CLEAN DEVELOPMENT MECHANISM
PROPOSED NEW METHODOLOGY: BASELINE (CDM-NMB)
Version 01 - in effect as of: 1 July 2004

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As of April 17, 2005 by N. Matsuo

SECTION A. Identification of methodology

A.1. Proposed methodology title:

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Generalized baseline methodology for transportation Bio-Fuel production with LCA

A.2. List of category(ies) of project activity to which the methodology may apply:

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Type III Other Project Activities,
— III.C. Emission Reductions by Low-Greenhouse Gas Emitting Vehicles

(in the categorization of small scale CDM projects).

Note: This categorization does not mean that the project is categorized as small scale CDM.

The project is a sort of fuel-switching project from fossil fuel to biomass-based fuel in the transportation sector.

A.3. Conditions under which the methodology is applicable to CDM project activities:

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The methodology categorize the value-chain of the GHG emission reductions into three principal stages as follows:

We categorize the elements of the methodology into these stages (which are influenced by the project activity) of emission reductions in the methodology.

The methodology is applicable to the project which produces a biomass-based transportation fuel[1] ("Bio-Fuel", for short) with the following applicability conditions (*italic* are explanation of the sub-conditions).

Conditions at the "biomass supply" stage are:

(a) Plantation of raw material (biomass) for the project does not lead to decrease of forest, or does not constrain the afforestation/reforestation activities;

[1] Biomass-based transportation fuel (Bio-Fuel) is categorized by the mixing rate of biomass-origin fuel and fossil-fuel (this methodology does not limit its application to 100% biomass-based fuel). In general, Bio-Fuel, which can be used for the same type of engine (without major modification) is regarded as the substitutable fuel to the regular fossil based fuel. Hereafter, Bio-Fuel is recognized not as the blended one with the fossil fuel unless otherwise stated, in order to avoid confusion. However, most of the logics can be applied for the blended fuel for its biomass-component.

In case that the Bio-Fuel is originated by biomass waste oil, the condition (b') is used instead of (a) and (b).

It is noted that transportation fuel includes those for automobiles, agricultural instruments, ships, *etc*.

(b) There are no other plans to utilize the area for other exclusive GHG emission reduction activities;

(b') In case waste oil is used as feedstock of the Bio-Fuel, such waste oil shall be biomass-based[2] and would not be utilized as an alternative to fossil fuel [in order to exclude the possibility of leakage].

Above conditions are for excluding the possibility to displace other GHG emission reduction activities at the plantation site.

The conditions (a) and (b) are confirmed by signed letter of the land owner or the seller of the biomass. Condition (b') is confirmed by documented evidences. The OE may request other evidences as it judges, if necessary.

Conditions at the "Bio-Fuel production" stage are:

(c) The project is the optimal solution in its scale in the project participants' decision making considering several barriers with economical consideration, if a Bio-Fuel production plant by using the same biomass is invested;

(d) The project participants do not have any plan to implement other biomass based fuel production projects with different type of production process nearby or at the same place;

(e) The project plant cannot be the most attractive course of action economically without the CER revenue, even if some subsidies[3] and/or tax credits for the Bio-Fuel production (if present) and sales revenue of Bio-Fuel itself and the by-products are included at the planning stage of the project *or* some prohibitive barriers to implement the project exist [additionality condition];

These conditions (c)–(e) exclude the case where any Bio-Fuel production scenario—in spite of its size and biomass-type—cannot be the baseline scenario of the project activity.

The conditions (c) and (d) are verified by the OE by assessing the related material/information provided by the project participants in order to exclude the possibilities to construct Bio-Fuel production plant with other scale as the baseline scenario. How to confirm whether the condition (e) is met, is shown in the sub-section D.1.

Conditions at the "Bio-Fuel consumption" stage are:[4]

(f) The Bio-Fuel produced by the project shall be consumed as to displace fossil fuel based liquid fuel.

The condition (f) can be restated that the Bio-Fuel does neither displace other biomass-based fuels, discard, nor realize hidden demand.

In order to ensure this, we categorize the related regulation(s) at the consumption stage. The associated regulations may be:

[Case 0] No regulations,

[Case 1] Subsidies or tax incentives to promote the Bio-Fuel or other compatible biomass-based fuels,

[Case 2] Non-mandatory or non-effective regulations to promote the Bio-Fuel or other compatible biomass-based fuels,

[2] If the waste oil is not purely biomass-based, appropriate correction is needed to extract the biomass part.

[3] Subsidies introduced after the Marrakech Accords do not have to be considered in the development of the baseline scenario, as it is categorized as the "E–"-type policy.

[4] We categorize "sales of fuel to consumers" in the "Bio-Fuel consumption" stage.

[Case 3] Mandatory or virtually mandatory regulation (targeting the fuel seller[5]*) to penetrate the Bio-Fuel or other compatible biomass-based fuels by setting some quantified threshold,*[6] *or*

[Case 4] Mandatory or virtually mandatory regulation (targeting the fuel seller or consumer) which exclude to use the fossil fuel and force the pure biomass-based fuel to use.

The underlying logic of this methodology ***is not applicable*** *to the [Case 4] (as far as it is not categorized as type E– policy*[7]*), while it* ***is applicable*** *to the [Cases 0–2]. In the case of [Case 3], if the compatible biomass-based fuel is not competitive in the market (i.e., the regulation is strictly complied without little excess penetration), supply of the BDF will displace other biomass-based fuel. Therefore, the methodology* ***is not applicable*** *to this case. However, if we observe that the compatible biomass-based fuel penetrate more than the threshold specified by the regulation, we can consider that the biomass-based fuel is more competitive than the fossil fuel in the market. In this case, the methodology* ***can be applied****. The reasons are shown below.*

The condition (f) is confirmed if all of the sub-conditions (i)–(v) below are met (*italic* are explanation of the sub-conditions):

(i) The fossil fuel, which the Bio-Fuel is going to replace, is not banned to use legally or substantially in the host country, or the same Bio-Fuel type is not required to use by some mandatory regulation (which is not the type E– policy) in the host country.

This sub-condition excludes the Case 4 above.

(ii) In case some mandatory or virtually mandatory regulation (targeting the fuel seller) to penetrate the Bio-Fuel or other compatible biomass-based fuels by setting some quantified threshold has been/will be introduced as non-type E– policy, the compatible biomass-based fuel penetrate more than the threshold level and/or competitive in the associated fuel market.

This ensures that the compatible biomass-based fuel is competitive in the market beyond the regulation. See explanation of the sub-condition (iii) below why this condition is good for substitution of fossil fuel by the Bio-Fuel.

(iii) The penetration rate of some biomass based fuels, which can be alternative to, and whose biomass-ratio is above the Bio-Fuel produced by the project, is less than [70]% in the host country if sub-conditions (i) and (ii) are met,

In case we see a biomass fuel (for the same usage) penetrates in the market (less than 100%), there is a concern that the Bio-Fuel produced by the project would displace this penetrated biomass fuel. However, this will not happen, because in this case, such biomass has economically more competitive than the fossil fuel, i.e., the Bio-Fuel of the project would displace less competitive fossil fuel in the market. This logic can be applied for any penetration rate (less than 100%), while the threshold rate is set as [70%] for conservativeness.

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5 Regulations targeting biomass-based fuel producers or consumers can be possible, in theory (but difficult in reality).

6 Examples of such a regulation include setting mandatory minimum percentage on the biomass-component added to the associated fossil fuel, or on the sales amount of the biomass-based fuel among the whole amount of the associated fossil fuel. The "mandatory" nature of the regulation is confirmed that the penetration level of the biomass-component is almost equal to or above the threshold level of the regulation.

7 To date, the difference between type E– and type L– policies (and whether these are exclusive or not) is uncertain. Moreover, the CDM EB has not decided for the case of type L– policy. We expect that the CDM EB will clarify these in the near future.

(iv) The Bio-Fuel produced by the project is sold through an ordinary sales channel, used in-house, or used to specific purpose as an alternative to fossil based fuel, and not be exported to/used in Annex I countries,

This sub-condition ensures that the Bio-Fuel would not be discarded (and maybe substitute the associated fossil fuel). It is noted that the emission reductions are linked to the "sold and/or used amount", and not the generated amount of the Bio-Fuel.

(v) Supply of the fossil fuel, which the Bio-Fuel displaces, has excess supply capacity in the host country, therefore the project does not create new/hidden demand of the fossil fuel, *i.e.*, the Bio-Fuel displace fossil fuel fully under the competitive environment of the Bio-Fuel,

This sub-condition ensures that the Bio-Fuel would not generate hidden demand. In other words, this sub-condition shows that the Bio-Fuel would displace the fuel demand to be met by the fossil fuel, otherwise.

The project participants shall demonstrate them with suitable evidences/documents, such as signed agreement by the wholesaler and/or retailer of the Bio-Fuel. The OE may request other evidences as it judges, if necessary.

Condition to assure that the build margin component of the grid electricity used is negligible:

(g) In calculation of the CO_2 emission factor of the grid to which the Bio-Fuel plant is connected to, the electricity demand by the plant is small enough not to affect the power development plan, thus only operating margin component is applied.

In order to justify the usage of operating margin, the project participants shall obtain the signed letter of the person who is in charge of the power development plan of the power company that the power development plan is never affected by the existence/non-existence of the facility.

What these applicability conditions imply and how these conditions are used are explained in the sub-section D.1.

A.4. What are the potential strengths and weaknesses of this proposed new methodology?

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The methodology figures out each stage of the value chain which, as a whole, generates GHG emission reductions. This clarifies the role of each stage in the elements, *i.e.*, applicability conditions, baseline scenario identification, baseline emissions formula, *etc*., in the baseline methodology.

Usually, it is assumed implicitly that the Bio-Fuel usage does not affect the fuel efficiency (on the calorific base). This methodology set some condition how to confirm this condition or how to modify the emission reduction formula. However, the methodology does provide a general formula/data to calculate the amount of such modification.

In addition, this methodology tries to incorporate possible leakage effects into the calculation through LCA (life-cycle-assessment), such as direct/indirect N_2O emissions related to fertilizer use, *etc* for more accurate GHG reduction effect estimation. Based on the LCA analysis studies, N_2O emissions from fertilizer use is "significant", therefore cannot be neglected. Therefore, the methodology incorporates LCA estimation with ISO14040 criteria basically.[8]

[8] LCA is not well-defined scientifically for the "allocation" criteria. For example, even if aggregated life-cycle GHG emissions of petroleum products are determined as a whole (at the output point of refinery), dividing such amount to each petroleum product (petrol, diesel, fuel oil, kerosene, …) has arbitrariness. Therefore,

SECTION B. Overall summary description:

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The baseline methodology is mainly constituted of three parts:

(1) Applicability conditions,

(2) Identification of the baseline scenario,

(3) Mathematical formula of baseline (and project) emissions

as well as some extraneous parts such as project boundary and uncertainty analysis.

Throughout the methodology, each stage of the value chain which, as a whole, generates GHG emission reductions is considered to factorize the elements.

It is characteristic that LCA estimation is incorporated to the "Biomass Supply" stage, because direct/indirect N_2O emissions from fertilizer use are significant, *i.e.*, cannot be neglected in comparison to the uncertainty level of whole emission reductions.

Applicability conditions specify those to exclude the possibility to displace other GHG emission reduction activities. Economical analysis on investment is the principal judging criterion to demonstrate additionality and baseline scenario identification.

Identification of the baseline scenario shows step-wise procedures to identify the baseline scenario for each stage. Among those, modified version of the additionality tool is used. Identifying the screening criteria and application of the applicability conditions, logically determines the unique baseline scenario as the continuation of current practice.

Mathematical formulas of baseline (and project) emissions are developed to include the fuel efficiency difference between baseline and project scenarios.

ISO14040 recommends criteria to choose (1) avoiding allocation by expanding the system boundary, (2) physical quantity-based allocation, or (3) price-based allocation. In reality, mass or thermal content is used in many studies. This methodology follows this ISO14040's criteria basically.

SECTION C. Choice of and justification as to why one of the baseline approaches listed in paragraph 48 of CDM modalities and procedures is considered to be the most appropriate:

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C.1. General baseline approach:

☐ Existing actual or historical emissions, as applicable;

☑ Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment;

☐ The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 per cent of their category.

C.2. Justification of why the approach chosen in C.1 above is considered the most appropriate:

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This methodology demonstrates the additionality of the project by assessing the economical analysis on investment. Therefore, the second approach is regarded as most appropriate.

On the other hand, the actual amount of Bio-Fuel sold links directly to the emission reductions. Therefore, the first approach may be chosen as well.

Theoretically, the first and the third approach are for the mathematical formula of the baseline emissions, while the second one is for the identification of the baseline scenario. Therefore, the first and the second approach are not exclusive.

SECTION D. Explanation and justification of the proposed new baseline methodology:

D.1. Explanation of how the methodology determines the baseline scenario (that is, indicate the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases (GHG) that would occur in the absence of the proposed project activity):

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We categorize the value chain to GHG emission reductions into three stages:

Stage 1: Biomass supply,

Stage 2: Bio-Fuel production, and

Stage 3: Bio-Fuel consumption.

In order to identify the baseline scenario, the alternative scenario options are to be listed up for each stage under the no CER revenue condition. These options are narrowed down, by applying the applicability conditions, to the unique baseline scenario.[9]

[BLS: Baseline scenario, PJS: project scenario]

Stage 1 [Biomass supply]

In case that the biomass is supplied by the plantation in the PJS, possible baseline options of the plantation area are:

- Option 1-1: Current situation continues,
- Option 1-2: Deforestation with some use of the vacant area,
- Option 1-3: Afforestaion/reforestation is done,
- Option 1-4: Some other plants, not used for biomass based fuel, are planted;
- Option 1-5: Plant for bio-fuel, which is different from the plant in the PJS, is planted;
- Option 1-6: Plant for Bio-Fuel, which is that of the PJS, is planted;
- Option 1-7: Some facility which emits GHGs is constructed.

By using the applicability conditions (sub-section A.3.), Option 1-3 is not realized through the condition (a). Options 1-1 and 1-4 are identical in the sense of emissions considering the condition (a). Option 1-5 is excluded from the condition (b). Option 1-2 and 1-7, which increases baseline emissions, can be neglected by selecting the conservative estimation.

Therefore, Option 1-1 (equivalent to 1-4 in GHG context) or Option 1-6 (*incl*. PJS) are remained as the possible scenario.

In case that the biomass is supplied as biomass-based waste-oil, the condition (b') exclude the case where some positive leakage are found.

As the result, continuation of current practice or the Option 1-6 (*incl*. PJS) are only the solutions left at this stage for the related land area use.

Stage 2 [Bio-Fuel production]

Whether the Option 1-6 (*incl.* PJS) is realized or not is the unique question at this stage considering the remaining options at Stage 1.

The conditions (c) and (d) exclude the cases where other scale of the facility using the same biomass (by (c)), and where another biomass-based fuel with different production process is used (by (d))

9 Several baseline scenarios may be chosen whose baseline emissions are identical. Those scenarios are regarded as the "same" or "equivalent" scenario in a sense to calculate emission reductions.

under the current legal framework of the host country. And condition (e) excludes the PJS itself[10] from the BLS candidates.

Therefore, the only remained option is the continuation of current practice.

The method how to confirm the condition (e) is by the barrier analysis and/or by the economical analysis with calculations of the indicator used for investment decision-making at the planning stage of the Bio-Fuel production plant.

"Step 3. Barrier analysis" and/or "Step 2. Investment analysis" of the "Tool for the demonstration and assessment of additionality" is applied. If barrier analysis well demonstrates that the project would not be implemented as the baseline scenario, the investment analysis is needed. While, if the barrier analysis is insufficient, investment analysis is needed in addition (in this case, the barrier analysis is recognized as the supportive analysis to demonstrate additionality).

Step 3 (of the Additionality Tool):

Sub-step 3a. Identify barriers that would prevent implementation of type of the proposed project

(Sub-step 3b. on the alternatives are not needed as no alternatives are left as shown above)

The barriers may include barriers, *e.g.*, cumbersome/complex procedures to get approval to construct/operate the bio-Fuel production facility, lack of acceptability of the Bi-Fuel in the market, limited access by the consumers because of fewer Bio-Fuel supply facilities, risks associated with new Bio-Fuel technology (e.g., lack of skills), lack of finance suppliers to implement the Bio-Fuel production project, *etc*. as specific examples of the generalized expression of the "Additionality Tool" to this type of projects.

Step 2 (of the Additionality Tool):

Sub-step 2a. Determine appropriate analysis method

Sub-step 2b. – Option II. Apply investment comparison analysis, or

Sub-step 2b. – Option III. Apply benchmark analysis

Sub-step 2c. Calculation and comparison of financial indicators

Sub-step 2d. Sensitivity analysis (only applicable to options II and III)

The method to assess this investment analysis is the same as shown in the "Additionality Tool". Specific to this type of projects, for the investment analysis, all economical components—*e.g.*, costs of biomass plantation/purchase, internal energy use, feedstock use, transportation of the Bio-Fuel, *etc*., and revenue such as from the sales of the Bio-Fuel, by-products, *etc*.—of the Bio-Fuel production plant shall be incorporated.

In addition, "Step 4. Common Practice" is assessed for credibility check as follows:

In case that the penetration of the same type (differentiated by the mixing ratio of biomass component) of Bio-Fuel is more than [10%] in the host country, the project participants shall demonstrate that the project is facing the prohibitive barriers without CER revenue with appropriate evidences.

<u>Stage 3 [Bio-Fuel consumption]</u>

The applicability condition (f), together with (i)–(v), ensures that the Bio-Fuel, produced at Stage 2, displaces relevant normal fossil-based liquid fuel.

As explained in the sub-section A.3. (applicability conditions), we need to consider the possibility of the case where the Bio-Fuel produced by the project plant may replace bio-fuels produced by other plants (in the market). In general, the reason why a bio-fuel production facility is operated is that the bio-fuel is competitive in the market as an alternative to the fossil fuel-based liquid fuel (*incl*. the

[10] The project may use other indigenous biomass, not planned in the beginning at later stage, by using the same production process.

effect of subsidies and/or CER credits). Therefore, it is *unrealistic* that such competitive bio-fuel is replaced by the project Bio-Fuel. Considering the viewpoint of conservativeness, the methodology sets the sub-applicability sub-condition (iii) as the penetration of the alternative Bio-Fuel as below [70%].[11]

This logic cannot be applied to the situation where some mandatory regulation force the compatible biomass-based fuel to use by the consumers at the rate specified by the regulation. The applicability sub-conditions (i) and (ii) exclude this case.

In addition, if the fossil fuel supply is limited and such limitation results to set ceiling on demand, the Bio-Fuel supply simply meets the hidden demand, *i.e.*, the fossil fuel is not displaced. In order to exclude such situation, sub-condition (v) is set.

The logics above lead to a conclusion, that the baseline scenario is to continue current practice when all of the applicability conditions are met. Even if other bio-fuels penetrate in the market, such effect does not influence the proposed project itself, and amount of emission reductions through the project.

D.2. Criteria used in developing the proposed baseline methodology:

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For Stages 1 and 2, the baseline scenario options are assessed by introducing barrier analysis and investment analysis. The applicability conditions on both Stages are set for this screening process.

As the result, only two options (continuation of current practice and the project scenario) are left for investment analysis. Therefore, in this case, additionality check for this project is equivalent to identifying the baseline scenario.

For Stage 3, the applicability conditions are set to ensure, that the produced Bio-Fuel does not dig out hidden demand or replace other bio-fuels.

D.3. Explanation of how, through the methodology, it can be demonstrated that a project activity is additional and therefore not the baseline scenario (section B.3 of the CDM-PDD):

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As shown in sub-section D.1., the additionality is demonstrated as a "sub-module" to identify the baseline scenario. The "Additionality Tool" is applied in this context with suitable modification.

STEP A

At the production stage of the Bio-Fuel, the applicability conditions (c) and (d) exclude the cases where other scale of the facility using the same biomass (by (c)), and where another biomass-based fuel with different production process is used (by (d)) under the current legal framework of the host country. Therefore, the remaining baseline options are

- the PJS itself, or
- continuation of current practice

from the baseline scenario candidates.

Next, the applicability condition (e), which is nothing but the additionality condition, is confirmed in the following steps:

STEP B

[11] It is noted that even alternative bio-fuels' penetration is 100%, emission reductions are realized if the biomass mixing ration of the alternative bio-fuel is lesser than that of the project Bio-Fuel.

The method how to confirm the applicability condition (e):

> (e) The project plant cannot be the most attractive course of action economically without the CER revenue, even if some subsidies[12] and/or tax credits for the Bio-Fuel production (if present) and sales revenue of Bio-Fuel itself and the by-products are included at the planning stage of the project *or* some prohibitive barriers to implement the project exist [additionality condition];

is by the barrier analysis and/or by the economical investment analysis with calculations of the indicator used for investment decision-making at the planning stage of the Bio-Fuel production plant. In this regard, "Step 3. Barrier analysis" and/or "Step 2. Investment analysis" of the "Tool for the demonstration and assessment of additionality" is applied as shown in sub-section D.1.

The barriers may include barriers, *e.g.*, cumbersome/complex procedures to get approval to construct/operate the bio-Fuel production facility, lack of acceptability of the Bi-Fuel in the market, limited access by the consumers because of fewer Bio-Fuel supply facilities, risks associated with new Bio-Fuel technology (*e.g.*, lack of skills), lack of finance suppliers to implement the Bio-Fuel production project, *etc*. as specific examples of the generalized expression of the "Additionality Tool" to this type of projects.

The method to assess this investment analysis is the same as shown in the "Additionality Tool". Specific to this type of projects, for the investment analysis, all economical components—*e.g.*, costs of biomass plantation/purchase, internal energy use, feedstock use, transportation of the Bio-Fuel, *etc*., and revenue such as from the sales of the Bio-Fuel, by-products, *etc*.—of the Bio-Fuel production plant shall be incorporated.

For details, see D.1.

STEP C

In addition, "Step 4. Common Practice" is assessed for credibility check as follows:

In case that the penetration of the same type (differentiated by the mixing ratio of biomass component) of Bio-Fuel is more than [10%] in the host country, the project participants shall demonstrate that the project is facing the prohibitive barriers without CER revenue with appropriate evidences.

STEP D

As the baseline scenario identification process (sub-section D.1.) derives that the baseline scenario (continuation of current practice) is not identical to the project scenario. It is obvious that the emission level in the project scenario is less than that of baseline scenario. Therefore, the project is additional.

D.4. How national and/or sectoral policies and circumstances can been taken into account by the methodology:

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Some of the applicability conditions—(i) to (iii) and (v) under (f)—on the Stage 3 are dependent on the host-country specific policies or situations.

D.5. Project boundary (gases and sources included, physical delineation):

[12] Subsidies introduced after the Marrakech Accords do not have to be considered in the development of the baseline scenario, as it is categorized as the "E–"-type policy.

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The principal GHG reductions through the project are realized at many vehicles[13] which utilizes the Bio-Fuel. This case is similar to the grid-connected renewable energy project-type. Therefore, the project boundary is chosen as

- the plantation site,
- transportation to the project site (Bio-Fuel production facility),
- the project site,
- the steam supply site (to the project site), if present (outside of the project site),
- transportation to fuel-supply facility,
- fuel-supply facility, and
- all vehicles which utilizes the Bio-Fuel produced by the project

referring to the case of ACM0002.

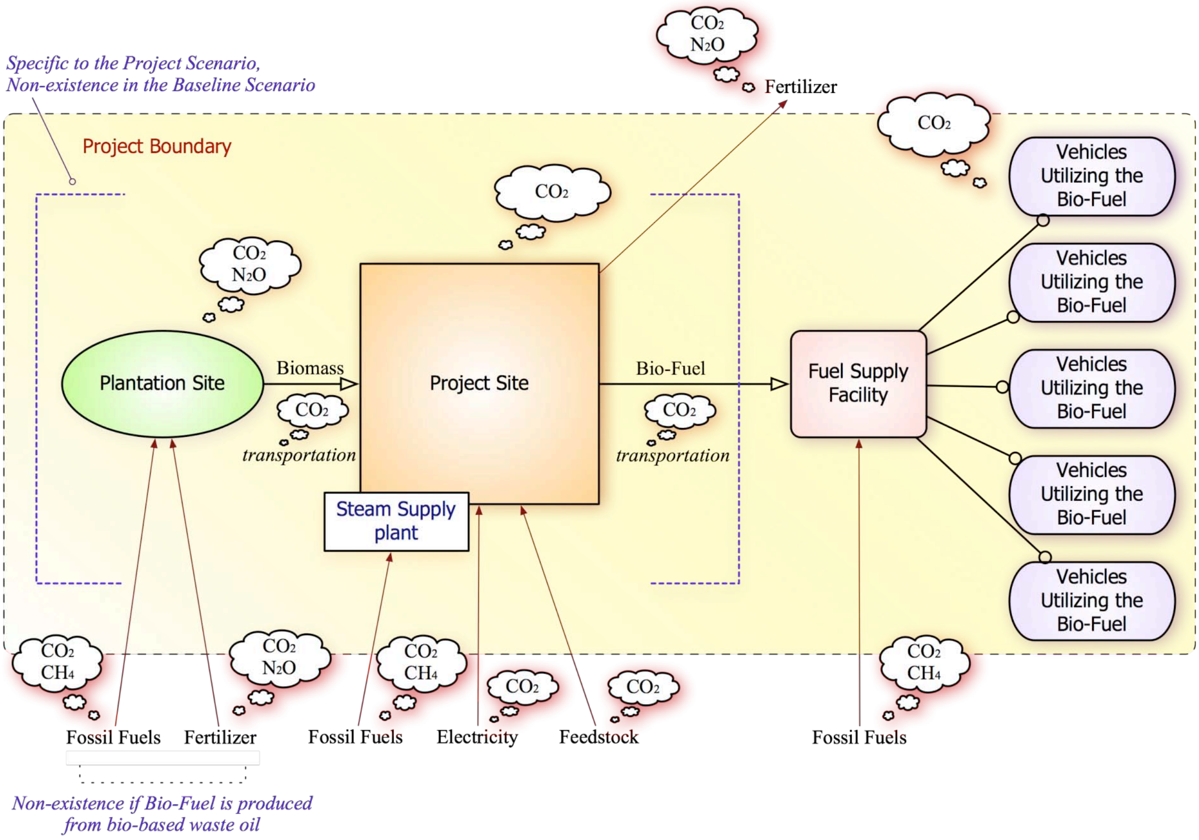

Figure NMB-1: Project Boundary and Associated GHG Emissions

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[13] The relevant vehicles are unspecified (*i.e.*, not monitored) each by each in the methodology, however, well-defined as those can be identified strictly. ACM0002 does not estimate each power plant's emission reductions, while this case can monitor them in theory. However, because only aggregated value is needed to calculate emission reductions, monitoring methodology does not require monitoring of each vehicle.

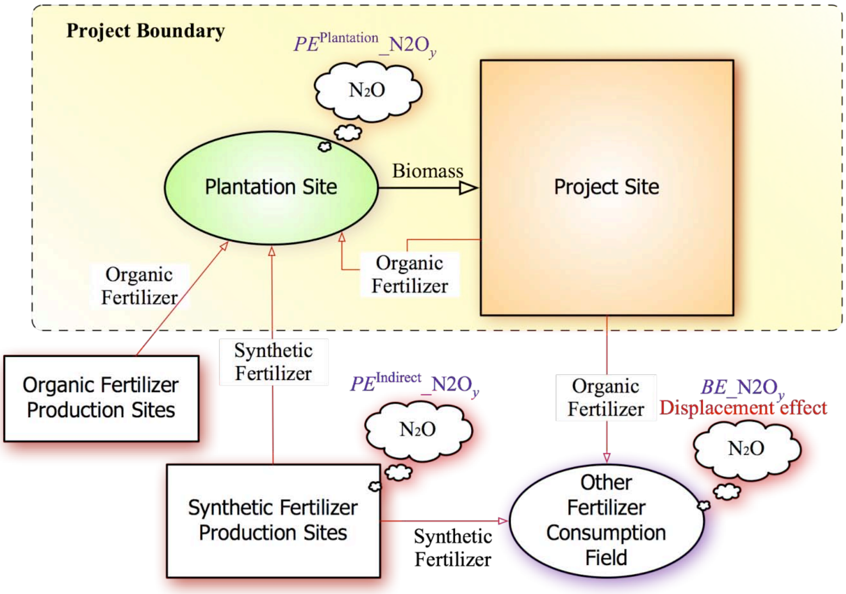

Figure NMB-2: Fertilizer-Related N_2O Emission Sources

Each emission source and associated GHGs are listed below:

		In the Boundary	Outside of the Boundary
Baseline Scenario	Significant (monitored)	• Each vehicle to utilize the Bio-Fuel in the PJS (CO_2 from fossil fuel use substituted by biomass part of the Bio-Fuel) *[substitution effect]*	• Fertilizer production and fertilizer use (fertilizer: by-product of the Bio-Fuel plant) (N_2O) *[substitution effect]* • Exploitation, Refinement, Transportation of fossil fuels substituted by the Bio-Fuel [oil field/port/refinery/gas station] (CO_2, CH_4)[14]
	Negligible *or* Common (not monitored)	• Fuel supply facility (CO_2: common) • Each vehicle to utilize the Bio-Fuel in the PJS (N_2O from fossil fuel use)	n.a.
Project Scenario	Significant (monitored)	• Each vehicle to utilize the Bio-Fuel in the PJS	• Power Plants linked to the grid (CO_2 from electricity used in

[14] Strictly speaking, LCA effects outside of the boundary must be treated as leakage, while it is *simpler* to include such effects in the CO_2 emission factor of the fossil fuel (as "adjustment"). The methodology, therefore, treats such LCA effects as a modified emission factor of the fossil fuel.

		feedstock) in the Bio-Fuel) • Transportation of Bio-Fuel [plant to gas station] (CO_2) • Bio-Fuel plant and/or Steam supply plant (CO_2 from in-house fossil fuel combustion and/or steam generation for in-house use) (CO_2 from C-content in non-bio feedstock combustion) • Transportation of biomass [plantation site to Bio-Fuel plant] (CO_2) • Transportation of organic fertilizer [Bio-Fuel plant to plantation site or other places] (CO_2) • Plantation site (CO_2 from Machinery use) (N_2O from Fertilizer use)	(CO_2, *etc.*) • Fertilizer production (synthetic fertilizer: used at plantation site) (N_2O) • Exploitation, Refinement, Transportation of fossil fuels used at the Bio-Fuel plant and plantation site [oil field/port/refinery/gas station] (CO_2, CH_4)[14] • Fertilizer production (fertilizer: used at plantation site) (CO_2)
	Negligible *or* Common (not monitored)	• Each vehicle to utilize the Bio-Fuel in the PJS (CO_2 from fossil fuel contained in the Bio-Fuel; common to BLS) (N_2O from fuel burning) • Bio-Fuel plant (N_2O from in-house fossil fuel combustion) • Fuel supply facility (CO_2: common) • Plantation site (CO_2 from Fertilizer use)	• Co-products outside of the boundary [transportation, *etc.*] (CO_2) • Commuter of the plant (CO_2)

The reason why this methodology incorporates the LCA-type assessment is that the N_2O emissions, especially indirect N_2O emissions from synthetic fertilizer use, are comparable in size to the whole emission reductions.

The emissions of items categorized as “negligible” are much smaller than the uncertainty level of total emission reductions. See section F for uncertainty analysis. If, at the PDD level, some emissions categorized as “significant” are regarded as “negligible”, those are not needed to be monitored. In this case, the project participants shall demonstrate its rationale (*e.g.*, by showing the rough estimation of such emissions to be much smaller than the uncertainty range of emission reductions).

It is noted that the fuel consumed at the fuel supply facility can be recognized as common for the project scenario and the baseline scenario (*i.e.*, no need to be counted).

When the project participants could not provide sufficient information on the LCA analysis on GHG (CO_2, CH_4) emissions through exploitation, refinement, transportation of fossil fuels substituted by the Bio-Fuel outside of the project boundary (oil field/port/refinery/gas station) in the baseline scenario and also such effects in the project scenario, are not needed to be estimated. This omission

can be justified, as it is a conservative estimation.

For fertilizer production CO_2 as a leakage, some conservative value can be used if the project participants provide sufficient documented information with plural scientific reports. The appropriateness of the information is judged by the validator (OE). In case such fertilizer is produced in Annex B country which ratified the Kyoto Protocol, this effect can be neglected.

D.6. Elaborate and justify formulae/algorithms used to determine the baseline scenario. Variables, fixed parameters and values have to be reported (e.g. fuel(s) used, fuel consumption rates):

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In order to elaborate the mathematical formula of the baseline emissions, we need some relations between the baseline scenario and the project scenario, because the baseline scenario is counter-factual and cannot be observed, in theory.

The underlying criterion to relate the parameters in the baseline scenario to those of project scenario is that the service provided by the Bio-Fuel is common for the project scenario and the baseline scenario. Such service can be regarded as the "mileage traveled" in this case.

The baseline emissions BE_y within in the boundary in a certain year y is given by:

$$BE_y = BF_y * COEF^{FF} * (1 + \delta)$$

where

BF_y : Bio-Fuel sold or utilized in a certain year (thermal content) [GJ/yr]

$= BF^{vol}_y * Density_y * HV_y$

where :
- BF^{vol}_y: Volume content of BF_y [m^3/yr],
- $Density_y$: Mass density of the Bio-Fuel [ton/m^3]
- HV_y: Thermal content of the Bio-Fuel per unit of mass [GJ/ton]

$COEF^{FF}$: Life-cycle CO_2 equivalent emission factor of the fossil fuel, which the Bio-Fuel substitutes [tCO_2eq/GJ]

δ : Adjustment factor related to the difference of fuel efficiency for km drive per GJ

$= [L_{biofuel}/L_{fossil}] – 1$

where :
- L_{fossil}: Mean mileage of the fossil fuel to be replaced per GJ [m/GJ],
- $L_{biofuel}$: Mean mileage of the Bio-Fuel to be replaced per GJ [m/GJ].

<u>Life-cycle GHG emission factor of the fossil fuel</u>:

In parallel with the LCA estimation of the Bio-Fuel, the LCA is also assessed for displaced fossil fuel.

This is dependent on the host country and the fossil fuel type, and not needed when conservative.

Therefore, project participants shall provide related objective information, such as scientific documents/paper with relative comparison between several studies. The appropriateness of the information is judged by the OE, as a validator, considering the cases applied beforehand. Life-cycle assessment is not needed if the project participants cannot provide such information as a conservative estimation (only CO_2 emissions from direct combustion is considered).

This LCA effect is included in the emission factor $COEF^{FF}$ as it is easier to understand. However, strictly speaking, it is outside of the boundary.

<u>The mean mileage information per GJ</u>:

Project participants shall provide related objective information, such as scientific documents/paper. If δ is obtained as a significant value, such value is used for calculation. The appropriateness of the information is judged by the OE, as a validator, considering the cases applied beforehand.

In case that such fuel is used by minor modes such as agriculture machinery, δ is set as zero considering the scarcity of data and insignificant contribution to whole emission reductions.

D.7. Elaborate and justify formulae/algorithms used to determine the emissions from the project activity. Variables, fixed parameters and values have to be reported (e.g. fuel(s) used, fuel consumption rates):

>>

Project emissions within the project boundary in a certain year *y* is given by:

$$PE_y = \sum_i FF^{BFP}_{i,y} * COEF^{FF}_i + BF^{mass}_y * COEF^{FS} + PE^{Tarnsp1}_y + PE^{Tarnsp2}_y + PE^{Plantation}\_N2O_y + PE^{Plantation}\_CO2_y$$

where

$FF^{BFP}_{i,y}$: Fossil fuel *i* combusted at the Bio-Fuel production plant and/or at the steam generation plant [physical unit/yr]

$COEF^{FF}_i$: LCA CO_2 emission factor of the fossil fuel *i* (*incl*. oxidization factor) [tCO_2/physical unit]

BF^{mass}_y : Bio-Fuel sold or utilized in a certain year (in mass) [ton-BioFuel/yr]

$COEF^{FS}$: CO_2 emission factor of the non-bio feedstock contained in the Bio-Fuel [tCO_2/ton-BioFuel]

$PE^{Tarnsp1}_y$: Transportation-related CO_2 emissions from plantation site to the project site $= \sum_{\text{transportation mode1}} EN^{TR}_{mode1,y} * COEF^{TR}_{mode1}$ [tCO_2/yr]

$PE^{Tarnsp2}_y$: Transportation-related CO_2 emissions from project site to the fuel supply facilities $= \sum_{\text{transportation mode2}} EN^{TR}_{mode2,y} * COEF^{TR}_{mode2}$ [tCO_2/yr]

where $EN^{TR}_{mode\,i,y}$: energy used for transportation mode *i*,
$COEF^{TR}_{mode\,i}$: CO_2 emission coefficient for transportation mode[15] *i*.

$PE^{Plantation}\_N2O_y$: N_2O emissions from fertilizer use at plantation site (direct) $= Fertilizer^{in}_y * UREA\_EQ^{in} * COEF^{Direct}\_N2O * GWP\_N2O$ [tCO_2eq/yr]

where $Fertilizer^{in}_y$: fertilizer input to the plantation site [ton-fertilizer/yr],
$UREA\_EQ^{in}$: urea-equivalence factor of the fertilizer for N-component [ton-urea/ton-fertilizer],
$COEF^{Direct}\_N2O$: direct N_2O emission factor of the fertilizer (=1.0%) [tN_2O/ton-urea],
GWP_N2O: GWP potential for N_2O (=310 for 1st Commitment Period) [tCO_2eq/tN_2O]

$PE^{Plantation}\_CO2_y$: CO_2 emissions from fossil fuel use at plantation site $= \sum_i FF^{Plantation}_{i,y} * COEF^{FF}_i$

where $FF^{Plantation}_{i,y}$: fossil fuel *i* combusted at the plantation site [physical unit/yr]

[15] "Transportation mode" implies ship, railway, truck, *etc*.

D.8. Description of how the baseline methodology addresses any potential leakage of the project activity:

>>

Leakage L_y, as the net emission change in a certain year y, is given by:

$$L_y = EL_y * COEF^{EL}_y / (1 - \text{Loss}_y) - BE\_\text{N2O}_y + PE^{\text{Indirect}}\_\text{N2O}_y + PE^{\text{Feedstock}}_y + PE^{\text{Fertilizer}}_y$$

where

EL_y : Electricity consumed at the Bio-Fuel production plant [MWh/yr]

$COEF^{EL}_y$: CO_2 emission factor of the used electricity [tCO_2/MWh]

Loss_y : Transmission loss of the grid, if grid electricity is used [no dimension]

BE_N2O_y : N_2O emissions substituted by bio-based fertilizer (by-product of the Bio-Fuel)

$= BioFertilizer^{out}_y * UREA\_EQ^{out} * COEF\_\text{N2O} * \text{GWP\_N2O}$ [tCO_2eq/yr]

where: $BioFertilizer^{out}_y$: Bio-based fertilizer sold out in the market [t-(bio-fertilizer)/yr]

$UREA\_EQ^{out}_y$: Coefficient to convert from bio-based fertilizer to synthetic urea fertilizer [t-urea/t-(bio-fertilizer)]

$COEF\_\text{N2O}^{tot}$: N_2O emission factor of the synthetic urea fertilizer (direct + indirect) (=0.030) [tN_2O/t-urea]

GWP_N2O : GWP of N_2O (=310 in the 1st Commitment Period) [tCO_2eq/tN_2O]

$PE^{\text{Indirect}}\_\text{N2O}_y$: Indirect N_2O emissions from fertilizer use at plantation site (emitted at the fertilizer production facility) in PJS

$= Fertilizer^{in}_y * UREA\_EQ^{in}_y * COEF^{\text{Indirect}}\_\text{N2O} * \text{GWP\_N2O}$ [tCO_2eq/yr]

where $COEF^{\text{Direct}}\_\text{N2O}$: indirect N_2O emission factor of the fertilizer (=2.0%) for synthetic fertilizer only [tN_2O/ton-urea]

$PE^{\text{Feedstock}}_y$: Indirect GHG emissions of feedstock used at the Bio-Fuel production facility (emitted at the feedstock production process).

$PE^{\text{Fertilizer}}_y$: Indirect CO_2 emissions from synthetic fertilizer production.

The CO_2 emission factor of the electricity used $COEF^{EL}_y$ is obtained by using the calculation method of Operating Margin specified in "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (ACM0002), if grid electricity is used, while in case for the self-generation facility being used, apply the CO_2 emission factor of the facility.

In order to justify the usage of operating margin, the project participants shall obtain the signed letter of the person who is in charge of the power development plan of the power company that the power development plan is never affected by the existence/non-existence of the facility.

N_2O emissions from synthetic N-fertilizer:

N_2O emissions are those substituted by the bio-based fertilizer, as a by-product of the Bio-Fuel production process, sold in the market. If all of the bio-based fertilizer is brought back to the plantation site, it is no use to calculate these emissions.

In the world market of synthetic N-fertilizer, most of them (90% or more) is urea ($CO(NH_2)_2$) and minor portion (less than 10%) is ammonium sulfate ($(NH_4)_2SO_4$). Therefore, it is reasonable to assume that the synthetic N-fertilizer is represented by urea. Using the method specified in the IPCC Good Practice Guidance on GHG Inventory with default values, we can derive that

$$COEF\_\text{N2O}^{tot} = 2.6\% \text{ to } 3.0\%$$

considering N_2O emissions from synthetic N-fertilizer production stage and from direct/indirect N_2O emissions at the fertilizer application stage ($COEF\_N2O^{Direct}$ = 1.0%). Within the range, 3.0% is chosen as a conservative estimation in this methodology.[16] If the project participants provide country-specific information,[17] *COEF*_N2O can be replaced by such a value. See Annex I for details.

CO_2 emissions from synthetic N-fertilizer production:

Some conservative value can be used if the project participants provide sufficient documented information with plural scientific reports (on LCA of bio-fuel). The appropriateness of the information is judged by the validator (OE). In case such fertilizer is produced in Annex B country which ratified the Kyoto Protocol, this effect can be neglected.

D.9. Elaborate and justify formulae/algorithms used to determine the emissions reductions from the project activity. Variables, fixed parameters and values have to be reported (e.g. fuel(s) used, fuel consumption rates):

>>

Emission reductions ER_y is given by:

$$ER_y = BE_y - PE_y - L_y$$

using the notations defined above.

16 It seems strange why such higher value of 3% is conservative. Throughout the project, N-component in the biomass is recycled (to the plantation area) or sold in the market (in this case). All of such N_2O emissions abated is cancelled by the N_2O fertilized to the plantation site, considering the N-budget of the whole system (with some loss). Therefore, it is reasonable to set the higher value here which is to be cancelled in the project scenario.

17 The appropriateness of such information is judged by the Operational Entity (validator).

SECTION E. Data sources and assumptions:

E.1. Describe parameters and or assumptions (including emission factors and activity levels):

>>

The parameters used in the methodology are listed below:

Baseline Emissions

Name	Description	Key variable?	Time-dependence
BF_y	Bio-Fuel utilized or sold	**yes**	yes
$COEF^{FF}$	LCA emission factor of displaced fossil fuel	**yes**	no
δ	Adjustment factor of fuel efficiency	no	no

Key assumption:

- Activity related parameter BF_y is directly monitored (the unit measured is volume, mass, calorific value, *etc*.). The uncertainty associated with the physical unit of BF_y is much smaller than that LCA $COEF^{FF}$.
- For LCA $COEF^{FF}$, a conservative value is selected surveying the scientific literatures with reasonable assumptions.
- δ is regarded as zero or very small if the fuel efficiency is estimated per thermal content of the fuel, in general.

Other assumptions are shown in the applicability conditions.

Project Emissions

Name	Description	Key variable?	Time-dependence
$FF^{BFP}{}_{i,y}$	Fossil fuel combusted at the Bio-Fuel production plant and/or at the steam generation plant	no	yes
$COEF^{FF}{}_i$	LCA emission factor of the above fossil fuel *i*	no	no
$BF^{mass}{}_y$	Bio-Fuel utilized or sold (mass unit)	**yes**	yes
$COEF^{FS}$	CO_2 emission factor of non-bio feedstock contained in the Bio-Fuel	**yes**	no
$PE^{Transp1}{}_y$	Transportation CO_2 from plantation site to project site	no	yes
$PE^{Transp2}{}_y$	Transportation CO_2 from project site to Bio-Fuel supply facility	no	yes
$PE^{Plantation}\_N2O_y$	N_2O emissions from fertilizer use at plantation site	**yes**	yes
$PE^{Plantation}\_CO2_y$	CO_2 emissions from fertilizer use at plantation site	no	yes

Key assumption:

- Key factors in project emissions are non-bio part of the Bio-Fuel and N2O from fertilizer use. Former is easily obtained by theoretical consideration of chemical reaction,

therefore less uncertain. Latter N_2O emissions from fertilizer use are calculated by default factor of the IPCC Guidelines on National GHG Inventory. It is unrealistic to directly monitor such emissions at the plantation site.

Leakage

Name	Description	Key variable?	Time-dependence
EL_y	Electricity consumed at the Bio-Fuel production plant	**yes**	yes
$COEF^{EL}_y$	LCA emission factor of grid electricity	**yes**	yes
$Loss_y$	Transmission loss of the grid	no	yes
$PE^{Indirect}\_N2O_y$ $-BE\_N2O_y$	Fertilizer related N_2O emission increase due to fertilizer production	**yes**	yes
$PE^{Feedstock}_y$	GHG from feedstock production	no	yes
$PE^{Fertilizer}_y$	CO_2 from feedstock production	no	yes

Key assumption:

- For indirect N_2O emissions from fertilizer use, see the explanation for “Project Emissions”.
- For electricity displacement effect, pure operating margin is applied with confirmation of no build margin component by asking people who is responsible for power development plan. In many cases, OM is more conservative than BM because it does not include no CO_2 must-run plants, noting that such effect comes in the project scenario, not in the baseline scenario.

E.2. List of data used indicating sources (e.g. official statistics, expert judgement, proprietary data, IPCC, commercial and scientific literature) and precise references and justify the appropriateness of the choice of such data:

>>

N_2O related information (direct/indirect emission factor of fertilizer):

- IPCC GHG Inventory Guidelines/Good Practice Guidance (see Annex I).

Grid electricity displacement emission factor:

- Local or national statistics provided by the power company

LCA adjusted emission factor of the fossil displaced or used:

- Data to be provided by the fuel supplier, or IPCC default factor is used (if such local data are unavailable) for direct emissions in the boundary.
- Several scientific literatures are assessed to be used in the PDD. If such assessment is not provided, only the direct emissions are applied.

Fuel efficiency of the Bio-Fuel:

- For principal usage mode, adjustment factor shall be assessed by using scientific literatures or reports.

The methodology takes most potentially significant factors/sources into account based on the most appropriate data sources to date.

E.3. Vintage of data (e.g. relative to starting date of the project activity):

>>

Most of the data is monitored as the data for such a year. While emission factor of the grid electricity is based on the latest data provided by the information by the Power Company.

E.4. Spatial level of data (local, regional, national):

>>

The methodology tries to utilize the local data as possible, while for direct/indirect N_2O emission factors are obtained by the IPCC default factors due to the difficulties in direct measurement.

SECTION F. Assessment of uncertainties (sensitivity to key factors and assumptions):

>>

As shown in sub-section E.1., key factors to evaluate emission reductions are shown below:

Baseline Emissions

Name	Description	Key variable?	Time-dependence
BF_y	Bio-Fuel utilized or sold	**yes**	yes
$COEF^{FF}$	LCA emission factor of displaced fossil fuel	**yes**	no

Project Emissions

Name	Description	Key variable?	Time-dependence
BF^{mass}_y	Bio-Fuel utilized or sold (mass unit)	**yes**	yes
$COEF^{FS}$	CO_2 emission factor of non-bio feedstock contained in the Bio-Fuel	**yes**	no
$PE^{Plantation}\_N2O_y$	N_2O emissions from fertilizer use at plantation site	**yes**	yes

Leakage

Name	Description	Key variable?	Time-dependence
EL_y	Electricity consumed at the Bio-Fuel production plant	**yes**	yes
$COEF^{EL}_y$	LCA emission factor of grid electricity	**yes**	yes
$PE^{Indirect}\_N2O_y - BE\_N2O_y$	Fertilizer related N_2O emission increase due to fertilizer production	**yes**	yes

Among them, the largest amount of emissions is the baseline emissions:

$BF_y * COEF^{FF}$

As BF_y is measured directly, the uncertainty range is small, therefore LCA adjusted emission factor $COEF^{FF}$ governs the uncertainty range. The methodology does not specify the concrete method to calculate LCA effect in it, left the appropriateness of such estimation for the Operational Entity in the PDD because such effect may differ among countries and fuel types with the condition:

> *... project participants shall provide related objective information, such as scientific documents/paper with relative comparison between several studies. The appropriateness of the information is judged by the OE, as a validator, considering the cases applied beforehand. Life-cycle assessment is not needed if the project participants cannot provide such information as a conservative estimation (only CO_2 emissions from direct combustion is considered).*

Another source of uncertainty is N_2O emissions at the fertilizer application and synthetic fertilizer production. As it is unrealistic to measure such emissions, IPCC default value is applied which has two significant digits:

$COEF\_N2O^{tot}$ = 2.6% to 3.0%

In comparison to above LCA-related uncertainties, other uncertainties are less significant.

SECTION G. Explanation of how the baseline methodology allows for the development of baselines in a transparent and conservative manner:

>>

The methodology incorporates every significant factors in it, such as N_2O emissions from synthetic fertilizer production and application of fertilizers, because such LCA effect is too large to be neglected (these effect contribute to the conservative side to calculate emission reductions).

In addition, fertilizer production CO_2, to which a conservative estimation is applied, is incorporated.

Several factors such as fuel efficiency adjustment effect are prepared in advance in the methodology, while concrete assessment of such effects are left for the project participants to be described in the PDD, which are to be checked by the Operational Entity for its appropriateness.

As for the carbon emission factor of the grid electricity, Operating Margin, which is conservative in most cases, is applied.

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ANNEX I. Supplemental Information – N_2O Emissions from (Synthetic) N-Fertilizer Use

>>

In general, N_2O emission source from nitrogen (N) fertilizer use are categorized as follows as specified in the IPCC Guidelines/Good Practice Guidance:

- Fertilizer production stage (for synthetic fertilizer only)
- Fertilizer application stage (both for synthetic and organic fertilizers)

In addition, for the latter application stage, direct emissions and indirect emissions are treated separately.

Synthetic fertilizer production stage:

Presently, most of the synthetic N-fertilizer is urea, although minor portion (less than several percent) is ammonium sulfate.

Urea: $CO(NH_2)_2$ [60]

Therefore, here we set the synthetic fertilizer as "urea" as a good approximation.

Urea is made from nitric acid (HNO_3) [63]. The production process of nitric acid is the origin of N_2O emissions.

In the nitric acid production stage, N_2O is emitted as:

(8 to 10) kg-N_2O/ton-HNO_3

as the IPCC default value range of non-Annex I countries.

Urea contains 2 nitrogens with almost the same molecular weight of nitric acid, N2O emissions at the production stage of urea is:

(16 to 20) kg-N_2O/ton-urea.

Therefore, N_2O emissions in the fertilizer production stage is:

(1.6 to 2.0)% of fertilizer (urea-equivalent mass unit)

Fertilizer application stage:

Direct Emissions:

N_2O emissions directly emitted from the applied fertilizer are

Direct N_2O emissions = [(all N-component in fertilizer) * (1 – volatilization rate) * EF_1] * 28/44

where 28/44 is the mass ratio of N in urea. EF_1 is the emission factor for emissions from N inputs [kg-N_2O-N/kg-N input].

IPCC sets the default values of volatilization rate as 10% and EF_1 as 1.25%.

Therefore,

Direct N_2O emissions = [fertilizer (urea-equivalent)] * 90% * 1.25% * 44/60

= [fertilizer (urea-equivalent)] * 0.825%

Indirect Emissions:

Indirect emissions is those from N-component, which once volatilized, or as NH_3 or NO_X but emitted as N_2O after deposited onto soil or water.

Indirect N_2O $emissions^{soil}$ = [(all N-component in fertilizer) * (volatilization rate) * EF_4] * 28/44

EF_4 is the emission factor for N_2O emissions from atmospheric deposition of N on soils surfaces [kg-N_2O-N/kg-NH_3-N and NO_X-N emitted] with the default value of 1%.

Therefore,

Indirect N_2O emissions^{soil} = [fertilizer (urea-equivalent)] * 10% * 1% * 44/60
= [fertilizer (urea-equivalent)] * 0.073%

On the other hand, N_2O emissions from leaching/runoff are:

Indirect N_2O emissions^{water} = [(all N-component in fertilizer) * (leaching/runoff rate) * EF_5] * 28/44
= [fertilizer (urea-equivalent)] * 30% * 0.25% * 44/60
= [fertilizer (urea-equivalent)] * 0.055%

with the IPCC default value of leaching/runoff rate as 30% and EF_5 as 0.25%.

The aggregated indirect emissions are:

Indirect N_2O emissions = [fertilizer (urea-equivalent)] * 0.128%

As the result, direct and indirect N_2O emissions at the application stage are summarized:

Total N_2O emissions = [fertilizer (urea-equivalent)] * 0.953%

Considering the uncertainty level, 1.0% of the fertilizer weight is emitted as N_2O at the application stage.

In summary, N_2O emissions are:

	Production stage	Application stage
Synthetic Fertilizer	1.6% to 2.0%	1.0%
Organic Fertilizer[18]	–	1.0%

multiplied by [fertilizer (urea-equivalent)].

18 Here "organic fertilizer" is a by-product of Bio-Fuel production process, originated by biomass plantation.