6. Transport / Railway (Freight) / Electrification

1. Typical Project

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

2. Applicability

(1) Electrification of railway freight transportation.

(2) Modal shift effects by enhancement of transportation capacity along with the electrification are also considered and the baseline transport modes should be road transportation such as trucks and trailers 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 freight modal shift is determined as the differences between the GHG emission of baseline scenario (existing modes of transportation, e.g. trucks and trailers) and project scenario (electrified railway transportation), and only the increased amount of freight transportation through the electrification is considered.

$$ER_y = BE_y - PE_y$$

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 of the effect of electrification itself is calculated based on annual fossil fuel consumption of the existing railway and CO_2 emission factor of the fossil 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/y)

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 of the effect of modal shift is calculated based on the increased freight transportation activity/volume through the project in t-km, share of freight by baseline transport modes and CO_2 emission factor per t-km.

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

$BTKM_y$: Increased freight transportation activity/volume by the project in year y (t-km/y)

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

$EF_{TKM,i}$: CO_2 emission factor per ton kilometer for transport mode i (t-CO_2/t-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-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>$BTKM_y$</td><td>Increased freight transportation activity/volume by the project in year y (t-km/y)</td><td>A planned value</td><td>A monitored value</td><td colspan="2" rowspan="4">N/A</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>A planned value</td><td>From the following sources in the order of priority
i) A monitored value
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/y)</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>
<tr><td>$EF_{TKM,i}$</td><td>CO_2 emission factor per ton kilometer for transport mode i (t-CO_2/t-km)</td><td colspan="2">A default value: Table 8, Appendix
If there is no default value applied or if there is another appropriate value, that value may be used.</td></tr>
<tr><td>$EC_{PJ,y}$</td><td>Electricity consumption associated with the operation of the project activity in year y (MWh/y)</td><td colspan="2" rowspan="3">N/A</td><td>A planned value</td><td>A monitored value (Electric meter or estimated by, e.g., annual total trip distances and specific electricity consumption)</td></tr>
<tr><td>EF_{elec}</td><td>CO_2 emission factor of the grid electricity (t-CO_2/MWh)</td><td colspan="2">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.</td></tr>
<tr><td>$EF_{fuel,i}$</td><td>CO_2 emission factor</td><td colspan="2">A default value (Table 1 and 2, Appendix)</td></tr>
</table>

	of fuel i (t-CO_2/TJ)		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 methodology is developed mainly based on the CDM methodology, AM0090 (Modal shift in transportation of cargo from road transportation to water or rail transportation). The CDM methodology is applicable for water transportations as well as railway transportations; however, this methodology is only applicable for railway transportation. The CDM methodology allows both in the baseline and project activity, only one type of cargo owned by the project participant and excludes mix of cargo. But this methodology does not set any limitation for the cargo type. The CDM methodology also has some strict applicability conditions regarding investments to the project and conditions for project participants; however, this methodology has no limitation for these conditions.

(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.