VCS Methodology

VMR0004

IMPROVED EFFICIENCY OF FLEET VEHICLES

Version 2.0

04 October 2024

Sectoral Scope 7: Transport

This methodology was developed by dynaCERT, based on CDM methodology *AMS-III.BC Emission Reductions Through Improved Efficiency of Vehicle Fleets*, *v3.0*. It also incorporates elements from *VMR0004 Revisions to AMS-III.BC to Include Mobile Machinery, v1.0* that was developed by Carbon Offset Aggregation Cooperative and Grütter Consulting AG.

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1 SUMMARY DESCRIPTION OF THE METHODOLOGY

Additionality, Crediting Method, and Mitigation Outcome	
Additionality	Project Method
Crediting Baseline	Project Method
Mitigation Outcome	Reductions

This methodology is globally applicable to project activities that improve the efficiency of vehicle fleets, including transport vehicles and mobile machinery (e.g., fleets of trucks, buses, cars, taxis or motorized tricycles, excavators, cranes), resulting in reduced fuel usage and greenhouse gas (GHG) emissions.

It is not applicable to fuel switch activities and measures that improve fleet system efficiency, such as changes to operational procedures.

Project activities that introduce new electric or hybrid vehicles to replace fossil fuel vehicles must apply *AMS-III.C Emission Reductions by Electric and Hybrid Vehicles*. Where both energy efficiency measures and new electric or hybrid vehicles are implemented in the vehicle fleets, the project proponent may apply both methodologies to the project activity.

Similarly, project activities that switch from fossil fuels to biofuels may apply this methodology in conjunction with another VCS-eligible methodology, where both energy efficiency measures and fuel switching are implemented in vehicle fleets.

The methodology is based on CDM methodology *AMS-III.BC Emission Reductions Through Improved Efficiency of Vehicle Fleets, v3.0* and *VMR0004 Revisions to AMS-III.BC to Include Mobile Machinery, v1.0*.

2 SOURCES

This methodology is based on the following methodologies:

- *AMS-III.BC Emission Reductions Through Improved Efficiency of Vehicle Fleets, v3.0*
- *VMR0004 Revision to AMS-III.BC to Include Mobile Machinery, v1.0*

This methodology uses the most recent versions of the following sources:

- *VT0008 Additionality Assessment*[1]
- *VT0011 Electricity System Emission Factors*[2]

3 DEFINITIONS

In addition to the definitions set out in the *VCS Program Definitions*, the following definitions apply to this methodology.

Activity level
Index used to determine the output level of the vehicle (e.g., kilometers traveled) or mobile machinery (e.g., machine-hour or gross tonne-hour of the machine)

Gross vehicle weight (GVW)
Maximum allowable total weight of a vehicle when loaded, including fuel, passengers, and cargo, as specified by the vehicle manufacturer

Measure
Any equipment or device that reduces fuel or electricity consumption in vehicles while maintaining or enhancing the level of service. See Appendix 1 for detailed descriptions of applicable measures under this methodology.

Mobile machinery
A vehicle category consisting of equipment that is not fixed at a specific site but can be moved around either under its own power or with assistance when engineering specifications or logistics dictate (e.g., moving a loader using a low bed rather than driving the loader to the destination). Examples include stationary internal combustion generators, excavators, log harvesting bunchers, log loaders, cranes, timber processors, fork-lifters, road-building machines, and bulldozers.

Telematics system
Method of monitoring cars, trucks, equipment, and other assets by using global positioning system (GPS) technology and on-board diagnostics (OBD) to plot the asset's movements on a computerized map. By connecting to the OBD, telematics devices retrieve data generated by the vehicle, such as GPS position, speed, fuel usage, engine light information, and faults.

[1] This tool is currently under development and will be published shortly after the publication of this methodology

[2] This tool is currently under development and will be published shortly after the publication of this methodology

Vehicle
A motorized device used for the transportation of people, goods, or the performance of specific tasks. It includes both transport vehicles (e.g., cars, taxis, motorized tricycles, trucks, buses) and mobile machinery (e.g., excavators, cranes).

Vehicle category
The classification of motorized devices based on their design, purpose, and gross vehicle weight (GVW), including:

1) Trucks with a gross vehicle weight (GVW) greater than 3.5 t;
2) Trucks with a GVW equal to or less than 3.5 t;
3) Buses with a GVW greater than 3.5 t;
4) Taxis: significantly different taxi types (e.g., conventional cars, minibuses, jeepneys) must be considered as separate vehicle categories;
5) Passenger cars (e.g., company cars, rental cars);
6) Motorized tricycles (e.g., used as taxis or for deliveries); and
7) Mobile machinery.

Vehicle fleet
A collection of multiple vehicles of the same vehicle category. Project vehicle fleets may use various fuel types. A fleet operator may have multiple fleets.

4 APPLICABILITY CONDITIONS

This methodology applies to project activities that improve vehicle efficiency in fleets, resulting in reduced fuel usage and GHG emissions.

This methodology is applicable under the following conditions:

1) Project activities implement one or more of the following measures (see Appendix 1 for a description of each measure):
    a) Idling stop device
    b) Eco-drive system
    c) Tire-rolling resistance improvements
    d) Air-conditioning system improvements
    e) Use of low-viscosity oils
    f) Aerodynamic drag reduction
    g) Transmission improvements

h) Retrofits that improve engine or combustion efficiency or both

i) Other energy efficiency improvements. Such other measures must have been demonstrated to lead to fuel savings in independent third-party studies.

The measures implemented may vary across vehicles in the fleet(s).

2) Where the project proponent is not the owner of the vehicle fleets (e.g., the project proponent is a fleet manager with many clients), a contract exists between the project proponent and each fleet owner to establish clear ownership of the emission reductions.

3) Only vehicles in which at least one of the ex-ante-identified project activity measures has been implemented are included as project vehicles.

4) A project activity may encompass various fleets.

Note—The use of a fixed biofuel blend or plug-in hybrid electric vehicle (PHEV) is permitted, provided that the project vehicles use the same biofuel blend or electricity-to-fuel ratio as the baseline vehicles.

This methodology is not applicable under the following conditions:

5) The measures improve fleet system efficiency, such as changes in operational procedures to increase vehicle occupancy rates or shifts in transportation modes.

6) The project activities involve fuel switch activities. Project activities that introduce new electric or hybrid vehicles to replace fossil fuel vehicles may apply the CDM methodology *AMS-III.C Emission Reductions by Electric and Hybrid Vehicles* or other VCS-eligible methodologies for switching from fossil fuels to biofuels.

5 PROJECT BOUNDARY

The project boundary is the physical geographic location of the vehicles that are part of the project activity. The spatial extent of the project boundary encompasses the geographic area of the trips and areas of operation of the project vehicles.

The greenhouse gases included in or excluded from the project boundary are shown in Table 1.

Table 1: GHG sources included in or excluded from the project boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Vehicles exhaust gas	CO_2	Yes	Major source of GHG emissions in the exhaust gas
		CH_4	No	Excluded for simplification. This is conservative.

		N_2O	No	Excluded for simplification. This is conservative.
		Other	No	Negligible in the exhaust gas
	Electricity consumption from the grid	CO_2	Yes	Major source of GHG emissions
		CH_4	No	Negligible
		N_2O	No	Negligible
		Other	No	Negligible
Project	Vehicle exhaust gas	CO_2	Yes	Major source of GHG emissions in the exhaust gas
		CH_4	No	Excluded for simplification. This is conservative since the emissions are higher in the baseline.
		N_2O	No	Excluded for simplification. This is conservative since the emissions are higher in the baseline.
		Other	No	Negligible in the exhaust gas
	Electricity consumption from the grid	CO_2	Yes	Major source of GHG emissions
		CH_4	No	Negligible
		N_2O	No	Negligible
		Other	No	Negligible

6 BASELINE SCENARIO

The baseline scenario is the operation of a group of vehicles of the same fleet without energy efficiency measures, providing comparable transportation and operational services as the project vehicles.

7 ADDITIONALITY

This methodology uses a project method for the demonstration of additionality. Project proponents using this methodology must:

1) Demonstrate regulatory surplus;
2) Conduct an investment analysis and/or identify implementation barriers; and
3) Demonstrate that the project activity is not common practice.

7.1 Regulatory Surplus

The project proponent must demonstrate regulatory surplus in accordance with the rules and requirements regarding regulatory surplus set out in the most recent versions of the *VCS Standard* and *VCS Methodology Requirements*.

The regulatory surplus must be assessed for each of the energy efficiency measures included in the project activity.

7.2 Investment Analysis and Implementation Barriers

The project proponent must conduct either an investment analysis (Section 7.2.1) or a barrier analysis (Section 7.2.2). Project proponents may choose to apply both analyses to further strengthen the additionality demonstration.

7.2.1 Investment Analysis

When applying this step, project proponents must conduct an "investment comparison analysis" following the procedures and requirements of the "Investment Analysis" section of the most recent version of the *VT0008 Additionality Assessment*. The project scenario must be compared to the baseline scenario described in Section 6.

7.2.2 Barrier Analysis

When applying this step, project proponents must follow the procedures and requirements of the "Barrier Analysis" section of the most recent version of the *VT0008 Additionality Assessment*.

Under this methodology, such barriers are limited to:

1) **Commercial/legal barrier:** The "owner/tenant" contractual issue may be a barrier to implementation of energy efficiency measures in vehicles. For example, this is typical in the case of car rental company fleets, where the car renter buys the fuel and the owner makes the vehicle investment. Many taxi fleets are also managed in this manner, especially in developing countries, with taxi drivers paying a fixed daily rent per vehicle. The same is true in the case of leased vehicles typical in the trucking business. For projects facing the commercial/legal barrier, project proponents must demonstrate that the contractual relationship between the parties does not provide an incentive for any party to implement the project activity.
2) **Aggregation barrier**: In order to make efficiency projects feasible, an aggregation mechanism may be required. Aggregation parties are generally business associations, efficiency-driven institutions, or providers of technology solutions for efficiency improvements. The cost of establishing and maintaining such an aggregation mechanism can be a significant barrier that can be offset with carbon credit revenues.

Note — Projects may choose to demonstrate additional implementation barriers using the list of barriers provided in the most recent version of the VT0008 Additionality Assessment. *However, as a minimum requirement, project proponents must demonstrate additionality through the existence of at least one of the barriers listed above or an investment analysis. Other barriers may further strengthen the additionality demonstration but are not sufficient on their own.*

7.3 Common Practice

The project proponent must demonstrate that the market penetration rate of each of the planned project measures is individually less than 20% for the types of vehicles included in the fleets. Penetration rates are assessed for the specific vehicle categories in which the measures are implemented, not for the entire fleet. Sources of data for market penetration rates may include independent studies, information from business associations, or other publicly available information.

8 QUANTIFICATION OF REDUCTIONS AND REMOVALS

8.1 Baseline Emissions

Baseline emissions are calculated using a baseline emission factor for each vehicle category *i* using fuel type *x* or electricity in period *y*, $BEF_{i,x,y}$ and $BEF_{i,elec,y}$. This factor represents the specific fuel consumption ($SFC_{BL,i,x,y}$) or specific electricity consumption ($SEC_{BL,i,y}$) per activity level ($AL_{i,x,y}$).

The activity level reflects the operational usage or output of the vehicle, such as kilometers traveled, kilowatt-hours consumed, tonnes transported, or hours of operation. Specific fuel/electricity consumption is measured in a fuel metric per activity level (e.g., liters per kilometer, liters per tonne, kilowatt-hours per kilometer, kilowatt-hours per tonne).

Baseline emissions are calculated by multiplying the baseline emission factors by the corresponding activity level of each project group vehicle category *i*:

$$BE_y = \sum_{i,x} BEF_{i,x,y} \times AL_{i,x,y} \times 10^{-6} \quad (1)$$

Where:

BE_y	=	Baseline emissions in period *y* (t CO_2)
$BEF_{i,x,y}$	=	Baseline emission factor of vehicle category *i* using fuel type *x* or electricity in period *y* (g CO_2/activity level)

$AL_{i,x,y}$ = Activity level of project group vehicle category *i* using fuel type *x* or electricity in period *y* (activity level)

For vehicles using fuel (with or without telematics), the baseline emission factor is determined using the following equation:

$$BEF_{i,x,y} = SFC_{BL,i,x,y} \times EF_{CO2,x,y} \tag{2}$$

Where:

$SFC_{BL,i,x,y}$ = Specific baseline fuel consumption of vehicle category *i* using fuel type *x* in period *y* (fuel metric/activity level)

$EF_{CO2,x,y}$ = CO_2 emission factor for fuel type *x* in period *y* (g CO_2/fuel metric)

For vehicles using electricity (with or without telematics), the baseline emission factor is determined as follows:

$$BEF_{i,elec,y} = SEC_{BL,i,y} \times EF_{elec,y} \times (1 + TDL_y) \tag{3}$$

Where:

$BEF_{i,elec,y}$ = Baseline emission factor of vehicle category *i* using electricity in period *y* (g CO_2/activity level)

$SEC_{BL,i,y}$ = Specific baseline electricity consumption of vehicle category *i* in period *y* (kWh/activity level)

$EF_{elec,y}$ = CO_2 emission factor of electricity in period *y* (g CO_2/kWh)

TDL_y = Average technical transmission and distribution losses for providing electricity in period *y* (%)

In cases where mobile machinery uses both electricity and fossil fuels, emissions from both sources are summed. Where biofuel blends are used, the biofuel share is treated as zero-emitting.

8.1.1 Specific Baseline Fuel and Electricity Consumptions

The specific baseline fuel consumption ($SFC_{BL,i,x,y}$) and the specific baseline electricity consumption ($SEC_{BL,i,y}$) are determined using one of the following methods:

1) For vehicles equipped with telematics systems, historical fuel and electricity consumption and activity level are used.

2) For vehicles without telematics systems, values are based on the monitored fuel and electricity consumption and activity level of a control group.

8.1.1.1 Option 1: Telematics Systems

For vehicle types using telematics systems, specific baseline fuel/electricity consumptions and activity level must be determined using the vehicle's own data prior to implementation of the project activity by applying one of the following options:

1) Monitoring the fuel/electricity consumption and activity level of all project vehicles for a minimum of 5000 km or 200 hours[3] of vehicle operation before implementation of the energy efficiency measures.

2) Monitoring fuel/electricity consumption and activity level for a sample of project vehicles before implementation of the energy efficiency measures. The sampling must achieve at least 90/5 confidence/precision following the most recent versions of the CDM's *Standard: Sampling and Surveys for CDM Project Activities and Programmes of Activities* and *Guidelines: Sampling and Surveys for CDM Project Activities and Programmes of Activities.*

The project proponent must demonstrate that the fuel type, driving terrain (e.g., percentage of city driving compared to highway driving), operational characteristics, and applications (e.g., crane loads) of the baseline measurements are comparable to the project scenario or are conservative.

8.1.1.2 Option 2: Control Group

Control group vehicles must be selected from the vehicle fleets of the project proponent or from third-party fleets. A control group must be established for each vehicle category that uses this option and that belongs to the same fleet.

The specific baseline fuel/electricity consumptions and activity level are monitored within the control group and project group of vehicles.

To avoid crediting GHG emission reductions to the project that are due to external factors, the specific baseline fuel/electricity consumptions must be based on comparable vehicles driving in comparable situations. This may be based on a project control group that complies with the following conditions to ensure the control group is comparable to the project group:

1) For buses, passenger cars, taxis, and jeepneys:
    a) Control group vehicles must be of the same age or younger on average than the project group vehicles.
    b) Control group vehicles must be used in the same area of usage on average as the project vehicles.
    c) Control group vehicles must have the same or a lower passenger capacity on average than the project vehicles.

[3] Based on approximately 5% of annual travel for an average class 8 vehicle in North America from US Department of Energy data available at: https://afdc.energy.gov/data/10309

   d) The share of vehicles with air conditioning in the control group must be the same or lower than that in the project group.

2) For trucks:
   a) The average GVW of control group vehicles must be the same as or greater than that of project group vehicles.
   b) The average annual distance driven by control group vehicles must be the same as or greater than that driven by project group vehicles.
   c) The share of inter-urban trips made by control group vehicles must be on average equal to or higher than that made by project group vehicles.

3) For mobile machinery:
   a) Mobile machinery in both groups must have a comparable power rating with variations of not more than ±20%.
   b) Control group mobile machinery must be of the same age or younger on average than project group mobile machinery.
   c) Control group mobile machinery can be used to produce the same product or perform the same activity as project group mobile machinery and operates in similar conditions (e.g., geography, temperature, sloping, idling).

The project proponent must demonstrate that the control group is comparable to the project group and leads to conservative baseline estimations.

8.1.2 Activity Level

The activity level must be established in the project description and meet the following criteria:

1) The activity level metric must be measurable with an acceptable level of certainty (acceptable data precision is ±5% with 90% confidence).
2) Changes in the relationship between fuel usage and activity level must be related to improvements in efficiency or changes in the type of fuel used. These changes should not result from exogenous factors that are not associated with the project activity. To prove this relationship, data used to determine the baseline emission factor must show a deviation of less than 20% from the mean value at the lower boundary of the 90% confidence interval. If this deviation exceeds 20%, more homogenous subgroups of vehicles must be established.

At validation, the project proponent must demonstrate that the activity level metric is appropriate to the project, and provide a qualitative analysis or ex-ante data to demonstrate that changes in fuel consumption are directly linked to efficiency improvements.

At verification, the project proponent must demonstrate that changes in fuel consumption are directly linked to efficiency improvements by conducting the 20% deviation check within the 90% confidence interval, as described above.

8.1.3 Net Zero Transition

To align with net zero goals, the project proponent must apply the requirements in Sections 8.1.3.1 and 8.1.3.2. Additional background is provided in Appendix 2.

8.1.3.1 Exclusion of New Fossil Fuel Vehicles

From 1 January 2035, no new fossil fuel vehicles may be added to the project vehicle fleets. Where the host country or region has an earlier phase-out date specified in its net zero transition plan or equivalent policy, this earlier date must be applied.

8.1.3.2 Net Zero Alignment

Projects must align with the net zero transition plans and decarbonization strategies of the host country and region. This includes adherence to targets related to vehicle fleet emissions, composition, technologies, fuels, and other relevant targets related to GHG emissions set forth in these plans.

The project proponent must monitor and report the net zero targets relevant to the project fleets and adjust the baseline emissions to reflect the targets for reducing fossil fuel consumption and GHG emissions, starting from the date on which these targets become effective. Both binding and non-binding targets must be considered when adjusting baseline emissions.

The project proponent must explain in the monitoring reports how the baseline emission adjustments are made, demonstrate how these adjustments align with the applicable net zero targets, and ensure that they are conservative.

The following guiding examples outline how baseline emissions could be adjusted to reflect net zero targets:

- **Example 1:** Transition all light-duty and passenger vehicles to fully electric vehicles (EVs) by 2035.

  Guidance: From 2035 onwards, replace the baseline emission factors for all light-duty and passenger vehicles with baseline emission factors of comparable EVs. Emission factors should be taken from comparable EVs of the project proponent's fleets or third-party evidence, such as independent studies or market data. Alternatively, exclude all light-duty and passenger vehicles from the project activity from this date.

- **Example 2:** Reduce overall GHG emissions from all vehicle fleets, including heavy-duty trucks and mobile machinery, by 50% by 2030 compared to the 2020 baseline.

  Guidance: Establish the 2020 baseline GHG emissions for all project vehicle fleets. From 2030 onwards, apply a cap of 50% of the 2020 baseline emissions of the project fleets when calculating baseline emissions in Equation (1).

- **Example 3:** By 2040, all mobile machinery and trucks should use renewable fuels such as biodiesel, hydrogen, or renewable natural gas (RNG).

  Guidance: From 2040 onwards, exclude all mobile machinery and trucks from the project activity, since no further GHG emission reductions can be achieved for these vehicle fleets.

- **Example 4:** Phase out fossil fuel consumption for mobile machinery by 2030

  Guidance: From 2030 onwards, replace the baseline emission factors for mobile machinery with non-fossil fuel baseline emission factors for mobile machinery that represent realistic alternatives for substitution of fossil fuels (e.g., electricity). Alternatively, exclude all mobile machinery from the project activity.

8.2 Project Emissions

8.2.1 Project Emission Equations and Calculations

Project emissions for all vehicle categories with or without telematics systems must be determined following the procedure below.

$$PE_y = \sum_{i,x} PEF_{i,x\ or\ elec,y} \times AL_{i,x,y} \times 10^{-6} \quad (4)$$

Where:

PE_y	=	Project emissions in period y (t CO_2)
$PEF_{i,x,y}$	=	Project emission factor of vehicle category i using fuel type x in period y (g CO_2/activity level)
$PEF_{i,elec,y}$	=	Project emission factor of vehicle category i using electricity in period y (g CO_2/activity level)

For vehicles using fuel with or without telematics:

$$PEF_{i,x,y} = SFC_{PJ,i,x,y} \times EF_{CO2,x,y} \quad (5)$$

Where:

$SFC_{PJ,i,x,y}$	=	Specific project fuel consumption of vehicle category i using fuel type x in period y (fuel metric/activity level)

For vehicles using electricity with or without telematics:

$$PEF_{i,elec,y} = SEC_{PJ,i,y} \times EF_{elec,y} \times (1 + TDL_y) \quad (6)$$

Where:

$SEC_{PJ,i,y}$ = Specific project electricity consumption of vehicle category *i* in period *y* (kWh/activity level)

8.3 Leakage Emissions

There are no leakage emissions associated with the project activity.

8.4 Net Reductions and Removals

Net GHG emission reductions are calculated as follows:

$$ER_y = 0.95 \times (BE_y - PE_y) \quad (7)$$

Where:

ER_y = Net GHG emission reductions in year *y* (t CO_2)
0.95 = Conservativeness deduction to account for uncertainties

9 MONITORING

9.1 Data and Parameters Available at Validation

Data/Parameter	$EF_{CO2,x,y}$
Data unit	g CO_2/fuel metric
Description	CO_2 emission factor of fuel type *x* in period *y*
Equations	(2), (5)
Source of data	National values or the most recent version of the IPCC Guidelines for National Greenhouse Gas Inventories
Value applied	-
Justification of choice of data or description of measurement methods and procedures applied	Based on official sources
Purpose of data	Calculation of baseline emissions
Comments	Where CO_2 emission factors are not directly available, they may be calculated from net calorific values (e.g., kJ/L) and fuel emission factors (e.g., g CO_2/kJ) available in the sources above.

	If fossil fuel-biofuel blends are used, the biofuel share and the blend emission factor must be recorded.

9.2 Data and Parameters Monitored

Data/Parameter	$AL_{i,x,y}$
Data unit	km, t-km, p-km or h
Description	Activity level of project vehicle category *i* using fuel type *x* or electricity in period *y*
Equations	(1), (4)
Source of data	**Option 1** Telematics system data recording or project group data **Option 2** Used for mobile machinery. For activity level metrics based on time (e.g., operating hours for mobile machinery), time must be measured on hour-monitoring devices installed on the mobile machinery and recorded by electronic or paper records. The activity level metric for both options and its measurement must be detailed in the project description. Activity level metrics must not change between baseline and project monitoring periods and must be measured in comparable manners.
Description of measurement methods and procedures to be applied	For activity level metrics based on time and distance: **Option 1** Monitoring via use of a vehicle telematics recording system capable of continuously tracking and securely recording accurate engine data including odometer, fuel consumption, and engine operational time, as provided by the vehicle's engine control module. The telematics system must transmit engine measurements over-the-air to the telematic service provider's protected database, where the data can be analyzed and reviewed to ensure compliance. **Option 2** Monitoring must be based on vehicle usage logs. The activity level metric t-km should only be used for trucks and buses. Measurements may use:

	a) A telematics system to record and monitor the GVW and odometer of the vehicle; or b) A sample of vehicles randomly chosen in accordance with the most recent version of the *CDM Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities*.
Frequency of monitoring/recording	Where using a telematics system, data are continuously monitored. Otherwise, data must be monitored monthly or annually.
QA/QC procedures to be applied	Where using a telematics system, the telematics device must remain connected to, and plugged into, the on-board diagnostics (OBD) of the engine for the entire project duration.
Purpose of data	Calculation of baseline and project emissions
Calculation method	N/A
Comments	N/A

Data/Parameter	$SFC_{BL,i,x,y}$ $SFC_{PJ,i,x,y}$
Data unit	L/activity level fuel metric/activity level
Description	Specific baseline fuel consumption of vehicle category *i* using fuel type *x* in period *y* Specific project fuel consumption of vehicle category *i* using fuel type *x* in period *y*
Equations	(2), (5)
Source of data	**Option 1:** Telematics system data **Option 2:** Mobile machinery statistics or sample measurements Where based on sample measurements, sample vehicles must be randomly chosen in accordance with the most recent version of the *CDM General Guidelines for Sampling and Surveys for Small-Scale CDM Project Activities* using a 90% confidence interval. To determine specific fuel consumption, the fuel consumed by the respective category of mobile machinery must be divided by the activity level of that category during the same time period over which fuel consumption was monitored (e.g., fuel consumed by a category of five pieces of mobile machinery during two days is divided by the activity level performed by those five pieces of mobile machinery during the two days).
Description of measurement methods	**Option 1:** Monitoring may be via use of a vehicle telematic recording system capable of continuously tracking and securely recording

and procedures to be applied	accurate engine data including odometer, fuel consumption, and engine operational time, as provided by the vehicle's engine control module. The telematics system must transmit engine measurements over-the-air to the telematic service provider's protected database, where the data can be analyzed and reviewed to ensure compliance. **Option 2:** Electronic fuel consumption measurement devices or fuel records for fuel consumption. The specific fuel consumption is calculated (fuel usage/activity level).
Frequency of monitoring/recording	Where using a telematics system, data are continuously monitored. Otherwise, data must be monitored monthly.
QA/QC procedures to be applied	Where using a telematics system, the telematics device must remain connected to, and plugged into, the OBD of the engine for the entire project duration. For both options, the project proponents must document and report the measures implemented in each project vehicle category, along with their operation status (active/inactive) per vehicle, to confirm that the fuel savings are a direct result of these measures.
Purpose of data	Calculation of baseline emissions Calculation of project emissions
Calculation method	N/A
Comments	The fuel metric used (g, L) is determined based on available data. Where a telematics system is used to monitor the project, the fuel recording will likely be measured in liters.

Data/Parameter	$SEC_{BL,i,y}$ $SEC_{PJ,i,y}$
Data unit	kWh/activity level
Description	Specific baseline electricity consumption of vehicle category *i* in period *y* Specific project electricity consumption of vehicle category *i* in period *y*
Equations	(3), (6)
Source of data	Measurements
Description of measurement methods and procedures to be applied	**Option 1:** Telematics system data, see Section 8.1.1.1 **Option 2:** Control group method, see Section 8.1.1.2

Frequency of monitoring/recording	Where using a telematics system, data are continuously monitored. For $SEC_{BL,i,y}$ the data must be monitored for a minimum of 5000 km or 200 hours. Otherwise, data must be monitored monthly.
QA/QC procedures to be applied	Where using a telematics system, the telematics device must remain connected to, and plugged into, the OBD of the engine for the entire project duration. For both options, the project proponents must document and report the measures implemented in each project vehicle category, along with their operation status (active/inactive) per vehicle, to confirm that the electricity savings are a direct result of these measures.
Purpose of data	Calculation of baseline emissions Calculation of project emissions
Calculation method	N/A
Comments	For electric vehicles

Data/Parameter	$EF_{elec,y}$
Data unit	g CO_2/kWh
Description	CO_2 emission factor of electricity in period *y*
Equations	(3), (6)
Source of data	1) Local utilities (electrical) authority 2) International Energy Agency (IEA); or 3) Calculated based on the most recent version of *VT0011 Electricity System Emission Factors*
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Annual
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of baseline and project emissions
Calculation method	N/A

Comments	N/A

Data/Parameter	TDL_y
Data unit	%
Description	Average technical transmission and distribution losses for providing electricity in period *y*
Equations	(3), (6)
Source of data	**Option 1:** Local authority such as electric utility **Option 2:** Use a default value of 0%
Description of measurement methods and procedures to be applied	The local electrical utilities provider is the owner of the power transmission and distribution lines and can provide first-hand information.
Frequency of monitoring/recording	Annual
QA/QC procedures to be applied	Where different values are available, the lowest value must be used.
Purpose of data	Calculation of baseline and project emissions
Calculation method	N/A
Comments	N/A

9.3 Description of the Monitoring Plan

The data and parameters set out in Section 9.1 must be monitored by the project proponent and must be made available during verification. Project proponents must establish a comprehensive monitoring plan for ensuring the collection, measurement, recording, and quality assurance / quality control (QA/QC) procedures for these data and parameters and this must be documented in the project description.

The project proponent must report at each verification on any existing or upcoming net zero transition plans and decarbonization strategies of the host country or region, and how they relate to the project activity. If these plans or strategies are relevant to the project activity, the requirements in Section 8.1.3 must be applied to adjust the baseline and estimate emission reductions.

All data collected as part of the monitoring plan must be archived electronically and kept for at least two years after the end of the last project crediting period. Equipment used for measurements must comply with relevant industry standards (where applicable) and must be calibrated according to such standards where relevant and applicable. Fuel consumption may be based specifically on tanking invoices/records.

Where any device installed in a project vehicle (e.g., eco-drive or engine retrofits, including fuel flow sensors or meters) is not operating correctly or has been disabled, no GHG emission reductions may be attributed to that vehicle for the period during which the system has not been operating correctly.

10 REFERENCES

Davies, T. 2003. *Calculation of CO_2 Emissions from Fuels, Exeter*.

Geotab Team, 2021. “What Is Telematics?” Accessed 26 March 2021. https://www.geotab.com/blog/what-is-telematics/

APPENDIX 1: ENERGY EFFICIENCY MEASURES APPLICABLE UNDER THE METHODOLOGY

Idling stop device

Refers to the action of turning off the vehicle engine and thus preventing idling and the associated fuel consumption that would otherwise have occurred while idling, in absence of the project activity. Anti-idling devices may also include techniques to avoid use of the base engine during extended idle by substituting alternative sources of heating, ventilation, or air conditioning (HVAC) and electricity during rest stops.

Eco-drive system

Includes equipment that monitors vehicle and driver performance and provides real-time feedback to drivers on efficient driving behavior

Tire-rolling resistance improvements

Rolling resistance can be reduced by avoiding under-inflation of existing tires (e.g., through automatic tire inflation, ATI), using special low rolling resistance tires, or substituting one wide tire for a pair of dual tires on trucks.

Air conditioning system improvements

Enhanced air conditioning systems can decrease base engine load requirements from mobile air conditioning systems by replacing fixed displacement compressors (FDCs) with externally controlled variable displacement compressors (VDCs), or using improved control systems, condensers, and evaporators.

Use of low-viscosity oils

Low-viscosity engine lubricants are made from synthetic or mineral oil blends for the purpose of reducing internal engine friction. Low-viscosity oils based on SAE viscosity classes are 0W30 and 5W30.

Aerodynamic drag reduction

Aerodynamic drag of trucks can be significantly reduced by:

- Installing add-on devices to improve the vehicle profile:
  - Truck tractor options include cab top deflector, sloping hood, and cab side flares.
  - Truck side and underside options include closing and covering the gap between tractor and trailer (or van), aerodynamic bumper, underside air baffles, and wheel well covers.
- Installing pneumatic blowing systems that blow air from slots at the rear of heavy-duty vehicle trailers in order to smooth air flow over the trailer surfaces and reduce aerodynamic drag.

- Installing boat tail plates mounted to the end of the trailer to reduce the truck’s wake.
- Improving vehicle load profile.

Transmission improvements

Improving transmission systems by using high-efficiency transmission technologies (e.g., continuously variable transmission (CVT) and/or low-viscosity transmission lubricants)

Retrofits that improve engine or combustion efficiency or both

Retrofits involve direct installation of technologies onto the vehicle/engine that improve the efficiency of engine operation and fuel combustion by, for example, tapping into spare unused kinetic energy, solar energy, or thermo-electric generation, or generating hydrogen on board through electrolysis (e.g., electro-catalytic efficiency technologies).

Other energy efficiency improvement measures

Such other measures must have been demonstrated to lead to fuel savings in independent third-party studies.

APPENDIX 2: TRANSITION TO NET ZERO AND MITIGATING CARBON LOCK-IN RISK

This appendix provides the background and rationale for aligning the project activity with net zero goals, as outlined in Section 8.1.3. The Paris Agreement establishes a global target to achieve net zero GHG emissions by 2050, requiring substantial changes across key sectors such as energy, transportation, and agriculture. Achieving this target requires significant reductions in GHG emissions and enhancement of both natural and technological carbon sinks.

A key consideration in this alignment is the risk of carbon lock-in, which occurs when investments are made in technologies that have extended lifetimes and are reliant on fossil fuels. Such investments, like the acquisition of new fossil fuel vehicles, can delay the transition to low-carbon alternatives. Given that vehicles have an average lifespan of approximately 15 years, incorporating new fossil fuel vehicles into the project activity after 2035 would conflict with net zero transition goals. To mitigate this risk, no new fossil fuel vehicles should be added to the fleet beyond this date, as doing so would extend the operational use of high-emission technologies beyond the 2050 net zero target.

Moreover, project activities must align with national and regional net zero plans and decarbonization strategies to ensure that they contribute to broader efforts toward achieving these targets. This includes adhering to specific timelines and milestones outlined in national or regional net zero plans. Aligning with these strategies supports the global net zero goal and helps prevent the risk of carbon lock-in, ensuring that the project activity does not result in extended reliance on fossil fuel-based vehicles.

By adhering to the guidelines in Section 8.1.3, project proponents can ensure that their activities are compatible with the long-term objectives of reducing GHG emissions and advancing the transition to a low-carbon future.

APPENDIX 3: UNCERTAINTY ASSESSMENT

The uncertainty associated with this methodology was assessed in accordance with the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, utilizing Monte Carlo simulation. The fuel emission factors ($EF_{CO2,x,y}$) are considered to have low uncertainty during project implementation, with an assumed uncertainty ranging between 1% and 2% for the aggregated fleet. Activity level ($AL_{i,x,y}$), and specific fuel/electricity consumption ($SFC_{i,x,y}$, $SEC_{i,y}$) are required to comply with a 5% uncertainty and are likely to have lower uncertainty for projects using telematics. The contribution of these data to the overall uncertainty is small. The relationship and change between fuel usage and activity level was identified as the most relevant factor and must comply with a deviation of less than 20% from the mean value at the lower boundary of the 90% confidence interval.

Normal distributions were assumed for all modeled variables.

The Monte Carlo simulation was performed with 500 iterations, resulting in an aggregated uncertainty of around 20% for emission reductions. In line with the *VCS Methodology Requirements*, a conservativeness deduction was calculated using the following formula:

$$Discount\ factor = \frac{Uncertainty}{t_{\alpha=10\%}} \times t_{\alpha=66.6\%} \qquad (8)$$

Where:

Discount factor	=	Discount factor to be applied for calculating the conservativeness deduction (%)
Uncertainty	=	Half-width of the 90% confidence interval as a percentage of the mean estimate (%)
$t_{\alpha=10\%}$	=	t-value for the two-sided 90% confidence interval, approximately 1.6449 (dimensionless)
$t_{\alpha=66.6\%}$	=	t-value for a one-sided 66.67% confidence interval, approximately 0.4307 (dimensionless)

The calculation is as follows:

$$Discount\ factor = \frac{20\%}{1.6449} \times 0.4307 = 5\%$$

Therefore, the conservativeness deduction was determined as 1 − *Discount factor* = 95% and is included in Equation (7).

DOCUMENT HISTORY

Version	Date	Comment
v1.0	24 Mar 2013	Initial version of VMR0004 based on *AMS-III.BC Emission Reductions Through Improved Efficiency of Vehicle Fleets*, *v1.0*, including: • Addition of mobile machinery as eligible vehicle type • Expansion of energy efficiency improvement measures
v2.0	04 Oct 2024	• Replacement of the CDM tools by *VT0008 Additionality Assessment*[4] and *VT0011 Electricity System Emission Factors*[5] • Inclusion of telematics as a measurement method • Revisions to the additionality section to include the Investment analysis option, the requirement to conduct a common practice analysis and the exclusion of the common practice barrier • Alignment with net zero transition goals • Improvements for consistency and clarity • Inclusion of uncertainty assessment, adjustment of parameters uncertainty requirements and introduction of a conservativeness deduction

[4] This tool is currently under development and will be published shortly after the publication of this methodology

[5] This tool is currently under development and will be published shortly after the publication of this methodology