Application of the Oeko-Institut/WWF-US/ EDF methodology for assessing the quality of carbon credits

This document presents results from the application of version 3.0 of a methodology, developed by Oeko-Institut, World Wildlife Fund (WWF-US) and Environmental Defense Fund (EDF), for assessing the quality of carbon credits. The methodology is applied by Oeko-Institut with support by Carbon Limits, Greenhouse Gas Management Institute (GHGMI), INFRAS, Stockholm Environment Institute, and individual carbon market experts. This document evaluates one specific criterion or sub-criterion with respect to a specific carbon crediting program, project type, quantification methodology and/or host country, as specified in the below table. Please note that the CCQI website Site terms and Privacy Policy apply with respect to any use of the information provided in this document. Further information on the project and the methodology can be found here: www.carboncreditquality.org

Sub-criterion:	1.3.2 Robustness of the quantification methodologies applied to determine emission reductions or removals
Project type:	Landfill gas utilization
Quantification methodology:	CAR Landfill Project Protocol, Version 5.0
Assessment based on carbon crediting program documents valid as of:	30 June 2021
Date of final assessment:	20 May 2022
Score:	4

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Assessment

Relevant scoring methodology provisions

The methodology assesses the robustness of the quantification methodologies applied by the carbon crediting program to determine emission reductions or removals. The assessment of the quantification methodologies considers the degree of conservativeness in the light of the uncertainty of the emission reductions or removals. The assessment is based on the likelihood that the emission reductions or removals are under-estimated, estimated accurately, or over-estimated, as follows (see further details in the methodology):

Assessment outcome	Score
It is very likely (i.e., a probability of more than 90%) that the emission reductions or removals are underestimated, taking into account the uncertainty in quantifying the emission reductions or removals	5
It is likely (i.e., a probability of more than 66%) that the emission reductions or removals are underestimated, taking into account the uncertainty in quantifying the emission reductions or removals OR The emission reductions or removals are likely to be estimated accurately (i.e., there is about the same probability that they are underestimated or overestimated) and uncertainty in the estimates of the emission reductions or removals is low (i.e., up to ±10%)	4
The emission reductions or removals are likely to be estimated accurately (i.e., there is about the same probability that they are underestimated or overestimated) but there is medium to high uncertainty (i.e., ±10-50%) in the estimates of the emission reductions or removals OR It is likely (i.e., a probability of more than 66%) or very likely (i.e., a probability of more than 90%) that the emission reductions or removals are overestimated, taking into account the uncertainty in quantifying the emission reductions or removals, but the degree of overestimation is likely to be low (i.e., up to ±10%)	3
The emission reductions or removals are likely to be estimated accurately (i.e., there is about the same probability that they are underestimated or overestimated) but there is very high uncertainty (i.e., larger than ±50%) in the estimates of the emission reductions or removals OR It is likely (i.e., a probability of more than 66%) or very likely (i.e., a probability of more than 90%) that the emission reductions or removals are overestimated, taking into account the uncertainty in quantifying the emission reductions or removals, and the degree of overestimation is likely to be medium (±10-30%)	2
It is likely (i.e., a probability of more than 66%) or very likely (i.e., a probability of more than 90%) that the emission reductions or removals are overestimated, taking into account the uncertainty in quantifying the emission reductions or removals, and the degree of overestimation is likely to be large (i.e., larger than ±30%)	1

Information sources considered

1 CAR Landfill Project Protocol, Version 5.0, 24. April 2019.

2 TOOL: none: The methodology does not refer to any tools.

3 Abushammala et al 2014 “Methane Oxidation in Landfill Cover Soils: A Review” https://www.researchgate.net/publication/264153104_Methane_Oxidation_in_Landfill_Cover_Soils_A_Review

4 Cames et al, 2015 “How additional is the Clean Development Mechanism? Analysis of the application of current tools and proposed alternatives.” https://ec.europa.eu/clima/sites/clima/files/ets/docs/clean_dev_mechanism_en.pdf

5 Kühle-Weidemeier und Bogon 2008 “Wirksamkeit von biologischen Methanoxidationsschichten auf Deponien.“ http://www.wasteconsult.net/files/referenzen/Bimetox.pdf

Assessment outcome

The quantification methodology is assigned a score of 4.

Justification of assessment

Project type

This assessment refers to the following project type: “Capture and utilization of gas from an existing and closed solid waste disposal site. The collected gas is mainly used for energy purposes, such as for electricity and/or heat generation. A smaller fraction of the gas may be flared (e.g. during maintenance of an on-site electricity generation plant).” Pure flaring of LFG is thus not part of this assessment even if it is allowed under the CAR Landfill Project Protocol.

Focus of assessment

The project boundary, project emissions and leakage are not a major source of uncertainty. Regarding the project boundary, the methodology clearly delimitates applicable landfills (e.g. only those without regulation or other legal requirements to destroy landfill gas). Possible project emissions are accounted for and we estimate that they contribute only insignificantly to overall emission reduction calculations. Leakage effects do not play a role.

In the following, we thus focus the assessment on the determination of the baseline emissions. The overall score depends on the balance of elements with the potential for over- as well as underestimation of emission reductions. We focus on these elements, as well as elements that introduce uncertainty. The methodology contains further elements, which are not discussed however, as they introduce presumable little uncertainty (e.g. the baseline emissions associated with heat generation).

Elements potentially overestimating emission reductions

OE1 Oxidation factor

In the baseline, oxidation of methane in the top-soil layer of a SWDS occurs if the landfill is not covered by a synthetic liner or if methane does not leave the SWDS through a pre-existing collection system. The corresponding “oxidation factor” (OX) is a key parameter to determine the baseline emissions (see Eq (5.3)):

$$BE = CH_4Dest_{PR} \times GWP \times (1 - OX) \times (1 - DF) - Dest_{base} \times (1 - OX)$$

The CAR Landfill Project Protocol fixes the factor at $OX_{top\_layer} = 0.1$ or at $OX_{top\_layer} = 0$ for landfills that have a synthetic liner. The latter case is reasonable, as it is to be expected that no methane leaves the landfill via the topsoil layer in such a case. In cases where methane leaves the landfill in the baseline mainly through a collection system, the soil oxidation is of minor relevance as well.

The methodology does not provide a justification or a source for $OX_{top\_layer} = 0.1$. The CDM methodology ACM0001 uses the same value. Based on Abushammala et al 2014 (Source 3), Kühle-Weidemeier und Bogon 2008 (Source 5) and Cames et al, 2015 (Source 4) (discussion in chapter 4.8.4), we estimate the uncertainty to be high. There are little available data and the specific value depends on landfill management, type of the landfill, soil texture, soil thickness, soil organic content, soil moisture content, methane concentration or the prevailing climate among other things. Given the high uncertainties, we estimate that $OX_{top\_layer} = 0.1$ is not a conservative choice and may thus lead to overestimation of emission reductions.

For more details see also the assessment of the CDM methodology ACM0001. Compared to the CDM methodology, which is applied globally, the CAR methodology is only applied in the US. It is likely that the fraction of projects affected by the uncertainty of the oxidation factor is lower in the US, because (i) some US landfills have a synthetic liner and (ii) others have an existing collection system that in the baseline may be used in later stages of the landfill's aftercare to simply vent low-methane-LFG without a destruction device. For the former projects top-soil oxidation is not relevant, for the latter it is less relevant. On the other hand, a landfill's top layer may be thicker in the US than the global average, which would increase the oxidation in the baseline.

OE2 Perverse incentives

Landfill gas projects can potentially generate two types of perverse incentives, which may lead to an overestimation of baseline emissions:

a. A project owner may change the management in landfills to generate more methane (e.g., increasing the hight of a landfill or injecting water/leachate into a landfill which creates increasingly anaerobic conditions and thus more methane). For that reason, the methodology explicitly excludes landfills that are bioreactors. By EPA definition[1] bioreactors are designed to increase and accelerate the decomposition and increase LFG production (at least in the initial phase). As this requirement can arguably be monitored rather stringently, we assume this type of perverse incentive does not play a significant role in the US. We thus neglect it in our further considerations.

b. In order to increase the potential for issuing carbon credits, carbon revenues' beneficiaries may influence policy makers and private actors (i) to engage less in recycling (or other ways of preventing waste generation), (ii) to engage less in compositing of organic material or (iii) even to prevent waste incineration. Policy related perverse incentives can hardly be accounted for in a methodology. It is thus likely that a substantial overestimation occurs in case this perverse incentive is relevant (especially if the installation of a waste incineration plant would be prevented). It is unclear, how many projects are affected by this type of perverse incentive, as it

[1] https://www.epa.gov/landfills/bioreactor-landfills (23.03.2022)

is unknown to what extent the carbon revenues' beneficiaries can influence the recycling sector and the policy process.

Elements potentially underestimating emission reductions

UE1 Utilization of landfill methane

Projects utilize landfill methane for energy generation and thus substitutes GHG emissions associated with fossil fuel combustion. Under the CAR Landfill Project Protocol projects do not receive credit for the fossil fuel substitution by the methane but only for its avoidance. This leads to an underestimation of emission reductions by approximately 10-15% in all projects (as the project type does not include projects with flaring only).[2]

UE2 Baseline LFG destruction

The methodology is not applicable in cases where regulation or other legal requirements to destroy the landfill methane gas exists (in CDM's ACM0001 such projects are not excluded). Existing collection or destruction devices may be in place and have to be accounted for according to the following **Table 1**.

[2] A ton of avoided LFG methane has a global warming potential of 25 according to the 4th IPCC assessment report and the value is 28 according to the 5th IPCC assessment report. In addition to avoiding methane emissions, the LFG is used to replace fossil fuels. If e.g. fossil methane is replaced, this lowers fossil CO_2 emission by approx. 2,5 tCO_2 per tCH_4. This means that emission reductions are underestimated by approximately 10% if the replacement of fossil fuels is not accounted for. Putting these two numbers is in relation yields shows that substitution contributes 10%. In case methane replaces coal, the fraction is rather 15%, as coal's emissions per energy content are approximately 65% higher than for methane (not considering different efficiencies). The contribution of substitution would be higher if upstream emissions from fossil fuel extractions would be considered as well. Upstream emissions can be quite significant and depend on type of fuel and location of extraction.

Table 1 Cases for determining methane captured and destroyed in the baseline

In place prior to the project	Deduct methane oxidized by soil bacteria w/o project	Deduct amount of methane destroyed
No collection or destruction	Yes	No
Collection and/or destruction in non-qualifying destruction device	Yes	Yes by the non-qualifying destruction device
Collection and destruction in qualifying destruction device	Yes	Yes Amount that could have been destroyed if the baseline destruction device was operating at full capacity
Closed landfills with collection and destruction in qualifying flare	Yes	Yes Amount of methane collected by baseline landfill gas wells and destroyed in the qualifying flare.

If collection and/or destruction are already in place, there are detailed requirements on how to measure and account for the corresponding destruction in the baseline. For example, the methane emissions flow has to be measured and the 90% upper confidence limit in the metered period must be used. This is a conservative element and there are no fall-back values. Baseline emissions are calculated once as absolute values at the beginning of the project. Methane production from landfills typically decreases over time. The methodology applies, however, a fixed value such that the baseline remains constant, which likely lead to successively higher underestimation of emission reductions over time.

We therefore estimate that the methodology’s treatment of methane destruction in the baseline leads to an underestimation of emission reductions.

Summary and conclusion

Table 1 summarizes the assessment. For each of the previously discussed elements it estimates the potential impact on emission reduction quantification.

Table 2 Relevant elements of assessment and qualitative ratings

Element	Fraction of projects affected by this element[3]	Average degree of under- or overestimation where element materializes[4]	Variability among projects where element materializes[5]
Elements likely to contribute to overestimating emission reductions or removals			
OE1 Oxidation factor	Medium	Medium	High
OE2 Perverse incentives: overall policy/action related to waste	Unknown	Medium	High
Elements likely to contribute to underestimating emission reductions or removals			
UE1 Utilization of landfill methane	All	Medium	High
UE2 Baseline LFG destruction	Unknown	Medium	Medium
Elements with unknown impact			
None	-	-	-

Overall, most of the elements in the methodology are accurate (not shown in the table). The oxidation factor is likely to lead to an overestimation of the emission reductions. The oxidation factor is fixed for all projects, whereas project specific conditions vary considerably, which introduces a certain magnitude of uncertainty. Another potential source of overestimation is the impact of perverse incentives (yet probably to a lesser extent overall).

On the other side there are two elements that lead to an underestimation of emission reductions. For both elements, there is variability among projects, but this is appropriately considered in the methodology, as project-specific values must be applied.

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3 This parameter refers to the likely fraction of individual projects (applying the same methodology) that are affected by this element, considering the potential portfolio of projects. “Low” indicates that the element is estimated to be relevant for less than one third of the projects, “Medium” for one to two thirds of the projects, “High” for more than two third of the projects, and “All” for all of the projects. “Unknown” indicates that no information on the likely fraction of projects affected is available.

4 This parameter refers to the likely average degree / magnitude to which the element contributes to an over- or underestimation of the total emission reductions or removals for those projects for which this element materializes (i.e., the assessment shall not refer to average over- or underestimation resulting from all projects). “Low” indicates an estimated deviation of the calculated emission reductions or removals by less than 10% from the actual (unknown) emission reductions or removals, “Medium” refers to an estimated deviation of 10 to 30%, and high refers to an estimated deviation larger than 30%. “Unknown” indicates that it is likely that the element contributes to an over- or underestimation (e. g. overestimation of emission reductions in case of an omitted project emission source) but that no information is available on the degree / magnitude of over- or underestimation. Where relevant information is available, the degree of over- or underestimation resulting from the element may be expressed through a percentage range.

5 This refers to the variability with respect to the element among those projects for which the element materializes. “Low” means that the variability of the relevant element among the projects is at most ±10% based on a 95% confidence interval. For example, an emission factor may be estimated to vary between values from 18 and 22 among projects, with 20 being the mean value. “Medium” refers to a variability of at most ±30%, and “High” of more than ±30%.

Each of the three elements OE1, UE1 and UE2 have arguably a similar impact, OE2 is of lesser relevance overall. It is thus likely that on average emission reductions are underestimated. Therefore, the assigned score is 4.