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International Sustainability & Carbon Certification

Guidance

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PLUS

ISCC PLUS Mass Balance Guidance Document

Version 1.0

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Contents

1. Introduction

Chain of Custody

Under ISCC PLUS there are three different chain of custody options: physical segregation, controlled blending and mass balance. These chain of custody options differ in their connection between the physical material and the sustainability characteristics.

Mass Balance

Mass balance is the chain of custody method, where certified and non-certified materials can be physically mixed during storage, transport or processing, but are kept segregated on a bookkeeping basis. The mass balance model does not allow entities to claim more certified products than sourced.

Mass balance is a key enabler of the circular and bio-based economy. It allows companies to incorporate renewable and recycled feedstocks into existing production systems in a cost-effective way—making the transition to sustainable materials both practical and scalable.

Level playing field

To fully utilize the mass balance approach, it is important that all the stakeholders have the same understanding about the rules and limitations of mass balance. In this guidance document, the practical application of ISCC PLUS mass balance guardrails will be described in detail.

This document serves as a supporting document to the requirements set in the System Document *ISCC PLUS 203-2 – Chain of Custody*. General requirements and detailed definitions related to the mass balance system are outlined in the system document. ISCC PLUS Mass Balance Approach aims to align with the relevant international standards such as ISO 22095 and ISO 13662, which are referenced in this document through footnotes.

Regular updates

The examples present as of now can be developed further and in addition, new examples are being developed, based on which the present Mass Balance Guidance document will be updated regularly.

2. Mass Balance Bookkeeping under ISCC PLUS

Sustainability characteristics in Bookkeeping

In the context of mass balance accounting, the quantities of both certified and non-certified materials are systematically recorded in terms of incoming and outgoing materials, as well as remaining inventory. In the System Document *ISCC PLUS 203-1 – Traceability,* all the mandatory and voluntary information on the sustainability characteristics that shall be reflected to the sustainability declarations are described[1]. In order to ensure this information is kept correctly, the same mandatory and voluntary information on the sustainability characteristics shall also be maintained for the Mass Balance bookkeeping under ISCC PLUS.

While the sustainability characteristics of the material remain assigned on a bookkeeping basis under mass balance, physically the materials are allowed

[1] *More on the mandatory and voluntary information related to sustainability characteristics of material can be found in the Sustainability Declaration Guidance Document.*

to be mixed with other materials with different sustainability characteristics as well as non-certified (fossil) materials. The quantity bookkeeping and physical mixture of certified material is limited to certain periodical, spatial and also legal boundaries. It is mandatory for the system users to keep site-specific and in cases that certified site has multiple scopes, scope-specific mass balance bookkeeping.

The requirements for mass balance bookkeeping under ISCC PLUS are stated in the System Document *ISCC PLUS 203-2 – Chain of Custody*.

2.1 Mass Balance Bookkeeping for Incoming Materials under Different ISCC Schemes

Only the materials that fulfils the conditions described in the System Document *ISCC PLUS 201 – System Basics*, can be accepted to the ISCC PLUS certified entities, thus their quantity bookkeeping. There are different options on how such transfer of materials from different schemes to ISCC PLUS can take place.

One site certified under both ISCC EU and ISCC PLUS

If a system user operates under both ISCC EU and ISCC PLUS schemes (have both ISCC EU and ISCC PLUS certificate in place for the same site), the bookkeeping for both schemes shall be strictly separated. It shall be ensured that no material is accounted more than once (double counting) in the mass balance bookkeeping (it shall be only accounted for once, either under ISCC EU or ISCC PLUS).

If the system user receives the ISCC EU certified (ISCC Compliant) material with the ISCC EU sustainability declaration, this material can be booked in either for ISCC EU or ISCC PLUS. The system user is free to choose the certification scheme for the particular incoming material(s), as they are certified under both schemes.

If the system user would like to use the ISCC EU certified (ISCC Compliant) input under ISCC EU, but certain co-products are to be used for the ISCC PLUS scheme, then the following steps shall be taken:

> The system user books the input material into the ISCC EU mass balance bookkeeping.

> The system user attributes the credits from the certified input to the products according to the ISCC EU mass balance rules.

> The (co-)products with attributed credits that are to be sent to ISCC PLUS supply chains are booked out of the ISCC EU mass balance bookkeeping and booked into the ISCC PLUS mass balance bookkeeping.

ISCC PLUS certified site receiving ISCC Compliant material from ISCC EU supply chain

If the system user receives the ISCC EU certified (ISCC Compliant) material with the ISCC EU sustainability declaration, this material can be booked into the ISCC PLUS certified bookkeeping. In such cases, appropriate raw material category shall be assigned to the material (bio or bio-circular).

There are some sustainability characteristics of the certified incoming material, which are optional under ISCC PLUS, but mandatory under ISCC EU. If the certified entity wishes to not maintain these (under ISCC PLUS voluntary) sustainability characteristics for the bookkeeping, it is possible to do so. However, if the certified entity wishes to preserve the origin of ISCC EU materials and transfer them further in the supply chain as such, the mass balance bookkeeping shall be kept in a way that materials with these sustainability characteristics are kept separately.

One site certified under both ISCC CORSIA and ISCC PLUS

If a system user operates under both ISCC CORSIA and ISCC PLUS schemes (have both ISCC CORSIA and ISCC PLUS certificate in place for the same site), the bookkeeping for both schemes shall be strictly separated. It shall be ensured that no material is accounted more than once in the mass balance bookkeeping (it shall be only accounted for once, either under ISCC CORSIA or ISCC PLUS).

If the system user receives ISCC CORSIA certified (upstream is completely ISCC CORSIA certified) material with the ISCC CORSIA sustainability declaration, this material shall be booked in for ISCC CORSIA bookkeeping.

If the system user is a producer of CORSIA Eligible Fuel (CEF) and other co-products and would like to use the product(s) that is not a CORSIA Eligible Fuel (CEF) under ISCC PLUS, which originates from the ISCC CORSIA certified input (upstream is completely ISCC CORSIA certified), then the following steps shall be taken:

> The system user books the input material into the ISCC CORSIA mass balance bookkeeping.

> The system user attributes the credits from the certified input to the products according to the ISCC CORSIA mass balance rules.

> The (co-)products that are not CORSIA Eligible Fuels (CEF) with attributed credits that are to be sent to ISCC PLUS supply chains are booked out of the ISCC CORSIA mass balance bookkeeping and booked into the ISCC PLUS mass balance bookkeeping.

2.2 Downgrading

Under ISCC PLUS, the term “downgrading” means changing sustainability characteristics of a product to a lower category or removing the voluntary sustainability characteristics, to have same type of products. It is not possible to change all the sustainability characteristics of a certified material, e.g. raw material category or type of recycling operations. After downgrading, if the rest of the sustainability characteristics are the same, it is possible to merge certified materials on a bookkeeping basis (refer to System Document *ISCC PLUS 203-2 – Chain of Custody*).

Under mass balance, it is possible to downgrade when:

> System users want to have a higher quantity of certified material with a similar set of sustainability characteristics.

> The complete information about the sustainability characteristics is not available for a batch of certified materials.

Some practical examples for downgrading are given in Annex II of this document, in accordance with the System Document *ISCC PLUS 203-2 – Chain of Custody*.

3. Consideration of Losses

Under the mass balance approach, when the materials are processed, the losses must always be taken into consideration. In the cases of processing certified and non-certified materials together, it is not possible to consider the losses only for non-certified materials. The process losses must be reflected to all type of inputs, and those losses must be based on the actual setup and operational data, not theoretical work.

Under ISCC PLUS, there are two methods, which allows the system users to account for their losses:

- Conversion Factor (see *Chapter 3.1*)
- Consumption Factor (see *Chapter 3.2*)

The following subchapters provide a brief overview of the calculation methods, based on System Document *ISCC PLUS 203-2 – Chain of Custody*. Further details on losses, conversion factors, and consumption factors can also be found in the same document.

3.1 Conversion Factor

Conversion factor is used to determine the amount of attributable credits to the output(s) based on the total amount of input and total amount of output of the processes. The attribution of credits (sustainable characteristics) must not exceed the amount of the certified input(s) and must be applied within the rules and system boundaries of the mass balance (refer to System Document *ISCC PLUS 203-2 – Chain of Custody*).

Conversion factor allows to account for the losses occurred during the processing of material. The calculation of conversion factor must be based on the operational data (not theoretical data).

$$CF(\%) = \frac{A_o}{A_i} \times 100 \tag{1}$$

CF: *Conversion Factor*
A_o: *Amount of the total produced output material*
A_i: *Amount of the total processed input material*

For operations that do not result in a change of quantity of the material, such as the storage of materials, the conversion factor (CF) can be assumed to be 1 (CF=1).

By applying the CF to the amount of certified input, system users can calculate the actual amount of credits of certified material that can be attributed to the process outputs. It is expressed as:

$$A_{Cr} = CF \times A_{CI} \tag{2}$$

A_{Cr} : Amount of Attributable Credits
A_{CI} : Amount of Certified Input

Conversion factor based on mass and energy:

The conversion factor is calculated based on the total amount of inputs and outputs. Only under the mass balancing option Free Attribution - *Attribution determined by energy* (refer to System Document *ISCC PLUS 203-2 – Chain of Custody*), the conversion factor is calculated based on the total energy contents of inputs and outputs.

3.2 Consumption Factor

Another way of accounting for the losses occurring during processing is using the consumption factor. Consumption factors reflect how much of an individual input material *i* must be consumed to produce a specific amount of the desired output material/ component (also taking material losses due to chemical reactions or process inefficiencies into account). When applying the consumption factor to certified inputs, the numerator A_i in the equation represents the mass of certified input material *i* consumed in producing the desired output, A_o , in the denominator.

$$ConsF_i = \frac{A_i}{A_o} \tag{3}$$

$ConsF_i$: Consumption Factor
A_o: *Amount of the total produced output material*
A_i: *Amount of produced output material with contribution of input i*

The determination of consumption factors must always be site specific and based on bills of material and/or process orders being updated and adjusted based on actual consumption data on a regular basis (e.g. annually), so it accounts for the losses of the reaction. Therefore, the amount of each individual input and output must be known prior to calculating the consumption factor.

This method is also applicable for multistep reaction network at one site (e.g. chemical park), where it may not be possible to use the above stated approach for the determination of the conversion factor of the site/processing unit. In such cases consumption factor can be more accurate than an overall conversion factor, since each process step can be analysed individually, leading to specific consumption factors for each individual input component of the process step.

In order to calculate the attributable amount of certified input to the output, the share of the respective input in the output, in addition to the consumption factor must be known, as described below:

$$Attribution\ Factor\ (i) = \frac{\text{Proportion of } input_i\ in\ output}{ConsF} \quad (4)$$

$$A_{Cr(i)} = m(input_i) \times AF_i \quad (5)$$

$A_{Cr(i)}$: Amount of Attributable Credits originating from input i
$m(input_i)$: Amount of certified input i
AF_i: Attribution factor of input i

3.3 Consideration of Losses for Water

Water is not among the list of eligible materials for ISCC. It is not possible to have water as a certified input or certified output.

When calculating the conversion factor in the setups where water is an input, amount of water as the input must be added for the total amount of input materials, as any other non-certified material.

When calculating the conversion factor in the setups where water is an output, the water shall be considered as a loss during the process, and it must be reflected to the conversion factor.[2]

When water is an output and certified shares originating from certified input are present in the water, this share cannot be re-attributed to the other products in the reaction and are considered lost.

[2] *For the cases, where water produced at the end of the process is a solvent, it is considered an integral part of the product until it is being removed. This approach is specific to those setups where all the inputs are certified, and water is originating from certified inputs. The product and the water (as solvent) are integral parts of the output. Once the water is removed, it is not counted towards the certified amount, since water is not among the certifiable materials, so the corresponding amount must be deducted from the total certified amount.*

4. Credit Method – Mass Balancing Options

Under ISCC PLUS Mass Balance – Credit Method, there are different mass balancing options for attribution of credits and the calculation/determination of certified share (see *Figure 1*).

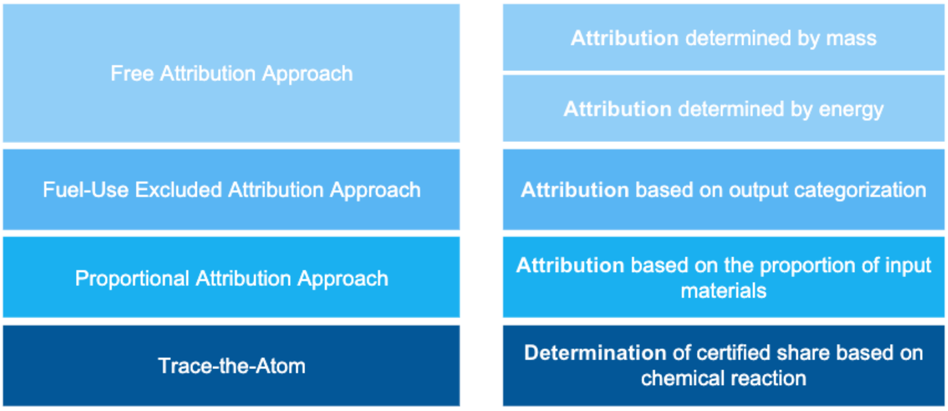

Figure 1: Overview on Credit Method - Mass Balancing Options under ISCC PLUS

4.1 Free Attribution Approach

Under the Free Attribution Approach, system users may freely assign sustainability characteristics from the certified input(s) to product(s) following the guardrails defined in the System Document *ISCC PLUS 203-2 – Chain of Custody*. The certified share is calculated based on either mass or energy and applying relevant conversion/consumption factors[3].

Chemical connectivity shall always be present for any Mass Balancing Option, including but not limited to the Free Attribution approach. Chemical connectivity refers to the proven link between certified inputs and process outputs, ensuring that the inputs can be chemically converted and feasibly processed into the final product. It requires both a theoretical chemical link and practical process feasibility, confirming that certified input atoms or molecules are present in the resulting output (see Chapter 4.5).

4.1.1 Similar-in-nature

As explained in the System Document *ISCC PLUS 203-2 – Chain of Custody*, under the Free Attribution Approach, sustainability characteristics of certified input material(s) can be assigned to one or multiple outputs. Input characteristics can follow one of the following options:

> Complete reflection of input characteristics, where the outgoing material’s certified share is completely reflected based on only the share of certified input(s).

[3] *It is not possible to use consumption factor, in case of attribution determined by energy*

> Compensation of input characteristics, where the non-certified inputs apart from the certified inputs are compensated based on the certified inputs' sustainability characteristics for the certified share of the outgoing material.

In cases, where the system user decides to follow the compensation of input characteristics, compensation is permitted only if:

> The certified inputs and other inputs, although not certified, are among the List of Materials Eligible for ISCC Certification and are "similar-in-nature"

> Between inputs that are intermediate products according to the list of materials eligible under ISCC

> Under Free Attribution for multi-input processes

> For materials that are handled under the scope of Processing Unit

> Within the Mass Balancing Guardrails

The "similar-in-nature" conditions are met if both inputs shall have an economic value within tenfold of each other and either one of the following conditions are met:

> Falls under the same "category for similar-in-nature" (Annex III)

> Both inputs are chemically convertible on a theoretical basis[4].

The "similar-in-nature" criterion can never be applied between organic and inorganic materials[5].

Moreover, in the Sustainability Declaration Guidance Document, the methods of transparent communication and information transfer regarding certified shares and certified material amounts are outlined. Furthermore, as the attribution of sustainable characteristics and the respective calculations, are governed by the "similar-in-nature" principle[6], Chapter 5 of this document demonstrates whether compensation between certified and non-certified input materials is feasible based on practical examples.

Categories for similar-in-nature, based on functionality and application of the materials that are eligible for certification and the logic tree be found in the Annex III.

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[4] *Chemical convertibility means that a material can be theoretically transformed into another without fully restructuring its molecular composition.*
[5] *Note that an organic hydrocarbon containing inorganic atoms is still considered organic.*
[6] *See ISO 13662:2025*

Starting from 01 January 2027, reflection of input characteristics will become a mandatory guardrail in case of free attribution. Compensation of input characteristics can be applied, only if the requirements for compensation (including the similar-in-nature aspect) is met between the certified inputs and inputs that are intended to be compensated (see System Document *ISCC PLUS 203-2 – Chain of Custody*).

4.2 Fuel-Use Excluded Attribution

Under the Fuel-Use Excluded Attribution approach, system users can allocate sustainability characteristics from certified inputs to outputs based on the classification of the outputs as either:

> Fuel outputs – used for energy generation (either used internally or sold to be used as fuel or sold to be processed into fuel), or

> Material (non-fuel) outputs – used for material application in products, product components or product precursors.

The certified share of input material that ends up in fuel-use outputs must be calculated based on actual yields or input shares (mass basis). The certified portion in fuel outputs are fixed and they cannot be reattributed to material (non-fuel) outputs.

The details on how to apply the Fuel-Use Excluded Attribution approach will follow in the upcoming versions of this document. To avoid any different Fuel-Use Excluded Attribution approach in the market, ISCC PLUS will publish the details of application only after the relevant legislations are set.

4.3 Proportional Attribution

Under Proportional Attribution Approach, the determination of the certified share of the outputs is based on the proportion of the certified inputs that are fed into that process. This approach is applicable for single input-single output, single input-multiple output and multiple input-single output scenarios.

The calculation of certified share of the output is calculated based on the share of certified input(s) to the total input(s), as given below:

$$\text{Share of certified input (\%)} = \left(\frac{\text{Amount of the certified input}}{\text{Total amount of all inputs}}\right) \times 100 \qquad (6)$$

$$\text{Certified amount of the respective output} = \text{Share of certified input (\%)} \times \text{Amount of respective output} \qquad (7)$$

For single input-multiple output setups, all the respective outputs shall have the same certified share. A "re-attribution" or "shift" of credits from one product of the process to another is not allowed under this approach (See Chapter 5, examples Steam Cracker and Renewable Energy). For the electrolysis process, it is mandatory to use Proportional Attribution Approach.

4.4 Trace-the-Atom

For this option, attribution follows the share of atoms originating from the input in the output. To apply this mass balancing option, the mechanism of the reaction must be known and followed.

$$\text{Certified share of the respective output (\%)} = \left(\frac{\text{Amount of certified input(based on atoms)}}{\text{Amount of respective output(based on atoms)}}\right) \times 100 \qquad (8)$$

To calculate the certified share, the amount of atoms (total molecular weight of atoms) originating from the certified input is divided by the molecular weight of the output.

If a system user chooses ISCC PLUS Trace-the-Atom approach as the mass balancing option, it is not possible for the system user to apply compensation of input characteristics. Even that the certified share of an output is determined via the chemical reaction under Trace-the-Atom, this approach is still credit based. The system user, which processes certified and non-certified inputs together, chooses dedicated product volumes to which the certified input is attributed to.

Notably, as the consumption factor calculations are based on the relation between the mass of individual input to the mass of the output of interest, the consumption factor must be either equal or bigger than the certified share calculated with Trace-the-Atom approach (See Chapter 5).

4.5 Mass Balancing Guardrails

The following guardrails/rules must be applied for the correct application of the mass balancing options:

1. **Chemical connectivity:** Chemical Connectivity must be ensured for the system user to attribute the sustainability characteristics from the certified input to the outputs. To verify the chemical connectivity, a clear understanding of production process (or reaction mechanism) and contribution of different inputs to produce the end-product(s).

   Under chemical connectivity, both the chemical link and process feasibility shall be in place (see *System Document ISCC PLUS 203-2 – Chain of Custody*)

2. **Physical Output:** The amount of attributable credits cannot be higher than the physical output (certified and non-certified) in a mass balance period. It is not possible to attribute to a quantity of output, which is not produced at the site within a mass balance period.[7]

3. **Operational Data:** Within the traceability system all data related to inputs, outputs, losses, production and attribution shall be collected and documented. All data used shall be valid for the relevant evaluation

[7] *If the attributable amount of credits is more than the actual physical output, it is not possible to keep the surplus amount as credit for that particular output.*

period. Each certified output material/product with specified characteristics must be calculated defined conversion or consumption factor, reflecting relevant inputs with specified characteristics. The conversion factor/consumption factor must be determined based on operational data.

4. **Site specific:** It must be ensured that the mass balance is done site specific. Under ISCC PLUS, both the mass balance accounting and mass balance calculations (the attribution/determination) must be done on a site level. Company level mass balance is not possible[8].

In addition, ISCC PLUS has the requirement when it comes to the transparent communication about the use of mass balance approach. It is crucial that the system users are communicating the use of mass balance with their downstream supply chain, which shall be communicated via Sustainability Declaration (See Sustainability Declaration Guidance Document). This transparent communication within the supply chain includes the transfer of information on:

- Used mass balancing option
- Multi-site credit transfer
- Compensation of input characteristics (if applicable)

Transparent communication is also critical for the end product communications and claims (for further details, refer to System Document *ISCC 208 – Logos & Claims*).

[8] Separate site-specific mass balances must be kept also for the dependent storage facilities covered under one certificate.

5. Examples for Mass Balance Calculations

In this Chapter, there are some practical examples from different sectors, based on the requirements and rules under ISCC PLUS for mass balance calculations. Examples in the chapter are solely for demonstration purposes and shall not be interpreted as actual or accurate data.

5.1 Steam cracker

In *Figure 2*, ISCC PLUS certified Naphtha and Fossil-based Naphtha are mixed, and processed together for the production of different products. Based on the process conditions of cracking naphtha and its composition, the amount of products that could be used for fuel applications (e.g. C4, Pygas, Diesel, etc.) or material applications (e.g. ethylene, propylene, butadiene, etc.) can vary. Below different attribution approaches are applied and compared based on this set-up.

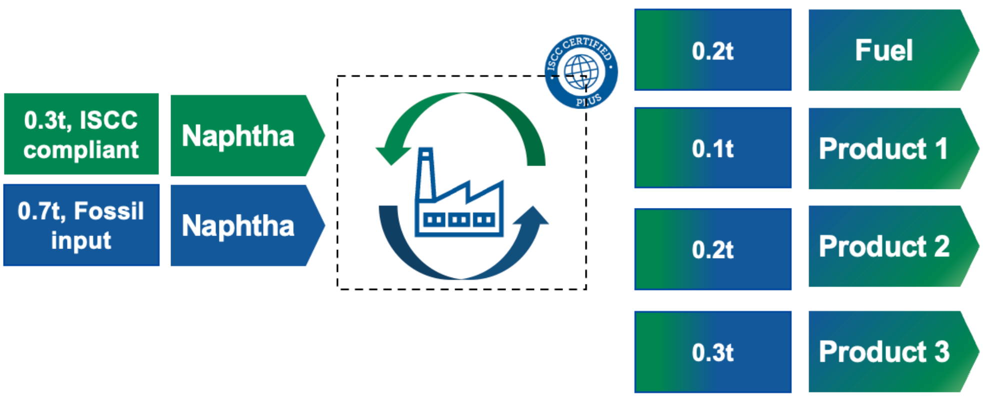

Figure 2: Numeric representation of the steam cracker setup of ISCC PLUS certified and fossil-based Naphtha over a mass balance period.

Free Attribution (attribution determined by mass) with conversion factor:

$$\text{CF} = \frac{\text{A}_O\ (Total\ mass\ of\ outputs)}{\text{A}_i\ (Total\ mass\ of\ inputs)} \qquad (1)$$

$$\begin{aligned}\text{Total amount of input}\\ &= \text{Amount of ISCC PLUS certified Naptha}\\ &+ \text{Amount of fossil Naphtha}\end{aligned}$$

$$\begin{aligned}\text{Total amount of output}\\ &= \text{Amount of Fuel} + \text{Amount of Product 1} + \text{Amount of Product 2}\\ &+ \text{Amount of Product 3}\end{aligned}$$

$$\text{CF} = \frac{0.8\ \text{ton}}{1\ \text{ton}} = 0.8$$

$$\mathrm{CF}(\%) = 0.8 \times 100 = 80\%$$

$$\mathrm{A}_{Cr} = \mathrm{CF} \times \mathrm{A}_{CI} \qquad (2)$$

$$\mathrm{A}_{Cr} = 0.3 \text{ ton} \times 0.8 = 0.24 \text{ ton} \ \ (240 \text{ kg})$$

Amount of attributable credit to the outputs/products is 240 kg. Under Free Attribution – attribution determined by mass, for the example above, the system user can choose to attribute the credits to one/some/all of the outputs following the guardrails defined in the System Document *ISCC PLUS 203-2 – Chain of Custody*.

If the system user chooses to attribute to Product 1, the maximum amount of attributable credit is 100 kg, since it is not possible to attribute more than the physical output (certified and non-certified) in a mass balance period.

Free attribution (attribution determined by energy) with conversion factor:[9]

$$\text{Total energetic content of inputs} = \text{Energetic Content of ISCC PLUS certified Naptha} + \text{Energetic Content of fossil Naphtha}$$

$$\text{Total energetic content of inputs} = (\text{Amount of ISCC PLUS certified Naptha} \times \text{Lower Heating Value of Naphtha}) + (\text{Amount of fossil Naphtha} \times \text{Lower Heating Value of Naphtha})$$

$$\text{Total energetic content of inputs} = \left(300 \text{ kg} \times 45 \frac{\text{MJ}}{\text{kg}}\right) + \left(700 \times 45 \frac{\text{MJ}}{\text{kg}}\right) = 45{,}000 \text{ MJ}$$

$$\text{Total energetic content of outputs} = \text{Energetic Content of Fuel} + \text{Energetic Content of Product 1} + \text{Energetic Content of Product 2} + \text{Energetic Content of Product 3}$$

$$\text{Total energetic content of outputs} = (\text{Amount of Fuel} \times \text{Lower Heating Value of Fuel}) + (\text{Amount of Product 1} \times \text{Lower Heating Value of Product 1}) + (\text{Amount of Product 2} \times \text{Lower Heating Value of Product 2}) + (\text{Amount of Product 3} \times \text{Lower Heating Value of Product 3})$$

[9] *The lower heating values for the outputs are based on realistic numbers but with illustrative purposes and therefore do not specify the exact fuel nor product.*

$$\text{Total energetic content of outputs}$$
$$= \left(200\text{ kg} \times 47\frac{\text{MJ}}{\text{kg}}\right) + \left(100 \times 48\frac{\text{MJ}}{\text{kg}}\right) + \left(200\text{ kg} \times 45\frac{\text{MJ}}{\text{kg}}\right) + \left(300 \times 46\frac{\text{MJ}}{\text{kg}}\right) = 37{,}000\text{ MJ}$$

$$\text{CF} = \frac{\text{A}_O(\text{Total energetic content of outputs})}{\text{A}_i(\text{Total energetic content of inputs})} \qquad (1)$$

$$\text{CF} = \frac{37{,}000\text{ MJ}}{45{,}000\text{ MJ}} = 0.82$$

$$\text{A}_{Cr}\ (\text{in Energy}) = \text{CF} \times \text{A}_{CI}\ (\text{Energetic content of certified input}) \qquad (2)$$

$$= 0.82 \times \left(300\text{ kg} \times 45\frac{\text{MJ}}{\text{kg}}\right) = 11070\text{ MJ}$$

Amount of attributable credits that can be attributed to different outputs:

$$\text{A}_{Cr}\ (\text{Energy to Mass}) = \frac{\text{CF} \times \text{A}_{CI}\ (\text{Energetic content of certified input})}{\text{LHV of attributed Product}}$$

Scenario 1 – Attribution to Product 1:

$$\text{Certified Amount (Product 1)} = \frac{11070\text{ MJ}}{47\text{ MJ/kg}} = 235\text{ kg}$$

The amount of attributable credits for Product 1 is maximum of 100 kg and if 100 kg (4700 MJ) of credits is attributed to Product 1, the available amount of attributable credits can be freely attributed among the other products. In this case, it needs to noted that the available amount of attributable credits would be in terms of energetic content as 6370 MJ (11070 MJ – 4700 MJ = 6370 MJ) and not 135 kg (235 kg – 135 kg).

Scenario 2 – Attribution to Product 3:

$$\text{A}_{Cr}\ (\text{Product 3}) = \frac{11070\text{ MJ}}{45\text{ MJ/kg}} = 246\text{ kg}$$

The amount of attributable credits for Product 3 is maximum of 246 kg and if 246 kg (11070 MJ) of credits is attributed to Product 3, no attributable credits would be available for other outputs. For instance, if the amount of attributable credits (11070 MJ) is attributed to only 100 kg of Product 3, the rest of the energetic content can be attributed to other output(s). The calculation will be as follows:

$$A_{Cr}\ (\text{available}) = (11070\ \text{MJ}) - \left(100\ \text{kg} \times 45\,\frac{\text{MJ}}{\text{kg}}\right)$$

$$A_{Cr}\ (\text{available}) = 6570\ \text{MJ}$$

The available attributable credits (in energy) of 6570 MJ can be attributed to other output(s). By calculating the mass for the other outputs to which the remaining energy can be attributed, one must divide to the respective LHV of this product, as already done for the previous examples.

Reflection of input characteristics:

Under Free Attribution, for the steam cracker example, reflection of input characteristics would not be relevant as there is only a single input of naphtha.

Proportional attribution:

For the same setup, the proportional attribution approach can be applied as following:

Figure 3: Example of the steam cracker setup of ISCC PLUS certified and fossil-based Naphtha over a mass balance period when Proportional attribution approach is applied.[10]

$$\text{Share of certified input (\%)} = \left(\frac{\text{Amount of the certified input}}{\text{Total amount of all inputs}}\right) \times 100 \qquad (6)$$

$$\text{Share of the certified input(\%)} = \left(\frac{0.3\ \text{t}}{1\ \text{t}}\right) \times 100 = 30\%$$

The certified share of each output will be the same (30%). It is not possible to reattribute the share between any of the outputs when Proportional attribution is applied. For the setup above, the amount of certified outputs will be:

[10] *The numbers presented are illustrative and can change based on the actual amount of certified input of naphtha and the distributed certified share among the products.*

$$\text{Certified amount of the respective output} = \text{Share of certified input (\%)} \times \text{Amount of respective output} \quad (7)$$

$$\text{Certified amount of Fuel} = 0.2\,\text{t} \times 30\% = 0.06\,\text{t}$$

$$\text{Certified amount of Product 1} = 0.1\,\text{t} \times 30\% = 0.03\,\text{t}$$

$$\text{Certified amount of Product 2} = 0.2\,\text{t} \times 30\% = 0.06\,\text{t}$$

$$\text{Certified amount of Product 3} = 0.3\,\text{t} \times 30\% = 0.09\,\text{t}$$

In this setup, it would be possible to claim the 0.09t of the 0.3t of Product 3 as 100% ISCC PLUS certified. However, it is not possible to re-attribute credits from other outputs to increase the amount of ISCC PLUS certified Product 3.

Trace-the-Atom approach

In a steam cracking process, a variety of chemical reactions are occurring to break down a mixture of mostly unsaturated hydrocarbons (naphtha) into olefins and aromatics. Hence, it is not possible to trace the atoms originating from the certified input to the output and calculate the certified share with the Trace-the-Atom approach.

On the molecular level of the outputs there is no uniform share of atoms originating from the certified naphtha for the molecules of one individual output. Since the certified share is required in order to find the attributable credits with the consumption factor, it is not possible to attribute those with the consumption factor for a steam cracking process.

5.2 Styrene

In the setup shown in *Figure 4*, an ISCC PLUS certified processing unit produces Styrene from Benzene and Ethylene. The processing unit receives 74 tons of ISCC certified Benzene and 26 tons of fossil ethylene. The multi-input, single output setup below is assumed to have no losses occurring during the process. As there are no losses during the process, **conversion factor is equal to 1.**[11]

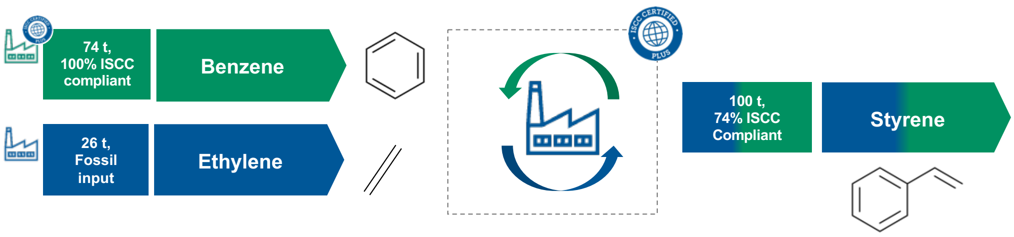

Figure 4: Example of Styrene production with certified Benzene

[11] *For simplicity reasons, the minimal amounts of hydrogen produced from this reaction is neglected in this example.*

Free Attribution (attribution determined by mass) with conversion factor:

The conversion factor of the reaction must be calculated, based on the amounts of input and output, accounting for the losses:

$$CF = \frac{Ao\ (Total\ mass\ of\ outputs)}{Ai\ (Total\ mass\ of\ inputs)} \qquad (1)$$

$$CF = \frac{100t}{74t + 26t} = \frac{100t}{100t} = 1$$

$$\mathrm{A}_{Cr} = \mathrm{CF} \times \mathrm{A}_{CI} \qquad (2)$$

$$\mathrm{A}_{Cr} = 74\mathrm{t} \times 1 = 74\mathrm{t}$$

Reflection of input characteristics:

Complete reflection of input characteristics

Under Free Attribution, the system user can choose to completely reflect the input characteristics, which means that 74 tons of 100 tons, i.e., 74% of 100 tons of Styrene, is claimed as certified.

Compensation of input characteristics

The other option is to choose compensation of input characteristics. Under this option, system user can claim 74 tons as 100% certified and 26 tons as 0% certified (or non-certified). Any compensation must be correctly indicated in the incoming/outgoing SD respectively.

Free Attribution (attribution determined by mass) – Compensation of input characteristics:

It would be possible to claim a certain batch of the styrene as 100% certified, if the system user decides to compensate them. Since the amount of attributable credits are 74 tons under free attribution (both calculated with conversion and consumption factor), the output cannot exceed that amount. However, if the outgoing batches are compensated, it would be possible to attribute the available credits completely to a single batch (or multiple), to have a 100% certified product (as in *Figure 5*).[12]

[12] *Under the current definition, benzene and ethylene as inputs can be considered as similar-in-nature.*

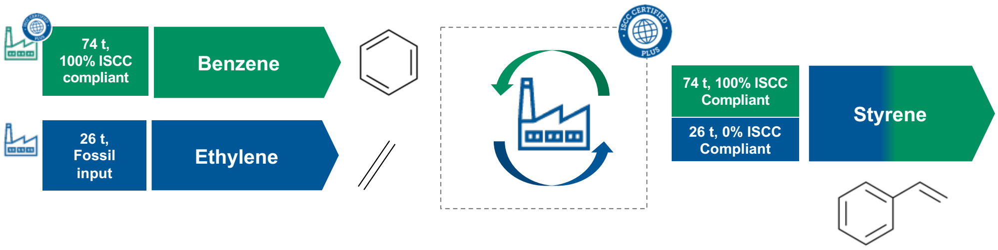

Figure 5: Example of Styrene production with one certified input under Free Attribution Approach (Compensation of input characteristics applied)

Trace-the-Atom approach:

Molecular weight of the inputs and outputs:

M (Benzene) = 6x12g/mol(C) + 6x1g/mol (H) = 78 g/mol
M (Ethylene) = 2x12g/mol(C) + 4x1g/mol (H) = 28 g/mol
M (Styrene) = 8x12g/mol(C) + 8x1g/mol (H) = 104 g/mol

Ratio of atoms coming from the ISCC certified input:

$C_{certified}$: 6/8
$H_{certified}$: 5/8

Molecular weight of the atoms coming from the ISCC certified input:

M (ISCC PLUS certified atoms) = 6x12g/mol(C) + 5x1g/mol (H) = 77 g/mol

$$\text{Certified Share (Styrene)} = \frac{\text{Amount of certified input(based on atoms)}}{\text{Amount of respective output(based on atoms)}} \quad (8)$$

$$\text{Certified Share (Styrene)(\%)} = \frac{77}{104} = 74\ \%$$

For the calculations of the consumption factor, one should apply the following:

$$ConsFi = \frac{Ai}{Ao} \quad (3)$$

$$ConsF = \frac{m(Benzene)}{m(Styrene)} = \frac{74}{100} = 0.74$$

Once the Consumption Factor (ConsF) for the certified input to the output is calculated, the following Attribution factor must be calculated based on the following:

$$\text{Attribution Factor (i)} = \frac{\text{Proportion of input(i)}\ in\ output}{ConsF} \quad (4)$$

$$AF_i = \frac{0.74}{0.74} = 1$$

$$A_{Cr(i)} = m(input_i) \times AF_i \qquad (5)$$

$$A_{Cr(i)} = 74 \times 1 = 74kg$$

In the given example, as there are no losses the amount of attributable credits with each of the calculation methods, are the same and equal to 74kg.

5.3 Vinyl acetate

In the following subchapter, an example of a common chemical reaction for the production of Vinyl Acetate (VA) is given, a monomer used for the production of Polyvinyl acetate (PVA) and Ethyl-vinyl acetate (EVA) polymers.

In *Figure 6* below, 5.57t of ISCC certified Ethylene reacts with 11.2t of fossil-based Acetic Acid and a small amount of oxygen, to produce 16.1t of ISCC certified Vinyl Acetate and 3.38t of water. Notably, when water is produced as an output, under ISCC PLUS it is considered as a loss and is therefore, excluded from the calculations.

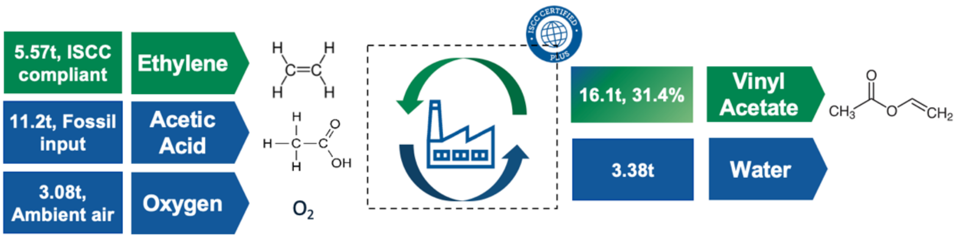

Figure 6: Example of Vinyl Acetate production

Free Attribution (attribution determined by mass) with conversion factor:

The conversion factor of the reaction shall be calculated, based on the amounts of input and output, accounting for the losses:

$$CF = \frac{Ao\ (Total\ mass\ of\ outputs)}{Ai\ (Total\ mass\ of\ inputs)} \qquad (1)$$

$$CF = \frac{16.1t}{5.57 + 11.2 + 3.08} = \frac{16.1t}{19.85} = 0.811$$

$$A_{Cr} = \mathrm{CF} \times A_{CI} \qquad (2)$$

$$A_{Cr} = 5.57\mathrm{t} \times 0.811 = 4.51\mathrm{t}$$

Reflection of input characteristics:

Complete reflection of input characteristics

Under Free Attribution, one option is that the system user can choose complete reflection of input characteristics, which means that 4.51 tons of 16.1 tons, i.e., the 28% of 16.1 tons of Vinyl-Acetate, is certified. It is also possible to claim 4.51 tons of 14.36 tons as certified (31.4% of 14.36 tons) and 1.74 tons as not certified, because this would still reflect the relative share of certified input in the product. With both options, complete reflection of input characteristics is fulfilled.

Compensation of input characteristics

The other option is to choose compensation of input characteristics. Under this option, system user can claim 4.51 tons as 100% certified and 11.59 tons as 0% certified (or non-certified). Any compensation must be correctly indicated in the incoming/outgoing SD respectively.

Trace-the-Atom approach:

Molecular weight of inputs and outputs:

M (Ethylene) = 2x12g/mol (C) + 4x1g/mol (H) = 28 g/mol
M (Acetic acid) = 2x12g/mol (C) + 4x1g/mol (H) + 2x16g/mol (O) = 60 g/mol
M (Vinyl Acetate) = 4x12g/mol (C) + 6x1g/mol (H) + 2x16g/mol (O) = 86 g/mol

Ratio of atoms coming from the ISCC certified input:

$C_{certified}$: 2/4
$H_{certified}$: 3/6
$O_{certified}$: 0/2

Molecular weight of the atoms coming from the ISCC certified input:

M (ISCC PLUS certified atoms) = 2x12g/mol(C) + 3x1g/mol (H) = 27 g/mol

$$\text{Certified share} = \frac{\text{Amount of certified input(based on atoms)}}{\text{Amount of respective output(based on atoms)}} \times 100 \qquad (8)$$

$$\text{Certified share (VA)} = \frac{27}{86} = 0.314 = 31.4\%$$

The certified share in vinyl acetate from ethylene was determined as 31.4%, or 0.314.

$$\text{ConsF(i)} = \frac{Ai}{Ao} \qquad (3)$$

$$ConsF = \frac{m(Ethylene)}{m(Vinyl\ Acetate)} = \frac{5.57}{16.1} = 0.345$$

In order to find the attribution factor, the calculations below must be followed:

$$AF(Ethylene) = \frac{\text{Proportion of input(i) } in\ output}{ConsF} \quad (4)$$

$$AF(Ethylene) = \frac{0.314}{0.345} = 0.91$$

$$A_{Cr(i)} = m(input_i) \times AF_i \quad (5)$$

$$A_{Cr} = 5.57 \times 0.91 = 5.068\ \text{t}$$

Under Trace-the-Atom approach, the system user can claim 5.068 tons of 16.1 tons, hence the 31.4% of 16.1 tons of Vinyl-Acetate, as certified. For any sub-batches of this 16.1 tons, it is not possible to change the certified share.

5.4 Polyphenylene sulphide (PPS)

The example shown in *Figure 7*, represents the conversion of ISCC certified Benzene to p-DCB, which is then converted in the second step of the reaction to ISCC certified PPS as final product (*Figure 8*).[13]

In the first step of this reaction, the processing unit receives 60 tons of ISCC certified Benzene and 108 tons of fossil chlorine. The multi-input, multi-output setup below is considering the losses occurring during the process, with Conversion factor (CF) of 0.95.

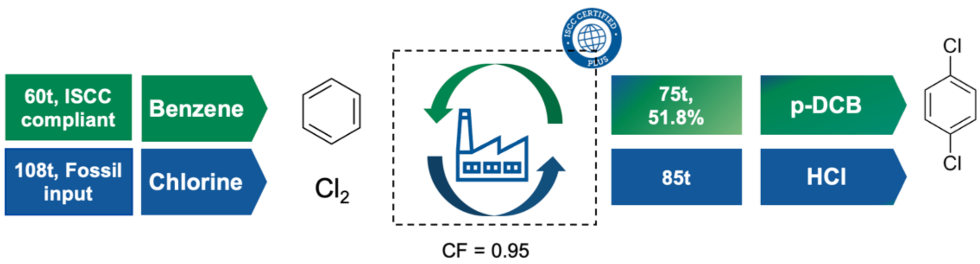

Figure 7: Example of para-dichlorobenzene (pDCB) production with certified input of Benzene under Free Attribution Approach (Complete reflection of input characteristics).

In order to account for the certified share, by applying the guardrail of the Mass Balance approach - reflection of input characteristics, the calculations below are followed:

[13] *Excluding the other by-products of the reaction, such as o,p-DCB and on the assumption that no credits are allocated to the other product in the reaction, HCl.*

First step of the reaction (based on *Figure 7*):

Free Attribution (attribution determined by mass) with conversion factor:

For the calculation of the conversion factor and the respective attributable credits the following is given:

$$CF = \frac{Ao\ (Total\ mass\ of\ outputs)}{Ai\ (Total\ mass\ of\ inputs)} \tag{1}$$

$$CF = \frac{75t + 85t}{60t + 108t} = 0.952 = 95\%$$

$$A_{Cr} = \mathrm{CF} \times A_{CI} \tag{2}$$

$$A_{Cr} = 0.952 \times 60\mathrm{t} = 57\mathrm{t}$$

Reflection of input characteristics:

Complete reflection of input characteristics

Under Free Attribution, when conversion factor is used, the amount of attributable credits is calculated as 57t of 75t in p-DCB. However, the certified share in the 75t reflecting the input characteristics is equal to 51.8% (see below Trace-the-Atom approach) which limits the amount of attributable credits to 38.85t in p-DCB. The difference between 57t and 38.85t, which is the available amount of attributable credits of 18.15t can either be attributed to the other batches of p-DCB or to the other products, e.g. HCl.

Compensation of input characteristics

Compensation of input characteristics will not be possible for this reaction since the benzene is not considered similar-in-nature to chlorine.

Trace-the-Atom approach:

Molecular weight of the inputs and outputs:

M (Benzene) = 6x12g/mol (C) + 6x1g/mol (H) = 78 g/mol
M (Chlorine)= 2x35.45g/mol (Cl) = 70.9 g/mol
M (p-DCB)= 6x12g/mol (C) + 4x1g/mol (H) + 2x35.45g/mol (Cl) = 147 g/mol
M (HCl) = 1x1g/mol (H) + 1x35.45g/mol (Cl) = 35.45g/mol

Ratio of atoms coming from the ISCC certified input:

$C_{certified}$: 6/6
$H_{certified}$: 4/4
$Cl_{certified}$: 0/2

Molecular weight of the atoms coming from the ISCC certified input:

M (ISCC PLUS certified atoms) = 6x12g/mol (C) + 4x1g/mol (H) = 76 g/mol

$$Certified\ share\ (pDCB) = \frac{\text{Amount of certified input(based on atoms)}}{\text{Amount of respective output(based on atoms)}} \times 100 \quad (8)$$

$$Certified\ share\ (pDCB) = \frac{76}{147} = 0.518 = 51.8\%$$

$$ConsF(i) = \frac{A_i}{A_o} \quad (3)$$

$$ConsF = \frac{m(Benzene)}{m(pDCB)} = \frac{60t}{75t} = 0.8$$

In order to find the attribution factor, the calculations below must be followed:

$$Attribution\ Factor(i) = \frac{Proportion\ of\ input(i)\ in\ output}{ConsF} \quad (4)$$

$$AF(Benzene) = \frac{0.518}{0.8} = 0.647$$

$$\mathrm{A}_{Cr(i)} = m(input_i) \times AF_i \quad (5)$$

$$\mathrm{A}_{Cr} = 60 \times 0.647 = 38.85$$

Therefore, the amount of credits that one can attribute to the p-DCB from the certified Benzene is equal to 38.85t.

Second step of the reaction (based on Figure 8):

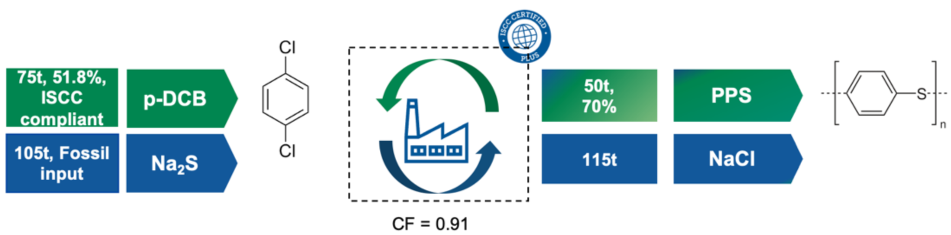

Figure 8: Example of polyphenylene sulphide (PPS) production with certified input of p-DCB under Free Attribution Approach (Complete reflection of input characteristics)

Free Attribution (attribution determined by mass) with conversion factor:

For the calculation of the conversion factor and the respective attributable credits the following is given:

$$\mathrm{CF} = \frac{Ao\ (Total\ mass\ of\ outputs)}{Ai\ (Total\ mass\ of\ inputs)} \quad (1)$$

$$\text{CF}(\%) = \frac{(50t + 115t)}{(75t + 105t)} = \frac{165}{180} = 0.917 = 91.7\%$$

$$A_{Cr} = \text{CF} \times A_{CI} \qquad (2)$$

$$A_{Cr} = 0.917 \times 38.85\text{t} = 35.62\text{t}$$

Reflection of input characteristics:

Complete reflection of input characteristics

Under Free Attribution for the second step of the reaction, when conversion factor is used, the amount of attributable credits is calculated as 35.62t of 50t in PPS. However, the certified share in the 50t reflecting the input characteristics is equal to 70% (see below Trace-the-Atom approach) which limits the amount of attributable credits to 35t in PPS. The difference between 35.62t and 35t, which is the available amount of attributable credits of 0.62t can be attributed to the other batches of PPS.

Compensation of input characteristics

The compensation of input characteristics is not possible for this reaction because the certified input of p-DCB is not similar-in-nature to the non-certified input of sodium sulphide, Na_2S.

Trace-the-Atom approach:

To calculate the certified share for the second step of the reaction, the same guardrails of the Mass Balance approach must be considered - complete reflection of input characteristics:

Molecular weight of the inputs and outputs:

M (p-DCB) = 6x12g/mol (C) + 4x1g/mol (H) + 2x35.45g/mol (Cl) = 147 g/mol
M (Na_2S)= 2x23g/mol (Na) + 1x32g/mol (S) = 78g/mol
M (PPS)= 6x12g/mol (C) + 4x1g/mol (H) +1x32g/mol (S) = 108g/mol
M (NaCl) = 2x23g/mol (Na) + 1x35.45g/mol (Cl) = 58.45g/mol

Ratio of atoms coming from the ISCC certified input:

$C_{certified}$: 6/6
$H_{certified}$: 4/4
$Cl_{certified}$: 0/2

Molecular weight of the atoms coming from the ISCC certified input:

M (ISCC PLUS certified atoms) = 6x12g/mol (C) + 4x1g/mol (H) = 76 g/mol

$$\text{Certified share}(\%) = \frac{\text{Amount of certified input(based on atoms)}}{\text{Amount of respective output(based on atoms)}} \times 100 \qquad (8)$$

$$\text{Certified share (PPS)} = \frac{76}{108} = 0.7 = 70\%$$

$$ConsFi = \frac{Ai}{Ao} \quad (3)$$

$$\mathrm{ConsF\ (pDCB)} = \frac{m(pDCB)}{m(PPS)} = \frac{75t}{50t} = 1.5$$

In order to find the attribution factor, the calculations below must be followed:

$$\mathrm{Attribution\ Factor\ (i)} = \frac{\mathrm{Proportion\ of\ input(i)}\ in\ output}{\mathrm{ConsF}} \quad (4)$$

$$\mathrm{AF}(pDCB) = \frac{0.7}{1.5} = 0.466$$

$$\mathrm{A}_{Cr(i)} = m(input_i) \times AF_i \quad (5)$$

$$\mathrm{A}_{Cr} = 75\mathrm{t} \times 0.466 = 34.95t$$

Therefore, the amount of credits that one can attribute to the PPS from the certified p-DCB is equal to 34.95t.

Free Attribution (attribution determined by mass) with Global Conversion and Consumption factors:

In addition, it is also possible to apply global conversion or consumption factor, which are calculating the certified share directly from the certified benzene input to the final certified output of PPS. These calculations can be applied, if intermediate product(s) (p-DCB for this example) is not sold as a product to external customers, but only used within the same site for the next production steps.

With Global Conversion Factor:

$$\mathrm{CF} = \frac{Ao\ (Total\ mass\ of\ outputs)}{Ai\ (Total\ mass\ of\ inputs)} \quad (1)$$

$$\mathrm{CF} = \frac{(50t + 115t)}{(60t + 108t + 105t)} = \frac{165t}{273t} = 0.604 = 60.4\%$$

$$A_{Cr} = \mathrm{CF} \times A_{CI} \quad (2)$$

$$A_{Cr} = 60\mathrm{t} \times 0.604 = 36.24\mathrm{t}$$

With Global Consumption Factor:

$$ConsF = \frac{mi(input)}{m(output)} \quad (3)$$

$$ConsF = \frac{m(Benzene)}{m(PPS)} = \frac{60t}{50t} = 1.2$$

In order to find the attribution factor, the calculations below must be followed:

$$\text{Attribution Factor(i)} = \frac{Proportion\ of\ input(i)\ in\ output}{ConsF} \quad (4)$$

$$\text{AF(Benzene in PPS)} = \frac{0.73}{1.2} = 0.608$$

$$\text{A}_{Cr(i)} = m(input_i) \times AF_i \quad (5)$$

$$\text{A}_{Cr} = 60\text{t x } 0.608 = 36.48t$$

Therefore, the amount of credits that one can attribute to the PPS from the certified input Benzene when using global conversion factor or global consumption factor is equal to 36.24t and 36.48t respectively. However, the certified share in the 50t reflecting the input characteristics is equal to 70%, which limits the amount of attributable credits to 35t in PPS. The difference between 36.24t and 35 t (also 36.48t and 35 t respectively) can be attributed to the other batches of PPS. The compensation of input characteristics is not possible for this reaction.

5.5 Base films

The example below (shown in *Figure 9*) illustrates the copolymerisation process of 88kg ISCC compliant PP homopolymer, 17kg fossil based PP copolymer and 2kg of additives, for the production of 100kg ISCC compliant PP base film.

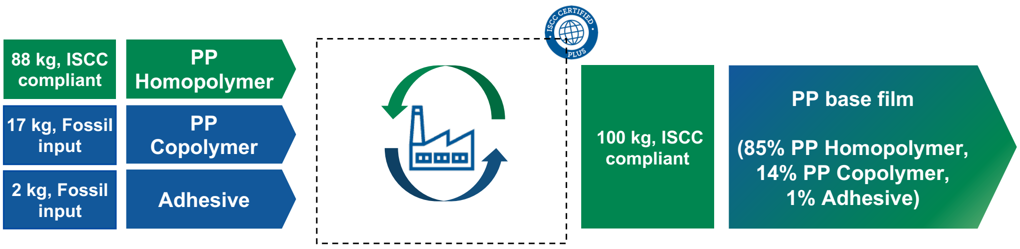

Figure 9: Illustrative example of copolymerisation process for the production of ISCC compliant PP base film

In order to account for the certified share, by applying the guardrail of the Mass Balance approach - reflection of input characteristics, the calculations below are followed:

Free Attribution (attribution determined by mass) with conversion factor:

$$\text{CF} = \frac{A_O\ (Total\ mass\ of\ outputs)}{A_i\ (Total\ mass\ of\ inputs)} \quad (1)$$

$$\text{CF} = \frac{100\text{kg}}{88\text{kg} + 17\text{kg} + 2\text{kg}} = \frac{100kg}{107} = 0.934 = 93.5\%$$

$$\mathrm{A}_{Cr} = \mathrm{CF} \times \mathrm{A}_{CI} \quad (2)$$

$$A_{Cr} = 0.935 \times 88\mathrm{kg} = 82.28\ \mathrm{kg}$$

Free Attribution (attribution determined by mass) with consumption factor:

$$ConsF(i) = \frac{Ai}{Ao} \quad (3)$$

$$ConsF = \frac{m(PP\ homopolymer)}{m(PP\ base\ film)} = \frac{88kg}{100kg} = 0.88$$

In order to find the attribution factor, the calculations below must be followed:

$$Proportion\ of\ input\ (i)\ in\ output = \frac{85}{100} = 0.85$$

$$Attribution\ Factor\ (i) = \frac{\mathrm{Proportion\ of\ input(i)}\ in\ output}{ConsF} \quad (4)$$

$$AF\ (PP\ homopolymer) = \frac{0.85}{0.88} = 0.966$$

$$\mathrm{A}_{Cr(i)} = m(input_i) \times AF_i \quad (5)$$

$$\mathrm{A}_{Cr}\ (PP\ base\ film) = 88\mathrm{kg} \times 0.966 = 85\ \mathrm{kg}$$

Reflection of input characteristics:

Complete reflection of input characteristics

Under Free Attribution, one option is that the system user can choose complete reflection of input characteristics, which means that 85 kg of 100 kg, i.e., the 85% of 100 kg of base film, is certified, based on the calculation done with the consumption factor. Following the chapter "Consideration of Additives, Masterbatches and Not certified Organic Content for Mass Balancing" from the System Document *ISCC PLUS-203 – Chain of Custody*, it is possible to claim that 86 kg of 100 kg, i.e., the 86% of 100 kg of base film, as certified, since the additive is less than 3% of the total weight of the product.

For conversion factor, this would lead to 82.28 kg of 100 kg, i.e., the 82.28% of 100 kg of base film, is certified. Following the chapter "Consideration of Additives, Masterbatches and Not certified Organic Content for Mass Balancing" from the System Document *ISCC PLUS-203 – Chain of Custody*, it is possible to claim that 83.28 kg of 100 kg, i.e., the 83.28% of 100 kg of base film, as certified, since the additive is less than 3% of the total weight of the product. While calculating with the conversion factor, it is also possible to claim 83.28 kg of 96.84 kg as certified (86% of 96.84 kg) and 3.16 kg (the difference between 100kg and 96.84kg) as not certified. The later still reflects the relative share of certified input in the product. With both options, complete reflection of input characteristics is fulfilled.

Compensation of input characteristics

Alternatively, the system user may apply compensation of input characteristics. Under this option, 83.28 kg (based on the conversion factor calculation) or 86 kg (based on the consumption factor calculation) may be claimed as 100% certified, while the remaining 16.72 kg or 14 kg, respectively, is considered 0% certified[14]. Any compensation must be correctly indicated in the incoming/outgoing SD respectively.

5.6 Consideration of Hetero atom approach – Ammonia

The example present in this subchapter is illustrating the production of 10 t of ammonia (NH_3) from a chemical reaction between 2.1 t of certified hydrogen (H_2) and 9.8 t of fossil-based nitrogen (N_2). Under the ISCC PLUS Hetero Atom approach, hetero atoms, which in this case is nitrogen sourced from ambient air, may be attributed to the certified share in the output, provided they react with the certified input and are present in the final certified product.

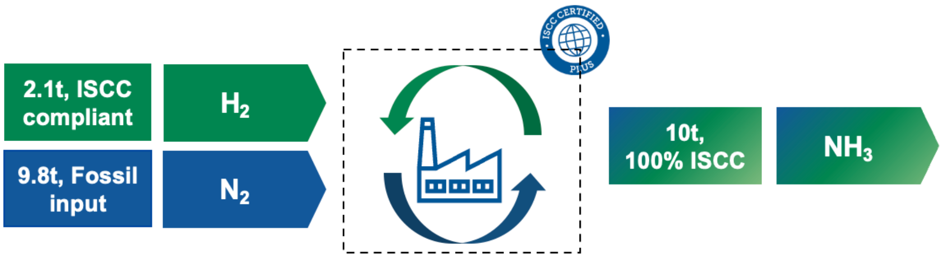

Figure 10: Example of production of 100% certified NH_3 with certified H_2 (renewable energy derived) and accounting for the N_2 (nitrogen) from ambient air under the Hetero atom approach

Trace-the-Atom approach:

Molecular weight of the inputs and outputs:

Molar Mass (H_2) = 2x1g/mol (H) = 2 g/mol

Molar mass (N_2) = 2x14g/mol (N) = 28 g/mol

Molar mass (NH_3) = 3x1g/mol (H) + 1x14g/mol (N) = 17.03 g/mol

Ratio of atoms coming from the ISCC certified input:

$N_{certified}$: 1/1
$H_{certified}$: 3/3

Molecular weight of the atoms coming from the ISCC certified input:

[14] *Following the chapter "Consideration of Additives, Masterbatches and Not certified Organic Content for Mass Balancing" from the System Document ISCC PLUS-203 – Chain of Custody*

M (ISCC PLUS certified atoms) = 3x1g/mol (H) = 3 g/mol

$$\text{Certified share (\%)} = \frac{\text{Amount of certified input(based on atoms)}}{\text{Amount of respective output(based on atoms)}} \times 100 \qquad (8)$$

$$\text{Certified share} = \frac{3.03}{17.03} = 0.1779 = 17.79\%$$

Therefore, the share originating from the certified Hydrogen in the molecule of ammonia is 17.79%, based on the Trace-the-atom approach.

With the following calculations, the consumption factor, expressing the relation between hydrogen and ammonia, is given below:

$$\text{ConsF(i)} = \frac{Ai}{Ao} \qquad (3)$$

$$\text{ConsF} = \frac{m(H_2)}{m(NH_3)} = \frac{2.1t}{10t} = 0.21$$

$$\text{Attribution Factor (i)} = \frac{\text{Proportion of input(i) } in\ output}{ConsF} \qquad (4)$$

$$\text{AF (Hydrogen)} = \frac{0.178}{0.21} = 0.84$$

$$A_{Cr(i)} = m(input_i) \times AF_i \qquad (5)$$

$$A_{Cr} = 2.1 \times 0.84 = 1.74\text{t}$$

Considering that the total amount of hydrogen is reacting with the nitrogen from ambient air and this nitrogen is present in the molecule of the product of ammonia, the total amount of ammonia (10 tons) is considered 100% certified.

5.7 Consideration of post-industrial CO_2 – Urea

In the example shown in *Figure 11*, post-industrial fossil CO_2 captured from industrial processes is used as an input. When this CO_2 reacts with ISCC PLUS–compliant material, and carbon atoms from the CO_2 are present in the outgoing material, the share from CO_2 in the output is considered ISCC PLUS certified. The figure also illustrates how the corresponding calculations are carried out.

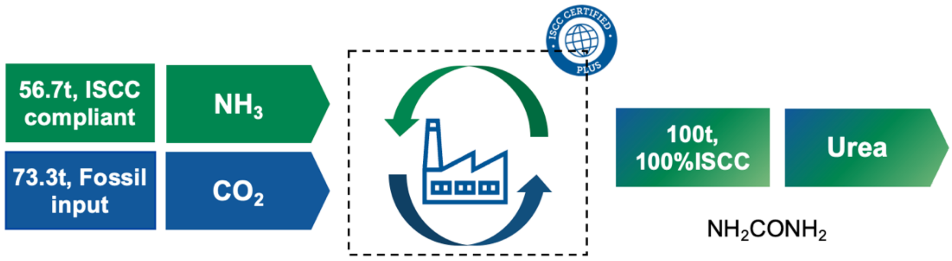

Figure 11: Example of production of Urea with certified NH_3(ammonia) and accounting for post-industrial CO_2 to the share for the production of 100% certified Urea

Trace-the-Atom approach:

Molecular weight of the inputs and outputs:

Molar mass (NH_3) = 3x1.01g/mol (H) + 1x14g/mol (N) = 17.03 g/mol
Molar mass (CO_2) = 1x12g/mol (C) + 2x16g/mol (O) = 44 g/mol
Molar mass (NH_2CONH_2) = 4x1g/mol (H) + 2x14g/mol (N) + 1x12g/mol (C) + 1x16g/mol (O) = 60g/mol

Ratio of atoms coming from the ISCC certified input:

$N_{certified}$: 2/2
$H_{certified}$: 4/4
$C_{certified}$: 0/1
$O_{certified}$: 0/1

Molecular weight of the atoms coming from the ISCC certified input ammonia:

M (ISCC PLUS certified atoms) = 2x14g/mol (N) + 4x1g/mol (H)= 32 g/mol

$$\text{Certified share } (\%) = \frac{\text{Amount of certified input(based on atoms)}}{\text{Amount of respective output(based on atoms)}} \times 100 \qquad (8)$$

$$\text{Certified share } (NH_3) = \frac{32}{60} = 0.533 = 53.3\%$$

Based on the previous, the certified share originating from the ammonia in the molecule of urea will be 53.3%.

$$\text{ConsF(i)} = \frac{Ai}{Ao} \qquad (3)$$

$$\text{ConsF } (NH_3) = \frac{m(NH_3)}{m(Urea)} = \frac{56.7}{100} = 0.567$$

$$\text{Attribution Factor (i)} = \frac{\text{Proportion of input(i) } in\ output}{ConsF} \qquad (4)$$

$$AF(NH_3) = \frac{0.533}{0.567} = 0.94$$

$$A_{Cr(i)} = m(input_i) \times AF_i \quad (5)$$

$$A_{Cr}\ (NH_3) = 0.94 \times 56.7 = 53.5t$$

After calculating the consumption factor for the ammonia and knowing the certified share, the attribution factor is found to be 0.94. This attribution factor is used to find the attributable credits from ammonia to urea, which are equal to 53.5t.

Considering that the post-industrial CO_2 is reacting with the urea and the atoms from the CO_2 are present in the molecule of the produced urea, the total amount of urea (100 tons), is considered 100% certified.

5.8 Proportional Attribution for Electrolysis Process

In the example in *Figure 12*, the production of 20t of hydrogen from 600kWh certified renewable electricity and 400kWh non-certified electricity is illustrated. For the electrolyzer setups, the calculations of the certified amount of product can only be determined by the proportional attribution.

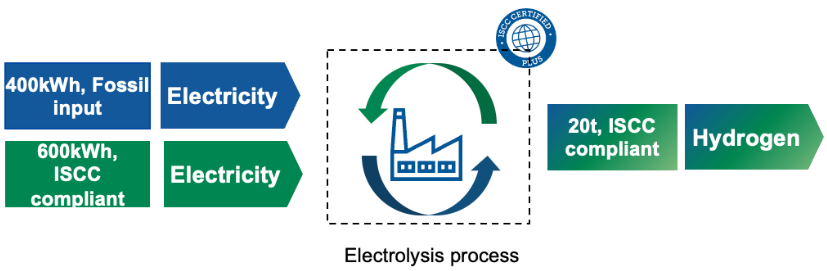

Figure 12: Example of electrolysis process from NaCl and certified renewable electricity.

$$\text{Share of certified input (\%)} = \left(\frac{\text{Amount of the certified input}}{\text{Total amount of all inputs}}\right) \times 100 \quad (6)$$

$$\text{Share of certified input (\%)} = \left(\frac{400\text{kWh}}{1000\text{kWh}}\right) \times 100$$

$$\text{Share of certified input (\%)} = 0.6 \times 100 = 60\%$$

$$\text{Certified amount of the respective output} = \text{Share of certified input (\%)} \times \text{Amount of respective output} \quad (7)$$

$$\text{Certified amount of the respective output} = 60\% \times 20t = 0.6 \times 20t = 12t$$

For the process 60% of the total input was based on renewable electricity. Therefore, 60% of each output (if more than one) can be certified as renewable. Hence 12t of the 20t of hydrogen can be claimed as renewable (either 12t as 100% certified or 20t as 60% certified). In case if there are multiple certified products, it is not possible to re-attribute credits from one product to another to increase the amount of certified hydrogen or vice versa.

Annex I: Free Attribution vs. Trace-the-Atom Approach

In the following table, the list of differences is highlighted for the certified free attribution approach and Trace-the-Atom approach. Based on the chosen mass balancing approach, different requirements must be fulfilled by the system user.

	Free Attribution	Trace-the-Atom
Attributable outputs	The sustainability characteristics can be attributed to one or multiple outputs that fulfils the chemical connectivity requirement.	The sustainability characteristics can be attributed to one or multiple outputs that fulfils the chemical connectivity requirement.
Compensation of input characteristics	It is possible to apply compensation of input characteristics or complete reflection of input characteristics for attribution. The applied option shall be reflected to the Sustainability Declaration.	Complete reflection of input characteristics is ensured, when Trace-the-Atom approach is chosen.
Certified Share	Calculated by dividing the amount of attributed credits of the output to the total amount of the output (for one batch)	Calculated based on the chemical reaction
Calculation of process losses	Both conversion factor and consumption factor can be used.	Only consumption factor can be used.
Credit Transfer (from one Mass Balance period to the next)	It is possible to transfer the positive credits from one mass balance period to the other is possible, even the physical stock is not available at the site.	It is possible to transfer the positive credits from one mass balance period to the other is possible, even the physical stock is not available at the site.
Multi-site credit transfer	It is possible, if the requirements in the ISCC PLUS System Document are fulfilled.	It is possible, if the requirements in the ISCC PLUS System Document are fulfilled.
Certified Amount	Calculated based on the amount of attributable credits and the guardrails for attribution limitations	Calculated based on the produced amount of output from certified inputs and the certified share

Annex II: Downgrading

In the following table, examples of downgrading between materials with different characteristics are given. These examples include downgrading between materials with different and same waste status, and with and without GHG Add-on.

	Input	Input Waste Status	Output	Output Waste Status	Possibility under ISCC PLUS
1	Circular Acrylic Acid	Pre-consumer	Polymer blend	Mixed/unspecified	✅
	Circular Polypropylene	Mixed/Unspecified			
2	Circular Polystyrene	Post-consumer	Circular Polystyrene	Mixed/unspecified	✅
	Circular Polystyrene	Mixed/Unspecified			
3	Circular PET flakes	Post-consumer	Circular PET	Mixed/unspecified	✅
	Circular PET flakes	Pre-consumer			
4	Bio-circular UCO	Mixed/unspecified	Bio-circular UCO	Mixed/unspecified	✅
	Bio-circular UCO	Post-consumer			
5	Circular PET flakes	Post-consumer	Circular PET bottle	Post-consumer	❌
	Circular PET flakes	Pre-consumer			

	Input Examples	Input Add-on	Output	Output Add-on	Possibility under ISCC PLUS
1	Bio Ethanol	with GHG Add-on	Bio Ethanol	without GHG Add-on	✅
	Bio Ethanol	without GHG Add-on			

Annex III: Similar-in-nature

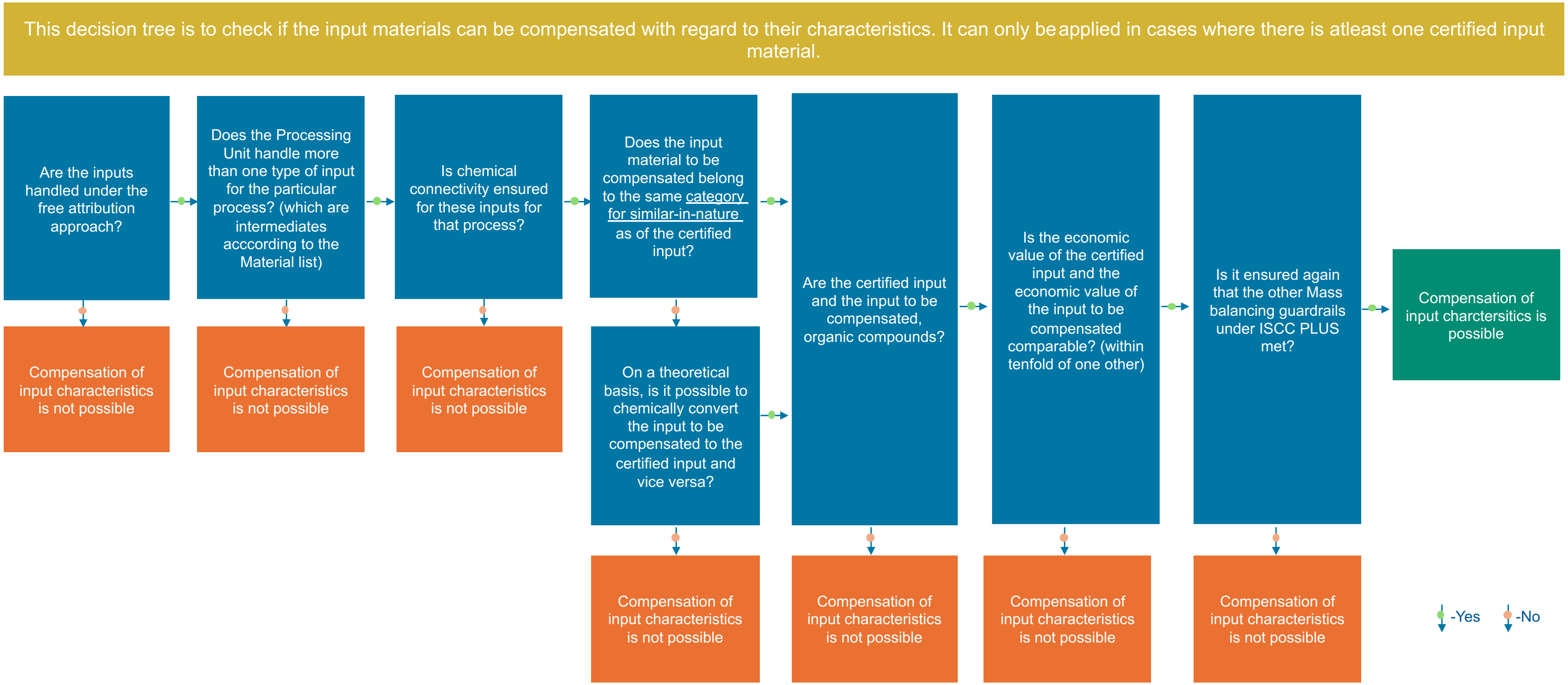

Figure 13: Decision tree to check the possibility of applying Compensation of input characteristics

Categories for similar-in-nature

<table>
<tr><th colspan="2">Categories for similar-in-nature</th><th>Description</th></tr>
<tr><td rowspan="8">Organic & Inorganic intermediates</td><td>Refinery & upgrading products</td><td>Products leaving a refinery. Pre products for primary commodity chemicals</td></tr>
<tr><td>Bulk/Commodity chemicals (Organic and Inorganic)</td><td>Building blocks for the chemical industry</td></tr>
<tr><td>Fine chemicals</td><td>Complex, single, pure chemical substances, produced in limited quantities in multipurpose plants by multistep chemical or biotechnological processes</td></tr>
<tr><td>Specialty Chemicals</td><td>Chemicals formulated for specific applications, providing unique performance or functionality rather than being produced in bulk for general use. Can also be a mixture</td></tr>
<tr><td>Plastic compounds & composites</td><td>Plastic compounds are made by blending a base polymer with various additives.
Plastic composites are materials formed by combining a polymer matrix with reinforcing materials</td></tr>
<tr><td>Polymers</td><td>Large molecules composed of repeating structural units called monomers, which are covalently bonded together.</td></tr>
<tr><td>Recovered materials</td><td>Operations where waste serves a useful purpose by replacing other materials or being prepared to fulfil that function, reducing the use of primary resources. Treatment operations for recovery can include sorting, washing, shredding etc. for the raw material</td></tr>
<tr><td>Components (intermediates)</td><td>Intermediate parts or elements made from certified materials, designed to serve specific functions</td></tr>
<tr><td rowspan="3">Final products</td><td>Final consumer products</td><td>Final products made from other alternative feedstocks (excluding plastic polymers)</td></tr>
<tr><td>Plastic products</td><td>Plastic products made from plastic polymers. Can be further specified under final consumer products</td></tr>
<tr><td>Packaging</td><td>Materials used to enclose and protect products for storage, transportation, distribution, and sale.</td></tr>
<tr><td>Food and feed</td><td>Food & feed intermediates/ products</td><td>Intermediates/products from biogenic feedstocks for food and feed applications</td></tr>
</table>

Definitions for the terms used in the logic tree (Figure 14)

- **Final product:** Completed output of a process that is ready for delivery, sale, or use by the end customer.
- **Formulation:** A mixture of ingredients combined in specific proportions to achieve a desired function or performance.
- **Intermediate:** A processed material or component that is used as an input in the production of another intermediate or a final product.
- **ISCC certified input:** A raw material or product that enters the system boundary of a System User at any stage of the supply chain, including both certified and non-certified materials used in the production process. A input material (according to ISCC's naming) that is ISCC compliant is utilised in an ISCC PLUS certified entity (processing unit) to produce a certified output.
- **ISCC raw material:** Materials listed as an eligible raw material in the raw material table of the ISCC material list. (Table 1)
- **Large-scale dedicated facilities:** Specialized industrial or manufacturing sites designed for high-volume production of a specific product or process.
- **Mixture:** Mixtures are one product of mechanically blended or mixed chemical substances such as elements and compounds, without chemical bonding or any other kind of chemical transformation.
- **Multipurpose facilities:** Designed to support a variety of functions, activities, or operations within the same infrastructure, offering flexibility and adaptability for different uses.
- **Output material:** An intermediate or final product that leaves the system boundary of a system user, generated at any stage of the supply chain, including all certified and non-certified products resulting from the production process. An output material must be derived from at least from one ISCC certified input material to be claimed as ISCC Compliant.
- **Recovery:** Operations where waste serves a useful purpose by replacing other materials or being prepared to fulfil that function, reducing the use of primary resources.
- **Refining:** Purification and separation to improve product quality. Refining refers to physical processes like distillation
- **Simple mixture:** A combination of two or more substances that are physically blended without any chemical bonding.
- **Treatment of waste:** Mechanical or physical processes to make waste usable downstream. Treatment can include sorting, washing, shredding etc. for the raw material.
- **Upgrading:** Chemical transformations to create improved products with higher value.

The below logic tree provides a method for a System User to determine an individual material's category for similar-in-nature. The certified input material and the input material that is to be compensated are to be referred as 'material' in the logic tree.

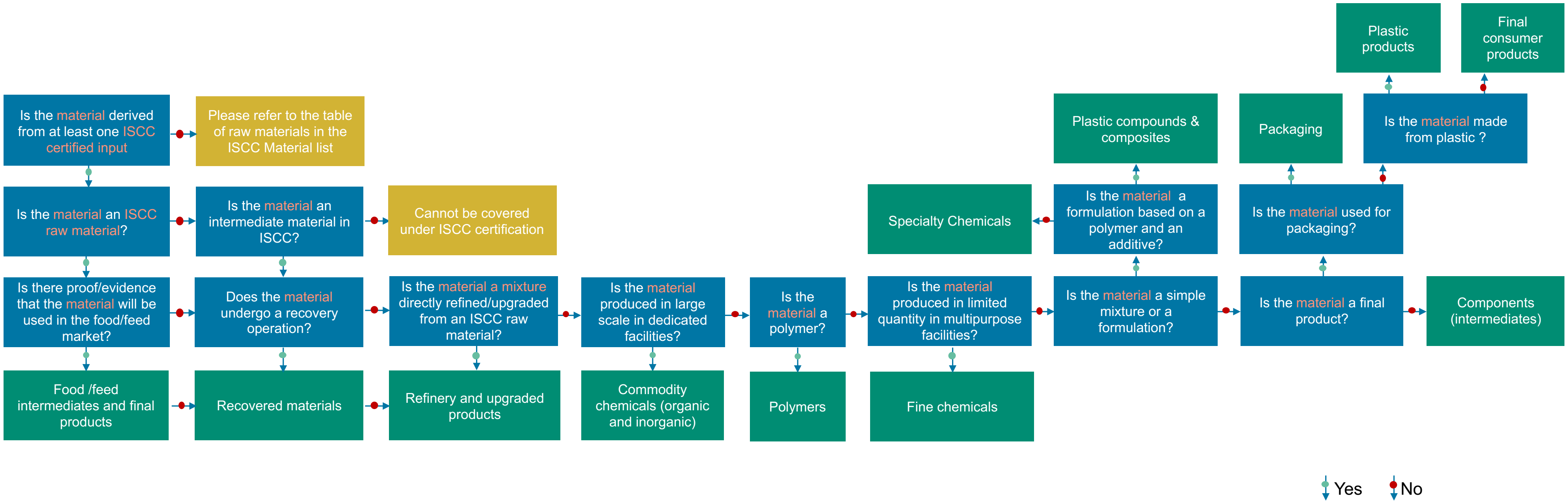

Figure 14: Logic tree to determine the suitable category for the materials to be compensated based on similar-in-nature