Hochschule für Angewandte Wissenschaften Hamburg
Hamburg University of Applied Sciences

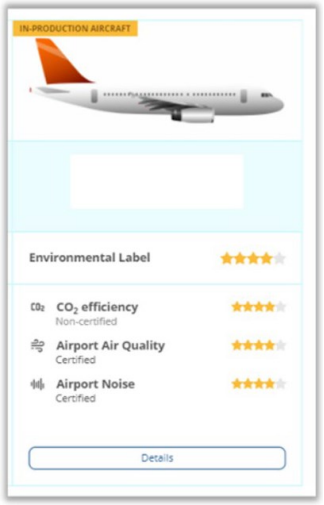
AIRCRAFT DESIGN AND SYSTEMS GROUP (AERO)

EASA's Proposed Environmental Label Programme – Benefits and Shortcomings

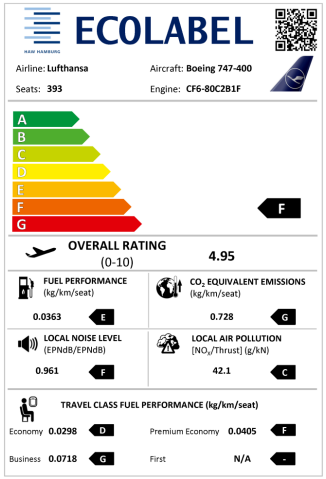
Dieter Scholz Hamburg University of Applied Sciences

German Aerospace Congress
Stuttgart, 19-21 September 2023

EASA (idea)



HAW (ready)



Including work since 2015 of:

- **Tim Haß** (Bachelor Thesis)
- **Lynn Van Endert** (Master Thesis)
- **Sophie Sokour** and **Tobias Bähr** (Project)
- **Benjanin Kühner**
- **Alejandro Ridao Velasco** (Bachelor Thesis)
- **Daan Hurtecant** (Master Thesis)
- **Christian Rösing** (Project)
- **Pascal Mattausch** (Master Thesis)

Homepage:

http://ecolabel.ProfScholz.de

Outlook

Sustainable Aviation Fuel, **SAF and Hydrogen Aircraft** may not be the solution to aviation's climate burden, when combined with unrestricted aviation growth. In contrast, **traveling less, choosing the right mode of transport, or selecting the best flight will certainly help the climate**. Passengers need information to make such decisions.

On 13 September 2023, the European Parliament voted on a Union **labeling scheme** about the **environmental performance of flights** of aircraft operators to help **consumers make informed travel choices**. The presentation comments on **ReFuelEU, Article 14 "Environmental Labeling Scheme".**

The presentation summarizes the information available so far about **EASA's** proposed **Environmental Label Programme**, which is based on the requirements laid down in ReFuelEU.

An already existing aviation ecolabel definition from Hamburg University of Applied Sciences is presented to contrast EASA's proposal.

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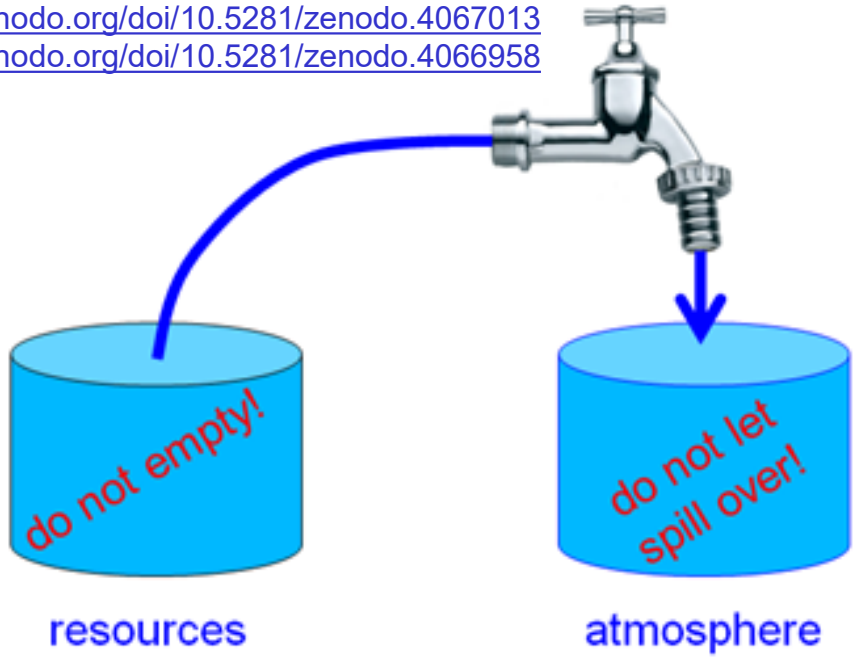
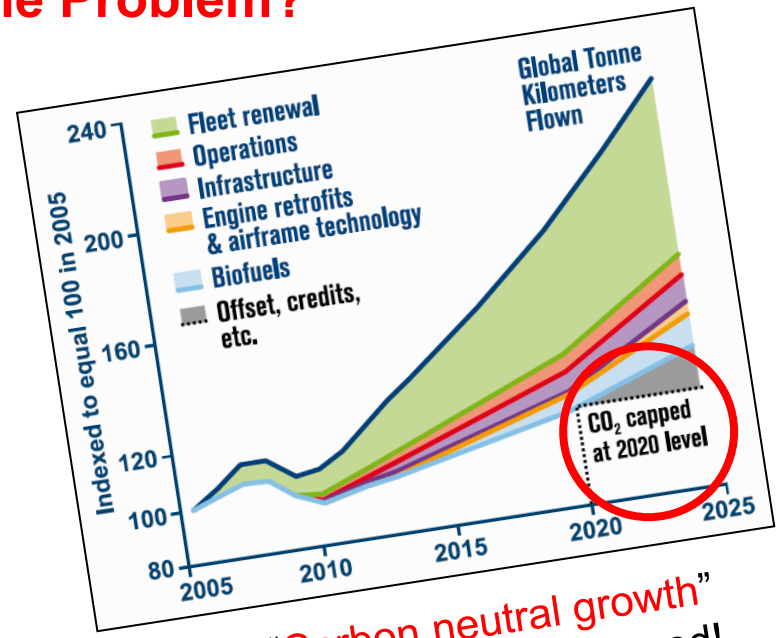
Fundamental Thoughts

Fundamental Thoughts

Resources or Atmosphere – What is the Problem?

https://zenodo.org/doi/10.5281/zenodo.4067013
https://zenodo.org/doi/10.5281/zenodo.4066958





IATA: "Carbon neutral growth" from 2020. It never happened!

Two barrels symbolize:

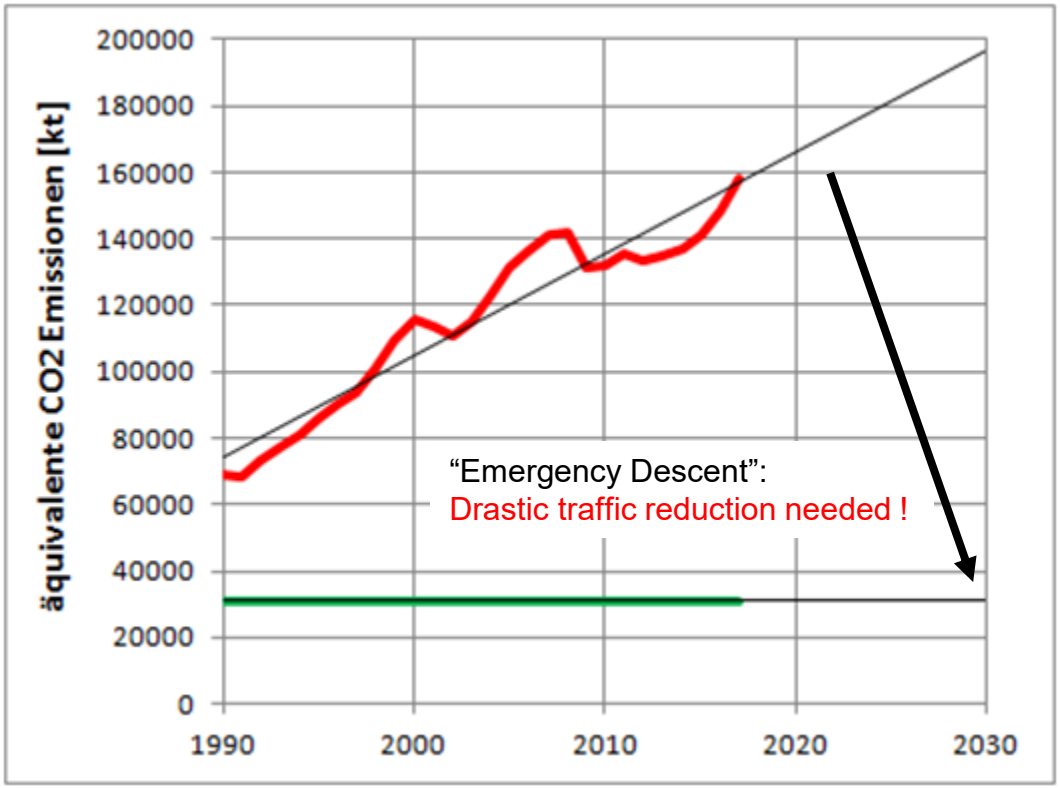
- left: the finite fossil energy reserves and
- right: the finite capacity of the atmosphere to absorb is the limiting factor.

=> It does not work to open the tap more each year.

=> It also does not work to set the tap at constant flow. It needs to be closed!

Fundamental Thoughts

"Green Deal" (2050) and "Fit for 55" (2030)



The equivalent CO2 emissions (in 1000 tonnes or kt) of international aviation in the EU are rising continuously (red line). According to the "Green Deal" of the EU, they have to go to 45% of the 1990 value (by 2030) (green line). Diagram created with data from EEA 2019 (https://perma.cc/2EZ6-DQBN).

80% of humans on earth never flew and will probably never fly.

Global warming from aviation is a "rich world's problem"!

https://doi.org/10.48441/4427.225

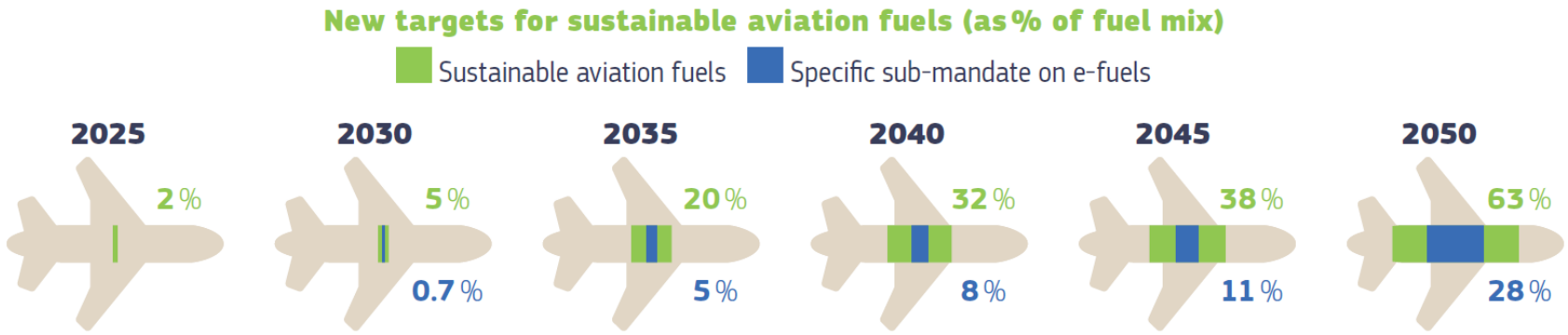
Fundamental Thoughts

With SAF in 2050: Still 40% Remaining CO2 Emissions per Tank Together with Aviation Growth: 17% More CO2 Emissions than Today

ReFuelEU, Annex I: Shares of SAF referred to in Article 4

https://perma.cc/F7Z6-JJK5

ReFuelEU, July 2021



https://perma.cc/MZ44-SLZT

RefuelEU, September 2023 NEW!

2% 6%/1.2% 20%/5% 34%/10% 42%/15% 70%/35%

Biofuel has ≈ 70% CO2-Efficiency: 35% Biofuel => 25% CO2 Reduction

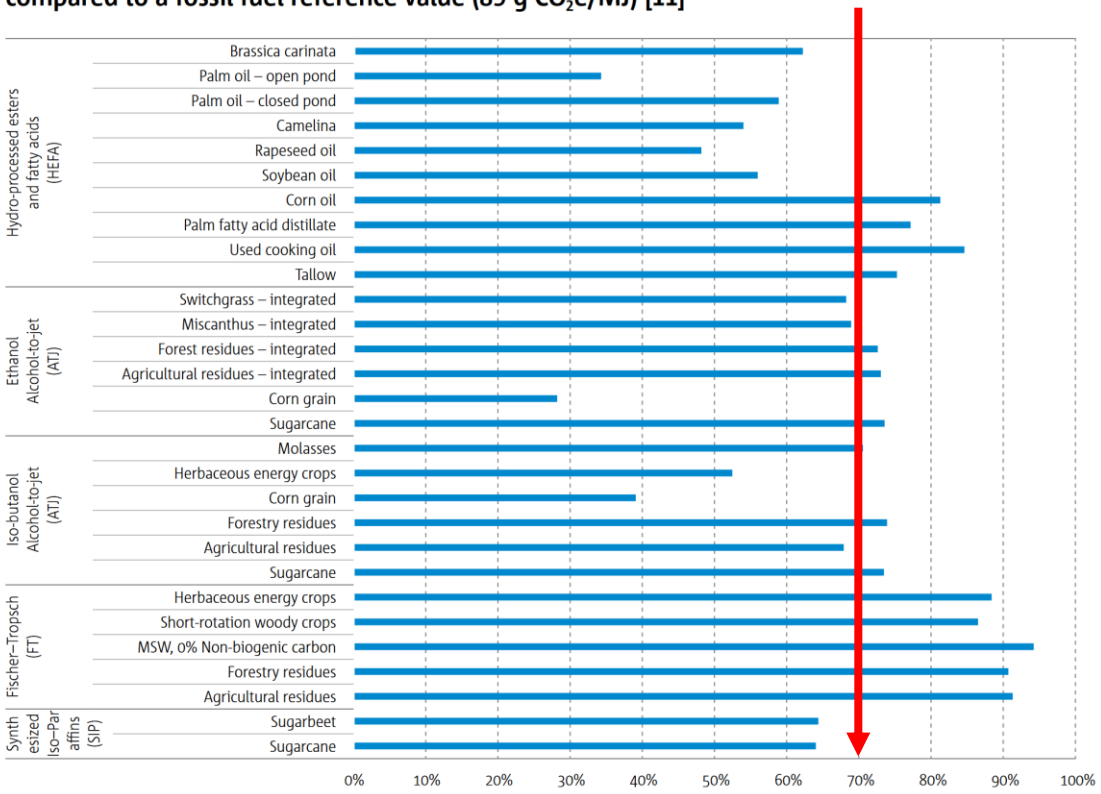
E-Fuel has ≈ 100% CO2-Efficiency: 35% E-Fuel. Total with biofuel: 40% remaining CO2 per tank are left!

Traffic Growth ≈ 4% p.a. over 27 years: Factor ≈ 2.88 => 2.88 · 0.40 => 16% more global CO2 emissions!

Fundamental Thoughts

CO2-Efficiency of SAF (Biofuel)

Figure 4.3 LCA emissions reductions for CORSIA eligible SAF pathways and feedstock compared to a fossil fuel reference value (89 g CO_2e/MJ) [11][38]



EASA
European Union Aviation Safety Agency

EUROPEAN AVIATION ENVIRONMENTAL REPORT 2022

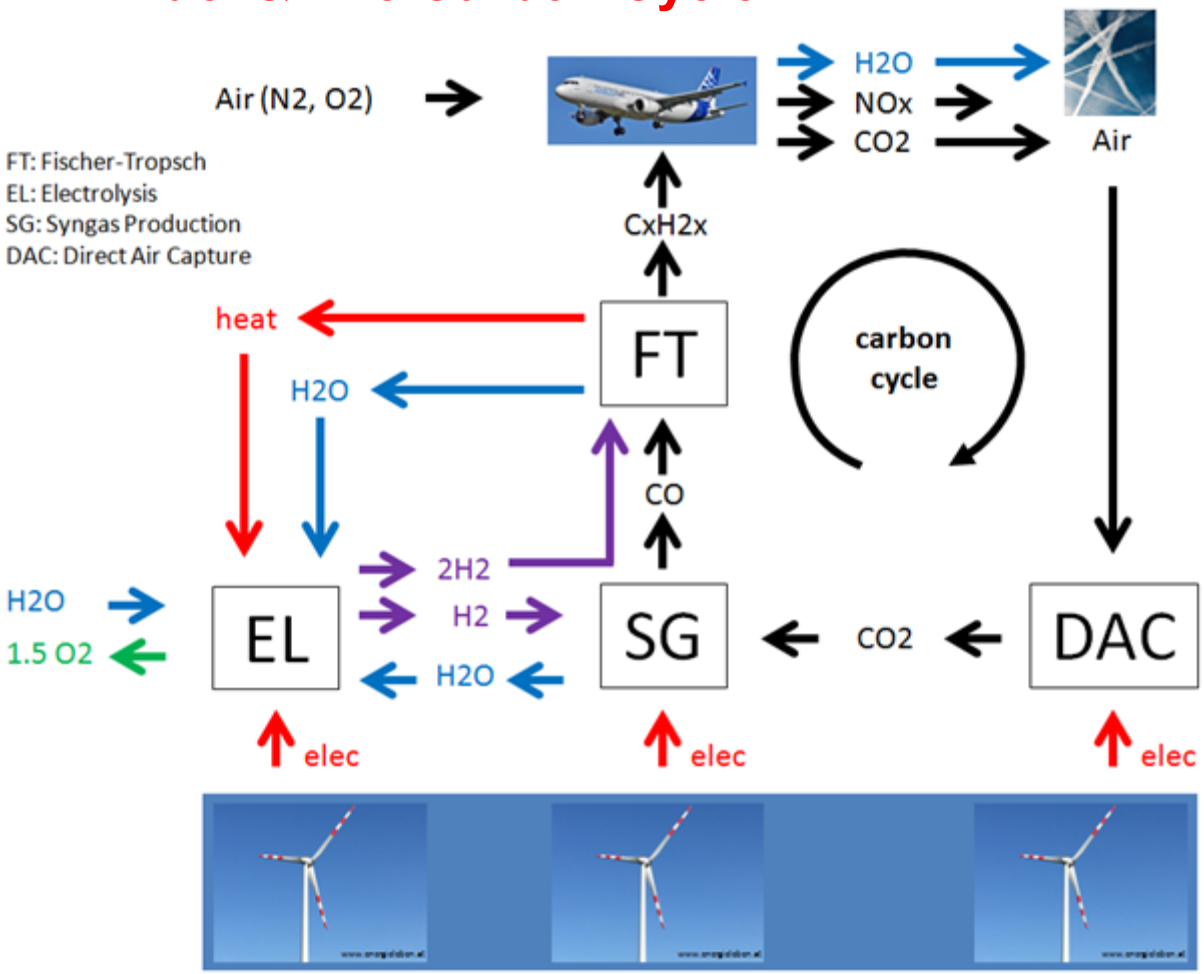
https://www.easa.europa.eu/eco/eaer
https://perma.cc/ED4C-PNWY

LCA emission reduction efficiency of an average SAF pathway compared to fossil fuel is about 70%

Fundamental Thoughts

https://doi.org/10.48441/4427.225

E-Fuel & The Carbon Cycle



Production of synthetic kerosene (e-fuel) with power-to-liquid (PtL). Taking CO2 from the air (Direct Air Capture, DAC) enables a carbon cycle.

- **E-Fuels need DAC (Direct Air Capure) to compensate for CO2 ("carbon cycle")**
- **In addition: E-Fuel and Bio Fuel need more DAC to compensate for the global warming effect due to**
  - **NOX and**
  - **H2O (AIC)**

Note:

1. DAC is not and will not be available to scale and is too expensive.
2. If CO2 is taken from a coal power plant, aviation and the fossile power plant have (philosophically) to split the achievement. 50% of CO2 remains with aviation.

Fundamental Thoughts

E-Fuel for Aviation or Switching Off Coal Power Plants?

https://doi.org/10.48441/4427.225
http://ptl.ProfScholz.de

Substituting coal is better than E-Fuel for aviation by a factor of 0.9/0.057 = 15.7

1.

O=C=O

0.057 kg CO2 ← 0.22 kWh PtL fuel ← 1 kWh → 2.5 kWh Coal → 0.9 kg CO2

O=C=O

5. 4. 2. 3.

1. 1 kWh of renewable energy ...
2. ... can substitue 2,5 kWh of coal (lignite, brown coal) in a coal power plant (efficiency of a coal power plant: 40%) this is ...
3. equivalent to 0.9 kg CO2 (0.36 kg CO2 for 1 kWh of energy burning lignite*) .
4. ... but if used in an aircraft it generates "Sustainable Aviation Fuel" (SAF) from "Power to Liquid" (PtL) with an energy of 0.22 kWh (efficiencies: 70% electrolysis, 32% Fischer-Tropsch process, 99% transport; https://perma.cc/BJJ6-5L74, p. 44)
5. which substitutes the same amount of kerosene. This is equivalent to 0.057 kg CO2 (0.26 kg CO2 for 1 kWh of kerosene*).

* UBA, 2016. CO2 Emission Factors for Fossil Fuels. Available from: https://bit.ly/3r8avD1

Fundamental Thoughts

Will Hydrogen Aircraft Safe Us? – No!

Simplified thoughts:

- Airbus has a market share of 50% (and no other hydrogen aircraft is built).
- Fuel burned on short/medium range is 50% (and 50% on long range).
- An aircraft can live 30 years (assume 25 years).
  The hydrogen aircraft will come not before 2037-2038. 12,5 years (50%) is left to 2050.
  Max. 50% of the aircraft in market segment reached an age to be replaced
  Max. 50% of the aircraft get replaced, if there are no production limitations.
- The aircraft will emit more than “zero” emissions. Say, 50%.

Simplified thoughts show:

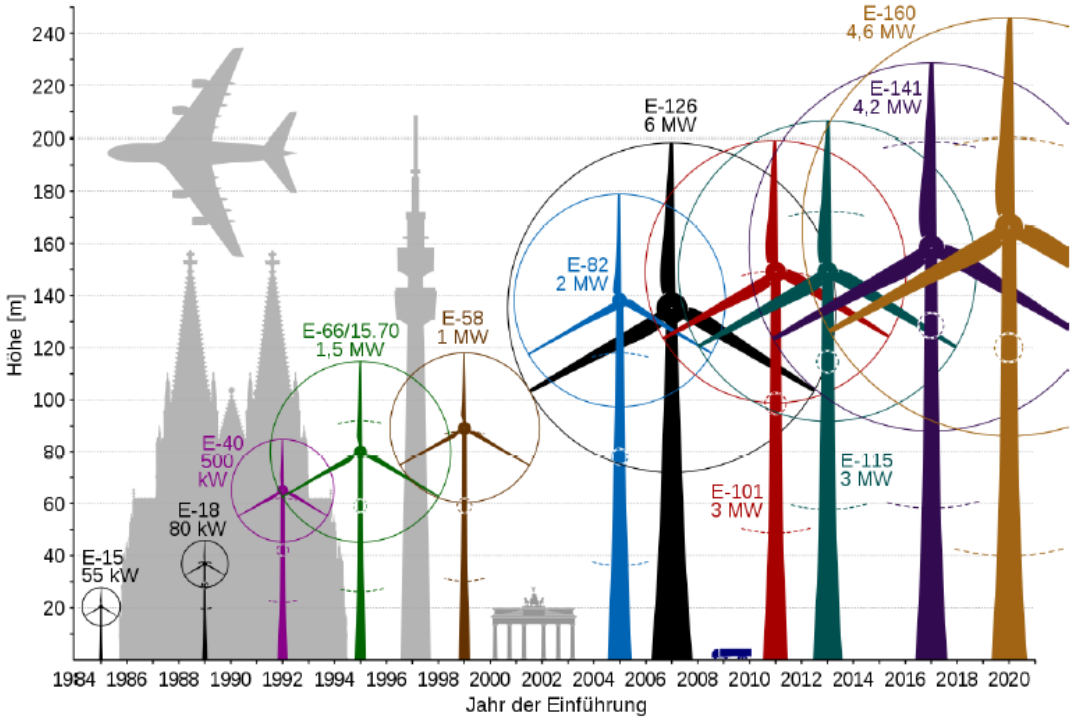
- The emission problem is solved globally by 50%*50%*50%*50% = 1/16 = 6.25% due to a hydrogen aircraft type.

https://perma.cc/HJ6L-3HUB

Fundamental Thoughts

https://zenodo.org/doi/10.5281/zenodo.4301103

Refueling One A350 Once per Day
Can Be Done with 52 Big Wind Power Plants (4.6 MW Each)



Airbus A350-900:

Kraftstoffkapazität: 138.000 L

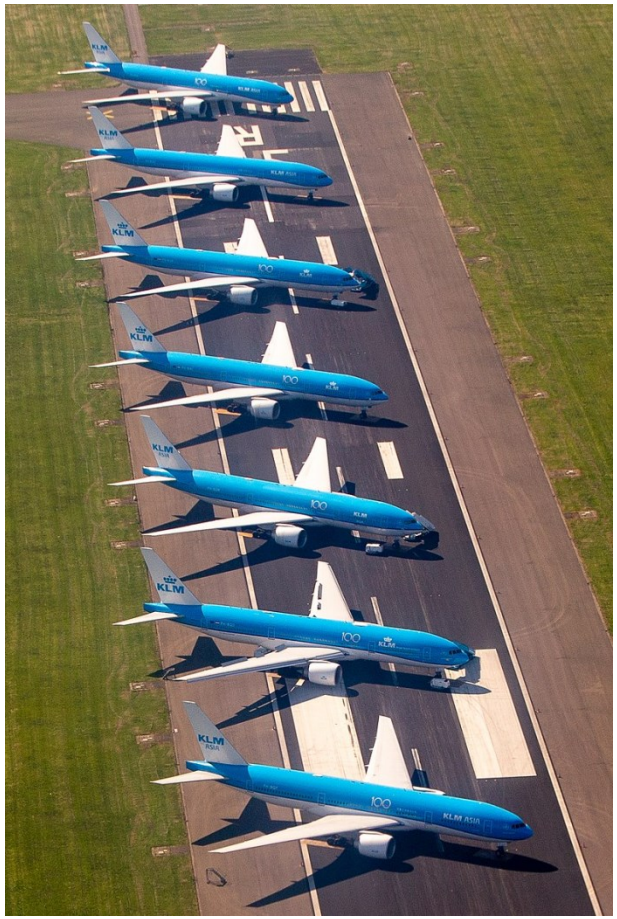
1x Volltanken pro Tag

entspricht

52x E-160 4,6 MW

(Annahmen: CF=50%, η_{PtL} = 0.45%)

Largest Reduction of Emission in Aviation History: Corona Pandemic



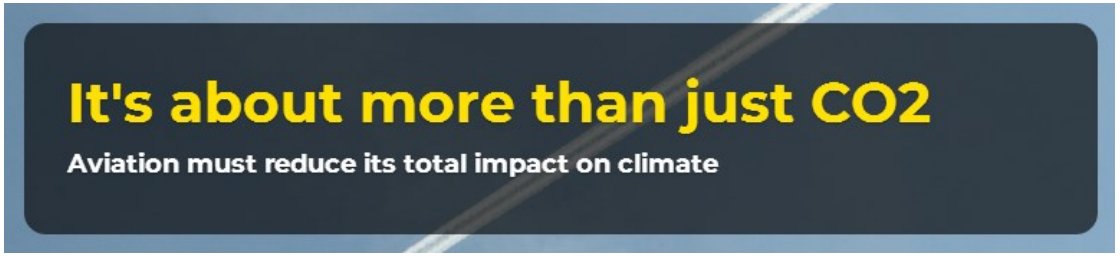
Ikreis, CC BY-SA, https://bit.ly/2Jn11T0

Fundamental Thoughts

STAY GROUNDED

Traffic reduction is more efficient than technology

https://stay-grounded.org



Fundamental Thoughts

Passengers Must Vote with Their Feet

SAF and hydrogen aircraft are proposed, but are not a solution, if traffic growth and limited renewable energy is considered.

Flying less is a fundamental solution that works!

Passengers:

1. need to get informed (with an Ecolabel),
2. need to decide if they want to travel at all, if they want to take the aircraft (or another mode of transport), and which aircraft and airline,
3. need to vote with their feet !

Fuel Consumption and CO2

Fuel Consumption

Definition of the Aircraft's Fuel Consumption

	Full Mission Metrics				
Single parameter metric	Block Fuel / Range				
Two-parameter metric	Block Fuel / **Payload** * Range	Block Fuel / **Useful Load** * R	Block Fuel / **MTOW** * Range	Block Fuel / **Floor Area** * R	Block Fuel / **Av. Seats** * R
Three-parameter metric	Block Fuel / **Payload** * R.*Speed	Block Fuel / **Useful Load** * R.*Speed	Block Fuel / **MTOW** * R. *Speed	Block Fuel / **Floor Area***R.*Speed	Block Fuel / **Av. Seats** * R. *Speed
	Block Fuel / **Payload** * R./Time	Block Fuel / **Useful Load***R./Time	Block Fuel / **MTOW** * R./Time	Block Fuel / **Floor Area***R./Time	Block Fuel / **Av. Seats** * R./Time
	Instantaneous Performance Metrics				
Single parameter metric	1 / **Specific Air Range** = 1 / **SAR**				
Two-parameter metric	1 / SAR * **Payload**	1 / SAR * **Useful Load**	1 / SAR * **MTOW**	1 / SAR * **Floor Area**	1 / SAR * **Av. Seats**
Three-parameter metric	1 / SAR * **Payload** * Speed	1 / SAR * **Useful Load** * Speed	1 / SAR * **MTOW** *Speed	1 / SAR * **Floor Area*** Speed	1 / SAR * **Av. Seats** * Speed

Note: R = Range

https://perma.cc/8YAS-PG6J

PARTNER
Partnership for Air Transportation Noise and Emissions Reduction

Selecting a Fuel Metric:

$$1/(SAR \cdot n_{seat})$$

$$SAR = \frac{V \cdot L/D}{SFC \cdot m \cdot g} \quad ; \quad g = 9.81\ \mathrm{m/s^2}$$

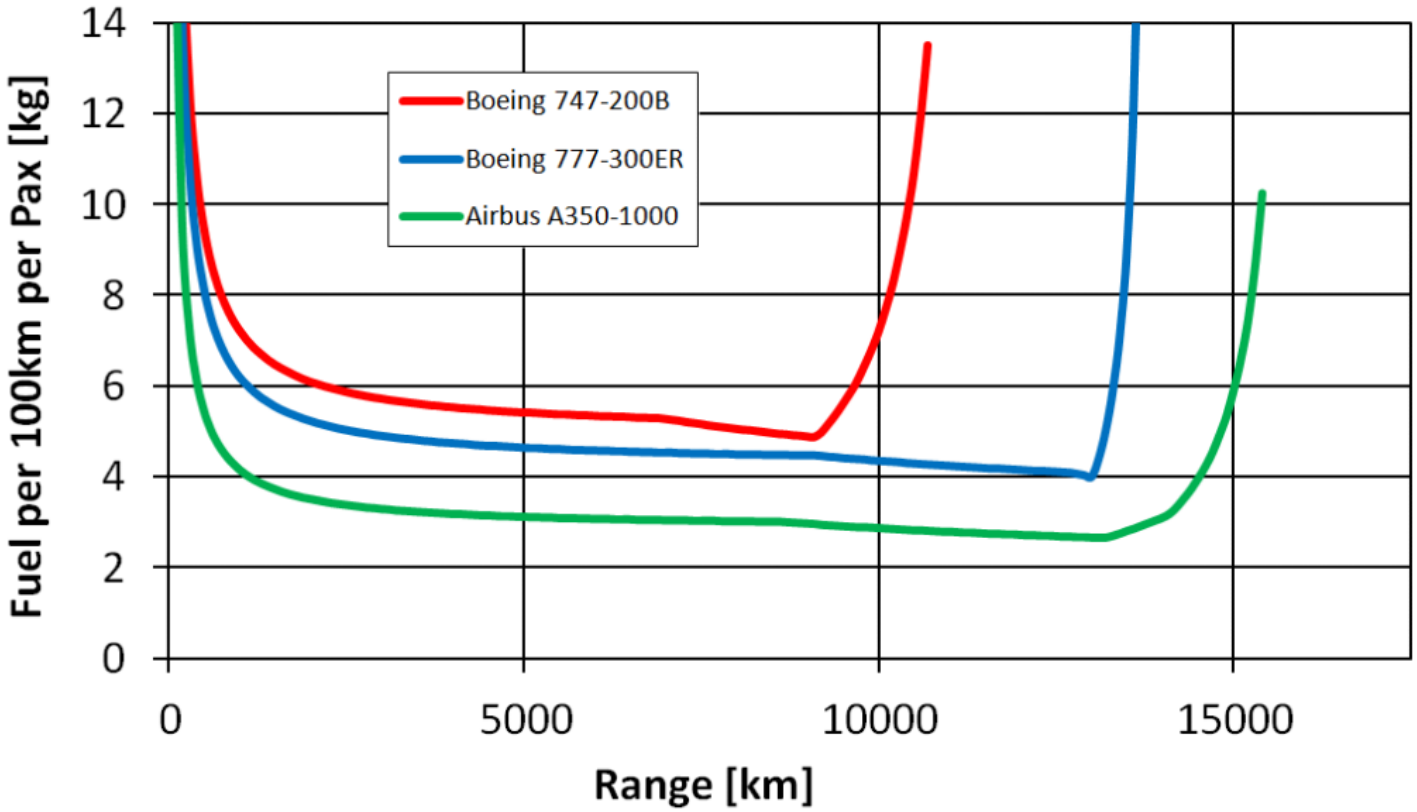
Specific Air Range; 1/SAR=fuel consumption can be **measured** in flight **or calculated** from basic aircraft parameters:

- aircraft mass, *m*
- aerodynamic efficiency, *L/D*
- specific fuel consumption, *SFC*
- aircraft speed, *V*

or extracted from published **Payload Range Diagrams**

Fuel Consumption

Fuel Consumption per 100 km and Person Depends on Distance!



BURZLAFF, Marcus, 2017. *Aircraft Fuel Consumption - Estimation and Visualization*. Project. Hamburg University of Applied Sciences, Aircraft Design and Systems Group (AERO). Available from: https://nbn-resolving.org/urn:nbn:de:gbv:18302-aero2017-12-13.019

Fuel Consumption and CO2 Emissions are Proportional *

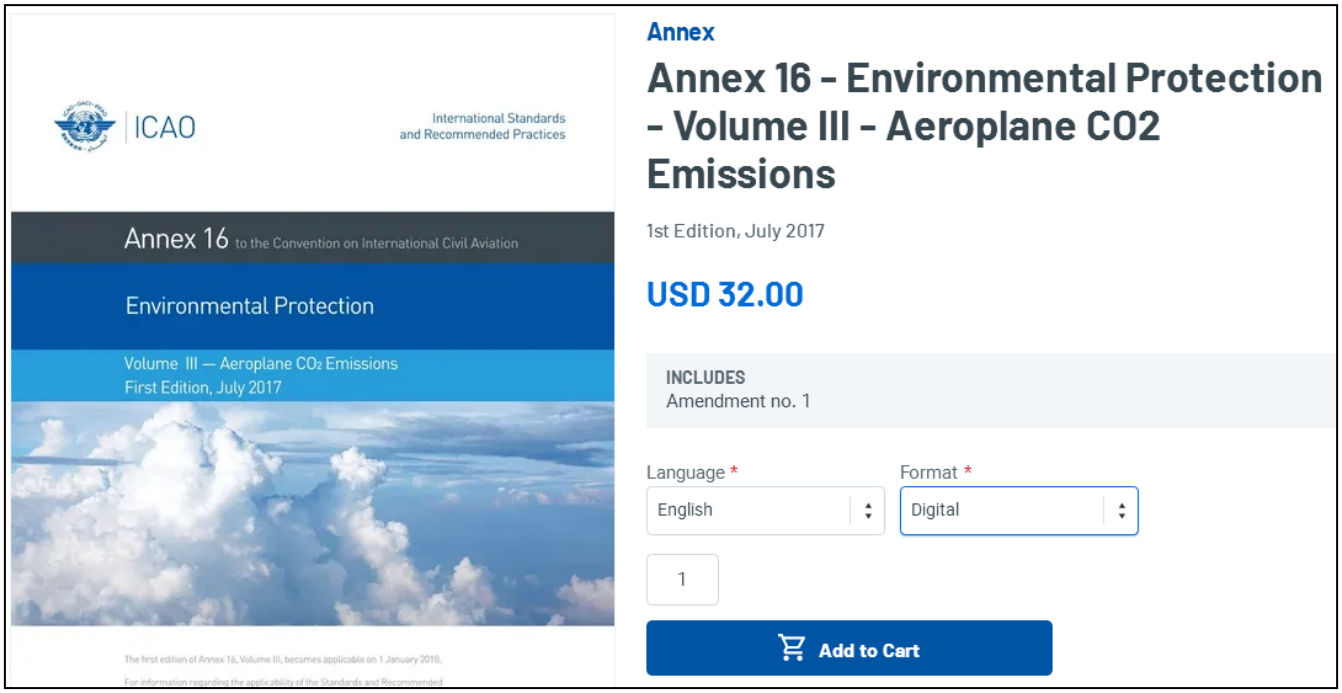
1 kg kerosene => 3.15 kg CO2

*** when using the same fuel in the comparison**

https://perma.cc/K2LK-F27M

ICAO Annex 16, Volume III: Aeroplane CO2 Emissions

- ICAO CO2 adopted CO2 standard in 2016 after 6 years of negotiations.
- EASA requirement CS-CO2 introducted after further 3 years in 2019.



https://store.icao.int/en/annex-16-environmental-protection-volume-iii-aeroplane-co2-emissions

https://purl.org/aero/ICAO-2017_CO2-Emissions (Open Access)

ICAO Annex 16, Volume III: Aeroplane CO2 Emissions

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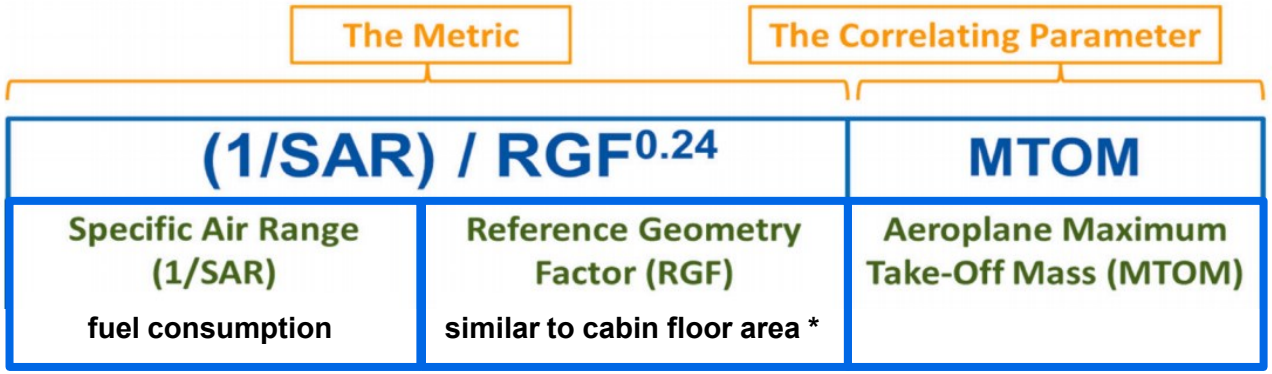
-

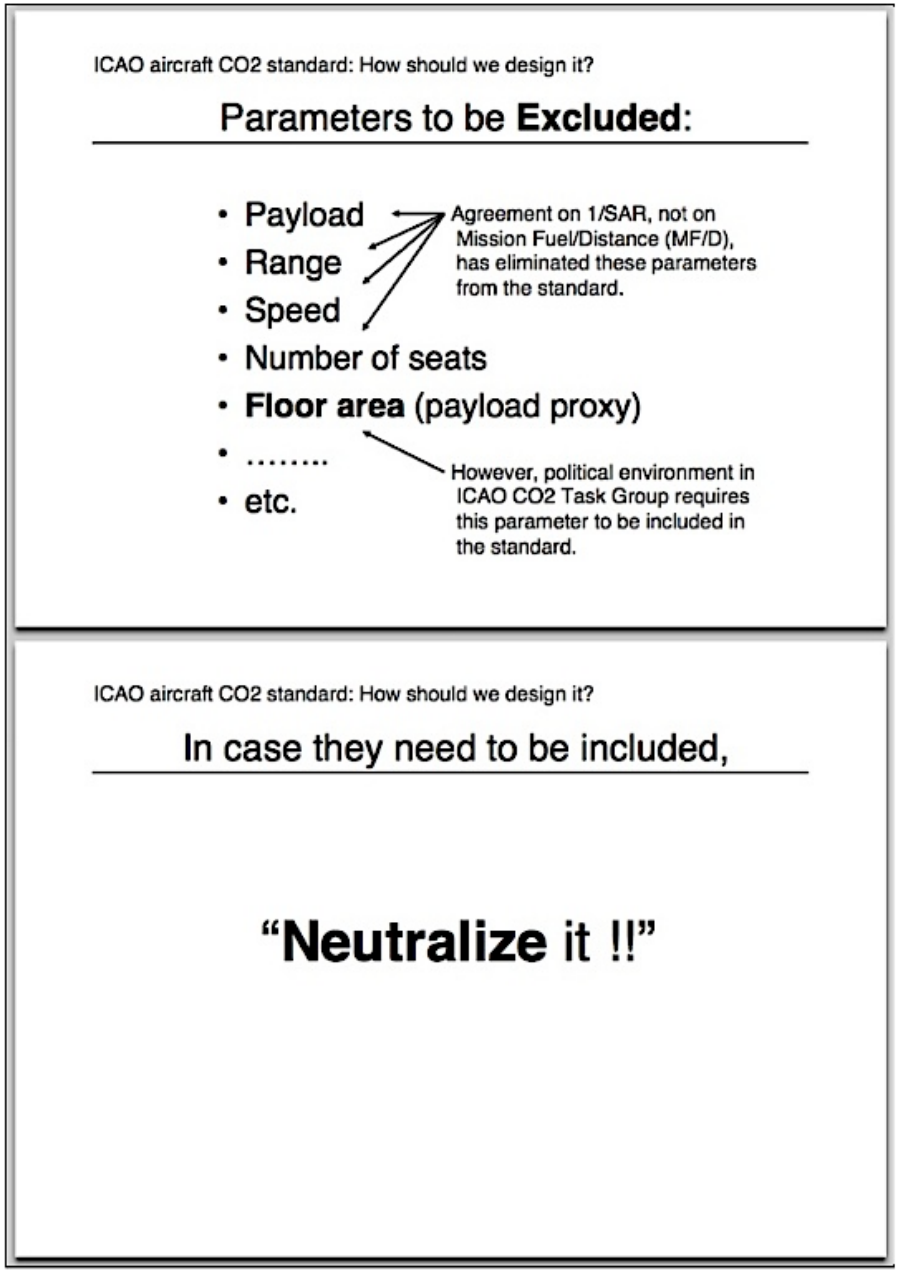


https://perma.cc/U6R3-RJHE

MV: Metric Value
$MV = (1/SAR)/RGF^{0.24}$

* divided by 1 m²

- **1/SAR** (in kg/km) determined for the aircraft either ...
  - from validated performance model or
  - from flight test: $SAR = TAS/W_f$
    where: TAS is the true air speed, W_f is total aeroplane fuel flow.
- An RGF-exponent of 1 would normalize the fuel consumption by a payload substitute.
- The "magic" exponent 0.24 obscures the metric. So, MV is not helpful for an ecolabel!



Perspectives of one manufacturer participating in the ICAO process:

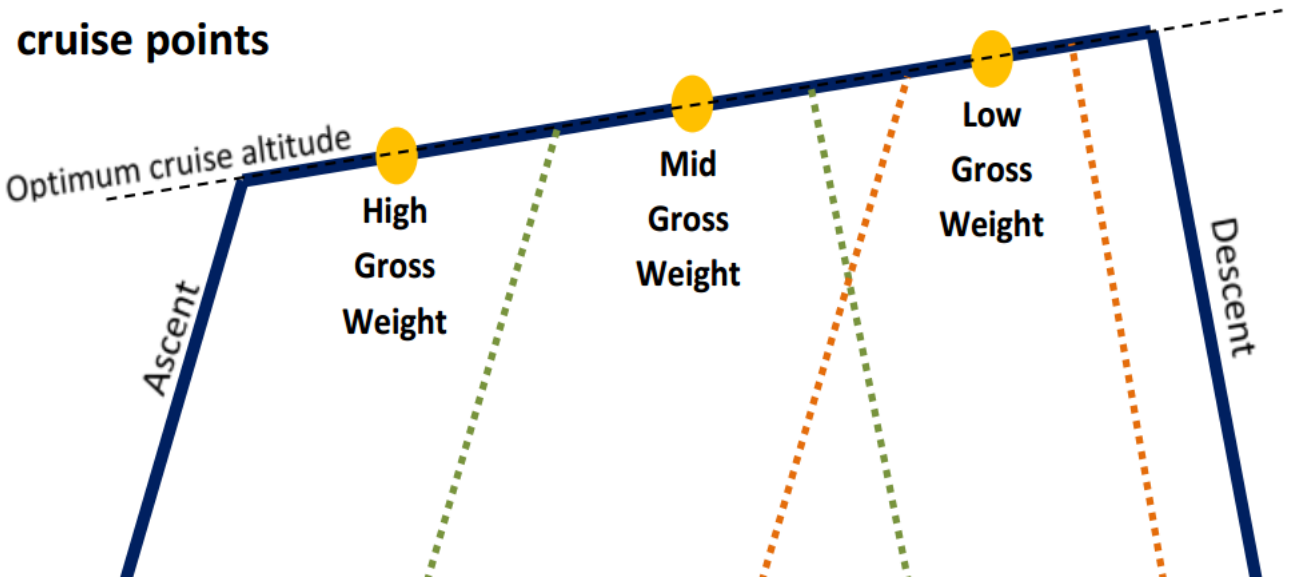
It is about hiding data!

https://perma.cc/2Z89-YK7Z

ICAO Annex 16, Volume III: Aeroplane CO2 Emissions

- **1/SAR** determined as the average of 3 conditions (given by aircraft mass in flight):
  high gross mass: 92% MTOM
  low gross mass: 0.45 MTOM + 0.63 $MTOM^{0.924}$
  mid gross mass: average of high and low gross mass.

An illustrative example of the three representative cruise points



https://perma.cc/J4JY-JGXX

The EU Ecolabel "Law"

ReFuelEU

ReFuelEU

Level Playing Field for Sustainable Air Transport (ReFuelEU)

Article 14

https://perma.cc/F7Z6-JJK5

Environmental Labelling Scheme

1. A voluntary environmental labelling scheme enabling the environmental performance of flights to be measured is hereby established.

Flight Label

2. Labels issued pursuant to this Article shall apply to aircraft operators falling within the scope of this Regulation for flights covered by this Regulation departing from Union airports. Where an aircraft operator requests the issuance of a label under this Article, it shall request such a label for all its flights covered by this Regulation departing from Union airports. Aircraft operators may request the issuance of labels under this Article also for their flights covered by this Regulation arriving at Union airports. Where an aircraft operator requests the issuance of a label under this subparagraph, it shall request such a label for all its flights arriving at Union airports.

Voluntary

No cherry picking

Comment color scheme: GREEN: good; BLUE: neutral, PURPLE: unfit; RED: bad.

Level Playing Field for Sustainable Air Transport (ReFuelEU)

3. Labels issued pursuant to this Article shall certify the level of environmental performance of a flight on the basis of the information referred to in the second subparagraph of this paragraph. The level of environmental performance of a flight shall be determined on the basis of the average environmental performance of the flights carried out by a given aircraft operator on a specific route for the previous corresponding scheduling period within the meaning of Article 2, point (d), of Regulation (EEC) No 95/93.

Labels issued pursuant to this Article shall consist of the following information:

(a) the expected carbon footprint per passenger, expressed in metrics such as in kilograms of CO_2 per passenger, for the period of validity of the label;

(b) the expected CO_2 efficiency per kilometre, expressed in metrics such as in grams of CO_2 per passenger per kilometre, for the period of validity of the label.

Standard Metric Used *

*** The distorted Metric Value (MV) from ICAO Annex 16, Volume III is not used.**

Level Playing Field for Sustainable Air Transport (ReFuelEU)

4. The expected carbon footprint per passenger and the expected CO2 efficiency per kilometre of a flight shall be determined by the Agency on the basis of a standardised and science-based methodology and the information from the aircraft operators concerning all or some of the following factors:

(a) the types of aircraft, average number of passengers and freight loads supplemented when needed with estimations of those factors, such as the average load factors for the specified route for a given time period; and

(b) the performance of the fuel used on the flights carried out by the aircraft operator based on the fuel uptake and using metrics such as the total amount of SAF uplifted, the percentage over the total fuel uptake, the quality and origin, the composition and the lifecycle emissions from fuel use calculated for the flight.

See: CO2-Efficiency of SAF

No aircraft specific data available !!!

Too much. May obscure method & data

SAF: Makes comparison with other modes of transport difficult

Level Playing Field for Sustainable Air Transport (ReFuelEU)

5. Labels issued pursuant to this Article shall be valid for a limited period not exceeding one year specified in the implementing acts referred to in paragraph 11, point (c). The period of validity of the label shall be clearly displayed by the aircraft operator together with the label.

6. The Agency shall issue labels at the request of an aircraft operator for each flight or set of flights operated under the same conditions, on the basis of the information referred to in paragraph 3 and the standardised and science-based methodology and factors referred to in paragraph 4.
The Agency may require the aircraft operator to provide additional information necessary for the issuance of the label.
Where the aircraft operator does not submit all the information necessary for the Agency to issue the requested label, the Agency shall reject the request.

Level Playing Field for Sustainable Air Transport (ReFuelEU)

An appeal may be brought by the aircraft operator against decisions of the Agency taken pursuant to this paragraph and paragraph 7 of this Article. Such appeal shall be filed to the Board of Appeal referred to in Article 105 of Regulation (EU) 2018/1139 of the European Parliament and of the Council18 within 10 days of notification of the decision. Articles 106 and 107, Article 108(2) and (3), and Articles 111, 112, 113 and 114 of Regulation (EU) 2018/1139 shall apply. Any decision taken by the Agency pursuant to this paragraph shall be taken without undue delay.

7. The Agency shall review periodically whether the factors on the basis of which a label was issued for each flight or set of flights operated under the same conditions have changed. If the Agency concludes that a label is no longer appropriate, it shall, after giving the operator the opportunity to be heard revoke the existing label or issue a new label. The Agency shall inform the aircraft operator of its decision. The aircraft operator shall without any delay adjust the display of the label accordingly.

Level Playing Field for Sustainable Air Transport (ReFuelEU)

8. Aircraft operators that have been granted a label pursuant to paragraph 6 shall display the label containing the information referred to in paragraph 3, second subparagraph. The label shall be easily accessible and understandable. It shall be presented in a way that enables customers to easily compare the environmental performance of flights operated by different aircraft operators flying the same route. Where an aircraft operator displays the label at a point of sale or any other contact with the customers, they shall do so for all flights within scope of this Regulation.

Operator designs the label ? No !

9. In order to finance the costs of the service provided by the Agency, the issuing of a label at the request of an aircraft operator shall be subject to the payment of a charge. The revenues generated from such charges shall constitute other revenues within the meaning of Article 120(1) of Regulation (EU) 2018/1139 and shall be treated as assigned revenues to be allocated by the Agency to cover those costs. Article 126(2) and (3) of Regulation (EU) 2018/1139 shall apply. The amount of the charge shall be defined pursuant to Article 126(4) of Regulation (EU) 2018/1139.

Level Playing Field for Sustainable Air Transport (ReFuelEU)

10. As part of its tasks in the field of environmental protection as set out in Article 87(2) of Regulation (EU) 2018/1139, the Agency shall contribute to raising awareness of the existence of the labelling scheme set up by this Article.

p.t.o.

Level Playing Field for Sustainable Air Transport (ReFuelEU)

11. In order to ensure the uniform implementation and compliance with the rules set out in this Article, the Commission shall adopt by 1 January 2025 implementing acts laying down detailed provisions concerning:

(a) the standardised and science-based methodology referred to in paragraph 4, based on the best available scientific data, in particular the data provided by the Agency and including the methodology for using estimations referred to in paragraph 4, point (a);

(b) the procedure through which aircraft operators are to provide the Agency with the relevant information for the issuance of a label, and the procedure for the Agency to issue that label, including the time-limit by which the Agency is to take a decision pursuant to paragraph 6;

(c) the duration of the validity of labels issued pursuant to this Article, not exceeding one year;

(d) the conditions under which the Agency is to carry out the review referred to in paragraph 7;

(e) the procedure mentioned in paragraph 7 through which the Agency can either revoke existing labels or issue a new label;

Operator provides data. Agency ticks off. Customer believes !!!

Level Playing Field for Sustainable Air Transport (ReFuelEU)

(f) the templates for displaying labels issued pursuant to this Article;
(g) ensuring an easy access to all issued labels in machine-readable format;
(h) the possibility and conditions under which aircraft operators may display, without using a label under this Article, any environmental performance information similar to the one referred to in paragraph 3 for flights departing from Union airports.
Those implementing acts shall be adopted in accordance with the examination procedure referred to in Article 16(3).

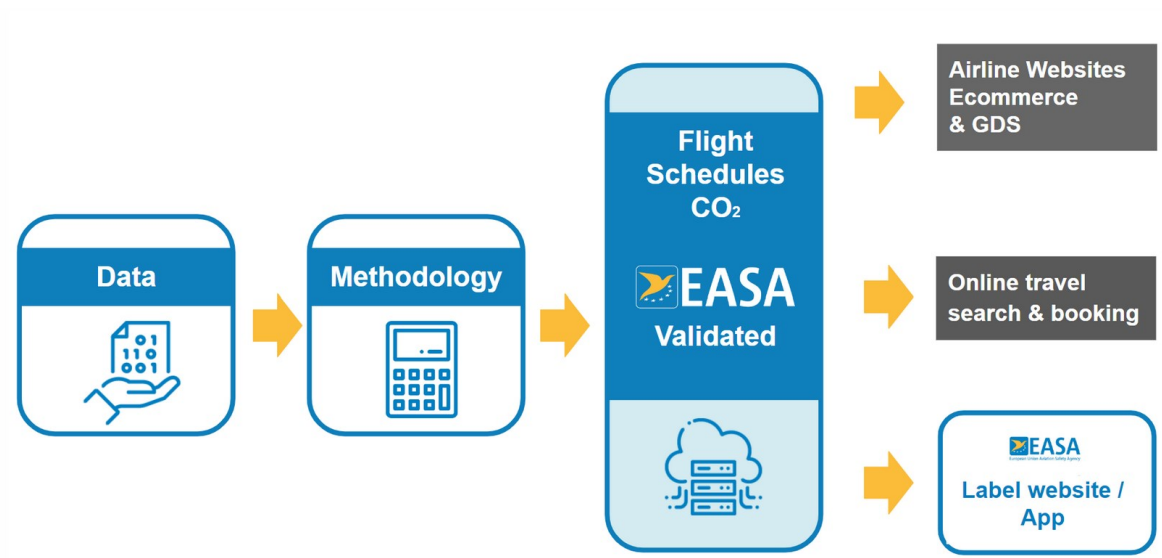
Level Playing Field for Sustainable Air Transport (ReFuelEU)

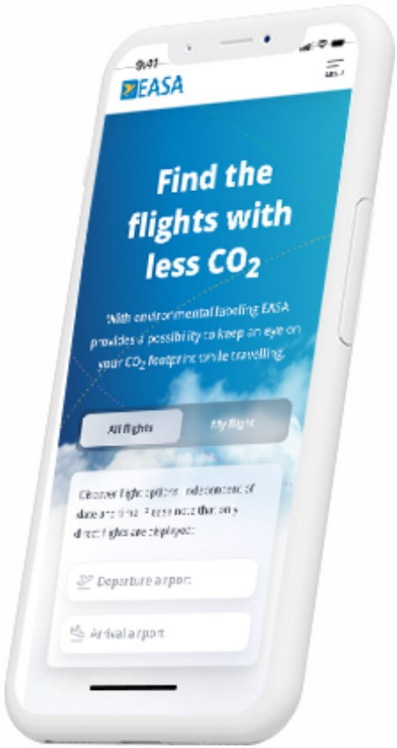
12. By 1 July 2027, the Commission shall identify and assess the developments on the functioning of the labelling scheme set up by this Article as well as possible improvements or additional measures to such scheme, with a view in particular to establish a compulsory environmental labelling scheme encompassing all aspects of the environmental performance of flights or set of flights and the different decarbonisation measures that aircraft operators take, in full compliance with Union law. The Commission shall present a report with the main findings of the assessment carried out pursuant to this paragraph to the European Parliament and to the Council. It may, where appropriate, accompany that report with a legislative proposal.

First Ideas at EASA

Information from EASA'S Website

Environmental Labelling Scheme for Aviation





https://perma.cc/Z5L7-52UQ

Press Release, 2023-06-07

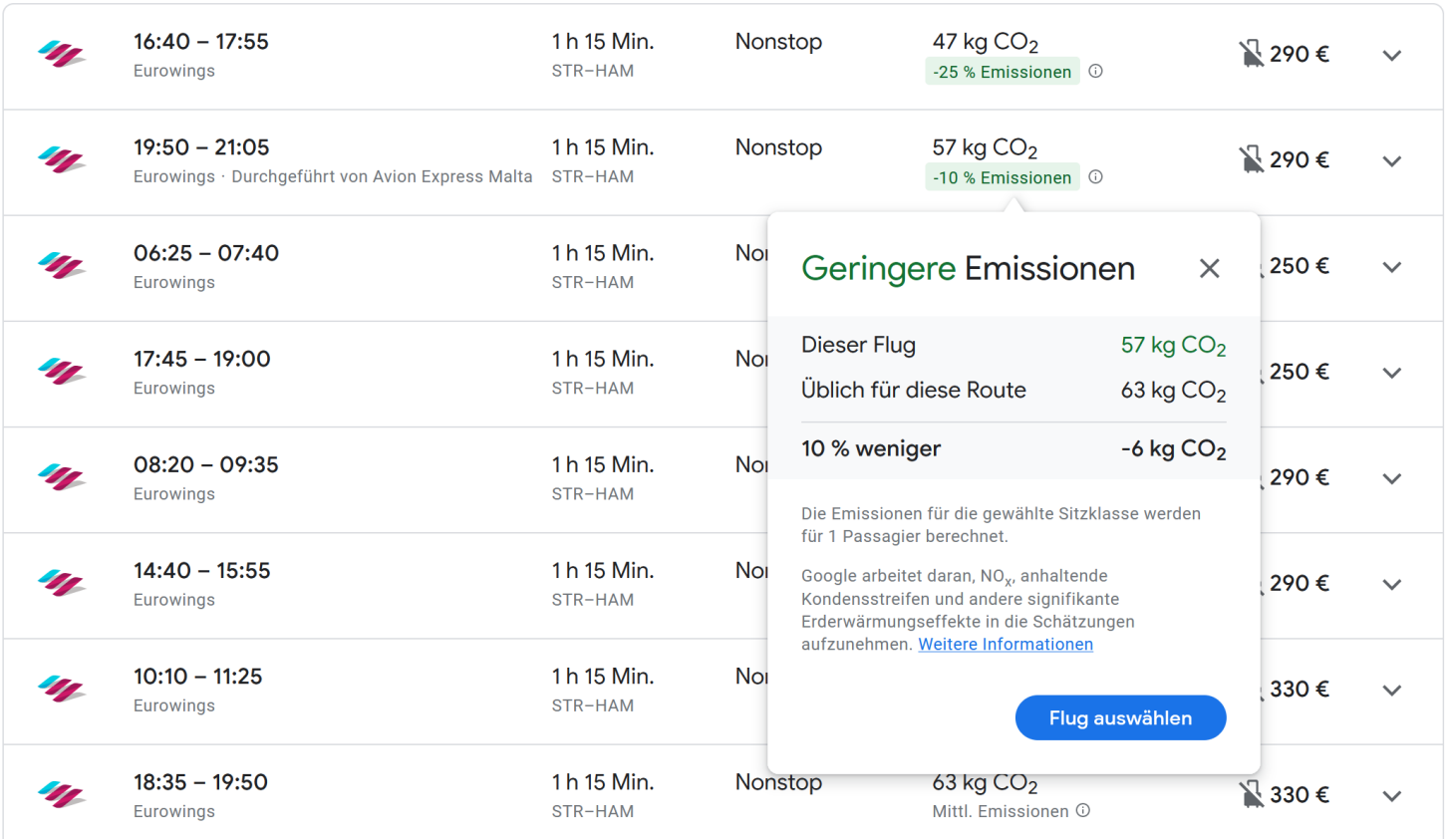
EASA and Google working together on environmental transparency for air passengers, with Lufthansa Group as pilot partner

https://perma.cc/GL3C-E3KU

https://github.com/google/travel-impact-model

First Ideas at EASA

https://flights.google.com



First Ideas at EASA

https://flights.google.com

European Environment Agency

Topics Analysis and data

FILE

1.A.3.a Aviation 2019

Wie werden CO2-Emissionen geschätzt?

Google Flüge zeigt Schätzungen der CO_2-Emissionen neben den einzelnen Flügen an. Flüge werden mit „Höhere Emissionen“, „Übliche Emissionen“, „Geringere Emissionen“ oder „Emissionen unbekannt“ gekennzeichnet.

Woher hat Google diese Informationen?

Zur Ermittlung der geschätzten CO_2-Emissionen verwendet Google die Schätzungen der Europäischen Umweltagentur (EUA) mit dem aktuellsten Algorithmusmodell aus dem Jahr 2019 sowie Daten von Drittanbietern wie Fluggesellschaften. Die Daten umfassen beispielsweise die Art des Flugzeugs und die Sitzplatzanordnung. In seltenen Fällen können diese Daten aufgrund verschiedener Faktoren von den tatsächlichen Werten abweichen, z. B. durch eine relativ kurz vor dem Abflug erfolgende Änderung des eingesetzten Flugzeugtyps.

First Ideas at EASA

https://flights.google.com

Alle Züge

Preise beinhalten erforderliche Steuern und Gebühren für 1 Erwachsenen. Es können optionale Gebühren und Gepäckgebühren anfallen.

Sortieren nach:

DB	08:51 – 14:36 Deutsche Bahn	5 h 45 Min. Zugverbindung	Direktverbindung Klimafreundlich	70 €
DB	18:51 – 01:37+1 Deutsche Bahn	6 h 46 Min. Zugverbindung	Dir	70 €
DB	02:22 – 10:14 Deutsche Bahn	7 h 52 Min. Zugverbindung	Dir	90 €
DB	05:51 – 12:14 Deutsche Bahn	6 h 23 Min. Zugverbindung	Dir	90 €
DB	07:51 – 14:14 Deutsche Bahn	6 h 23 Min. Zugverbindung	Dir	90 €

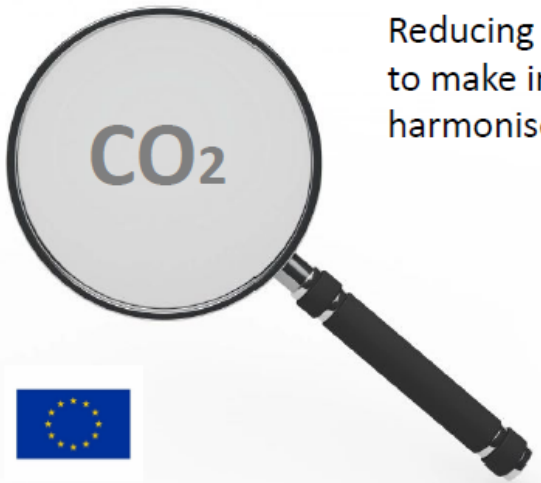
Klimafreundlich

Züge haben einen geringeren Energieverbrauch als Flugzeuge und verursachen daher bei gleicher Wegstrecke **weniger Emissionen**. Mit CO_2-freien Energiequellen betriebene E-Loks sind besonders klimafreundlich.

Weitere Informationen

First Ideas at EASA

Environmental Labelling Scheme for Aviation



Reducing aviation's environmental impacts by **enabling passengers** to make informed choices when booking their flights based on trusted, harmonised, **reliable** and easily understandable information.

EU **Green Deal** Objectives

European Commission
Sustainable & Smart and Mobility Strategy

Governance

EASA Management Board* (Member States Representatives)

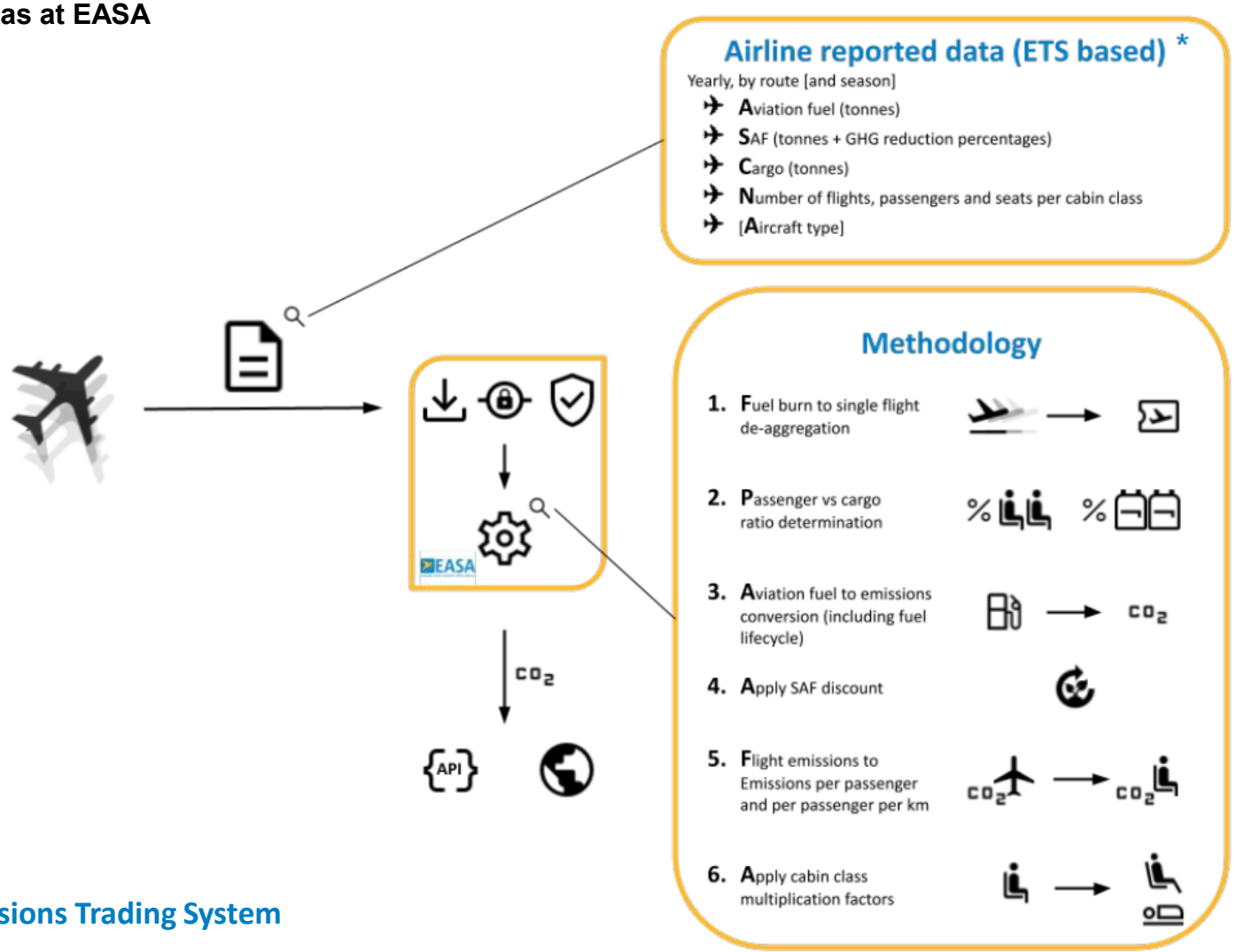
Expert Groups with Airlines, aircraft manufacturers, Online travel booking.

Consultation with Non Governmental Organisations

EASA

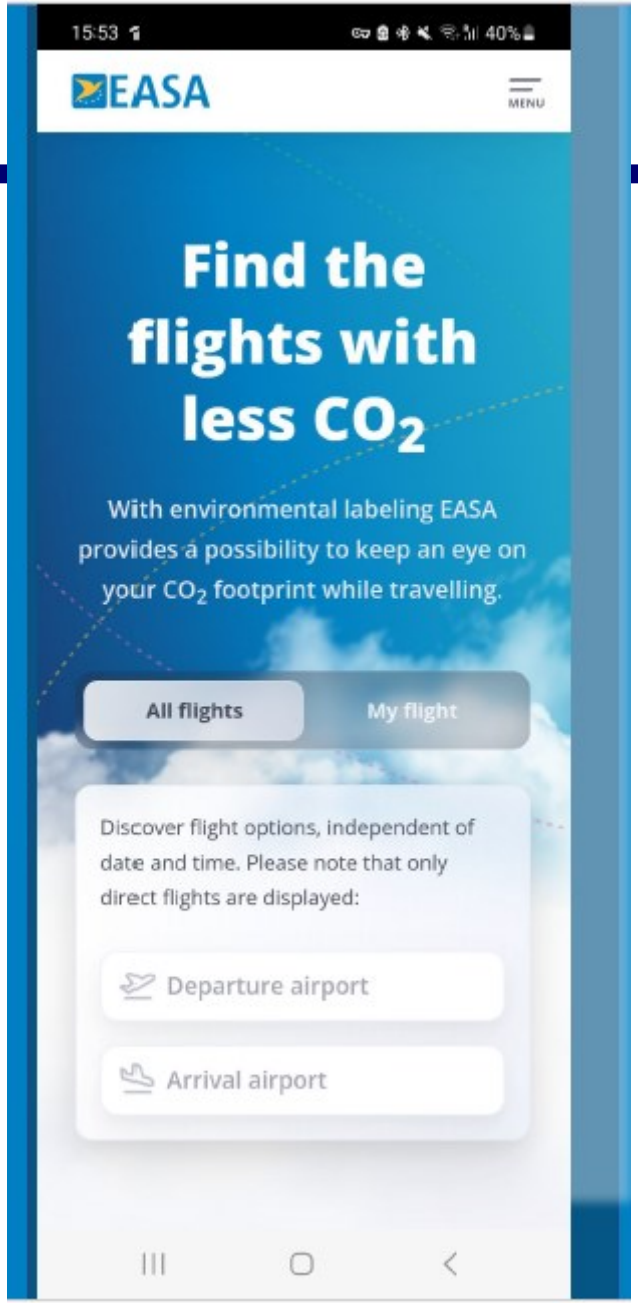
***The Federal Republic of Germany is represented at the EASA Management Board by the Bundesministerium für Digitales und Verkehr & Luftfahrt-Bundesamt (LBA)**

First Ideas at EASA

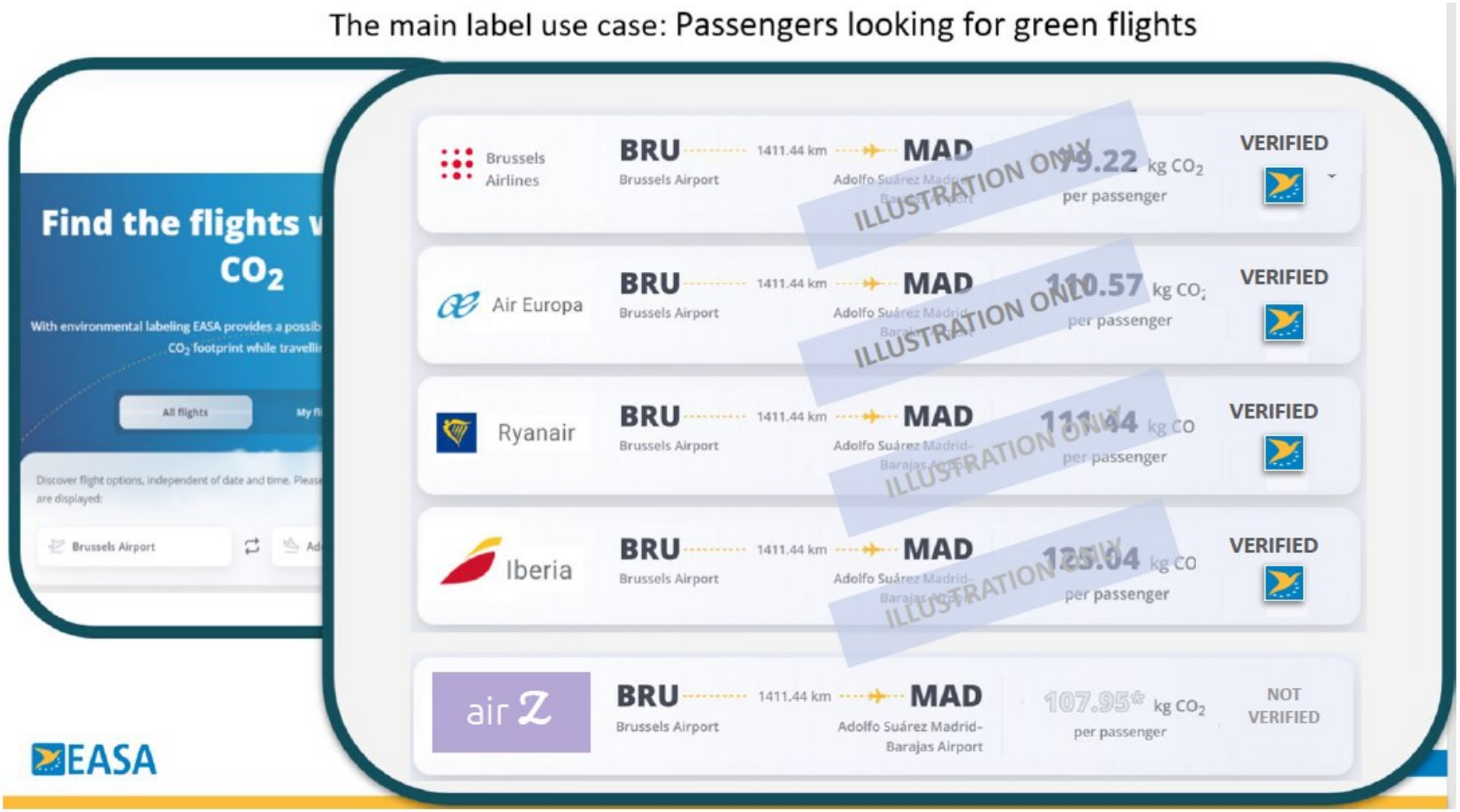


* EU Emissions Trading System

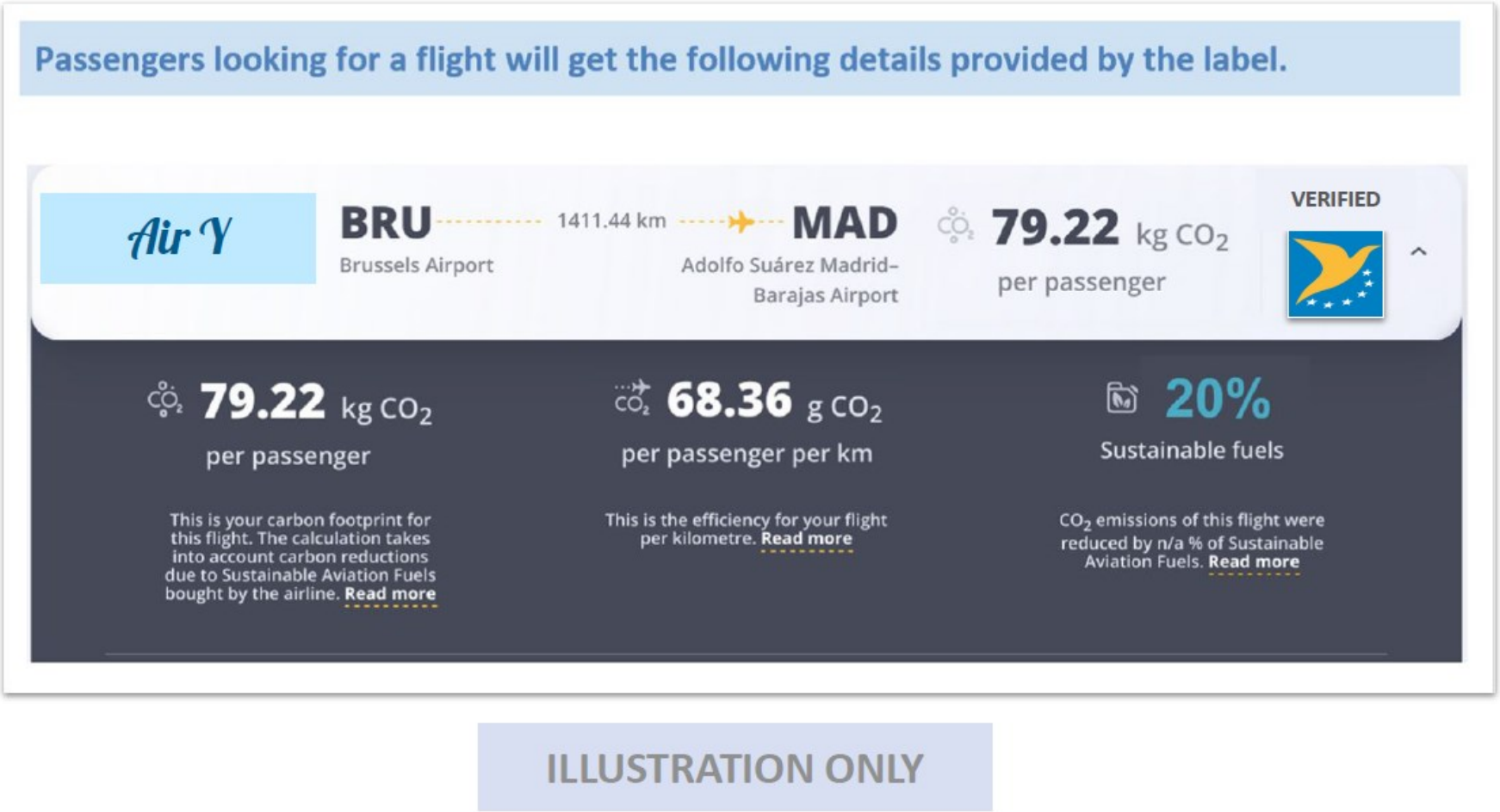
First Ideas at EASA



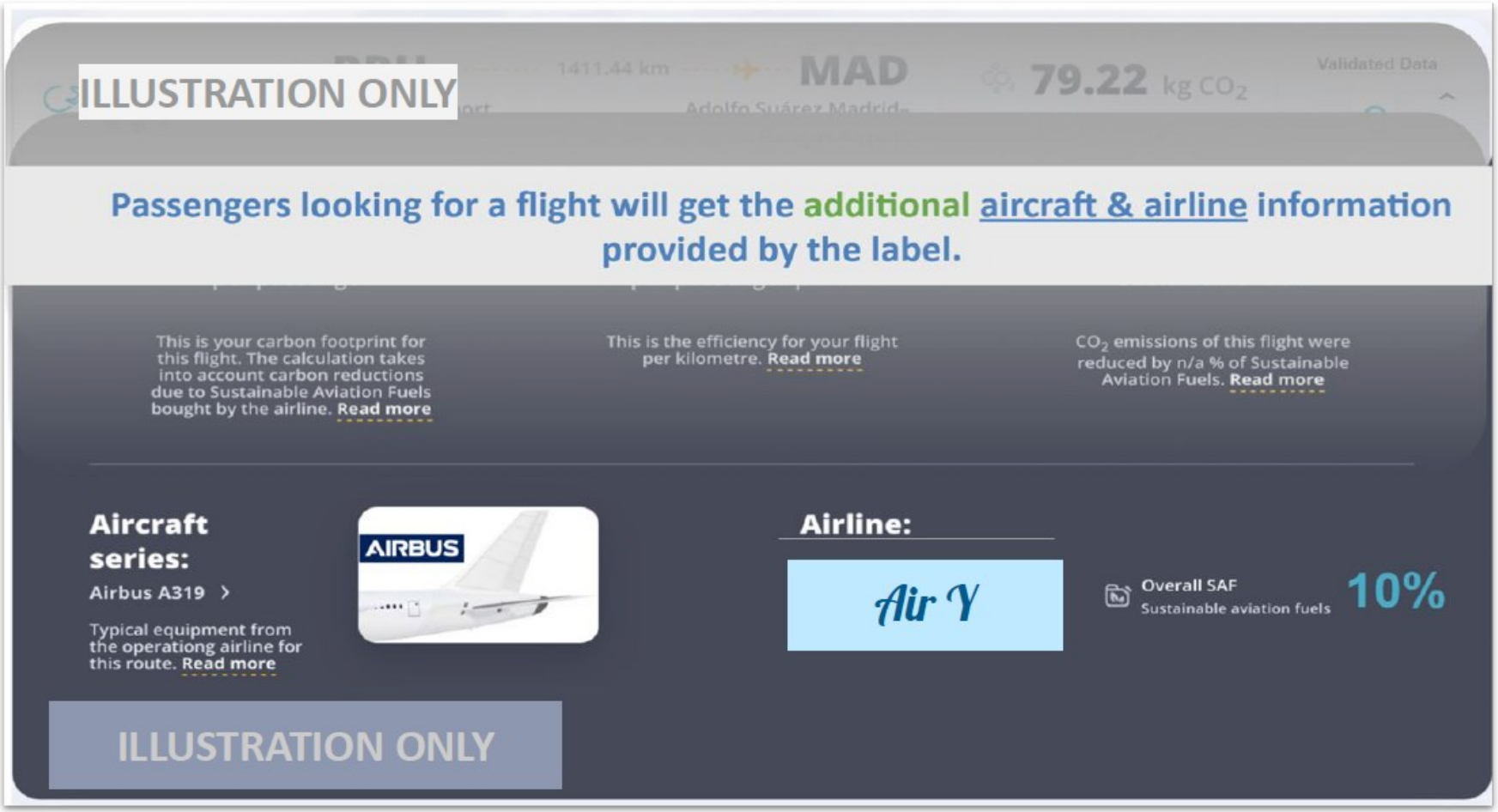
First Ideas at EASA



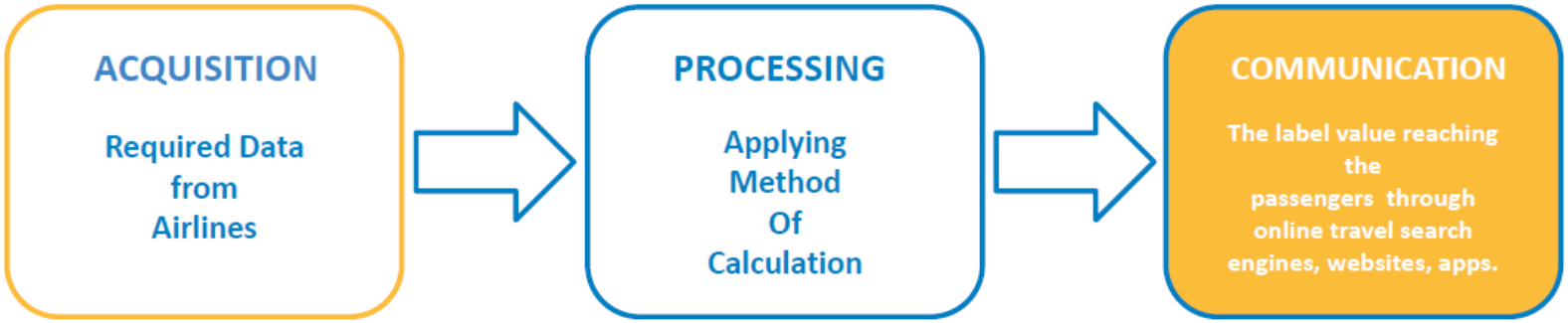
First Ideas at EASA



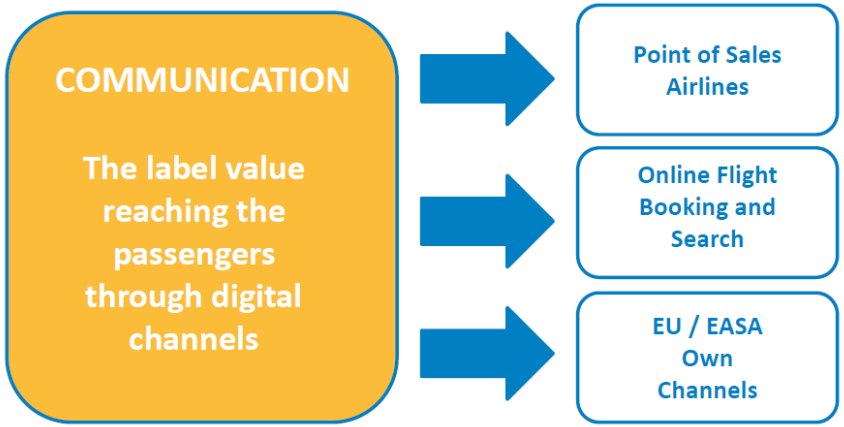
First Ideas at EASA



Communication to Passengers



System - Close up



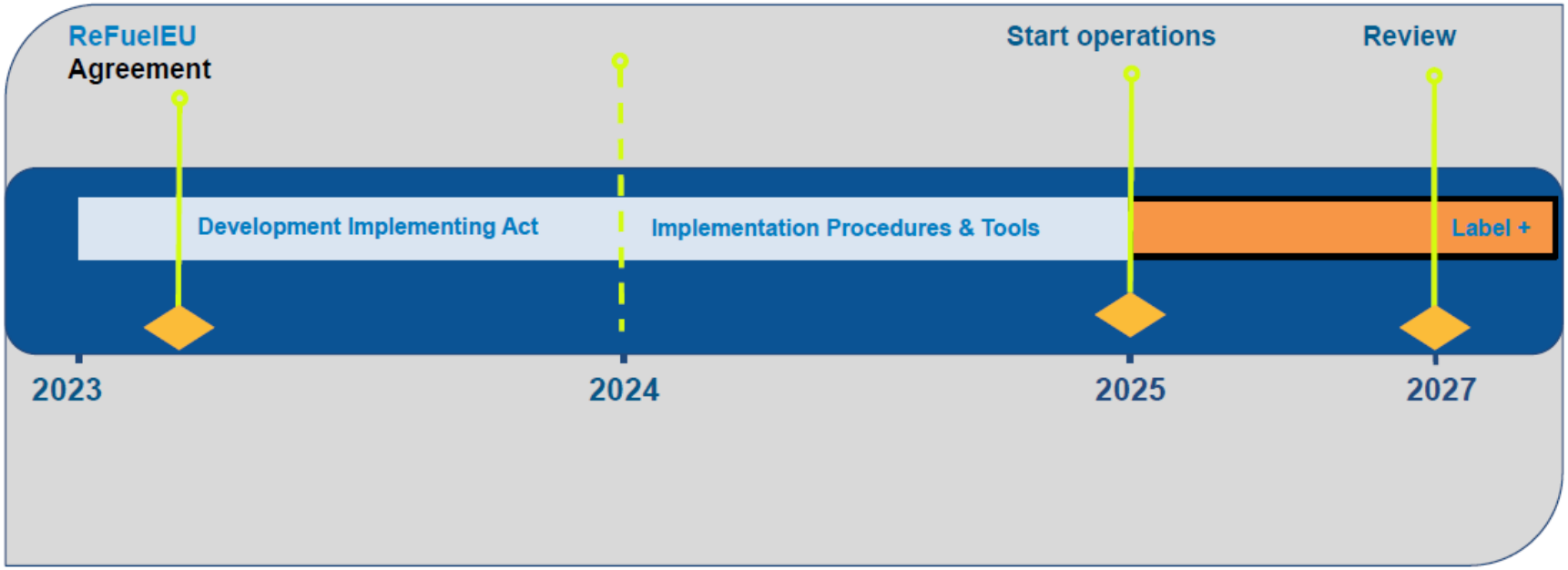
First Ideas at EASA

EASA Environmental Label : Testing feasibility with Airlines

Operators actively engaging through agreements
Air France, HOP!
Air Baltic
Lufthansa, Lufthansa Cityline
Finnair
ITA
KLM, KLM Cityhopper
Norwegian, Norwegian Air Shuttle
Transavia, Transavia France
Volotea
Wizz Air
Ryanair
TUI

First Ideas at EASA

Labelling Scheme Deployment



Ecolabel for Aircraft

Hamburg University of Applied Science (HAW Hamburg)

Priorities

Let's get priorities right to protect the **environment**:

1. **Avoid to travel** (do something else instead)
2. For each trip select the **best mode of transportation** (aircraft, train, bus?)
3. Select the **shortest route**
4. Select the **best aircraft-airline-combination** (**based on the Ecolable for Aircraft**)
5. Select an **economy seat** and hope the **aircraft is full**.
6. **Compensate** (... or maybe just do not compensate, if you do not like the idea)

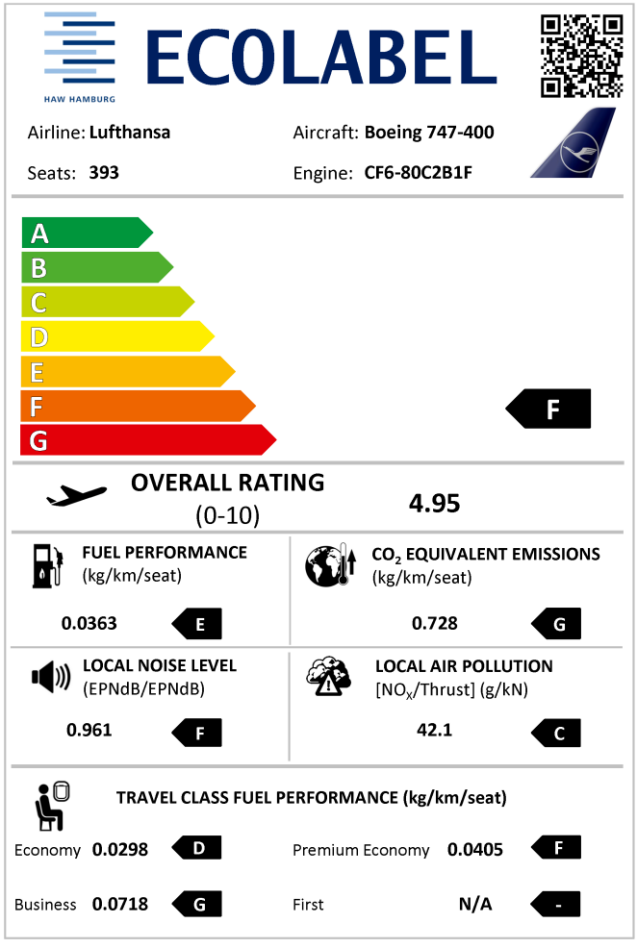
Idea / Goal & the "Ecolabel for Aircraft"

- **The travelling public should make an informed choice when selecting a flight**
  - **Price**
    - ticket price (basic fare, baggage, seat selection, ..., payment fees)
  - **Time**
    - useful time & wasted time
  - **Comfort**
    - travel class (=> seat pitch, seat width, ...)
    - number of transfers
  - **Environmental footprint** => **Ecolabel for Aircraft**
    (**simplified** Life Cycle Assessment, **LCA**)
    - **Resource depletion** (fuel burn)
    - **Global warming** (fuel burn)
    - **Local air quality** (Nox, PM)
    - **Noise**

The Ecolabel for Aircraft …

… can well be used to compare direct flights!

- Information: airline, aircraft, number of seats, engine
- Overall Rating (average rating on airline level)
  - Metric scaled between 0 and 1 (90% of aircraft)
  - category: A to G
- Fuel consumption (from manufacturer's payload & range diagram)
  - resource depletion:
    fuel per seat-km (kg/km) & A to G
  - global warming (depending on altitude):
    CO2-equivalent per seat-km (kg/km) & A to G
- Local air quality (ICAO LTO cycle)
  - NOx (g/kN) & A to G
- Noise (from NoisedB database; ICAO & DGAC)
- Rating according to passenger travel class

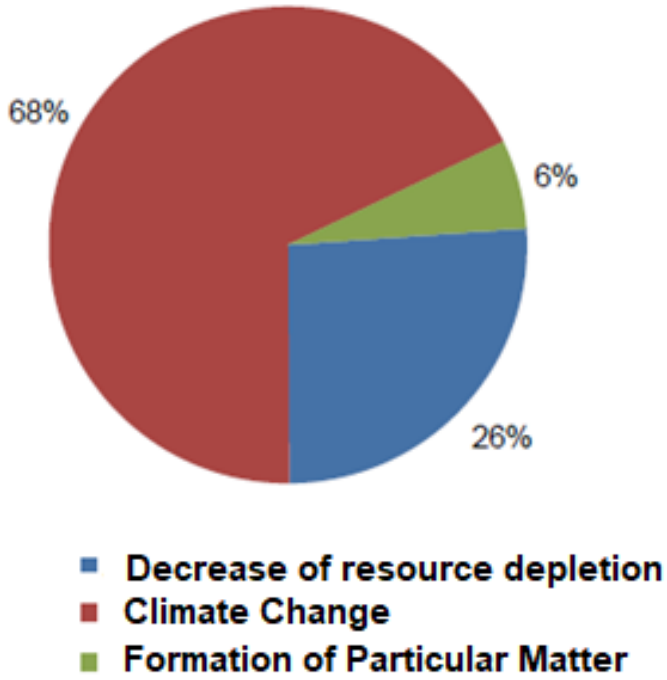


Ecolabel for Aircraft (HAW Hamburg)

… Based on Life Cycle Assessment (LCA)

ReCiPe – Result (A320):

https://purl.org/aero/JOHANNING_DISS_2017



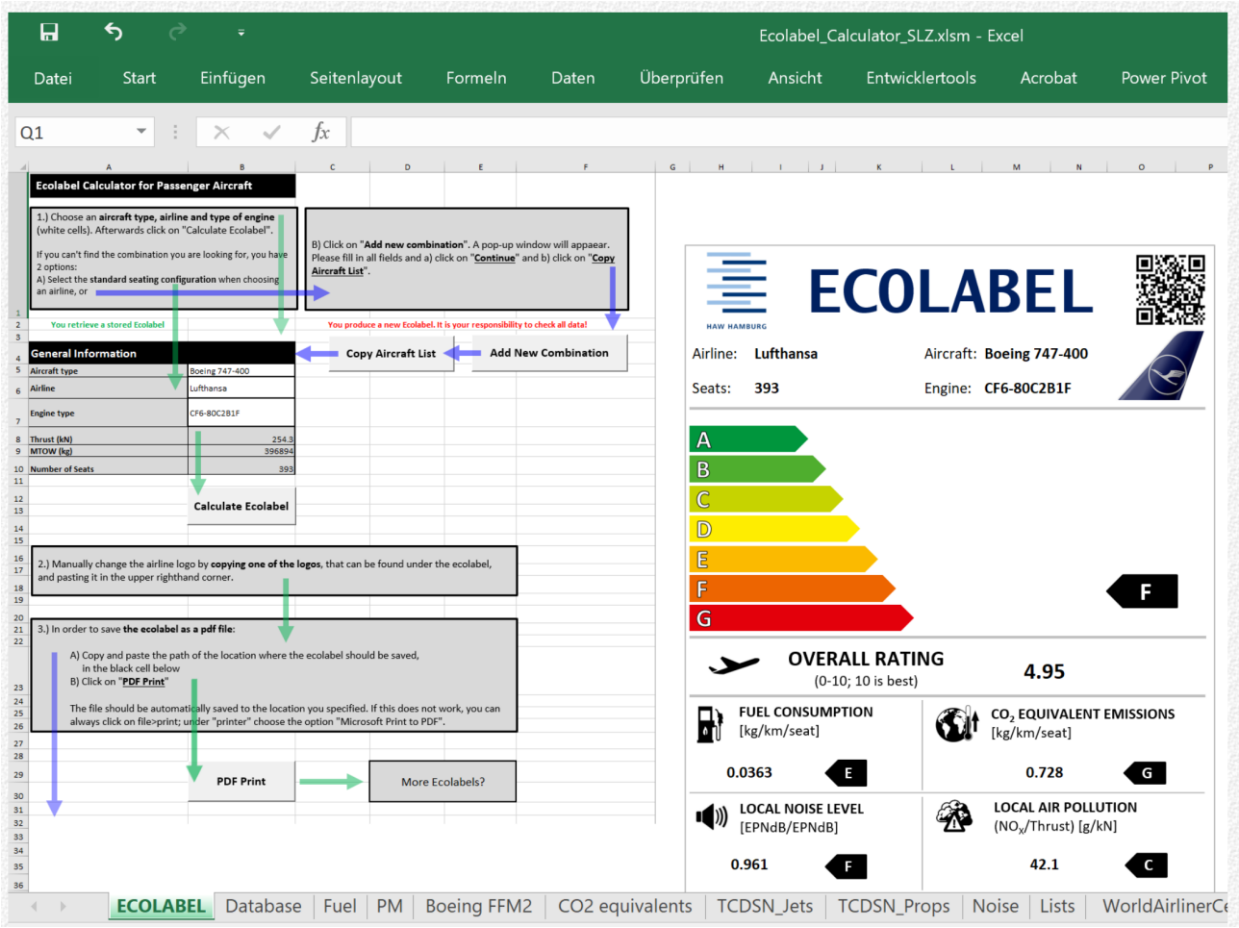
Ecolabel for Aircraft

Overall Rating:

$$R_{overall} = 0.4R_{warming} + 0.2R_{depletion} + 0.2R_{localAir} + 0.2R_{noice}$$

Ecolabel for Aircraft (HAW Hamburg)

Main GUI of the Ecolabel Tool



Not published yet

Ecolabel for Aircraft (HAW Hamburg)

Airline Label

$$AR = \frac{\sum N_{A/C,i} S_{A/C,i} O_{A/C,i}}{\sum N_{A/C,i} S_{A/C,i}}$$

- AR: airline rating
- $N_{A/C}$: number of aircraft type in fleet
- $S_{A/C}$: number of seats per aircraft
- $O_{A/C}$: overall aircraft rating
- i: ID

LATAM Airlines Brasil						
ID (I)	**Aircraft Type**	**No. Of A/C (*N*)**	**Seats per A/C (*S*)**	**Overall rating (*O*)**	***N S***	***N S O***
1	Airbus A319-100	19	138	7.22	2622	18930.84
2	Airbus A320-200	59	180	7.66	10620	81349.2
3	Airbus A320 Neo	12	180	8.58	2160	18532.8
4	Airbus A321-200	31	224	7.48	6944	51941.12
5	Boeing 767-300	2	221	7.28	442	3217.76
6	Boeing 777-300ER	10	410	7.14	4100	29274
7	Boeing 787-9 Dreamliner	1	304	7.43	304	2258.72
	Total:	134		∑:	27192	205504.44
				Airline Rating:		**7.56**

Ecolabel for Aircraft (HAW Hamburg)

Airline Label

Rank	Airline	Country	Overall Rating
1	TUI Airways	UK	7,82
2	TUIfly	GER	7,69
3	American Airlines	USA	7,63
4	Eurowings	GER	7,57
5	LATAM Airlines Brasil	BRA	7,56
6	Ryanair	IRL	7,52
7	KLM	NLD	7,34
8	Condor	GER	7,29
9	Lufthansa	GER	7,03
10	Emirates	ARE	6,29

These 10 airlines were ranked in this sequence
(preliminary data)

Note:
Methods for a Flight Label are also available from HAW Hamburg.

http://ecolabel.ProfScholz.de

More Information on the Ecolabel for Aircraft (HAW Hamburg)

http://ecolabel.ProfScholz.de

1. SCHOLZ, Dieter, 2020: **Ecolabel for Aircraft – Definition and Application** (Hamburg Aerospace Lecture Series, Hamburg/Online, 04.06.2020). Presentation. Available from: https://doi.org/10.5281/zenodo.4462458.

2. SCHOLZ, Dieter, 2017: **An Ecolabel for Aircraft** (Deutscher Luft- und Raumfahrtkongress, München, 05.09 - 07.09 2017). Presentation. Available from: https://doi.org/10.5281/zenodo.4072826. See also in DGLR-Database: https://publikationen.dglr.de/?tx_dglrpublications_pi1[document_id]=450316.

Summary

- On their own, **SAF** and **hydrogen aircraft** are not the solution to aviation's climate problems (as conveyed by industry). E-fuels are needed rather than biofuels. E-fuels must be made from CO2 from the atmosphere (extracted by Direct Air Capture, DAC). Unfortunately, the renewable energy demand for aviation's e-fuel is higher than its availability .
- Any small progress is immediately compensated by **traffic growth**. **Flying less** is a fundamental solution that works!
- **Passengers need to get informed (with an Ecolabel)**, need to decide if they want to travel at all, if they want to take the aircraft (or another mode of transport), and which aircraft and airline to select.
- Passenger are in a strong position. **Passengers can vote with their feet!**
- **ReFuelEU**, Article 14 "Environmental Labelling Scheme" is **very promising**, but some changes would be helpful.
- EASA has started with its "Environmental Labeling Scheme for Aviation". **EASA's progress seems slow**.
- EASA partnered with Google. **Google has already a good solution**: https://flights.google.com.
- HAW Hamburg has an Ecolabel for Aircraft ready and is working on its Airline Label and Flight Label.

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German Aerospace Congress (Stuttgart, 19-21 September 2023).
Available from: https://doi.org/10.5281/zenodo.10049455