EMISSIONS FROM BIOENERGY: IMPROVED ACCOUNTING OPTIONS AND NEW POLICY NEEDS

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ABSTRACT: A recent paper by Searchinger [1] highlighted that Annex-I nations do not count CO2 emissions due to combustion of biomass in their commitments. This is because it is assumed that emissions from use of biomass are accounted for in the land use sector, where they should appear as reductions in carbon stocks. However, if the biomass comes from a non-Annex I country, these reductions are not counted within the Kyoto Protocol. Indeed, even Annex I countries do not necessarily fully account for carbon stock losses associated with bioenergy. This results in overestimating the mitigation benefits of bioenergy.
The problem can be rectified by modifying the accounting system, adopting new policy measures or a combination of both. In this paper, we describe possible options and policy measures to improve the accounting of emissions from bioenergy. The pros and cons of the identified solutions are also discussed
Keywords: CO_2 emission, greenhouse gas (GHG), Kyoto Protocol, life cycle assessment (LCA), carbon credits

1 THE GOALS OF POLICY AND GREENHOUSE GAS ACCOUNTING SYSTEMS IN BIOENERGY

Biomass, in the form of fuelwood, is the oldest used and most prevalent source of energy (traditional use). Nevertheless, in recent years there has been large increase in interest in bioenergy because it is seen as a solution to numerous problems facing society. These problems are:

1. Limited fossil fuel supplies (and energy security);
2. Low agricultural and forest commodity prices; and
3. Climate change

Ideally, policies and greenhouse gas accounting systems (P&A) should help combat these problems. They should promote transition to more sustainable, renewable energy systems and thus improve security of energy supply. Policies and accounting systems should provide stimulus to the rural economy (agriculture and forestry), to support regional development and primary production. They should also help mitigate the impacts of climate change and stimulate adaptation to the potential impacts of climate change. Hence P&As should provide incentives for these outcomes and facilitate strategies and technologies that allow actors to respond effectively.

Early work on the accounting of greenhouse gas emissions from bioenergy identified the following five principles for an accounting system: accuracy, simplicity, scale independence, precedence, and incentives [2]. We agree with these principles and we believe that a greenhouse gas accounting system should also have the following characteristics. It should:

- Allocate emissions (and removals) to the party that causes the emissions (and removals);
- Be as comprehensive in time and space as possible;
- Be applicable at all scales from projects to national inventories; and
- "Be as simple as possible, but not simpler"[3]

The greenhouse gas accounting system is just a method for allocating the different flows between the producer and consumer. Policies, on the other hand, are used to provide further incentives (or disincentives) to various types of biomass, production and consumption. If the accounting system also provides incentives to combat the problems listed earlier, then that is even better.

2 BIOENERGY – A LITERAL APPROACH

Simplistically, bioenergy is often referred to as 'carbon neutral', that is, having no CO_2 emissions. Literally, bioenergy has zero CO_2 emissions only if the biomass would have oxidized anyway, had it not been used for energy. This is schematically shown in figure 1.

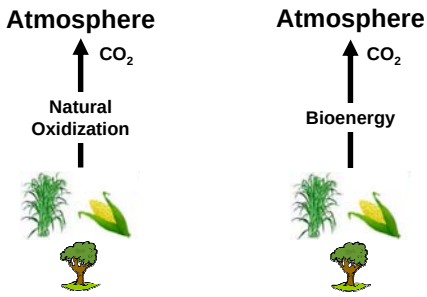

Figure 1: Schematic diagram of when bioenergy is literally has zero CO_2 emissions. Biomass that would naturally have oxidised (left) has zero CO_2 emissions when it is used for bioenergy (right).

However, this analysis ignores the impact of timing of emissions. Timing influences the climate change impact: delaying emissions avoids increasing atmospheric CO_2 in the short term. Use for bioenergy, in contrast, accelerates oxidization. So when the temporal pattern of emissions is taken into consideration, in reality only fast oxidizing biomass such as agricultural waste and some paper products literally have zero CO_2 emission when used for energy. In order to maintain the "carbon neutrality" of biomass, one could match consumption to the natural

oxidization rate. Alternatively, policy measures need to recognise a temporary drawdown of carbon stocks

3 BIOENERGY - A SYSTEMS APPROACH

The above is a simplified view of bioenergy, because it is a system in which one cannot separate the consumption of the bioenergy from the sequestration that occurred when the biomass grew. In some cases, the growth may not have occurred without the consumption or use of the biomass. A more comprehensive schematic diagram of the entire system is shown in figure 2.

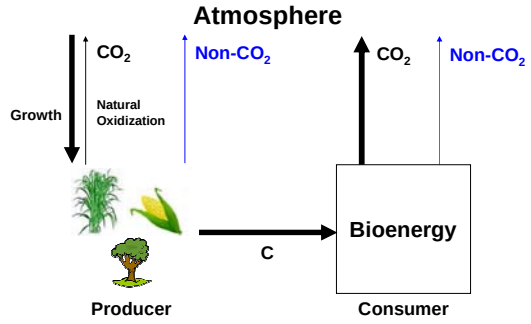

Figure 2: A schematic diagram of the bioenergy system where accounting for the removal of CO_2 from the atmosphere is separated from accounting for the oxidation flux.

4 THE UNFCCC AND KYOTO PROTOCOL SYSTEM - ZERO EMISSIONS IN THE ENERGY SECTOR

4.1 The assumption

The current accounting system that has been adopted by the UNFCCC accounts for CO_2 emissions from bioenergy in the agriculture, forestry and other land use (AFOLU sector)[(1)], and accounts zero CO_2 emissions for bioenergy in the energy sector (figure 3).

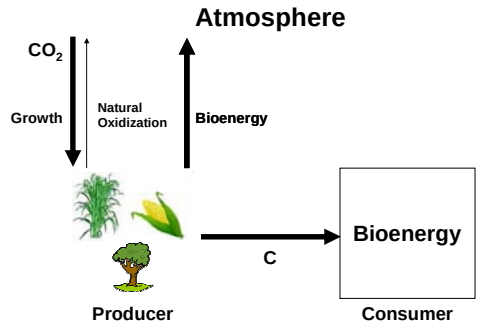

Figure 3: The UNFCCC accounting system

Bioenergy was given zero CO_2 emissions in the energy sector because:

- "the net release of carbon should be evident in the calculation of CO_2 emissions described in the Land Use Change and Forestry chapter" [4];
- "of the sustainable nature of biofuels" [4];
- "the accounting system should be as simple as possible, but not simpler" [2];
- "net emissions or removals of CO_2 are estimated in the AFOLU sector and take account of these emissions" [5];
- "biomass data are generally more uncertain than other data in national energy statistics" [5];
- "a large fraction of the biomass, used for energy, may be part of the informal economy, and the trade is not registered in the national energy statistics and balances" [5]; and
- "it avoids any double counting" [5].

It is quite clear from the IPCC guidelines [4,5] that bioenergy was not considered to have zero CO_2 emissions, but just zero emissions in the energy sector.

This system does adhere to all our principles with the exception of allocating emissions to the party that causes the emissions. Moreover, it provides incentives for sustainable management of the biomass by the producer since any reduction of biomass stocks in this country does appear as an emission. The system also provides an incentive to move to a sustainable, renewable energy system (bioenergy) since bioenergy has no emissions. And if the biomass is managed sustainably by the producer then the sequestration and consumption combined have no CO_2 emissions. This accounting system does not provide incentives or support directly to the rural economy though since the benefit of zero CO_2 emissions for bioenergy is benefit for the consumer that has emission targets. This benefit may be passed to the rural economy through price and demand.

The UNFCCC methodology does not provide any additional incentive to use the biomass efficiently since biomass consumption does not bear any penalty under the current climate policy.

4.2 The problem with the Kyoto Protocol

The Kyoto Protocol has adopted the UNFCCC accounting methodology and assumption, but as was pointed out by Searchinger et al [1] and Pingoud et al [6], there are some "loop-holes" in the Kyoto Protocol. The principle of comprehensiveness over space is violated because:

a) some countries are not participating (specifically non-Annex I); and
b) in countries which are participating, some portions of the AFOLU sector are not included since only afforestation, deforestation and reforestation are mandatory. A reduction in carbon stock in a forest is not accounted.

Since not all emissions from AFOLU are included, the assumptions made that allow for zero CO_2 emissions, from bioenergy in the energy sector, are not valid. As a result, the emission benefits from bioenergy are overestimated.

Nevertheless the problem can be rectified by using a new accounting system or adopting stricter policies or a mixture of both. We will investigate these in the next sections.

5 OTHER ACCOUNTING SYSTEMS

5.1 All lands

Clearly, there is a very obvious solution to the problem – include all countries and all AFOLU activities. With this, the "loop holes" would be closed. However, it may be

some time before this is possible because the post-2012 climate change agreement still needs to be negotiated and historically AFOLU was a sticky point in the negotiation of the Kyoto Protocol.

5.2 Tail pipe

Searchinger et al [1] in their paper suggest to "fix the accounting of bioenergy... [by] tracing the actual flows of carbon and counting emissions from tailpipes and smokestacks whether from fossil energy or bioenergy".

From this passage, we have adopted the term 'tailpipe accounting' for a system in which only the emissions from the consumption of bioenergy are considered (figure 4). This is the identical to taking the literal view of bioenergy has presented in section 2.

Tailpipe accounting is extremely simple, but fails to fulfill two of the principles stated earlier. The removals are not allocated to the producer, which means that this system is not balanced or comprehensive.

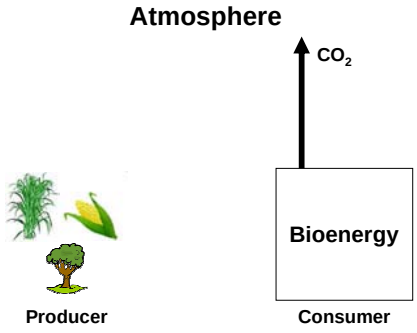

Figure 4: Schematic of tail pipe accounting

In addition, this system does not provide incentives to move to a sustainable energy system and may provide incentives to increase greenhouse gas emissions. For example; the large carbon stock losses that would result if deforestation would occur, are not considered. On the other hand, emissions are immaterial of the source of the biomass. For example, bioenergy coming from low emission biomass sources such as using crop wastes or annual crops (assuming there is no indirect land use change) have the same emissions. As a result, good practices are burdened and bad practices get a preferential treatment. Clearly, this system does nothing for the rural economy either.

5.3 Points-of-uptake and release (POUR)

Points-of-uptake and release accounting is similar to "atmospheric flow accounting" in the harvested wood products (HWP) discussion [5]. We use the term, POUR, so as not to be confused with this discussion. The producer receives negative emissions (removals) and emissions are accounted for by the consumer (figure 5). Contrary to what is often thought, one does not need to measure fluxes to the atmosphere in this accounting system. The removals by the producer can be estimated from the carbon stock change plus the amount of biomass sold to consumers. The emissions by the consumer are equal to the amount of biomass purchased minus the consumer's change in stock.

From the perspective of our principles, POUR accounting works reasonably well. It allocates emissions (and removals) to the party that causes the emissions (and removals) and it is applicable at all scales. However POUR does not solve the problem of limited coverage, and it is less simple than the current UNFCCC approach, because trade is considered.

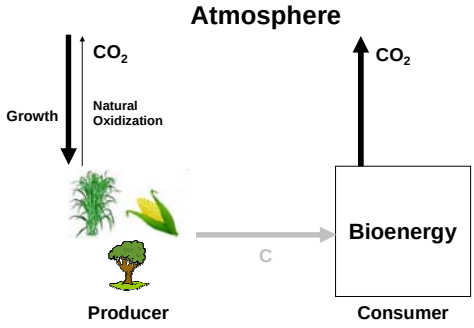

Figure 5: Schematic of points-of-uptake and release (POUR) accounting

The interesting aspects of POUR accounting are the incentives it produces. For the producer, there are clear incentives provided to the rural economy. It receives a direct benefit from the sequestration of biomass. However, there is also an incentive to produce biomass unsustainably since the producer's removals are equal to the stock change PLUS the amount traded to the consumer. Assuming that the producer does manage its biomass sustainably, then there is an additional incentive for the producer to improve the efficiency of converting the harvested biomass to product, since more biomass traded means more removals.

For the consumer, POUR accounting provides an incentive to improve the efficiency of biomass consumption and to delay the release to atmosphere as long as possible (i.e. cascading, recycling, etc). POUR does not provide incentive for the consumer to move to renewable energy sources though.

In POUR accounting, climate change mitigation is stimulated through the reduction in consumption by the consumer, but this will have negative effects on the producer's economy.

It is interesting to speculate whether POUR accounting would interest more developing countries to participate in a post-2012 climate change agreement, since they are mostly producers. Of course, if POUR accounting was accepted, then all targets would need to be negotiated based on a POUR accounting inventory

If POUR accounting is adopted, one may be required to extend the accounting to all carbon-based products, because it may be difficult to separate grain used for bioenergy from grain used for food in trade balances. Using grain as an example, in 2007, Europe produced 270 Mt grain and consumed 263 Mt grain – a net removal of 7 Mt biomass. This is potentially 13 Mt CO_2 or 0.2% of Europe's annual emissions.

5.4 Consumption based

Finally, there is the possibility of consumption-based accounting. In this system, the CO_2 emissions and removals from the entire production and consumption system would be considered the responsibility of the consumer (Figure 6). The emissions in consumption based accounting are calculated using life-cycle assessment.

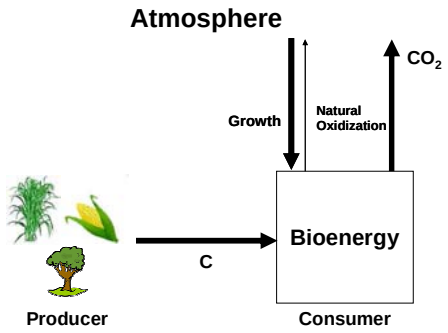

Figure 6: Schematic of consumption-based accounting

Assessed against our principles, consumption-based accounting fails on three counts. It is not comprehensive in time and space since it tends to be a "product-based" approach analysis and not all products may be included. It is not really applicable at all scales, since it is a product-based approach and it is not simple – as is obvious from LCA. There are issues about proper description of the system, its boundaries and allocation of emissions to by-products. However, consumption-based accounting is a "consumer pays" approach so the emissions and removals are allocated to the consumer, whose demand caused the emissions.

However, in principle, the consumption-based accounting could have a country-based component (CBA+). It might be possible to estimate the AFOLU emissions of the non-committed biomass exporting countries without commitments. The net changes in terrestrial C stocks could be allocated to the whole biomass export flux and roughly estimate an average emission factor (per tonne of dry matter biomass) that could be applied in the biomass importing, committed countries.

From the perspective of incentives, consumption-based accounting does provide incentive to reduce greenhouse gas emissions by the consumer. The consumer could also choose products that have lower emissions during production, so provide an incentive through the market to improve production efficiency by the producer.

International climate commitments are basically negotiated between sovereign states being responsible for their emissions. CBA+ would create a disincentive for committed countries to import biomass from non-committed countries with high emissions from LULUCF (i.e. suspicious biomass sources) and also an incentive to the non-committed countries to decrease their emissions.

Providing incentives for the transition away from fossil fuels and to the rural sector is not really a strong point of consumer-based accounting.

6 POLICY OPTIONS

An alternative to designing a new accounting system is to live with the existing one but correct flaws as they appear using policies that restrict some types of biomass entering the accounting system. This is somewhat similar to Canada's income tax system[(2)]. It may evolve over time into a complicated mess of rules and regulations with loop-holes and fixes to the loop-holes.

6.1 "Acceptable" lands and land-use change

Instead of designing a new accounting system, one could use policies that limit the source and type of biomass so that eligible biomass can still have zero CO_2 emissions. For example, a policy could stipulate that biomass that was produced on dedicated plantations had zero emissions given certain pre-plantation conditions (i.e. degraded or agriculturally non-productive land). The European Union with its directive to promote the use of energy from renewable sources [7] is a using policy in this manner to fix the accounting flaw. The Directive does not accept biomass from "high carbon stock" forests and peatlands[(3)] (see Article 17 for the complete list).

A problem with this approach may be that the policies may be difficult to enforce or that they discriminate against potentially useful management changes. For example, the European Union Renewable Energy Directive states that biomass must not originate from lands that are "primary forest and other wooded land, namely forest and other wooded land of native species, where there is no clearly visible indication of human activity and the ecological processes are not significantly disturbed".

While this definition is meant well, it is hard to evaluate the criteria and difficult to enforce. It will be very easy for a producer to show that there is human activity in the forest and make the biomass acceptable even though its use would create a large carbon stock loss.

As well, fixed definitions, while making decisions easier, may restrict some very important project types, since "one type does not fill all". For example, if the criteria are based on canopy closure, then projects that improve stocking on degraded forest lands may not be eligible even though there would a climate benefit to restock the lands.

6.2 "Acceptable" trading partners

Alternatively, a consumer could adopt a policy that the biomass must be produced by a trading partner that has accepted greenhouse gas emission restrictions in the prevailing climate agreement. This would mean that the "loop-hole" would be partially closed at least between these two players.

There is a view emerging in the aftermath of Copenhagen that bi-lateral climate change agreements with multi-lateral non-binding commitments may be more realistic and easier to negotiate than a world-wide climate change agreement with commitments. In this scenario, an "acceptable" trading partner approach would fit nicely. This type of policy may even provide incentives for parties to make post-2012 climate agreement commitments. However, one issue that would have to be addressed is whether such bi-lateral agreements would be considered a trade barrier by the WTO?

This type of approach would fulfill all the principles and objectives outlined previously, and could also provide the proper incentives because it would be tailored to each partners needs. However, the incentive for reducing greenhouse gas emissions would probably be weakest because commitments would not be binding. It would require strong vigilance by NGOs to ensure public sentiment (and hence political action) favoured transparent reporting and stronger commitments. This accounting system would still be simple, but the political tapestry would not.

7 CONCLUSIONS

We started this paper by presenting the principles by which an accounting system should operate and the

objectives to which the accounting system and associated policies should give incentives. An accounting system should

- Allocate emissions (and removals) to the party that causes the emissions (and removals);
- Be as comprehensive in time and space as possible;
- Be applicable at all scales from projects to national inventories; and
- "Be as simple as possible, but not simpler"

As well, the combination of accounting system and policies should promote

- the transition to more sustainable, renewable energy system
- maintain and improve economic competitiveness specifically in the rural economy (agriculture and forestry); and
- the mitigation of climate change and adaptation to its potential impacts.

The simple system initially conceived of by the UNFCCC and adopted by the Kyoto Protocol has a flaw. This flaw can be remedied by keeping the existing accounting system and adopting stiffer policy options, creating a new accounting system, or a combination of both. The means something more complicated because, as we have seen, the existing system is too simple. The challenge is to create an improved accounting system and policy combinations that is still "as simple as possible".

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9 NOTES

(1) In fact, the UNFCCC and KP assume that there is no sequestration or CO_2 emission from annual crops. Only changes in soil organic carbon stocks are considered.
(2) The lead author is Canadian
(3) As well as lands of high biodiversity value

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11 LOGO SPACE