Aviation industry lacks a unified policy on reporting sustainability metrics. While various stakeholders are working towards defining a shared understanding of measures of environmental sustainability, at the moment the metrics used are not consistent and data and methodologies are perceived as insufficiently transparent.

Uncertainty in environmental performance criteria is a major obstacle in making investment decisions and furthering the aviation sustainability agenda.

Incompatible reporting may include

- Selective reporting of metrics
- Different underlying methodologies
- Inconsistent units of measurements

A first step of acknowledging these challenges and awareness of diverse practices may help investors navigate the sustainability reporting and guide their decision making processes.

AIR TRANSPORT SUSTAINABILITY

The concept of sustainability typically covers three elements: **environmental**, **social** and **economic**. The aviation industry is experiencing increased regulatory and public pressure to address environmental concerns; hence the focus of this paper stays on the environmental aspect of sustainability.

For several airlines, communicating environmental developments is key to their activity. Environmental reports and summary statistics of environmental performance help demonstrate they are committed institutions, which may influence consumers' and investors' behaviours. Sustainability reporting is typically published either as part of annual or self-contained sustainability reports.

Environmental sustainability covers multiple aspects, e.g., noise, waste, energy, water, biodiversity, and **emissions**. Atmospheric emissions represent the biggest challenge as they have the most significant impact on the environment. Most reporting on emissions tend to focus on CO_2, but increasingly other greenhouse gases emitted by aircraft are also being reported, e.g. NO_X, HC, CO and SO_2 emissions.

SUSTAINABILITY GUIDELINES

The framework for environmental sustainability reporting is guided by standards and recommendations produced by several organisations, including ISO, GRI, SEC, EU taxonomy, and IATA. The work of these organisations aims to promote sustainability characteristics and recommend common approaches to reporting sustainability metrics.

However, these guiding principles holistically look at environmental issues. They are voluntary guidelines addressing waste and pollution reduction and increased efficiency regarding environmental risk management. They do not define specific environmental performance criteria [1]. This results in a diverse interpretation and measuring of sustainability, which in turn can cause a lack of comparability and clarity.

REPORTED METRICS & QUALITATIVE INFORMATION

Reporting on environmental performance drivers typically includes very diverse parameters. Some measure current performance ability, and some reflect future commitments. While there is some commonality between airlines' sustainability reporting approaches, there are also numerous differences. The differences point out that even somewhat-similar airlines evaluate environmental guidelines differently and may report diverse metrics. Common aspects reported by airlines: fleet renewal, fuel efficiency, total and relative CO_2 emissions, deployment of SAF, and carbon offsetting. Differences come in the shape of selective reporting of metrics, different underlying methodologies, inconsistent units of measurements and the use of differently nuanced indicators.

I. **Fleet renewal** strategies are seen as fundamental to reaching sustainability targets and reducing CO_2 emissions from aircraft operations. The solution involves retiring older aircraft and investing in newer, more fuel-efficient aircraft.

II. **Fuel efficiency** can be measured in liters (l) of fuel consumed per revenue tonne kilometer (RTK) or liters per revenue passenger kilometer (RPK). The RTK indicator accounts for the passenger load factor, the mass of cargo transported and the distance flown. Improvements can be achieved via optimisation tools aimed at network planning, identifying the best match between aircraft types and flown routes and supporting systems that find the most efficient relationships between the condition of flight and fuel consumption. One of IATA's achieved targets was the improvement of fuel efficiency by an average of 1.5% annually across the industry from 2009 to 2020. Some airlines continue to improve on this target beyond IATA's timeline and even exceed the target with a 2% fuel efficiency improvement every year. Fuel-efficient airlines manage to bring this performance indicator below 0.2l fuel/RPK.

III. **Absolute CO_2 emissions** refer to the total quantity of CO_2 emissions. Aside from the 2020-2021 COVID induced reductions, the total CO_2 emissions have been consistently growing over the years in line with air travel growth. Absolute CO_2 emissions are calculated using fuel burn data multiplied by 3.157*. Airlines report fuel burn in aircraft operations (Scope 1†); typically, the order of emissions is millions of tonnes of CO_2 per year.

IV. **Total CO_2 emissions reduction** compared to a baseline year. Such targets may not be comparable as they reference different baseline years, e.g., the reference year can be 2005 (an IATA reference year) or 2019 (pre-pandemic).

V. **CO_2 emissions reduction year-on-year** is another variation of reporting improvement in CO_2 emissions. However, during the COVID-19 pandemic, reduced operations year-on-year camouflage some of the CO_2 emission reduction achieved from fleet renewal or the deployment of airlines' youngest fleets.

VI. **Non-CO_2 emissions** are other types of pollutants emitted during aircraft operations. They represent ~1% of the exhaust composition and consist of nitrogen oxides (NO_X), unburned hydrocarbons (UHC) — compounds from incomplete combustion, carbon monoxide (CO) and sulphur dioxide (SO_2) emissions. Non-CO_2 emissions are not included in the current aviation climate targets and are only selectively reported by airlines.

Absolute CO_2 emissions are largely, but not exclusively, a function of the airline's size (fleet size, frequency of operation, passenger, aircraft size). The bigger the airline, the higher the quantity of emissions. Absolute emissions track an airline's performance over time but do not help compare airlines directly. In their recently issued proposal for Climate Disclosure Requirements, SEC [2] recommends standardizing the disclosures and facilitating comparability — requiring the disclosure of greenhouse gases (GHG) intensity in terms of metric tons of CO_2 emitted per unit of total revenue and per unit of production. In aviation terms, that translates into **CO_2 relative to units of production**, e.g. passenger kilometers, cargo, payload.

VII. **Carbon intensity expressed as CO_2 per passenger kilometer** is defined as emitted CO_2 per passenger per flown kilometer. It can be reported in grams (g) of CO_2 per revenue passenger kilometer (RPK), but also as g CO_2 per passenger kilometer (PKM) or as kilograms (kg) CO_2 per 100 PKM. PKM accounts for all flown passengers (revenue and non-revenue passengers), thus producing a carbon intensity value marginally smaller than the one obtained from RPK. Therefore some airlines may prefer reporting PKM instead of RPK metrics.

* One kg of jet fuel emits 3.157 kg of CO_2.
† Most airlines report Scope 1 emissions – direct emissions produced by the airline. Scope 1 emissions may be split into airline and ground operations. Some airlines additionally estimate and report Scope 2 emissions from energy consumption in buildings. Scope 3 emissions are harder to estimate as they cover the value chain of airlines (e.g. suppliers produced CO_2 emissions). Scope 1 emissions can be verified with high assurance, while Scope 2 and 3 with limited assurance.

The carbon intensity of short-haul flights (<500 km) is nearly double that of medium (2,000-5,000 km) or long-haul flights (>5,000 km). On short-haul flights, the aircraft spends a higher ratio of its time, relative to the flight duration, in the take-off stage, which has a higher fuel burn rate than the cruise phase or landing. Thus, aside from other parameters, airlines that operate many regional flights could be expected to produce a higher carbon intensity value than airlines operating many long-haul flights.

Some airlines adjust the calculation of carbon intensity by first separating the amount of fuel used between cargo and passenger before dividing the amount of CO_2 generated by fuel burn by PKM or RPK. For combined operations with passengers and undercarriage cargo, one way to allocate fuel burn between passenger and cargo is according to IATA's calculator [3].

VIII. **Carbon intensity expressed as CO_2 relative to cargo transport** is a performance indicator for airlines with full freight operations, typically reported in g CO_2/ freight tonne kilometer (FTK).

IX. **Carbon intensity expressed as CO_2 per flown weight (passengers and cargo)** can be reported as g CO_2/tonne kilometer (TKM) to use all passengers, including non-revenue producing passengers or as g CO_2/revenue tonne-kilometer (RTK) to use only the payload weight. The weight is calculated as the total weight of freight and passenger, typically assuming an average weight of 100 kg for any person, including the luggage, and a 50 kg add-on for the weight of the infrastructure related to passenger use (e.g., seats).

X. **Carbon intensity expressed as CO_2 per capacity** is an alternative relative CO_2 indicator. Some airlines distinguish between actual (sold) air transport performance (i.e., RPK, RTK) and available transport performance (ASK, ATK). Carbon intensity regarding supply indicators can be reported as grams of CO_2 per available seat kilometer (ASK). Not all airlines report CO_2 relative to planned capacity metrics.

SAF consumption is seen as the primary way to achieve carbon neutrality for aviation by 2050. The number of commercial flights partially fueled by SAF is growing. Additionally, carbon offsetting is seen as a transitional solution to reach environmental targets in short to medium term.

XI. **SAF consumption** reached nearly 100 million liters in 2021, still a lot less than 1% of airlines' total fuel consumption. Airlines intend to increase SAF usage to various levels, e.g., 10% of the total fuel consumption by 2025 (SAS), a 10% SAF uptake by 2030 (Finnair), or 12.5 % uptake by 2030 (Ryanair).

XII. **Partnerships with SAF producers** (Lanzatech, Gevo, Neste, etc.) and offtake agreements will secure some of the SAF needed to reach these targets.

XIII. **Carbon Offsets** are intermediate programmes used by airlines that allow them to buy carbon credits. One carbon credit gives the airlines the right to emit one tonne of CO_2. The two major offsetting programs in aviation are the EU Emissions Trading Scheme (EU ETS) and the UN Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). Airlines also offer separate offsetting programmes connected to third party renewable energy projects all over the world.

The aviation industry clearly requires the consolidation of sustainability-related metrics. Different stakeholders need and demand different information, so airlines report a diversity of metrics that are not immediately comparable across the industry.

Conclusion

This paper highlights the diverse reporting of sustainability metrics and the challenges in comparing them.

Airlines have also highlighted the desire for internationally unified methodologies. For example, Lufthansa called for a "unified, internationally harmonised and accepted" method of fuel allocation between passengers and cargo. Lufthansa follows the guidelines of the European standard DIN EN 16258, in contrast to IATA's calculations proposal used by other airlines, e.g., SAS, Finnair.

The challenges highlighted in this paper – and others in the broader sustainability context - are actively identified and addressed by airlines. Progress is made year on year as airlines communicate sustainability efforts.

There are attempts made by various aviation stakeholders to standardise environmental reporting. There is no doubt that the consolidation of metrics — similar to accounting reporting — will facilitate direct comparability between airlines and their progress in environmental sustainability.

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