

# Determining recycled content with the 'mass balance approach'

10 recommendations for development of methods and standards

Position paper - February 2021



RETHINK  
PLASTIC



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## 10 recommendations for development of methods and standards

### Introduction

If the label on the bottle in your hand said it was made from recycled plastic, would you believe it? Depending on the method behind the claim, the bottle might contain little to no recycled content at all.

There is a clear need to increase recycled content in the context of a circular economy. In implementing the EU Single Use Plastics (SUP) Directive, an ambitious set of methods are needed for calculation, verification, and reporting of recycled content in beverage bottles which can live up to the purpose of the European Union's (EU) circular economy agenda. Such a method can later form the basis for determining recycled content beyond single-use packaging such as other packaging, vehicles, and electronics.

The 'mass balance approach' is one such set of rules for determining the use of recycled content<sup>1</sup> in products such as plastic packaging in order to claim and market the content as 'recycled'. The EU is now developing these rules for both mechanical and 'chemical recycling'.<sup>2</sup> **If the rules for mass balance are developed too loosely, this method could become a major tool for greenwashing and would allow companies to claim and market products as made from recycled materials regardless of their true content. Ultimately, this could block incentives to improve recyclability of plastics and to increase the amount of recycled content in products, while harming the credibility of the recycling industry.**

A mass balance approach must be strictly regulated and not allow for unreliable 'creative accounting'. It is crucial that, if the mass balance approach is used in the context of calculating recycled content in plastic packaging and other materials, limited flexibility is allowed to ensure that the targets for circularity in the EU (and globally) are not undermined.

Key industry players, including those from the 'chemical recycling' industry, are now calling for a mass balance method which allows for very flexible rules - such as a liberal allocation of recycled feedstock to the final product of their choosing, regardless of its true content. This would mean that a plastic product could be sold as fully recycled while containing only very small fractions of actual recycled content. **This is a simplistic and meaningless bookkeeping exercise.**

This position paper highlights recommendations to ensure that the methodologies for determining recycled content are developed in a manner which contributes to a circular economy.

### Our recommendations in short

The mass balance approach is not new for the industry. It is a well-known 'chain of custody'<sup>3</sup> model which has been used for years to introduce, for instance, 'sustainably harvested wood' into furniture, or 'organic cotton' in textiles. What is new is the application of mass balance specifically to recycling to determine recycled content in the chemical industry. If the mass balance approach is to be used to manage supply chains where recycled feedstock such as plastic is mixed with virgin fossil feedstock to develop new products, we recommend the following:

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<sup>1</sup> For a brief description of the difference between 'recycled content' and 'recyclability' see here: <https://sustainablepackaging.org/101-recycled-content-vs-recyclability/>

<sup>2</sup> 'Chemical recycling' is put in citation marks to reflect the lack of common definition of the term and technologies and the need for distinction between chemical recycling and recovery technologies (such as pyrolysis and gasification). In reality, recycling should not be used to reference for example recovery of feedstock for petrochemical industry

<sup>3</sup> 'Chain of custody' is the general term to describe the approach taken to demonstrate the link (physical or administrative) between the verified unit of production and the claim about the final product. More details available at:

[https://www.isealalliance.org/sites/default/files/resource/2017-11/ISEAL\\_Chain\\_of\\_Custody\\_Models\\_Guidance\\_September\\_2016.pdf](https://www.isealalliance.org/sites/default/files/resource/2017-11/ISEAL_Chain_of_Custody_Models_Guidance_September_2016.pdf)

1. **Aim for the highest possible amount of recycled content** and segregate recycled feedstock from virgin feedstock in the supply chain.
2. **Use 'batch level' mass balance to determine recycled content when segregation is not feasible**, which enables you to know the proportion of recycled material fed into the process and estimate actual recycled content in final products placed on the market.
3. **Do not allow for the trading of recycled content as part of a credit system**, both between sites and countries, including other sites belonging to the same company.
4. **Evenly allocate the recycled content to output products where mass balance is used** instead of allocating it arbitrarily (unless the actual recycled content of each output can be verified).
5. **Ensure strong physical and chemical traceability of recycled content**, thus ensuring that there is a proven chemical route between the input feedstock and the final product; and that input material can only replace its own share of the final product.
6. **Avoid converting recycled content into theoretical 'currencies'**<sup>4</sup> such as calorific value or carbon, which would further facilitate a certification scheme for recycled content.
7. **When determining recycled content, only include post-consumer waste and not pre-consumer waste.**
8. **Set strict eligibility criteria for plastic waste used for 'chemical recycling'** to avoid competition with mechanical recycling feedstock.
9. **Account for the full life cycle of products in the chain of custody model**, taking consideration to material and carbon losses.
10. **Ensure full transparency towards consumers** by avoiding false claims and excluding additives from counting towards recycled content targets.

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<sup>4</sup> Such theoretical currencies, including carbon or calorific value, would facilitate the untransparent trading of recycled content

## What is the 'mass balance approach'?

'Mass balance' is an accounting principle that matches inputs (such as plastic waste) with outputs from a recycling or production process, to determine the recycled content.

The mass balance method is therefore useful for manufacturers who face recycled content targets or want to advertise their products as bearing a specific characteristic; in our case, recycled plastic. It should be noted that the mass balance approach is not just one homogenous approach, but includes several different models with large differences in accounting and flexibility. The physical mixing of materials, for example recycled and virgin plastics, is allowed (but not required) at any stage in the production process. However, the quantities must be documented. According to ISEAL,<sup>5</sup> the mass balance approach is very heterogeneous and varies depending on whether the mixing occurs at batch-level, site level, or multi-site level.

## Recommendations for determining recycled content

Zero Waste Europe and ECOS, supported by the Rethink Plastic alliance, have studied the existing certification schemes, industry initiatives, and proposed methods and standards under development for the mass balance approach. The following main issues and recommendations have been identified:

- 1. Aim for the highest possible amount of recycled content and segregate recycled feedstock from virgin feedstock in the supply chain:** always prefer the most credible and transparent chain of custody model relying on either identity preservation or physical segregation of recycled inputs. The chain of custody system ensuring the most environmental integrity, credibility, transparency, and the easiest to verify is the one which does not allow mixing of different inputs - in this case, virgin with recycled materials into the same product. For this reason, the ambition should always be to integrate as much recycled content as possible into the product so that physical segregation of inputs is possible through each step of the supply chain. While segregating the inputs would also require separate process steps and logistics, it considerably simplifies recycled content accounting and ensures a fair communication towards targets and consumers.
- 2. Use 'batch level' mass balance to determine recycled content when segregation is not feasible.** Segregation between virgin and recycled feedstock is not always preferable for the industry. For so-called 'chemical recycling' technologies, the recovered feedstock coming out of the process is too contaminated to be directly integrated in new plastic products and must be diluted or mixed with virgin fossil material to be clean enough to meet the requirements needed to produce new plastics. It should be noted that while this mixing of inputs may make the feedstock ready to use in new plastic, it also significantly reduces the yield or level of recycled content ultimately coming out of the process. If such mixing calls for the use of a mass balance approach, then this must be via the 'batch level mass balance'. This specific mass balance system enables you to know the proportion of recycled material fed into the process at the batch level, and can provide a rather precise estimate of the actual recycled content contained in final products placed on the market. The 'batch level' mass balance system ensures a much higher accuracy of information provided to consumers than any other mass balance system.
- 3. Do not allow for the trading of recycled content as part of a credit system, between sites and countries, including to other sites belonging to the same company.** Recycled feedstock should be used at the site where the end product is made and should not be transferred or traded between multiple sites or countries. Such trading schemes undermine the credibility of recycled products and transparency of recycling systems.  
Many private actors call for the possibility to allocate recycled feedstock to materials and products produced in other sites or other countries, even when there is no connection to the recycled feedstock in the supply chain. This is sometimes called 'multi-site' or 'group level' mass balance. This is concerning from both credibility as well as verification perspective

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<sup>5</sup> [https://www.isealalliance.org/sites/default/files/resource/2017-11/ISEAL\\_Chain\\_of\\_Custody\\_Models\\_Guidance\\_September\\_2016.pdf](https://www.isealalliance.org/sites/default/files/resource/2017-11/ISEAL_Chain_of_Custody_Models_Guidance_September_2016.pdf)

as it changes the nature of the chain of custody system by borrowing characteristics from certificate trading systems<sup>6</sup>. Here, the end product contains no known recycled content and there is no physical traceability through the supply chain. Furthermore, aggregating recycled material at company/group/multi-site level does not drive structural changes in companies. Rather than ensuring that investments are made to increase recycled content in products from all plastic production lines, an aggregated mixing level enables companies to marginally change/invest in a limited number of sites and allocate recycled content to any of their products, coming out from any site, even those not having fed any recycled materials into their processes. This would be a missed opportunity to achieve the structural changes needed for a transition to a circular economy.

4. **Evenly allocate the recycled content to output products where mass balance is used, instead of allocating it arbitrarily (unless the actual recycled content of each output can be verified).** The recycled content should be reported to competent authorities and claimed to consumers as such, and not simply allocated to the product which would benefit the most from having a sustainability label from a marketing perspective.<sup>7</sup> See 'The cake comparison' below.

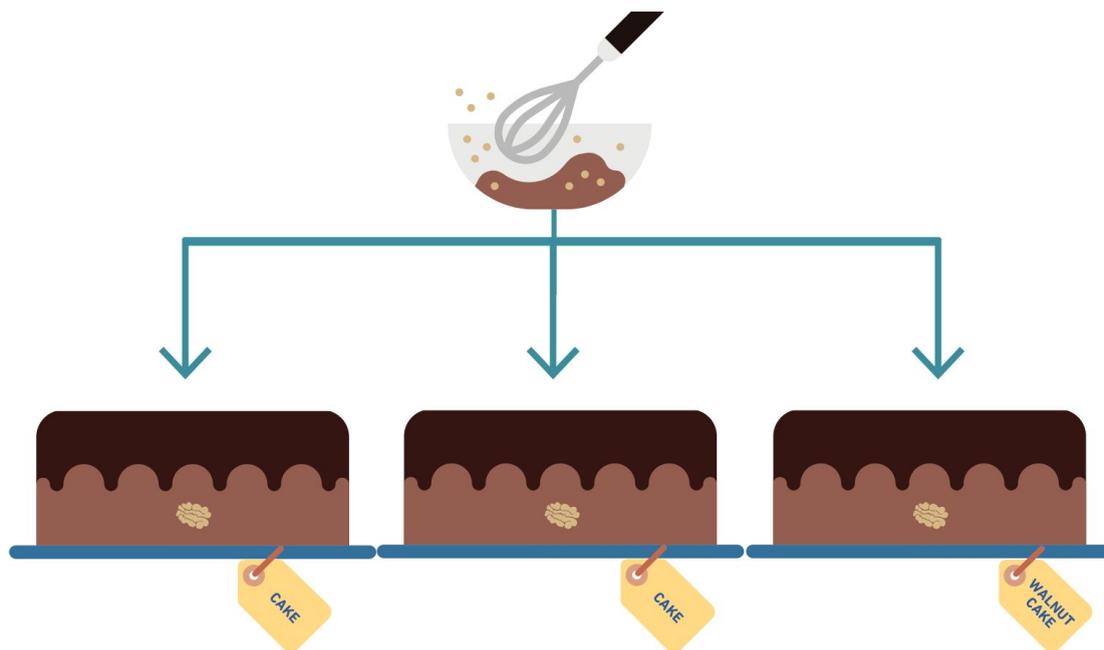


Figure 1: The cake comparison

#### The cake comparison

A handful of walnuts are mixed with other ingredients in a cake factory. The walnuts are mixed into the batter and distributed across the cakes. The number of walnuts going in is so low that only a couple of walnuts find their way into the final cake. However, the company knows there is a market for 'walnut cakes' and decides to market some of the cakes as 'walnut cakes'. In reality, the company has not monitored to make sure the cake contains walnuts, and the cake may contain little to no nuts at all. Customers expecting walnuts in their cake may find themselves misled and disappointed.

The company decides to market the other cakes simply as 'cakes' and chooses not to disclose that the 'cake may contain walnuts. In addition to being misleading, this particular flaw in disclosing the content of the cake might be a health hazard to allergic consumers. Similarly, the mass balance approach could be misused to allow for false accounting and marketing of recycling content in plastic packaging.

<sup>6</sup> This is sometimes called 'multi-site' or 'group level' mass balance when the certificate trading happens between locations and sites owned by the same group or company, or 'certificates trading' when it is traded more freely between different companies.

<sup>7</sup> This is of course unless the actual recycled content of each output can be verified

- 5. Ensure strong physical and chemical traceability of recycled content:** we call for a strong physical and chemical traceability<sup>8</sup> of virgin versus recycled feedstock for determining recycled content in new products. Such traceability should be complied with by ensuring that there is a proven chemical route between the input feedstock and the final product and that input material can only replace its own share of the final product. Recycled feedstock should not be allowed to be allocated to a product to which there is no feasible chemical pathway. For example, recycled PET should not be reported as nylon in the final product. In other words, it should not be possible to 'turn apples into truffles'. This is especially important considering the different market value of different plastics. In addition, allowing for one plastic type to be traded for another would harm incentives to increase recyclability of the plastic, especially where the other plastic type is no longer recyclable, and block efforts to phase out certain types of harmful or unsustainable plastics. The physical and chemical traceability of materials can be further guaranteed by ensuring that the 'batch level' mass balance approach is used (see recommendation 2), whereby the recycled feedstock is used at the site where the end product is made instead of being traded between sites (see recommendation 3).

Furthermore, if the mass balance method applied lacks transparency and chemical and physical traceability, we would strongly advise against companies using claims provided by the mass balance approach for marketing purposes on products in a way that may influence consumer behaviour.

- 6. Avoid converting recycled content into theoretical 'currencies':** for certain methods of determining recycled content, instead of following material and chemical flows transparently, certification schemes and private initiatives are suggesting the conversion of recycled feedstock into a theoretical 'currency'; a sort of proxy for recycled content. This currency could be in the form of mass, calorific value, or carbon. The conversion into a currency leads to less transparency and traceability of the materials and makes it more difficult to understand the final fate of the inputs (for instance the amount of 'chemically recycled' content in a final product). Once the input is converted into this currency, the latter is traded and no longer represents the recycled material itself. There is also a risk that the choice of currency or proxy is made in a strategic way to 'hide' key process losses in the system. If a transparent 'batch level' approach were applied (see recommendation 2), there would be no need to translate recycled content to a theoretical currency.
- 7. When determining recycled content, only include post-consumer waste and not pre-consumer waste:** pre-consumer waste is material diverted from the waste stream during a manufacturing process. No pre-consumer waste input should be allowed in the mass balance certification schemes. This would be in line with the EU legal practice, such as in the Single Use Plastics Directive (where the plastic recycled content target is only valid for beverage bottles already placed on the market), the Packaging and Packaging Waste Directive (that excludes production residues from the definition of packaging waste), and the 2018 Plastics Strategy.<sup>9</sup> Moreover, considering pre-consumer waste would undermine the efficiency of the production process and deter waste reduction. This is confirmed in the Niselli case:<sup>10</sup> pre-production plastic scraps cannot be considered waste when they are being included in other plastic items because this is an efficiency measure for the production process, as it saves raw material and provides a financial and operational advantage to the producer and not a burden.
- 8. Set strict eligibility criteria for plastic waste used for 'chemical recycling' to avoid competition with mechanical recycling feedstock:** for 'chemical recycling', no mechanically recyclable waste input (such as PET beverage bottles) should be allowed to be fed as input materials eligible to be claimed as 'recycled content'. Because of the cost and challenge of sorting and separating, most chemical recyclers are not targeting low quality waste but rather the same waste streams that would typically be used in mechanical recycling. Due to the technical and environmental limitations of chemical recycling and recovery technologies, we recommend strict eligibility criteria so that plastics waste streams fit for

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<sup>8</sup> The importance of physical and chemical traceability in mass balance has also been highlighted by a number of Swedish industry representatives: <https://www.trioplast.com/media/2249/pressrelease-traceable-mass-balance.pdf>

<sup>9</sup> European Commission Staff Working Document accompanying the European Strategy for Plastics in a Circular Economy SWD (218) 16, sections 2.3.1 and 2.3.3.

<sup>10</sup> ECJ, 2004, Case C-457/02, Niselli, para. 46, see: <http://curia.europa.eu/juris/liste.jsf?language=fr&num=C-457/02>.

mechanical recycling are not diverted to chemical recycling processes. For more information on the limitations of the use of chemical recycling, see the publications in the footnote.<sup>11</sup>

- 9. Account for the full life cycle of products in the chain of custody model, from sorting and recycling towards final integration into new products.** For chemical recovery technologies such as pyrolysis,<sup>12</sup> this means accounting of the full process, including the breaking down of the plastic to its basic building blocks (oil), purification of resulting pyrolysis oil, feeding the oil through the crackers, and producing the plastic which eventually may end up in a product. By covering the full process, the material and carbon losses are taken into account, giving a more transparent picture of how much recycled content it is possible to produce.
- 10. Ensure full transparency towards consumers:** brands and product manufacturers communication towards consumers should be as transparent as possible. Brands should not be allowed to make recycled content claims based on a mass balance approach which lacks physical and chemical traceability, and whereby recycled content is loosely allocated to products. **Only trustworthy green claims, which reflect the actual recycled content in final products, should be allowed and supported. In particular, claims not directly related to the fact that recycled input is used, and extrapolating the potential environmental impacts of using recycled inputs – such as ‘reduces greenhouse gas emissions’ or ‘climate friendly’ – should in no way be displayed.**

In addition, brands and product manufacturers should inform the consumers about the disaggregated amounts of virgin feedstocks, those of recycled content and those of additives in their products. Additives can represent up to half of the content in plastic materials and should not count towards recycled content targets. Handling of additives in the mass balance approach should be fair, consistent, and future-proof. Allowing additives to count towards the recycled content targets risks creating perverse incentives and weaken efforts for toxic-free and recyclable plastics. The percentage of additives in final products should be reflected alongside the recycled content claims. This means that a product containing additives could never contain or claim 100% recycled content.

## The risk of using flexible mass balance for ‘chemical recycling’

The chemical and thermal treatment of plastic waste through solvolysis, pyrolysis or gasification is sometimes referred to as ‘chemical recycling’. For technologies such as pyrolysis, this is closer to being a ‘chemical recovery’ operation rather than recycling. Here, plastic waste is converted to its original building blocks and either transformed to fuel or feedstock for the petrochemical industry. In a few cases the pyrolysis output (oil) is used as feedstock to produce new plastic.

Numerous studies have found that pyrolysis oil from waste plastic has a very high level of toxic pollutants (see Rollinson and Oladejo, 2020<sup>13</sup> for a more complete description). These include heavy metals as well as chlorinated, fluorinated, and brominated compounds. Many of these contaminants are added to plastic during manufacturing, to impart particular properties. Others, such as dioxin, are produced in the pyrolysis process itself. In addition, the hydrocarbon mix in the oil is not the right mix for plastic production.

As a result of the contamination, pyrolysis oil cannot meet the specifications of thermal crackers used in plastic production. There are two possible solutions to this problem:

- 1. Purification:** one is to remove the contaminants, upgrade the oil and change the hydrocarbon mix until it meets industry specifications. However, this process is energy-intensive, carbon-intensive, and low-yield.<sup>14</sup> In particular, approximately

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<sup>11</sup> GAIA: [https://www.no-burn.org/wp-content/uploads/CR-Technical-Assessment\\_June-2020.pdf](https://www.no-burn.org/wp-content/uploads/CR-Technical-Assessment_June-2020.pdf)

ZWE: <https://zerowasteurope.eu/2020/07/chemical-recycling-legislation-should-take-a-precautionary-approach/>

CHEMTrust: <https://chemtrust.org/wp-content/uploads/Chemical-Recycling-Eunomia.pdf>

<sup>12</sup> For a recent blog on the topic see <https://zerowasteurope.eu/2021/01/chemical-recycling-underwhelming-oversold/>

<sup>13</sup> <https://www.no-burn.org/chemicalrecycling/>

<sup>14</sup> Seidl et al., 2020; Mamani-Soliz et al., 2020;

half the carbon in the pyrolysis oil is lost as CO<sub>2</sub> during the cleanup/upgrading process. So this approach is not favoured by industry.

2. **Dilution:** the other approach is dilution. A small quantity of pyrolysis oil can be mixed into a much larger quantity of virgin fossil feedstock. This will reduce the contamination and unsuitable hydrocarbon mix sufficiently to allow for production, but it also means only a small portion of recycled feedstock will find its way to the final product.

To facilitate the process of making chemically recovered pyrolysis oil ready for integration into new plastic by diluting it with virgin fossil feedstock, the petrochemical companies are adopting the 'mass balance approach'.

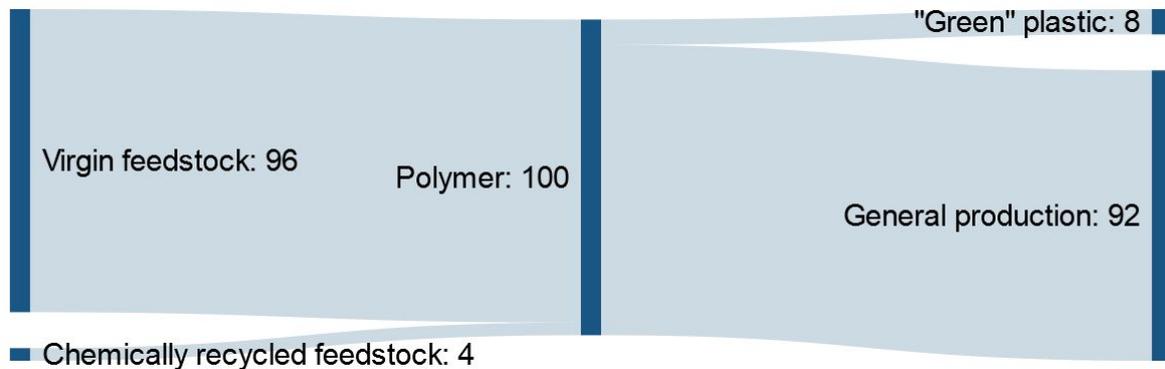


Figure 2: An example of a mass balancing process for 'chemical recycling'. The numbers are purely hypothetical.

In the hypothetical example above, 4 tons of "chemically recycled" feedstock is diluted with 96 tons of virgin material. The 4 tons of recycled feedstock is then allocated to 8 tons of "green" plastic produced, allowing the company to sell 8 tons of plastic that "has 50% recycled content". The other 92 tons of production are sold without claiming any recycled content. In reality, the recycled feedstock is blended throughout the outputs and there are no attempts to segregate or track the amount of recycled content actually present in the different outputs.

By preferentially allocating recycled content, manufacturers are able to meet customer or regulatory demands for high recycled content while fabricating the true content in the final products and without having to adapt their processes to increase the actual levels of recycled content. **As long as manufacturers continue to rely on dilution to address the challenges of contamination, the proportion of recycled feedstock will remain quite low. Increased levels of chemical recycling must thus be matched by increasing levels of virgin polymer production.** If manufacturers begin cleaning and upgrading the pyrolysis oil, the yield will drop considerably. Again, this will need to be compensated for by increased virgin production or competition with waste which would otherwise go towards mechanical recycling. Either way, pyrolysis or gasification offer no routes to a circular economy and a mass balance approach which allows for free allocation is an inappropriate tool to increase recycling rates.

#### Certification systems for mass balance

Several certification systems already exist in the field of recycled content of plastic products. They all derive from systems initially certifying biomass used in biofuels, then biomass for bio-based products, and for a couple of years, recycled-content in products. RSB, RedCert or ISCC plus are among the most famous.

Several existing certification schemes allow flexible allocation, which leads to deceptive claims. For instance, as far as bio-based products are concerned, these schemes allow the placing on the market of the so called 'renewable attributed products' i.e. products whose bio-based content is allocated by means of creative accounting, and can reach 100% even though physically and technically speaking, their true bio-based counterparts would not even be able to reach that percentage. This is now also allowed for recycled content related claims.

Sustainability certification schemes have a responsibility to ensure that their seal of approval is not used for greenwashing purposes and should stop allowing the loose attribution of characteristics where it best suits the manufacturer's economic interest.

## In a nutshell, how to prevent a greenwashing exercise

The different ways in which industry players are attempting to misuse the mass balance approach to chain of custody are clear cases of greenwashing, which also have serious implications for the circular economy.

Chain of custody models for assessing recycled content or certifying products play an important role in communicating sustainability aspects towards consumers. For instance, if physical segregation of certified and non-certified materials is required, as is the case in the certification of organic food products, it is possible to tell consumers that 100% of a product bears the organic characteristics of the certification. Similarly for plastic recycling, if 'batch level' mass balance is used, it is possible for product manufacturers to know the percentage of certified recycled content in the final product. The level of information remains high and claims such as 'contains at least x% of recycled material' can be made. If, however, recycled content is instead attributed to a final product according to a more flexible mass balance approach, only softer claims can be made such as 'supports the introduction of recycled materials in the production system' or 'contributes to the recirculation of materials'.

It is not obvious whether consumers can understand the subtle differences between these various claims. **If the sustainability claim is perceived equally by consumers, why would companies and brand owners be interested in increasing the share of recycled content in the product in order to make stronger claims?**

The EU has set clear recycled content targets for bottles in the Single Use Plastics Directive: 25% recycled content for PET bottles by 2025 and 30% recycled content in all bottles by 2030. Such targets are well suited for a 'batch level' mass balance type of communication of the recycled content and there is no need to allow for more flexible accounting and communication exercises under the name of 'mass balance' to distract decision-makers and consumers.

## Resources

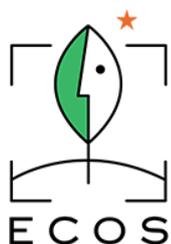
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- CHEMTrust: <https://chemtrust.org/wp-content/uploads/Chemical-Recycling-Eunomia.pdf>
- Plastics Europe position paper: mass balance approach to accelerate the use of renewable feedstocks in chemical processes <https://www.plasticseurope.org/en/resources/position-papers>
- American Chemistry Council: <https://plastics.americanchemistry.com/recycling-and-recovery/Mass-Balance-Certification-Principles-2020.pdf>

Author(s): Shanar Tabrizi (ZWE), Mathilde Crêpy (ECOS), Fanny Rateau (ECOS)  
 Editor(s): Janek Vahk, Justine Maillot, Ana Oliveira (ZWE)  
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Zero Waste Europe is the European network of communities, local leaders, businesses, experts, and change agents working towards the same vision: phasing out waste from our society. We empower communities to redesign their relationship with resources, to adopt smarter lifestyles and sustainable consumption patterns, and to think circular.



ECOS is an environmental NGO with a network of members and experts advocating for environmentally ambitious technical standards, policies, and laws. We ensure the environmental voice is heard at the table where these standards, policies, and laws are developed, challenging policymakers and industry players to implement strong environmental principles.



Rethink Plastic, part of the Break Free From Plastic movement, is an alliance of leading European NGOs working towards ambitious EU policies on plastics. It brings together the Center for International Environmental Law (CIEL), ClientEarth, Environmental Investigation Agency (EIA), European Environmental Bureau (EEB), European Environmental Citizen's Organisation for Standardisation (ECOS), Greenpeace, Seas At Risk, Surfrider Foundation Europe, and Zero Waste Europe. Together they represent thousands of active groups, supporters and citizens in every EU Member State working towards a future free from plastic pollution.



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