distance divided by time under movement (total time minus standstill time of vehicle), on the affected road.<br>Taxis and passenger cars are treated identical. This condition should be monitored for each affected road |
| Monitoring frequency: | Once in the at the end of years 1 and 4 of the crediting period |
| QA/QC procedures: | - |
| Any comment: | Only passenger cars and 4-wheel taxis. See also table for $V_B$ |

**Data / Parameter table 26.**

| **Data / Parameter:** | $P_{EL,i,y}$ |
|---|---|
| Data unit: | Passengers |
| Description: | Total passengers transported by baseline rail-system in year *y* |
| Source of data: | Rail operator |
| Measurement procedures (if any): | Based in general on turnpike or electronic ticketing system; Cross check with ticket sales possible in some cases |
| Monitoring frequency: | Annually |
| QA/QC procedures: | - |
| Any comment: | Only required in case baseline rail systems operates |

**Data / Parameter table 27.**

| **Data / Parameter:** | $TE_{EL,i,y}$ |
|---|---|
| Data unit: | t $CO_2$ |

| | |
|---|---|
| ~~Description:~~ | ~~Total emissions from the electricity-based rail system in year *y*~~ |
| ~~Source of data:~~ | ~~Rail operator for electricity consumption and as per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"~~ |
| ~~Measurement procedures (if any):~~ | ~~As per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"~~ |
| ~~Monitoring frequency:~~ | ~~Annually~~ |
| ~~QA/QC procedures:~~ | ~~-~~ |
| ~~Any comment:~~ | ~~When applying the tool, the parameter $EC_{BL,k,y}$ in the tool should be taken as the amount of electricity used by the electricity-based rail system.~~<br>~~All electricity emission factors used should be defined at the validation stage and fixed for the crediting period. Therefore if the grid emission factor is used, the ex ante approach should be used~~ |

**Data / Parameter table 28.**

| **Data / Parameter:** | $LE_{UP,y}$ |
|---|---|
| Data unit: | $tCO_2$ |
| Description: | Leakage upstream emissions of gaseous fuels during the year *y* |
| Source of data: | As per "Upstream leakage emissions associated with fossil fuel use" |
| Measurement procedures (if any): | As per "Upstream leakage emissions associated with fossil fuel use" |
| Monitoring frequency: | As per "Upstream leakage emissions associated with fossil fuel use" |
| QA/QC procedures: | As per "Upstream leakage emissions associated with fossil fuel use" |
| Any comment: | As per "Upstream leakage emissions associated with fossil fuel use" |

# Appendix 1. Guideline for the establishment of load factor studies for buses based on visual occupancy

1. Load factor surveys based on visual occupancy studies use the following procedures:

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

    (b) Occupancy categories are defined (usually five or six), for instance <50 per cent occupied, 50-100 per cent seats occupied, 100 per cent seats occupied, <50 per cent space for standing passengers occupied, 50-100 per cent of standing space occupied, overload (>100 per cent of legally permitted space occupied);

    (c) 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 occupancy with actual in vehicle counts;

    (d) Formats for field study are prepared;

    (e) Field data collectors are trained;

    (f) 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 season (school or university vacations) should be avoided. The recommended time period for the study is 6AM-9PM. 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;

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

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

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

2. 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.

# Appendix 2. Guideline for the establishment of load factor studies for buses based on boarding-alighting surveys

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

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

    (b) The load factor (occupancy 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;

    (c) 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;

    (d) 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;

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

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

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

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

1. 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 occupancy counting the number of passengers occupying the vehicle excluding the driver for taxis. The procedures to establish visual occupancy are:

    (a) 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;

    (b) Field data is collected. Coverage of the occupancy 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;

    (c) Occupancy is the number of passengers using the vehicle. The driver is not counted for taxis. Taxis without passengers are counted as no (zero) occupancy;

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

    (e) The study is realized in different locations of the larger urban zone of the city;

    (f) 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 the larger urban zone of the 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 4. Methodological design of survey MRTS

## 1. Methodological design of survey

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

   (a) Survey objective;

   (b) Target population;

   (c) Sample frame;

   (d) Sample design;

   ~~(e) Relative error level;~~

   (f) Geographical coverage;

   (g) Sample frequency;

   (h) Sample size;

   (i) ~~Size and result~~ Use of ~~the~~ a pilot test survey;

   (j) ~~Selection method of~~ Selecting the sample;

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

   ~~(l) Data verification and validation including QA and QC;~~

   (m) Survey realization;

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

   ~~(o) Default questionnaire.~~

2. Whenever the MRTS 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 MRTS extension.

## 1.1. Technical summary data sheet of the survey -

**Table 1. Strategy and sample design in the MRTS passenger survey**

| | |
|---|---|
| **Parameter** | ~~Main parameters:~~<br>~~Baseline emissions;~~<br>~~Indirect project emissions~~<br>~~Secondary parameters and inputs:~~<br>~~Proportion of passengers using each mode of transport, with the project and in absence of the project;~~<br>~~The average distance travelled by these modes with the project and in absence of the project~~The main parameters that must be determined from the survey are:<br>• For Baseline Emissions:<br>o Share of passengers who shifted from electricity-based or road-based vehicle category *i* (parameter $S_i$ from the TOOL18);<br>o Average trip distance travelled by passengers who shifted from electricity-based or road-based vehicle category *i* (parameter $D_i$ from the TOOL18).<br>• For Indirect Project Emissions:<br>o Average indirect project trip distance of surveyed passengers using mode *i* in years 1 and 4 of the crediting period (parameter $D_{ind,i,1-4}$ from Equation 4). |
| **Target population** | Passengers over 12 years using the MRTS |
| **Sample frame** | Passenger flow in ~~all the~~ selected stations of the MRTS |
| **Sample design** | ~~Two staged probabilistic design:~~<br>~~First stage: stratified – simple random sampling (SRS);~~<br>~~Second stage: systematic sampling based on passengers flow per station~~<br>~~Stratum: Stati~~<br>~~Sub stratum: Days in a week and hours~~Two stage probabilistic design:<br>• **First stage:** Stratified – Simple Random Sampling (SRS);<br>o Main strata: Group of Stations based on passenger flow; stations sampled from within such strata;<br>o Sub-strata: Ranges of hours; an hour interval sampled from within such sub-strata;<br>• **Second stage:** Systematic Sampling of passengers in selected hour intervals. |
| ~~**Relative error level (CV)**~~[1] | ~~For the survey a global desired level of precision (relative standard error or coefficient of variation – CV) between 5 per cent and 10 per cent for the parameters of interest, which also implies that having precision levels of 90/10, is required. Results obtained are based on a 95 per cent confidence level using the more conservative boundary~~ |
| **Coverage** | Larger urban zone of the city where the MRTS operates |

~~[1] 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.~~

| | |
|---|---|
| **Size of Universe** | Generally, in one day an MRTS mobilizes 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 per cent of the original sample.~~[2] 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~~ At the end of years 1 and 4 of the crediting period, ~~during~~ through 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 shall 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 |

## 2. Survey objective

3. The survey objective is to determine the input parameters needed to calculate:

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

(b) The indirect project emissions caused by passengers using the MRTS, which correspond to the emissions caused from the ~~trip~~ point of origin (O) to the MRTS entry station, and from the MRTS exit station to the final destination (D).

## 3. Target population

4. 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.

## 4. Sample frame

5. The sample frame is the passenger flow in ~~all the~~ selected stations of the MRTS. Data for the passenger frame is obtained from the system manager.

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

## 5. Sample design

6. A two staged probabilistic design is applied:

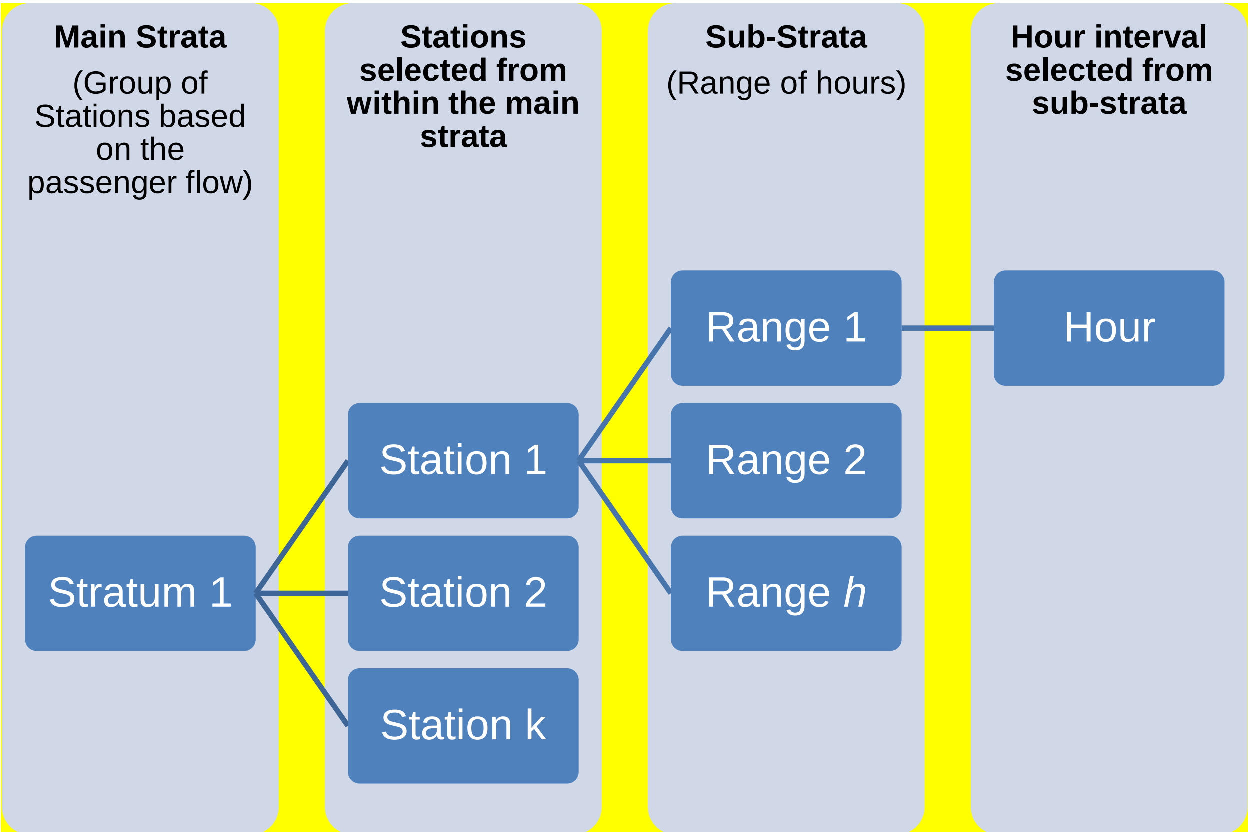
(a) **First stage:** Stratified – Simple Random Sampling (SRS) to identify the MRTS stations and the hours interval when the survey will be conducted, where:

(i) Main strata: Group of Stations. Stations are grouped depending on the passenger flow per station to provide information for busier stations and less frequented stations. In practical terms, three groups of stations could be 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.

The stations where the survey will be conducted are selected from main strata. The selected stations shall remain fixed through the survey week;

(ii) Sub-strata: Ranges of hours. In MRTSs, there are generally periods of heterogeneous passenger flow (e.g. morning peak, evening peak, /off-peak hours). Such ranges of hours are to be determined for the 7 days of the survey week, and an hour selected from each range.

**Figure 1. Stratification model used**




(b) **Second stage:** Systematic sampling ~~based on~~ of passengers ~~flow per~~ in selected stations within the selected hours.

7. 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.

8. 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.

9. 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.

10. In MRTS, 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.

11. 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.

## 6. Relative error level

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

13. It is considered that the result of an estimate is:

(a) Statistically robust if its coefficient of variation is less than 5 per cent;

(b) Practically acceptable if its coefficient of variation is between 5 per cent and 10 per cent;

(c) Of low precision if its coefficient of variation is higher than 10 per cent and less than 15 per cent;

(d) It is not considered as robust if its coefficient of variation is higher than 15 per cent.

14. For the results obtained, a 95 per cent confidence level is calculated taking the (conservative) lower boundary for baseline emissions and the (conservative) upper boundary for indirect project emissions. The parameters determined in the survey are thus quantified at the 95 per cent confidence level following the Appendix 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 per cent confidence level”.

## 7. Geographical coverage

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

## 8. Sample frequency

16. Two surveys shall be conducted during the crediting period: at the end of the 1st and 4th years of the crediting period.

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

18. 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 evidence of the same, 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 will be done only once a year, on the contrary, they will 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 years 4 and 7 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.

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

(a) 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;

(b) 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.

## 9. Sample size

20. To ensure that the input parameter estimates are sufficiently precise (where precision is quantified via a 95% confidence interval for a parameter), the sample size for estimating the input parameters below is to be considered at the planning stage:

(a) $S_i$ (“Share of passengers who shifted from electricity-based or road-based vehicle category *i*”);

(b) $D_i$ (“Average trip distance travelled by passengers who shifted from electricity-based or road-based vehicle category *i*”);

(c) $D_{ind,i,1-4}$ (Average indirect project trip distance of surveyed passengers using mode *i* in years 1 and 4 of the crediting period).

21. Following the “Standard: Sampling and surveys for CDM project activities and programmes of activities”, sample size determination should be based on 95/10 confidence/precision for large-scale CDM project activities. The sample size selected shall be the highest among the values determined for each input parameter.

~~22. For the calculation of the sample size, a global level of precision (relative standard error or coefficient of variation – CV) between 5 per cent and 10 per cent 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 per cent and a maximum precision level of 10 per cent.~~

~~23. 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.~~

$$CV = \left(\frac{\sqrt{V(\hat{t_y})}}{\hat{t_y}}\right) \times 100$$

~~Equation (1)~~

~~Where:~~

| | | |
|---|---|---|
| ~~$\hat{t_y}$~~ | ~~=~~ | ~~Average for the parameter of interest *y*~~ |
| ~~$V(\hat{t_y})$~~ | ~~=~~ | ~~Variance of this estimate~~ |

~~24. 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 11 which provides formulas for the calculation of the variance in case of multi-stage designs).~~

~~25. 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.~~

~~26. 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.~~

~~27. 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, and under the multistage design (see the formulae described in section 11) 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.~~

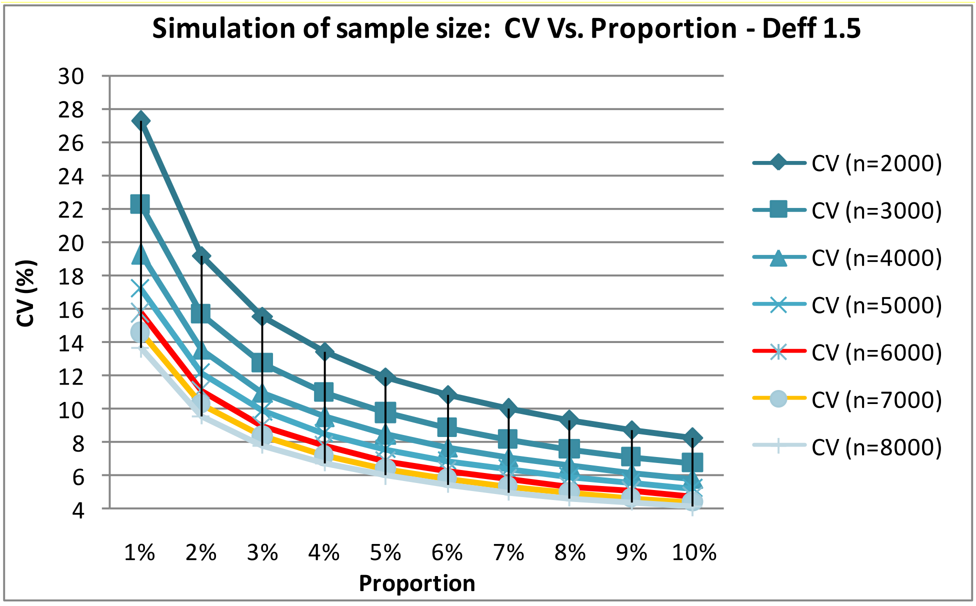
~~28. The DOE shall verify that the procedures used to derive the sample size will lead to the level of precision for the parameters of interest stipulated above.~~

### ~~9.1. Design effect (Deff)~~

~~29. 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. In the simulation case, the Deff value was assumed between 1 and 3.5, in such a way that the sample size is considered under the worst scenario i.e. when the variance associated to the multi-stage design was factor 2.5 fold the SRS. Sample size simulation were performed considering the variation coefficient (less than 10 per cent), the design effects (deff) (value between 1.5 and 3.5) and the lowest frequencies for the modal proportions (between 5 and 10 per cent) to be estimated.~~

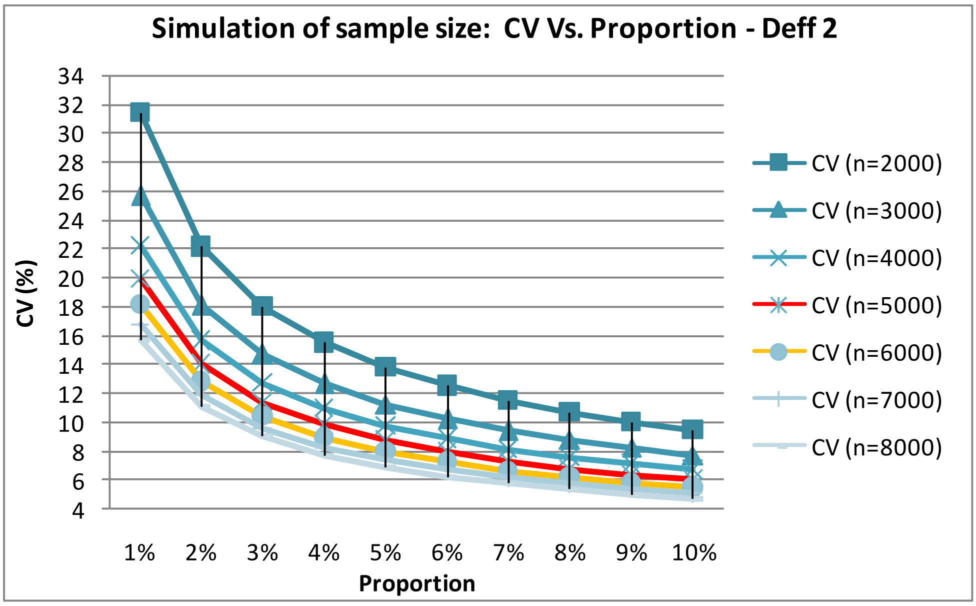
~~30. The graphs below, provided for illustrative purposes only, present the result of such simulations. They show that a sample size of 6,000-8,000 would be sufficient even facing extreme scenarios such as with a deff of 3.5.~~

**Figure 2. Simulation of sample size with Deff 1.5**



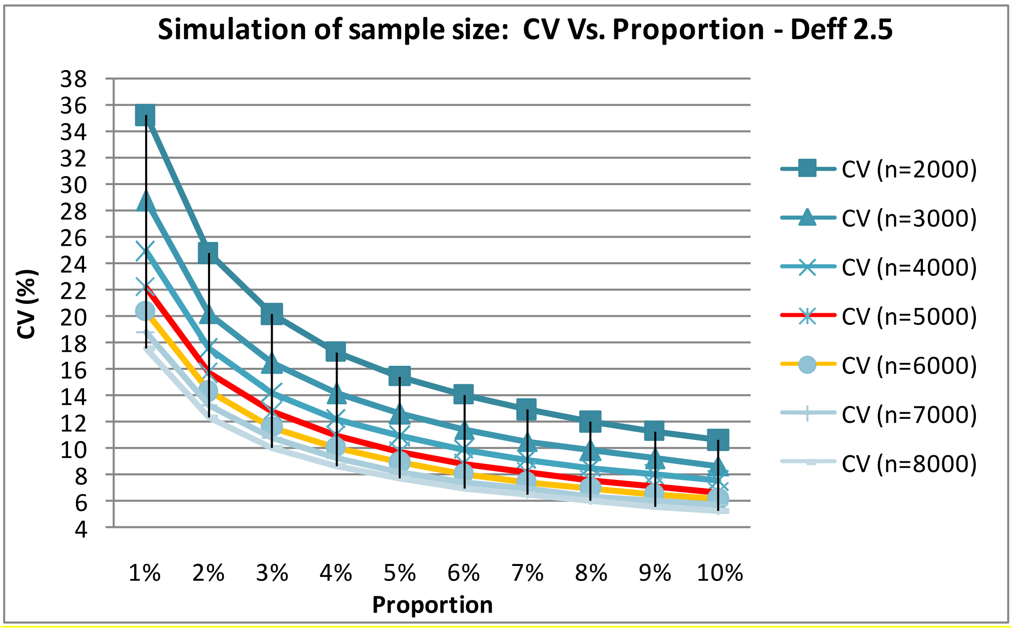

| Proportion | CV (n=2000) | CV (n=3000) | CV (n=4000) | CV (n=5000) | CV (n=6000) | CV (n=7000) | CV (n=8000) |
|---|---|---|---|---|---|---|---|
| 1% | 27.2 | 22.2 | 19.3 | 17.2 | 15.7 | 14.5 | 13.6 |
| 2% | 19.2 | 15.6 | 13.5 | 12.1 | 11.1 | 10.2 | 9.6 |
| 3% | 15.6 | 12.7 | 11.0 | 9.8 | 9.0 | 8.3 | 7.8 |
| 4% | 13.4 | 10.9 | 9.5 | 8.5 | 7.7 | 7.2 | 6.7 |
| 5% | 11.9 | 9.7 | 8.4 | 7.5 | 6.9 | 6.4 | 6.0 |
| 6% | 10.8 | 8.8 | 7.7 | 6.8 | 6.3 | 5.8 | 5.4 |
| 7% | 10.0 | 8.1 | 7.1 | 6.3 | 5.8 | 5.3 | 5.0 |
| 8% | 9.3 | 7.6 | 6.6 | 5.9 | 5.4 | 5.0 | 4.6 |
| 9% | 8.7 | 7.1 | 6.2 | 5.5 | 5.0 | 4.6 | 4.3 |
| 10% | 8.2 | 6.7 | 5.8 | 5.2 | 4.7 | 4.4 | 4.1 |

**Figure 3. Simulation of sample size with Deff 2.0**



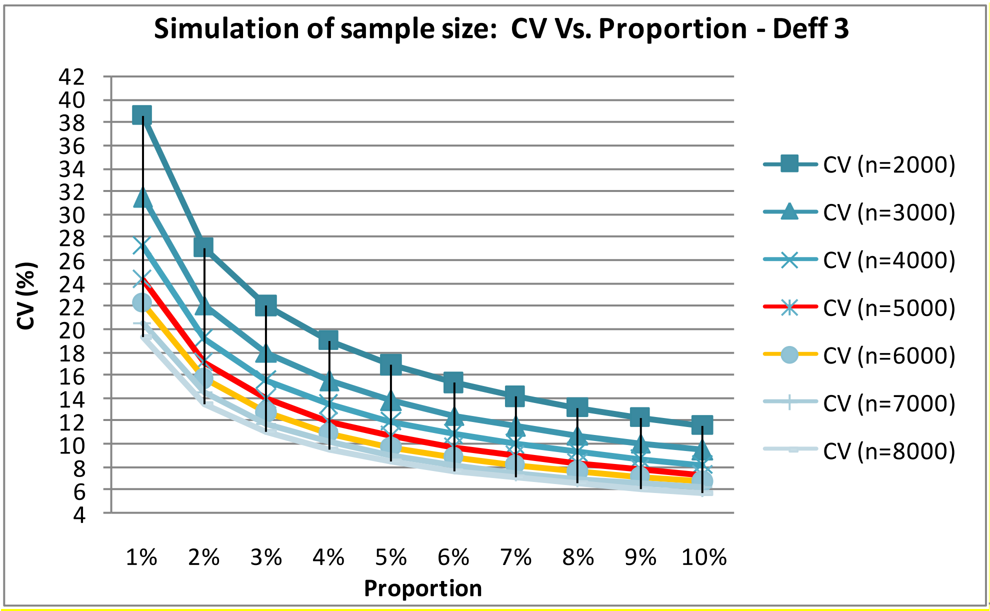

| Proportion | CV (n=2000) | CV (n=3000) | CV (n=4000) | CV (n=5000) | CV (n=6000) | CV (n=7000) | CV (n=8000) |
|---|---|---|---|---|---|---|---|
| 1% | 31.5 | 25.7 | 22.2 | 19.9 | 18.1 | 16.8 | 15.7 |
| 2% | 22.1 | 18.1 | 15.6 | 14.0 | 12.8 | 11.8 | 11.1 |
| 3% | 18.0 | 14.7 | 12.7 | 11.4 | 10.4 | 9.6 | 9.0 |
| 4% | 15.5 | 12.6 | 10.9 | 9.8 | 8.9 | 8.3 | 7.7 |
| 5% | 13.8 | 11.2 | 9.7 | 8.7 | 8.0 | 7.4 | 6.9 |
| 6% | 12.5 | 10.2 | 8.8 | 7.9 | 7.2 | 6.7 | 6.2 |
| 7% | 11.5 | 9.4 | 8.1 | 7.3 | 6.6 | 6.2 | 5.8 |
| 8% | 10.7 | 8.8 | 7.6 | 6.8 | 6.2 | 5.7 | 5.4 |
| 9% | 10.1 | 8.2 | 7.1 | 6.4 | 5.8 | 5.4 | 5.0 |
| 10% | 9.5 | 7.7 | 6.7 | 6.0 | 5.5 | 5.1 | 4.7 |

**Figure 4. Simulation of sample size with Deff 2.5**



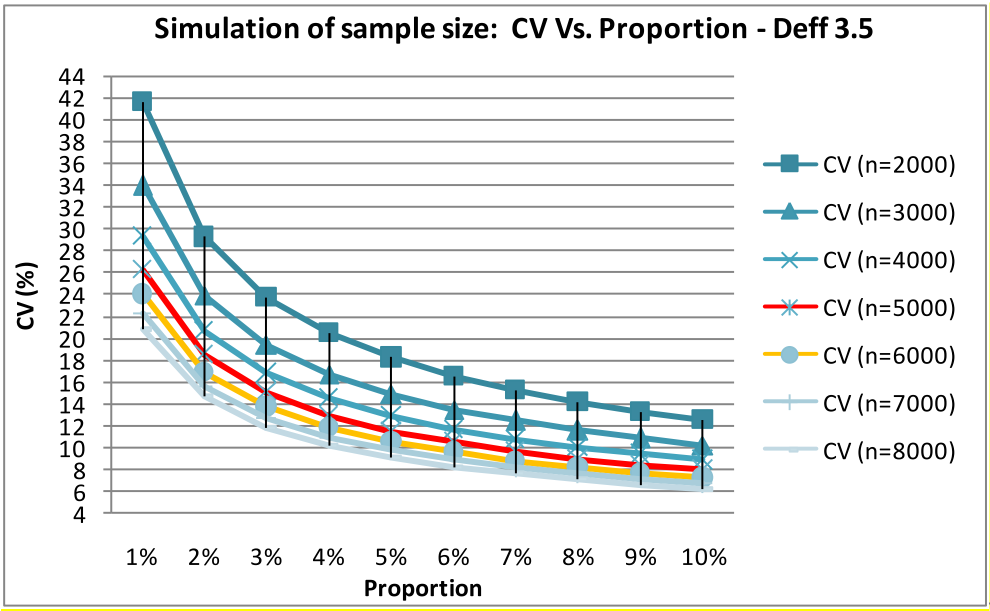

| Proportion | CV (n=2000) | CV (n=3000) | CV (n=4000) | CV (n=5000) | CV (n=6000) | CV (n=7000) | CV (n=8000) |
|---|---|---|---|---|---|---|---|
| 1% | 35.2 | 28.7 | 24.9 | 22.2 | 20.3 | 18.8 | 17.6 |
| 2% | 24.7 | 20.2 | 17.5 | 15.6 | 14.3 | 13.2 | 12.4 |
| 3% | 20.1 | 16.4 | 14.2 | 12.7 | 11.6 | 10.7 | 10.0 |
| 4% | 17.3 | 14.1 | 12.2 | 10.9 | 10.0 | 9.2 | 8.6 |
| 5% | 15.4 | 12.6 | 10.9 | 9.7 | 8.9 | 8.2 | 7.7 |
| 6% | 14.0 | 11.4 | 9.9 | 8.8 | 8.1 | 7.5 | 7.0 |
| 7% | 12.9 | 10.5 | 9.1 | 8.1 | 7.4 | 6.9 | 6.4 |
| 8% | 12.0 | 9.8 | 8.5 | 7.6 | 6.9 | 6.4 | 6.0 |
| 9% | 11.2 | 9.2 | 7.9 | 7.1 | 6.5 | 6.0 | 5.6 |
| 10% | 10.6 | 8.7 | 7.5 | 6.7 | 6.1 | 5.7 | 5.3 |

**Figure 5. Simulation of sample size with Deff 3.0**




| Proportion | CV (n=2000) | CV (n=3000) | CV (n=4000) | CV (n=5000) | CV (n=6000) | CV (n=7000) | CV (n=8000) |
|---|---|---|---|---|---|---|---|
| 1% | 38.5 | 31.4 | 27.2 | 24.4 | 22.2 | 20.6 | 19.2 |
| 2% | 27.1 | 22.1 | 19.2 | 17.1 | 15.6 | 14.5 | 13.5 |
| 3% | 22.0 | 18.0 | 15.6 | 13.9 | 12.7 | 11.8 | 11.0 |
| 4% | 19.0 | 15.5 | 13.4 | 12.0 | 10.9 | 10.1 | 9.5 |
| 5% | 16.9 | 13.8 | 11.9 | 10.7 | 9.7 | 9.0 | 8.4 |
| 6% | 15.3 | 12.5 | 10.8 | 9.7 | 8.8 | 8.2 | 7.7 |
| 7% | 14.1 | 11.5 | 10.0 | 8.9 | 8.1 | 7.5 | 7.0 |
| 8% | 13.1 | 10.7 | 9.3 | 8.3 | 7.6 | 7.0 | 6.6 |
| 9% | 12.3 | 10.1 | 8.7 | 7.8 | 7.1 | 6.6 | 6.1 |
| 10% | 11.6 | 9.5 | 8.2 | 7.3 | 6.7 | 6.2 | 5.8 |

**~~Figure 6. Simulation of sample size with Deff 3.5~~**




| ~~Proportion~~ | ~~CV (n=2000)~~ | ~~CV (n=3000)~~ | ~~CV (n=4000)~~ | ~~CV (n=5000)~~ | ~~CV (n=6000)~~ | ~~CV (n=7000)~~ | ~~CV (n=8000)~~ |
|---|---|---|---|---|---|---|---|
| ~~1%~~ | ~~41.6~~ | ~~34.0~~ | ~~29.4~~ | ~~26.3~~ | ~~24.0~~ | ~~22.2~~ | ~~20.8~~ |
| ~~2%~~ | ~~29.3~~ | ~~23.9~~ | ~~20.7~~ | ~~18.5~~ | ~~16.9~~ | ~~15.6~~ | ~~14.6~~ |
| ~~3%~~ | ~~23.8~~ | ~~19.4~~ | ~~16.8~~ | ~~15.0~~ | ~~13.7~~ | ~~12.7~~ | ~~11.9~~ |
| ~~4%~~ | ~~20.5~~ | ~~16.7~~ | ~~14.5~~ | ~~13.0~~ | ~~11.8~~ | ~~10.9~~ | ~~10.2~~ |
| ~~5%~~ | ~~18.2~~ | ~~14.9~~ | ~~12.9~~ | ~~11.5~~ | ~~10.5~~ | ~~9.7~~ | ~~9.1~~ |
| ~~6%~~ | ~~16.6~~ | ~~13.5~~ | ~~11.7~~ | ~~10.5~~ | ~~9.6~~ | ~~8.8~~ | ~~8.3~~ |
| ~~7%~~ | ~~15.2~~ | ~~12.4~~ | ~~10.8~~ | ~~9.6~~ | ~~8.8~~ | ~~8.1~~ | ~~7.6~~ |
| ~~8%~~ | ~~14.2~~ | ~~11.6~~ | ~~10.0~~ | ~~9.0~~ | ~~8.2~~ | ~~7.6~~ | ~~7.1~~ |
| ~~9%~~ | ~~13.3~~ | ~~10.9~~ | ~~9.4~~ | ~~8.4~~ | ~~7.7~~ | ~~7.1~~ | ~~6.6~~ |
| ~~10%~~ | ~~12.5~~ | ~~10.2~~ | ~~8.9~~ | ~~7.9~~ | ~~7.2~~ | ~~6.7~~ | ~~6.3~~ |

## 10. ~~Size and result~~ Use of a pilot ~~test~~survey

31. ~~The data~~ Data obtained ~~for~~ from a similar transport system ~~will~~ may be used as a reference and pilot result. In case the MRTS 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 MRTS is not operating, results from comparable surveys from comparable MRTS from other cities ~~can~~ may be used as a reference.

## 11. ~~Selection method of~~ Selecting the sample

32. ~~Stations~~The method to select stations, hours and passengers ~~shall be selected~~ for applying the ~~sample~~survey ~~. 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.

### 11.1. Selection of stations and evaluation hours.

33. Given that there is a complete list of stations that are part of each established group (stratum), the selection of stations within the main strata is carried out conducted according to a Simple Random Sampling design., through the negative coordinated algorithm.

34. The same happens for the defined hour ranges: within each range a specific hour is selected under this method for the sample selection.Similarly, a specific hour interval is selected from within each sub-stratum, that is, the range of hours (e.g. morning peak, evening peak, off peak) by simple random sampling.

35. Algorithm of the negative coordinated method

36. N: Universe size.

37. n: Sample size to be selected.

38. A value 0<$\pi$<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:

(a) If $\xi_k < \pi$ then $k$ belongs to the sample;

(b) If $\xi_k \geq \pi$ then $k$ does not belong to the sample

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

40. Since the expectation of the sample size is equal to /in the SRS design, it complies with / therefore the departure point is from an expected sample size equal to /, further it is said that / and from that value, the selection is carried out.

### 11.2. Selection of passengers

41. Given that there is no reference frame or list frame for the identification of MRTS users, the selection of the sample in the last stage will be performed according to the a systematic sampling design within each selected hour, replicated identically for each stratum and considering the following steps:

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

(b) Systematic selection of passengers: every $n^{th}$ 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.

# 12. Methodology for information collection and estimation of the parameter

## 12.1. General considerations on information collection

42. The information will be obtained through the face-to-face application of the established questionnaire provided in Appendix 5.

43. According to the selected days stations and hour range intervals, each survey interviewer will 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.

44. 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, owning a vehicle, among others, are represented within the selected sample.

45. It is recommended that additional to the surveyors other personnel systematically and in parallel to the information collection asks about and registers the system users on their 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.

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

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

48. 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.

## 12.2. Method of estimation and expansion factors

49. In accordance with the sample strategy and with the sample design specified in Section 5 there exist two stages in the method of estimation and selection of sampling observation units: (a) Selection of stations (SRS design); (b)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 will be calculated in an equivalent basis in each stratum:

(a) First stage:

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

(i) $\pi_{Ii}$: Probability of inclusion in the sample in the first stage (1);

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

(iii) $N_{Ihsp}$: Total number of *stations sp* in the stratum *h;*

(iv) *sp:* stations of the system.

(b) Second stage:

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

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

(ii) $n_{ihsp}$: Number of passengers selected in the station *sp*, in stratum *h*;

(iii) $N_{ihsp}$: Total number of passengers in the station *sp*, in stratum *h.*

50. The general formula to calculate the expansion factor is:

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

51. Thus the expansion factors are:

(a) First stage:

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

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

(b) 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.

(c) Estimator of the total for the variable of interest:[3]

[3] The variables of interest used to calculate totals correspond to the trip distances per mode of passengers of the MRTS (the parameter is not distance alone it is trip distance per mode) both in the baseline situation (for BE) and in the project situation (for IPE).

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

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

Where:

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

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

(d) Estimator of the variance:

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

Where:

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

52. The parameter (R) is not used to calculate directly BE or IPE or the distance per mode of transport which is the main parameter and the one required for calculating BE and IPE. 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 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 not used directly to determine BE or IPE 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.

(a) Estimator for the variable of interest:

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

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

a. $R$ 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);

b. The parameter (R) is not used to calculate directly BE or IPE or the distance per mode of transport which is the main parameter and the

~~one required for calculating BE and IPE. 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 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.~~

~~(b) Variance estimator:~~

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

~~(i) Where:~~

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

~~a. Thus it is established that:~~

$$S^2_{\hat{t}us_I} = \frac{1}{n_{Ihsp} - 1} \sum_{s_I} \left[ \hat{t}_{ui} - \left( \sum_{s_I} \hat{t}_{ui} / n_{Ihsp} \right) \right]^2$$

~~and~~

$$S^2_{u_k} = \frac{1}{n_{ihsp} - 1} \sum_{s_i} \left( u_{ksp} - \bar{u}_{ksp} \right)^2$$

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

~~53. Based on the formerly described formulas and based upon if it is a total or a proportion the parameter / and associated the variance/ is determined.~~

~~54. To calculate the confidence interval a normal distribution is assumed (large sample size) using the formula for a 95 per cent confidence interval:~~

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

~~(a) $\hat{t}_\pi$ represents BE and IPE, both calculated separately. For BE the lower confidence interval is taken and for IPE the upper one;~~

(b) The DOE shall verify the validity of the statistical procedures used and the assumptions made to determine the total baseline and indirect project emissions including the determination of their respective 95 per ent confidence intervals;

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

(i) Number of stations;

(ii) Passenger flow per station per hour, day and week;

(iii) Selection rate of passengers surveyed per hour per station (i.e. each n passenger was selected for an interview).

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

## 13. Data verification and validation including QA and QC

### 13.1. Criteria for evaluating data consistency

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

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

(b) 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;

(c) 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;

(d) 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;

(e) 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:

(i) ~~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;~~

(ii) ~~The Cronbach alpha coefficient will 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 hetereogenity and inconsistency in information;~~

(f) ~~With the goal of evaluating the possible correlation between BE and IPE a hypothesis test based on the Pearson or Spearman coefficient is to be made. The parameter to determine the existence of correlation is the p value. If the p value is less than 0.05 8 (significance value) it is concluded that the correlation is significant;~~

(i) ~~If a correlation between BE and IPE exists the variance associated to the estimator (defined as the difference between the two parameters) would have a covariance different from 0. If the variables x and y are correlated then:~~

~~Var(X-Y) = Var(X) + Var(Y) – 2 Cov (X,Y), where COV (X,Y) is not 0.~~

(ii) ~~If the correlation is significant complex estimators and alternative methods of variance need to be used which do not guarantee however that the estimators are unbiased and have a minimal variance. On the other hand if the correlation is non-significant the estimation of the two parameters BE and IPE separately leads to the same result as calculating them jointly;~~

(iii) ~~Realizing the estimation of BE and IPE guarantees that even in the case of correlation there is no problem with the bias in the variance of the estimators i.e. even in case of correlation the results are correct and no additional step needs to be taken. In the case of no correlation the difference between BE and IPE per passenger could also be determined directly reaching the same result (in the case of correlation it is necessary in all cases to make the estimation of BE and IPE separately);~~

(iv) ~~Therefore it is preferable, as suggested in these procedures, to calculate the two parameters separately and to determine for each one an unbiased level of error. Additionally for each parameter separate confidence levels can thus be constructed. If the two confidence intervals overlap there would be an indication of non-significant differences between BE and IPE.~~

## 14. Survey realization

57. The survey shall be realized through a company with minimum 3 years of experience in comparable surveys in the respective country to ensure a professional survey execution. The following principles are to be followed in the survey realization:

(a) Non-responses should be recorded;

(b) Record and store all original surveys;

(c) 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 latter will not want to invest time in a survey thus potentially giving wrong answers.

### 14.1. Preparation phase

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

(a) Drafting of the 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;

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

(i) 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;

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

### 14.2. Validation process of the information

59. 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.

## 15. Calculation of trip distance in the survey

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

(a) For NMT, others and induced traffic this is not required as the applied EF is “0”;

(b) For users of buses either:

(i) 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

(ii) 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;

(c) 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;

(d) For non-project rail systems based on official or GPS distances between the entry and exit station of the rail-systems.

61. A default questionnaire to be used is included in Appendix 5 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 shall 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.

62. 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.

## 16. Default questionnaire

# Appendix 5. Default Questionnaire

1. The questionnaire has to be adapted to local circumstances using local wording and language. The default questionnaire is basically the framework to follow.

**SECTION A: Data concerning surveyor**

Survey ID (correlative number): …………………………….

Interviewer: ……………………………

Date:.………………………………….

Time: …………………………………….

Place (station) where interview was performed:………………………….

Survey response/completeness:

☐ Survey was fully completed

☐ Survey was fully or partially not responded

Comments/Observations of surveyor:………………………….

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**SECTION B: General Data of Interviewed Person**

*This section can also be filled out at the end of the interview!*

Age of surveyed person:

☐ 12-17 years ☐ 18-25 years ☐ 26-35 years ☐ 36-45 years ☐ 46-55 years ☐ 56-65 years ☐ over 65 years

Gender of the surveyed person

☐ female ☐ male

Socio-economic level of the surveyed person

☐ < 1 minimum wage ☐ 1-2 minimum wages ☐ 2-4 minimum wages ☐ 4-6 minimum wages ☐ > 6 minimum wages

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**SECTION C: Trip Data of Interviewed Person**

**Question 1**

"Describe the trip you are currently realizing"

Your trip origin (starting trip point, e.g. my home):………………………………

**1.1.** Your entry (boarding) station MRTS lane (name or code of MRTS station):……………………

**1.2.** Your exit (deboarding) station MRTS lane (name or code of MRTS station):……………………

**1.3.** Your final trip destination (final trip point, e.g. office):…………………………………….

*Explanations for the interviewer:*

- *The question refers to the current trip the passenger is making;*
- *The trip origin and the trip destination shall be identified with a clear address. Use a map if it is unclear. If the person does not know or does not want to disclose this information then stop at this point. The questionnaire is deemed thereafter as non valid;*
- *The MRTS stations identified in 1.2 and 1.3 shall be listed with their official names or codes;*
- *Only urban trips are considered. If the passenger has as trip origin or trip destination a point outside the boundaries of larger urban zone of the city then discontinue the interview. The questionnaire is deemed thereafter as non-valid.*

**Question 2**

"What mode of transport did you use from your trip start to the MRTS? Please refer to the mode on which you performed the longest stretch if you used various modes"

☐ Bus (conventional not bus lane) ☐ Existing bus lane/BRT (NOT the project) ☐ Rail (NOT the project) ☐ Taxi ☐ Passenger car ☐ Motorcycle ☐ Motorized taxi tri-cycle ☐ Bike or per foot ☐ Other

*Explanations for the interviewer:*

- *See graph 1 for explanation;*
- *Rail refers to non-project metro, urban rail, tram etc.;*
- *Only tick 1 answer (the mode used for the longest stretch of this trip segment).*

**Question 3**

"What mode of transport will you use from the point where you leave the MRTS lane until your final destination? Please refer to the mode on which you will perform the longest stretch if you intend to use various modes"

☐ Bus (conventional not bus lane) ☐ Existing bus lane/BRT (NOT the project) ☐ Rail (NOT the project) ☐ Taxi ☐ Passenger car ☐ Motorcycle ☐ Motorized taxi tri-cycle ☐ Bike or per foot ☐ Other

*Explanations for the interviewer:*

- *See graph for explanation;*

- *Rail refers to non-project metro, urban rail, tram etc.;*
- *Only tick 1 answer (the mode used for the longest stretch of this trip segment).*

**Question 4**

"Assuming that the MRTS you are currently using would not exist: Would you have made the trip you are currently doing anyway or would you have stayed at home/office/origin?"

☐ I would have made the trip" ➔ *Continue with question 5*

☐ I would have stayed at home/office/origin ➔*The questionnaire is terminated*

*For the interviewer:*

*The purpose of this question is to know if the passenger made this trip only because the MRTS exists. In absence of the MRTS he would not have made any trip and would have stayed at his point of origin.*

**Question 5**

"Have you moved your home or workplace since the start of operations of the MRTS?"

☐ No ➔*continue with question 6*

☐ Yes: "Has the availability of the new MRTS been an important factor when choosing the location of your new home or new workplace?"

☐ No ➔ *continue with question 6*

☐ Yes ➔ "What was your original/former trip origin and trip destination?" (at the time before you moved your home or workplace)

Origin point:………………………….

Destination point: ……………………….

*Continue with question 6 (based on the origin and destination as identified)*

**Question 6**

"Assuming that the MRTS you are currently using would not exist: How would you have made the same trip you are doing now?"

From Home/Office/Others[1] (……… ….) to point…………… by *……………….

From point………………to point ………………by *……………….

From point………………to point ………………by *……………….

From point…………….to home/office/others[2] (…………….) by *……………….

*can be

[1] Origin of trip.

[2] Final destination.

☐ Bus (conventional not bus lane)

☐ Existing bus lane/BRT (NOT the project)

☐ Rail (NOT the project)

☐ Taxi ➔ *continue with question 6A*

☐ Passenger car ➔ *continue with question 6B*

☐ Motorcycle ➔ *continue with question 6C*

☐ Motorized taxi tri-cycle ➔ *continue with question 6D*

☐ Bike or per foot

☐ Other

*Explanations for the interviewer:*

- *Rail refers to non-project metro, urban rail, tram etc.;*
- *For each segment of the trip make a separate answer.*

**Question 6A**

**“**Have you used a taxi in the last 6 months?”

☐ Yes ☐ No

**Question 6B**

**“**Do you or your family own a car or do you have access to a car (e.g. car-sharing) or have you used a passenger car in the last 6 months?”

☐ Yes ☐ No

**Question 6C**

**“**Do you or your family own a motorcycle or do you have access to a motorcycle or have you used a motorcycle in the last 6 months?”

☐ Yes ☐ No

**Question 6D**

**“**Have you used a motorized taxi tri-cycle in the last 6 months?”

☐ Yes ☐ No

If interviewed persons respond in the questions 6A to 6D with NO they are not included in the final calculation i.e. this specific survey is not included as the response is deemed as non-consistent with the one given in question 6.

The project proponent shall include the questionnaire as annex to the CDM-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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## Document information

| Version | Date | Description |
|---|---|---|
| 05.0 | 27 May 2021 | EB 110, Annex 2<br>Revision to:<br>• Align the requirements of sampling and survey of passengers with the “Standard: Sampling and surveys for CDM project activities and programmes of activities” and the “Guideline: Sampling and surveys for CDM project activities and programmes of activities”;<br>• Expand the baseline scenario by adding an option for possible expansion of the existing transport system using additional vehicles;<br>• Remove the expansion factor to calculate baseline and project emissions, improving the methodology’s consistency with AM0031. |
| 04.0 | 24 July 2015 | EB 85, Annex 10.<br>Revision to:<br>• Introduce a reference to the tool “Baseline emissions for modal shift measures in urban passenger transport”;<br>• Improve the approaches for additionality demonstration;<br>• Improve guidance on the renewal of the crediting period;<br>• Improve the language, readability, clarity and consistency. |
| 03.0 | 25 November 2011 | EB 65, Annex 18.<br>Revision to:<br>• Introduce a new approach to additionality demonstration;<br>• Reduce monitoring requirements set in the MRTS passenger survey from annual monitoring to monitoring in the years 1 and 4 of the crediting period;<br>• Remove an applicability condition requiring demonstration that the project system partially replaces a traditional public transport system in the city hosting the proposed project activity;<br>• Remove an applicability condition restricting the use of the methodology in case more gaseous fossil fuels are used in the project activity compared to the baseline scenario;<br>• Reduce monitoring requirements (from annual monitoring to monitoring in the years 1 and 4 of the crediting period) for leakage emissions from reduced congestion as a result of the project activity in case road capacity is reduced as a result of the project activity and requires no monitoring in case road capacity is not reduced as a result of the project activity. Provides additional guidance on assessing changes in road capacity due to the project activity; |

| *Version* | *Date* | *Description* |
|---|---|---|
| | | • Remove the requirement to conduct a sensitivity analysis of data and parameters used to determine baseline, project and leakage emissions;<br>• Introduce a reference to the “Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion” to determine direct project emissions;<br>• Introduce the requirement to account for leakage due to upstream emissions in case project vehicles consume more gaseous fuels than baseline vehicles;<br>• Improve language, readability and consistency;<br>• Title modified from “Baseline and Monitoring Methodology for Mass Rapid Transit Projects” to “Mass Rapid Transit Projects”. |
| 02.0 | 30 July 2010 | EB 55, Annex 14.<br>Revision to:<br>• Introduce the definition of larger urban zone (LUZ) of a city;<br>• Accommodate situations, for the common practice analysis, where the city has less than 1 million inhabitants in its LUZ. |
| 01.0 | 16 October 2009 | EB 50, Annex 2.<br>Initial adoption. |

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