TOGETHER FOR SUSTAINABILITY

Improving and harmonizing Scope 3 Reporting

TfS White Paper

Biogenic Carbon
Mass / Energy Balance
Recycled Content

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Context for this White Paper

With the launch of the Product Carbon Footprint (PCF) Guideline in November 2022, Together for Sustainability (TfS) completed one of its most impactful projects to date. Experts from over 25 chemical companies collaborated to tackle the chemical industry's Scope 3 challenge and formulated the first set of chemical industry specific guidelines for PCF determination. The PCF Guideline will be an important enabler for responsible companies to navigate this "Decade of Action". During this work, TfS identified improvement potentials for the Corporate Greenhouse Gas accounting that are addressed in this White Paper.

01 Introduction

Amid the urgent global challenge of climate change, humanity stands at a critical juncture that demands immediate and resolute action [IPCC 2023]. The chemical industry, recognizing its pivotal role, is committed to spearheading innovative solutions to combat the pressing issue of climate change. However, within the realm of this commitment, a unique and complex challenge surfaces in the pursuit of emission reduction.

Central to this challenge is the intricate relationship with fossil carbon materials. These materials not only serve as energy sources, but are also fundamental feedstocks for chemical products. The industry's path to decarbonization must therefore encompass a comprehensive approach, extending beyond energy supply replacement strategies. The focus now shifts to separating disentangling carbon from conventional fossil sources; embracing alternatives like biomass, captured atmospheric CO_2; and innovative waste stream recycling [Gabrielli et al 2019], [Schneider et al 2019], [Tan & Vegelan 2022] [McKinsey 2021].

As the industry takes action to achieve a net-zero future, a re-examination of carbon accounting standards comes to the forefront. The Greenhouse Gas (GHG) Protocol, a cornerstone of corporate reporting, faces the imperative to recalibrate and accurately reflect the evolving landscape of renewable carbon cycles and emerging technologies. TfS has identified three key modifications needed to address this issue:

Biogenic Carbon Accounting

As biogenic carbon sources gain prominence, the development of a robust framework for their accurate accounting becomes essential.

Mass Balance as a Transitional Mechanism

Acknowledging the dynamic shifts underway, the adoption of a Mass Balance (MB) approach needs to be considered as a market-based mechanism that reinforces the industry's transition towards sustainable practices.

Recycled Materials and Content

With the increasing integration of recycled materials and content within the chemical industry, there is a need to harmonize approaches to carbon accounting to recognize the positive effects of a circular economy at both corporate- and product-levels.

However, the path ahead is complex, marked by differing perspectives across industries, standards bodies, and stakeholders. This discrepancy underscores the necessity for further research, dialogue, and collective collaboration to build a coherent path forward. Neutral entities like standards-setters and regulatory bodies are positioned to offer crucial guidance in navigating these challenges based on the best scientific data available and the support of NGOs, academia, and industry.

In the upcoming chapters, this white paper embarks on an exploratory journey. Each chapter explores the challenges and potential solutions to harmonize carbon accounting methodologies, uncovering complexities and strategies for a more sustainable chemical industry. The initial focus is on biogenic carbon and the need to have an accounting methodology that matches its physical flows across the technosphere [Chapter 2]. The discussion then shifts to the complexities of mass and energy balance [Chapter 3], before delving into the nuances of recycled content accounting methodologies [Chapter 4].

Within the realm of these discussions, complexity and differing viewpoints are acknowledged. It is within this context that the call for research, cooperation, and clarity becomes pronounced. Through collective insights from industry, neutral bodies, and stakeholders, transparency, comparability, and tangible impacts can be fostered. This enables companies to methodically track their decarbonization efforts, aligning with the urgency of the net zero imperative. As we navigate towards a sustainable future, the path is guided by collaboration and knowledge-sharing, fueling progress towards a more resilient and balanced world.

02 Biogenic Carbon

2.1 Context & Problem Statement

Customers in the chemical industry are using biogenic carbon from bio-based materials, or biomass balance materials, to reduce the PCF of their products in the market. The benefit of these types of products is that they contain biogenic carbon that was removed as CO_2 from the atmosphere and is stored in chemicals until it is released into the atmosphere.

The uptake of CO_2 from the atmosphere during the photosynthesis process is a unique feature of plant biomass, and leads to a reduction of CO_2 in the atmosphere. The transformation of biomass (and its embodied biogenic carbon) into products represents, in effect, a removal of CO_2 for as long as the CO_2 is kept out of the atmosphere. This is a benefit of biogenic carbon that shall be considered in PCF calculations.

According to the GHG protocol [GHG Protocol Corporate Value Chain (Scope 3) Standard], companies that are purchasing products with biogenic carbon shall report the emissions and removals of biogenic CO_2 separately from the GHG Scopes. Thus, the removal of CO_2 from the atmosphere is not accounted for in Scope 3.1 of that company. Similarly, the emissions of biogenic CO_2 at the end-of-life (EoL) (e.g., during combustion or biodegradation) are not accounted for in the respective scopes, but separately.

Therefore, companies are not able to promote the benefits of products that contain biogenic carbon adequately in their Scope 3.1 GHG accounting. Instead, CO_2 uptake or biogenic CO_2 emissions must not be included in a Scope 3 inventory but reported separately in Scope 3.12 accounting.

Currently, the GHG protocol uses the so-called 0/0 approach where no biogenic removals and no biogenic emissions are considered in the corporate emission accounting (only separately from the scopes).

The benefits of products made from biogenic carbon are therefore only visible at their EoL in 3.12, and only if the biogenic CO_2 gets released back into the atmosphere (e.g., via combustion or biodegradation). Under the current cut-off approach suggested by the GHG Protocol for the recycling of materials (see chapter 4), this means that the benefit of removing biogenic CO_2 from the atmosphere would not be considered in emission accounting when recycling products made from biogenic carbon.

With the current 0/0 approach, the benefit of biogenic materials is firstly not accounted in the scope where it appears and secondly, in case of recycling, not considered at all.

In contrast, the Product PCF standards [GHG Protocol Product Standard] as well as [ISO 14067:2018] request the reporting of a PCF value excluding and including biogenic GHG emissions and removals as well as the biogenic carbon content. This approach is the so-called -1/+1 calculation approach and considers both the biogenic CO_2 removals when entering the product system (as negative emissions) and the emissions if generated in the EoL phase (as positive emissions). This allows to account for the benefit of biogenic carbon materials where they appear and the consideration if the materials are recycled.

The current accounting approach of the [GHG Protocol Corporate Value Chain (Scope 3) Standard] has significant disadvantages for companies who are selling products that contain biogenic carbon and where the customer wants to show that benefit in Scope 3.1 without relying on the uncertain EoL scenario.

Moreover, the described approach in the [GHG Protocol Corporate Value Chain (Scope 3) Standard] is not in line with the product GHG product accounting approach of the

[GHG Protocol Product Standard], [ISO 14064-1:2019] or [ISO 14067:2018] where the benefits of biogenic CO_2 uptake can be considered directly when biogenic carbon is entering the product system. Benefits of biogenic carbon products with a long-term application that continuously store the removed carbon cannot be claimed accurately.

Benefits of other technologies like biogenic "Carbon Capture and Use" (CCU) or "Bioenergy with Carbon Capture and Storage" (BECCS) that remove CO_2 from the atmosphere cannot be reported accurately due to the 0/0 accounting approach for biogenic CO_2. Currently, the fact that the CO_2 is not emitted back into the atmosphere in these systems cannot be considered. In contrast to offsetting, which cannot be considered in corporate emission accounting according to the [GHG Protocol Corporate Value Chain (Scope 3) Standard], the benefits of these types of technologies are in the same value chain (called "insetting"). For this reason, it is not possible to consider advantages of these technologies accurately to promote their utilization. Therefore, the current [GHG Protocol Corporate Value Chain (Scope 3) Standard] approach hinders companies to market the benefits of their products that are based on biogenic CCU or on BECCS.

2.2 Incompleteness of GHG Protocol

[ISO14067:2018] and [GHG Protocol Product Standard] require the separate reporting of biogenic CO_2 emissions and removals, but also allow the introduction of all emissions and removals in the inventory added to both total cradle-to-grave PCF and partial cradle-to-gate PCF calculations.

For short-term uses of materials with incineration, both approaches are identical in cradle-to-grave considerations. For long-term applications, significant differences will be observed, depending on the final disposal method. The accounting is incomplete today as it does not transparently show the relevant emissions and removals in Scope 3.1, Scope 3.5, and Scope 3.12 corporate GHG inventories.

The current version of the [GHG Protocol Corporate Value Chain (Scope 3) Standard] is incomplete in the sense that:

- Full incineration of products made from biogenic carbon is assumed at the EoL for all cases, even if they are recycled or reused.
- The storage time of CO_2 removals and emissions are not assessed and included, although addressed within the [GHG Protocol Land Sector and Removals Guidance] draft but without clear guidance. Hence, the benefits of a long storage time of biogenic CO_2 can currently not be considered in emission accounting.
- For other technologies like CCS or CCU that remove CO_2 from the atmosphere the same applies. Hence, the specific benefit in formal GHG reduction cannot be reported.
- The same applies for biogenic CO_2 uptake and storage as products that act as a carbon sink for longer time periods.

This way of reporting hinders the use and marketing of materials containing biogenic carbon in the chemical industry and downstream industries that can significantly contribute to GHG reduction. Full incineration of biogenic carbon materials at EoL is assumed for all cases. Cases where materials are used for long-lasting applications, that effectively help to reduce emissions by storing biogenic carbon, cannot be highlighted through this accounting mechanism.

Further details might come with the final version of the [GHG Protocol Land Sector and Removals Guidance].

2.3 Recommendations and Solution Proposals

For corporate GHG accounting purposes, biogenic carbon embodied in a product should be considered as CO_2 removal at the gate of its production in the same way as in a PCF calculation according to [ISO 14067:2018].

Chemical companies want to show the benefits of reduced GHG emissions in Scope 3.1 by using materials with biogenic carbon instead of fossil-based alternatives where they occur.

If biogenic carbon uptake can be considered in Scope 3.1, biogenic emissions shall also be considered in Scope 3.12 for shortterm uses, preferably based on actual product-specific data instead of generalized statistics. For long-term use and/or recycling, the reporting in Scope 3.12 shall be adjusted to reflect the benefit of long-term use. Biogenic carbon emissions and removals need to be accounted for within all GHG Protocol scopes. Wherever biogenic CO_2 is emitted, it should be accounted as biogenic CO_2 emission. Similarly, CO_2 should be handled with a negative figure of -1 kg CO_2e per kg CO_2 wherever it is removed. The [TfS PCF Guideline] allows both calculations, with and without biogenic carbon removal.

With a -1/+1 approach, the disadvantages of the current reporting approach can be avoided. Therefore, we propose to use the -1/+1 gross flow accounting approach as already mentioned in [GHG Protocol Product Standard] and more generally in [ISO 14064-1:2019]. Aggregation of all removals and emissions (biogenic and fossil) shall be possible if disaggregated figures are reported as well.

Many chemical companies are developing goals for the reduction of emissions of products in the Scope 3.1 category. Thus, companies need to be able to account for benefits in Scope 3.1 accounting when using biogenic materials. On one hand, this approach will motivate companies to take long-term transformative actions, while on the other hand also allow them to be acknowledged for their efforts. The incentives must also be accounted for on corporate level. A harmonization with PCF calculation according to [ISO 14067:2018] and [GHG Protocol Product Standard] is therefore needed.

TfS recommends considering the use of materials with biogenic carbon accurately, allowing companies to claim carbon removal by using biogenic carbon materials in Scope 3.1. The approach should be adapted so that biogenic CO_2 uptake can be considered as a benefit (negative value). Scope 3.1 accounting shall be harmonized with the PCF calculation of biogenic carbon products. Biogenic CO_2 uptake could end up as a CO_2 removal mechanism if the lifetime of the products can be considered long-term (in-use, stored for a long time) at the EoL. A definition of long-term use shall be introduced and harmonized.

In Figure 1 both approaches, the -1/+1 and the 0/0, are visualized and compared.

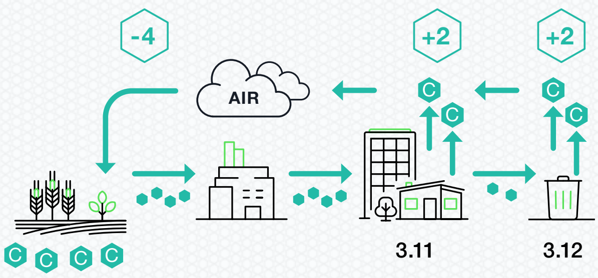
Specifically, the following must be addressed:

- The possible double-counting in Scope 3.1 if multiple companies using the same product several times is not seen as critical in comparison to the common practice of double-counting of emissions in Scope 3.12. Hence, in all corporate emission inventories, the removals and emissions will balance each other out (provided that the CO_2 is emitted at EoL).
- Recycling of materials that contain biogenic carbon under the -1/+1 approach results in difficulties for emission accounting. Therefore, it is crucial that the approach to account for recycling is aligned with the accounting for biogenic carbon materials.

It must be avoided that the benefit of "removing CO_2 from the atmosphere" is counted multiple times over multiple life cycles without accounting for the respective emissions of its EoL. This is crucial as it otherwise would enable the artificial reduction of a corporate emission inventory by considering the benefit of 1 kg of removed CO_2 multiple times. The issue is visualized in Figure 2.

Figure 1 - Comparison of the -1/+1 and the 0/0 approaches for biogenic CO_2

-1/+1 APPROACH (consideration of biogenic CO_2)

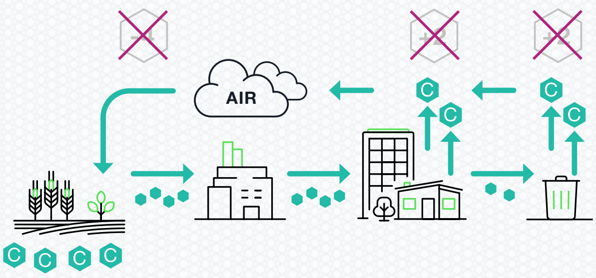


Uptake (-4) and emission ((+2) ; (+2)) are counted

- Scope 3.1: (-4)
- Scope 3.11 / Scope 3.12: (+4)

Total: (-4) + (+4) = (0)

0/0 APPROACH (no consideration of biogenic CO_2)

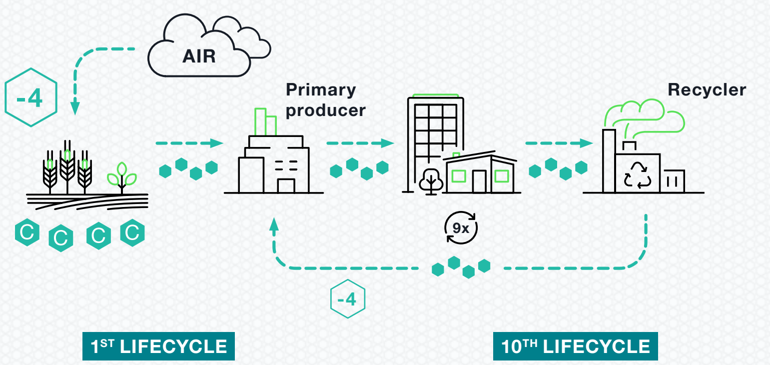


Neither uptake nor emission are counted ((0) !)

- Scope 3.1: (0)
- Scope 3.11 / Scope 3.12: (0)

Total: (0) + (0) = (0)

Figure 2 - Problem: Multiple-counting of biogenic carbon credit in recycling system



If accounting for the biogenic carbon credit in Scope 3.1 in every lifecycle, the calculated uptake of CO_2 is higher than the actual uptake of CO_2. Therefore, multiple-counting of biogenic carbon credits over multiple lifecycles shall be avoided.

Scope 3.1: 1 x (-4) = (-4) CO_2

Scope 3.1: 1 x (-4) + 9 x (-4) = (-40) CO_2

03 Mass / Energy Balance

3.1 Context & Problem Statement

The concept of Mass / Energy Balance accounting, an established "Chain of Custody (CoC)" technique delineated in ISO 22095 [ISO 22095:2020], serves as a crucial approach in reinforcing the sustainability of products. It accomplishes this by integrating biomass, recycled materials, and energy sources. In practical terms, this approach offers industries a streamlined way to gradually incorporate recycled materials into existing production systems alongside conventional resources. It addresses scenarios where physically segregating alternative and traditional materials during processing isn't feasible.

Within the realm of chemical production, a limited range of raw materials yield a multitude of products. The steam cracker serves as the starting point, "cracking" naphtha - a long hydrocarbon - into smaller molecules like hydrogen, butenes, ethylene, and propylene. These molecular components act as foundational units for various products including plastics, coatings, solvents, and crop protection agents. However, changing the feedstock in large-scale facilities, such as steam crackers, presents challenges.

To use alternative feedstocks like biomass in a relatively low amount compared to the overall feed of the cracker, the Mass Balance (MB) approach is applied. Here, chemical production using renewable or recycled resources follows a calculation-based method to attribute these sustainable elements to certain final products. This ensures that products incorporating the MB method can be used interchangeably with traditionally manufactured items, without requiring modifications in recipes, processes, or facilities, while the benefits of low-carbon feedstocks can be passed along to customers requiring sustainability attributes.

The application of the MB approach within the chemical sector presents a myriad of benefits, as highlighted by BASF [2022]:

1. A facilitated transition towards a carbon-neutral circular economy by integrating sustainable raw materials into existing chemical infrastructure.
2. The production of more affordable eco-friendly products without requiring extensive new investments.
3. Flexible scalability while maintaining consistent product quality.
4. Enhanced transparency for informed sustainable purchasing decisions, backed by third-party certification.
5. Leveraging an established methodology successfully employed in diverse sectors to facilitate the transition to sustainable alternatives within the chemical industry.

MB accounting has been designed to trace the flow of materials through a complex value chain, not just within the chemical sector but across various industries. It is used in several established programs related to sustainable and/or responsible sourcing, such as the Forest Stewardship Council (FSC) and Better Cotton Initiative (BCI).

The "Mass / Energy Balance" approach provides a set of rules for how to attribute the bio-based or recycled material to different products to be able to claim and market the content as 'bio-attributed' or 'circular'. This is currently not reflected in the current version of the GHG Protocol. To a chemicals manufacturer, alternative feedstock is just another raw material that enters the production system. Inside, it will be blended with and converted to many other products, but the amount of alternative material leaving the production plant equals the amount entering it (within the physical and chemical constraints of conversion efficiency and losses).

For example, several processes can be applied for chemical recycling. In a MB approach, main inputs, as e.g., pyrolysis oil can be blended with fossil naphtha in a chemical production site. This means the recycled material is distributed over several products and that a MB approach is necessary to calculate the plastic-to-plastic yield [Broeren et al 2022].

Multi-input single-output systems necessarily need different raw materials with different footprints to produce the desired output. Via the free attribution approach, MB accounting allows to attribute the bio-based or recycled characteristics from one input to the whole molecule of the single output (mass of input equals mass of output multiplied by a conversion factor). There is a certain risk that a raw material with a low footprint is used to be attributed to the output share and the higher footprints of the other raw materials are neglected. To avoid accusation of 'greenwashing', this should not be done.

3.2 Recommendations and Solution Proposals

3.2.1 Recommendations

The PCF calculation of a MB product including biogenic carbon and/or secondary materials with a single input of the MB product and the output of identical materials can easily be calculated by a separate footprint for each product. When physically identical materials from separate sources are mixed without further transformation, mass balance is easy to conduct. Special rules are needed for e.g., the steam cracking step of bio-based and secondary mass balanced materials because a complex mix of many products (materials and fuels) are made depending on the feed slate. One solution could be using a system expansion method for fuels that are exported out of the cracker boundary while the rest of the outputs can be mass allocated.

Since chemicals are often used in complex combinations, discrete cycles are only possible in some cases (e.g., glass, metals, some plastics). Moreover, when products move through the economy, there will often be additional mixing and contamination, making it practically and economically infeasible to separate them even if they are physically and chemically distinguishable. Chemical recycling can play its part in valorizing EoL plastic waste streams, enabling the production of new chemicals including plastics. It will be very difficult to meet ambitious recycling targets without significant and rapid scale-up of both mechanical and chemical recycling technologies [Ishii & Stuchtey 2022]. The MB approach is not defined in the current GHG protocol and cannot be applied so far. TfS recommends implementing the following aspects [TfS PCF Guideline]:

- MB should be accepted as recycled materials, bio-based materials and other types of materials and should follow the accounting rules we recommend in this white paper.
- MB should be accepted as materials that are used directly in chemical supply chains. In this sense, different CoC models as e.g., Mass / Energy Balance, system expansion etc. should be accepted.
- The dilution of this type of material in large chemical industry plants should be accepted as direct input if an accepted accounting and certification scheme is in place.
- For biomass, a C14 method for the validation of the "real" amount of recycled or bio-based Carbon is not meaningful as the attributed amounts cannot be detected accurately. According to ISO 22095 the MB approach is defined as a CoC model and should forward certain sustainability characteristics. These characteristics should be precisely defined.

3.2.2 Solution Proposals

Circular economy-enabling low GHG emissions requires a shift to raw materials based on biomass or waste. The MB approach is a means to achieve this transition in a fast, economic, scalable, and socially accepted manner for a large number of products. To consider the benefits of the materials used in MB / Energy Balance, system expansion in the corporate accounting of companies is a key element for accurate reporting. The following proposal should be used as a basis for further developments of the GHG protocol:

1. Mass / Energy Balance system expansion shall be site-specific, allow the sustainable portion of the feedstock to be assigned to a specific product or output – a principle known as free attribution – towards the products of a process.
2. Multi-site transfer of renewable credits should follow the requirements of the respective certification schemes. In any case it should be made transparent if multisite transfer is used.
3. For PCF assessments, other elements of renewable feedstock (such as N, H, O) can be taken into consideration for the calculation of attributable amounts in addition to carbon. All renewable feedstocks can be considered for the PCF calculation if they have a relevant impact: e.g., renewable Hydrogen or Ammonia.
4. The accounting period (for balancing of going short) should be one year.
5. MB must be certified under a MB scheme, fulfilling these requirements.

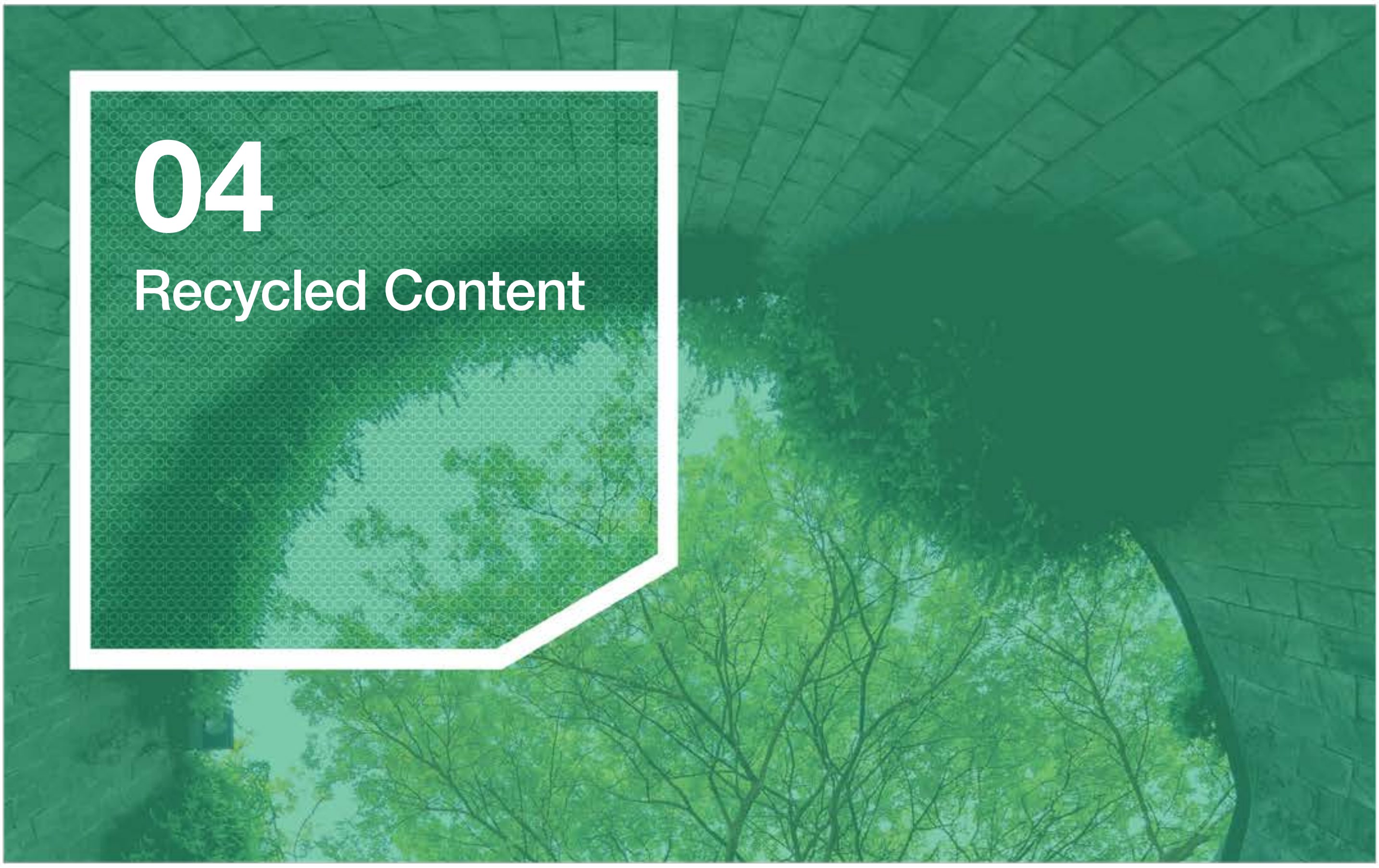
For the MB approach to work and be widely applied, it is crucial that the basis for calculation and allocation rules are generally applicable and robust.

Because compounds entering the value chain might be of different value to the chemical process even if their atomic content is the same, MB accounting cannot be based on mass alone. In some cases using chemical value-related properties, e. g., the 'lower heating value' (LHV), Carbon content, functional units etc. might be preferrable as the basis for the calculation (e.g., for mixed plastic waste) or carbon content. In general, an adequate fossil feedstock demand shall be considered to avoid greenwashing with simple operations.

3.2.3 Summary

MB concepts ensure efficient and sustainable use of existing infrastructure, as similarities in conversion processes are used to avoid the double installation for renewable carbon sources. With mass balancing, the chemical industry would follow an established mechanism that is well perceived and accepted for other industries and sectors.

A chemical sourced from multiple feedstock types (e.g., fossil, biomass, circular processes) put into a large-scale operation cannot be differentiated based on feedstock types because it is chemically identical. The MB methodology is required to accurately calculate and verify the amount of renewable carbon content or recycled content attributed to products. This shall ensure the transition to a fully circular and/or bio-based chemical industry.



04 Recycled Content

4.1 Context & Problem Statement

Transitioning towards a circular economy and achieving net zero targets will require the uptake of secondary materials through reuse and recycling. In this context, the chemical industry plays a pivotal role. Technologies like mechanical and chemical recycling show promise in reducing GHG emissions while keeping materials in the circular loop [Ellen MacArthur Foundation 2019]. GHG emission reduction using recycled materials should be reflected in corporate GHG accounting for both the users and producers of secondary materials. However, the GHG Protocol's cut-off accounting method falls short in addressing the complex interactions involved.

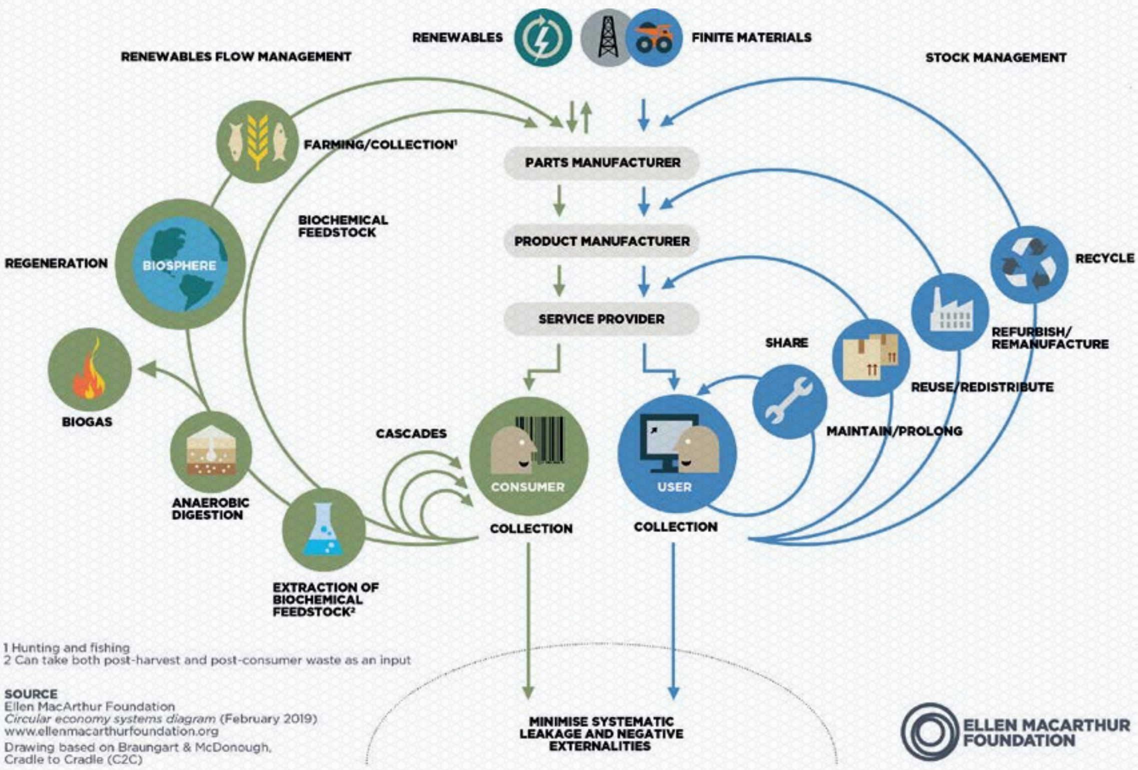
The specific approach to incorporating recycled content into GHG accounting is outlined in pages 77-79 of the [Technical Guidance for Calculating Scope 3 Emissions]. According to this approach, in the first use of the product, the value chain actors are not required to account for recycling burdens in Scope 3.5 or Scope 3.12 if recycling of waste streams can be proven. The responsibility for the burden associated with recycling processes is then accounted for within Scope 3.1 (Purchased Goods & Services) of the company that purchases and employs the recycled product, commonly referred to as the second user. This creates an imbalanced distribution of recycling burdens across value chain participants, leading to an issue for many companies to concentrate their Scope 3 carbon reduction efforts primarily on sub-categories Scope 3.1 (Purchased Products and Services) and 3.5 (Operational Waste). These segments are integral constituents of the partial cradle-to-gate product carbon footprint (PCF) shared with downstream partners, thus forming a vital part of a company's operational mandate.

Conversely, in Scope 3.12 (End-of-Life Treatment of Sold Products), the actual GHG emissions reduction enabled by a producer and user of recycled material taking direct action to reduce emissions and enabling a circular economy doesn't translate in a reduction of its Scope 3.12 emissions. Outside the direct control of reporting entities, most 3.12 accounting methods rely on high-level assumptions and global statistics, such as those from the Organization for Economic Cooperation and Development [Global OECD Statistics 2022]. The following section seeks to address the challenges confronting chemical companies in GHG emissions reporting, both at the corporate and PCF levels, within the current framework. The objective is to underline the shortcomings of the existing GHG Protocol Corporate Value Chain (Scope 3) Standard, with the intention of stimulating an open discourse among stakeholders.

Figure 3 outlines the options for how virgin materials can be introduced into a circular economy and be reused in different ways. Many of these options are applicable to the chemical industry and must be addressed and linked with meaningful figures in the corporate reporting of companies.

The circular economy system diagram, known as the butterfly diagram, illustrates the continuous flow of materials in a circular economy. There are two main cycles – the technical cycle and the biological cycle.

Figure 3 - The Butterfly Diagram: Visualizing the Circular Economy [Ellen Macarthur Foundation]



4.2 Identified GHG Protocol Gaps for Recycled Content

First Challenge – Limitations in the Cut-Off Approach: The GHG Protocol Corporate Value Chain (Scope 3) Standard employs a cut-off methodology for all materials. For EoL, this results in recognition of "benefits" solely within sub-category Scope 3.12, as the share of recycled material is accounted with zero emissions (excluding collection and sorting). In parallel, the environmental impact of recycling emissions is incorporated when the second user is procuring recycled materials (in upstream Scope 3.1). This approach proves problematic for upstream value chain actors, as Scope 3.12 is often beyond their direct control.

Here is an illustrative example of the Cut-Off Approach shortcomings:

Company A that produces a material from fossil feedstocks which has an overall recycling rate of 10% from Global OECD Statistics [Global OECD Statistics 2022] can claim that 10% recycling rate as a cut-off of its carbon emissions in its Scope 3.12. This is despite not actively contributing to enabling the circular economy. On the other hand, Company B that offers the same material made of, e.g., 20% recycled content is not fully recognized because it can only use the 10% recycling rate from the [Global OECD Statistics 2022] despite being an active player and enabler of the circular economy. Effectively, this is incentivizing Company A to continue operating from fossil feedstocks and let the other value chain actors find ways to increase the material's recycling rate.

Second Challenge – Complexity of Waste Incineration Accounting: Challenges abound in accounting for waste incineration with energy recovery and attributing the impact between Scope 3.5 and Scope 3.12. Currently, waste incineration primarily serves as the ultimate waste treatment method, with energy recovery as a byproduct. The GHG emissions intensity of this process is based on waste carbon content and heating value. Under the cut-off approach, this impact is allocated to recovered energy. However, this method can inadvertently lead to skewed GHG emission allocation, disincentivizing proactive waste reduction and optimized energy recovery efforts.

Third Challenge – Non-Recognition of Recycling Benefits in Scope 3.1: An issue arises when products produced via recycling exhibit higher cradle-to-gate PCF than their virgin counterparts, despite having a lower cradle-to-grave PCF. This in turn leads to a situation where the climate benefit of recycled materials compared to fossil materials cannot be reflected in purchasing decisions. This opacity hinders companies from confidently embracing recycled materials, hampering the transition to a circular economy.

Fourth Challenge – Non-Recognition of increasing importance of Circular Contributions: A comprehensive circular economy contribution extends beyond material reuse. The current GHG protocol approach fails to recognize the increasing importance of the circular economy. It does not include accounting approaches for: i) recycling-enabled products (e.g., a polymer which is designed for better recycling), ii) enhanced recyclability (e.g., design for recycling in the automotive industry), iii) empowerment of other products' recyclability (e.g., by introduction of additives). An inclusive view of circular economy incentives should encompass these aspects.

05 Outlook

Biogenic Carbon

With a -1/+1 approach, the disadvantages of the current reporting approach can be avoided. Therefore, TfS proposes to use the -1/+1 gross flow accounting approach. This approach enables companies to use more biogenic carbon in their products and to report the use of them accurately. Double-counting shall be avoided, and meaningful accounting traceability and accounting systems will support it in the future.

Mass / Energy Balance

PCF calculation of MB bio-based materials or materials from recycling with a single output of identical materials can easily be calculated by a separate footprint for each product as if they are fully separated. When physically identical materials from separate sources are mixed without further transformation, mass balance is easy to conduct. Special rules are needed for the steam cracking step of MB bio-based materials as a complex mix of many raw materials and fuels are made because of the cracking that also depends on the feed slate.

Recycled Content

A reimagined corporate reporting methodology is key to enable the chemical industry's progression towards a circular economy, encouraging resource efficiency and GHG emission reduction. While universal solutions to these intricate challenges may be difficult, TfS members aspire to engage in constructive dialog with the diverse stakeholders of the GHG Protocol, envisioning a harmonized and refined accounting methodology in future iterations.

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Abbreviations

BCI	Better Cotton Initiative
BECCS	Bioenergy with Carbon Capture & Storage
CCU	Carbon Capture and Use
CCS	Carbon Capture and Storage
CO_2	Carbon dioxide
CoC	Chain of custody
EoL	End-of-life
FSC	Forest Stewardship Council
GHG	Greenhouse Gases
ISCC	International Sustainability and Carbon Certification
LHV	Lower heating value
MB	Mass balance
NGO	Non-governmental organization
PCF	Product Carbon Footprint
OECD	Organization for Economic Co-operation and Development

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