DRAFT GUIDANCE ON APPORTIONING OF EMISSIONS TO CO-PRODUCTS AND BY-PRODUCTS

I. Introduction

The production of renewable biomass/biofuels often involves generation of co-products, by-products or wastes.[1] In such cases, a procedure to apportion the project emissions associated with the production of renewable biomass/biofuels, between the renewable biomass/biofuels and its co- and by-products needs to be provided.

In currently approved methodologies, all project emissions are attributed to the renewable biomass/biofuels. This is a very conservative approach. To address this issue, the Meth Panel recommends the Board to adopt the guidance described below on apportioning project emissions between renewable biomass/biofuels and its co- and by-products. Though the guidance was developed in context of biofuel methodologies, the procedure presented can be applied to other processes where co- and by-products are produced, for example, where heat is consumed by a project activity from a co-generation source.

II. Background information

The International Energy Agency (IEA), the European Commission and others have undertaken considerable work on apportioning emissions between by-products and co-products. The BIOMITRE (**BIO**mass-based Climate Change **MIT**igation through **R**enewable **E**nergy) project was established by IEA to develop a software tool to provide a standard procedure for analyzing the GHG balance and emissions-saving cost-effectiveness of biomass energy technologies. The following extract from this tool provides the basic definitions and a proposal on how to apportion emissions:

The following assessment of three approaches to apportioning of emissions is based on BIOMITRE Technical Manual (Horne and Matthews, 2004).[2]

"Process chains which involve the provision of more than one product or service present a further important issue for LCA, because inputs and outputs then need to be divided between them. The various methods of division are called allocation procedures, and there is no single procedure, which is appropriate for all circumstances. Indeed, there are three main ways to allocate primary energy/GHG implications between main products, co-products (which involve similar revenues to the main product), by-products (which result in smaller revenues), and waste products (which provide little or no revenue).

According to ISO14040,[3] the preferred allocation procedure uses a substitution approach, where the main conventional process for producing a co-product, by-product or waste product is used to generate comparative effective credits, which are then subtracted from the life cycle inventory of the process chain under investigation.

---

[1] Co-products are defined as products with similar revenues to the main product; by-products are defines as products that have a lower revenues than that of the main product; and waste in this document this defined as a material that provide little or no revenue.

[2] <http://www.ieabioenergy-task38.org/systemdefining/biomitre_technical_manual.pdf>.

[3] The standard provides " an overview of the practice, applications and limitations of Life Cycle Assessment to a broad range of potential users and stakeholders, including those with a limited knowledge of life cycle assessment". For further details see <http://www.ems-14000.com/ems-iso14040.htm>.

This allocation procedure is fundamentally sound, but clearly increases the scope of the LCA to include process chains of main methods of production of the relevant by-products and co-products. Also, the substitution approach cannot necessarily be used when co-products, by-products or waste products are not normally produced by any main process. There are numerous co-products, by-products and waste products generated by biomass energy production, including, variously, straw, soil, meal, bran and glycerine. Invariably, these are produced mainly as by-products of other process chains. Although this apparent conundrum may be solvable mathematically, using simultaneous equations, it does not necessarily make practical sense to expand the system boundary in such a way, for reasons which may vary from resources and data availability to the actual substitutability (in detail), to the potential availability of the substitution product in the quantities expected, produced by the current conventional means.

Hence, it is sometimes necessary to revert to simpler allocation procedures, of which allocation by market price and subsequent revenue is often the most appropriate.

This is invariably not an 'ideal' solution, since market prices often fluctuate, and in such cases the results of the LCA will change. However, the market price should reflect the value of the by-product in proportion to the main product as far as the producer is concerned, and thus, it is a valid measure of the proportional value society places on each, and therefore the same proportion of primary energy/GHG implications can be used in calculating allocation credits.

The third means of achieving allocation is by using more fixed physical relationships between the main product and by-products. The mass, volume or calorific value of products can be used, although such simple bases for allocation need to be justified satisfactorily, and this is only likely to be a logical and valid option in specific circumstances. For example, in cases where all the products are fuels, such as petroleum products produced by an oil refinery, allocation by relative output and calorific value can be regarded as appropriate. However, allocation by this means for products, which might have calorific values but are not, in fact, used as fuels, is quite tenuous and not suitable."

The Meth Panel recommends the Board to any one of the following four approaches for apportioning project emissions between main product and its co- and by-products can be used by the project participants:

1. **Allocation by market prices.** This approach can be used provided transparent information on market prices is available;
2. **Substitution approach.** This approach can be used provided that the conventional production process for the co-product or by-product can be clearly identified and that sufficient information is available to determine the GHG emissions intensity of the conventional process;
3. **Allocation by energy content.** This approach can only be used in cases where all the co-products or by-products are fuels (e.g. petroleum products produced by an oil refinery);
4. **Attributing all project emissions to the main product.** This approach may be used if the main product is produced as part of the CDM project activity, as a simple and conservative approach.

In exceptional cases, project participants may use other allocation approaches but should justify their appropriateness compared to the above-mentioned approaches.

In line with the above recommendation, the panel proposed the following draft guidance to the Board.

DRAFT GUIDANCE ON APPORTIONING EMISSIONS FROM PRODUCTION PROCESSES BETWEEN MAIN PRODUCT AND CO- AND BY-PRODUCTS

I. Scope and rationale of the guidance

1. The purpose of this guidance is to provide criteria for apportioning emissions from a production process between the main product, the co-products, the by-products and the residues (waste) where the main product is produced and/or consumed/used in a CDM project activity.

2. For example, the production of renewable biomass/biofuels often involve generation of co-products, by-products or residues (waste). In such cases, a procedure to apportion emissions, associated with the production of renewable biomass/biofuels, between the renewable biomass/biofuels, the co-products, and the by-products needs to be provided.

3. For the purpose of this guidance the following definitions apply:

- Co-products: products produced along with the main product and having similar revenues as the main product;
- By-products: products produced along with the main product and having smaller revenues than the main product; and
- Residues/wastes: residues/wastes are generated along with the main product but have no or negligible revenues.

II. Proposed guidance for apportioning emissions from production process

4. This guidance is for situations where a product, which is a main product/co-product/by-product/residue (waste), is produced and/or consumed/used under a CDM project activity.

5. One of the following approaches to apportion emissions shall be used in the methodologies:

(a) **Apportioning by market prices**, i.e. apportioning of the emissions proportional to the market prices of the main product and the by-products or co-products. The market prices may be either monitored ex-post or be determined once for the crediting period. This rule can be applied only if transparent and reliable information on market prices is available;

(b) **Substitution approach (or system expansion)**. The by-products and co-products are included in the project boundary. For each by-product or co-product, the alternative production process(es) is/are identified as part of the procedure to identify how the by-product or co-product would have been produced. Respectively, the emissions associated with the alternative production process of the co-products and by-products are allocated to the co-product or by-product;

(c) **Allocation by energy content**, i.e. apportioning of the emissions proportional to the enthalpy of the main product and the by-products or co-products. This rule can only be applied in cases where the main product and all co-products or by-products are fuels (e.g. petroleum products produced by an oil refinery);

(d) **Attributing all emissions to the main product**. As a conservative approach, all emissions from production process are accounted as project emissions. This approach cannot be used for the calculation of baseline emissions.

6. Furthermore, the following guidance applies:

- Emissions from the production process shall not be allocated to residues/wastes, which are used/consumed in a CDM project activity, for example, if biomass residues from sugar cane production (i.e. bagasse) are used for the production of electricity;
- If a co-product or by-product produced in conjunction with the production of the main product is not sold on the market and is not used/consumed no production emissions shall be apportioned to the co-product(s)/by-product(s). This applies, for example, where the oilseed meal or glycerin produced along with biofuel in the project activity would be dumped or left to decay. In such situation no emissions are apportioned to oilseed meal or glycerin;
- If a co- or by-product is currently not used in the market or is available in excess and project participants plan to use it under the CDM project activity, no emissions should be apportioned to it.

III. Procedure for proposing alternative approaches

7. In exceptional cases, project participants may propose, as revision of this guidance or as part of proposed new methodologies, different allocation rules if they can justify that they are better suited than the allocation approaches provided in this guidance or if the necessary data to apply the allocation approaches provided in this guidance are not available.

Examples of the application of the guidance

(a) Apportioning by market prices

8. The CDM project is the production, sale and consumption of blends of petrodiesel with palm methyl esther to be used as fuel.

9. In the oil mill (process 1 for the production of biodiesel) the main product is the palm oil and the by-product is the palm kernel. For apportioning by market prices to the main product (palm oil) the following equation is used:

$$AF_{1,y} = (MP_{MP,y} \times M_{MP}) / (MP_{MP,y} \times M_{MP} + MP_{BP,y} \times M_{BP})$$

Where:

$AF_{1,y}$	=	Allocation factor for process 1 (oil mill) in year y (fraction)
$MP_{MP,y}$	=	Market price per ton of main product (palm oil) in year y ($/tonne)
M_{MP}	=	Mass of main product (palm oil) associated with the production of 1 tonne of final biofuel (tonne)
$MP_{BP,y}$	=	Market price per ton of dry co-product (palm kernels) in year y ($/tonne)
M_{BP}	=	Mass of co-product (palm kernels) associated with the production of 1 tonne of final biofuel (tonne)

For calculations, the following values are applied:

Parameter	Value Applied	Source
$MP_{MP,y}$	586 €/tonne	Malaysian Palm Oil Board. July 2008. http://econ.mpob.gov.my/upk/daily/20080730latest.htm
M_{MP}	1.05 tonnes	Ecofys.(2007). Technical Specification: Greenhouse Gas Calculator for biofuels. p. 56
$MP_{BP,y}$	332 €/tonne	Malaysian Palm Oil Board. July 2008. http://econ.mpob.gov.my/upk/daily/20080730latest.htm
M_{BP}	0.25 tonnes	Ecofys.(2007). Technical Specification: Greenhouse Gas Calculator for biofuels. p. 56

$$AF_{1,y} = (586 \times 1.05) / (586 \times 1.05 + 332 \times 0.25) = 0.88$$

10. The emissions associated with the cultivation of biomass will then be allocated to the palm oil using the allocation factor. In the example as the allocation factor is 88%, 88% of the emissions of producing the biomass will be taken into account as emissions for the palm oil.

(b) Substitution approach (or system expansion)

11. A CDM project is a natural gas fired combined heat and power plant. Electricity and steam are co-products. The project emissions from combustion of natural gas have to be apportioned between electricity and steam.

12. The apportioning of project emissions is made by including the production of the steam in the baseline scenario. Hence, the baseline scenario is not only determined for the generation of electricity but also for the generation of steam (co-product). For this example, it is assumed that the procedure to identify the most plausible baseline scenario results in that the electricity would be generated in the grid and the steam would be generated in a natural gas fired heat-only boiler.

13. With the substitution approach, all emissions from combustion of natural gas are accounted as project emissions and the baseline emissions are determined for both electricity and steam generation:

$$PE_y = FC_{PJ,NG,y} \times NCV_{NG,y} \times EF_{CO2,NG,y}$$

$$BE_y = EG_{PJ,y} \times EF_{grid,y} + HG_{PJ,y} \times EF_{BL,boiler} \quad \text{with} \quad EF_{BL,boiler} = \frac{EF_{CO2,NG,boiler}}{\eta_{boiler}}$$

Where:

PE_y	=	Project emissions in year y (t CO_2 / yr)
$FC_{PJ,NG,y}$	=	Quantity of natural gas combusted in the project plant in year y (m^3/yr)
$NCV_{NG,y}$	=	Net calorific value of natural gas in year y (GJ/m^3)
$EF_{CO2,NG,y}$	=	CO2 emission factor of natural gas in year y (t CO_2 / GJ)
BE_y	=	Baseline emissions in year y (t CO_2 / yr)
$EG_{PJ,y}$	=	Quantity of electricity produced in the project plant in year y (MWh / year)
$EF_{grid,y}$	=	Grid emission factor for electricity in year y (t CO_2 / MWh)
$HG_{PJ,y}$	=	Quantity of heat generated in the project plant in year y (GJ / year)

$EF_{BL,boiler}$ = Emission factor for heat generation in the boiler in the baseline scenario ($t\ CO_2 / GJ$)
η_{boiler} = Energy efficiency of the boiler that would be used in the baseline scenario for heat generation

14. This approach avoids the determination of an allocation factor (AF) by including both co-products in the boundary. This approach has been applied in several approved baseline and monitoring methodologies.

(c) Allocation by energy content

15. A CDM project is gas treatment plant, where the input is wet gas, the main product is natural gas and the by-products are liquefied petroleum gas (LPG) and gasoline. For apportioning emissions of the treatment plant to the natural gas by energy content the following equation is used:

$$AF_1 = (NCV_{MP} \times M_{MP})/(NCV_{MP} \times M_{MP} + NCV_{BP1} \times M_{BP1} + NCV_{BP2} \times M_{BP2})$$

Where:
AF_1 = Allocation factor for treatment to the natural gas (fraction)
NCV_{MP} = Net calorific value of main product (natural gas) (GJ/m^3)
$M_{MP,}$ = Mass of main product (natural gas) associated with the daily production of the treatment plant (m^3)
NCV_{BP1} = Net calorific value of LPG (GJ/m^3)
$M_{BP1,}$ = Mass of LPG by-product from the gas treatment plant associated with the daily production of the treatment plant (m^3)
NCV_{BP2} = Net calorific value of gasoline (GJ/m^3)
$M_{BP,2}$ = Mass of gasoline by-product from the gas treatment plant associated with the daily production of the treatment plant (m^3)

For calculations, the following values are applied:

Parameter	Value Applied	Source
NCV_{MP}	0.0336	IPCC 2006
M_{MP}	21,000,000	Hypothetical configuration of a gas treatment plant.
NCV_{BP1}	24.123	IPCC 2006
M_{BP1}	1,650	Hypothetical configuration of a gas treatment plant.
NCV_{BP2}	31.453	IPCC 2006
M_{BP2}	500	Hypothetical configuration of a gas treatment plant.

$$AF_1 = (0.0336 \times 21{,}000{,}000)/(0.0336 \times 21{,}000{,}000 + 24.123 \times 1{,}650 + 31.453 \times 500) = 0.93$$

16. The emissions associated with the gas treatment process will then be allocated to the natural gas using the allocation factor. For example if the allocation factor is 93%, then 93% of the emissions from the gas treatment process will be taken into account for the natural gas.

(d) Attributing all emissions to the main product

17. The application of this option is illustrated for the same combined heat and power plant as for the substitution approach above. The emissions from combustion of natural gas in the project plant are fully allocated to the generation of electricity (main product). The steam generation (in this case a by-product) is not included in the boundary.

18. Hence, project emissions are the emissions from combustion of natural gas and baseline emissions are the emissions from electricity generation in the grid:

$$PE_y = FC_{PJ,NG,y} \times NCV_{NG,y} \times EF_{CO2,NG,y}$$

$$BE_y = EG_{PJ,y} \times EF_{grid,y}$$

Where:

PE_y	=	Project emissions in year y (t CO_2 / yr)
$FC_{PJ,NG,y}$	=	Quantity of natural gas combusted in the project plant in year y (m^3/yr)
$NCV_{NG,y}$	=	Net calorific value of natural gas in year y (GJ/m^3)
$EF_{CO2,NG,y}$	=	CO2 emission factor of natural gas in year y (t CO_2 / GJ)
BE_y	=	Baseline emissions in year y (t CO_2 / yr)
$EG_{PJ,y}$	=	Quantity of electricity produced in the project plant in year y (MWh / year)
$EF_{grid,y}$	=	Grid emission factor for electricity in year y (t CO_2 / MWh)

19. This option results in lower emission reductions than the substitution approach. However, it is simple and would not require to determine the baseline scenario for the heat generation. This may be a simple option for project participants in situations where the quantity of the steam generation is very small or where the steam generation would in the baseline only cause very minor emissions (e.g. if generated with renewable sources).

- - - - -