Principles for the Accounting of Biogenic Carbon in Product Carbon Footprint (PCF) Standards

BIO (Biotechnology Industry Organization) is the world's largest biotechnology organization, providing advocacy, business development and communications services for more than 1,100 members worldwide. Our mission is to be the champion of biotechnology and the advocate for our member organizations—both large and small. BIO members are involved in the research and development of innovative healthcare, agricultural, industrial and environmental biotechnology technologies. Corporate members range from entrepreneurial companies developing a first product to Fortune 100 multinationals. We also represent state and regional biotech associations, service providers to the industry and academic centers.

The uptake of carbon dioxide (CO_2) from the atmosphere during the photosynthesis process is a unique feature of plant biomass. The transformation of biomass (and its embodied "biogenic" carbon[1]) into products represents in effect a removal of CO_2, via its continued storage in the product over a period of time. Biobased products can thus contribute to reduce the CO_2 level in the atmosphere and address global warming.

For GHG accounting purposes, biogenic carbon embodied in a product should be considered as a CO_2 reduction or a "negative emission". Therefore it is essential that biogenic carbon flows are assessed in a correct, transparent and consistent way in Life Cycle Assessment (LCA) and product carbon footprint (PCF) tools. The lack of adequate assessment would hinder the introduction of innovative solutions to climate change rather than support it.

A product carbon footprint is a compilation of greenhouse gas (GHG) emissions and sinks along the value chain of a product, from raw materials extraction through production, often including use and end of life. The PCF is a derivative of the more comprehensive LCA, which is described in the international standards ISO 14040/14044.

This position document focuses on the tracking of biogenic carbon in PCF and LCA methodology.

1 Harmonisation and alignment of PCF standards

As several standards (ISO 14067, GHG protocol and PAS 2050) are developed in parallel, it is important that their approach and principles are consistent with one another and with generally accepted LCA guidance such as ISO 14040/14044, and the ILCD handbook[2]. Discrepancies between PCF and LCA methods will cause confusion, waste resources and hinder the acceptance of PCF results.

Recommendations:

- ***Harmonization of PCF standards***
  A single, globally accepted standard, which harmonizes not only between countries but also between application areas or product categories, is desirable to maximize the credibility, consistency and practicality of product carbon footprinting.
- ***Compatibility with commonly accepted LCA guidelines***
  PCF methods shall be compatible with common LCA guidance, so that LCA studies, data sources, tools and resources can be leveraged to generate PCFs in an effective and credible manner.

[1] Biogenic carbon: carbon which is contained in biomass
Biomass: material of biological origin excluding material embedded in geological formations or transformed to fossilised material.

[2] Detailed LCA guidance building on ISO http://lct.jrc.ec.europa.eu/publications

2 Accounting of biogenic carbon in PCF

2.1 Transparent Accounting of Biogenic Carbon in All Stages of a Product Life Cycle

During the Goal & Scope phase of an LCA, system boundaries are drawn and the included processes are defined. In the next step, the life cycle inventory phase, *all* flows that cross these system boundaries are to be mapped. In the case of a PCF, all carbon flows (CO_2 or methane, biogenic or fossil-based) are relevant and have to be reported in a transparent manner during the proper phase of a product's life cycle, so that the total carbon balance over each phase is closed. Excluding the fixation of atmospheric CO_2 in plants is a biased approach and goes against LCA principles as outlined in ISO 14040/44.

In specific cases, such as biofuels or short-lived materials, atmospheric carbon fixation and end-of-life carbon emissions occur in such a short period of time that they can be regarded as offsetting each other (concept of "carbon neutrality"). However, biobased products are *not* automatically biogenic carbon neutral. Just two examples: Under certain conditions, the initial feedstock growth or ultimate degradation of a biobased product may cause emissions of NOx or methane, more powerful GHGs than CO_2. In this case, the assumption of carbon neutrality would underestimate the GHG impact of the product. By contrast, if biogenic carbon remains sequestered in a stable, durable good, then the assumption of carbon neutrality would overestimate the actual GHG impact of such a product. Hence the rigorous accounting of all carbon flows, i.e. fixation and emissions, is necessary to avoid mistakes and misinterpretation.

Recommendation:

- **Transparent accounting of biogenic carbon emissions and sinks throughout the life cycle**
  In agreement with common LCA guidance to track all relevant flows, both emissions and sinks of biogenic carbon shall be tracked in all life cycle stages of a product. Carbon balances can be used to validate the correctness of the accounting at any stage and for the complete life cycle.

2.2 Accurate Accounting of Biogenic Carbon Embodied in a Biobased Product

Two types of carbon footprint are commonly used:

1. The full PFC, which covers all phases in a products life cycle, starting at the cradle and ending with the final disposal, i.e. "cradle-to-grave". This PCF is helpful to assess the overall life cycle of a product and is often used in business-to-consumer communications.

2. A partial PFC, which starts at the cradle of a life cycle and ends at a certain point, e.g. the PFC of a material placed on the market by a producer ("cradle-to-gate"). Partial PCFs are often used in business-to-business communications and can serve as the starting point for a cradle-to-grave PCF.

Knowledge of the amount of biogenic and fossil carbon embodied in a product is a prerequisite for meaningful cradle-to-grave PCFs. However, quite often different parties are responsible for different parts of the life cycle. As an example: if bioplastics producers put their products on the market, they often have no control over the downstream applications (e.g. disposable, durable,...) nor the products' end-of life, i.e. how the bioplastic will be recycled or finally be disposed of. Consequently, transparent and consistent reporting of carbon flows and transparent documentation of the amount of biogenic and fossil carbon embodied in a product are especially critical in partial PCFs to build full PCFs along the value chain..

Recommendation:

- ***Accurate accounting of biogenic carbon embedded in products***
  Complete information about the amount of biogenic and fossil carbon embodied in a product shall be passed on when PCF data is transferred among value chain partners. Stoichiometric calculations and standardized physical measurements[3] can be used to quantify biogenic carbon in a product.

[3] Described in ASTM D6866

2.3 Representation of end-of-life options

Biobased products have been designed for a broad range of applications. End-of-life performance is an important criterion in product selection. While some biobased products are biodegradable, others are designed to be durable. Material properties define whether products remain inert when landfilled, whether they are recyclable or provide valuable energy in waste incineration.

The common notion of carbon neutrality assumes that the carbon embodied in a product is released completely in the form of CO_2. However, complete carbon release only occurs if the product is completely incinerated or biologically degraded to CO_2.

In reality, embodied carbon may remain completely sequestered, may be partially emitted, and/or may be emitted as methane. Incineration and biological degradation are not the only end of life options for bio-based products. Land-filling is also widely applied in many countries and can result in biogenic carbon sequestration for some biobased materials. This is particularly true for stable (inert) materials that are typically utilised for long-life products. In the case of mechanical and chemical recycling, the biogenic carbon flows into other product life cycles and is therefore stored in products for a longer period of time.

Recommendation:

- ***Realistic representation of end-of-life options***
  Where a full PCF (cradle-to-cradle) is carried-out, it shall provide an accurate representation of the end-of-life fate of biogenic carbon embodied in a product, and correctly account for the storage, release or transformation of this biogenic carbon.

2.4 Defining Time Horizons for Carbon Storage

After their release, GHG gases remain in the atmosphere for extended periods of time. The time horizon of a PCF is the specific period of time over which the greenhouse gas impacts are assessed.

To calculate a PCF, different gases are normalized to CO_2 equivalents with Global Warming Potential (GWP) factors. GWPs represent the combined effect of the differing times GHGs remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation. The GWP set most often used is the 100 year average GWP as defined by the IPCC. Although other time horizons are available (IPCC also publishes 20 and 500-year GWPs), 100 years is the widely accepted time horizon adopted by UNFCCC in the Kyoto Protocol. Specifically, the ILCD handbook proposes a 100-year assessment period for carbon storage in products, to be consistent with the use of 100-year GWP.

Hence the use of a 100 year time horizon in a PCF is consistent with common scientific practices and international climate change policies.

Recommendation:

- ***Reasonable thresholds for permanent carbon storage***
  The long term stability of a material shall be assessed with state-of-the art scientific methods. If there is sufficient evidence to support the hypothesis that a material will remain stable for more than 100 years in a given product use or end-of-life scenario, then the carbon embodied in the product shall be considered as sequestered permanently.

It is also important to recognize that carbon sequestered now, even for less than 100 years, can actively contribute to reducing the peak atmospheric CO_2 level according to IPCC scenarios. This will have the effect of mitigating the impact of the overall CO_2 build-up, resulting in a lower overall peak and an earlier reversal of the current trend of accumulation. When atmospheric carbon is stored in a product for a period of time and is finally emitted, it did not contribute to climate change for this period of time. The temporary removal of CO_2 from the atmosphere should therefore be accounted for in the PCF.

The ILCD handbook provides explicit guidance on the accounting of temporary removal of carbon dioxide from the atmosphere, storage in long-living bio-based products or landfills, and delayed emission as CO_2 or CH_4 for time periods shorter than 100 years, including a formula to calculate resulting GHG impacts for a 100 years assessment period. Separate tracking of biogenic and fossil carbon (see section 2.1) is a pre-requisite of this method.

Recommendation:

- ***Purposeful accounting of temporary carbon storage / delayed emissions:***
  PCF standards shall be consistent with ILCD guidance for the accounting of temporary removal of carbon dioxide from the atmosphere, storage in long-living bio-based products or landfills, and delayed emission as CO_2 or CH_4.

3 Reporting of PCF information

Though LCA have traditionally been used as an assessment tools for companies, they are being increasingly used for a broader set of purposes, incl. legislation compliance and information to consumers. However, the complexity of the information generated by an LCA and the necessary interpretation of the results complicate the communication and comparison of results. To be used for comparison of products, further guidance would need to be developed and be product category specific.

Since technical reports, especially those intended for general audiences, can only provide a limited amount of details about the underlying methodology and assumptions, it is essential that standards provide clear and consistent guidance on the calculation of PCF results.

Recommendation:

- **Transparent and accurate accounting as the basis of meaningful reporting**
  PCF standards shall provide clear and specific guidance on how to calculate PCF results and how to document them, to ensure credibility and consistency of PCF data.

A single number for the total carbon footprint of a product will be most useful and desired by the majority of audiences. In addition, a break-down of total GHG emissions by life cycle stage may provide further information to some decision making processes, while displaying GHG emissions by species may be of interest to PCF experts, but could be overwhelming, if not confusing, to general audiences.

Recommendation:

- **Customized Level of Detail for Different Audiences**
  PCF standards shall provide reporting templates designed to meet the needs of different audiences, e.g. the general public in business to consumer communications or LCA experts in a business-to-business exchange of information. In its simplest form, the result of the PCF is a single aggregated number representing all GHG flows (including biogenic carbon) passing the system boundaries.

For further information, please contact
Rina Singh, PhD., Director Policy, BIO
rsingh@bio.org; 202-312-9295