MRV Methodology Title: “Improvement of Fuel Efficiency for Taxies in Vietnam”
(Draft Ver. 3.0)

Note: This methodology is drafted as the result of the GEC’s JCM Demonstration/Feasibility Study in JFY2012. Therefore, this draft methodology is not officially approved by any governments involved in JCM, and is subject to change in the future.

Note: The following CDM methodologies are referred to develop the draft of MRV methodology.
AMS-III.C : Emission Reductions by electric and hybrid vehicles
AMS-III.BC : Emission reductions through improved efficiency of vehicle fleets
AMS-III.AT : Transportation Energy efficiency Activities installing digital tachograph system "Guidelines Standardized Baseline for the Transport Sector", (hereinafter called Guidelines)

1. Title of Methodology
   “Improvement of Vehicle/Fuel Efficiency and or transit efficiency for Taxies in Vietnam”

2. Summary of the Methodology for the Project
   This methodology is applicable to the project that improves vehicle/fuel efficiency or transit efficiency for taxies in Vietnam. Guidelines are referred for the following term definition.

   (Vehicle/Fuel Efficiency Measures)
   Vehicle/Fuel efficiency measures improve the vehicle and or fuel efficiency and thereby reduce carbon emissions per distance unit e.g. through usage of low carbon fuels, vehicle improvements, driver training etc. No significant change of the vehicle size, the load factor or of usage types occur. The indicator used in vehicle/fuel efficiency is emissions per kilometer. The comparison bases for these types of measures are comparable operating vehicles.

   (Transit Efficiency Measures)
   Transit efficiency measures increase occupied rate of taxis or decrease non-occupied drive distance through vehicle dispatch measures or put taxi stand. These measures reduce emissions per paid mileage km which are therefore used as indicator. The difference of improved transit efficiency to vehicle/fuel efficiency is that in transit efficiency improvements the vehicles, fuel and driving techniques remains the same and only the circumstances such as taxi stand or dispatch system are changed. The comparison bases for transit efficiency measures are operating vehicles of the same mode.

   (Combined Measures)
   Interventions may include vehicle efficiency plus transit efficiency measures e.g. vehicle efficiency plus improved vehicle dispatch measures. In combined cases always the indicator paid mileage km shall be taken as transit efficiency will always reflect changes in both types of efficiency.

3. Eligibility Criteria
   This methodology is applicable to projects that fully satisfy the following cases.

   | Case 1 | The project activity is for improvement of vehicle/fuel efficiency and or transit efficiency for taxi operation in Vietnam. | ☐ |
   | Case 2 | The taxi vehicles are ICE vehicle, Electric vehicle or Hybrid vehicle. | ☐ |
   | Case 3 | At least, driving distance, paid mileage and fuel consumption of taxi vehicles in the project activity are recorded and managed. | ☐ |
   | Case 4 | The technical assistance and/or the financial aid from developed country including Japan are introduced for the project activity of taxi fuel efficiency improvement. | ☐ |

< I -1>
4. Selection of Calculation Method
To calculate the reference emission, the project developer must refer to the calculation method best-suited for his/her project using the flow chart below.

**Calculation method 1**
Vehicle/Fuel efficiency measures

- **Option 1: Project vehicle measurement method**
  The reference fuel economy of project vehicles or reference vehicles is measured directly before project start. The value is used as a constant during project period.

- **Option 2: Improvement rate method**
  Fuel economy improvement rate is estimated at the first year of project. The rate is used as a constant during the project period.

- **Option 3: Reference vehicle measurement method**
  Reference fuel economy is measured annually during project period for the vehicles selected as a control group.

**Calculation method 2**
Transit efficiency measures

- **Option 1: Project vehicle measurement method**
  The reference occupation rate of project vehicles or reference vehicles is measured directly before project start. The value is used as a constant during project period.

- **Option 2: Improvement rate method**
  Occupancy improvement rate is estimated at the first year of project. The rate is used as a constant during the project period.

- **Option 3: Reference vehicle measurement method**
  Reference occupation rate is measured annually during project period for the vehicles selected as a control group.

**Calculation method 3**
Combined measures

- **Option 1: Project vehicle measurement method**
  The reference fuel economy and occupation rate of project vehicles or reference vehicles are measured directly before project start. The value is used as a constant during project period.

- **Option 2: Improvement rate method**
  Fuel economy and occupation improvement rates are estimated at the first year of project. The rates are used as a constant during the project period.

- **Option 3: Reference vehicle measurement method**
  Reference fuel economy and occupation rate are measured annually during project period for the vehicles selected as a control group.
5. Necessary Data for Calculation

The data that requires presetting in the planning stage of the project or monitoring after the start of the project is determined below based on the calculation method selected in section 4. If the data shown below is imported, a calculation tool is provided in this methodology that will allow you to measure emission reductions.

5.1 Common to Calculation method 1to 3

(1) Monitoring and input after project starts

<table>
<thead>
<tr>
<th>Description of data</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCV&lt;sub&gt;x&lt;/sub&gt;: Net calorific value of fuel type x</td>
<td></td>
<td>J/mass or volume units of fuel</td>
</tr>
<tr>
<td>EF&lt;sub&gt;CO2,x&lt;/sub&gt;: Carbon emission factor for fuel type x</td>
<td></td>
<td>gCO2/J</td>
</tr>
</tbody>
</table>

5.2 Calculation method 1: For increased vehicle/fuel efficiency activities

(1) In the planning stage, enter the data to determine fuel consumption rate per driving distance of the reference

<table>
<thead>
<tr>
<th>Description of data</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC&lt;sub&gt;i(x)&lt;/sub&gt;: Specific fuel consumption of vehicle category i before project start</td>
<td></td>
<td>(mass or volume units of fuel/km)</td>
</tr>
<tr>
<td>p&lt;sub&gt;VE&lt;/sub&gt;: Fuel efficiency improve rate by vehicle/fuel efficiency measures for option 2 only</td>
<td></td>
<td>%</td>
</tr>
</tbody>
</table>

(2) Monitoring and input after project starts

<table>
<thead>
<tr>
<th>Description of data</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFC&lt;sub&gt;i(x),y&lt;/sub&gt;: Specific fuel consumption of vehicle category i in year y</td>
<td></td>
<td>(mass or volume units of fuel/km)</td>
</tr>
<tr>
<td>DD&lt;sub&gt;i,y&lt;/sub&gt;: Relevant activity level of the project (total driving distance) in year y</td>
<td></td>
<td>km</td>
</tr>
</tbody>
</table>

5.3 Calculation method 2: For increased transit efficiency activities

(1) In the planning stage, enter the data to determine fuel consumption rate per paid mileage of the reference

<table>
<thead>
<tr>
<th>Description of data</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC&lt;sub&gt;i(x)&lt;/sub&gt;: Specific fuel consumption of vehicle category i before project start</td>
<td></td>
<td>(mass or volume units of fuel/km)</td>
</tr>
<tr>
<td>PMR&lt;sub&gt;i&lt;/sub&gt;: Occupation rate by vehicle category i before project start</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>p&lt;sub&gt;TE&lt;/sub&gt;: occupation improve rate by transit efficiency measures for option 2 only</td>
<td></td>
<td>(%)</td>
</tr>
</tbody>
</table>

(2) Monitoring and input after project starts

<table>
<thead>
<tr>
<th>Description of data</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFC&lt;sub&gt;i(x),y&lt;/sub&gt;: Specific fuel consumption of vehicle category i in year y</td>
<td></td>
<td>(mass or volume units of fuel/km)</td>
</tr>
<tr>
<td>PMR&lt;sub&gt;i,y&lt;/sub&gt;: Occupation rate by vehicle category i in year y</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>PD&lt;sub&gt;i,y&lt;/sub&gt;: Relevant activity level of the project (total paid mileage)</td>
<td></td>
<td>km</td>
</tr>
</tbody>
</table>
5.4 Calculation method 3: For combined measure

(1) In the planning stage, enter the data to determine fuel consumption rate per paid mileage of the reference

<table>
<thead>
<tr>
<th>Description of data</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFC&lt;sub&gt;(x),y&lt;/sub&gt;: Specific fuel consumption of vehicle category i in year y</td>
<td></td>
<td>(mass or volume units of fuel/km)</td>
</tr>
<tr>
<td>PMR&lt;sub&gt;i,y&lt;/sub&gt;: Occupation rate by vehicle category i in year y</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>p&lt;sub&gt;VE&lt;/sub&gt;: Fuel efficiency improve rate by vehicle/fuel efficiency measures for option 2 only</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>p&lt;sub&gt;TE&lt;/sub&gt;: occupation improve rate by transit efficiency measures for option 2 only</td>
<td>(%)</td>
<td></td>
</tr>
</tbody>
</table>

(2) Monitoring and input after project starts

<table>
<thead>
<tr>
<th>Description of data</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFC&lt;sub&gt;(x),y&lt;/sub&gt;: Specific fuel consumption of vehicle category i in year y</td>
<td></td>
<td>(mass or volume units of fuel/km)</td>
</tr>
<tr>
<td>PMR&lt;sub&gt;i,y&lt;/sub&gt;: Occupation rate by vehicle category i in year y</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>PD&lt;sub&gt;i,y&lt;/sub&gt;: Relevant activity level of the project (total paid mileage)</td>
<td>km</td>
<td></td>
</tr>
</tbody>
</table>

6. Terms and Definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
</table>
| p<sub>VE</sub>: Fuel efficiency improve rate by vehicle/fuel efficiency measures (%) | \[REF_{VE,i,y} = PEF_{VE,i,y}/(1 - p_{VE})\]  
Where:  
REF<sub>VE,i,y</sub>: Reference emission factor for vehicle type i in year y (gCO2/km)  
PEF<sub>VE,i,y</sub>: Project emission factor for vehicle type i in year y (gCO2/km) |
| p<sub>TE</sub>: occupation improve rate by transit efficiency measures (%) | \[PMR_{i,y,ref} = PMR_{i,y} - p_{TE}\]  
Where:  
PMR<sub>i,y</sub>: Project occupation rate by vehicle category i in year y (%)  
PMR<sub>i,y,ref</sub>: Reference occupation rate by vehicle category i in year y (%) |

Occupation rate | The rate of paid mileage distance against total drive distance (%) |

7. Project Boundaries

The project boundary shall include the following GHG emission sources and GHG emissions.

- The geographical scope sets the national boundary of Vietnam
- The taxies introduced project activity for increased vehicle/fuel efficiency and or transit efficiency
- In case of gaseous fuels CH4 emission shall be included
- In addition, it is necessary to check so as not to double-count the emission reductions because of the project vehicles being inclusive of the other projects such as CDM, PoA or NAMAs.

8. Reference Scenario

The reference scenario for increased vehicle/fuel efficiency and or transit efficiency is continuation of operating comparable vehicles. For example, fuel efficiency of reference vehicle may be determined by measuring the actual fuel consumption of a sample of
comparable vehicles operating in comparable traffic situations. Comparable vehicles are those with similar age structure, motorization and passenger capacity. Comparable traffic situations are considered as vehicles operating in the same city.

Based on the reference scenario, reference emission factor is set from the selection of three options depending on the reference emission variation.

1) Reference emission factor increase

2) Reference emission factor is constant

3) Reference emission factor decrease

9. Reference Emissions and Calculation

The reference emissions are calculated by vehicle category. Vehicle category shall be determined conservatively and be based on the fuel type used, the vehicle model and other relevant factors to distinguish vehicles with different occupation rates and fuel consumption rates.

Monitoring shall apply to all the vehicles or sample vehicles within boundary. Sample vehicles shall be randomly chosen referring to the latest version of "The Standard for sampling and surveys for CDM project activities and programme of activities".

Monitoring vehicles and monitoring method for reference emissions estimation are shown on the following table;
### Table Monitoring vehicles and monitoring method for reference emissions estimation

<table>
<thead>
<tr>
<th>Monitoring vehicles</th>
<th>Estimation method for reference fuel economy and/or occupation rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project vehicles (all vehicles or sample)</td>
<td>Estimate based on at least one year of operation records and preferably three years. (Option1,2)</td>
</tr>
<tr>
<td>Reference vehicles (control group)</td>
<td>Estimate based on at least one year of operation records and preferably three years (Option1), or estimate based on the operation records for the first year of project period. (Option1,2)</td>
</tr>
<tr>
<td>Reference vehicles (control group)</td>
<td>Estimate based on the annual operation records during project period.</td>
</tr>
</tbody>
</table>

#### 9.1 Calculation method 1: Increased vehicle/fuel efficiency activities

The reference emissions shall be determined using either of the following three options:

**Option 1: Project vehicles measurement method**

The reference emission factor is determined on the basis of emissions per kilometer \( (REF_{VE,i}) \). Vehicle fuel efficiency for existing vehicle or specific reference vehicle is determined as the average annual fuel consumption \( (FC) \) divided by the average distance travelled \( (D) \) by each vehicle categories based on at least one year of historical data and preferably three years.

Once measured, the reference vehicle fuel efficiency will be fixed throughout the project period.

\[
REF_{VE,i} = RFC_{i(x)} \cdot NCV_x \cdot EF_{CO2,x} \\
RE_{VE,Y} = \sum_i (REF_{VE,i} \times DD_{i,y})
\]

Where:

- \( REF_{VE,i} \) Reference Emission Factor for vehicle/fuel efficiency measures for vehicle type \( i \) \( (gCO2/km) \)
- \( RFC_{i(x)} \) Reference fuel consumption of vehicle category \( i \) \( (mass or volume units of fuel/km) \)
- \( NCV_x \) Net calorific value of fuel type \( x \) \( (J/mass or volume units of fuel) \)
- \( EF_{CO2,x} \) Carbon emission factor for fuel type \( x \) \( (gCO2/J) \)
- \( RE_{VE,Y} \) Reference CO2 emissions for increased vehicle/fuel efficiency activities \( (tCO2/y) \)
- \( DD_{i,y} \) Total distance driven by vehicle category \( i \) in year \( y \) during project period \( (km/y) \)

**Option 2: Improvement rate method**

The reference fuel economy is measured in accordance with the procedure of Option 1. Project fuel economy in the first year of project period is measured. The fuel economy improvement rate is calculated from the reference fuel economy and the first year project fuel economy. The reference fuel economy of second and the latter year of project period is estimated using the rate and project fuel economy of each year. The rate will be fixed throughout the project period.

The fuel consumption specification data observed on manufacturer’s specification of project vehicles and comparable vehicles are possible to set the fuel economy improvement rate. The driving mode to get the specification data should be the same.

\[
REF_{VE,Y} = \sum_i (REF_{VE,i,y} \times DD_{i,y})
\]

\[
REF_{VE,Y} = PVE_{i,Y} / (1 - p_{VE,i,(x)})
\]
Where:

- **REF\_VE\_i,y** Reference Emission Factor for vehicle/fuel efficiency measures for vehicle type i in year y during project period (g\(\text{CO}_2/\text{km}\))
- **PEF\_VE\_i(x)** Project Emission Factor for vehicle/fuel efficiency measures for vehicle type i (g\(\text{CO}_2/\text{km}\))
- **p\_VE\_i(x)** Fuel efficiency improve rate by Vehicle/fuel efficiency measures for vehicle category i (%)
- **RE\_VE\_y** Reference CO2 emissions for increased vehicle/fuel efficiency activities (t\(\text{CO}_2/\text{y}\))
- **DD\_i,y** Total distance driven by vehicle category i in year y during project period (km/y)

### Option 3: Reference vehicles measurement method
Reference emission factor is estimated from annual monitoring results during project period.

\[
REF\_VE\_i,y = RFC\_i(x),y \cdot NCV\_x \cdot EF\_CO2\_x
\]

\[
RE\_VE\_y = \sum_i \left(REF\_VE\_i,y \times DD\_i,y\right)
\]

Where:

- **REF\_VE\_i,y** Reference Emission Factor for vehicle/fuel efficiency measures for vehicle type i in year y (g\(\text{CO}_2/\text{km}\))
- **RFC\_i(x),y** Reference fuel consumption of vehicle category i in year y (mass or volume units of fuel/km)
- **NCV\_x** Net calorific value of fuel type x (J/mass or volume units of fuel)
- **EF\_CO2\_x** Carbon emission factor for fuel type x (g\(\text{CO}_2/\text{J}\))
- **RE\_VE\_y** Reference CO2 emissions for increased vehicle/fuel efficiency activities in year y (t\(\text{CO}_2/\text{y}\))
- **DD\_i,y** Total distance driven by vehicle category i in year y during project period (km/y)

### 9.2 Calculation method 2: Increased transit efficiency activities
Reference Emission Factor for transit efficiency measures by vehicle category i (REF\_TE\_i) shall be determined using either of the three following options:

#### Option 1: Project vehicles measurement method
The reference occupancy rate necessary to calculate reference emission factor for existing vehicle or specific reference vehicle is determined as the average annual piad mileage divided by the average annual driving distance (\(D\)) by each vehicle categories based on at least one year of historical data and preferably three years.

Once measured, the reference vehicle fuel efficiency will be fixed throughout the project period.

The reference fuel economy per kilometer driven is set in accordance with the procedure for Option.1 of calculation method 1. Reference emission factor is determined as reference fuel economy per kilometer driven devided by reference occupancy rate.

\[
REF\_VE\_i = RFC\_i(x) \cdot NCV\_x \cdot EF\_CO2\_x
\]

\[
REF\_TE\_i = \frac{REF\_VE\_i}{PMR\_i,ref}
\]

\[
RE\_TE\_y = \sum_i \left(REF\_TE\_i \times PD\_i,y\right)
\]
Where:

- \( \text{REFVE}_i \) Reference Emission Factor for vehicle/fuel efficiency measures for vehicle type \( i \) during project period (gCO2/km)
- \( \text{RFC}_{i(x)} \) Reference fuel consumption of vehicle category \( i \) (mass or volume units of fuel/km)
- \( NCV_x \) Net calorific value of fuel type \( x \) (J/mass or volume units of fuel)
- \( \text{EF}_{CO2,x} \) Carbon emission factor for fuel type \( x \) (gCO2/J)
- \( \text{RETE}_y \) Reference CO2 emissions for increased transit efficiency activities during the period of year \( y \) (tCO2/y)
- \( \text{REFTE}_i \) Reference Emission Factor for transit efficiency measures for vehicle type \( i \) (gCO2/paid mileage km)
- \( \text{PMR}_{i,\text{ref}} \) Reference occupation rate by vehicle category \( i \) (%)
- \( \text{PD}_{i,y} \) Total paid mileage by vehicle category \( i \) project vehicles in year \( y \) during project period (paid mileage km/y)

**Option 2: Improving rate method**

The reference emission factor is determined in accordance with the procedure of Option 1. Project occupancy rate measured in the first year of project period. The occupancy rate improvement rate is calculated as the difference between the reference and project occupancy rate. The reference emissions second and the latter year of project period is estimated using the determined rate and project emission factor of each year. The rate will be fixed throughout the project period.

\[
\text{RETE}_{i,y} = \text{PEFTE}_{i,y} \times \left( \frac{\text{PMR}_{i,y}}{\text{PMR}_{i,y} - \text{PR}_{i(x)}} \right)
\]

\[
\text{RETE}_y = \sum_i \left( (\text{RETE}_{i,y} \times \text{PD}_{i,y}) \right)
\]

Where:

- \( \text{REFTE}_{i,y} \) Reference Emission Factor for transit efficiency measures for vehicle type \( i \) in year \( y \) (gCO2/paid mileage km)
- \( \text{PEFTE}_{i,y} \) Project emission factor for transit efficiency measures for vehicle type \( i \) in year \( y \) (gCO2/paid mileage km)
- \( \text{PMR}_{i,y} \) Occupation rate by vehicle category \( i \) in year \( y \) (%)
- \( \text{PR}_{i(x)} \) Occupation improve rate by transit efficiency measures in year \( y \) (%)
- \( \text{RETE}_y \) Reference CO2 emissions for increased transit efficiency in year \( y \) (tCO2/y)
- \( \text{PD}_{i,y} \) Total paid mileage by vehicle category \( i \) project vehicles in year \( y \) (paid mileage km/y)

**Option 3: Reference vehicles measurement method**

Reference emission factor is estimated from annual monitoring results during project period.

\[
\text{REFVE}_i = \text{RFC}_{i(x)} \times \text{NCV}_x \times \text{EF}_{CO2,x}
\]

\[
\text{REFTE}_{i,y} = \frac{\text{REFVE}_i}{\text{PMR}_{i,\text{ref},y}}
\]

\[
\text{RETE}_y = \sum_i \left( (\text{REFTE}_{i,y} \times \text{PD}_{i,y}) \right)
\]

Where:

- \( \text{REFVE}_i \) Reference Emission Factor for vehicle/fuel efficiency measures for vehicle type \( i \) during project period (gCO2/km)
- \( \text{RFC}_{i(x)} \) Reference fuel consumption of vehicle category \( i \) (mass or volume units of fuel/km)
NCV<sub>x</sub> Net calorific value of fuel type x y (J/mass or volume units of fuel)
EF<sub>CO2,x</sub> Carbon emission factor for fuel type x (gCO2/J)
RE<sub>TE,y</sub> Reference CO2 emissions for increased transit efficiency activities during the period of year y (tCO2/y)
REF<sub>TE,i,y</sub> Reference Emission Factor for transit efficiency measures for vehicle type i in year y (gCO2/paid mileage km)
PMR<sub>i,ref,y</sub> Reference occupation rate by vehicle category i in year y (%)
PD<sub>i,y</sub> Total paid mileage by vehicle category i project vehicles in year y during project period (paid mileage km/y)

9.3 Calculation method 3: Combined measures
In the case of combined measure with vehicle/fuel efficiency measures and transit efficiency measures, reference emission factor by vehicle category i (REF<sub>TE,i</sub>) shall be determined using either of the three following options:

Option 1: Project vehicles measurement method

\[
\begin{align*}
REF_{VE,i} &= RFC_{i(x)} \cdot NCV_x \cdot EF_{CO2,x} \\
REF_{TE,i} &= \frac{REF_{VE,i}}{PMR_{i,ref}} \\
RE_{TE,y} &= \sum_i (REF_{TE,i} \times PD_{i,y})
\end{align*}
\]

Where:
- REF<sub>VE,i</sub> Reference Emission Factor for vehicle/fuel efficiency measures for vehicle type i during project period (gCO2/km)
- RFC<sub>i(x)</sub> Reference fuel consumption of vehicle category i (mass or volume units of fuel/km)
- NCV<sub>x</sub> Net calorific value of fuel type x y (J/mass or volume units of fuel)
- EF<sub>CO2,x</sub> Carbon emission factor for fuel type x (gCO2/J)
- RE<sub>TE,y</sub> Reference CO2 emissions for increased transit efficiency activities during the period of year y (tCO2/y)
- REF<sub>TE,i</sub> Reference Emission Factor for transit efficiency measures for vehicle type i (gCO2/paid mileage km)
- PMR<sub>i,ref</sub> Reference occupation rate by vehicle category i (%) 
- PD<sub>i,y</sub> Total paid mileage by vehicle category i project vehicles in year y during project period (paid mileage km/y)

Option 2: Improvement rate method

\[
\begin{align*}
REF_{TE,i,y} &= PEF_{VE,i,y}/\left\{ (1 - p_{VE,i(x)}) \cdot (PMR_{i,y} - p_{TE,i(x)}) \right\} \\
RF_{TE,y} &= \sum_i \left( (REF_{TE,i,y} \times PD_{i,y}) \right)
\end{align*}
\]

Where:
- REF<sub>TE,i,y</sub> Reference Emission Factor for transit efficiency measures for vehicle type i in year y (gCO2/paid mileage km)
- PEF<sub>VE,i,y</sub> Project Emission Factor for vehicle/fuel efficiency measures for vehicle type i in year y (gCO2/km)
- PMR<sub>i,y</sub> Occupation rate by vehicle category i in year y (%) 
- p<sub>VE,i(x)</sub> Fuel efficiency improve rate by Vehicle/fuel efficiency measures for vehicle category i (%) 
- p<sub>TE,i(x)</sub> occupation improve rate by transit efficiency measures in year y
RETE,y  Reference CO2 emissions for increased transit efficiency activities during the period of year y (tCO2/y)
PD_{i,y}  Total paid mileage by vehicle category i project vehicles in year y (paid mileage km/y)

Option 3: Reference vehicles measurement method
Reference emission factor is estimated from annual monitoring results during project period.

\[
REF_{VE,i,y} = RFC_{i(x),y} \cdot NCV_x \cdot EF_{CO2,x} \\
REF_{TE,i,y} = \frac{REF_{VE,i,y}}{PMR_{i,ref,y}} \\
RE_{TE,y} = \sum_i \left( REF_{TE,i,y} \times PD_{i,y} \right)
\]

Where:
REF_{VE,i,y}  Reference Emission Factor for vehicle/fuel efficiency measures for vehicle type i during project period in year y (gCO2/km)
RFC_{i(x),y}  Reference fuel consumption of vehicle category I in year y (mass or volume units of fuel/km)
NCV_x  Net calorific value of fuel type x in year y (J/mass or volume units of fuel)
EF_{CO2,x}  Carbon emission factor for fuel type x (gCO2/J)
RE_{TE,y}  Reference CO2 emissions for increased transit efficiency activities during the period of year y (tCO2/y)
REF_{TE,i,y}  Reference Emission Factor for transit efficiency measures for vehicle type i in year y (gCO2/paid mileage km)
PMR_{i,ref,y}  Reference occupation rate by vehicle category i in year y (%)
PD_{i,y}  Total paid mileage by vehicle category i project vehicles in year y during project period (paid mileage km/y)

10. Project Emissions and Calculation

10.1 Calculation method 1: Increased vehicle/fuel efficiency activities

\[
PEF_{VE,i,y} = PFC_{i(x),y} \cdot NCV_x \cdot EF_{CO2,x} \\
PE_{VE,y} = \sum_i \left( PEF_{VE,i,y} \times DD_{i,y} \right)
\]

Where:
PEF_{VE,i,y}  Project Emission Factor for vehicle/fuel efficiency measures for vehicle type i in year y (gCO2/km)
PFC_{i,x,y}  Project fuel consumption of vehicle category i using fuel type x in year y (mass or volume units of fuel/km)
NCV_x  Net calorific value of fuel type x (J/mass or volume units of fuel)
EF_{CO2,x}  Carbon emission factor for fuel type x (gCO2/J)
PE_{VE,y}  Project CO2 emissions for increased vehicle/fuel efficiency activities during the period of year y (tCO2/y)
DD_{i,y}  Total distance driven by vehicle category i project vehicles in year y during project period (km)

10.2 Calculation method 2: Increased transit efficiency activities

\[
PEF_{VE,i,y} = PFC_{i(x),y} \cdot NCV_x \cdot EF_{CO2,x}
\]
\[
PE_{TE,i,y} = \frac{PEF_{VE,i,y}}{PMR_{i,y}}
\]

\[
PE_{TE,y} = \sum_i \left( PE_{TE,i,y} \times PD_{i,y} \right)
\]

Where:

- **PEF_{VE,i,y}** Project emission factor for project vehicle type i in year y (gCO2/km)
- **PFC_{i(x),y}** Project fuel consumption of vehicle category i using fuel type x in year y (mass or volume units of fuel/km)
- **NCV_x** Net calorific value of fuel type x (J/mass or volume units of fuel)
- **EFCO2,x** Carbon emission factor for fuel type x (gCO2/J)
- **PEF_{TE,i,y}** Project emission factor for transit efficiency measures for vehicle type i in year y (gCO2/paid mileage km)
- **PMR_{i,y}** occupation rate by vehicle category i in year y (%)
- **PE_{TE,y}** Project CO2 emissions for increased transit efficiency activities in year y (tCO2/y)
- **PD_{i,y}** Total paid mileage by vehicle category i project vehicles in year y (km)

10.3 Calculation method 3: Combined measure

Calculation method of project emission for combined measure activity is same to calculation method 2 shown on the above.

11. Leakage emissions and Calculation

No leakage calculation is required.

12. Calculation of Emission Reduction

Emission reductions are calculated from specific reference emissions and project emissions.

For Increased vehicle/fuel efficiency activities

\[
ER_{VE,y} = RE_{VE,y} - PE_{VE,y}
\]

Where:

- **ER_{VE,y}** Emission reductions for vehicle/fuel efficiency measures in year y [tCO2/y]
- **RE_{VE,y}** Reference emissions for vehicle/fuel efficiency measures in year y [tCO2/y]
- **PE_{VE,y}** Project emissions for vehicle/fuel efficiency measures in year y [tCO2/y]

For Increased transit efficiency activities

\[
ER_{TE,y} = RE_{TE,y} - PE_{TE,y}
\]

Where:

- **ER_{TE,y}** Emission reductions for Increased transit efficiency activities in year y [tCO2/y]
- **RE_{TE,y}** Reference emissions for Increased transit efficiency activities in year y [tCO2/y]
- **PE_{TE,y}** Project emissions for Increased transit efficiency activities in year y [tCO2/y]

For combined measure activities

\[
ER_{TE,y} = RE_{TE,y} - PE_{TE,y}
\]

Where:

- **ER_{TE,y}** Emission reductions for combined measure activities in year y [tCO2/y]
- **RE_{TE,y}** Reference emissions for combined measure activities in year y [tCO2/y]
- **PE_{TE,y}** Project emissions for combined measure activities in year y [tCO2/y]

< I - 11>
13. Monitoring
The project developers must monitor the parameters described in the table below based on the calculation method of the selected GHG emission reductions.

13.1 Reference emissions (Calculation method 1: for increased vehicle/fuel efficiency activities)

**Option 1**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Measurement Method</th>
</tr>
</thead>
</table>
| RFC\(_{i(x)}\) | Reference fuel consumption of vehicle category i (mass or volume units of fuel/km) | a) Collecting distance driven and fuel consumption from monthly operation report of comparable vehicles.  
  b) Fuel consumption are summed up the purchase amount from retailer invoices and inputting to an spreadsheet manually. The distance driven are based on GPS (preferred), other electronic means or odometer |

**Option 2**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Measurement Method</th>
</tr>
</thead>
</table>
| p\(_{VE,i(x)}\) | Fuel efficiency improve rate by vehicle/fuel efficiency measures for vehicle category i (%) | a) Set default value from collecting data in the from demonstration test before project start.  
  b) set from the fuel consumption specification data observed on manufacturer’s specification of project vehicles and comparable vehicles |

13.2 Reference emissions (Calculation method 2: for increased transit efficiency activities)

**Option 1**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Measurement Method</th>
</tr>
</thead>
</table>
| RFC\(_{i(x)}\) | Reference fuel consumption of vehicle category i (mass or volume units of fuel/paid mileage km) | a) Collecting distance driven and fuel consumption from monthly operation report of comparable vehicles.  
  b) Fuel consumption are summed up the purchase amount from retailer invoices and inputting to an spreadsheet manually. The distance driven are based on GPS (preferred), other electronic means or odometer |

**Option 2**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Measurement Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>p(_{TE,i(x)})</td>
<td>Fuel efficiency improve rate by transit efficiency measures for vehicle category i (%)</td>
<td>Collecting the data from demonstration test before project start.</td>
</tr>
</tbody>
</table>
13.3 Project emissions (Calculation method 1: for increased vehicle/fuel efficiency activities)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Measurement Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD&lt;sub&gt;i,y&lt;/sub&gt;</td>
<td>Total distance driven by vehicle category i project vehicles in year y during project period (km)</td>
<td>a) Collecting distance driven and fuel consumption from monthly operation report of comparable vehicles. b) Based on GPS (preferred), other electronic means or odometer. Continuously, aggregated at least annually</td>
</tr>
<tr>
<td>PFC&lt;sub&gt;i(x),y&lt;/sub&gt;</td>
<td>Project fuel consumption of vehicle category i in year y (mass or volume units of fuel/km)</td>
<td>a) Collecting distance driven and fuel consumption from monthly operation report of comparable vehicles. b) Fuel consumption are summed up the purchase amount from retailer invoices and inputting to an spreadsheet manually. The distance driven are based on GPS (preferred), other electronic means or odometer</td>
</tr>
</tbody>
</table>

13.4 Project emissions (Calculation method 2: for increased transit efficiency activities)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Measurement Method (e.g.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD&lt;sub&gt;i,y&lt;/sub&gt;</td>
<td>Total paid mileage by vehicle category i project vehicles in year y (km)</td>
<td>Based on transactions from taxi drivers. Continuously, aggregated at least annually</td>
</tr>
<tr>
<td>PFC&lt;sub&gt;i(x),y&lt;/sub&gt;</td>
<td>Project fuel consumption of vehicle category i in year y (mass or volume units of fuel/paid mileage km)</td>
<td>a) Collecting distance driven and fuel consumption from monthly operation report of comparable vehicles. b) Fuel consumption are summed up the purchase amount from retailer invoices and inputting to an spreadsheet manually. The distance driven are based on GPS (preferred), other electronic means or odometer</td>
</tr>
</tbody>
</table>

13.5 Other common monitoring parameters

The following parameters are common in monitoring through the methodology.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Measurement Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCV&lt;sub&gt;x&lt;/sub&gt;</td>
<td>Net calorific value of fuel type x (J/mass or volume units of fuel)</td>
<td>a) Value provided by the fuel supplier b) Regional or national default value c) IPCC default values</td>
</tr>
<tr>
<td>EF&lt;sub&gt;CO2,x&lt;/sub&gt;</td>
<td>Carbon emission factor for fuel type x (gCO2/J)</td>
<td></td>
</tr>
</tbody>
</table>
### 13.1 Reference emission (Calculation method 1: for increased vehicle/fuel efficiency activities)

**Option 1**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description of data</th>
<th>Estimated Values</th>
<th>Units</th>
<th>Monitoring Pattern</th>
<th>Source of data</th>
<th>Measurement Methods and procedure</th>
<th>Monitoring Frequency</th>
<th>QA/QC procedures</th>
<th>Other comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCV</td>
<td>Net calorific value of fuel type x in year y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Carbon emission factor for fuel type x in year y</td>
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</table>

**Option 2**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description of data</th>
<th>Estimated Values</th>
<th>Units</th>
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</thead>
<tbody>
<tr>
<td>NCV</td>
<td>Net calorific value of fuel type x in year y</td>
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<td>Carbon emission factor for fuel type x in year y</td>
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</tbody>
</table>

### Option 3

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description of data</th>
<th>Estimated Values</th>
<th>Units</th>
<th>Monitoring Pattern</th>
<th>Source of data</th>
<th>Measurement Methods and procedure</th>
<th>Monitoring Frequency</th>
<th>QA/QC procedures</th>
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</tr>
</thead>
<tbody>
<tr>
<td>NCV</td>
<td>Net calorific value of fuel type x in year y</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Carbon emission factor for fuel type x in year y</td>
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</tr>
</tbody>
</table>

### 13.2 Reference emission (Calculation method 2: for increased (fuel) efficiency activities)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description of data</th>
<th>Estimated Values</th>
<th>Units</th>
<th>Monitoring Pattern</th>
<th>Source of data</th>
<th>Measurement Methods and procedure</th>
<th>Monitoring Frequency</th>
<th>QA/QC procedures</th>
<th>Other comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCV</td>
<td>Net calorific value of vehicle category x in year y</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Carbon emission factor for vehicle category x in year y</td>
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</tr>
</tbody>
</table>

### 13.3 Project emission (Calculation method 1: for increased vehicle/fuel efficiency activities)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description of data</th>
<th>Estimated Values</th>
<th>Units</th>
<th>Monitoring Pattern</th>
<th>Source of data</th>
<th>Measurement Methods and procedure</th>
<th>Monitoring Frequency</th>
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</thead>
<tbody>
<tr>
<td>NCV</td>
<td>Net calorific value of vehicle category x in year y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Carbon emission factor for vehicle category x in year y</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

### 13.4 Project emission (Calculation method 2: for increased (fuel) efficiency activities)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description of data</th>
<th>Estimated Values</th>
<th>Units</th>
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<tbody>
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<td>NCV</td>
<td>Net calorific value of vehicle category x in year y</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
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<td>CO2</td>
<td>Carbon emission factor for vehicle category x in year y</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Table 1. Calculations for emission reductions**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
</tr>
</tbody>
</table>

<table>
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<th>Units</th>
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<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
</tr>
</tbody>
</table>

**Table 2. Set values for calculation of project emissions**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
</tr>
</tbody>
</table>

<table>
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<tr>
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<th>Value</th>
<th>Units</th>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
</tr>
</tbody>
</table>

**Table 3. Calculations for project emissions**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
</tr>
</tbody>
</table>

**Table 4. Calculations for reference emissions**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
<td>tCO2/y</td>
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<td>tCO2/y</td>
</tr>
</tbody>
</table>

**Table 5. Calculations for reference emissions**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>tCO2/y</td>
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<td>tCO2/y</td>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
<td>tCO2/y</td>
<td>0.00</td>
<td>tCO2/y</td>
</tr>
</tbody>
</table>
1. Calculations for emission reductions

<table>
<thead>
<tr>
<th>Vehicle category</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Set values for calculation of project emissions

<table>
<thead>
<tr>
<th>Value 1</th>
<th>Value 2</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Calculations for project emissions

<table>
<thead>
<tr>
<th>Vehicle category</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Set values for calculation of reference emissions

<table>
<thead>
<tr>
<th>Value 1</th>
<th>Value 2</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Calculations for reference emissions

<table>
<thead>
<tr>
<th>Vehicle category</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Emission Reductions during the Period of Year Y

#### Values
- **Emission Reductions during the Period of Year Y:** 0.00 tCO₂/y

#### Units
- **Year:** y

### Occupation Improve Rate by Transit Efficiency Measures

- **NCVx:** 0

### Reference Emissions during the Period of Year Y

- **RFCi(x),y:** 48,741.92 tCO₂/y

### Fuel Properties

- **GJ/1000Nm³:** 43.5

### CO₂ Emission Factor of Fossil Fuel

- **tCO₂/GJ:** 0.0666 kg/km

### Specific Fuel Consumption Rate

- **L/km:** 0.0555

### Paid Mileage Distance

- **km/yr:** 10,000,000

### Occupation Rate to DD

- **45%**

### Net Calorific Value of Fossil Fuel

- **GJ/kl:** 37.7

### CO₂ Emission Factor of Fossil Fuel

- **tCO₂/GJ:** 0.0687

### Specific Fuel Consumption Rate

- **L/km:** 0.0889

### Paid Mileage Distance

- **km/yr:** 10,000,000

### Occupation Rate to DD

- **40%**

### Net Calorific Value of Fossil Fuel

- **GJ/kl:** 33.0

### CO₂ Emission Factor of Fossil Fuel

- **tCO₂/GJ:** 0.0693

### Specific Fuel Consumption Rate

- **L/km:** 0.0777

### Paid Mileage Distance

- **km/yr:** 10,000,000

### Occupation Rate to DD

- **45%**

### Net Calorific Value of Fossil Fuel

- **GJ/kl:** 43.5

### CO₂ Emission Factor of Fossil Fuel

- **tCO₂/GJ:** 0.0599

### Specific Fuel Consumption Rate

- **L/km:** 0.0740