3. Transport / Modal Shift (Passenger)

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 (hereinafter "railway"), including both urban and intercity projects.

2. Applicability

(1) Development of transport system(s) that can realize an efficient urban or intercity 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, existing railways and aircrafts etc[1].

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 (e.g. existing mode of transportation such as buses, private car, taxi, motorbike) and project scenario (e.g. railway).

Details of sources of each data in the following formulae are provided in "4. Data and Parameters for the Estimation".

$$ER_y = BE_y - PE_y$$

ER_y : GHG emission reduction through the project in year y (t-CO_2e/y)

BE_y : GHG emission from the baseline scenario in year y (t-CO_2e/y)

PE_y : GHG emission from the project scenario in year y (t-CO_2e/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[2], share of passengers by baseline transport modes and CO_2 emission factor per passenger-km. CO_2 emission factor per passenger-km can be set by dividing CO_2 emission factor per km by average occupation rate.

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

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

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

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

$BTDP_y$: Average trip distance of the passenger of the railway 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_2 emission factor of transport mode i (t-CO_2/passenger-km)

[1] The target year shall be a representative year under average operation or an annual average of multiple years.

[2] In case if the number of passenger who would not have made the trip without the project can be obtained, subtract that number from P_y in order to deduct the demand induced by the project.

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

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

$EF_{KM,i}$: CO_2 emission factor of transport mode i (t-CO_2/km)

(2) Calculation of Project Emission

- In the case of the project activity using electricity

It is estimated by multiplying annual electricity consumption of the railway and CO_2 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 railway in year y (MWh/y)

EF_{elec} : CO_2 emission factor of the grid electricity (t-CO_2/MWh)

- In the case of the project activity using fossil fuels

It is estimated by multiplying annual fossil fuel consumption of the railway and CO_2 emission factor of the fossil fuel.

$$PE_y = FC_{PJ,y} \times NCV_i \times EF_{fuel,i} \div 10^6$$

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

NCV_i : Net calorific value of fuel i (TJ/Gg = TJ/kt)

$EF_{fuel,i}$: CO_2 emission factor of fuel i (kg-CO_2/TJ)

- In case if consumption of electricity and fuel is not available

Multiply “Passenger transportation volume/activity by the railway in year y (passenger-km/y)” by CO_2 emission factor per passenger-km of railway.

$$PE_y = BPKM_y \times EF_{PKM,MRT}$$

$EF_{PKM,MRT}$: CO_2 emission factor of railway (t-CO_2/passenger-km)

4. Data and Parameters for the Estimation

Data	Description	Data Sources	
		For baseline emission calculation	For project emission calculation
$BPKM_y$	Passenger transportation volume/activity by the railway in year y (passenger-km/y)	A planned value [2]	N/A
P_y	Number of passengers transported by the railway in year y (passenger/y)	A planned value [2] (in case if BPKM is not available)	N/A
$BTDP_y$	Average trip distance of the passenger of the railway 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	
$EF_{PKM,i}$	CO_2 emission factor of transport mode i (t-CO_2/passenger-km)	From the following sources in the order of priority i) A project specific value: use values of the country/city. Or calculate using $EF_{KM,i}$ and OR_i. ii) Literature value which can be applied to the project iii) Default value (Appendix 6)	
$EF_{KM,i}$	CO_2 emission factor of transport mode i (t-CO_2/km)	From the following sources in the order of priority i) A project specific value: use values of the country/city. ii) Literature value which can be applied to the project iii) Default value (Appendix 6)	
OR_i	Average occupation rate of transport mode i (passenger/vehicle)		
$EC_{PJ,y}$	Electricity consumption associated with the operation of the railway in year y (MWh/y)	N/A	A planned value
$FC_{PJ,i,y}$	Consumption of fuel i associated with the operation of the railway in year y (t/year)		A planned value
EF_{elec}	CO_2 emission factor of the grid electricity (t-CO_2/MWh)		A default value (Table 3, "Electricity Consumption", Appendix) However, if there is no default value applied or if there is another appropriate value, that value may be used.
$EF_{fuel,i}$	CO_2 emission factor of fuel i (kg-CO_2/TJ)		A default value (Table 1 and 2, Appendix) However, if there is no default value applied or if there is another appropriate value, that value may be used.
NCV_i	Net calorific value of fuel i (TJ/Gg=TJ/kt)		
$EF_{PKM,MRT}$	CO_2 emission factor of railway (t-CO_2/passenger-km)		From the following sources in the order of priority i) A project specific value: use values of the country/city. ii) Literature value which can be applied to the project iii) Default value (Table 6, Appendix)

5. Others

(1) Project Boundary

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

(2) Leakage

There are indirect emissions that potentially lead to leakage due to activities such as productions and transportations of raw materials for railway 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 railway 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 methodology proposed in JICA "Data Collection Survey on Development of Measurement, Report and Verification (MRV) System in Urban Railway Sector in Vietnam"[3], and the JBIC J-MRV methodology number 5 (The methodology for transport projects in urban area)[4]. 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 methodology will be more practical for users. Existing CDM methodologies similar to the methodology are AM0031 (Bus rapid transit projects), ACM0016 (Mass Rapid Transit Projects) and AM101 (High speed passenger rail systems). 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 railway. On the other hand, these CDM methodologies include origins and destinations of passengers.

(4) CH_4 and N_2O

Since methane (CH_4) and nitrous oxide (N_2O) do not have a significant impact on emission reductions by the project, they were not considered for simplification.

(5) Revision history

Version	Year/Month	Revisions
2.0	March 2014	• Integrated and recategorized the calculation methodologies as follows based on objects (passengers/ freights) and measures (modal shift/ electrification) - Railway /passenger (Modal Shift) - Railway /passenger (Electrification) - Railway /Freight (Modal Shift) - Railway /Freight (Electrification) • Amended the calculation method for baseline emissions to calculate emissions per passenger-kilometer
3.0	September 2019	• Amended the calculation method to calculate emissions based on consumption of fuel • Added instructions to calculate annual emission reductions by using an average for the calculation period • Added a method for road congestion

[3] https://openjicareport.jica.go.jp/616/616/616_123_12357349.html
[4] https://www.jbic.go.jp/ja/business-areas/sectors/images/jmrv_guideline_ja.pdf

		• Prioritized the use of default values • Added instructions not to consider CH_4 and N_2O emissions
4.0	March 2023	• In the methodology "3. Traffic Congestion Mitigation / Modal Shift (Passenger), version 3.0)", both modal shift and congestion mitigation were involved in the same methodology. However, since the emission reduction logic differs between the two components, the methodology was separated into "3. Transport / Modal Shift (Passenger)" and "4. Transport / Measures on road congestion". • In order to enable estimation of emission reductions due to introduction of intercity transportation, revised the text of each item such as in " 1. Typical Project" and "2. Applicability ". Since it is assumed that a choice of the baseline will be an aircraft, default values of the emission factor are provided. In addition, since it is assumed that many cases in which demand that was not included in the baseline are stimulated by the development of intercity transportation, the treatment of such stimulation for the estimation of emission reduction is described in the methodology. • An alternative method is presented for cases where electricity consumption cannot be obtained for the project emissions (i.e., a method based on the number of passengers, average travel distance, and emission factors). • In the description of the calculation method and necessary data of baseline emissions, the words "before project implementation" was revised to use "the baseline scenario". The baseline scenario is the scenario that would have occurred in the absence of the project, such as continuation of the pre-project conditions. • Deleted the column "Ex-post" in "4. Data and Parameters Estimated and Need Monitoring": current version of Climate-FIT aims to quantify GHG emission reductions in the "planning phase").
5.0	March 2024	• No revision.