Carbon Accounting Renewable Fuels:

a tool for decarbonising civil aviation

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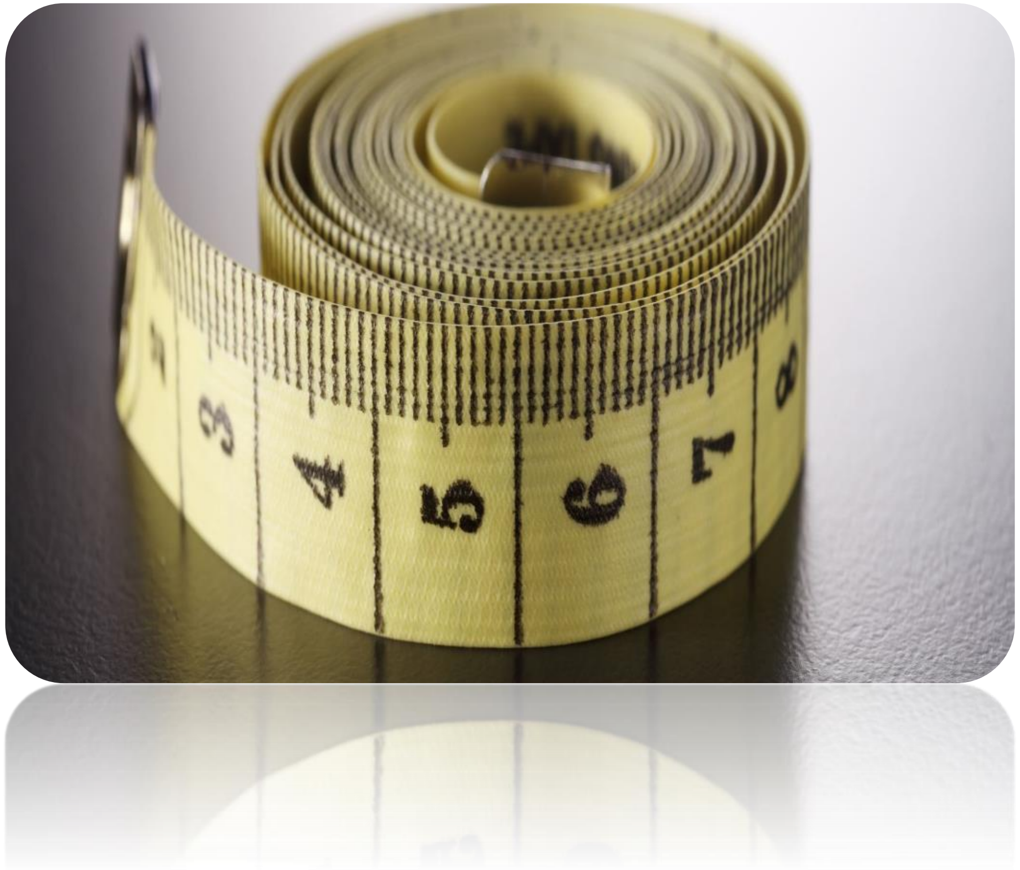
1859

Carbon accounting

Why is it needed

Carbon accounting to measure progresses

- At international and regional levels there are **targets** on the **GHG reduction**.
- Various **incentives/mandates** exist.
- **E**mission **T**rading **S**chemes associates **economic** value to the **unit** of **CO2 saved.**
- **Voluntary** markets allow for **valorising CO2 reductions**.



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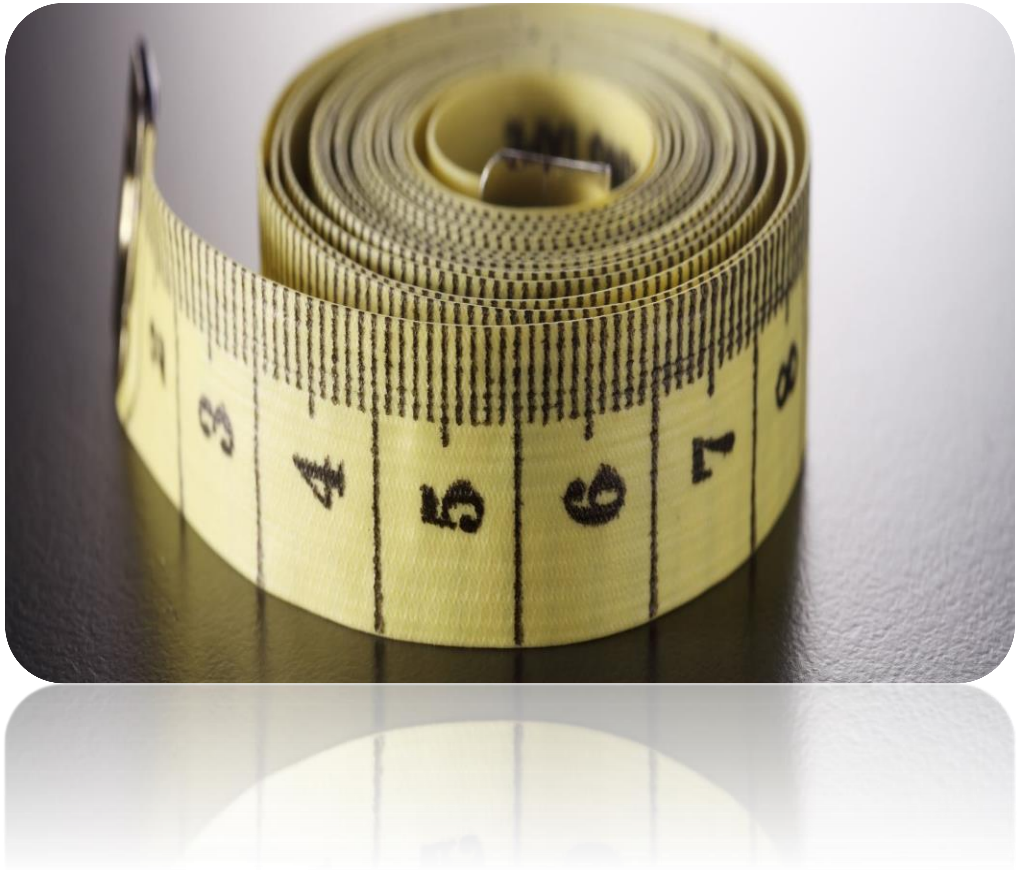


In this context, being able to **properly quantify** the **CO2 reduction is key.**

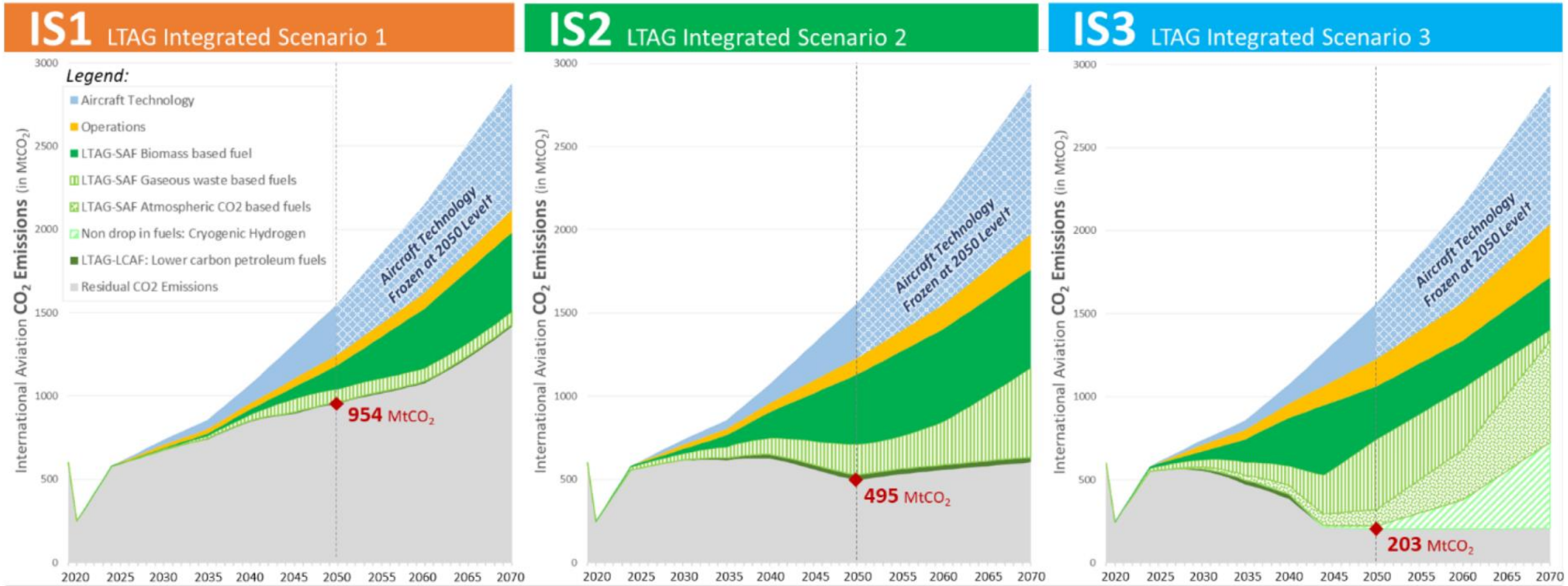
Civil Aviation sector

We we stand about
carbon accounting

Why we need renewable SAF liquid fuels?

- Due to some peculiar characteristics of the aviation sector, **the penetration of disruptive technologies** (e.g. electrification) is expected to **occur at a different pace than in other sectors** (e.g. road).
- **Alternative** to fossil kerosene should ideally **be able to supply exisiting infrastructures and engines** (**drop-in** fuels).
- This is the reason why **liquid alternative fuels could be an effective short-medium term mean** for deacarbonising international aviation.

The ICAO LTAG feasibility study: the expected role of SAF



† Caution required with the interpretation of absolute CO_2 emissions levels after 2050 due to modelling assumptions e.g., frozen aircraft technology after 2050. Under these assumptions, CO_2 emissions are higher than in an alternative scenario (and modelling approach) where aircraft technology would continue to improve after 2050.

Figure 1. CO_2 emissions from international aviation associated with LTAG Integrated Scenarios

https://www.icao.int/environmental-protection/Pages/LTAG.aspx

- The 41st **ICAO Assembly adopted** a long-term global aspirational goal (**LTAG**) for international aviation of **net-zero carbon emissions by 2050**.
- **3** main **integrated scenario** with **increasing aspiration** and **decreasing readiness** and **attainability**

From LTAG it is clear the **crucial role of SAF**

IEA G20 – 2024

Carbon Accounting for Sustainable Biofuels:

- IEA, supporting Brazil's G20 presidency, **explores regulatory approaches** on biofuels **carbon accounting**.
- Sustainable **biofuels** are **crucial** for **decarbonizing** the transport sector, especially in **aviation**, **shipping**, and **complementing EVs** in **road transport**.
- Transparent, **science-based carbon intensity calculations** are **essential** for creating regulatory frameworks that **attract investments** for biofuel scaling.
- IEA recommends adopting **pragmatic**, **verifiable**, and **performance-based policies** to ensure continuous improvement in sustainable biofuels.

https://www.iea.org/reports/carbon-accounting-for-sustainable-biofuels

Claiming Emission Reductions from CORSIA ELIGIBLE FUELS

Emission reductions are related to the life cycle emissions value of the CEF

UPDATE: Second edition of Annex 16 Vol IV now uses the acronym "L_{CEF}" to represent the life cycle emissions of the CEF.

Fuel Conversion Factor, fixed value, 3.16 for Jet-A/ Jet-A1 or 3.10 for AvGas/ Jet B [kg CO_2/kg fuel]

life cycle emissions value (~~LS_f~~ L_{CEF}) of the CEF.

$$\textbf{CEF emissions reductions } (ER_y) = FCF * \left[\sum_f MS_{f,y} * \left(1 - \frac{L_{CEF}}{LC}\right)\right]$$

Total mass of CEF claimed in the year y, by fuel type f [tonnes]

Baseline life cycle emissions, fixed value, 89 for jet fuel or 95 for AvGas [gCO2e/MJ]

Example: If, in 2021, an operator uses 10,000 tonnes of Jet-A fuel produced from Used Cooking Oil (default ~~LSf~~ L_{CEF} **=13.9 gCO2e/MJ***), the amount of emissions reductions will be:

$$ER_{2021} = 3.16 * \left[10{,}000 * \left(1 - \frac{13.9}{89}\right)\right] = \textbf{26,665 tonnes of } CO_2$$

CORSIA – Life Cycle Assessment of SAF

CORSIA Sustainability Theme 1 requires lower carbon emissions on a **life cycle basis.**

→

CORSIA Sustainability Criterion 1.1 requires net greenhouse gas emissions **reductions of at least 10%** compared to a baseline.

These requirements are met based on **a Life cycle assessment of the SAF:**

SAF Life cycle emission value (L_{CEF})
Unit – gCO2e/MJ

=

Core Life cycle assessment (core LCA value)
emissions associated with all steps of SAF production and use

+

Induced Land use Change (ILUC value)
Emissions associated with possible land use change generated by SAF feedstock production

+

Emission Credits
Reductions that can be obtained on MSW-based fuels, due to benefits associated with recycling and avoided waste on landfills

CORSIA – Life Cycle Assessment of SAF

There are two options to obtain the life cycle emissions of SAF and LCAF

DEFAULT Life Cycle Emissions

ICAO document

“CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels”

Default emission values, as a function of the feedstocks and conversion processes.

ACTUAL Life Cycle Emissions

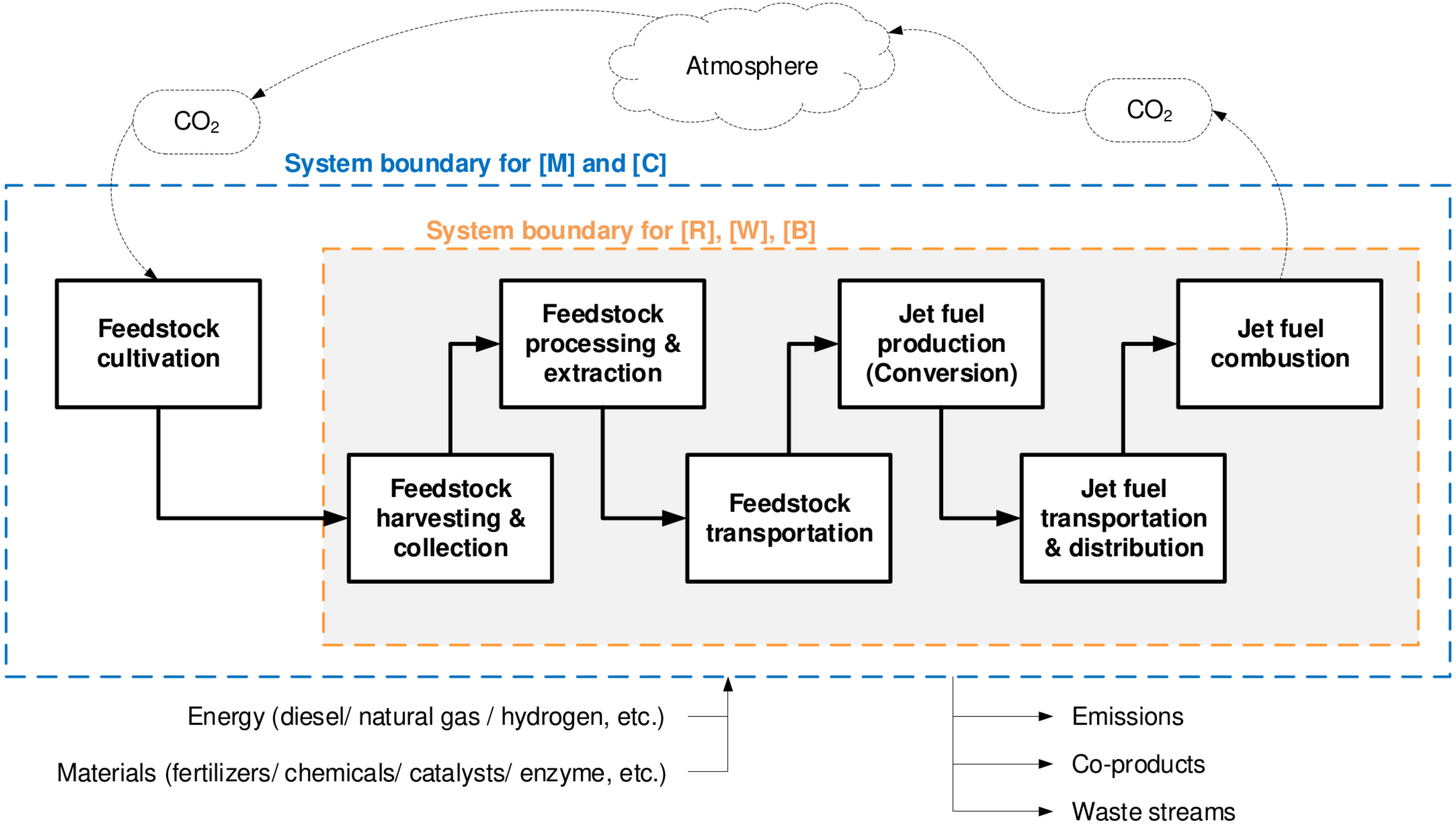
ICAO document

“CORSIA Methodology for Calculating Actual Life Cycle Emissions Values”

Allows calculation of specific emissions values to a given SAF or LCAF

CLCA CORSIA methodology

$$\text{Core LCA } [gCO_2e/MJ] = e_{fe\_c} + e_{fe\_hc} + e_{fe\_p} + e_{fe\_t} + e_{fefu\_p} + e_{fu\_t} + e_{fu\_c}$$



Prussi, Matteo, et al. "CORSIA: The first internationally adopted approach to calculate life-cycle GHG emissions for aviation fuels." *Renewable and Sustainable Energy Reviews* 150 (2021): 111398.

Default life cycle emissions values

Core Default LCA values depend on:
- conversion process
- feedstock
- pathway specification

Region is only relevant to ILUC values

Table 1. CORSIA Default Life Cycle Emissions Values for CORSIA Eligible Fuels produced with the Fischer-Tropsch Fuel Conversion Process

Region	Fuel Feedstock	Pathway Specifications	Core LCA Value	ILUC LCA Value	LS_f (gCO_2e/MJ)
Global	Agricultural residues	Residue removal does not necessitate additional nutrient replacement on the primary crop	7.7	0.0	7.7
Global	Forestry residues		8.3		8.3
Global	Municipal solid waste (MSW), 0% non-biogenic carbon (NBC)		5.2		5.2
Global	Municipal solid waste (MSW) (NBC given as a percentage of the non-biogenic carbon content)		NBC*170.5 + 5.2		NBC*170.5 + 5.2
USA	Poplar (short-rotation woody crops)		12.2	-5.2	7.0
Global	Poplar (short-rotation woody crops)		12.2	8.6	20.8
USA	Miscanthus (herbaceous energy crops)		10.4	-32.9	-22.5
EU	Miscanthus (herbaceous energy crops)		10.4	-22.0	-11.6
Global	Miscanthus (herbaceous energy crops)		10.4	-12.6	-2.2

For more details, please refer to ICAO document 06 - Default Life Cycle Emissions - June 2022.pdf

The regional dimension

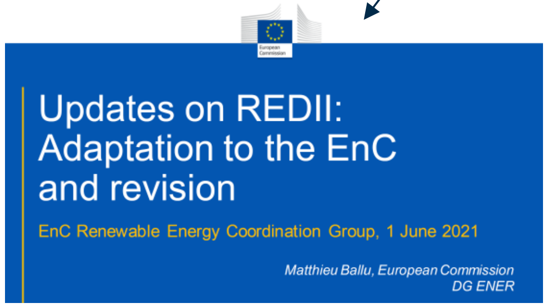
The need for alignment

INTERNATIONAL

CORSIA

CARBON OFFSETTING AND REDUCTION SCHEME FOR INTERNATIONAL AVIATION

EUROPEAN



Emission Trading System (EU ETS)

REDII(I) methdology for calculating CI of alternetive fuels

L 328/150 EN Official Journal of the European Union 21.12.2018

C. METHODOLOGY

1. Greenhouse gas emissions from the production and use of transport fuels, biofuels and bioliquids shall be calculated as follows:

   (a) greenhouse gas emissions from the production and use of biofuels shall be calculated as:

   $$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr},$$

   where

E	=	total emissions from the use of the fuel;
e_{ec}	=	emissions from the extraction or cultivation of raw materials;
e_l	=	annualised emissions from carbon stock changes caused by land-use change;
e_p	=	emissions from processing;
e_{td}	=	emissions from transport and distribution;
e_u	=	emissions from the fuel in use;
e_{sca}	=	emission savings from soil carbon accumulation via improved agricultural management;
e_{ccs}	=	emission savings from CO_2 capture and geological storage; and
e_{ccr}	=	emission savings from CO_2 capture and replacement.

Emissions from the manufacture of machinery and equipment shall not be taken into account.

Annex V REDII

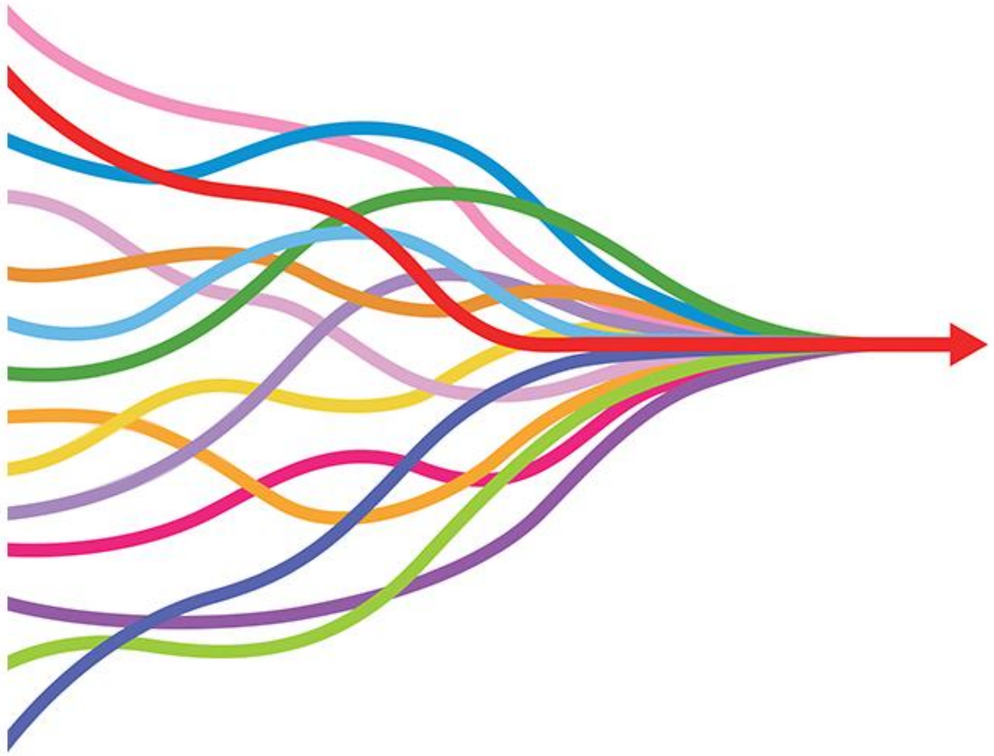
Delegated Act on a methodology for renewable fuels on non-biological origin (**RFNBO**)

For use in **ReFuel EU aviation** and **FuelEU maritime**

Example of aspects where alignment may be challenging

- **Indirect effects** (i.e. iLUC)
- **Conterfactual** scenarions
  - important for CCU
- **PtL** (RFNBO or eFuels)
  - **quality** of the **feedstock**:
    - electricty requirement, CO_2 streams allowed
    - approach for combustion

    (CO_2 atmospheric balance vs caounterfactual)
- **Etc**.



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	ICAO CORSIA	EU RED meth.
ILUC	Calculated	Risk-based approach
Counter factual	Partially considered	Partially considered
PtL	Under development	Secific meth. For calc and feedstock requirements
…	..	.

Conclusions

- **Alternative fuels** are considered an **effective tool** for the **decarbonisation transport**, especially for “**hard-to-abate**” sectors.
- **Aviation** has been **growing**, **with** a **significant associated environmental impact**.
- **Civil aviation** is **expected** to **rely on** Sustainable aviation **liquid** fuels **(SAF) in the short-medium term**, especially for the long-haul flights.
- **SAFs** as defined in CORSIA **can reduce life-cycle GHG emissions by over 90%**.
- **Carbon accounting** for **policy** is **complicated** by **inconsistent GHG emission reports** and **lack** of **consensus** on **methodologies**.
- However**, accounting** is **crucial** to **foster** the **alternative fuels uptake** at **international level**.
- **Impact** of such **risk** may be **mitigated by strong presence of regional actors in the international inititives.**