

### 3. Transport / Railway (Passenger) / Modal Shift

#### 1. Typical Project

- Passenger modal shift from existing transportation modes (e.g. buses, private car, taxi, motorbike) to MRT (Mass Rapid Transit), railway, monorail, LRT (Light Rail Transit), BRT (Bus Rapid Transit) and trunk bus.

#### 2. Applicability

- (1) Development of transport system(s) that can realize an efficient inner-city passenger transport such as MRT (Mass Rapid Transit), railway, monorail, LRT (Light Rail Transit), BRT (Bus Rapid Transit) and trunk bus.
- (2) The baseline transport modes should be buses, private cars, taxis and existing railways etc.

#### 3. Methodology of Emission Reduction Calculation

The emission reduction from the project activity is determined as the differences between the GHG emission of baseline scenario (existing mode of transportation, e.g. buses, private car, taxi, motorbike) and project scenario (e.g. MRT etc.).

$$ER_y = BE_y - PE_y$$

$ER_y$  : GHG emission reduction through the project in year y (t-CO<sub>2</sub>e/y)

$BE_y$  : GHG emission from the baseline scenario in year y (t-CO<sub>2</sub>e/y)

$PE_y$  : GHG emission from the project scenario in year y (t-CO<sub>2</sub>e/y)

##### (1) Calculation of Baseline Emission

Baseline GHG emission is calculated based on the transportation activity (in passenger-km or multiplying number of passenger and average trip distance) completed by the project, share of passengers by baseline transport modes and CO<sub>2</sub> emission factor per passenger-km.

$$BE_y = \sum_i (BPKM_y \times MS_{i,y} \times EF_{PKM,i})$$

$$= \sum_i (P_y \times BTDP_y \times MS_{i,y} \times EF_{PKM,i})$$

$BPKM_y$  : Passenger transportation volume/activity by the project in year y (passenger-km/y)

$P_y$  : Number of passengers transported by the project in year y (passenger/y)

$BTDP_y$  : Average trip distance of the passenger of the project activity in year y (km)

$MS_{i,y}$  : Share of passengers by transport mode i in the baseline scenario in year y (%)

$EF_{PKM,i}$  : CO<sub>2</sub> emission factor per passenger kilometer for transport mode i (t-CO<sub>2</sub>/passenger-km)

##### Calculation of $EF_{PKM,i}$

CO<sub>2</sub> emission factor per passenger kilometer for transport mode i can be calculated by the following formula:

$$EF_{PKM,i} = \frac{EF_{KM,i}}{OR_i}$$

$EF_{KM,i}$  : CO<sub>2</sub> emission factor of transport mode i (t-CO<sub>2</sub>/km)

### 3. Transport / Railway (Passenger) / Modal Shift

$OR_i$  : Average occupation rate of transport mode i (passenger/vehicle)

#### (2) Calculation of Project Emission

##### 1) In the case of the project activity using electricity

It is estimated by multiplying annual electricity consumption of the project activity and CO<sub>2</sub> emission factor of the grid electricity.

$$PE_y = EC_{PJ,y} \times EF_{elec}$$

$EC_{PJ,y}$  : Electricity consumption associated with the operation of the project activity in year y (MWh/y)

$EF_{elec}$  : CO<sub>2</sub> emission factor of the grid electricity (t-CO<sub>2</sub>/MWh)

##### 2) In the case of the project activity using fossil fuels

It is estimated by multiplying annual fossil fuel consumption of the project activity and CO<sub>2</sub> emission factor of the fossil fuel.

$$PE_y = \sum_i (FC_{PJ,i,y} \times NCV_i \times EF_{fuel,i})$$

$FC_{PJ,i,y}$  : Consumption of fuel i associated with the operation of the project activity in year y (t/y)

$NCV_i$  : Net calorific value of fuel i (TJ/t)

$EF_{fuel,i}$  : CO<sub>2</sub> emission factor of fuel i (t-CO<sub>2</sub>/TJ)

#### 4. Data and Parameters Estimated and Need Monitoring

Data	Description	Data Sources			
		For baseline emission calculation		For project emission calculation	
		Ex-ante	Ex-post	Ex-ante	Ex-post
$BPKM_y$	Passenger transportation activity/volume by the project in year y (passenger-km/y)	A planned value	A monitored value (in case the project monitor within their daily operation)	N/A	
$P_y$	Number of passenger of the project activity in year y (passenger/y)	A planned value (in case $BPKM_y$ is not available)	A monitored value (in case $BPKM_y$ is not available, monitored through an automatic gate system, etc.)		
$BTDP_y$	Average trip distance of the passenger of the project activity in year y (km)				
$MS_{i,y}$	Share of passengers by transport mode i in the baseline scenario in year y (%)	From the following sources in the order of priority i) A planned value ii) Modal share of the city done by an previous study	From the following sources in the order of priority i) A monitored value (e.g. interview survey) ii) A planned value		
$EF_{PKM,i}$	CO <sub>2</sub> emission factor per passenger	From the following sources in the order of priority			

### 3. Transport / Railway (Passenger) / Modal Shift

	kilometer for transport mode i (t-CO <sub>2</sub> /passenger-km)	i) A project specific value: Published value of the city or the country. Or calculated using EF <sub>KM,i</sub> and OR <sub>i</sub> . ii) A default value: Table 7, Appendix		
EF <sub>KM,i</sub>	CO <sub>2</sub> emission factor of transport mode i (t-CO <sub>2</sub> /km)	A project specific value: Published value of the city or the country.		
OR <sub>i</sub>	Average occupation rate of transport mode i (passenger/vehicle)			
EC <sub>PI,y</sub>	Annual electricity consumption associated with the operation of the project activity in year y (MWh/y)	N/A	A planned value	A monitored value (Electric meter or estimated by, e.g., annual total trip distances and specific electricity consumption)
FC <sub>PI,i,y</sub>	Annual consumption of fuel i associated with the operation of the project activity in year y (t/year)		A planned value	A monitored value (Purchase receipt of the fuel or estimated by, e.g., annual total trip distances and specific fuel consumption)
EF <sub>elec</sub>	CO <sub>2</sub> emission factor of the grid electricity (t-CO <sub>2</sub> /MWh)		From the following sources in the order of priority i) A project specific value by an interview to the related power supply company ii) A published value of the country iii) A default value (Table 3, Appendix)	
EF <sub>fuel,i</sub>	CO <sub>2</sub> emission factor of fuel i (t-CO <sub>2</sub> /TJ)		From the following sources in the order of priority i) A national default value ii) A default value (Table 1 and 2, Appendix)	
NCV <sub>i</sub>	Net calorific value of fuel i (TJ/t)			

### 5. Others

#### (1) Project Boundary

The physical boundary for estimating GHG emissions includes the operation of MRT etc.

#### (2) Leakage

There are indirect emissions that potentially lead to leakage due to activities such as productions and transportations of raw materials for MRT facilities and rolling stocks, and their constructions and productions. However, these emissions are temporary and negligible compare to the project scale. Therefore, it can be ignored. These indirect emissions are also not counted in the CDM methodologies for MRT such as ACM0016 (Mass Rapid Transit Projects) and AM0031 (Bus rapid transit projects).

#### (3) Comparison with existing methodologies

The methodology is developed mainly based on the JBIC J-MRV methodology number 5 (The methodology for transport projects in urban area). The logic of emission reduction calculation in the methodology is in line with the J-MRV methodology. The methodology provides default values for some key parameters and simplifies the emission reduction calculations, so that the

### 3. Transport / Railway (Passenger) / Modal Shift

methodology will be more practical for users. Existing CDM methodologies similar to the methodology are AM0031 (Bus rapid transit projects) and ACM0016 (Mass Rapid Transit Projects). The major difference from these methodologies in terms of the logic of emission reduction calculation is the definition of project boundary. For simplicity, the methodology limits the project boundary from the entry station to the exit station of MRT. On the other hand, these CDM methodologies include origins and destinations of passengers.