1.Typical Project Outline

The project intends to reduce GHG emissions by realizing “modal shift” from existing transport systems (i.e., buses, private cars, taxies and bikes) to Bus Rapid Transit (BRT) or trunk bus systems.

2.Applicability

〇After the projects completes, the BRT or trunk bus system will have its own bus lanes, separating it from other transport systems, and will provide rapid transportation for a large number of passengers.

〇The current baseline transport system should be road based (i.e., buses, private cars, taxies and bikes). Hence, the current transport system does not involve railways, ships, or civil aviation.

〇The motive power of buses should be through an internal combustion (engine), meaning not electricity.

3. Methodology on Emission Reduction

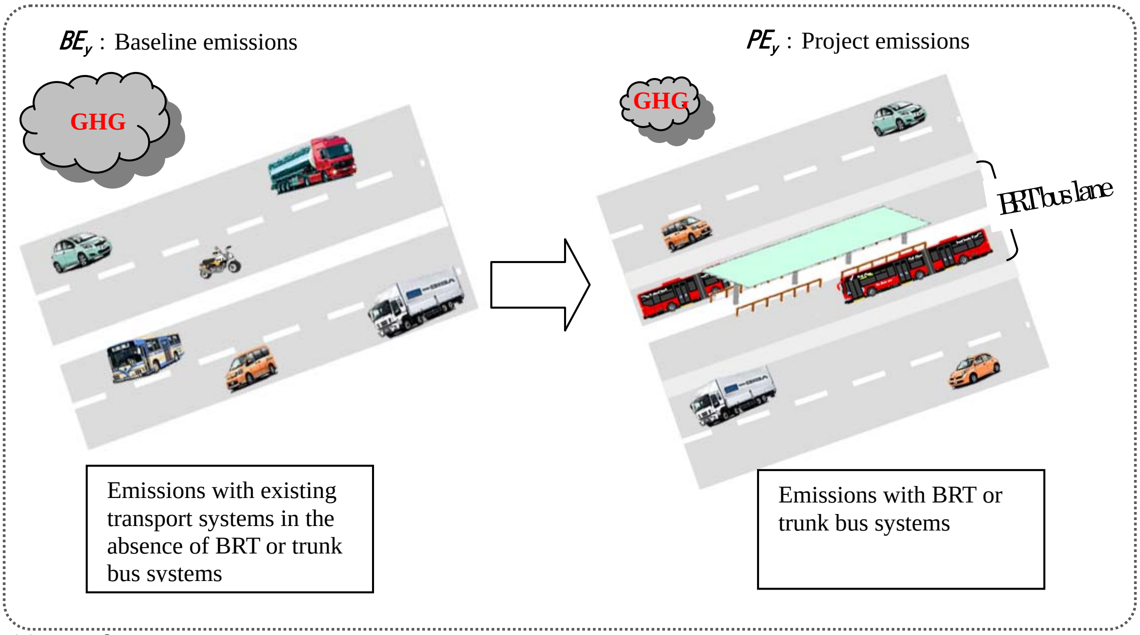
GHG emissions reduction due to BRT or trunk bus systems is calculated as the difference between the GHG emissions with the existing transport systems (baseline) and those after the success of the modal shift to BRT or trunk bus systems (project emission).

$$ER_y = BE_y - PE_y \quad (\text{t-}CO_2/\text{y})$$

ER_y : GHG emissions reduction due to project activity in year y (t-CO_2/y)

BE_y : GHG emissions with existing transport systems in year y (t-CO_2/y) (Baseline emissions)

PE_y : GHG emissions after the success of modal shift to BRT or trunk bus systems from the existing transport systems in year y (t-CO_2/y) (Project emissions)



(1) Baseline emissions estimation

In case the existing transport systems would share a similar number of passengers transported by the projected BRT, baseline emissions for various types of vehicles are estimated by multiplying their shared number of passengers with their CO_2 emission factors per passenger before the project starts.

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

Type	Items	Description
Output	BE_y	Baseline emissions： GHG emissions in the absence of BRT (gr-CO_2/y)
Input	$EF_{P,i,y}$	CO_2 emission factor per passenger for vehicle category i (gr-CO_2/passenger)
	$P_{PJ,i,y}$	Annual number of passengers transported by vehicle category i after the project completes

3. Methodology on Emission Reductions (Continuation)	

Determination of $EF_{P,i,y}$

The CO_2 emission factor per passenger for each vehicle category is estimated by the following formula, involving variables such as CO_2 emission factor per kilometer, average trip distance, and average occupation rate of vehicle before the project starts:

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

$EF_{KM,i}$: CO_2 emission factor per km for vehicle category i before the project starts（gr-CO_2/km）
TD_i : Average daily trip distance driven by vehicle category i (km/vehicle)
OC_i : Average daily occupancy rate for vehicle category i (person/vehicle)

$EF_{KM,i}$ is calculated using the following formula:

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

$SEC_{x,i}$: Specific fuel consumption per vehicle category i (km/L)
$EF_{CO2,x}$: CO_2 emission factor of fuel category x (gr-CO_2/L)
$N_{x,i}$: Number of vehicle category i using fuel category x (vehicle)
N_i : Number of vehicle category i (vehicle)
$\alpha_{x,i}$: Mixing rate of biofuel (i.e., = 0.1 for biodiesel 10% mixing fuel)

(2) Project emissions estimation

Project emissions are calculated by multiplying the total annual fuel consumption of BRT or trunk buses after the project starts (planned value), with the CO_2 emission factor of fuel.

$$PE_y = TC_y \times EF_{CO_2,x}$$

Type	Item	Description
Output	PE_y	Project emissions： GHG emissions of BRT or trunk buses after the project has completed (t-CO_2/y)
Input	TC_y	Total annual fuel consumption of BRT or trunk buses after the project has completed (L/y)
	$EF_{CO2,x}$	CO_2 emission factor of fuel category x (gr-CO_2/L)

Determination of TC_y

The total annual fuel consumption of BRT buses is estimated considering their specific fuel consumption multiplied by their total annual trip distance. By involving a mixing rate of biofuel in fuel consumption, the formula is as follows:

$$TC_y = \frac{(1-\alpha_{x,bs})DD_y}{SEC_{x,bs,y}}$$

$SEC_{x,bs,y}$: Specific fuel consumtion (km/L)
DD_y : Total annual trip distance driven by BRT buses (vehicle km/y)
$\alpha_{x,bs}$: Mixing ratio of biofuel

4. Data Required for Estimation and Monitoring

Data Type		Description of Data	Data Acquisition Methods			
			Baseline Emissions		Project Emissions	
			Before the project starts	After project completion	Before the project starts	After project completion
Passengers of existing transport systems (After : $P_{PJ,i,y}$)		Passengers of existing transport systems that would be shared in the absence of the BRT project. The total number of passengers of existing transport systems is equal to the passengers of BRT buses	Planned values	Measured values	(Not necessary because data are not involved in the calculation)	
Total annual trip distance driven by BRT buses (After: DD_y)		Total annual trip distance driven by BRT buses	(Not necessary because data are not involved in the calculation)		Planned values	Measured values
Specific fuel consumption rate of BRT buses ($SEC_{x,bs,s}$)		Specific fuel consumption of BRT buses	(Not necessary because data are not involved in calculation)		Planned values	Measured values
CO_2 emissions factor	Total number of existing vehicles in fuel type x, and vehicle category i, ($N_{x,i}$)	Total number of vehicles in a vehicle category and a fuel type	Measured values	Measured values	(Not necessary because data are not involved in the calculation)	
	Total number of existing vehicles in vehicle category i, ($N_{x,i}$)	Total number of vehicles in a vehicle category	Measured values	Measured values	(Not necessary because data are not involved in the calculation)	
	Average trip distance driven by existing vehicles in vehicle category i,(OD_i)	Trip distance for each vehicle category before the project starts	Measured values	Measured values	(Not necessary because data are not involved in the calculation)	
	Average occupation rate of existing vehicles in vehicle category i, (OC_i)	Occupation rate of each vehicle category before the project starts	Measured values	Measured values	(Not necessary because data are not involved in the calculation)	

<table>
<tr><th colspan="2" rowspan="3">Data Type</th><th rowspan="3">Description of Data</th><th colspan="4">Data Acquisition Methods</th></tr>
<tr><th colspan="2">Baseline Emissions</th><th colspan="2">Project Emissions</th></tr>
<tr><th>Before the project starts</th><th>After project completion</th><th>Before the project starts</th><th>After project completion</th></tr>
<tr><td rowspan="3">CO_2 emissions factor</td><td>Specific fuel consumption of existing vehicles in fuel type x, vehicle category i, ($SEC_{x,i}$)</td><td>Fuel consumption rate per liter (km/L)</td><td colspan="2">It is best desirable to use national or regional data and information of the project, so the availability of relevant data and information should be justified and used in the following order (see the tables hereinafter):
i) Specific data in the project obtained through interviews with transport management authorities
ii) Published values in the country where the project exists
iii) Values based on IPCC database</td><td colspan="2">(Not necessary because data are not involved in the calculation)</td></tr>
<tr><td>CO_2 emission factor of fuel（$EFCO_{2,x}$）</td><td>CO_2 emission factor of fuel per liter, such as gasoline, diesel</td><td colspan="4">It is desirable to use national or regional data and information of the project, so the availability of relevant data and information should be justified and used in the following order (see the tables hereinafter):
i) Specific data in the project obtained through interviews, etc. with the transport management authorities
ii) Published values in the country where the project exists
iii) Values based on IPCC database</td></tr>
<tr><td>Mixing ratio of biofuel</td><td>Mixing ratio of biofuel in gasoline, diesel</td><td colspan="4">It is desirable to use national or regional data and information of the project, so the availability of relevant data and information should be justified and used in the following order (see the tables hereinafter):
i) Specific data in the project obtained through interviews, etc. for the transport management authorities
ii) Published values in the country where the project exists</td></tr>
</table>

5. Others	(1) Project boundary The project delineation for GHG estimations is defined by the outreach of the BRT or trunk bus project. (2) Leakage Considering the life cycle assessment (LCA) related to the freight train project, the production and freight of raw materials needed for BRT or trunk buses, and the energy consumed during construction and manufacturing of raw materials are expected as leakages of GHG emissions. However, these are significantly small as compared with the GHG emissions reduction caused by the project. Hence, these are not counted as leakages in this estimation methodology. Looking at five CDM registered projects, only the Bagota Bus Rapid Transit (BRT) Project took account of leakage, while the other projects counted leakage as zero. For reference, the estimated leakages of the Bogota BRT Project are shown in the appended Table B-3 attached herewith. The total volume of leakages is 0.8% as compared with that of the GHG emissions reduction due to the BRT project. (3) Relevant methodologies and their differences with this estimation methodology AM0031：Methodology for Bus Rapid Transit Projects 【Differences】 ・ CH_4 and N_2O can be counted as GHG emission other then CO_2, while CO_2 emission is only counted in this estimation methodology. ・ The effects of GHG emission reduction by technology improvements can be counted; however, these are not counted in this estimation methodology. ・ GHG emissions including construction for BRT bus lanes and related facilities such bus stations with platforms, production of new BRT buses, scrap of conventional buses, and GHG emission reductions by decreasing fuel finery volume, are considered as leakages; however, these leakages are not considered in this estimation methodology. ・ Reduction of traffic congestions after the project has started may cause GHG emission reductions from speeding up vehicle operation due to reduced traffic congestion. On the other hand, it may induce an increase in GHG emissions because of the increasing traffic caused by transport systems other than BRT buses. These are involved in AM0016 but not considered in this estimation methodology. ・ The changes in load factors of conventional buses and taxies after the BRT project starts is involved in its GHG emissions estimation; however, these factors are not considered in this estimation methodology. ・ Biofuels cannot be considered in GHG emissions estimation; thus these factors are not suitable in this estimation methodology. ACM0016：Baseline Methodology for Mass Rapid Transit Projects 【Differences】 ・ All mass rapid transit (MRT) systems including not only rail-based systems such as subways and light rail transit (LRT) but also bus systems such as BRT; however, only BRT or trunk bus systems are considered in this estimation methodology. ・ CH_4 and N_2O can be counted as GHG emissions other than CO_2; however, only CO_2 emission is counted in this estimation methodology. ・ The effects of GHG emission reduction by the improvement of technology can be counted; however, these are not counted in this estimation methodology. ・ The effects of GHG emission reduction due to the improvement of technology can be counted; however, these are not counted in this estimation methodology. In particular, a technology improvement factor is assumed 0.99/year (or 1%/year) and the GHG emissions are expected to reduce by 1% per year with the technology improvement. In 10th year, 0.99 to the 9th power equals 0.91, and so the baseline emissions from the existing transport systems becomes 0.91 times due to their technological improvement. Simply assuming annual GHG emissions is constant over 10 years, the difference between with and without the technology improvement factors is around 4%. Thus, the baseline GHG emissions over 10 years would reduce by 4% due to technology improvement, and so the effects of GHG emission reduction lessen by 4%, meaning it is on the safety side. In developing countries,

however, it is reasonable to consider that old vehicles will be continuously used rather than acquiring brand-new vehicles. Because of this, the technological improvement factors are not considered in this estimation methodology.

・ Once the freight railway system has been newly introduced, freight must utilize the freight stations that were not available before the project has started in order to reach their destinations. This results in producing additional GHG emissions. These indirect GHG emissions can be counted; however, these are not considered in this estimation methodology.

・ The reduction of traffic congestions after the project has started may reduce GHG emissions since vehicle operation will speed due to reduced traffic congestion. On the other hand, it may induce an increase in GHG emissions because of the increasing traffic caused by transport systems other than BRT or trunk buses. These are involved in AM0016 but not considered in this estimation methodology.

・ CO_2 emission factors for passenger cars and taxies are a function of speed; however, these are not considered as a function of speed (constant for average speed) in this estimation methodology.

・ The changes in load factors of conventional buses and taxies after the MRT project has started are involved in its GHG emissions estimation; however, these factors are not considered in this estimation methodology.

AMS-III-U：Cable Cars for Mass Rapid Transit Projects

【 Differences】

・ Cable car projects can be the target for GHG emissions estimation; however, the freight railway project is the target in this estimation methodology.

・ CH_4 and N_20 can be counted as GHG emissions other then CO_2; however, only CO_2 emissions are counted in this estimation methodology.

・ The effects of GHG emissions reduction due to technology improvements can be counted; however, these are not counted in this estimation methodology.

・ Once the cable car system has been introduced, passengers must utilize the cable car stations, which were not available before the project started in order to reach their destinations. This results in additional GHG emissions. These indirect GHG emissions can be counted; however, these are not considered in this estimation methodology.

・ Cable cars are powered by electricity; however, internal combustion is considered in this estimation methodology.