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Carbon projects supporting REDD+

Identifying and optimizing synergies

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6 January 2014

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Important Notice – Disclaimer

The study "Carbon projects supporting REDD+" was financed by the KFW-managed "PoA Support Centre", which has been initiated and funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

Content

1 Conclusion and recommendations

There are different ways to achieve the outcome of reducing emissions from deforestation and forest degradation (REDD+) that to date have largely progressed in parallel. This report differentiates between two types of approaches: the first includes activities that take a land-use accounting approach to achieve REDD+ outcomes. They account for emissions reductions from a specific location from within a forest. The first group includes voluntary and compliance carbon market projects as well as international and multilateral approaches that have been traditionally labelled as 'REDD+'; the second group of activities use non-land-use accounting approaches to deliver REDD+ outcomes. These activities aim to address the drivers of deforestation and forest degradation through e.g. a reduction in demand for fuel wood or ensuring that fuelwood is sustainably sourced. This second group does not take into account the emissions reductions from a specific location within a forest and have traditionally been labelled as energy efficiency or fuel switching projects. For shorthand during this report we will use the term 'non-REDD+' to describe these methodologies and activities.

This report highlights methodological differences between the land-use accounting and non-land-use accounting approaches (chapters 3 and 4). The differences are analysed across important REDD+ design principles including additionality (defining what would have happened in absence of the project activity), permanence (of enhanced carbon stocks or avoided emissions from deforestation) and leakage (changes in carbon stocks outside the project boundaries which can be attributed to the project). A major difference from our analysis is that non-land-use accounting approaches typically make use of national statistics as proxy for the impact of the drivers of deforestation targeted by the project, while the impact of the project is often geographically specific.

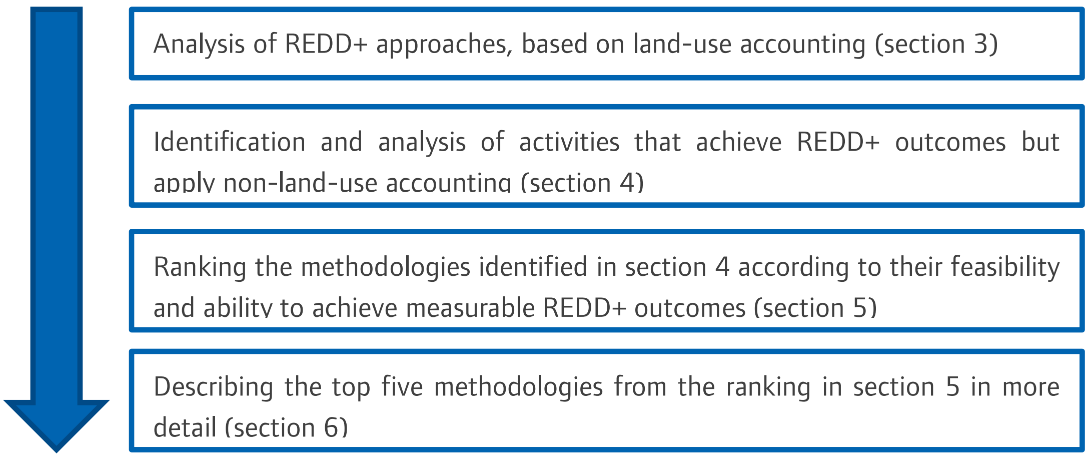
The objective of this analysis is to identify and rank this second group of projects that, while achieving REDD+ outcomes, are based in non-land-use accounting approaches. The selected methodologies have been ranked based on four criteria (chapter 5):

- Criterion 1 looks at financial feasibility, encompassing three performance figures derived from registered projects that use the specified methodology;
- Criterion 2 captures the robustness of the potential REDD+ outcome by qualitatively assessing how accurately the methodology addresses REDD+ relevant issues such as leakage, permanence and additionality;
- Criterion 3 looks at the technical feasibility of the methodology and is based on the issuance success rate of registered projects under this methodology;
- Criterion 4 reflects the REDD+ mitigation potential of the methodology.

The identified non-REDD+ project methodologies can be organised into four major categories: the first category comprises methodologies that reduce local demand for non-renewable biomass (NRB) by either switching from fuelwood to solar or biogas technologies, or by improving the energy efficiency of appliances that use fuelwood; the second category encompasses methodologies for projects that establish a dedicated plantation to address an increased demand for fuelwood from a new energy installation; the third category addresses the same increase in demand, but uses sustainable biomass sources other than a dedicated plantation; the fourth category consists of projects in which demand for land is affected, for example through the construction of power lines, railroads, or hydropower stations, which could increase or create pressure on forest areas.

A final group of methodologies – that aim to reduce emissions through agricultural intensification - may also have a positive impact on deforestation by increasing agricultural yields, and thereby reducing the demand for agricultural land. There is, however, still limited understanding on the causal link between intensification and reduced deforestation in practice, so these projects have been excluded from the ranking. Project-based methodologies for agriculture also typically refrain from monitoring their impact on forest carbon and measure other agricultural emissions.

Figure 1: Analytical steps towards identification of the most feasible methodologies that deliver REDD+ outcomes.



Of the 26 methodologies assessed, we elicit five that demonstrate the highest potential for REDD+ synergies (chapter 6). We find that in general, this first group of methodologies, which avoid the use of NRB achieve higher average scores due to the closer link between their baseline scenarios and the desired REDD+ outcome. These score higher than, for example, projects with dedicated plantations since typically a higher share of the emission reductions stems from avoiding deforestation. The second category of methodologies, which use plantations to replace unsustainable fuelwood use, tend to score lower due to the limited of stringency in requirements on how to source the fuel. Methodologies which aim to minimise the adverse that a project may have on forest carbon, e.g. by making way for construction activities have been left out of the ranking as they create a driver of deforestation rather than addressing one.

The top five methodologies and their strongest REDD+ characteristics are listed in table 1. Chapter 6 provides further detail on these methodologies.

Table 1: REDD+ characteristics of the top 5 methodologies

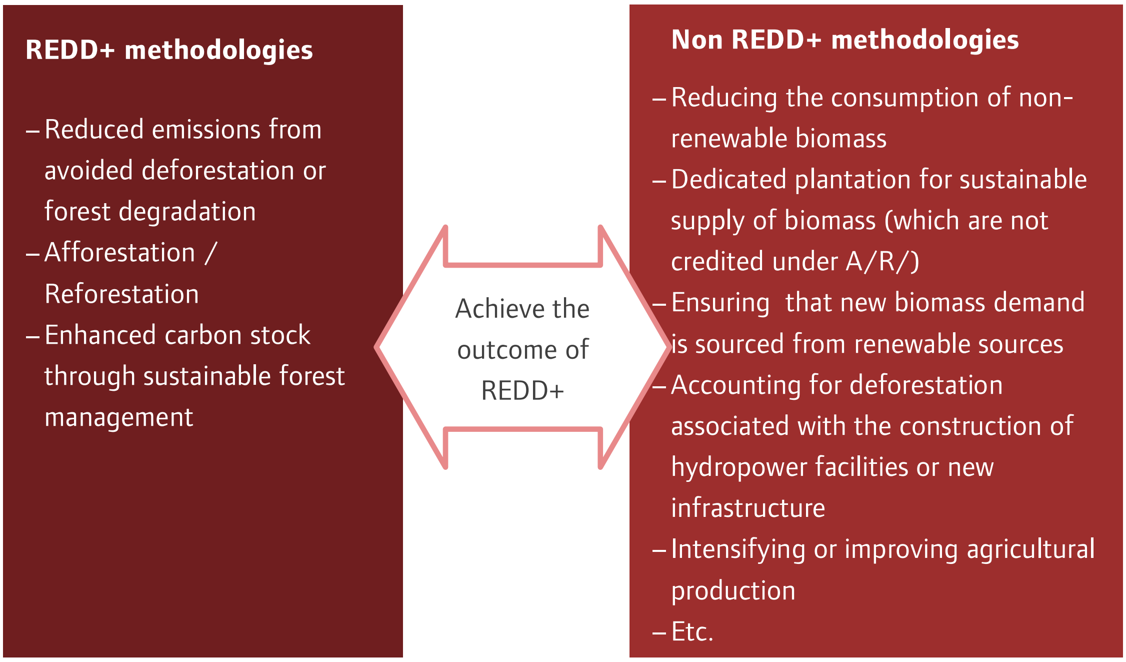
Rank	Methodology	Project scope within the methodology	Evaluation characteristics
1	Gold Standard Methodology: "Technologies and Practices to Displace Decentralized Thermal Energy Consumption"	Only projects that use NRB in the baseline scenario.	• Unsustainable use of NRB must be the baseline • Highly detailed description for NRB assessment • Existing carbon projects have been successful in achieving emission reductions
2	CDM AMS-I.E.: Switch from non-renewable biomass for thermal applications by the user	All project types	• Unsustainable use of NRB must be the baseline • Leakage considerations highly relevant to REDD+
3	CDM AMS-I.D.: Grid connected renewable electricity generation	Only projects that source biomass from dedicated plantations in compliance with AM0042.	• Strong financial and technical feasibility • Widely accepted methodology for biomass projects
4	CDM AMS-II.G.: Energy efficiency measures in thermal applications of non-renewable biomass	All project types	• Unsustainable use of NRB must be the baseline • REDD+ relevant leakage requirements
5	American Carbon Registry Methodology: "Energy efficiency measures in thermal applications of non-renewable biomass"	All project types	• Alternative to CDM AMS-II.G. with no additional benefits

Methodologies that include biogas as an alternative energy source for NRB, like AMS-I.E., are often used in combination with methodologies that reduce emissions from manure, waste water treatment or decay of biomass. For these combinations, the analysis focussed on the methodology that actually affect forest carbon stocks, rather than the methodology that accounts for reduced methane emissions.

2 Introduction

REDD+, while originating in the negotiating rooms of the UNFCCC, has become shorthand with environmentalists for any activity that aims to reduce deforestation and forest degradation in developing countries[1].

Figure 2: Synergies between non-REDD+ and REDD+ projects.



This report identifies two types of activities that aim to achieve REDD+ outcomes: Firstly, activities that have commonly become known as REDD+ activities take a land-use accounting approach to generate emissions reductions and removals; the other group of activities also achieve REDD+ outcomes, i.e. they result in reductions in deforestation and forest degradation but they calculate emissions reductions through other, non-land-use accounting approaches. In this report we evaluate to what extent this second group of activities can contribute to greenhouse gas mitigation, as well as their financial and technical feasibility in comparison with traditional REDD+ projects and activities (figure 2).

[1] REDD+ actually stands for *"Policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries"*

3 Land-use based accounting for REDD+

The 2006 IPCC Guidelines for National Greenhouse Gas Inventories set the general framework for greenhouse gas accounting both at the project level and for national inventories. They provide guidance on the choice of methods, data aggregation, equations, default values and uncertainty assessments. Generally, IPCC guidance aims for "good practice" accounting and continuous improvement, i.e. accounting should be consistent, accurate, comparable, accurate, complete, conservative and transparent. Countries or project developers can chose between tiers of increasing methodological complexity and certainty, depending on their capacity, data availability and national circumstances. For REDD+, generally higher tiers (requiring more accurate and location-specific data) should be selected due to the need for spatially explicit data.

Box 1: Measurement, Reporting and Verification basics for REDD+

MRV systems for land use accounting approaches can be expressed as the product of activity data (i.e. the change in land cover or forest cover) and emissions factors for that activity (i.e. how much CO_2 is emitted when a hectare of forest is lost). This can be expressed simply by the following equation:

$$\sum Emissions = \sum activity\ data \cdot emissions\ factors$$

Activity data are typically expressed in hectares changed per year (ha/yr) and emissions factors in tons of carbon dioxide per hectare (tCO_2/ha). Regardless of the units, by multiplying emissions factors and activity data, we get to an estimate of emissions in tCO_2/year.

While REDD+ accounting approaches have different standards for quantifying activity data and emissions factors, in general these systems adhere to IPCC guidelines on GHG accounting to ensure that estimates and their uncertainty are quantified using accepted international standards. IPCC guidance also provides a tiered approach that allows countries at different levels of development and sophistication to present estimates using different levels of complexity and precision.

All of the projects described in this section fall into the "Agriculture, Forestry and other Land Use" (AFOLU[2]) sector, as outlined by the 2006 Guidelines. There are a variety of signalling bodies that provide guidance under this type of accounting framework for REDD+,[3] including:

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[2] AFOLU covers all emissions and removals in agriculture as well as "Land Use, Land-Use Change and Forestry" (LULUCF).

- International frameworks under the UNFCCC, e.g. REDD+ and the Clean Development Mechanism (CDM) of the Kyoto Protocol;
- Multilateral frameworks, namely the carbon fund of the Forest Carbon Partnership Facility (FCPF);
- Bilateral arrangements e.g. Norway's NICFI fund and Germany's REDD Early Movers (REM) program; and
- Voluntary carbon standards, e.g. the Verified Carbon Standard (VCS), Climate Action Reserve (CAR), and American Carbon Registry (ACR).

These approaches vary in the way that they address methodological aspects of REDD+ but in general they all take an AFOLU approach to accounting for emission reductions by sources or removals by sinks[4]. The approaches outlined above vary significantly in both their level of maturity of methodological development, as well as their ability to accurately measure, report and verify (MRV) emissions reductions (see Box 1 above). To ensure the environmental integrity of land-use accounting approaches, however, they all aim to ensure that emission reductions are permanent, additional, and avoid leakage or displacement of emissions. These terms, which are key principles of REDD+ methodologies, are defined as follows.[5]

Permanence refers to the longevity of emission reductions or removals and if these reductions may be reversed. Permanence is an important criterion for environmental integrity - if the forest underlying an emissions reduction is destroyed, the reduction (or removal) will also be compromised unless the loss of forest is taken into account. The risk of non-permanence (known as 'reversals') is sometimes categorized as 'intentional' vs. 'unintentional' referring to whether it was anthropogenic or a natural disturbance. There are challenges, though, in attributing and separating natural from anthropogenic effects on emissions.

Additionality refers to whether an emissions reduction (or removal) was the result of a REDD+ activity or if it would also have occurred in the absence of the intervention.

Leakage (or 'displacement') refers to changes in emission reductions and removals *outside* the accounting system that result from REDD+ activities *within* the boundary of the accounting system. Failure to account for leakage can affect the environmental integrity of a REDD+ project or programme. Leakage can occur at any scale from project- to international-level. Unique to the land-based accounting of REDD+ approaches is the consideration of geographical shifts of

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[3] Note that there are AFOLU activities which do not deliver REDD+ outcomes. For example, AFOLU would cover methane emissions from rice cultivation but reducing these emissions has no impact on carbon stocks and is thereby not related to REDD+.

[4] For shorthand we will hereafter refer to emission reductions by sources and removals by sinks simply as 'emission reductions'

[5] Taken from http://theredddesk.org/markets-standards

deforestation to areas that are adjacent but outside of the designated project area. If this occurs, the net decrease in deforestation can be overestimated.

In addition to these principles we further define some key criteria below which influence the way in which emissions reductions are accounted for under REDD+ methodologies.

Scope refers to the activities that are eligible and that can contribute towards emission reductions. Standards and initiatives define the scope of eligible forest-related activities in different ways, but these can generally be grouped into:

- Afforestation and reforestation (A/R) (or enhancement)
- Avoided deforestation (which includes conservation)
- Avoided degradation (which includes sustainable management of forests)

Scale is defined as the geographic area to which a standard is applied. The scale might be:

- Jurisdictional (e.g. an entire country or a federal state or province)
- Project level or an area defined by other specified boundaries, such as an eco-region.

Reference Levels are benchmarks for assessing performance and are the backbone of the accounting methodology for REDD+. Reference levels provide a quantitative way to measure the performance of an activity in reducing emissions or increasing removals. Reference levels can be:

- Historical reference levels use past rates of deforestation as a proxy for future behaviour
- Adjusted reference levels use modifications to allow for changes based on national circumstances.
- Modelled reference levels aim to predict how deforestation rates might change in the future and can use a variety of methods

Table 2 outlines the key REDD+ programmes and how they address the criteria referred to above. The remainder of this section then looks at the major frameworks developing guidelines for REDD+ and how they address the principles of permanence, leakage and additionality.

Table 2: Overview of REDD+ initiatives and their different approaches to achieve permanence, additionality, and avoid leakage.

Legal framework	Mechanism	Scope	Scale	Reference Level
UNFCCC	Clean Development Mechanism (CDM)	[small trees icon]	[pennant flag icon]	[left arrow icon]
	REDD+	[small trees icon] [felled tree icon] [outline tree icon]	[flag icon]	[left arrow icon] [double arrow icon]
Multilateral	Forest Carbon Partnership Facility (FCPF)	[small trees icon] [felled tree icon] [outline tree icon]	[flag icon]	[left arrow icon] [double arrow icon]
Bilateral	Brazil, The Amazon Fund	[felled tree icon]	[flag icon] [pennant flag icon]	[left arrow icon]
	Guyana REDD+ Investment Fund	[felled tree icon]	[flag icon]	[double arrow icon]
	REDD+ Early Movers Programme (REM)	[felled tree icon] [outline tree icon]	[flag icon]	[left arrow icon]
Voluntary Carbon Standards	Verified Carbon Standard	[small trees icon] [felled tree icon] [outline tree icon]	[flag icon] [pennant flag icon]	[left arrow icon] [double arrow icon]
	Climate Action Reserve	[small trees icon] [felled tree icon] [outline tree icon]	[pennant flag icon]	[left arrow icon] [double arrow icon]
	American Carbon Registry (ACR)	[small trees icon] [felled tree icon] [outline tree icon]	[pennant flag icon]	[left arrow icon] [double arrow icon]
	California AB 32	[small trees icon] [felled tree icon]	[pennant flag icon]	[left arrow icon] [double arrow icon]

3.1 UNFCCC: Reducing Emissions from Deforestation and Forest Degradation

Parties engaging in REDD+ activities have been encouraged to develop national[6] forest reference levels; national Measurement, Reporting and Verification (MRV) systems; and national forest

[6] With the option of interim subnational approaches.

monitoring systems[7]. Parties have further been encouraged to follow IPCC guidelines and guidance to account for emission reductions. REDD+ methodologies can therefore use either an activity-based or a land-based approach to quantify emission reductions. At COP 19 in Warsaw, Parties concluded several years of negotiations with a package of seven decisions that provides the architecture for results-based REDD+ actions. These include specific guidance on finance and coordination of support including an 'information hub'; national forest monitoring systems; reference levels and MRV; Summary of information on safeguards; and drivers of deforestation and forest degradation.[8]

Activity-based accounting is the traditional approach to REDD+ accounting and focuses on the activity being implemented to assess emissions.[9] Land-based accounting takes a broader perspective. A land-based approach captures changes that occur across a landscape, typically using a combination of inventory plots and remote sensing data. In this case emission reductions associated with *all activities* would, in theory, be captured.

Under the UNFCCC definition of REDD+, the following five general types of activities have been identified:

a) Reducing emissions from deforestation
b) Reducing emissions from forest degradation
c) Conservation of forest carbon stocks
d) Sustainable management of forests
e) Enhancement of forest carbon stocks

Additionality. There is no reference to additionality in UNFCCC decisions related to REDD+.

Leakage. REDD+ activities must take actions to reduce displacement of emissions[10]. This is not qualified, but can be interpreted that both subnational and national level implementation should address leakage.

Permanence/reversals. Actions to address the risk of reversals should be promoted and supported.[11]

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[7] Decision 1/CP.16

[8] Climate Focus, Warsaw briefing note, (Amsterdam, 2014) available at: http://www.climatefocus.com/pages/climate_focus_publishes_warsaw_briefing_note

[9] http://www.v-c-s.org/sites/v-c-s.org/files/Summary%20of%20Technical%20Recommendations%20V2%200.pdf

[10] Appendix I of Decision 1/CP.16.

[11] Appendix I of Decision 1/CP.16

3.2 Clean Development Mechanism

The CDM allows crediting from afforestation and reforestation (A/R) projects, but excludes REDD+ and other forest carbon activities. A/R projects hold a very minor share of the CDM market, due to the temporary nature of credits issued for these project types, and their exclusion from the major carbon trading platform: the European Union Emissions Trading System (EU-ETS). A/R credits through June 2013 comprise only 0.5% of total credits issued under the CDM.

Additionality. The CDM requires the demonstration of additionality. It has developed two tools for assessing the additionality of different project types, the 'Tool for the Demonstration and Assessment of Additionality in A/R CDM Project Activities' and the 'Combined Tool to Identify the Baseline Scenario and Demonstrate Additionality in A/R CDM Project Activities'. The methodology used determines the tool chosen. Additionality can be demonstrated via barrier analysis, investment analysis, and common practice analysis.

Leakage. Project methodologies must provide information on how the project intends to estimate leakage, have operational and management structures to monitor leakage, and measures to be implemented to minimize potential leakage. Sometimes procedures for periodic review of implementation of activities to minimize leakage are required by the approved methodology and must be documented in the project design document.

Permanence. "Temporary CERs" (tCERs) and "long-term CERs" (ICERs) manage the risk of non-permanence. Both types of CERs require verification every 5 years—tCERs periodically expire and new tCERs are issued for the amount of carbon stored at a particular verification. ICERs are re-verified and only cancelled during the crediting period if there has been a reversal. Approaches for addressing non-permanence are documented in the project design document.

3.3 Voluntary Carbon Standards

Voluntary Carbon Standards include the Verified Carbon Standard (VCS), Climate Action Reserve (CAR) and American Carbon Registry (ACR). These provide general standards comprised of project, methodology, and validation and verification requirements applied to all projects across a number of sectors. To date, VCS is the most popular voluntary carbon standard comprising 58% of 2011 overall voluntary market share.[12] Under VCS, forest-related projects are subject to the additional Agriculture, Forestry, and other Land Use (AFOLU) requirements. There are 13 approved VCS AFOLU methodologies and 14 under development. AFOLU projects may also use relevant CDM methodologies.

[12] Peters-Stanley, M. and D. Yin (2013). "State of the Voluntary Carbon Markets 2013.

Additionality. Methodologies provide procedures for the demonstration and assessment of additionality. Methodologies use either a project method, performance method and/or activity method to determine additionality. They may refer to an appropriate additionality tool developed under the VCS or an approved GHG programme, develop a full procedure within the methodology itself or develop a new separate tool.

Leakage. Leakage may be addressed through leakage sharing agreements, a leakage belt, or simplified leakage deduction factors. The VCS requires monitoring of market leakage, activity-shifting leakage, and ecological leakage, where applicable. The VCS AFOLU Requirements provide significant guidance for monitoring leakage for REDD, IFM and ARR projects.

Permanence/reversals. VCS REDD+ project proponents are required to use the AFOLU Non-Permanence Risk Tool to determine the volume of buffer credits that must be deposited into the AFOLU pooled buffer account. This account holds non-tradable buffer credits which may be used to cover any reversals associated with AFOLU projects to ensure the permanence of credits issued. A 10–60% buffer is required, as determined through the application of the AFOLU Non-Permanence Risk Tool. The tool also allows projects to demonstrate where they have reduced risk by implementing risk mitigation strategies. Projects that demonstrate their longevity, sustainability and ability to mitigate risks are eligible for release of buffer credits from the AFOLU pooled buffer account.

Various VCS methodologies have gone beyond simple accounting structures to develop reference levels and MRV systems. These deserve a more detailed discussion which is provided in Annex 1. Table 3 shows how VCS methodologies map onto the various IPCC and UNFCCC definitions of REDD+.

Table 3: Comparison of IPCC, UNFCCC, and VCS division of REDD+ (adopted from JNR Summary of Technical Recommendations)

IPCC categories	UNFCCC REDD+ activities	Broad VCS project activities	Specific VCS project activities
Conversion of forest to non-forest	RED (Reducing Emissions from Deforestation)	REDD (reduced emissions from deforestation and degradation)	APD + RDP (avoided planned deforestation plus peat rewetting)
			APD + CUPP (avoided planned deforestation and peat drainage)
			AUD (avoided unplanned deforestation)
			AUD + RDP (avoided unplanned deforestation plus peat rewetting
			APD + CUPP (avoided planned deforestation and peat drainage)
Forests remaining as forests	REDD (Reducing Emissions from Degradation)		AUDD (avoided unplanned degradation)
			AUDD + RDP (avoided unplanned degradation plus peat rewetting)
			AUDD + CUPP (avoided unplanned degradation and peat drainage)
		IFM (improved forest management)	RIL (reduced impact logging)
			LtPF (logged to protected forest)
			ERA (extended rotation age)
			IFM + RDP (improved forest management plus peat rewetting)
			IFM + CUPP (improved forest management and preventing peat drainage)
	REDD+ (Sustainable management of forests and enhancement of forest carbon stocks)		LtHP (low productive to high-productive forest)
		ARR (afforestation, reforestation and revegetation)	ARR (afforestation, reforestation and revegetation)
			ARR + RDP (afforestation, reforestation and revegetation plus peat rewetting)
Conversion of non-forest to forest			ARR (afforestation, reforestation and revegetation)
			ARR + RDP (afforestation, reforestation and revegetation plus peat rewetting)

3.4 Forest Carbon Partnership Facility (FCPF)

The carbon fund of the FCPF is currently developing accounting modalities for REDD+. This process is still under development and guidance on REDD+ accounting frameworks is expected to be finalised in 2014.

Additionality. Additionality is primarily addressed through conservative approaches to setting Reference Levels (e.g., including existing and clearly funded programs or activities within the Reference Level), rather than through additionality tests often utilized by project-level initiatives, which have proven difficult to operationalize.

Leakage/displacement. Potential sources of domestic and international displacement of emissions are identified by assessment of all drivers of land-use change relevant for the Program; and measures to minimize and/or mitigate the risk of displacement of domestic emissions are incorporated into the Program design and the estimation and monitoring of emission reductions. Programs should seek to minimize and mitigate displacement outside the accounting area (domestic and international) to the extent possible. However, due to accounting and attribution challenges and following UNFCCC guidance on REDD+, potential international displacement should not be accounted for or deducted from the emission reductions credited to Carbon Fund Programs.

Permanence/reversals. Carbon Fund Programs should identify potential sources of reversal of emission reductions (non-permanence), have the capacity to monitor and report any reversal of previously monitored and reported emission reductions, and have measures in place to address major risks of anthropogenic reversals for the Carbon Fund Program are, to the extent feasible. Programs should have in place a robust reversal management mechanism (e.g. buffer reserve or insurance).

3.5 Bilateral Programmes

Several bilateral programmes exist including the Brazilian Amazon Fund, Guyana REDD+ Investment Fund (GRIF), and REDD+ Early Movers (REM) Programme. These programmes vary in their approaches in addressing REDD+ and are not discussed in detail at this stage.[13]

Additionality. It is generally assumed that additionality is captured in the construction of a conservative reference emission level.

[13] Further information available at: www.amazonfund.gov.br, http://www.guyanareddfund.org/ and http://www.bmz.de/en/publications/topics/climate/FlyerREDD_lang.pdf

Leakage. Leakage is either not addressed (Amazon Fund) - or is assumed to be captured in the national accounting system (REM, GRIF).

Permanence/reversals. Under the Amazon Fund, if the deforestation rate for a given year is higher than the reference emission level, the government will not receive funds that year and will have to compensate for those emissions the following year. The GRIF however doesn't have any requirements for permanence/reversals. To mitigate risk of non-permanence, REM encourages participating countries to have in place adequate measures and relies on conservative estimates.

3.6 Conclusions

REDD+ methodologies follow land-use accounting guidelines to account for emissions reductions from deforestation and forest degradation. These methodologies must all specify areas of land that are affected by REDD+ interventions and changes in forest carbon stocks occurring on that land. While the majority of REDD+ approaches use an activity-based approach to account for changes in forest carbon stocks, both land-based and activity-based approaches should accurately account for changes in forest carbon stocks using a combination of activity data and emissions factors.

Because of the nature of AFOLU accounting, emissions reductions are dependent on the existence of forest carbon stocks indefinitely into the future, since any changes in accounting of land area in future years would result in the reversal of those emissions reductions. This has led to complicated systems of accounting under AFOLU to ensure that permanence is accounted for in national and project level inventories. Buffers are one way of achieving this alongside other approaches such as discounting, guarantees and insurance.

Certain voluntary carbon market methodologies have developed provisions to address these complexities. The VCS Jurisdictional and Nested REDD (JNR) standard, for example, in recognition of the contribution that non-AFOLU methodologies can have on forest carbon stocks (see next section), requires any emissions reductions within the jurisdiction resulting from these methodologies to be subtracted from the jurisdictional baseline.

4 Non-REDD+ activities and REDD+ synergies

This section describes the range of voluntary and compliance methodologies that, while not being *labelled* as REDD+, nonetheless have synergies with the *outcome* of REDD+ by reducing the drivers of deforestation and forest degradation. These drivers are manifold and range from increased demand for timber and fuelwood, urban and agriculture expansion, livestock farming to uncontrolled fires.[14] The main difference between these methodologies and those described above is that they do not use an AFOLU approach to accounting emissions reductions. These methodologies are categorised along the ways in which they contribute to REDD+ outcomes. The five main categories are listed in Table 4, distinguishing biomass-related methodologies from other forms of land-use.

Table 4: Categories of Non-AFOLU methodologies with REDD+ synergies.

#	Category	Scope	Approach
1a	Reducing consumption of non-renewable biomass		By providing access to alternative energy sources or improving the efficiency of current energy sources these projects can reduce the demand for biomass where this is typically sourced from non-renewable sources.
1.b	Sustainable plantations to meet new biomass demand		These methodologies are used for projects that increase the demand for biomass (e.g. for a new power plant), which risks adding a driver for deforestation. The methodology aims to avoid deforestation or forest degradation by establishing a new plantation to meet the new demand. For projects that do not claim credits under CDM or voluntary afforestation/reforestation. the dedicated plantation of the project might even create a net carbon sink.
1.c	Ensuring sustainable biomass supply		These methodologies are used for projects that increase the demand for biomass (e.g. for a new power plant), which risks adding a driver for deforestation. The methodologies aim to avoid deforestation or forest degradation by securing a sustainable source of renewable biomass other than a dedicated planation.
2	Increased land demand		This category includes methodologies that aim to avoid or account for deforestation as a result of new demand for land due to the construction of infrastructure, mines, agricultural or other activities that are not related to timber or fuelwood.
3	Agricultural intensification		By improving production efficiency and increasing yields on agricultural land, the pressure on forests from agricultural

[14] See Kissinger *et al.* (2012) *Drivers of Deforestation and Forest Degradation – A Synthesis Report for REDD+ policy-makers*, Lexeme Consulting, Vancouver Canada, available here (accessed 03/12/2013)

expansion may decrease.

Within all of these categories of methodologies, the REDD+ outcome depends on the type of project. Some methodologies include optional sections which apply only to a selection of projects. For example, there are methodologies that cover fuel switch but which only deliver REDD+ outcomes if the fuel that is being replaced is actually biomass.

A second category is methodologies for projects that aim to avoid that increased biomass demand becomes a driver for deforestation by ensuring that biomass is sourced from renewable biomass sources. These projects potentially create a new driver of deforestation, for example with the construction of a new biomass-fired power plant. In this case, methodological imperfections could result in a negative REDD+ synergy as the project would contribute to deforestation or forest degradation. This is being avoided by including requirements to ensure the use of renewable biomass only. Methodological shortcoming in projects that remove a driver for deforestation only risk overestimating the contribution of the project to avoiding deforestation or forest degradation. This category does not include projects that secure renewable biomass supply by establishing a dedicated plantation.

Figure 3 provides an overview of the different categories. In the core are REDD+ activities described in section 3, followed by activities directly related to biomass demand and activities related to land demand. The development of sustainable livelihoods can affect forest carbon either by reducing demand and consumption of NRB or by reducing demand for land.

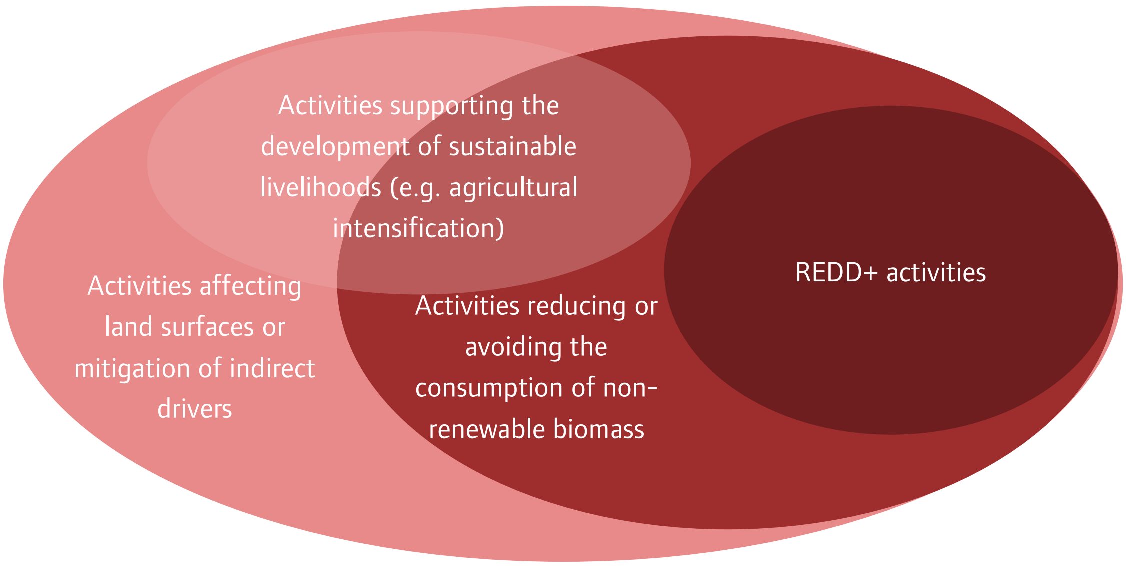

Figure 3: Different categories of REDD+ synergies in carbon projects, from directly reducing deforestation to avoiding it and indirectly removing drivers for deforestation.

In the following sections we take a closer look at these four categories of methodologies and the nature of their REDD+ synergies. This will form the basis for the analysis in section 5 on the ability of these projects to demonstrate their positive REDD+ outcomes.

4.1 1a. Reducing consumption of non-renewable biomass

Projects in this category reduce deforestation and forest degradation by providing an alternative source of energy to biomass or by improving the efficiency of current biomass-fired appliances. The kind of appliances typically ranges from cook stoves and heating appliances up to industrial boilers. Alternative energy sources provided are solar energy or biogas. Methodologies that aim at using biogas as an alternative energy source for NRB are often used in combination with methodologies that reduce emissions from manure, waste water treatment or decay of biomass. These projects have an impact on forest carbon stock only when the methane captured is used to replace NRB. They would thereby always be applied in combination with a fuel switch methodology like the ones discussed in this section.

Table 5 shows the range of projects that reduce demand of NRB to achieve REDD+ outcomes. Methodologies that aim at using biogas as an alternative energy source for NRB are often used in combination with methodologies that reduce emissions from manure, waste water treatment or decay of biomass. These projects have an impact on forest carbon stock only when the methane captured is used to replace NRB. They would thereby always be applied in combination with a fuel switch methodology like the ones discussed in this section.

Table 5: Carbon project methodologies reducing demand for NRB.

Project Type / Sector	Applicable Methodologies
Cook stoves, e.g in households	CDM AMS-I.K., CDM AM0094, Gold Standard Simplified Methodology for efficient cook stoves
Energy efficiency e.g. in industrial boilers or boilers for residential heating	CDM AMS-II.G. CDM AMS-II.R., ACR Methodology - Energy Efficiency Measures in Thermal Applications of Non-Renewable Biomass
Fuel switch	CDM AMS-I.E., ACR Methodology Switch from non-renewable biomass for thermal applications
Low-carbon drinking water production system	CDM AMS-III.AV, CDM AM0086
Sustainable charcoal production	CDM AMS-III.BG.

Table 6 gives an overview of the ways in which methodological aspects of REDD+ are addressed in non-AFOLU projects that avoid the consumption of NRB.

Reference level. There are several differences in approaches between AFOLU and non-AFOLU based methodologies. As with all methodologies the reference level is a combination of activity data and emissions factors. But unlike AFOLU projects, reference levels for NRB projects do not require activity data on specific areas of land. Instead, activity data is taken from data on consumption of biomass (i.e. fuelwood). Emissions factors are derived from a calculation of the appropriate fraction of NRB (fNRB): a variable that is needed to determine the potential avoided forest degradation and related emission reductions induced by the fuel switch or energy efficiency measures. The fraction aims to represent the share of harvested biomass dedicated to act as fuel wood that is not compensated through the regrowth of existing vegetation ('Mean Annual Increment') in the area, region or country.[15]

Table 6: Ways in which the methodological aspects of REDD+ are addressed in this category.

Methodological aspect	Approach
Reference level	The baseline is generally established with a national figure for fNRB.[16] Under the Gold Standard fNRB is more location specific and should be monitored.
Permanence	Continued forest degradation in the area of the project is used to ensure that woody biomass sourced in the region would continue to be NRB.
Leakage	A second form or leakage that is addressed is that the biomass saved by one, should not consequently be used by another. The CDM methodologies that reduce NRB use with energy efficiency measures also looks at shift of pre-project activities and leakage if the biomass saved is consequently used by others. The Gold Standard addresses all three kind of leakages only for PoAs and required bi-annual monitoring. Only charcoal methodologies face and address the issue of leakage where charcoal users would also claim emission reductions.

Most CDM methodologies[17] refer to the details outlined in the CDM methodology "Switch from non-renewable biomass for thermal applications by the user" (AMS-I.E.) to determine fNRB.[18] AMS.-I.E. refers to country default values published by the UNFCCC as the best proxy for fNRB. These default values take into account country-specific factors such as forest extent, biomass growth, removal rate and/or protected area extent to calculate a national average figure for fNRB. This national average is then used for the calculation of baselines on a project-level basis.[19] In addition, the emission reductions are calculated with an emission factor for fossil fuels, which is more conservative than using the emission factor for woody biomass.

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[15] The calculation is illustrated in the Gold Standard Methodology "Technologies and Practices to Displace Decentralized Thermal Energy Consumption" (p.29).

[16] fNRB is the fraction of non-renewable biomass (NRB), which refers to the part of the biomass consumed that contributes to deforestation or forest degradation. In this project category, emission reductions can be claimed for reducing the consumption of NRB.

[17] CDM AMS-I.K., CDM AMS-III.AV., CDM AMS-III.B.G.

[18] Available here: AMS-I.E.

[19] A comprehensive list of factors and values by country was published in Annex 1 to Annex 14 to the UNFCCC thirty-seventh meeting. The note is available here.

In the absence of a national default value for fNRB, project developers can estimate fNRB based on nationally approved methods. A common approach is to use data from governmental or international sources to determine the annual increment and the total annual consumption of wood. Although these calculations represent a conservative estimate that aims to prevent or at least minimize continuous forest loss (and thus thereby addresses REDD+ issues), their accuracy is limited, since they do not reflect the local project specifics other than applying a proxy that confirms that forest degradation is an issue in the project area.

The "Gold Standard simplified methodology for efficient cook stoves" refers to the NRB assessment developed and outlined in the related Gold Standard methodology "Technologies and Practices to Displace Decentralized Thermal Energy Consumption".[20] The assessment offers quantitative and qualitative approaches to the fNRB calculation, but recommends a conservative combination of the two. The quantitative technique is to a large extent a replica of the national approach applied in the CDM, but takes into account local parameters that better reflect the project specifics. The qualitative technique can apply satellite imagery, literature reviews and expert consultation. From a REDD+ perspective, both approaches under this Gold Standard methodology are more likely to achieve more robust REDD+ outcomes than the national values used in the CDM, as they consider regional aspects. The methodology also requires continuous monitoring and updating of the fNRB variable, which enhances the accuracy of the REDD+ outcome on the longer term.

Switching from non-renewable to renewable biomass sources is another way to reduce emissions from deforestation of forest degradation. This requires demonstrating that biomass sourced after implementation of the project is renewable, in addition to demonstrating that part of the historic use of biomass was non-renewable. CDM methodologies for projects that switch from NRB to "Demonstrably Renewable Biomass" (DRB) need to demonstrate that the fuel wood sources used by the project originate either from:

1. Land areas that meet the forest definitions adopted under the UNFCCC,[21]
2. Cropland or grassland areas which remain cropland or grassland or are converted into forest.

Both land area types should be subject to sustainable land management practices in compliance with national or regional forestry, agriculture and nature conservation regulations.

The majority of the CDM methodologies require a historical proof of continuous use of NRB in the area where the project or PoA is located.[22] This proof needs to reach back until December 31st 1989, which is the reference for, among other things, forest non-existence in

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[20] Available here (Annex 1).

[21] Decisions 11/CP.7 and 19/CP.9

[22] e.g. CDM AMS-I.E., CDM AMS-II.G., CDM AMS-II.R.

afforestation/reforestation projects developed under the framework of Land-use, Land-use Change & Forestry (LULUCF)[23]. With this reference date the methodology aims to ensure that the overuse of local NRB is a long-term problem, which aligns with the longer-term horizon of REDD+ projects.

Permanence. Although permanence is not explicitly referenced in NRB project methodologies there are provisions that consider the permanence of forest carbon stocks. The CDM methodology AMS-I.E defines NRB as the quantity of woody biomass used in the absence of the project minus the DRB component. In addition, two out of the following four indicators must also be met:

1. Increase in time needed or distance travelled for gathering firewood;
2. Survey results indicating that carbon stocks are depleting in the project area;
3. Increasing fuel wood prices in the project area;
4. Degradation over time of the types of wood collected.

This condition aims to ensure that forest degradation or deforestation are indeed an issue in the area of the project and continue to be an issue throughout the lifetime of the project. Compliance with these two requirements should be maintained throughout the project's lifetime. It does not establish causality between the use of firewood and forest degradation or deforestation, nor does it affect the fNRB in the specific project area.

Leakage. Leakage is a critical issue for REDD+ projects. Establishing a project area, where deforestation or forest degradation is avoided while the drivers of degradation or deforestation are not addressed, can increase pressure on adjacent areas outside the project area. Given that non-AFOLU methodologies - as described here - by nature address drivers of deforestation, leakage is less of a concern in general for these types of projects. Methodologies that reduce consumption of NRB, therefore do not address the *geographical* aspect of leakage. Instead they focus on the type of leakage where reducing fuel wood demand from one source makes more fuel wood available for others. This occurs, for example, when households outside the project start using the NRB that is no longer used by households that are part of the project. To address this, AMS-I.E[24] requires that this type of leakage from project households to non-project households is quantified through surveys and the emission reductions adjusted accordingly.

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[23] This date was determined during the Kyoto LULUCF negotiations. See for more information: Höhne, N., Wartmann, S., Herold, A., & Freibauer, A. (2007). The rules for land use, land use change and forestry under the Kyoto Protocol—lessons learned for the future climate negotiations. *Environmental Science & Policy*, 10(4), 353–369. doi:10.1016/j.envsci.2007.02.001.

24 CDM AMS-II.G., CDM AMS-II.K., CDM AMS-A.V., CDM AMS-B.G. (CDM AMS-II.R refers to CDM AMS-II.G.).

Another form of leakage is overlapping baselines, where the NRB saved under one project is also claimed in the baseline scenario of another project. To quantify these two potential sources of leakage, an adjustment factor of 0.95 has to be applied.

AMS-II.R, AMS-III.AV and, implicitly, AMS-II.G are three CDM methodologies that target projects that use energy efficiency to reduce demand for fuel wood. These methodologies take the concept of leakage further by referring to the general CDM guidance for small-scale renewable biomass projects.[25] This guidance mentions three potential leakages:

1. Shifts of pre-project activities (geographical shift akin to REDD+);
2. Emissions related to the production of biomass (important but not in the context of REDD+);
3. Competing use for biomass (similar to the leakage between households under AMS-I.E.).

This alternative guidance, in particular source 1, is more closely aligned with the REDD+ concept for leakage than the household-level leakage approach. If the project entails a shift of pre-project activities (i.e. NRB is consumed outside of the project boundaries), no or less positive REDD+ outcome is achieved.

The "Gold Standard simplified methodology for efficient cook stoves" does not consider leakage for micro-scale project activities, but has a more comprehensive leakage methodology for Programme of Activities (PoA) projects[26]. This methodology considers the geographical leakage, the leakage to non-project households, but also the issue of potential impact of the project on the fNRB that is part of another CDM/VER project in the same area. It is thus probably the most comprehensive methodologies of all those examined here. Under this standard, a leakage investigation has also to be conducted every two years.

An interesting case is made in the American Carbon Registry methodology "Energy efficiency measures in thermal applications of non-renewable biomass"[27]. Paragraph 16 lists detailed instructions for the calculation of the extracted biomass. These include assumptions on the use of root and aboveground biomass as fuel, as well as the emissions associated with the harvest of the biomass. The level of detail suggests that the methodology benefitted from relevant REDD+ principles

The charcoal methodology AMS-III.B.G identifies and addresses another form of leakage. The project aims to reduce the consumption of NRB in charcoal production and requires contractual agreements that avoid that also the end-users of the charcoal claim emission reductions from the reduced reliance on NRB.

[25] Chapter III.4 in CDM EB 47 Report Annex 28 (Available here).

[26] Section 6 in "Technologies and Practices to Displace Decentralized Thermal Energy Consumption".

[27] See: http://americancarbonregistry.org/, visited at 5 November 2013.

4.2 1b. Dedicated plantations for sustainable supply of biomass

The second group of projects aims to achieve REDD+ outcomes by establishing a dedicated biomass plantation that support fuel switch from fossil fuels to sustainable biomass Project types in this category range from greenfield power plants utilizing renewable biomass (e.g. CDM AM0042) to fuel switching in heavy industries (e.g. CDM ACM0003) and biodiesel production (e.g. CDM AMS-I.H). Table 7 shows the variety of methodology types that all either obligatorily or optionally involve the establishment of dedicated plantations.

Biomass is a potential renewable energy source if the use of biomass does not decrease forest carbon stocks. Projects that increase the demand for biomass as energy source risk creating a driver for deforestation. To avoid that, methodologies that cover the use of biomass as renewable energy source, include conditions for sourcing the biomass from sustainable sources. These sources can include waste biomass, sustainably produced biomass or dedicated plantations that are part of the project.

Table 7: Carbon project methodologies featuring dedicated plantations

Project Type / Sector	Applicable Methodologies
New biomass-fired power plant	CDM AM0042, CDM AMS-I.A, CDM AMS- I.C, CDM AMS- I.D, CDM AMS- I.F
Electricity and heat generation from biomass	CDM ACM0006, CDM AMS-I.A, CDM AMS- I.C, CDM AMS- I.D, CDM AMS- I.F, GS “Technologies and Practices to Displace Decentralized Thermal Energy Consumption”
Use of biomass in specific industries(fuel switch)	CDM AM0082, CDM ACM0003, CDM AMS- III.AS
Biodiesel production	CDM AMS-I.H, CDM AMS-III.AK, CDM ACM0017
Plant oil Production	CDM AMS- I.G, CDM AMS- III.T
Charcoal use in kilns	CDM ACM0021

If dedicated plantations are newly established to provide a constant flow of biomass, this implicitly achieves Afforestation or Reforestation (A/R) outcomes, assuming the type of plantation can be categorized as newly forested-land (and not agricultural land). This naturally depends on the type of plantation that is developed for biomass production. The CDM methodologies listed in table 7 typically distinguish projects with plantations that are also part of CDM A/R projects from those that are not. There are certain differences in the technicalities of the methodologies between the two cases, which, however, do not directly affect REDD+

outcomes.[28] More important is this distinction between projects that establish a plantation without claiming credits under a CDM A/R methodology, and projects that do claim these credits.

Table 8: Ways in which methodological aspects of REDD+ are addressed in this category.

Methodological aspect	Approach
Reference level	The CDM requires that new plantations are built on severely degraded land only. Other methodologies allow for plantations on land that was previously grassland, forest plantation after its last rotation or degraded area.
Permanence	Typical requirements to ensure permanence are that carbon stocks in soil organic matter, litter and deadwood are not decreased due to the project and the forest will regenerate by natural sprouting or direct planting or seeding after each harvest.
Leakage	CDM methodologies typically refer to a tool that addresses leakage due to crowding out other uses (or pre-project activities).

Reference level. In CDM AM0042, if a dedicated plantation is established, it needs to be shown that the chosen land area fulfils the criteria of "degraded land and in absence of the project activity would have not been used for any other agricultural or forestry activity".[29] This can be done by addressing one of the indicators listed in Table 9.

Table 9: Indicators for land degradation on the location of a future plantation.

#	Indicator	Aspects
1	Vegetation degradation, e.g.	- Crown cover of pre-existing trees has decreased in the recent past for reasons other than sustainable harvesting activities
2	Soil degradation, e.g.	- Soil erosion has increased in the recent past; - Soil organic matter content has decreased in the recent past
3	Anthropogenic influences, e.g.	- There is a recent history of loss of soil and vegetation due to anthropogenic actions; and - Demonstration that there exist anthropogenic actions/activities that prevent possible occurrence of natural regeneration.

Indicator 1 is particularly relevant in a REDD+ context, since a new plantation would in this case reverse a downward trend in tree coverage. The same methodology also states that the new biomass-fired power plant could also partially use fossil fuels or even other biomass residues. It is unclear, whether these residues come from renewable sources. This would have to be guaranteed to avoid negative REDD+ synergies.

[28] e.g. emissions from the establishment of the plantation are not considered, if the plantation is also part of a CDM A/R project (they are instead considered in the CDM A/R project).

[29] Also a condition for CDM ACM0003.

CDM AM0082 requires fairly elaborate conditions for the features of both the designated land area and the plantation itself. Specifically, the plantation must be located in tropical conditions and "all the corresponding land has to be geographically identified and delineated using maps or Geographic Information Systems (GIS) or similar system identified". The latter point resembles the complex accounting methods from traditional REDD+ methodologies. Further, there should be "evidence (e.g., official land use maps, satellite images/aerial photographs, cadastral information, official land use records) demonstrating that the location of plantations in the project boundary are established in areas that fall in one or more of the following categories":

1. Grasslands,
2. Forest plantation after its last rotation,[30]
3. Degraded areas.

If a forest plantation after its last rotation is chosen as the site for the new plantation, no significant REDD+ outcome can be achieved, as the carbon stock can be assumed to stay constant or even decrease compared to the original forest plantation. This risk is mitigated by demonstrating that this land would not be replanted in the absence of the project activity. Contrarily and to an extent even contradictory, the methodology further conditions that the land designated as the site for the plantation cannot have been forested for the last ten years. This requirement strengthens the likelihood of a positive REDD+ outcome.

The methodology also refers to the CDM "Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities"[31] for the demonstration of the "land degradation" criteria. This tool is also mentioned in a number of other methodologies for the same purpose. It essentially follows a two-step approach that first determines whether the land is subsumable under an existing classification scheme (local, regional, national or international) and, if this is not the case, applies a comparative and indicator analysis to assess the level of land degradation.

Permanence The plantation should meet a number of criteria that aim to ensure that carbon removals are not reversed:

1. The site preparation does not cause net emissions from soil carbon and carbon stocks in soil organic matter, litter and deadwood do would have increased less in absence of the project,
2. After harvest, direct planting or natural sprouting will provide for forest regeneration,

30 Lands that were previously stocked with human-induced forest plantations (e.g., pinus, palm trees, bamboo, eucalyptus, etc.) at the end of their rotation cycle (i.e., which were harvested after their last rotation).

31 From CDM EB 41 Report Annex 15 (available here).

Leakage. The other CDM tool that is frequently referred to is the "General guidance on leakage in biomass project activities"[32]. In general, leakage considerations that are relevant to REDD+ outcomes are only marginally discussed in the methodologies incorporating dedicated plantations. This guidance is equivalent to the leakage aspects discussed in chapter 4.1 and revolves again around the leakage source of *shifts of pre-project activities*[33]. Concisely put, leakage could occur, if goods (e.g. fuel wood) and services (e.g. grazing) that were previously provided in the confined plantation area will now have to be sourced in adjacent areas. Additionally, CDM AM0082 states that:

> *"The increased emissions from the displacement of economic activities such as harvest of fuel wood for meeting domestic energy needs and use of lands as pastures for grazing/fodder collection are taken into account for calculation of leakage associated with production of biomass resources needed for producing charcoal."*

For the calculation of these emissions, it refers to the steps outlined in the CDM A/R methodology AR-AM0005.[34] CDM ACM0006 makes an interesting case, as it expects no LULUCF-relevant leakage to occur.[35] Rather than addressing the dedicated plantation itself, CDM ACM0021 only requires a proof of the sustainability of the biomass sourced for the charcoal production through a certification agency or collection of field data.

4.3 1c. Ensuring sustainable supply of biomass without plantations

In category 1b, the methodologies CDM AMS-I.G., CDM AM42, CDM AM82 and CDM AMS-III.T require the establishment of a dedicated plantation to ensure that the biomass used originates from sustainable sources. The majority of the methodologies identified in category 1b allow for the use of waste biomass or other sustainable sources as well. This opens a new category of projects, for which applicable methodologies are listed in Table 10.

The newly added methodologies are CDM AM0036, which is a fuel switch methodology and CDM AM0007, which covers biomass fired power plants where impact of biomass use is considered as leakage. Further, CDM ACM0018 and CDM ACM0020 are methodologies for projects that specifically use biomass residues to achieve emission reductions. The Gold Standard methodology "Thermal energy from plant oil for the user of cooking stoves" requires the sustainable use of

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[32] From CDM EB 47 Report Annex 28 (available here).

[33] "Decreases of carbon stocks, for example as a result of deforestation, outside the land area where the biomass is grown, due to shifts of pre-project activities." (Chapter 4.A, page 2)

[34] Available here.

[35] "Changes in carbon stocks in the LULUCF sector are expected to be insignificant for biomass residues prevent changes in carbon stock requires that the project activity does not lead to a shift of pre-project activities outside the project boundary, and thus no leakage emissions are expected".

biomass (condition 7). CDM AMS-III.K finally aims at projects that avoid methane emissions from charcoal production, while ensuring that the sources of biomass are not affected by the project.

Table 10: Carbon project methodologies allowing other sustainable sources for renewable biomass.

Project Type / Sector	Applicable Methodologies
New biomass-fired power plant	CDM AMS-I.A, CDM AMS- I.C, CDM AMS- I.D, CDM AMS- I.F
Electricity and heat generation from biomass	CDM ACM0006, CDM AMS-I.A, CDM AMS- I.C, CDM AMS- I.D, CDM AMS- I.F, GS "Technologies and Practices to Displace Decentralized Thermal Energy Consumption", GS "Thermal energy from plant oil for the user of cooking stoves"
Use of biomass in specific industries (fuel switch)	CDM ACM0003, CDM AM0007, CDM AMS- III.AS
Biodiesel production	CDM AMS-I.H, AMS-III.AK
Charcoal use	CDM ACM0021, CDM AMS-III.K
Fuel switch from fossil fuels to biomass residues in heat generation equipment	CDM AM0036
Use of biomass residues	CDM ACM0018, CDM ACM0020

If no dedicated plantation is established for the project, methodologies aim to ensure that the biomass used is from sustainable sources. Consequently, the REDD+ synergies here are different from those that accrue from a dedicated plantation, which has the additional and major feature of also creating an enhanced carbon stock. Projects to which the methodologies in Table 10 apply do not have that feature and thus automatically descend in an overall ranking of methodologies with REDD+ synergies.

Rather than creating positive REDD+ synergies, these project strive to avoid negative REDD+ synergies, by avoiding that the additional demand for biomass fuel that they bring contributes to deforestation or forest degradation. CDM ACM0006, for instance, only allows the use of fuelwood sourced from either biomass residues (or a dedicated plantation). Using can avoid deforestation. Towards the same objective, CDM ACM0021 outlines that, if no dedicated plantation is established, the sustainability of the biomass source can be proven through official and independent certification agencies that demonstrate it is sourced from other sustainably managed plantations.

In terms of the methodological aspects of reference level, permanence and leakage, the REDD+ characteristics of these methodologies have already been described in the previous chapter, which is also why this category is not explicitly included as a separate section in the ranking system. Generally, it can safely be assumed that, if these methodologies are used for projects that do not establish a plantation, their REDD+ value is limited to the avoidance of deforestation by ensuring that the fuel supply comes from sustainable and renewable sources.

4.4 2. Mitigation actions affecting demand for land

The last group of projects with potential REDD+ synergies are mitigation actions that affect large land surfaces. REDD+ is about enhancing carbon stock and avoiding deforestation. That is also what these methodologies aim to achieve. The difference however is that the methodologies in section 4.1, reduce existing demand for NRB. The methodologies in this section aim to avoid, account for or minimise deforestation as a result of the project itself. In carbon project terminology: deforestation emissions are either part of the baseline, or part of the project emissions or leakage. Since deforestation drivers are created by the project itself, they score lower in the ranking exercise in the following chapter.

Across Africa, Latin America and (sub)tropical Asia, both commercial and local or subsistence agriculture are the main drivers for deforestation, followed by mining, infrastructure development and urban expansion. The causes of forest degradation are different, listing fuelwood gathering for charcoal and timber logging as most important drivers, followed by uncontrolled fires and livestock grazing in forests.[36]

Some carbon project activities affect the activities that can constitute a driver for deforestation or forest degradation. Table 11 gives an overview and also describes the synergy with REDD+ objectives. The methodologies listed share the characteristic that the underlying projects have an impact on land use and land demand but are not related to either fuelwood or biomass use. Like with the methodologies listed in 4.3, these methodologies aim at avoiding or accounting for negative impacts of carbon stock. As a consequence also these automatically descend in an overall ranking of methodologies that also involve positive REDD+ synergies.

Most methodologies in Table 11 are reducing emissions through the construction of interconnection grid lines or more sustainable transport infrastructure. In forested areas, these activities could become a driver of deforestation. In most cases, like with AM0045, AM0104, AM0108, AM0110, or AMS-III.BB, emissions due to deforestation during construction are accounted for by the project as leakage or project emissions. Other methodologies, also involving infrastructure development, do not account of potential deforestation, like AM0097 and AM0101.

Also renewable energy projects can increase pressure on land-use or involve clearing of forest areas to make way for new construction. Hydropower methodologies tend to take this into

[36] Streck C., Zurek M., Addressing Agricultural Drivers of Deforestation - Opportunities for Catalytic Donor Interventions (Amsterdam, 2013)

account by requiring that hydropower projects with a reservoir meet a certain "power density threshold", calculated as the installed capacity per square meter of reservoir surface.

Table 11: Carbon project methodologies that affect land demand that is not related to fuelwood.

Project Type / Sector	Applicable Methodologies	REDD+ synergy
Infrastructure development	CDM AM0045 CDM AM0097 CDM AM0101 CDM AM0104 CDM AM0108 CDM AM0110 AMS-III.BB CDM AM0090	These projects can involve the development of infrastructure in rural areas, for example high-speed passenger rail connections, grid interconnections, mini-grids, pipelines, cargo railroads or waterways.
Renewable energy projects that require significant land surfaces	CDM AM0100 CDM ACM0002	Renewable energy installations, like concentrated solar or hydropower, require a lot of land that could have been forested prior to project implementation.
Reducing food waste	GS Low GHG Food Preservation	The installation of more efficient technology to preserve food saves energy but may also reduce the amount of food that would otherwise be wasted. This in effect could reduce food demand and reduce agriculture as driver for deforestation.

Finally, there are methodologies that aim at using biogas as an alternative energy source for NRB. These projects have an impact on forest carbon stock only when the methane captured is used to replace NRB and would thereby always be applied in combination with a fuel switch methodology. This kind of methodologies is already covered in section 4.1.

4.5 3. Agricultural intensification

The final category consists of projects that support an intensification of agricultural production, reducing the need for land to meet demand for agricultural products. This category is listed last since its impact on forest carbon is relatively uncertain and could even be detrimental. Contrary to the previous category, also the link with land use is less clear.

Intensification can contribute to emissions reductions by improving the emissions efficiency of inputs and by avoiding deforestation. Various practices contribute to improved efficiency of agricultural production, i.e. producing more with less inputs and land. While conventional intensification practices are typically input-intensive and rely largely on agrochemicals,

mechanization and improved varieties or breeds, various agronomic practices are available to optimize the density, rotation and precision of farming.
There are a few methodologies that support agricultural intensification and the impact of the mitigation activities targeted by these methodologies on agricultural yields is not evident. First, there should be forested land in the project area which is under threat of deforestation as a result of expanding agricultural activities. Second, the increased yields should indeed incentivise farmers to refrain from clearing forest to make way for agricultural land.

Historically, a causal link between yield increases and reduced deforestation has been questioned, as intensification involves complex rebound effects. If activities do result in more efficient production, uncertainty remains on the impact that this will have on nearby but also on global forest (i.e. leakage). Higher efficiency generally increases rents and returns, enabling or encouraging the farmer to further intensify and expand production - if markets are sufficiently elastic to accommodate for additional supply.[37] The resulting increase in emissions, both from deforestation and agricultural production, can offset or even outweigh mitigation benefits.

There is still limited understanding under which conditions intensification can reduce deforestation and how unintended rebound effects can be mitigated, including spill-over effects that go beyond the project or landscape scale. While market factors such as demand elasticities play an important role, other requirements for a causal link of production efficiency and land-sparing relate to robust governance, land use planning, enforcement and financial incentives for conservation or carbon.

Table 12: Examples of carbon project methodologies that may improve agricultural yields.

Project Type / Sector	Applicable Methodologies	REDD+ synergy
Reduced use of synthetic fertilisers	CDM AMS-III.A CDM AMS-III.BF.	Reducing the use of synthetic nitrogen fertilizers by using other seeds or applying legumes grass rotation. N_2O emissions from synthetic fertilisers or CO_2 emissions from their production are reduced.
Reduced open burning	AMS-III.BE.	Avoidance of methane and nitrous oxide emissions from sugarcane pre-harvest open burning through mulching
Improved water management	CDM AMS-III.AU	Methane emission reduction by adjusted water management practice in rice cultivation

[37] Phelps, J., Carrasco, L.R., Webb, E.L., Koh, L.P. and Pascual, U. Agricultural Intensification Escalates Future Conservation Costs. Proceedings of the National Academy of Sciences (April 15, 2013); Rudel, T.K., Schneider, L., Uriarte, M., Turner, B.L., 2nd, DeFries, R., Lawrence, D., Geoghegan, J., Hecht, S., Ickowitz, A., Lambin, E.F., et al. Agricultural intensification and changes in cultivated areas, 1970-2005. Proc. Natl. Acad. Sci. U.S.A. 106, 20675–20680. (2009)

Project Type / Sector	Applicable Methodologies	REDD+ synergy
Energy efficiency in agriculture	CDM AMS-II.F. CDM AMS-II.P.	Energy efficiency and fuel switching measures for agricultural facilities and activities, including efficient pumps for irrigation, smaller tractors, reduced tillage and other fuel saving measures.

Methodologies like VCS "VM0006 Carbon Accounting for Mosaic and Landscape-scale REDD Projects" aim to address a broad range of drivers of deforestation. However, since this methodology requires remote sensing and "Accurate data on past land use, land cover, and forest cover" it applies a land-based rather than a project-based approach. This is also true for VM0017 Adoption of Sustainable Agricultural Land Management; VM0021 Soil Carbon Quantification Methodology and VM0022 Quantifying N_2O Emissions Reductions in Agricultural Crops through Nitrogen Fertilizer Rate Reduction. These methodologies are covered in chapter 3 and the related annex.

A number of CDM methodologies which can impact agricultural yields are project-based and aim at improved water management, reduced use of synthetic fertilisers or reduced burning of agricultural residues on the field. These practices could impact the intensity of agricultural production, increase yields and reduce demand for agricultural land. The MRV applied in these methodologies target parameters like the amount of synthetic fertiliser used or the amount of biomass burned. An exception is methodology CDM AMS-III.AU which uses emission proxies connected to the land surface to which new agricultural practices are applied. Still, none of the methodologies monitors the impact on yields, demand for agricultural land or impact on forest carbon.

4.6 Conclusions

How non-AFOLU methodologies generate emissions reductions and deal with leakage is highly relevant to the extent to which drivers of deforestation are addressed and how these projects deliver REDD+ outcomes. Ultimately several factors will influence the potential for non-AFOLU methodologies to generate synergies with REDD+.

Firstly, the calculation of the fNRB will be highly relevant to the extent to which emissions reductions can be said to be real, or additional. If fNRBs are conservative then these projects can have strong synergies with REDD+, but conversely, over-inflated fNRBs will lead to unrealistic assumptions of REDD+ benefits. More spatially explicit and locally derived fNRBs that use a combination of remote sensing and field plots can help to improve the precision of fNRBs.

Secondly, methodologies that require leakage and permanence to be addressed will be important in ensuring the environmental integrity of emissions reductions. Several provisions including guidance to assess changes in practices in non-project areas as well as discounting any double counting of emissions in adjacent projects provide good examples for how leakage can be addressed. Underlying assumptions, such as the 5% discount rate applied to overlapping baselines may, however, need further consideration.

Overall, despite various signs of commensuration and harmonization, the methodologies applied to dedicated biomass plantations comprise a large array of conditions that differ widely between project types and therefore have varying degrees of REDD+ outcomes. Projects that do not develop a separate CDM A/R component, due to the increased complexity of these methodologies, do have the potential to deliver increased forest cover that is not accounted for.

The fore last group of methodologies are those where, for example, the construction of infrastructure, renewable energy facilities increase demand for land. In forested areas these projects could become a driver for deforestation. The potential impact on forest carbon is typically addressed by accounting for deforestation emissions or imposing a cap on the land surface affected by the project. Since deforestation drivers are created by the project itself, they do not create positive REDD+ synergies but rather try to minimise the negative REDD+ synergies. As a consequence, these projects score lower in the ranking in the following chapter.

The last group are methodologies that support establishing sustainable livelihoods or where emissions from agricultural production are reduced in a way that could increase agricultural yields and reduce the demand for agricultural land. The impact of the activities that these methodologies target on forest carbon requires insight in the impact of the project on agricultural yields, and the subsequent impact of changes in yields on the pressure on forest areas for conversion to agricultural land. Both mechanisms are understood only to a limited extent and are likely to function only under specific market and institutional conditions. Therefore the impacts of changes in agricultural practices on deforestation are very location-specific. These interactions should be examined in a specific local context before using certain CDM activities with the aim of creating positive REDD+ synergies.

5 Ranking methodologies

The methodologies identified to bring significant synergies with REDD+ outcomes have been analysed against a number of criteria. The objective of the ranking is to select those methodologies for which the underlying project are most likely to deliver the targeted REDD+ outcomes at a significant scale. Some methodologies apply to a variety of project types (e.g. some of the broad-ranging consolidated CDM methodologies).

Table 13: Ranking criteria.

#	Criterion	Operationalisation	Weight factor
1	Financial feasibility	Three indicators (as available from CDM pipeline): - Contribution of carbon credits to annual investment (¼) - Carbon revenue share in IRR (¼) - Investment requirement per tCO_2 (½) Where data was unavailable, average values were applied	¼
2	Robustness of contribution to REDD+ outcome	This indicator tries to capture how detailed, accurate and strict the methodology addresses issues that will impact the REDD+ outcome by expert opinion on the following sub-categories, as discussed in chapter 4: - Leakage - fNRB (for NRB methodologies) - DRB (for NRB methodologies) - Plantation details (for plantation methodologies) - History of plantation area (for plantation methodologies) - Permanence - Other relevant details.	¼
3	Technical feasibility	- Defined as credit issuance success rate (weighted average for CDM and JI projects) - For VCM methodologies based on exemplary projects - Methodologies without data were given zero points	¼
4	REDD+ mitigation potential	This indicator tries to capture the potential REDD+ emission reductions that can be achieved with the methodology: - For NRB: when the methodology allows only NRB as the baseline scenario (4 points) - For NRB: when the methodology allows other measures next to NRB in the baseline (3 points) - Dedicated plantations: when the methodology allows only dedicated plantations (2 points) - Dedicated plantations: when the methodology allows other sources than dedicated plantations (1 point)	¼

The focus of the ranking has been on project types that deliver positive REDD+ synergies by reducing demand for NRB or ensuring sustainable biomass supply. Methodologies have been excluded that aim to minimise or account for a negative impact on forest carbon, for example as a result of construction activities.

The four ranking criteria are listed in Table 13: Ranking criteria. The methodologies assessed under this ranking scheme include all those analysed in chapter 4.1 and 4.2. While criteria 1 and 3 are based on data from the CDM UNEP/Risoe Pipeline, criterion 2 is a subjective quantitative conversion of the analysis conducted in chapter 4. Criterion 4 is also a subjective assessment based on the ranking specifics outlined in table 13.

Each methodology was assessed based on this ranking metrics and given a score from 1-4 for each criterion. The analysis resulted in the ranking outlined in table 14.

Table 14: Methodology ranking (scores 0-4).

Rank	Methodology	Criterion 1 Score	Criterion 2 Score	Criterion 3 Score	Criterion 4 Score	Total Score
1	GS methodology Technologies and Practices to Displace Decentralized Thermal Energy Consumption	2*	2.5	2	4	2.63
2	CDM AMS-I.E.	2*	2	1	4	2.25
3	CDM AMS-I.D.	3*	0.33	4	1	2.08
4***	CDM AMS-II.G.	2*	2	0	4	2.00
	ACR Methodology Energy Efficiency Measures in Thermal Applications of Non-Renewable Biomass	2*	2	0**	4	2.00
	ACR Methodology Switch from non-renewable biomass for thermal applications	2*	2	0**	4	2.00
7	CDM AMS-III.BG.	2*	1.5	0**	4	1.88
8	CDM AMS-I.C.	3	0.33	3	1	1.83
9	CDM AMS-II.R.	2*	1.75	0**	3	1.69
10	CDM ACM0003	2	1.67	2	1	1.67

* These scores are based on averages throughout all methodologies included in the ranking, as data was not available.

** The zeros are due to missing data on issuance success (no registered project in the pipeline/registry).

*** Three methodologies rank 4th. They all had the same score.

For the VCM methodologies exemplary projects where available had to be used to identify a proxy for the issuance success, as the VCM markit registries do not provide these information on an aggregate level.[38]

The top 10 mainly consists of methodologies that aim at projects which reduce the demand for NRB from both CDM and VCM. The methodologies ranked 4th, 8th and 10th are methodologies covering the implementation of a dedicated plantation. The decision to assign low values (1or 2) to plantation methodologies compared to the high values (3 or 4) for NRB methodologies in criterion 4 has a significant impact on the overall ranking, as the methodologies that here scored the highest also ended up in the same order in the top 10 (6 out of the top 7 received the highest score for criterion 4). This is also a result of the way the scoring has been designed. The ranking shows no tendency towards a specific project type with cook stoves, fuel switches and energy efficiency project methodologies all featuring in the top 10.

The financial and technical feasibility indicators are calculated from registered CDM/JI biomass projects that used the respective methodologies. Consequently, it cannot directly be inferred that, for instance, an NRB project that applies CDM AMS-I.E. will end up with a low issuance rate as suggested by the ranking metrics. Criterion 2 is arguably the most detailed indicator, as it qualitatively assesses how closely the methodology considers REDD+ relevant components such as leakage. In this light, CDM AM0082, which did not make the top 10 (as a plantation methodology), deserves separate mentioning, as it scored high in this highly relevant second category.

Overall, the ranking is undoubtedly skewed towards NRB methodologies and favours methodologies that accurately describe details that are considered relevant to the REDD+ outcome. While certainly hinting at important differences in the potential delivery of REDD+ synergies, the ranking should not be taken as an ultimate decision-tool, but rather as a guidance that illustrates how well the methodologies regarding the individual parameters. Methodologies that did not make it in the top 10 should by no means be discarded, but instead seen as methodologies of secondary relevance from a REDD+ outcome perspective.

[38] For more details see the ‘ranking’ sheet in the excel file Ranking of Carbon Project Methodologies v1.0 3Dec13.

6 Selected Methodologies

Chapter 5 ranked the methodologies identified in sections 4.1 and 4.2 according to their financial and technical feasibility and the robustness and scale of their potential REDD+ outcomes.

Four of the top 5 methodologies have the potential to achieve avoided deforestation as their REDD+ synergy by reducing the demand for NRB. Unlike those methodologies that also allow other measures in the baseline, they all require a baseline scenario that involves the verifiable historical use of NRB at the project site (criterion 4). Except for CDM AMS-I.D. (the only plantation methodology), all score well in our analysis of how detailed they address REDD+ relevant issues such as leakage and fNRB and DRB calculation. This chapter provides specific details of the top 5 methodologies. The details for the example project are from their project design documents and the information available from the CDM pipeline.

Projects with a more direct, large REDD+ impact relative to the overall project size and verifiable REDD+ outcome are typically in category 1a (table 5). In the other categories the core activity is typically a new power plant, grid connection, transport infrastructure or hydropower station. These core activities in are responsible for the majority of the emission reductions. Also the potential synergy with REDD+ is often avoiding a negative synergy rather than optimising a positive one.

6.1 GS Methodology: “Technologies and practices to displace decentralized thermal energy consumption”

The methodology that ranks first is a broadly defined small-scale methodology that can be used for a variety of projects that reduce or displace emissions from thermal energy consumption. It requires a baseline scenario that must involve the unsustainable use of NRB (criterion 4). It also achieved the highest score for criterion 4, which is largely influenced by its highly detailed description of the required fNRB assessment. The ACR registry lists three projects that applied this methodology. The two with registered issuance success were used as a proxy for this variable. Details of the three projects are shown in Table 15.

Table 15: Example projects using the GS thermal energy consumption methodology.

Project	Project Type	Average reduction ($tCO_2e/year$)	REDD+ mitigation potential[39]	Investment value (USD)	Issuance success	Average reduction per stove (tCO_2e/yr)
Energy Efficient Cook Stoves for Siaya Communities, Kenya	Cook stove	7,100	4	140,000 *	0.62	1.51
Stoves for Life: Energy Efficient Cook Stoves Project in Kakamega, Kenya	Cook stove	61,546	4	200,000*	0.58	2.15[40]
GS1205 Sustainable Energy for Development Programme of Activity Master Project	Cook stove	6,508[41]	4	328,000*	Not issued	1.95

* lower bound estimates (only include total cost of stove purchase).

6.2 CDM AMS-I.E: Switch from non-renewable biomass for thermal applications by the user

CDM AMS-I.E. is the reference for a number of other NRB methodologies and applies to projects which conduct a fuel switch from NRB to renewable resources in small-scale devices such as cook stoves. It is also applicable to energy efficiency projects that reduce the demand for NRB.

The methodology addresses the important risk of leakage to non-project households taking over the freed-up NRB, while many of the other methodologies only take into account leakage that is irrelevant to the REDD+ outcome. It also has fairly strict requirements on DRB and NRB indicators, although the fNRB can be determined through either government data or surveys. Table 16 shows details of two exemplary cook stove projects that applied CDM AMS-I.E.

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[39] As defined in the ranking metrics for criterion 4 of chapter 5.

[40] Based on average annual emission reductions / average number of stoves installed

[41] estimated average from PDD.

Table 16: Example projects using CDM AMS-I.E.

Project	Project Type	Average reduction (tCO_2e/ yr)	REDD+ mitigation potential	Investment value (USD)	Issuance success	Average reduction per stove (tCO_2e/yr)
Lusaka sustainable energy project1	Energy Efficiency / Cook Stoves	130,032	4	n/a	34%	4.33
Cleanstar Mozambique - Maputo Ethanol	Energy Efficiency / Cook Stoves	192,482	4	n/a	No issuance registered	6.42

6.3 CDM AMS-I.D: Grid connected renewable electricity generation

CDM AMS-I.D. is the only plantation methodology in the top 5. The methodology outlines the procedures for CDM projects that establish or expand existing renewable energy power plants with the use of a dedicated plantation as one of many options for fuel sources. It benefits from its good scores in financial and technical feasibility, which are based on averages of 165 registered projects that apply CDM AMS.I.D, indicating the wide acceptance of the methodology for biomass projects. In its more REDD+ relevant specifics (criteria 2 and 4) it achieves fairly low scores and often refers to the requirements outlined in CDM AM0042 (ranked 17^{th}), which is a more specific methodology for new biomass-fired power plants. Table 17 lists two projects that apply this methodology.

Table 17: Example projects using CDM AMS-I.D.

Project Name	Project Type	Average reduction (tCO_2e/yr)	REDD+ mitigation potential	Investment value (USD)	Issuance success	Average reduction per stove (tCO_2e/yr)
Biomass in Rajasthan - Electricity generation from mustard crop residues	Biomass energy	32,563	0	7.8 million	107%	n/a
JCT Hoshiarpur Small Scale Biomass Project	Biomass energy	31,270	0	4.8 million	100%	n/a

6.4 CDM AMS-II.G: Energy efficiency measures in thermal applications of non-renewable biomass

This methodology shares the fourth spot with the ACR energy efficiency methodology discussed below and with the ACR Methodology "Switch from non-renewable biomass for thermal applications", which is not discussed separately, as it in its essence a modified version of CDM AMS-I.E.. The CDM pipeline comprises 31 projects that used CDM AMS-II.G. to develop an energy efficiency project for domestic cook stoves, but the single project with registered issuance had only a 10% success rate and the pipeline did not provide financial information. REDD+ synergies are high, since the baseline must involve the use of NRB (criterion 4) and the methodology also outlines very specific requirements for the calculation of leakage. Table 16 shows some specifics of the one project with successful issuance.

Table 18: Example projects using CDM AMS-II.G.

Project	Project Type	Average reductions (tCO_2e/yr)	REDD+ mitigation potential	Investment value (USD)	Issuance success	Average reduction per stove (tCO_2e/yr)
Efficient Fuel Wood Stoves for Nigeria	Energy Efficiency / Cook Stoves	26,189 (PDD)	4	2.125 million[42]	10%	2.72

6.5 ACR Methodology: "Energy efficiency measures in thermal applications of non-renewable biomass"

The ACR methodology is a slightly modified version of CDM AMS-II.G for energy efficiency measures in thermal applications of NRB and has not been applied often. The ACR registry lists only one project, without any issuance. As a result, the financial parameters are averaged out by using the average of the 26 methodologies in the ranking. However, since the methodology only allows the replacement of NRB in the baseline scenario, it achieves the top score for criterion 4. It also outlines highly specific details for the calculation of above- and below-ground biomass.

The "DelAgua Public Health Program in Eastern Africa" is the only programme in the ACR registry that uses this methodology. The PDD was created in spring 2013 and therefore the project documentation provides only very limited information. Prospective emission reductions per cook stove are estimated at 1.2 tonnes per year. The PDD assumes a maximum of 35,000 stoves to be distributed, which entails a potential over emission reduction of 44,525 tonnes. At this early stage of the project, no further insights on REDD+ synergies can be drawn.

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42 Lower bound estimate from PDD (average stove price (USD 170)* maximum number of stoves (12,500)

Annex 1: VCS methodologies

VM0003 – Methodology for Improved Forest Management through Extension of Rotation Age, v1.2 (IFM-ERA)

Scope. Methodology VM0003 is applicable to managed forests where clear cutting or patch-cutting practices are implemented in the baseline. It quantifies the GHG emission reductions and removals generated from improving forest management practices to increase the carbon stock on land by extending the rotation age of a forest or patch of forest before harvesting. By extending the age at which trees are cut, projects increase the average carbon stock on the land and remove more emissions from the atmosphere.

Baseline Scenarios. The selected baseline approach for methodology VM0003 is "Changes in carbon stocks in the pools within the project boundary from the most likely land use at the time the project starts". In the determination of a baseline scenario, the possible land-use scenarios to be evaluated must include: continuation of the pre-project forest management (Historical Baseline); legal requirements for forest management in the region (Legal Baseline); common practice forest management in the region (Common Practice Baseline); and forest management as modelled under the project but in the absence of registration as an IFM project activity.

The *Legal Baseline* is defined by the forest management scenario that maximizes net present value to the forest owner(s) through timber harvesting while reflecting all legal requirements for forest management. The *Common Practice Baseline* must be defined by an independent forest consulting entity and should consider the following elements of forest management: (1) harvest rotations; (2) harvest methods; (3) species harvested and planted; (4) no harvest zones; (5) riparian management areas; (6) areas of steep slope or unstable soils; and/or (7) maximum patch cut areas. In all cases, the three baseline scenarios (Historical, Legal and Common Practice) must be described by the project proponent, then reviewed, and approved as plausible and accurate by an independent forest consulting entity.

The *Historical Baseline* must be selected as the most plausible baseline scenario if the following documents exist: (1) historical records of forest management exist for 20 or more years preceding the project start date; (2) historical records indicate that the management practices have surpassed the legal barriers provided by conforming with all local and regional forest legislation; and (3) historical records that indicate that the historical management surpasses financial barriers by providing above average market returns. If the Historical Baseline is not applicable, the Legal Baseline must be selected as the most plausible scenario if regulations of forest management practices exist and are readily enforced within the project region. The Common Practice Baseline must be selected whenever there is insufficient documentation to utilize the Historical Baseline and where regulations pertaining to specific forest management practices do not exist or are not readily enforced in the project region.

Baseline Emissions. Modelled over 100 years, the following baseline emissions are measured in VM0003: baseline net GHG removals by sinks (all pools, trees, dead wood, wood products); carbon stock changes in the baseline; baseline emissions; estimation of baseline non-CO_2 emissions due to biomass burning.

VM005 – Methodology for Conversion of Low-productive Forest to High-productive Forest, v1.2 (IFM-LtHF)

Scope. Methodology VM0005 is applicable to logged or degraded natural evergreen tropical rainforest. It quantifies the GHG emission reductions and removals generated by avoiding re-logging and/or the rehabilitation of previously logged forest. Rehabilitation is achieved by implementing silvicultural techniques to increase forest density, such as cutting climbers and vines, liberation thinning, or enrichment planting.

Baseline Scenarios. The baseline scenario consists of a logged-over natural Evergreen Tropical Rainforest, normally with no or insignificant regrowth that may or may not be reclogged. The following information must be provided to prove that the project proponent meets the minimum acceptable standard outlined for this baseline scenario:

- Documented history of the operator (operator must have at least 5 years of management records to show logging intensities and normal historical practices). Common records would include data on timber cruise volumes, inventory levels, harvest levels, etc. on the property that indicate the periodicity in logging operations in the area and in management planning; and
- The legal requirements for forest management and land use in the area; however, if these are not enforced then this requirement does not have to be met; and
- Proof that their environmental practices equal or exceed those commonly considered a minimum standard among similar landowners in the area.

Baseline Emissions. The baseline scenario is characterized by emissions from re-logging, which in the with-project scenario are avoided, or an absent or limited regrowth of the residual forest, which in the with-project scenario may be enhanced, or a combination of these two. If re-logging occurs in the baseline scenario, the volume of biomass that would have been removed from the project area over the lifetime of the project can either be determined by: (1) harvesting levels, defined in terms of cubic meters, as determined in advance and reflected for example in management plans for the project area; or (2) post-relogging carbon stocks in a reference area. Regrowth, if any, of the residual stand may be estimated on the basis of existing, peer-reviewed literature, quantifying regrowth in comparable areas, or in a reference area. This methodology accounts for carbon stock in above-ground tree biomass, below-ground biomass, dead wood and carbon stored in wood products. Stocks are estimated through fieldwork, possibly combined with carbon stock determination methods using aerial photography or remote sensing, or the use of peer-reviewed default factors for the project area. Below-ground biomass is not included.

VM0007 – Methodology for Avoided Deforestation, v2.1 (REDD)

Scope. Methodology VM0007 is applicable to forest lands that would be deforested or degraded in the absence of the project activity. This methodology includes a module for activities to reduce emission from forest degradation caused by extraction of wood for fuel. No modules are currently included for activities to reduce emissions from forest degradation caused by illegal harvesting of trees for timber. It quantifies GHG emission reductions and removals from avoiding unplanned and planned deforestation and forest degradation through a set of modules for various components of a methodology for REDD+.

Baseline Scenario. The baseline of a REDD+ project activity is estimated *ex-ante*. It can be monitored in a reference area (unplanned deforestation) or proxy area (planned deforestation) for the purpose of periodically adjusting the baseline. *Ex-ante* baseline estimations are therefore used in both the *ex-ante* and *ex-post* estimation of net carbon stock changes and GHG emission reductions. A description of how the baseline scenario is identified and the description of the identified baseline scenario shall be given in the VSC PD.

Baseline Emissions. Methods for estimating baseline carbon stock changes and greenhouse gas emissions are provided in the following modules: for planned deforestation; for unplanned deforestation; and for forest degradation from extraction of wood for fuel. This methodology estimates total net GHG emissions reductions (net of project minus baseline and leakage).

VM0009 – Methodology for Avoided Deforestation, v2.1 (REDD-AUPD)

Scope. This methodology is applicable to REDD projects throughout the world's tropics and beyond. It can model five different baseline scenarios including planned deforestation and unplanned deforestation in the mosaic and frontier configurations. These models utilize primary and secondary deforestation agents in order to fully describe the intricate nature of deforestation trends within these scenarios.

Baseline Scenarios. The baseline scenario in this methodology hinges on the identification of the agents and drivers and an understanding of how, when and where they might have acted in the project area. If the agents are sequential, they contribute to a *cascade of degradation*. A *participatory rural appraisal* is an optional tool that identifies the agents and drivers of deforestation in the event that they are not obvious. The baseline scenario is characterized by baseline emissions models that predict what would have happened in each project accounting area had the project not been initiated. The fundamental basis for these models is three parameters estimated by observing deforestation in a reference area over a historical reference period.

Baseline Emissions. The baseline emissions models include the Biomass Emissions Model and the Soil Emissions Model. The Biomass Emissions Model predicts cumulative emissions from biomass as a result of degradation and deforestation while the Soil Emissions Model predicts cumulative emissions from soil organic carbon as a result of deforestation. These models are parameterized in terms of days relative to the project start date. They dramatically simplify baseline accounting relative to other approaches, as all that is required is to determine the baseline type and select parameters.

VM0010 – Methodology for Improved Forest Management: Conversion from Logged to Protected Forest, v1.2 (IFM-LtPF)

Scope. This methodology is applicable where the baseline scenario includes planned timber harvest, and under the project scenario, forest use is limited to activities that do not result in commercial timber harvest or forest degradation. It quantifies the GHG removals generated from preventing logging of forests that would have been logged in the absence of carbon finance.

Baseline Scenarios. The selection of a baseline scenario is similar to that of VM0003, however if a Historical Baseline Scenario cannot be used, a Common Practice Baseline Scenario is used (the Legal Baseline Scenario is not applied to this methodology). The planned timber harvest events in the baseline scenario can occur in any year of the project activity, not just year 0.

Baseline Emissions. This methodology measures baseline emissions for emissions from wood product conversion, decomposition of dead wood from harvested trees, emissions from wood product retirement, and stock change due to regrowth following timber harvest. Baseline projections are calculated *ex-ante* and are not adjusted throughout the project lifetime. Baseline net GHG emissions are determined from calculation of dead wood (logging slash) generated in the process of timber harvest, the emissions resulting from production and subsequent retirement of wood products derived from the timber harvesting, minus the rates of forest regrowth post timber harvest.

VM0011 – Methodology for Calculating GHG Benefits from Preventing Planned Degradation, v1.0 (IFM-LtPF)

Scope. This methodology is applicable to previously logged or intact tropical forests where selective logging would have occurred in the absence of carbon finance. It quantifies the GHG emission reductions generated from improving forest management and preventing the planned degradation of a forest by stopping selective logging. This methodology accounts for a reduction in GHG emissions by stopping logging as well as an increase in carbon stock growth.

Baseline Scenarios. Baseline scenarios are established based on relevant national and or sectoral policies and circumstances such as historical land use and practices, and economic trends and must at least include: (1) continuation of pre-project land use; and (2) the protection of the land within the project area without being registered under the VCS as an IFM-LfPF project activity. To identify credible baseline scenarios, data is applied from land use records, field surveys, and data and feedback from stakeholders. In order to follow the selective logging baseline scenario, selective logging must be present in all data applied.

Baseline Emissions. Annual GHG emissions resulting are due to degradation of the project area as well as annual emissions due to the selective logging operations. Determination of GHG emission reductions relies on comparing a baseline scenario of selective logging to a "with GHG project" scenario that assumes all the selective logging will cease. Emission from degradation due to the baseline selective logging operations are determined by conduction a carbon mass balance over the entire project area.

VM0012 – Improved Forest Management in Temperate and Boreal Forests (LtPF), v1.2 (IFM-LtPF)

Scope. This methodology is applicable to publicly and privately owned temperate and boreal forests. It quantifies the GHG emission reductions generated by improving forest management and preventing logging in temperate and boreal forests. Specifically, it quantifies GHG emission reductions from Logged to Protected Forest (LtPF) activities, or activities that protect logged or degraded forests and further logging or that protect unlogged forests from future logging.

Baseline Scenarios. Selection of the baseline scenario is similar to that in methodology VM0010, in that the two choices for baseline scenarios are Historical and Common Practice.

Baseline Emissions. Baseline emissions are calculated from the baseline scenario, which does not change throughout the project duration. All calculations in this methodology represent annualized net changes in carbon stocks by polygon. Results from each polygon must therefore be summed across the project activity area to determine the annual total net emissions and reductions. Emissions calculated in this methodology include those from: live biomass gain, live biomass loss, dead organic matter dynamics, and harvested wood products.

VM0015 – Methodology for Avoided Unplanned Deforestation, v1.1 (REDD-AUD)

Scope. This methodology estimates greenhouse gas emissions from areas where unplanned deforestation is taking place and quantifies the emission reductions achieved by curbing deforestation. The methodology provides a comprehensive set of tools for analyzing both frontier and mosaic deforestation patterns to establish the baseline deforestation rate, monitor emission reductions and assess leakage.

Baseline Scenarios. Three baseline approaches are available for this methodology: (1) historical average approach; (2) time function approach; and (3) modelling approach. The historical average approach assumes the rate of the baseline to be a continuation of the average annual rate measured during the historical reference period within the reference region or, where appropriate, within different strata of the reference region. The time function approach estimates the rate of baseline deforestation by extrapolating the historical trend observed within the reference region as a function of time using either linear regression, logistic regression or any other statistically sound regression technique (requires multiple deforestation measurements during the past 10-15 years). The modelling approach estimates the rate of baseline deforestation using a model expressing deforestation as a function of driver variable selected by the project proponents.

Baseline Emissions. Baseline emissions are measured by calculating baseline carbon stock changes and (optionally) baseline non-CO_2 emissions from forest fires used to clear forests. This methodology considers the decay of carbon stock in soil carbon, below-ground biomass, dead wood and harvested wood products in the baseline case. It also measures above-ground biomass, litter, and soil organic carbon.

VM0017 – Adoption of Sustainable Agricultural Land Management, v1.0 (ALM)

Scope. This methodology is applicable to projects that introduce sustainable management practices to an agricultural landscape where the soil organic carbon would have remained constant or decreased in time without the intervention of the project. It quantifies the GHG emission reductions of sustainable land management practice activities that enhance aboveground, belowground and soil-based carbon stocks of agricultural areas. The methodology applies input parameters to analytic, peer-reviewed models to estimate the organic soil carbon density at equilibrium in each of the identified management practices in each land use category.

Baseline Scenarios. The baseline scenario is identified as existing or historical land management practices. The project proponent shall use the most recent version of the "Combined too to identify the baseline scenario and demonstrate the additionality in A/R CDM project activities, mutatis mutandis."

Baseline Emissions. The baseline emissions from synthetic fertilizer use are calculated using the latest version of the CDM A/R Tool "Estimation of direct nitrous oxide emission from nitrogen fertilization." Baseline emissions measured include those due to: the use of N-fixing species; the burning of biomass; the use of fossil fuels in agricultural management; changes in soil organic carbon; and total baseline emissions and removals. Baseline removals are measured from existing woody perennials.

VM0021 Soil Carbon Quantification Methodology, v1.0 (ALM)

Scope. This methodology is applicable to all ALM projects, including changes to agricultural practices, grassland and rangeland restorations, soil carbon protection and accrual benefits from reductions in erosion, grassland protection projects and treatments designed to improve diversity and productivity of grassland and savannah plant communities. It quantifies and monitors changes in carbon accrual in, and emissions from, soils as well as from other GHG pools and sources that may be affected by AFOLU projects through associated modules.

Baseline Scenarios. Baseline scenarios are determined using the latest version of the "CDM Combined Tool to identify the baseline scenario and demonstrated additionality for A/R CDM project activities." The tool is used for this methodology in the ALM context. Where the tool refers to forestation it is to be understood as referring to agricultural land management activities, and where the tool refers to forest it is to be understood as referring to agricultural land. CDM is to be substituted by VCS, and tCERs or ICERs are to be substituted by VCUs.

Baseline Emissions. Ex-ante estimation and projection of carbon pools and emissions are measured under the baseline scenario, and take into account the current and projection of future levels of: carbon content of soil carbon per unit area; carbon content of aboveground woody and non-woody biomass and below ground living biomass pools; wood harvest from within the project area used for production of long lived wood products; wood harvest outputs; dead wood pools within the project area; average domesticated animal populations within the project area; GHGs from domesticated animals within the project area; soil emissions of N_2O or CH_4 from within the project area; use of power equipment; litter pools; and a summation of all estimates and projections under the baseline scenario.

VM0022 – Quantifying N20 Emissions Reductions in Agricultural Crops through Nitrogen Fertilizer Rate Reduction, v1.1 (ALM)

Scope. This methodology is applicable to projects in the United States that optimize nitrogen fertilizer through the use of verifiable best management practices, specific to the crop, soil and environmental conditions of the project. It quantifies reductions of nitrous oxide from cropping system, and utilizes an IPCC default emission factor or an empirically derived, regional emission factor to calculate nitrous oxide emission reductions directly associated with reducing the applicable rate of inorganic and organic fertilizers.

Baseline Scenarios. The baseline scenario is the continuation of the historical cropping practices where, in the absence of the project activity, N fertilizer rate is applied in a business as usual (BAU) manner, resulting in higher emissions of N_2O from the soil when compared to a situation where the project is implemented and the application of lower N fertilizer rate results in lower emissions of N_2O.

Baseline Emissions. Baseline emissions are calculated on a 'per hectare of land' basis, and take into account both direct and indirect emissions of nitrous oxide from nitrogen fertilizer.