BIOENERGY AND THE CLEAN DEVELOPMENT MECHANISM

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ABSTRACT: This paper describes the eligibility of different types of biomass energy projects in developing countries, as a means for offsetting emissions through the Kyoto Protocol's Clean Development Mechanism. Specifically, the replacement of non-renewable types of biomass with renewable energy, or the improvement of the efficiency of energy systems based on non-renewable biomass, will be difficult if not impossible as CDM projects under current rules. These problems are caused by the categorical exclusion of land-use from the CDM (with the exception of afforestation and reforestation projects). The paper offers some possible solutions for both small-scale and "regular" CDM projects.

Keywords: CDM, non-renewable biomass, fuelwood, small-scale projects, developing countries

1. INTRODUCTION

The Clean Development Mechanism (CDM) is one of the "flexible mechanisms" under the Kyoto Protocol. It provides for industrialized countries to invest in emission-reducing projects in developing countries and to use (part of) the resulting "certified emissions reductions" towards their own compliance with the emission limitation targets set forth by the Kyoto Protocol. The CDM has two main objectives (ref. Article 12.2):

(1) to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and
(2) To assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments.

2. THE CURRENT CDM RULES

Examples of CDM projects proposed to date include two basic types of projects: renewable energy projects such as wind energy, biomass energy, promoting a switch from carbon-intensive to less carbon intensive fuels, and projects to enhance the efficiency of energy systems. For each of these projects and in order to calculate the amount of carbon emission reductions, it is necessary to compare emissions with those in a *baseline scenario*, which represents the situation that would have occurred in absence of the project activity. For example, the baseline scenario for a wind energy project could be a natural gas fired power plant. The certified emission reductions (CERs) would then be calculated as the difference in emissions between the baseline (gas-fired power plant) and the project (wind-based electricity).

The Marrakech Accords (MA)[1], which provide detailed rules for implementation of the Kyoto Protocol, define the term *baseline* as "the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases that would occur in the absence of the proposed [CDM] project activity". The MA go on to state that "a baseline shall cover emissions from all gases, sectors and source categories listed in Annex A within the project boundary".

[1] The Marrakesh Accords were negotiated and decided on the 7th conference of the parties in Marrakesh, Morocco.

Annex A of the Kyoto Protocol lists the following sectors and source categories of greenhouse-gas (GHG) emissions: Energy, Waste, Industrial Processes, and Agriculture. These are the sectors / source categories for which countries must estimate their national GHG inventories, as set forth in Guidelines elaborated by the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 1996). One particular sector in the IPCC Guidelines is not listed in Annex A of the Kyoto Protocol: *Land-use change and Forestry (LUCF).* The reason for this omission was that this category had been particularly controversial in the negotiations leading up to the Kyoto Protocol. Even after the adoption of the Kyoto Protocol it took almost four years to come to a final agreement among Parties. The outcome of these negotiations is that some LUCF activities are included in the Kyoto Protocol, notably afforestation, reforestation, deforestation, and that some other activities, notably the management of croplands, grazing lands and forests can also be used by countries towards compliance with their emission-limitation targets.

The inclusion of LULUCF activities in the CDM has been just as controversial, with the outcome that only afforestation and reforestation activities are eligible, and detailed rules have been elaborated by COP9 in Milan/Italy in December 2003 (BCF 2004). Other land-use activities, such as improved management of agricultural soils, improved forest management, or the reduction in the rate of deforestation, were excluded from the CDM.

3. CHALLENGES RELATED TO BIOENERGY PROJECTS

With these decisions and rulings, CERs can only be obtained under the CDM for

(1) projects for which baseline emissions are included in Annex A of the Kyoto Protocol (Figure 3-1), or
(2) Projects that constitute afforestation or reforestation activities.

This has important implications for activities that improve the efficiency of biomass energy systems in developing countries, as they will usually reduce emissions from land use, which is not included in Annex A of the Kyoto Protocol (Figure 3-2).

Mostly due to lack of financial capital for investment in modern, more efficient equipment, biofuels are used in a very unsustainable, often simply very inefficient way (for example in cooking or heating

applications). Increasing the efficiency of biomass use would not only have positive effects on greenhouse-gas emissions, but would also contribute to the sustainable development of project areas and the host countries in general, for example by reducing the unsustainable exploitation of natural resources, decreasing the amount of unproductive time spent on gathering e.g. fuelwood and by reducing local and indoor air pollution.

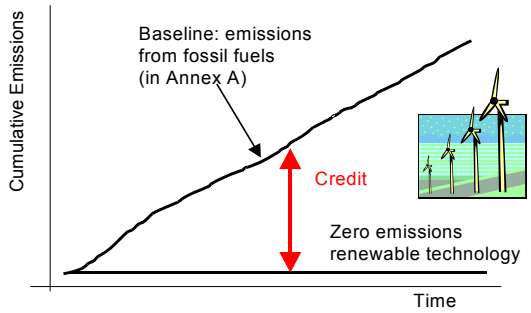

Figure 3-1: Project and baseline scenarios in conventional CDM projects.

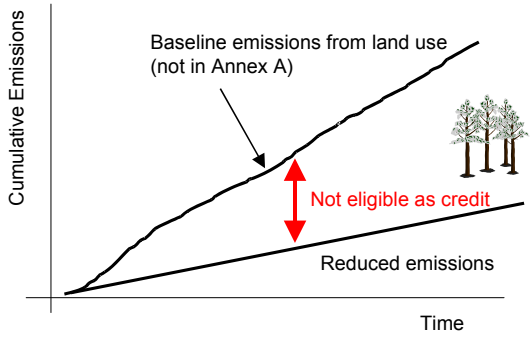

Figure 3-2: Project and baseline scenarios in bio-energy projects that increase efficiency of bioenergy use and thereby reduce loss of terrestrial carbon stocks

While energy-related projects have the greatest potential for GHG emission reduction and sustainable development, and thus for reaching the goals of the UNFCCC, biomass energy projects are only eligible for crediting in the CDM if the project baseline includes "Annex A" emissions that are in most cases, emissions from the use of fossil fuels, or non-CO2 greenhouse gases. For example, bioenergy projects that reduce or eliminate emissions from combustion of coal, oil, or natural gas, are eligible. Similarly, CH_4 recovery through enhanced animal waste management, and use for bioenergy, would be eligible, because CH4 emissions from animal waste management are included in the project baseline, and are also under the Agriculture sector in Annex A. The same goes for project activities using agricultural residues that would otherwise be burnt in the field (the latter constituting the baseline in this case)[2].

For most developing countries and in particular for the poorest of the poor, these baselines do not represent the current situation. Fossil fuels are largely not accessible, as they are far too expensive or infrastructures for their supply and diffusion are not in place, and the only fuels available (being both, accessible and affordable) in most cases are biomass fuels.

[2] In fact, the first approved CDM baseline and monitoring methodology for a bioenergy project activity (AM0004) uses this baseline of field burning of agricultural residues, see http://cdm.unfccc.int

Consequently, funding for energy project activities under the CDM would not be available for the neediest in most developing countries. The following chapter gives an overview about current use of bioenergy and thus the importance of an inclusion of these project types in the CDM.

4. IMPROVING TRADITIONAL BIOMASS USES FOR MITIGATION OF GHG EMISSIONS AND SUSTAINABLE DEVELOPMENT

4.1. Current use of traditional biomass

Bioenergy provides about 11 % of total global primary energy supply, and approximately 35% in developing countries. The share of biomass in primary energy consumption in Africa is more than 70% (Kaltschmitt 2001). Some Sub-Saharan countries, and Ethiopia and Haiti, obtain more than 90% of their energy needs from biomass (FAO 2004) and this situation is not expected to change in the near future. In terms of global wood consumption fuelwood represents more than 50% (FAO 2003).

One of the major problems of current patterns of biomass use for energy is the low conversion efficiency. In households, most biomass is burnt in so-called three stone stoves with an average conversion rate of 10% (Kaltschmitt 2001).

In urban areas or larger settlements, larger biomass-powered plants are common, but due to maintenance problems, low technical standards and lack of knowledge about operating them, conversion efficiencies are of the same order of magnitude of roughly 10-15%..

Industrial biomass plants are estimated to operate within the same efficiency range. In industrialised countries, average conversion rates of 70-75% are common (ibid.).

4.2. GHG emission reductions through enhanced bioenergy efficiency

The easiest and most feasible option to increase the sustainability of bioenergy use is an increase in its efficiency. Different categories of emission reduction can be distinguished.

1. CO2 emission reductions related to energy inputs into the fuel cycle, mostly during the production and conversion stages. These are eligible to the extent that the baseline is combustion of fossil fuels.
2. Non-CO2 emission reductions related to end use efficiency (and possibly, conversion). Increasing the efficiency of (e.g.) fuel stoves can result in significant reductions of other pollutants, including non-CO2 greenhouse gases (CH4; eligible as baseline emission) and other ambient air pollutants, particularly the emissions of unburned components such as VOC (Volatile Organic Carbons), PAH (Poly Aromatic Hydrocarbons) and carbon monoxide, and NOx .The main reasons for these unburned components are the "relatively low combustion temperatures and the insufficient mixing, of air and the combustible gases" (FAIR, final report 1998). Oxidation catalysts seem to present the most feasible alternative for the types of small-scale application used in developing countries.
3. Land-use related emission reductions and additional benefits. Land-use related emissions make up the bulk of GHG emissions from current, "traditional" biomass energy systems. Bioenergy activities (such as efficiency improvements) that reduce these land-use related emissions are currently not eligible as the associated baseline emissions are not eligible.

Studies in Asia for example have shown that CO2 emissions could be significantly reduced if more efficient cooking stoves would be introduced, or biofuels (e.g. rice husks) would be used more efficiently, in power and electricity production. Kaltschmitt (2002) identifies large potentials for efficiency improvements in current bioenergy applications, on both industrial and household scales (see also Figure 4-1). At the same time, less need for fuel wood bears obvious potential for improving the livelihood of people.

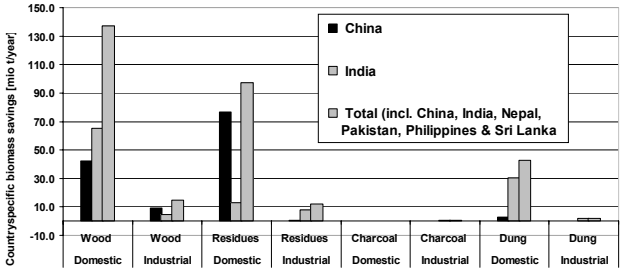

Figure 4-1: Biomass savings due to increased energy efficiency of domestic fuel stoves and industrial bakery ovens, boilers, furnaces and kilns

4.3. GHG emission reductions through switching to a sustainable (renewable) source of biomass fuel

A key aspect here is the differentiation between sustainable and unsustainable or renewable and non-renewable biomass. A non-renewable source of biomass would be one where the carbon stocks are declining over time, relative to a reference case without the biomass use.

An example of how GHG emissions from unsustainable land use can be reduced is a CDM project that includes the establishment of a sustainable source of fuel (such as through the establishment of a community-based fuelwood plantation). This has two benefits: 1) it enhances the carbon stocks in the plantation. This is eligible as a CDM afforestation/reforestation project, if there is a land-use change from non-forest to forest land. 2) it reduces the emissions from unsustainable land use, which is not eligible under current CDM rules.

5. PROPOSALS FOR BETTER INCLUSION OF BIOENERGY IN THE CDM

The desire to exclude all land-use activities except afforestation and reforestation from the CDM has led to a substantial limitation for bioenergy projects under the CDM, because the project types described on 4.2 and 4.3 above are not eligible, to the extent they reduce emissions from unsustainable land use. This unintended consequence is undesirable, as bioenergy has a legitimate and valuable role to play in mitigating climate change, so options should be found to resolve this problem. Different entry points can be identified.

5.1. Amendment of the existing Simplified Small Scale Methodologies and Procedures proposed to the CDM Methodology Panel

There are simplified baseline and monitoring methodologies for CDM projects that are small in size (below 15 MW for renewable energy, below 15 GWh of savings for energy efficiency projects).

These "small scale" methodologies have been published on the CDM website (cdm.unfccc.int) and undergo continuous revision. Currently, the small-scale methodologies distinguish three different types of project activities. We list only those subcategories that are relevant to this paper.

1. Type I: renewable energy project activities with a maximum output capacity equivalent to up to 15 MW.

I.C: Thermal energy for the user

This category comprises renewable energy technologies that supply individual households or users with thermal energy that displaces fossil fuel or non-renewable sources of biomass. Examples include solar thermal water heaters and dryers, solar cookers, energy derived from renewable biomass for water heating, cooking, space heating, or drying,

Here the methodology already provides for emission reductions from the land use sector, through the following language: "For renewable energy technologies that displace non-renewable sources of biomass, the simplified baseline is the non-renewable sources of biomass consumption of the technologies times an emission coefficient for the non-renewable sources of biomass displaced. IPCC default values for emission coefficients may be used."

With this, the project type explained in section 4.3 is eligible in small-scale projects that produce thermal energy, but not in "large" projects.

I.D. Renewable electricity generation for a grid

This project type currently does not adequately account for the possible replacement of non-renewable biomass, and modifications to the methodology have been proposed by the authors.

2. Type II: energy efficiency improvement project activities which reduce energy consumption, on the supply or demand side, by up to the equivalent of 15 GWh per year

II.C. Demand-side energy efficiency programmes for specific technologies

This category comprises programs that encourage the adoption of energy-efficient equipment, lamps, ballasts, refrigerators, motors, fans, air conditioners, appliances, **boilers, stoves** etc. at many sites. (bold text proposed by the authors to be inserted). Here, again, non-renewable biomass is not eligible in the baseline, and the authors have proposed small amendments to correct that. The same holds for the following categories:

II.D. Energy efficiency and fuel switching measures for industrial facilities

II.E. Energy efficiency and fuel switching measures for buildings

3. Type III: other project activities, including methane capture and agriculture (no changes proposed).

In summary, we have suggested three types of changes in the above project categories to the CDM Executive board:

- Slight alteration of the definitions of baselines in order to include non-renewable biomass energy
- Consistent differentiation between renewable and non-renewable biomass, in order to separate the respective baseline case from the project activity case.
- Explicit inclusion of typical bioenergy technologies and appliances in the definition of the technologies and measures of the different relevant types of project activities.

5.2. Inclusion of non-renewable biomass in the baseline of "non small-scale" CDM projects

All the activities described in 5.1 are small-scale, so that the scope of these proposed changes is limited. If, for

example, a national or regional agency in an Africa were to implement a programme to improve cooking stoves that use non-renewable biomass, then this may exceed the limit for small-scale projects. Programs to improve efficiencies of wood stoves, for example, would need have energy savings below 15 GWh per year. With an energy content of approx 4 MWh per ton of fuelwood, this corresponds to 4000 tons of fuelwood per year. An urban household in Mali for example uses 8 kg of fuelwood a day (rural about 5kg) of which about 30% have shown to be saved through efficiency enhancing measures (FOFANA/CNESOLER 2004) so that the programme would be limited to approx. 4500 urban or 7300 rural households

It appears that the only way to allow the replacement of non-renewable biomass into large projects would be through amendment of the Marrakesh Accords (unlikely to happen in the near future) or through a "liberal" interpretation by the CDM Methods Panel in approving new methodologies.

5.3. Introduction of new rules for combining carbon sequestration with bioenergy projects

Another approach to incorporate the land-use related benefits of bioenergy efficiency projects would be through the introduction of new rules that would allow limited crediting of carbon sequestration in land-use projects (other than afforestation / reforestation), provided that a certain amount of useful energy is produced for each ton of carbon credited (Schlamadinger et al, 2002). This would provide incentives for increased efficiency in biomass energy use, would continue to limit the use of land-use projects for carbon crediting, as intended, and would help address deforestation (a globally significant source of CO2 emissions) and land degradation.

5.4. Extending the scope of land-use activities that are eligible in the CDM

Currently only afforestation and reforestation projects are eligible in the CDM. This list could be expanded, at least for a possible Kyoto Protocol second commitment period, by other activities, such as the avoidance of deforestation and degradation of forests or the devegetation of other lands. However, such changes would only be effective for the time beyond 2012. In this respect it is instructive to look at the The BioCarbon Fund's approach to carbon sequestration in land-use systems.

The Biocarbon Fund explicitly requires that projects include rural development objectives as well as climate change mitigation Besides Kyoto eligible projects (window 1) the BCF aims at prototyping sequestration in replicable asset classes of high social and environmental value (window 2). The following classes (can) include a bioenergy component:

- Afforestation and Reforestation, e.g., fuel wood plantings at a commercial scale
- Forest Management , e.g., alternatives to fuel wood for forest/environmental protection
- Cropland Management
- Biomass fuels

For the BCF 2nd window the use of crop residues to produce energy combined with a carbon sequestration asset is considered an eligible project activity

6. CONCLUSIONS AND OUTLOOK

The purpose of this paper was to raise awareness of the minor but in their result severe gaps in the existing methodologies and the eligible baselines as defined in the Marrakesh Accords and Kyoto Protocol. The relevance of non-renewable biomass use as representing best the status-quo for developing countries has been demonstrated and examples of estimates from different studies have been presented in this context.

To start the discussion on how to fill the identified gap or deficiency, concrete amendments of methodologies for small-scale projects have been suggested.

To move the discussion on biomass baselines forward, a clear definition of non-renewable and renewable biomass is needed. Moreover, it is crucial to establish a clear monitoring procedure that at the same time does not entail excessive costs. The following points summarize the main conclusions of this study:

- CDM rules are inconsistent and unclear about the eligibility of *Efficiency improvements of bioenergy systems and fuel switching from non-renewable biomass to renewable energy carriers,* hampering the biggest share of potential projects in developing countries, particularly in Africa.
- The potential benefits from improvements of traditional biomass energy systems are significant, also compared to other types of project activities.
- For small-scale projects, such improvements can be made eligible as CDM projects through minor amendments of existing methodologies.
- The general scope of the CDM in terms of project eligibility should be revisited, keeping in mind the importance of biomass-based energy systems in many parts of the developing world.

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