T-VER-P-METH-04-01

Switching from Internal Combustion Engine Vehicles to Battery Electric Vehicle

Version 03

Sector 07: Transportation

Entry into force on 27 November 2024

1. Methodology	Switching from Internal Combustion Engine Vehicles to Battery Electric Vehicle
2. Project Type	Use of electric vehicle
3. Sector Scope	07 - Transportation
4. Project Outline	Emission reduction by using of electric vehicles from batteries to replace internal combustion engine vehicles for passenger or cargo transportation or personal use.
5. Applicability	It is the use of battery-powered electric vehicles for the transport of passengers or freight or private use, which are a new purchase or lease or rent, to replace internal combustion engine vehicles. This includes the modification of internal combustion engine vehicles to battery electric vehicles (electric vehicle conversion).
6. Project Conditions	1. Internal combustion engine vehicles (Baseline vehicle) and battery electric vehicles (Project activity) must be of the same type. 2. Battery electric vehicles must have a maximum load (for bus or truck) or engine power (for 4 wheels vehicles, motorcycle, and motor tricycle) difference of not more than 20 percent compared to baseline vehicle. 3. Electric vehicle conversion (a modification of internal combustion engines vehicle with battery electric vehicles) must comply with the law (Motor Vehicle Act / Land Transport Act). For other uses without law regulation, the EV conversion must have certified by a licensed engineer in Thailand. 4. Battery electric vehicle must be able to monitor the electricity consumption for charging and the travel distance. 5. The project owner or the project developer which uses a battery electric vehicle must demonstrate guidelines for managing damaged or end-of-life batteries. 6. Types of motor vehicles must comply with the law (Motor Vehicle Act/Land Transport Act) by the types that fall within the scope of: - 4-wheel vehicles such as sedans, pickup trucks, taxis, vans, etc.

	- Motorcycle - Motor tricycle (Tuk Tuk) - Bus - Truck 7. Bus is not included in project activity. 8. The electricity supplied to the charging station under the project boundary must not be generated using renewable source. 9. Internal combustion engine vehicles (Baseline vehicle) must not be used as the vehicle outside project boundary, which the project developer will have to have the evidence to prove. This is not included the electric vehicle conversion.
7. Project Starting Date	The date is that the project owner (buyer/rental) and the vendor/ the lessor have signed to purchasing agreement or hire purchase agreement or rental agreement in battery electric vehicle for the project of greenhouse gas emission reduction which will be developed to the T-VER project.
8. Definition	**Battery Electric Vehicle (BEV)** is a vehicle that uses only an electric motor to drive by using electric battery power.

Details of T-VER methodology for

Switching from Internal Combustion Engine Vehicles to Battery Electric Vehicle

1. Greenhouse gas emission reduction activities used in the calculations

Table 1. Sources and types of greenhouse gases

Greenhouse gas emission	Source	Greenhouse Gas	Details of activities that emit greenhouse gas emissions
Baseline Emission	Fossil fuel consumption	CO_2	The use of fossil fuels from internal combustion engine vehicles.
Project Emission	Electric power consumption	CO_2	The use of electricity for a battery electric vehicle
Leakage Emission	irrelevant	-	-

2. Scope of Project

2.1 Project Characteristics

It is a project that implements battery electric vehicles to replace fossil-fuel-powered internal combustion engine vehicles for passenger or freight or personal transport.

2.2 Project scope

1. Businesses for the transportation of passengers or freight or personal vehicles that use battery electric vehicle include:

(1) Travelled area for battery electric vehicles

(2) Other facilities such as gas stations, automotive repair shop, and service stations, etc., where the charging station is not within the scope of the project

2. Conditions governing the operation of a service business (such as tax rates, regulations)

3. Additionality

The project must undergo further proof of operation from normal operations. (Additionality) by using the “Proof of Operations Guidelines in addition to normal operations (Additionality) under the Thailand Voluntary Emission Reduction Program (T-VER)" as prescribed by TGO. Including project participants using battery electric vehicles that are subsidized by government measures to support the use of electric vehicles. Additional financial proof of operations must be established. All direct and indirect contributions, such as direct subsidies and tax breaks, are taken into account. Including project participants using battery electric vehicles that are subsidized by government measures to support the use of electric vehicles. Additional financial proof of operations must be established. All direct and indirect contributions, such as direct subsidies and tax breaks, are taken into account.

4. Baseline Scenario

Considering the guidelines for determining the baseline data based on the concept of Below Business as Usual (Below BAU), the baseline data for greenhouse gas emissions from the natural gas consumption of internal combustion engine vehicles for passenger transport or freight or private transportation. That is replaced by the electricity consumption supplied from the national grid for battery electric vehicles for transporting passengers or transporting goods or private transportation. Therefore, the baseline data is the use of natural gas of using internal combustion engine vehicles.

5. Baseline Emission

Baseline emission consider only the carbon dioxide (CO_2) emissions from the use of natural gas as fuel for internal-combustion-engine vehicles, based on passenger and freight load or traveled distance by battery electric vehicles. It has two approaches: greenhouse gas emissions from passenger or freight transport and greenhouse gas emissions from the private use.

5.1 Option I : Calculation based on passenger or freight transport

$$BE_y = \sum P_{i,y,k} \times BEF_i \times dP_{i,y} \qquad \text{Equation (1)}$$

Where

BE_y = Baseline emissions in year y (tCO_2/year)

$P_{i,y,k}$ = Total annual passengers or tons of goods transported by each project vehicle i in year y on route k

BEF_i = Baseline emission factor per passenger or ton of goods per kilometre for the baseline vehicle i (t CO_2/passenger-km or t CO_2/ton-km)

dp_i = The annual average distance of transportation per person or tonne of freight by each baseline vehicle i (km)

5.1.1 Calculation of the number of passengers or the total weight of the annual cargo transported

$$BEF_t = \frac{\sum_j \sum_i D_i \times \eta_{BLVi} \times NCV_j \times EF_{CO2,NG}}{P_i \times dp_i}$$

Equation (2)

Where;

BEF_t = Baseline emission factor per passenger or ton of goods per kilometre for the baseline vehicle i (t CO_2/passenger-km or t CO_2/ton-km)

P_i = Total annual passengers or tons of goods transported by each baseline vehicle i (passengers or tons)

dp_i = The annual average distance of transportation per person or tonne of freight by each baseline vehicle i (km)

D_i = Total annual distance travelled by each baseline vehicle i (km)

η_{BLVi} = Fuel efficiency of baseline vehicle i (unit/km)

NCV_j = Net calorific value of fuel j (GJ/unit)

$EF_{CO2,NG}$ = CO_2 emissions factor of natural gas (tCO_2/GJ) equal to 56,100 tCO_2/GJ

5.1.2 Calculating the fuel efficiency of vehicles

There are three options for calculating the fuel efficiency of a vehicle:

Option 1 The vehicle can be identified from the base case with similar operating conditions or in a similar area. The η_{BLVi} value is determined from the average operating data of vehicles under operating conditions from the base vehicle. The historical data for at least 1 year is collected for non-standard vehicles such as tricycles, η_{BLVi} values can be defined in two ways:

1) Measure the actual fuel consumption and corresponding distance travelled of a sample of baseline vehicles operating in comparable traffic situations with a similar age or newer, a similar or smaller engine size (for 4 wheels vehicles, motorcycle, and motor tricycle), a

similar or lower passenger/goods load capacity, and a similar weight or lighter and other relevant factors to distinguish vehicles with different fuel consumption rates.

2) Use a fuel efficiency value from a peer-reviewed literature source or report authored by a nationally/internationally recognized independent third party or a research institute under the following two conditions to ensure conservative value:

2.1) The fuel efficiency value was derived from measurements taken under highway driving conditions or similar non-urban traffic conditions;

2.2) The fuel efficiency values for baseline vehicles are derived with characteristics leading to similar or lower emissions as compared to the baseline vehicles, for example use fuel efficiency values for vehicles of a similar age or newer, a similar or smaller engine size (for 4 wheels vehicles, motorcycle, and motor tricycle), a similar or lower passenger/goods load capacity, and a similar weight or lighter and other relevant factors to distinguish vehicles with different fuel consumption rate;

Option 2 If no specific baseline vehicle can be identified or appropriate operational data is not available, then fuel efficiency should be obtained through a statistically significant control group or existing statistics that are regularly updated. Such a control group or the source of data must have similar or conservative characteristics with respect to vehicle age (equal or newer), traffic conditions (equal or better), and air conditioning. The choice of such control group will be, in descending order:

1) Fleet of the same company operating simultaneously with the project activity;

2) Fleet of company with similar operations operating simultaneously with the project activity;

3) Host country statistics.

4) IPCC or other international data such as EU Standard vehicle emission calculator (COPERT).

Under this option fuel, η_{BLVi} is monitored throughout the project crediting period thus gradual efficiency improvements of the fleet or gradual deterioration of driving conditions would automatically be incorporated into the project efficiency level.

Option 3, where neither Option (1) nor (2) is feasible then baseline fuel efficiency is determined by using the fuel efficiency of top 20% of the fleet before project activity, as determined according to travel distance of each vehicle for the previous three years or according

to manufacturers' specifications of the comparable new baseline vehicles. If no data exists for the time period, a shorter period can be chosen, with a minimum period of one year.

5.2 Option II: Calculation based on the use of personal vehicles

Greenhouse gas emissions from the use of vehicles. There are two approaches of calculating, the details are as follows:

Approach 1: Using distance travelled by project vehicles

$$BE_y = \sum_i EF_{BL,km.i} \times DD_{i,y} \times N_{i,y} \times 10^{-6} \quad \text{Equation (3)}$$

Where;

BE_y = Baseline emissions in year y (tCO_2/year)

$EF_{BL,km.i}$ = Emission factor for baseline vehicle category i (gCO_2/km)

$DD_{i,y}$ = Annual average distance travelled by project vehicle category i in the year y (km)

$N_{i,y}$ = Number of operational project vehicles in category i in year y

Approach 2: Using the electricity used to charge the vehicles

$$BE_y = \sum_i EF_{BL,km,i} \times \frac{EC_{PJ,y}}{SEC_{PJ,km,i,y}} \quad \text{Equation (4)}$$

Where

BE_y = Baseline emissions in year y (tCO_2/year)

$EC_{PJ,y}$ = The electricity consumed for charging project vehicles category i at the charging stations/points in year y (kWh)

$EF_{BL,km,i}$ = Emission factor for baseline vehicle category i (tCO_2/km)

$SEC_{PJ,km,i,y}$ = Specific electricity consumption per km per project vehicle category i in year y (kWh/km)

i = Vehicle type

1) The Emission factor for baseline vehicle category ($EF_{BL,km,i}$) shall be determined as follows:

$$EF_{BL,km,i} = SFC_i \times NCV_{BL,i} \times EF_{CO2,NG} \times IR^t \quad \text{Equation (5)}$$

Where;

SFC_i = Specific fuel consumption of baseline vehicle category i (unit/km)

$NCV_{BL,i}$ = Net calorific value of fossil fuel consumed by baseline vehicle category i (GJ /unit)

$EF_{CO2,NG}$ = Emission factor of natural gas consumed by baseline vehicle category i (tCO_2 /GJ) equalled to 56,100 tCO_2/GJ

IR^t = Technology improvement factor for baseline vehicle in year t.
The improvement rate is applied to each calendar year. The default value of the technology improvement factor for all baseline vehicle categories is 0.99

T = Year counter for the annual improvement (dependent on age of data per vehicle category)

Remark: In case of electric buses or electric trucks, option II would be applicable to calculate baseline emission, only if the annual freight load or the annual passenger load for baseline activity and project activity must be different with not over 5 percent.

1.1) Guidelines for determination of SFC_i

There are 5 options to determination of SFC_i the details are as follows.

Option (1): Sample measurement

Measure the actual fuel consumption rate of a representative sample of vehicles for each vehicle category identified for driving condition. Vehicle categories shall be determined conservatively and be based on the fuel type used, the vehicle category, engine model year, power rating, passengers load, auxiliary equipment (e.g. with and without air conditioners) and other relevant factors to distinguish vehicles with different fuel consumption rates. The sample vehicles are statistically randomly selected using Taro Yamane's table with a 95% confidence level and a 10% error, detailed in Annex 1.

Option (2): Top 20 percent of the comparable vehicles used for public/private transportation.

The specific fuel consumption for comparable vehicles is estimated using the specific fuel consumption for driving condition obtained from manufacturer's specification of the top 20 percent of vehicles operated/used for public/private transportation in the project region.

Option (3): Using operational data of the vehicles under baseline operational conditions.

A specific baseline vehicle can be identified under the same travel area and with similar operating conditions. The vehicle will not be replaced over the life of the project, the following options appliy:

(a) Specific fuel consumption (SFC_i) is determined from the average operational data of the vehicles under baseline operating conditions, using at least one year of operational data, if that data is available, Otherwise

(b) SFC_i should be obtained from manufacturer's specifications, if it can be demonstrated that the value is conservative given the operating conditions of the baseline vehicles (e.g. values for specific fuel consumption under standard testing conditions provided by the manufacturers). This may be the case when the project activity introduces new vehicles, and the baseline vehicle is also new and provides a similar service.

In project activities, baseline vehicles for non-standard vehicles such as jeepneys or tricycles, which they are assembled locally, and the manufacturer's data are not available, the specific fuel consumption may be determined using one of the following two options:

(a) Measure the actual fuel consumption and corresponding distance travelled of a sample of baseline vehicles operating in comparable traffic situations with a similar age or newer, a similar or smaller engine size, a similar or lower passenger/goods load capacity, and a similar weight or lighter and other relevant factors to distinguish vehicles with different fuel consumption rates. The sample vehicles are statistically randomly selected using Taro Yamane's table with a 95% confidence level and a 10% error, detailed in Annex 1.

(b) Use a specific fuel consumption value from peer-reviewed literature source or report authored by a nationally/internationally recognized independent third party

or a research institute under the following two conditions to ensure conservative value:

(1) The specific fuel consumption value was derived from measurements taken under highway driving conditions or similar non-urban traffic conditions;

(2) The specific fuel consumption value for baseline vehicles was derived with characteristics leading to similar or lower emissions as compared to the baseline vehicles, for example use specific fuel consumption values for vehicles of a similar age or newer, a similar or smaller engine size, a similar or lower passenger/goods load capacity, and a similar weight or lighter and other relevant factors to distinguish vehicles with different fuel consumption rate.

Option (4): Using data from a control group of vehicles

If baseline vehicle cannot be identified or appropriate operational data are not available, then specific fuel consumption should be obtained through a statistically significant control group or existing statistics that are regularly updated. Such a control group or the source of data must shall have similar or conservative characteristics with respect to vehicle age (equal or newer), traffic conditions (equal or better), and air conditioning. The choice of such control group will be, in order of preference:

(a) Fleet of the same company operating simultaneously with the project activity.
(b) Fleet of company with similar operations operating simultaneously with the project activity.
(c) Host country statistics.
(d) IPCC or other international data such as EU Standard vehicle emissions calculator (COPERT)

Under this option specific fuel consumption is monitored throughout the crediting period. Then, decrease gradually for efficiency improvement of the fleet or deterioration of driving conditions would be considered for the project efficiency levels.

Option (5): Existing statistics

If the above options are not applied due to lack of data, other published statistics could be used as the default values, such as host country statistics (released by transportation department or other authorities), IPCC or other international data.

6. Project Emission

Greenhouse gas emissions from the project activity are considered only carbon dioxide (CO_2) emissions from the use of electricity supplied by the National Grid for battery electric vehicles. For transporting passengers or transporting goods or private use can be calculated as follows

6.1 Option I : Calculation based on passenger or freight transport from project implementation.

Project Emission from the transportation of passengers or goods from the project implementation are determined by the electric power of battery-powered vehicles. can be calculated as follows

$$PE_y = \sum_i EC_{i,y} \times EF_{Elec,y} \quad \text{Equation (6)}$$

Where:

PE_y = Total project emissions in year y (t CO_2/yr)

$EC_{i,y}$ = Consumption of electricity by vehicle i in year y (MWh/yr)

$EF_{Elec,y}$ = Emission factor for electricity generation/consumption in year y (tCO_2/MWh)

6.2 Option II: Calculation based on using personal vehicles.

Project emission from using personal vehicles is determined by the use of electricity to charge a battery-powered vehicle. can be calculated as follows

$$PE_y = \sum_i EF_{PJ,km,i,y} \times \frac{EC_{PJ,i,y}}{SEC_{PJ,km,i,y}} \quad \text{Equation (7)}$$

or

$$= \sum_i EF_{PJ,km,i,y} \times DD_{i,y} \times N_{i,y} \quad \text{Equation (8)}$$

Where:

PE_y = Total project emissions in year y (tCO_2/yr)

$EC_{PJ,y}$ = Electricity consumed by the project vehicles of type i in year y (kWh)

$EF_{PJ,km,i,y}$ = Emission factor per kilometre travelled by the project vehicle type i (tCO_2/km)

$SEC_{PJ,km,i,y}$ = Specific electricity consumption by project vehicle category i per km in year y in urban conditions (kWh/km)

$DD_{i,y}$ = Annual average distance travelled by project vehicle category i in the year y (km)

$N_{i,y}$ = Number of operational project vehicles in category i in year y

i = Vehicle types of project activities

The emission factor of the project vehicles shall be established as follows:

$$\mathbf{EF_{PJ,km,i,y}} = \sum_{i} \mathbf{SEC_{pj,km,i,y} \times EF_{Elec,y}/(1\text{-}TDL_y) \times 10^{-3}} \quad \text{Equation (8)}$$

Where;

$SEC_{pj,km,i,y}$ = Specific electricity consumption by project vehicle category i per km in year y in urban conditions (kWh/km)

$EF_{Elec,y}$ = Emission factor for electricity generation/consumption in year y ($tCO/_2MWh$)

TDL_y = Average technical transmission and distribution losses for providing electricity in the year y

7. Leakage Emission

No leakage calculation is required.

8. Emission Reduction

Emission reduction from the project can be calculated as follows:

$$\mathbf{ER_y = BE_y - PE_y - LE_y} \quad \text{Equation (9)}$$

Where

ER_y = Emission reductions in year y (tCO_2e/year)

BE_y = Baseline emissions in year y (tCO_2e/year)

PE_y = Baseline emissions in year y (tCO_2e/year)

LE_y = Leakage emissions in year y (tCO_2e/year)

9. Monitoring Plan

9.1 Monitoring methodology

1) The project developer explains and specifies the steps for monitoring the project activity data (Activity data) or verify all measurement results in the project proposal document. including the type of measuring instruments used Person responsible for monitoring results and verifying information Calibration of measuring instruments (if any) and procedures for warranty and quality control Where methods have different options, such as using default values or on-site measurements The project developer must specify which option to use. In addition, the installation, maintenance and calibration of measuring instruments should be carried out in accordance with the instructions of the equipment manufacturer and in accordance with national standards. or international standards such as IEC, ISO

2) All data collected as part of the greenhouse gas reduction monitoring. The data should be stored in electronic file format and the retention period is in accordance with the guidelines set by the Administrative Organization or the organization's quality system, but the period of time is not less than that specified by the TGO. Must follow the follow-up methods specified in the follow-up parameters specified in Table 9.2.

9.2 Data and parameters monitored

9.2.1 Data and parameters monitored from greenhouse gas emissions from passenger or freight transport

Data / Parameter:	$\eta_{BLV,i}$
Data unit:	-
Description:	Fuel efficiency of baseline vehicle (unit/km)
Source of data:	According to section 5.1.2. Calculation of fuel efficiency of vehicles.
Measurement procedures:	According to section 5.1.2. Calculation of fuel efficiency of vehicles.
Monitoring frequency:	At the start of the crediting period
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$EC_{i,y}$
Data unit:	MWh/yr
Description:	Consumption of electricity by vehicle i in year y (MWh/yr)

Source of data:	Report on the amount of electricity consumption at the charging station
Measurement procedures:	-
Monitoring frequency:	The electric charge report is reviewed by the driver's report or invoice from the charging station.
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$EF_{Elec,y}$
Data unit:	tCO_2/MWh
Description:	Emission factor for electricity generation/consumption in year y
Source of data:	Report on greenhouse gas emissions (Emission Factor) from electricity generation/consumption for projects and activities of greenhouse gas reduction published by TGO.
Measurement procedures:	**For the preparation of project design documents** Use the latest $EF_{Elec,y}$ published by TGO **For carbon credit issuance** Use the $EF_{Elec,y}$ values announced by TGO according to the year of the carbon credit issuance. However, in the case that the year of the carbon credit issuance does not have $EF_{Elec,y}$ values published by TGO, use the latest $EF_{Elec,y}$ values published by TGO in that year instead.
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	P_i
Data unit:	passengers or tons
Description:	Total annual passengers or goods transported by each baseline vehicle
Source of data:	-
Measurement procedures:	Monitored data before project begins
Monitoring frequency:	At the start of the crediting period
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$P_{i,y,k}$
Data unit:	passengers or tons
Description:	Total annual passengers or goods transported by each project vehicle in year y on route k
Source of data:	Data monitored during the project, for example travel record and route maps plus receipts/invoices, ticketing data
Measurement procedures:	-
Monitoring frequency:	Annual
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	D_i
Data unit:	km
Description:	Total annual distance travelled by each baseline vehicle
Source of data:	-
Measurement procedures:	Monitored data before project begins
Monitoring frequency:	At the start of crediting period
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$dp_{i,y}$
Data unit:	km
Description:	Annual average distance of transportation per passenger or tonne by each project vehicle i
Source of data:	Monitored through company/operators records
Measurement procedures:	-
Monitoring frequency:	At the start of crediting period
QA/QC procedures:	-
Any comment:	-

9.2.1 Data and parameters monitored from using personal vehicles.

Data / Parameter:	$DD_{i,y}$
Data unit:	km
Description:	Annual average distance driven by project vehicle i in year y (km/yr)
Source of data:	Measurement
Measurement procedures:	Measure the annual average distance driven by the project vehicles through: Option (A): monitoring of all vehicles or Option (B): representative sample survey of vehicles for each vehicle category. The sample vehicles are statistically randomly selected using Taro Yamane's table with a 95% confidence level and a 10% error, detailed in Annex 1.
Monitoring frequency:	-

Data / Parameter:	TDL_y
Data unit:	-
Description:	Average technical transmission and distribution losses for providing electricity to source j in year y
Source of data:	Option 1 Measurement report In the case of information on the amount of electricity released from the producer and the amount of electricity received by the consumer Option 2 uses a Default Value of 0.03 (3%).
Measurement procedures:	1) If using Option 1, the project developer will have to monitor the value every year throughout the monitoring of greenhouse gas emissions reductions. 2) If using Option 2, the project developer must use this value throughout the monitoring of greenhouse gas emissions reductions.
Monitoring frequency:	Defined once in the first year of the credit period.
QA/QC procedures:	If the measurement results differ from previous measurements or other sources that are significantly related make additional measurements.
Any comment:	-

Data / Parameter:	$SEC_{PJ,km,i,y}$
Data unit:	kWh/km
Description:	Specific electricity consumption per km of project vehicle category i in year y
Source of data:	Measurement

Measurement procedures:	Measure the specific electricity consumption through: Option (A): monitor electricity consumption of all project vehicles or Option (B): measure the amount of electricity consumed per km travelled for a representative sample of each vehicle category. The sample vehicles are statistically randomly selected using Taro Yamane's table with a 95% confidence level and a 10% error, detailed in Annex 1.
Monitoring frequency:	-

Data / Parameter:	$N_{i,y}$
Data unit:	-
Description:	Number of project vehicle in operation in year y
Source of data:	-
Measurement procedures:	Establish the number of the project vehicles in operation through: Option (A): based on annual sales records or official data on registered project vehicles cross-checked against the results from a representative sample survey vehicles to determine the percentage of vehicles in use or Option (B): based on annual sales records or official data for registered project vehicles, multiplied by the default factor 0.9t, where t is year counter for the number of years since the vehicle was introduced (for example: if n vehicles are sold in year 1, in year 2 the number of vehicles still in operation are assumed to be equal to n*0.9, and in year 3, n*0.92, etc.)
Monitoring frequency:	-

Data / Parameter:	$EC_{PJ,i,y}$
Data unit:	kWh
Description:	Electricity consumed by the project vehicles of type i in year y
Source of data:	Electric charging records at the charging station
Measurement procedures:	-
Monitoring frequency:	The electric charging records will be checked by driver records or invoices from electricity filling station

9.3 Data and parameters not monitored

Data / Parameter:	$EF_{CO2,NG}$
Data unit:	tCO_2/GJ

Description:	CO_2 emissions factor of natural gas
Source of data:	Table 1.4 2006 IPCC Guidelines for National GHG Inventories
Value to be applied:	56,100

Data / Parameter:	NCV_j and $NCV_{BL,i}$
Data unit:	MJ/Unit
Description:	The net calorific value of type j fossil fuel used/ Net calorific value of fossil fuel consumed by baseline vehicle category i
Source of data:	Option 1 The net calorific value of fossil fuels stated in the invoice from the fuel supplier. Option 2 from the measurement Option 3 Thailand Energy Statistics Report Department of Alternative Energy Development and Efficiency Ministry of Energy Option 4 Reference values from the IPCC Table 1.2 in Chapter 1 of the 2006 IPCC Guidelines on National GHG Inventories Vol.2 (Energy).
Measurement procedures:	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

10. References

1) Clean Development Mechanism (CDM)

AMS-III.S : Small-scale Methodology: Introduction of low-emission vehicles/technologies to commercial vehicle fleets Version 04.0

AMS-III.C : Small-scale Methodology: Emission reductions by electric and hybrid vehicles Version 15.0

Appendix 1 Taro Yamane Sample Determination

Formula for finding the number of samples of Taro Yamane (Taro Yamane, 1973) according to Equation (1).

$$n = \frac{N}{1+Ne^2}$$ Equation (1)

Where n = number of samples

N = population

e = Tolerance

Table 1 Taro Yamane sample size at 95% confidence level and various discrepancies

Population	Sample size at the tolerance level (e)					
	± 1%	± 2%	± 3%	± 4%	± 5%	± 10%
500	*	*	*	*	222	83
1,000	*	*	*	385	286	91
1,500	*	*	638	441	316	94
2,000	*	*	714	476	333	95
2,500	*	1,250	769	500	345	96
3,000	*	1,364	811	517	353	97
3,500	*	1,458	843	530	359	97
4,000	*	1,538	870	541	364	98
4,500	*	1,607	891	549	367	98
5,000	*	1,667	909	556	370	98
6,000	*	1,765	938	566	375	98
7,000	*	1,842	959	574	378	99
8,000	*	1,905	976	580	381	99
9,000	*	1,957	989	584	383	99
10,000	5,000	2,000	1,000	588	385	99
15,000	6,000	2,143	1,034	600	390	99
20,000	6,667	2,222	1,053	606	392	100
25,000	7,143	2,273	1,064	610	394	100
50,000	8,333	2,381	1,087	617	397	100
100,000	9,091	2,439	1,099	621	398	100
∞	10,000	2,500	1,111	625	400	100

Document information T-VER-P-METH-04-01

Version	Amendment	Entry into force	Description
03	2	27 November 2024	- Revise the project condition of item 2 - Revise the measurement condition of fossil fuel efficiency for baseline vehicle - Add the condition for the use of equation with option II (Based on vehicle's distance) to determine baseline emission - Add the alternate equation for project emission calculation in addition to equation (4)
02	1	26 July 2023	- Add the project condition related to EV conversion for other use that are not regulated by law
01	-	1 March 2023	- Change document code from TVER-METH-04-01 Version 01. - Add the definition of project starting date. - Change the sign and the meaning for parameter of $EF_{grid,y}$ and revise the data sources.
01	-	30 November 2022	Initial adoption.