Date: 30/07/2024	Document:

TABLE FOR COMMENTS

Name of submitter: Loic Braune

Affiliated organization of the submitter (if any): _______________

Contact email of submitter: _____ loic.braune@laposte.net

Template for comments

Date: 30/07/2024	Document:

0	1	2	3	4	5	6
#	**Para No./ Annex / Figure / Table**	**Line Number**	**Type of comment** **ge** = general **te** = technical **ed** = editorial	**Comment** **(including justification for change)**	**Proposed change** **(including proposed text)**	**Assessment of comment** **(*to be completed by UNFCCC secretariat*)**

1	General	N/A	ge	Using this "landscape-based" approach like MoFuSS is incompatible with the current methodologies - such as CDM AMS-II.G, Gold Standard Reduced emissions from Cooking and Heating (also known as TPDDTEC) and VCS VMR-0006 - and would require to stop using any equation assuming that the Emission Reduction = fNRB x "displaced Emissions". In this paper, the fNRB is defined at landscape level as the fraction of harvested biomass above the level of sustainability (equilibrium). This means that every additional unit of consumption is 100% part of the overconsumption. Similarly, once a landscape is overharvested, any unit of consumption removed is 100% removed from the overconsumption. There is no sense in considering only fNRB x "displaced emissions". In other words, if a project reduces the harvesting, it reduces the unbalance and therefore it reduces the fraction of non-renewable biomass until the equilibrium is met. As such, from the landscape perspective, displaced emissions should be counted at 100% as emission reduction, and there is no rationale to assume that Emission Reductions = fNRB x displaced emissions. It should be Emission Reduction = displaced emissions. A technical paper provided below gets into more details and provides a rigorous mathematical demonstration how the fNRB term could be removed from the usual methodologies.	The paper should clarify that the approach and definitions it uses to calculate fNRB are incompatible with the methodologies stating that "Emission Reductions = fNRB x Displaced Emissions". This paper could make it more explicit that: 1. the non-renewable biomass is what is consumed in excess of a threshold. As such, one ton above the equilibrium threshold is 100% non-renewable, and similarly, as long as the harvesting is higher than the production of the landscape, one ton less should be considered 100% emission reduction; 2. the fNRB is not the same in the scenario with project because the landscape is less harvested, therefore fNRB is reduced (i.e. the landscape becomes closer to the sustainable equilibrium). 3. The system used for assessing the emission is the landscape, not the household. When a project reduces emission for some households, it frees renewable biomass for the households in the same landscape but outside of the project. The variation of their emissions is not accounted in the current methodologies As this paper is very clear on the definition of fNRB, it proves that this definition is incompatible with the narrative and	

Template for comments

Date: 30/07/2024	Document:

0	1	2	3	4	5	6
#	**Para No./ Annex / Figure / Table**	**Line Number**	**Type of comment** **ge** = general **te** = technical **ed** = editorial	**Comment** **(including justification for change)**	**Proposed change** **(including proposed text)**	**Assessment of comment** **(*to be completed by UNFCCC secretariat*)**
					definition of fNRB used in CDM AMS-II.G, Gold Standard Reduced emissions from Cooking and Heating (also known as TPDDTEC) and VCS VMR-0006 and other similar methodologies. The Technical paper attached below proves that – to remain coherent with the definition of fNRB provided in MoFuSS – the Emission Reductions in a clean cooking project should **NOT** be fNRB x displaced emissions.	

	14, 16, 17			We noted that, from the paragraph 14, fNRB was defined as such: "Trees grow naturally in many environmental conditions and if wood is harvested at or below the rate at which it naturally regenerates, then harvesting is sustainable. However, if more wood is harvested than the landscape can replace, as is often the case in low- and middle-income countries (LMICs) where people rely heavily on fuelwood and charcoal, harvesting is not sustainable and tree cover will decline over time. This causes landscape degradation and may also contribute to long-term deforestation. fNRB is a measure of the relative amount of wood that is harvested above the landscape's natural rate of regeneration." This is consistent with the previous definition of fNRB. However, this definition is inconsistent with the approach used in most of the methodologies that consider fNRB as the fraction of each unit of emissions that come from non-renewable source. With the definition in this paper, if a country/district/landscape would reduce harvesting to the sustainability threshold (equilibrium), the emissions should be reduced by 100% - as, per the definition above – harvesting would then be sustainable. Yet, according to paragraph 16 and 17, the concept of fNRB is used broadly by methodologies, and, for all of them, it is considered that a reduction of harvesting of "h" would lead to an emission reduction proportional to fNRB x "h".	This incoherence comes from 2 aspects: 1. fNRB is influenced by the impact of any project, and therefore, fNRB in the scenario with project is different from fNRB in the scenario without project; 2. the system used for fNRB is different than the system used in methodologies: fNRB represents the unbalance between the production of the landscape and the consumption of **all the households in a specific area.** Therefore, when we assess the change in emissions, we need to account the change in emissions for all the households, not only the households impacted by the project. Indeed, the variation of fNRB between the scenarios with and without project is undetectable – but, because it applies to a large population, it has a significant effect. Intuitively, it is clear that reducing harvesting for some consumers "frees" renewable biomass for the other households – in other words, it makes the whole landscape closer to the equilibrium. Mathematically, we can prove that the variation of fNRB x population = 1-fNRB, i.e. that there is a positive leakage from the households in the project that brings more renewable resource to everybody else. The technical paper attached below get into more details and proves mathematically, that, if we would consider the extra renewable biomass that is freed for the	

Template for comments

Date: 30/07/2024	Document:

0	1	2	3	4	5	6
#	**Para No./ Annex / Figure / Table**	**Line Number**	**Type of comment** **ge** = general **te** = technical **ed** = editorial	**Comment** **(including justification for change)**	**Proposed change** **(including proposed text)**	**Assessment of comment** **(*to be completed by UNFCCC secretariat*)**
				With this approach, in the example above, reducing harvesting back to the equilibrium would not reduce emission by "100% x displaced emissions" but by fNRB x "displaced emissions". This paradox shows that there is an incoherence between the definition and calculation of fNRB and the use that is made in the methodologies.	other households outside the project area, **the emission reduction would be 100% of the displaced emissions, not fNRB x displaced emissions.**	

	61		te	*"Where "j" is a pixel in the "project area" and "project area" is shorthand for a country, sub-national administrative boundary, or any project-specific geographic boundary. However, the boundary should be selected such that the area includes all likely harvest areas used by the target woodfuel consuming population."* This is very different from the "project area" or system used in the usual clean cooking methodologies, for which the "project emission" represents **the emissions from the households in the clean cooking project – not all the households in the landscape.**	With the definition of fNRB that is brough in MoFUSS, the system should include the consumption from all households in the landscape, because it is their consumption that will help assessing whether the landscape is above the equilibrium or not. As such, the emissions in the scenario with project should include the emissions from all the households harvesting the landscape – the households with clean cooking (emission = 0) and the emissions from the other households that benefits from the extra renewable biomass (formerly used by the project household and now available – i.e. the renewable biomass "transferred" from the household with clean cooking option to the others) . The key element of incompatibility is the following: - The methodologies restrict the system to the households using the clean cooking solution. They assume that fNRB represents the fraction of each piece of wood that creates emissions. - However, MoFuSS (and Tool30) defines fNRB as the quantity of overharvesting. It means the fraction of the consumption that creates 100% of the emissions. Each reduction of the consumption brings the landscape closer to equilibrium – but, because the methodology uses a definition of fNRB that is different and a system that is smaller, the methodology only accounts a portion of the actual reduction.	

Date: 30/07/2024	Document:

0	1	2	3	4	5	6
#	**Para No./ Annex / Figure / Table**	**Line Number**	**Type of comment** **ge** = general **te** = technical **ed** = editorial	**Comment** **(including justification for change)**	**Proposed change** **(including proposed text)**	**Assessment of comment** **(*to be completed by UNFCCC secretariat*)**
					This illustrates that the methodology and this MoFuSS approaches are, in fact, using different systems and different definitions and understanding of fNRB. This should be clearly stated and conclude that this approach of fNRB is incompatible with the clean cooking methodologies such as CDM AMS-II.G, Gold Standard Reduced emissions from Cooking and Heating (also known as TPDDTEC) and VCS VMR-0006 or any other methodology that consider – wrongly – that a project Emission Reduction equal fNRB x Displaced emissions	

Technical note: considerations on fNRB

Validity of fNRB factor in the clean cooking methodologies?

WORKING DOCUMENT, version 5.0

1. Purpose of this paper and executive summary

a. *General purpose of the paper*

The purpose of this paper is to demonstrate that most of the current methodologies used to assess the emission reductions from project activities displacing the use of non-renewable biomass (mostly improved or clean cooking but also safe water supply projects[1]) are based on a wrong understanding of the concept of the fraction of Non Renewable Biomass (f_{NRB}), which leads to incoherences in the calculation of the associated emission reductions.

Coming back to the definition of f_{NRB}, this paper establishes that f_{NRB} has been mistakenly interpreted as "the emissions per unit of consumption". In reality, the f_{NRB} assesses the discrepancy between the consumption and the sustainable production of biomass by the landscape. In simplified terms, a f_{NRB} of 30%, should not be interpreted as every piece of wood being 30% non-renewable. Instead, it rather means that 30% of the consumption exceeds the threshold of sustainability, and that portion of consumption in excess is causing 100% of the emissions. Therefore, any reduction of the consumption above the sustainability threshold should be integrally considered as emission reduction, not just a fraction of it, since the intervention reduces the overconsumption until the equilibrium between consumption and landscape production is reached. In essence, the marginal consumption of biomass (i.e. the last quantity of consumed wood) defines the renewability status of the consumption.

This paper does not aim to establish a consensus on the most appropriate method to calculate f_{NRB} (a.o. CDM Tool 30, WISDOM, MoFuSS). Instead, it questions the validity and utility of using this parameter in evaluating project emissions.

b. *Structure of the paper:*

The paper will first revisit the definition of f_{NRB}, to show that $f_{NRB}$is a ratio that measures the unbalance between the overall consumption and landscape sustainable biomass production. It will clarify that using current methodologies, the f_{NRB} is considered as an external and independent constant, regardless of the presence of a project.

Next, the paper will demonstrate that the approach chosen by most of the usual methodologies to measure cookstoves project emission reductions (i.e. using an identical f_{NRB} for both the baseline and project scenarios) leads to incoherences and paradoxes. This is explained by the fact that maintaining the same f_{NRB} with and without projects would suppose that the landscape regenerates less in the scenario with project. This contradicts the methodologies'

[1] In the scope of this paper, the focus will be on improved/clean cookstoves interventions. Although, the conclusions hold true for other methodologies using the concept of f_{NRB} (e.g. AMS-III.Z., AMS-III.AV., AMS-III.BG.)

own assumptions and definition of the landscape biomass production, which is supposed to be constant with or without project.

The paper will then analyze the implications of considering the landscape regeneration as a fixed number and suggests how the mainstream methodologies should be adjusted. This revision induces two key points: (i) f_{NRB} is different in the scenarios with/without project (if the consumption decreases with project, f_{NRB} should decrease too) and (ii) that f_{NRB} changes inside and outside of the project scope, because the reduction of consumption means that there is more renewable biomass available for the households outside the project area.

The paper will then show, both mathematically and through a physical reasoning, why f_{NRB} should **not** be a term in the equation assessing the emission reductions for improved/clean cooking projects. Finally, the paper will discuss that other parameters could be introduced instead of the f_{NRB}, such as the rate of re-use of the saved biomass by the other households, and the elasticity of the woodfuel price/demand.

2. Introduction

a. *Global context*

Household energy consumption significantly contributes to overall greenhouse gas emissions. According to SDG 7 Tracking report (2024), 2.1 billion people worldwide still rely on cooking over polluting open fires or inefficient stoves, representing more than one quarter of the total population. This results in the production of approximately 1 gigaton of carbon dioxide equivalent produced every year from burning woodfuels (equal to 1.9- 2.3% of global emissions). On top, exposure to household air pollution from burning biomass is a significant risk factor for respiratory and heart diseases, leading to nearly four million premature deaths annually. Tackling the emissions while maintaining the energy access for the most vulnerable is a priority.

According to Bailis et al. (2015), over half of all wood harvested worldwide is used as fuel, and biomass used for cooking is 27- 34% non-renewable (unsustainably harvested). This means that overall consumption exceeds the landscape regeneration capacity by 27–34% on a global level, with significant variations by country and region[2]. This disparity highlights the substantial effort required to reduce biomass consumption to a sustainable level.

To measure the impact of the policies aiming at improving household energy efficiency, it is important to correctly assess the variation of emissions when efficient solutions are implemented both at macro and at household levels.

b. *The concept of f_{NRB}*

The fraction of non-renewable biomass (f_{NRB}) is a fundamental concept of emission reduction methodologies, particularly in the context of improved or clean cookstove carbon projects. The basic principles are recalled hereafter.

It is considered that any biomass harvested for consumption (H) can be divided into two components:

[2] https://www.usaid.gov/sites/default/files/2022-05/cookstoves-toolkit-2017-mod3-climate-impacts.pdf

i. **The Renewable Biomass (RB)**: it represents the portion of biomass harvested at or **below** the natural regeneration rate of the landscape. This biomass loss does not result in long-term loss of biomass carbon stocks.

ii. **The Non-Renewable Biomass (NRB):** it is the portion of biomass harvested **above** the natural regeneration rate of the landscape. This over-extraction ultimately results in a net depletion of biomass stocks over time.

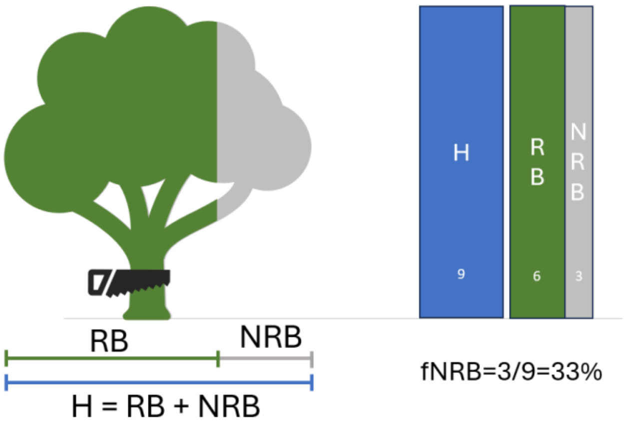

Figure 1 Illustrative example of fNRB

The f_{NRB} parameter quantifies the relative amount of wood harvested beyond the landscape's natural rate of regeneration. Mathematically, it is defined as the ratio of Non-Renewable Biomass (NRB) consumed to the total biomass consumption (H). The concept is illustrated on Figure 1.

$$f_{NRB} = \frac{NRB}{H} = \frac{NRB}{RB + NRB} \quad (1)$$

$$f_{NRB} = \frac{H - RB}{H} = 1 - \frac{RB}{H} \quad (2)$$

This definition clearly shows that f_{NRB} measures the over-consumption, representing the portion of the consumption that is above the equilibrium point (where harvesting equals regeneration, i.e. when H = RB). In a landscape where the consumption is lower than the renewable biomass, the emission would be null as f_{NRB}would be 0.

The same equation can alternatively be expressed as follows:

$$RB = H \times (1 - f_{NRB}) \quad (3)$$

The RB definition, as defined in CDM Tool 30, is a fixed parameter that is calculated based on the regenerative capacity of the accessible landscape. It is calculated using the Mean Annual Increment (in tonnes per hectare per year) multiplied by the accessible area per landscape type. Therefore, $H \times (1 - f_{NRB})$ remains constant, indicating that f_{NRB} adjusts accordingly when consumption levels change.

c. *Basic principles of emission reduction calculations*

In an effort to remain conservative, most of the current methodologies used to assess the emission reduction from improved/clean cookstoves projects -such as CDM AMS-II.G, Gold Standard Reduced emissions from Cooking and Heating (also known as TPDDTEC) and VCS VMR-0006- have considered that the reduction of consumption could not be entirely considered as the source of emission reduction. This is based on the understanding that only a portion of the consumption (i.e. the non-renewable biomass) effectively contributes to greenhouse gas emissions. It is assumed that an amount of CO_2 emissions equivalent to the renewable biomass combustion would eventually be sequestered back by the landscape through its own ability to regenerate.

In simplified terms, those methodology have made the following assumptions:

Emissions = Emission Factor x Activity Data = Emission Factor x Consumption x f_{NRB}

When biomass is used as fuel, the activity data to consider is typically represented by f_{NRB} multiplied by the consumption. This discount factor reflects the proportion of biomass consumption that cannot regrow sustainably from the landscape.

Based on this understanding, most of the methodologies assume that f_{NRB} can similarly apply to reduction in biomass consumption and that the emission reduction can be calculated as follows:

Emission reduction = Emissions without project – Emissions with project

Emission Reduction = Emissions from displaced consumption

Emission Reduction = f_{NRB} *x (displaced consumption) x Emission Factor*

This paper argues that this current approach, which calculates emission reductions based on f_{NRB} multiplied by consumption, is fundamentally flawed as it contradicts the hypotheses and definitions of these parameters, especially the definition of f_{NRB} itself.

Instead, the f_{NRB} parameter should not be included in the calculation of the emission reductions. Rather, emission reduction should be determined as:

Emission Reduction = (displaced consumption) x Emission Factor

Based on this proposed revision, most of the methodology used for evaluating emission reductions of cookstoves carbon projects have been **overly conservative** and have **minimized the impact of clean cooking interventions**.

3. Issues and incoherences with the current approach

While the definition of f_{NRB} is clear, its application to measure the impact of a reduction of consumption can be questioned. The main criticism arises from the fact that, at the theoretical level, the calculation of the emissions assumes that the f_{NRB} is the same in both scenarios with and without projects. While methodologies allow for periodic revision of the f_{NRB} (ex-post) between reporting periods, this does not address the issue of the f_{NRB} being constant in both scenarios. Practically, the complexity and effort involved with the calculation of the f_{NRB} at project level often lead carbon project developers to opt for an ex-ante validated value. This parameter is typically determined at the national level and remains fixed for the duration of the crediting period (generally 5 or 7 years depending on the carbon certification standard).

By using identical f_{NRB} in both scenarios, projects underestimate the actual emission reductions achieved by cookstove programs and other initiatives aimed at reducing biomass consumption. The incoherence arises from the fact that if $RB = H \times (1 - f_{NRB})$ (Eq. 3) is a constant, and the consumption H with project is lower than H without project, f_{NRB} should logically decrease between these two scenarios.

In Box 1, a few examples illustrate the paradox linked with the use of constant f_{NRB} in the baseline and project scenarios.

Box 1. *Illustrative examples of current methodological approach*

i. *Example 1: Incoherence looking at macro level*

In this example, we consider an isolated country that overconsumes its biomass (f_{NRB} >0). We assume the country launches a large-scale policy that reduces suddenly the country's biomass consumption to a level that is sustainable – meaning that "harvesting" equals the "regeneration".
As the country has reached equilibrium, there should be no more emissions in the scenario with project, and the emission reduction would be 100% of the emissions before project. Yet, according to the approach in the current methodologies, the emission reduction would be:

Emission Reduction = f_{NRB} *x (displaced consumption)*

Emission Reduction = f_{NRB} *x (emissions before project)*

This example shows that, even if a project area cuts entirely the excess harvesting and consumes a level of biomass that is sustainable, it would not be able to account for the entire emission reduction but only a fraction of it. This incoherence is caused by the fact that the f_{NRB} is not re-evaluated in the project scenario.

ii. *Example 2: the paradox of the lost renewable biomass*

We take as a second example a project distributing technologies to reduce the woodfuel consumption to zero for one-third of the households (e.g. through a fuel switch). Moreover, the project is located in an area with a f_{NRB} of 33%, meaning that one third of the woodfuel consumption is considered as non-renewable (NRB represented in grey below). According to the current emission reduction methodologies, the associated emission reduction corresponds to one unit of non-renewable biomass, as illustrated in Figure 2.

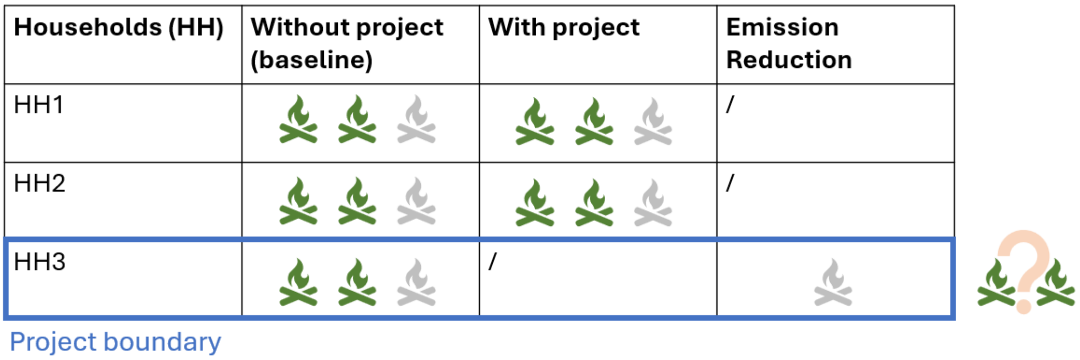

Figure 2 Current approach: example for project reducing one-third of fuel needs considering 33% f_{NRB}

Doing so, it appears that two units of renewable biomass (represented in green) were lost in the process. ***What happened to them?***

In the second example, the two units of biomass disappear because the methodology assumes that, in the scenario with project, these two units were never produced by the landscape. The same can be illustrated on the Figure 3 below:

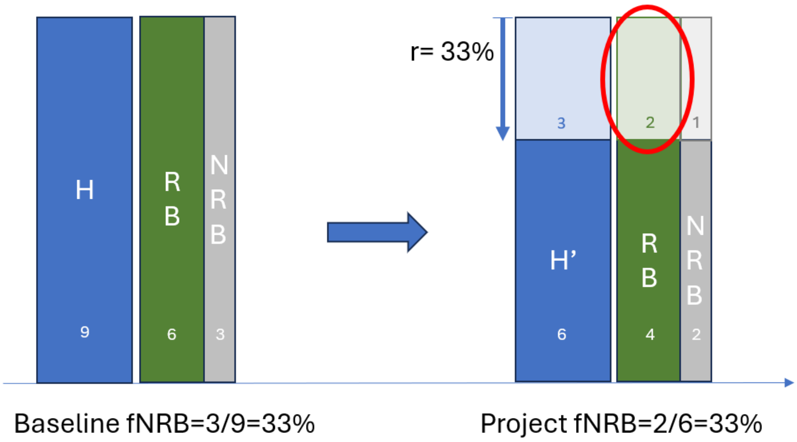

Figure 3 Example with current methodologies with constant f_{NRB}. H represents the harvesting of biomass for the consumption.

The Figure 3 is a visual representation of what it means to consider that the consumption is split between renewable biomass (RB) and non-renewable biomass (NRB), according to the f_{NRB} value. Stating that the emissions reduction is proportional to f_{NRB} x (displaced consumption) means that the avoided consumption is also composed of a portion of avoided RB and a portion of avoided NRB.

Thus, this approach with an identical f_{NRB} in the scenario with and without projects implies that the Renewable Biomass also decreases at a rate fixed by the f_{NRB} (red circle). In other words, it assumes that the Renewable Biomass was never produced by the landscape, as if the landscape would grow less biomass when not harvested.

According to the RB definition (as defined in CDM Tool 30), the renewable biomass is a constant parameter calculated based on the regenerative capacity of the accessible landscape (Mean Annual Increment in tonnes/ha/year times the accessible area per landscape type). Therefore, RB should theoretically remain the same with and without the project intervention since a reduction of consumption should not affect the natural regeneration of the biomass.

This shows that there is an incoherence between the approach used by the methodology and the definition of the parameters. As RB is constant, f_{NRB} should vary in the scenario with project. If f_{NRB} is the same in both scenarios, it means RB is lower in the scenario with project, which is inconsistent with the definition of RB.

This incoherence highlights that the current methodologies fail to consider what happens to the portion of RB in the project scenario.

In reality, the spared Renewable Biomass is available to replace NRB elsewhere. This extra supply of RB modifies the f_{NRB} for all other households, **both within and outside** the project area. Therefore, by not adequately accounting the spared RB that is still produced by the landscape, the methodology underestimates the emission reductions.

4. Alternative approach

a. *How to correct the incoherence*

These paradoxes come from a misinterpretation of the meaning of f_{NRB}. In the context of cookstoves project aimed at reducing woodfuel consumption in a specific area, rather than having an individualized approach (assuming f_{NRB} applies to every unit of wood that is consumed and that each household is “saving” only f_{NRB} x its consumption), it should be understood that f_{NRB} is the portion of the harvesting that is not sustainable. As such, every reduction in consumption/harvesting is deducted from the NRB amount until the sustainability equilibrium has been reached. This leads to a modification of the f_{NRB} in the scenario with project.

In simplified terms, a f_{NRB} of 30%, should not be interpreted as if every piece of wood is 30% non-renewable. Rather, it means that 30% of the consumption is above the threshold of sustainability – i.e. that 30% of the consumption is causing 100% of the emissions. As such, a reduction of the consumption should be integrally considered as emission reduction, not just a fraction of it, because it reduces the overconsumption until the equilibrium between consumption and landscape production is reached.

To illustrate, we consider the same Example Figure 2 as above (f_{NRB} of 33% before project, a project reducing the woodfuel consumption to zero for one-third of the households). This time, we interpret f_{NRB} as 33% of the overall consumption is 100% unsustainable (NRB), i.e. not that 33% of each household’s consumption is unsustainable.

The reduction of 100% of wood fuel for one-third of the households removes entirely the overconsumption and the remaining 2 households have now reached equilibrium. f_{NRB} in the scenario with project became 0, resulting in an increase of the emission reductions allowed by the project.

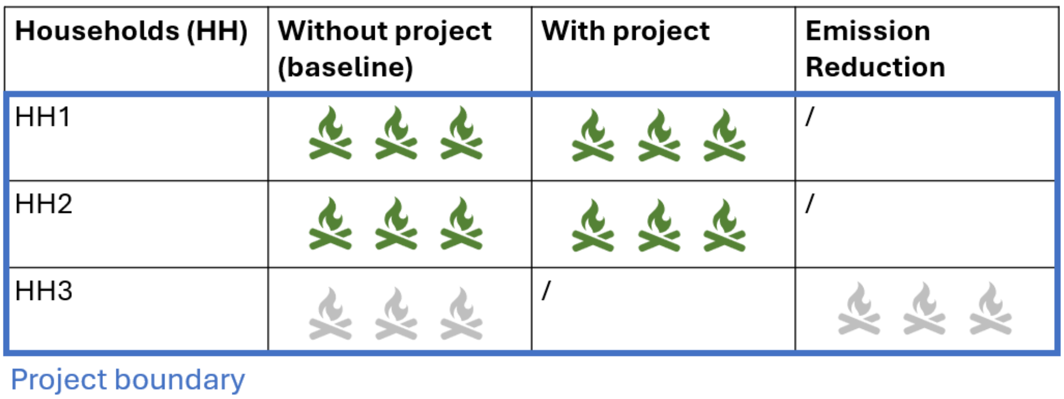

Figure 4 Revised approach: example for project reducing one-third of fuel needs considering 33% f_{NRB}

Mathematically, it is equivalent to state that the consumption of every household is 33% unsustainable or to state that the entire consumption of 33% of households is unsustainable. This intuitive interpretation helps to alleviate the inconsistency highlighted in the previous section.

b. *Suggested revision of the approach*

The suggested revision implies the reallocation of NRB among the households, even those not included in the project: when a project reduces the consumption of renewable biomass (RB) within a specific location, this RB becomes now available for everyone inside and outside the project boundary.

This can be considered as a **positive leakage** contribution, meaning that there is an additional reduction of the project emissions occurring outside the project intervention area. This redistribution helps to alleviate the NRB imbalance elsewhere, thereby reducing the overall f_{NRB} not only for the households in the project but for all the households in the area used to calculate f_{NRB}.

This insight has two implications for how the scenarios with and without projects should be designed:

i. **Dynamic f_{NRB} considerations:** fNRB should not be assumed to be the same in the scenarios with and without projects. This accounts for the fact that additional renewable biomass is available for use in the scenario with project and that will decrease the overall harvesting needs. Consequently, f_{NRB} should decrease in the scenario with project to reflect the improved sustainability brought about by the project.

ii. **Revision of the project system:** the project system should be re-evaluated as it now includes the overall consumption of the area used for f_{NRB} calculation. This means that all those households (from the area used to calculate f_{NRB}) will reduce their emissions since they change their f_{NRB}. This means that the calculation of emission reduction should also consider the households not necessarily part of the project (i.e. beyond those receiving a cookstove) but all those included in the area used for the initial f_{NRB}calculation. This can be seen as a positive leakage.

With those revisions, the equation evaluating the emission reductions from clean or improved cooking project would be simplified to:

Emission Reduction = (displaced consumption) x Emission Factor

This equation holds true as long as the harvesting of biomass exceeds the natural regeneration of the landscape. Once the biomass consumption aligns with or falls below the landscape's regenerative capacity, the resulting marginal emission reduction would be zero.

The same is illustrated in Figure 5, once again based on Example 2. When the reduction in consumption (r) is limited, any additional reduction directly contributes to lowering NRB usage, thereby increasing overall emission reductions (ER). However, once sustainability equilibrium is reached, where the remaining woodfuel consumption matches the natural regeneration rate, any further reduction efforts do not contribute to emission reductions since it only preserves renewable biomass.

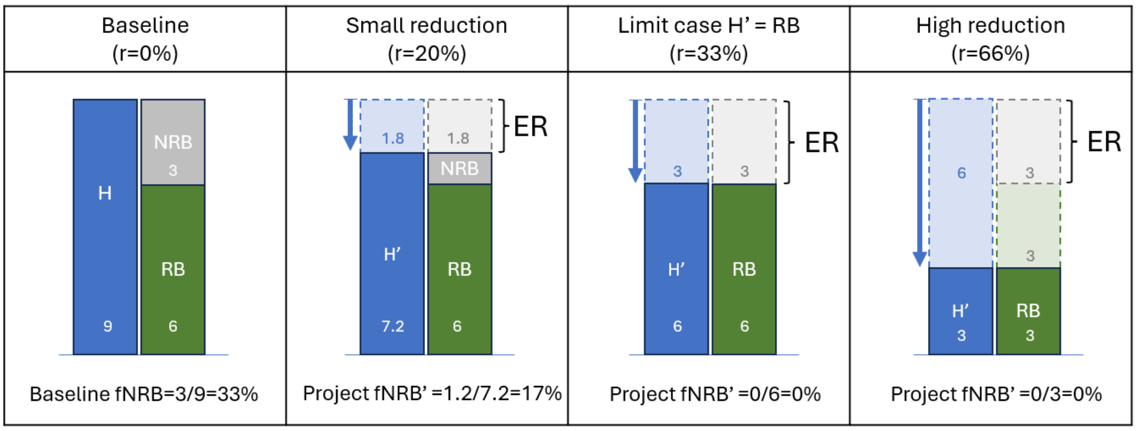

Figure 5 Illustrative examples of revised approach with different woodfuel reductions (r)

c. *Mathematic demonstration of the approach*

The following demonstration will prove that, when we reason with a different f_{NRB} for the scenario with project, and compare the overall emissions for the area (not only the households that uses the project cooking solution), the overall emission reductions should not include a f_{NRB} parameter.

Assuming an area with *n* households and considering a project activity which will distribute efficient cookstoves to *p* households, we can note the overall baseline consumption as:

$$H = \sum_{i=0}^{n} H_i = \sum_{j=0}^{p} H_j + \sum_{k=p+1}^{n} H_k \tag{4}$$

With *H* representing the consumption/ harvesting.

In the area, the renewable biomass (RB) production of the landscape is constant and remains unchanged in the project scenario. This is because the RB is calculated based on the regenerative capacity of the accessible landscape. Therefore, the non-renewable biomass can be evaluated as:

$$NRB = H - RB = \sum_{i=0}^{n} H_i - RB \tag{5}$$

By definition of f_{NRB}:

$$f_{NRB} = \frac{NRB}{RB + NRB} = \frac{\sum_0^n H_i - RB}{\sum_0^n H_i} = 1 - \frac{RB}{\sum_0^n H_i} \tag{6}$$

According to the methodologies for emission reduction for cookstoves interventions, the level of emissions without project, or baseline emission (BE), are as follows[3]:

[3] For the sake of simplicity in this demonstration, the emission factor, leakage sources and other discount factors have been included the terms PE and BE. Including those parameters would not change the suggested reasoning.

$$BE = f_{NRB} \times \sum_{0}^{n} H_i \tag{7}$$

a) Current approach (such as in methodologies CDM AMS-II.G, Gold Standard TPDDTEC and VCS VMR-0006)

The project emissions PE are calculated based on the fraction of non-renewable of residual consumption and the f_{NRB} held constant at its baseline value. Noting *H'*, the residual consumption of the *p* households in the project scenario, we find:

$$PE = f_{NRB} \times \left(\sum_{0}^{p} H'_j + \sum_{p+1}^{n} H_k \right) \tag{8}$$

Hence, the emission reductions ER are the fraction of the non-renewable of the preserved biomass (7)-(8):

$$\begin{aligned} ER &= BE - PE \\ &= f_{NRB} \times \left(\sum_{0}^{n} H_i - \sum_{0}^{p} H'_j - \sum_{p+1}^{n} H_k \right) \\ &= f_{NRB} \times \left(\sum_{0}^{p} H_i - \sum_{0}^{p} H'_j \right) \\ &= f_{NRB} \times \left(\sum_{0}^{p} (H_i - H'_i) \right) \end{aligned} \tag{9}$$

Which is the classical outcome where the emission reduction is proportional to f_{NRB} multiplied by the displaced consumption (*H- H'*) across the *p* households included in the project.

b) Suggested alternative

From Equations (6) & (7), we can redefine the baseline emissions as:

$$\begin{aligned} BE &= f_{NRB} \times \sum_{0}^{n} H_i \\ &= \left(1 - \frac{RB}{\sum_0^n H_i} \right) \times \sum_{0}^{n} H_i = \sum_{0}^{n} H_i - RB \\ &= \sum_{0}^{p} H_i + \sum_{p+1}^{n} H_j - RB \end{aligned} \tag{10}$$

The suggested approach involves a revision of the fNRB in the project scenario (noted f'_{NRB}) as the biomass consumption has now reduced. Based on (6), we find:

$$f'_{NRB} = \frac{NRB'}{RB + NRB'} = 1 - \frac{RB}{\sum_0^p H'_j + \sum_{p+1}^n H_k} \quad (11)$$

With $\sum_0^p H'_j + \sum_{p+1}^n H_k$ representing the new consumption (residual consumption for *p* household and the normal consumption for *n-p* households).

Therefore, the project emissions are:

$$\begin{aligned} PE &= f'_{NRB} \times \left(\sum_0^p H'_j + \sum_{p+1}^n H_k \right) \\ &= \left(1 - \frac{RB}{\sum_0^p H'_j + \sum_{p+1}^n H_k} \right) \times \left(\sum_0^p H'_j + \sum_{p+1}^n H_k \right) \\ &= \sum_0^p H'_j + \sum_{p+1}^n H_k - RB \end{aligned} \quad (12)$$

Hence, the emission reductions are the quantity of non-renewable of the preserved biomass (10)-(12):

$$\begin{aligned} ER &= BE - PE \\ &= \sum_0^p H_i + \sum_{p+1}^n H_j - RB - \sum_0^p H'_j - \sum_{p+1}^n H_k + RB \\ &= \sum_0^p H_i - \sum_0^p H'_j \\ &= \sum_0^p (H_i - H'_i) \end{aligned} \quad (13)$$

Compared to the current approach in Equation (9), we have now demonstrated that the f_{NRB} term has disappeared from the emission reduction calculations when we consider that $f_{NRB}$is not constant unlike the RB (as per RB definition).

5. Discussion

This work highlighted the limitation of the usual approach that is used in the most common methodologies used for emission reduction calculations of clean/improved cooking interventions. This is mainly because the $f_{NRB}$is assumed as an external factor and there is no accounting of the retroaction (the fact that the project intervention changes the f_{NRB}inside and outside the project area between the scenario with ad without projects).

It is technically impossible to measure the marginal variation of f_{NRB}in the project boundary. First because $f_{NRB}$is complex to measure and, secondly, because the variation would be infinitesimal per household but the cumulative effect at scale cannot be ignored. However, this paper has proven mathematically that considering this retroaction would result in the cancellation of the f_{NRB} term in the calculation of the emission reductions. Therefore, there is no need to calculate the f_{NRB} nor its variation.

The paper also explained the meaning of the mathematic equations: the RB being constant as per CDM definition, a reduction of the harvesting H reduces the excessive consumption above the sustainability equilibrium. Therefore, 100% of the harvesting reduction should be considered for the calculation of the emission reduction, not considering any f_{NRB} discount. Two additional concepts are presented hereafter to further ground the alternative approach.

a. *Using a fraction of "re-use" instead of fraction of non-renewable biomass*

This reasoning assumes that the spared RB (the RB that is not consumed thanks to the cookstove projects) will replace NRB in other households.

This last assumption can be discussed.

- There are cases in which the spared renewable biomass (RB) may not be available/accessible for consumption. This could occur for example if the woodfuel market is not liquid and the spared renewable biomass would not reach the other markets. However, in that case, the RB would still be produced by the landscape, and thus it would accumulate in the biome. Even if the other households still use NRB and the spared RB becomes a carbon stock, the measurement of the **net** emission would not change as the spared RB would become a local carbon sink.
- It may be considered that the spared biomass would result in an increase in supply, a decrease in price and thus an increase in demand that would annihilate the emission reduction (rebound effect). However, in the countries that are considered for this type of project (e.g. regions within Subsaharian Africa like Sahel or Madagascar), the supply is adjusted to fulfill the demand: the supply is not restricted by regulations (despite the best effort, illegal/informal firewood is flooding the market) and the demand is not restricted by the price. A reduction of demand will first reduce the least accessible woodfuel units at the margin (i.e. from sources collected the furthest away or from illegal harvesting) or slow-down the production (the same trees would still be cut, but with less frequent rotation, leading to an overall increase on the average carbon stock).
- It may be considered that the spared RB would be used anyway for new usage. Even if this is happening, it would mean a general increase of efficiency (more usage served for the same harvesting) or similarly be interpreted as a suppressed demand scenario. Thus, the project would still be able to account for the emission reduction due to the efficiency gains.

However, those caveats may be explored in more details, or could be appreciated with a correction factor that would represents the "rate of re-use" of the spared biomass.

Based on Eq. 13, we would then have:

$$ER = f_{RU} \times \left(\sum_{0}^{p} (H_i - H'_i) \right) \quad (14)$$

With $\boldsymbol{f_{RU}}$ being the fraction of Re-use and to account for a potential rebound effect.

Although in most of the regions relying heavily on biomass for cooking, such a rate would likely be close to 1 as it is uncommon for spared biomass to remain unused in countries where the consumption and harvesting is much higher than the sustainability threshold.

b. *Alternative presentation of the same result: adding a positive leakage in the current methodology*

Another option to materialize why the emissions from a project are greater than the emission of the households included in the project would be to include the notion of a positive leakage. This interpretation implies that the project households have reduced their emissions by f_{NRB} *x displaced consumption x Emission Factor* but, by reducing the consumption, the project has also provided an increase of renewable biomass **outside of the project area**.

Box 2. *Illustrative example of positive leakage*

The scheme represented on Figure 6 & Figure 1Figure 7 illustrates how the positive leakage helps rectifying the discrepancy between the landscape and project level. In this example, the landscape can only produce sustainably 6 units of biomass while there are 8 units of biomass consumed. f_{NRB} without project is 2/8 = 25%, i.e. every household consumes 25% of non-renewable biomass.
We assume a project helps 2 households (project system) switch to another non-biomass fuel. In the baseline scenario (Figure 6):

- For the "landscape system": the emissions are 25% x 8 = 2 units.
- For the "project system": according to the current approach, the emissions are 25% x 2 = 0.5 units.
- This means there is 1.5 unit of renewable biomass consumed by those 2 project households.

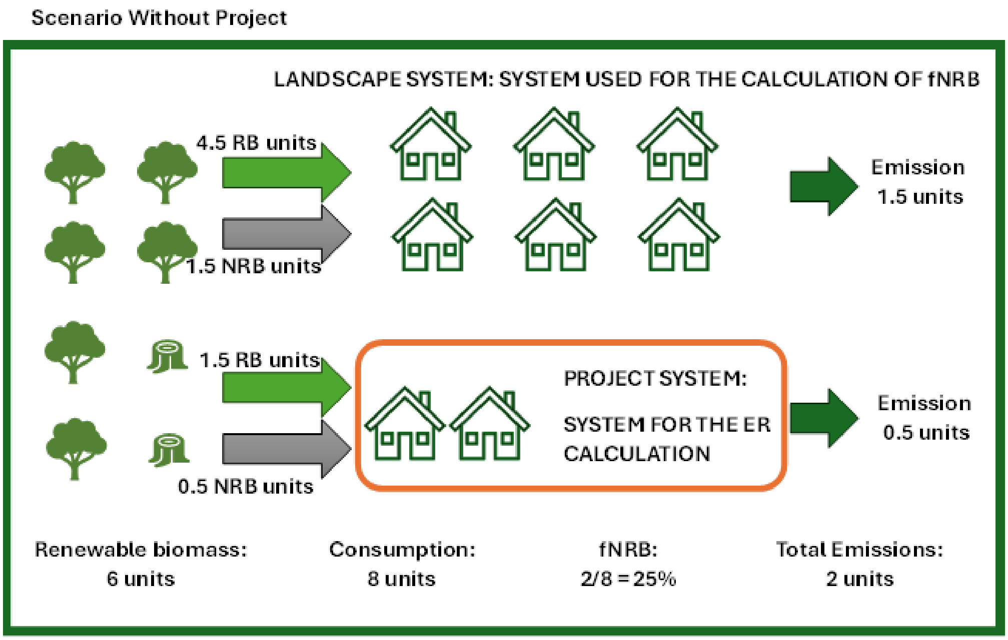

Figure 6 Example of baseline scenario considering 25% f_{NRB}

In the project scenario (Figure 7) the 2 households in the project area stop consuming, then:

- For the "project system": the emissions in the project scenario is 0 for the 2 households in the project area. As such, the emission reduction is 0.5 units.

- For the "landscape system": the landscape is now at equilibrium, meaning that emissions should be 0 **at landscape level**. Thus, the emission reduction at landscape level is 2 units.
- If the emission reduction at landscape level is 2 units and the emission reduction for the project area is only 0.5 units, it means that the project has induced a reduction of emissions outside of the project area for 1.5 units. This is the definition of a positive leakage.
- The reason we have this positive leakage is that the 1.5 unit of renewable biomass that used to be consumed by the 2 project households are now available for the other users outside of the project area. The reduction of consumption in the project area has impacted the emissions from every household of the landscape.

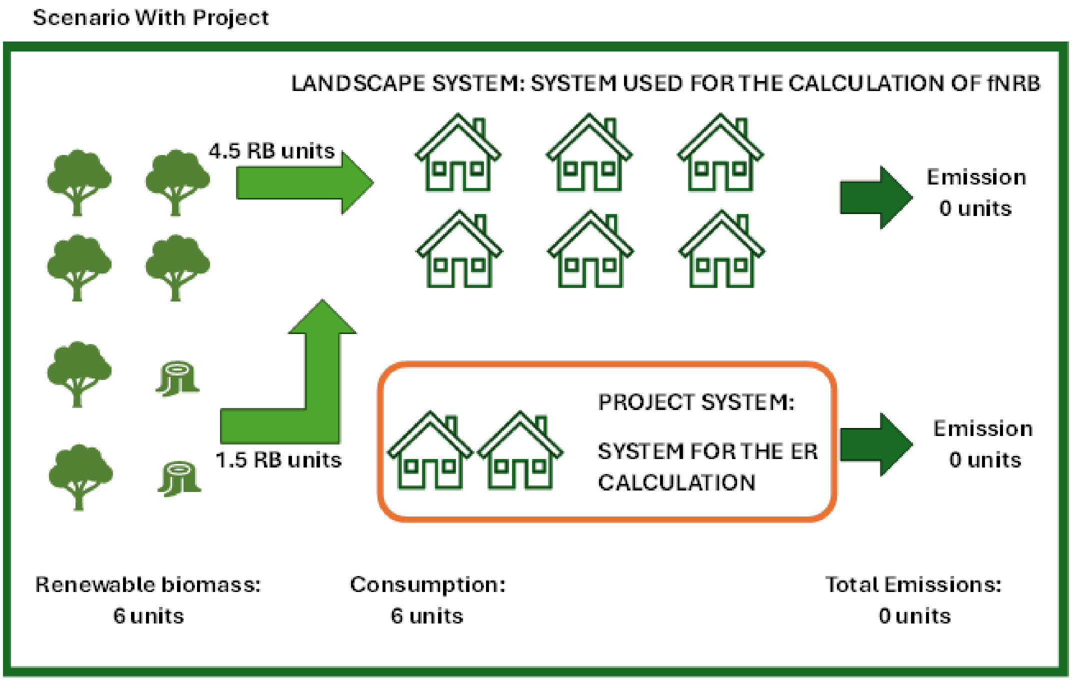

Figure 7 Example of project scenario, the renewable biomass from the project area is redirected outside of the project area, creating appositive leakage.

The example showed that if we assume that the entire renewable biomass is transferred to the other households, the positive leakage would be calculated as *(1- f_{NRB}) x (displaced consumption)*. Consequently, the f_{NRB} term cancels out, leading us back to the main conclusion of this paper:

Emission Reduction = f_{NRB} x displaced consumption x Emission Factor + positive leakage

Emission Reduction = f_{NRB} x displaced consumption x Emission Factor + (1- f_{NRB}) x (displaced consumption) x Emission Factor

Emission Reduction = displaced consumption x Emission Factor x (f_{NRB} + 1 – f_{NRB})

Emission Reduction = displaced consumption x Emission Factor

However, with this approach, it is possible to question whether the entire renewable biomass is indeed transferred. Perhaps the Mean Annual Increment is slightly lower in the absence of pruning/harvesting. Or, the market may not liquid enough and part of the renewable biomass is lost and left for decay. In such cases, we could reintroduce the notion of the factor of re-use ($\boldsymbol{f_{RU}}$) developed above, considering that only a portion $\boldsymbol{f_{RU}}$ is effectively transferred.

In such case, the equation would become:

Emission Reduction = f_{NRB} *x displaced consumption x Emission Factor + positive leakage*

Emission Reduction = f_{NRB} *x displaced consumption x Emission Factor +* f_{RU} **x** *(1-* f_{NRB}*) x (displaced consumption) x Emission Factor*

Emission Reduction = displaced consumption x Emission Factor x (f_{RU} *+* f_{NRB} *x (1 -* f_{RU} *))*

When f_{RU} is close to 1, the f_{NRB} term becomes negligeable, and we come back to the previous cases.

6. Conclusion

This note is not intended to reignite the debate on calculating fNRB parameters. Instead, it questions the validity of the parameter itself.

Current methodologies for emission reductions in cookstove projects rely on the arbitrary division of woodfuel reductions into renewable and non-renewable contributions, as determined by the fNRB parameter. We believe that this distinction between renewable biomass and non-renewable biomass is irrelevant for the calculation of the emission reduction for household energy efficiency projects.

This paper suggests that, by considering that fNRB is a constant independent from the project, the usual methodologies implies that the spared renewable biomass does not exist in the scenario with project.

Instead, this paper demonstrated that, since the Renewable Biomass production is considered constant, then the fNRB, which quantifies the excess consumption compared with the Renewable Biomass production, cannot remain constant. Within this work, it was also demonstrated mathematically that the definition of the RB according to the CDM Tool 30, implies that the fNRB factor becomes irrelevant to calculate the emission reductions, leading to the conclusion that emission reduction is independent of fNRB.

Therefore, this note advocates for the exclusion of the fNRB parameter from emission reduction estimates. On top, it discusses if another factor, representing the rate of “re-use” of the spared biomass, would not be more relevant in assessing emission reductions of cookstoves interventions.