VCS | VERIFIED CARBON STANDARD

A Global Benchmark for Carbon

Approved VCS Methodology Revision VMR0004

Version 1.0, 24 April 2013

Sectoral Scope 7

Revisions to AMS-III.BC to Include Mobile Machinery

Methodology developed by:

Carbon Offset Aggregation Cooperative

Document prepared by:

Jürg M. Grütter, Grütter Consulting AG

Table of Contents

1 SOURCES

This methodology revision applies to CDM small-scale methodology AMS-III.BC, *Emission reductions through improved efficiency of vehicle fleets*. Project proponents must apply this methodology revision in conjunction with the latest version of AMS-III.BC.

This methodology uses as sources:

- CDM methodology *AMS.III.C. Emission Reductions by electric and hybrid vehicles*
- CDM *Standard for Sampling and Surveys for CDM Project Activities and Programme of Activities*

2 SUMMARY DESCRIPTION OF THE METHODOLOGY REVISION

This methodology revision adds mobile machinery as an eligible vehicle type under AMS-III.BC and also expands upon the energy efficiency improvement measures that may be implemented in the project scenario. Accordingly, baseline emissions for mobile machinery are based on a monitored baseline emission factor per activity level, the metric of which depends on the type of mobile machinery under consideration (eg, quantity of fuel consumed per machine hour). Likewise, the procedure for quantifying project emissions has been adjusted to accommodate the inclusion of mobile machinery in the project scenario.

The approach for determining the project boundary, determining the baseline scenario, demonstrating additionality, quantifying leakage and quantifying net emission reductions remain unchanged from AMS-III.BC.

Additionality	Project Method
Crediting Baseline	Project Method

3 DEFINITIONS

In addition to the definitions provided in CDM methodology AMS-III.BC, the following definitions apply under this revision:

- **Activity level** is the index used to determine the output level of the vehicle/machinery (eg, machine hour or gross ton-hour of the machine).
- **Mobile machinery** is equipment which 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 (eg, moving a loader using a lo-bed rather than driving the loader to the destination). Mobile machinery must be self-propelled, except where a self-propelled unit has had its drive carriage removed to secure the unit to a structure during operation, and may include but not be limited to: excavators, log harvesting bunchers, log loaders, cranes, timber processors, fork-lifters, road-

building machines and/or bulldozers. Generators used for power generation do not qualify as mobile machinery under this methodology.

- **Gross tons** are the gross vehicle weight which equals vehicle weight plus freight weight.
- **Tons** are metric tonnes.

4 APPLICABILITY CONDITIONS

Projects must comply with all applicability conditions set out in CDM methodology AMS-III.BC, noting that applicability conditions 2, 4, 5, 9 and 10 (as specified in AMS-III.BC version 1.0, issued 20 July 2012, the version of the methodology current on the issuance date of this methodology revision) must be read as follows:

2. Project activities to improve operating vehicle and mobile machinery efficiency may include:

    - Idling stop device[1];
    - Eco-drive systems[2];
    - Tire-rolling resistance improvements[3];
    - Air-conditioning system improvements[4];
    - Use of low viscosity oils[5];
    - Aerodynamic drag reduction measures[6];
    - Transmission improvements[7];

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

[2] Eco-drive systems include equipment that monitors vehicle and driver performance and provides real-time feedback to drivers on efficient driving behavior.

[3] Rolling resistance can be reduced by avoiding under-inflation of existing tires (eg, through ATI (Automatic Tire Inflation), usage of special low rolling resistance tires, or substituting one wide tire for a pair of dual tires on trucks.

[4] 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), using improved control systems, condensers and evaporators.

[5] 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.

[6] Aerodynamic drag of trucks can be significantly reduced by installing add-on devices to improve the vehicle profile (truck tractor aerodynamic drag reduction options include cab top deflector, sloping hood, and cab side flares; truck side and underside aerodynamic drag reduction options include closing and covering the gap between a tractor and trailer (or van), aerodynamic bumper, underside air baffles, and wheel well covers), pneumatic blowing systems (this type of system blows air from slots at the rear of the trailers of heavy-duty vehicles in order to smooth air flow over the trailer surfaces and reduce aerodynamic drag, and boat tail plates rectangular plates mounted to the end of a trailer in an attempt to reduce the wake of trucks), or by improving vehicle load profile.

[7] Improving transmission systems, by using high-efficiency transmission technologies (eg, continuously variable transmission (CVT) and/or low-viscosity transmission lubricants).

- Other energy efficiency improvement measures identified by the project description. Such other measures must have been described in independent third party studies as leading to fuel savings.

4. Where the project proponent is not the owner of the vehicle fleets (eg, the project proponent is a fleet manager with many clients, each client being the owner of its respective vehicle fleets), there must exist a contract between the project proponent and each fleet owner to establish clear ownership of the emission reductions[8].

5. The project proponent must provide ex-ante estimation of the percentage of baseline emissions avoided per each energy efficiency measure. The ex-ante estimations must be based on published literature, official reports or statistics published by an independent third party or studies carried out by the project proponent, and validated by the validation/verification body. This is applied for any measure identified in the project description. The ex-ante estimations will also serve as a cap on the specific emission reductions (using the specific emission reduction percentage per activity unit as the metric[9]). In other words, the reduction in the project emission factor compared to the baseline emission factor may not exceed the ex-ante estimation.

9. The project description must include documentation of procedures to eliminate any potential double counting of emission reductions due to, for example, the project vehicles participating in another GHG program. The steps described in CDM methodology AMS.III.BC under applicability condition 9 must be carried out in the project description and in each monitoring report, *mutatis mutandis*.

10. Each fleet included in the project activity must include only one vehicle category. In each vehicle category, vehicles are classified according to the fuel types used. Baseline and project emissions are calculated for each fuel type of each vehicle category. A project activity may, however, encompass various fleets. Vehicle categories in the context of this methodology are:

    - Trucks with a gross vehicle weight[10] (GVW) > 3.5t;
    - Buses with a GVW > 3.5 t;

---

[8] Applicability condition 4 is not a substitute for the VCS requirements with respect to Right of Use. The project description must be accompanied by documentary evidence establishing Right of Use, in accordance with the VCS rules.

[9] In other words, it is the percentage of emission reductions that is relevant for consideration. Therefore, the cap is defined based on the specific emission reductions arising from each energy efficiency measure. For example, assume idling stop and eco-drive were estimated to reduce CO_2 emissions by 10% per machine hour. Also, ex-ante 5,000 machine hours were projected for the vehicle type, with specific emissions per machine hour of $2tCO_2$ per hour. The specific cap on emission reductions would therefore be $0.2tCO_2$ per machine hour (ie, 10% of $2tCO_2$). This is independent of the activity level. The absolute cap will thereafter be the specific cap multiplied with the activity level. If in year y, for example, there were 6,000 machine hours of operation (as opposed to 5,000), the cap would be 6,000*0.2 = 1,200 tCO_2. See applicability condition 5 of CDM methodology AMS-III.BC which states that the cap is based on the specific emission reduction (per tkm or per km) and not based on absolute figures.

[10] The gross vehicle weight is the maximum allowable total weight of a vehicle when loaded. This includes the actual vehicle as well as fuel, passengers and cargo. This is a fixed weight that is set and specified by the vehicle manufacturer.

- Taxis: in the case of significantly different taxi types such as conventional cars, minibuses, jeepneys, etc., these must also be considered as separate vehicle categories;
- Passenger cars (eg, company cars, rental cars);
- Motorized tricycles (eg, used as taxis for deliveries);
- Mobile machinery.

The following is provided by way of clarifying the intent on the revisions above:

- Applicability condition 2 of CDM methodology AMS-III.BC has been expanded to include other potential energy efficiency measures in light of the addition of mobile machinery as an eligible vehicle category.
- Applicability condition 4 of CDM methodology AMS-III.BC has been adapted to address VCS program-specific requirements.
- Applicability condition 5 of CDM methodology AMS-III.BC has modified to specify that the metric used for determining the cap is the specific emission reduction percentage per activity unit.
- Applicability condition 9 of CDM methodology AMS-III.BC has been expanded to address VCS program-specific considerations.
- Applicability condition 10 of CDM methodology AMS-III.BC has been expanded to include mobile machinery as an eligible vehicle category.

5 PROJECT BOUNDARY

The project boundary must be determined following the procedure provided in CDM methodology AMS-III.BC.

6 PROCEDURE FOR DETERMINING THE BASELINE SCENARIO

The baseline scenario must be determined following the procedure provided in CDM methodology AMS-III.BC.

7 PROCEDURE FOR DEMONSTRATING ADDITIONALITY

Additionality must be demonstrated following the procedure provided in CDM methodology AMS-III.BC.

8 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

8.1 Baseline Emissions

Baseline emissions for mobile machinery must be determined following the procedure below. For other vehicle categories, baseline emissions must be determined following the procedure provided in CDM methodology AMS-III.B.C.

The metric used for calculating the baseline emissions of mobile machinery is emissions per activity level (eg, per hour). The metric of the activity level must be defined in the project description for each type of mobile machinery.

To avoid crediting emission reductions to the project for external factors, the baseline emission factor must be based on comparable vehicles driving in a comparable situation. This can be based either on a Randomized Control Trial (RCT) (as described in CDM methodology AMS-III.BC) or with a control group that complies with the following conditions to ensure that the control group is comparable to, or more conservative than, the project group:

- Mobile machinery in both groups must have a comparable power rating with variations of not more than ±20%;
- Mobile machinery of the control group must have, on average, the same or lesser age than the project group mobile machinery;
- The mobile machinery of the control group can be used to produce the same product or perform the same activity as the mobile machinery of the project group.

The project proponent must consider these three criteria (at a minimum), and must demonstrate at validation that the control group and project group are similar/comparable.

Baseline emissions for mobile machinery are calculated based on the baseline emission factor per activity level for the control group vehicles. The activity level metric must be justified in the project description and must fulfill the following criteria:

- Higher activity levels must lead to higher fuel consumption. The relationship between fuel consumption and the activity level metric must be described in the project description based on measurements or independent third party studies.
- The activity level metric must be measurable with an acceptable level of certainty (acceptable data accuracy is ±10%).
- Changes in the relationship between fuel usage and activity level must be related to efficiency or changes of fuel type used. In other words, such changes must not be random or due to external factors not under the influence of the project. To demonstrate this relationship, data from the sample to determine the baseline emission factor at the lower boundary of the 90% confidence

interval must have a deviation of less than 20% from the average value. If this is not achieved, then more homogenous subgroups of mobile machinery must be made. At validation, the demonstration that changes in fuel consumption is directly related to efficiency or changes in fuel type are based on qualitative arguments or ex-ante data. At verification, this demonstration is based on the 20% deviation check of the 90% confidence interval described above.

Activity level metrics may be related to the mobile machinery itself, or to the production output (eg, amount of processed material). This is not a requirement, but rather an indication of how activity level metrics may be defined. The project proponent must demonstrate at validation that the activity level metric is appropriate to the project.

The emission factor is monitored within the control group of vehicles and multiplied by the activity level of the project:

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

Where:

BE_y	Baseline emissions in the year *y* (tCO_2)
$BEF_{i,x,y}$	Baseline emission factor per activity level metric of control group mobile machinery *i* using fuel type x in year y (gCO_2/activity level metric)
$AL_{i,x,y}$	Activity level of project per activity level metric of mobile machinery *i* using fuel type *x* in the year *y* (activity level metric)

$$BEF_{i,x,y} = SFC_{BL,i,x,y} \times NCV_{x,y} \times EF_{CO2,x,y} \quad \textbf{(2)}$$

Where:

$BEF_{i,x,y}$	Baseline emission factor per activity level metric of control group mobile machinery *i* using fuel type *x* in year y (gCO_2/activity level metric)
$SFC_{BL,i,,x,y}$	Specific baseline fuel consumption of control group mobile machinery *i* using fuel type *x* in year y (g/activity level metric)
$NCV_{x,y}$	Net calorific value of fuel type *x* in year y (MJ/g), determined in accordance with AMS-III.BC
$EF_{CO2,x,y}$	Carbon emission factor for fuel type *x* in year y (gCO_2/MJ), determined in accordance with AMS-III.BC

The activity level metric *AL* (eg, hours) is defined by the project description. See Section 9.2 for definitions and calculation method of *AL*.

For electric or hybrid vehicles, *BEF* is determined using equation 3 below. The parameters *SEC*, EF_{elec} and *TDL* are determined in accordance with the latest version of CDM methodology AMS-III.C.

$$BEF_{i,elec,y} = \sum_i SEC_{i,y} * EF_{elect,y} / \left(1 - TDL_y\right) * 10^{-3} \quad \textbf{(3)}$$

Where:

$BEF_{i,elec,y}$	Baseline emission factor per activity level metric of control group mobile machinery *i* using electricity in year *y* (gCO_2/activity level metric)
$SEC_{i,y}$	Specific electricity consumption by control group mobile machinery *i* per activity level in year *y* (kWh/activity level metric)
$EF_{elec,y}$	CO_2 emission factor of electricity in year *y* (gCO_2/kWh)
TDL_y	Average technical transmission and distribution losses for providing electricity in the year *y* (no unit)

If mobile machinery uses both electricity and fossil fuels, then the emissions from both sources must be summed using equation 1.

8.2 Project Emissions

Project emissions for mobile machinery must be determined following the procedure below. For other vehicle categories, project emissions must be determined following the procedure provided in CDM methodology AMS-III.B.C.

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

Where:

PE_y	Project emissions in the year *y* (tCO_2)
$PEF_{i,x,y}$	Project emission factor per activity level metric of project group mobile machinery *i* using fuel type *x* in the year *y* (gCO_2/activity level metric)
$AL_{i,x,y}$	Activity level of project per activity level metric of mobile machinery *i* using fuel type *x* in the year *y* (activity level metric)

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

Where:

$PEF_{i,x,y}$	Project emission factor per activity level metric of project group mobile machinery *i* using fuel type *x* in the year *y* (gCO_2/activity level metric)

$SFC_{PJ,i,x,y}$	Specific project fuel consumption of project group mobile machinery *i* using fuel type *x* in the year *y* (g/activity level metric)
$NCV_{x,y}$	Net calorific value of fuel type *x* in the year *y* (MJ/g), determined in accordance with CDM methodology AMS-III.BC
$EF_{CO2,x,y}$	Carbon emission factor for fuel type *x* in the year *y* (gCO_2/MJ), determined in accordance with CDM methodology AMS-III.BC

For electric or hybrid vehicles, PEF is determined in accordance with Equation 3 above, *mutatis mutandis*.

8.3 Leakage

Leakage must be determined following the procedure provided in CDM methodology AMS-III.BC.

8.4 Summary of GHG Emission Reduction and/or Removals

$$ER_y = BE_y - PE_y - LE_y \quad \textbf{(6)}$$

Where:

ER_y	Emission reductions in the year *y* (tCO_2)
BE_y	Baseline emissions in the year *y* (tCO_2)
PE_y	Project emissions in the year *y* (tCO_2)
LE_y	Leakage emissions in the year *y* (tCO_2)

9 MONITORING

Project proponents must follow the monitoring procedures provided in CDM methodology AMS-III.BC, noting the revisions set out in Sections 9.2 and 10 below.

9.1 Data and Parameters Available at Validation

The data and parameters available at validation must be provided in accordance with CDM methodology AMS-III.BC.

9.2 Data and Parameters Monitored

In addition to other information required to meet the monitoring requirements of AMS-III.BC, the following data and parameters must be monitored where mobile machinery is included.

Data Unit / Parameter:	$\mathbf{AL_{i,x,y}}$
Data unit:	Activity level
Description:	Activity level of project per activity level metric of mobile machinery *i* using fuel type *x* in the year *y*
Source of data:	Used for mobile machinery. The activity level metric is defined in the project description. For activity level metrics based on time (eg, operating hours for mobile machinery), time must be based on hour-monitoring devices installed at the mobile machinery and recorded by electronic or paper records. The metric for mobile machinery and its measurement must be detailed in the project description. Activity level metrics cannot be changed between baseline and project monitoring periods and must be measured in comparable manners.
Description of measurement methods and procedures to be applied:	If measurement equipment is used, *AL* must be calculated as the monitored level minus the maximum deviation defined by the measurement precision of the equipment used (eg, if ±5%, then the *AL* used for calculations is the monitored *AL* multiplied by 0.95 (acceptable data accuracy is ±10%)
Frequency of monitoring/recording:	Annual
QA/QC procedures to be applied:	Compare with activity levels as reported in previous year. Deviations larger than 20% must be explained. If deviations are beyond 20% and cannot be explained, then data must be excluded.
Any comment:	Acceptable data accuracy is ±10%. *AL* must be the same for project and baseline measurement for the same type of mobile machinery.

Data Unit / Parameter:	**$SFC_{PJ,i,x,y}$ / $SFC_{BL,i,x,y}$**
Data unit:	g/activity level metric
Description:	Specific project fuel (PJ) / baseline (BL) consumption of project/control group mobile machinery *i* using fuel type *x* in year y
Source of data:	Source of data can be mobile machinery statistics or sample measurements. If based on sample measurements, then sample vehicles must be randomly chosen in accordance with the latest version of the CDM *General guidelines for sampling and surveys for small-scale CDM project activities* using a 90% confidence interval and a ±10% error margin to determine the sample size. Further, the upper bound of the 90% confidence interval must be used as the Project Specific Fuel Consumption and the lower bound of the 90% confidence interval as the Baseline Specific Fuel Consumption. To determine the SFC, the fuel consumed by the respective group of mobile machinery must be divided with the activity level of that group during the same time period over which fuel consumption was monitored (eg, fuel consumed by a group of 5 mobile machinery during 2 days is divided by the activity level performed by these 5 mobile machinery during these 2 days).
Description of measurement methods and procedures to be applied:	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:	Annual
QA/QC procedures to be applied:	See CDM *General guidelines for sampling and surveys for small-scale CDM project activities* and *Best Practices Examples Focusing on Sample Size And Reliability Calculations*. If the width of the confidence interval exceeds 20% of the estimated value, then an appropriate confidence deduction must be

	applied. The deduction must be based on the CDM Meth Panel guidance on addressing uncertainty in its Thirty Second Meeting Report, Annex 14, Table 4. The confidence deduction must always be in a conservative manner (ie, to lower baseline SFC and to increase project SFC).
Any comment:	Changes in the relationship between fuel usage and activity level must be related to efficiency or changes of fuel type used. In other words, such changes must not be random or due to external factors not under the influence of the project. To demonstrate this relationship, data from the sample to determine the baseline emission factor at the lower boundary of the 90% confidence interval must have a deviation of less than 20% from the average value. If this is not achieved, then more homogenous subgroups of mobile machinery must be made.

10 DESCRIPTION OF THE MONITORING PLAN

The data and parameters required by this methodology revision set out in Section 9.2 must be monitored by the project proponent in addition to the data and parameters required by AMS-III.BC, where mobile machinery is included, and must be made available during verification. Project proponents must establish a comprehensive monitoring plan for ensuring the collection, measurement, recording and QA/QC procedures for these data and parameters and this must be documented in the project description.

All data collected as part of the monitoring plan must be archived electronically and be kept at least for 2 years after the end of the last project crediting period. Equipment used for measurements must comply with relevant industry standards (if existent) and must be calibrated according to such standards if relevant and applicable. Fuel consumption may be based specifically on tanking invoices/records.

11 REFERENCES AND OTHER INFORMATION

None