4. Transport / Railway (Passenger) / Electrification

1. Typical Project

- Realization of fuel/energy shift in railway passenger transport through electrification.
- Including modal shift effects by enhancement of transportation capacity along with the electrification.

2. Applicability

(1) The electrification railway passenger transport.

(2) Modal shift effects by enhancement of transportation capacity along with the electrification are considered and the baseline transport modes should be buses, private cars, taxis, motorbikes 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 (the non-electrified railway) and project scenario (the electrified railway). The emission reduction from the effects of passenger modal shift is determined as the differences between the GHG emission of baseline scenario (existing modes of transportation, e.g. buses, private car, taxi, motorbike) and project scenario (railway), and the effects can only be applied for the increased amount of passenger transport through the electrification.

$$ER_y = BE_y - PE_y$$

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)

The representative value of annual emission reductions should indicate the average value for the calculation period.

(1) Calculation of Baseline Emission

1) Electrification

Baseline GHG emission corresponding to the effect of electrification itself is calculated based on annual fossil fuel consumption of the existing railway and multiply CO_2 emission factor of the fuel.

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

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

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

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

2) Modal shift

Baseline GHG emission corresponding to the effect of modal shift is calculated based on the increased passenger transportation through the project based on the transportation number (or multiplying number of passenger and share of passengers and divided by average occupancy rate), average trip distance by baseline transport modes and CO_2 emission factor per km.

$$BE_y = \sum_i \left(\frac{P_y \times MS_{i,y}}{OR_i} \times BTDP_y \times SFC_i \times NCV_i \times EF_{fuel,i} \right)$$

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

P_y : Increased number of passenger by the project activity in year y (passenger/y)

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

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

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

SFC_i ： Fuel consumption rate of transportation i (t/km)

$EF_{KM,i}$: CO_2 emission factor per passenger kilometer for transport mode i ($t\text{-}CO_2$/passenger-km)

(2) Calculation of Project Emission

It is estimated by multiplying annual electricity consumption of the project activity with the 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 project activity in year y (MWh/y)

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

4. Data and Parameters Estimated and Need Monitoring

<table>
<tr><th rowspan="3">Data</th><th rowspan="3">Description</th><th colspan="4">Data Sources</th></tr>
<tr><th colspan="2">For baseline emission calculation</th><th colspan="2">For project emission calculation</th></tr>
<tr><th>Ex-ante</th><th>Ex-post</th><th>Ex-ante</th><th>Ex-post</th></tr>
<tr><td>P_y</td><td>Increased number of passengers by the project activity in year y (passenger/year)</td><td rowspan="2">A planned value</td><td rowspan="2">A monitored value</td><td colspan="2" rowspan="4">N/A</td></tr>
<tr><td>$BTDP_y$</td><td>Average trip distance of the passenger transportation in the project in year y (km)</td></tr>
<tr><td>$MS_{i,y}$</td><td>Share of passengers by transport mode i in the baseline scenario in year y (%)</td><td>From the following sources in the order of priority
i) A planned value
ii) Modal share of the city done by an previous study</td><td>From the following sources in the order of priority
i) A monitored value (e.g. interview survey)
ii) A planned value</td></tr>
<tr><td>$FC_{BL,i,y}$</td><td>Consumption of fuel i associated with the operation of the existing railway in year y (t/year)</td><td>A measured value (or estimated by, e.g., annual total trip distances and specific fuel consumption)</td><td>A measured value before the project starts</td></tr>
</table>

$EF_{KM,i}$	CO_2 emission factor of transport mode i ($t\text{-}CO_2$/km)	A default value: Table 7, Appendix If there is no default value applied or if there is another appropriate value, that value may be used.		
OR_i	Average occupation rate of transport mode i (passenger/vehicle)	Project specific value: Published value of the city or the country.		
$EC_{PJ,y}$	Electricity consumption associated with the operation of the project activity in year y (MWh/year)	N/A	A planned value	A monitored value (Electric meter or estimated by, e.g., annual total trip distances and specific electricity consumption)
$FC_{PJ,y}$	Fuel consumption 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_{elec}	CO_2 emission factor of the grid electricity ($t\text{-}CO_2$/MWh)		A default value (Table 3, Appendix) 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 ($t\text{-}CO_2$/TJ)		A default value (Table 1 and 2, Appendix) 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/t)			

5. Others

(1) Project Boundary

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

(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 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 part of modal shift in 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 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 the users. Related CDM methodologies are AM0031 (Bus rapid transit projects) and ACM0016 (Mass Rapid Transit Projects) in terms of modal shift. The major difference from these methodologies in terms of the logic of emission reduction calculation is the definition of project boundary. To simplify the calculation, the methodology limits the project boundary from the entry station to the exit station of MRT. On the other hand, these CDM methodologies include the 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.