Hydrogen – future energy source for aviation?

A320 Hydrogen Aviation Lab

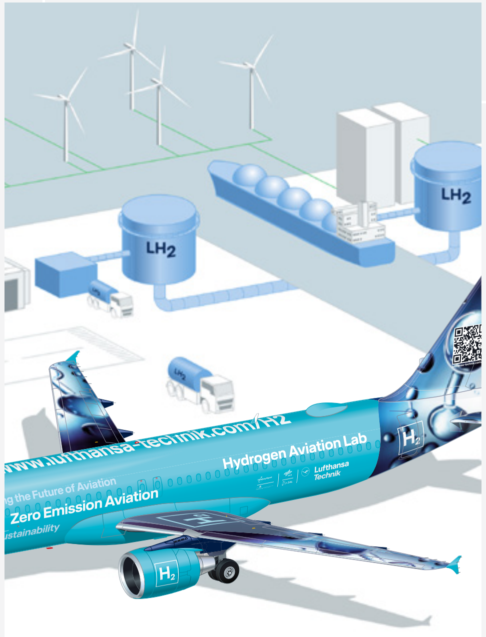
– a research project of Lufthansa Technik, the German Aerospace Center (DLR), the ZAL Center of Applied Aeronautics Research, and Hamburg Airport – supported by the Hamburg Ministry of Economic Affairs and Innovation and the Hamburg Investment and Development Bank

The aviation sector needs alternative energy sources that will enable it to significantly reduce its environmental footprint. In addition to sustainable aviation fuel (SAF), another focus of research is hydrogen, which can also be used for combustion in a turbine engine, to name one application. This has the advantage that the engine architecture would require comparatively moderate modification. There would be no more CO_2 emissions such as those from the combustion of fossil fuels.

Aircraft manufacturer Airbus has forecast that the first market-ready commercial aircraft fuelled by liquid hydrogen will be ready in the middle of the next decade. Yet in light of the long development and product life cycles in aviation, this topic is already relevant today. The introduction of such a new system is predicated on two conditions:

- **new or adapted infrastructures and ground processes** while maintaining the high level of safety in aviation
- **economic acceptance** on the part of users such as airlines, airport operators and maintenance companies, in order to achieve sufficiently large market penetration

In the **A320 Hydrogen Aviation Lab** in Hamburg, extensive maintenance and ground processes connected to hydrogen technology are being designed and tested with the stakeholders. These processes are not only developed and tested in a physical field laboratory – a decommissioned A320 of the Lufthansa Group – but also digitally using a “digital twin”. At all levels, the field laboratory is also designed to provide developers of future generations of aircraft with valuable inspiration. In this context, Lufthansa Technik will contribute its expertise in commercial aircraft maintenance, including the implementation and development of maintenance concepts and repair solutions for potential future hydrogen jets. Lufthansa Technik is also carrying out the retrofitting of different hydrogen components into the A320, such as an internal “deep-freeze tank” (where hydrogen is kept in a liquid state in cryotanks at –253 degrees Celsius).



Practical example
With the current state of the art, merely refuelling a long-haul flight with hydrogen could take several hours. This would hardly be practical, and no airline would want to use such an aircraft. Here too, the practical research being carried out by the **A320 Hydrogen Aviation Lab** is expected to provide valuable new insights and approaches.

Emissions

Absolute emissions[1]

EMISSIONS[2] 2022

in tonnes

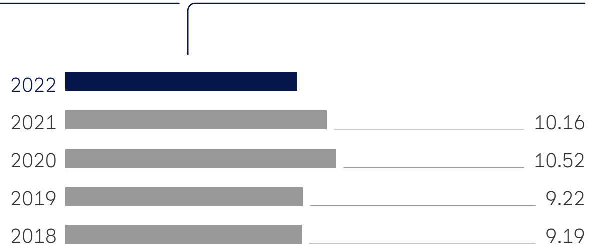
	Passengers	±PY	Cargo[3]	±PY	Total	±PY
CO_2	18,152,426	+99.5 %	4,794,014	+6.0 %	22,946,441	+68.4 %
NO_x	81,998	+96.8 %	24,898	+6.7 %	106,896	+64.5 %
CO	16,117	+104.4 %	3,229	+2.6 %	19,346	+75.4 %
UHC	1,961	+172.7 %	272	-5.2 %	2,234	+121.9 %

Specific CO_2 emissions[1]

PASSENGER TRANSPORTATION 2022

CO_2 Emissions

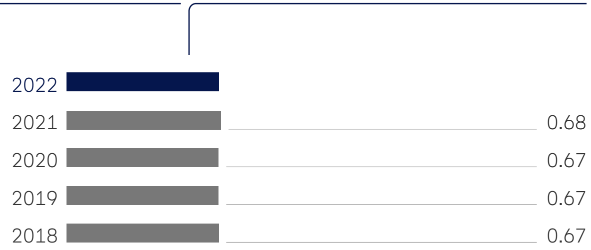
in kilogrammes/100 passenger-kilometres (kg/100 pkm) **9.00**



CARGO TRANSPORT[3] 2022

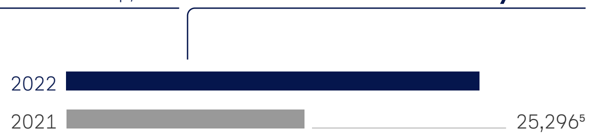
CO_2 emissions

in kilogrammes/cargo tonne-kilometre (kg/tkm) **0.67**



REDUCED FOSSIL CO_2 VOLUME THROUGH THE USE OF SUSTAINABLE AVIATION FUEL

in the Lufthansa Group, in tonnes **43,900**

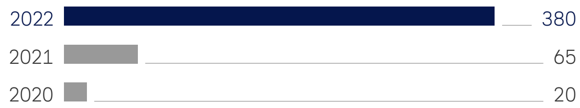


The use of Sustainable Aviation Fuel (SAF) reduced the Lufthansa Group's emissions with an impact on the climate by a total of 43,900 tonnes in 2022. Of this amount, 40,400 tonnes were accounted for by direct savings in the combustion of SAF (Scope 1) and 3,500 tonnes by savings in the upstream supply chain (production and transport, Scope 3). Both figures refer to the comparison with the use of fossil kerosene. This means that compared to the previous year, the use of SAF increased the reduction of CO_2 with an impact on the climate by 73.5 %.

CO_2 VOLUME OFFSET THROUGH HIGH-VALUE OFFSET PROJECTS

in thousand tonnes

By customers



by the Lufthansa Group for business trips

1 The following companies are included for the 2022 reporting year: Lufthansa (including Lufthansa CityLine, Eurowings Discover and Air Dolomiti), SWISS (including Edelweiss Air), Austrian Airlines, Eurowings (including Germanwings), Brussels Airlines and Lufthansa Cargo. Not included are other flights and services provided by third parties, as their performance is beyond our control (see tables "Fuel consumption" and "Third-party interests", p. 11). 2 Absolute emissions in tonnes from flight operations (all scheduled and charter flights). Emissions are recorded from gate to gate, i.e. including taxiing on the ground and holding patterns as well as flight detours. 3 Based on cargo tonne-kilometres transported in both cargo and passenger aircraft. 4 Excluding SWISS due to downstream capture. 5 Deviations from the figures in the 2021 Fact Sheet due to a subsequent correction in the calculation base.

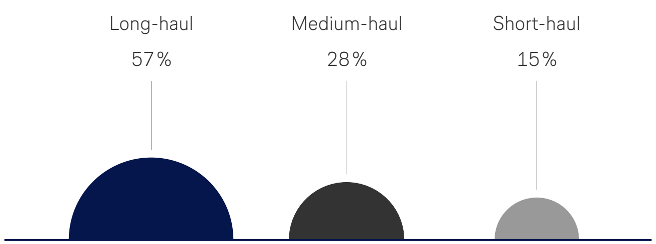
Specific fuel consumption and CO_2 emissions

SPECIFIC FUEL CONSUMPTION AND SPECIFIC CO_2 EMISSIONS IN THE LUFTHANSA GROUP[1] 2022

- Specific fuel consumption in litres/100 passenger-kilometres (l/100 pkm)
- Specific CO_2 emissions in kilogrammes/100 passenger-kilometres (kg/100 pkm)

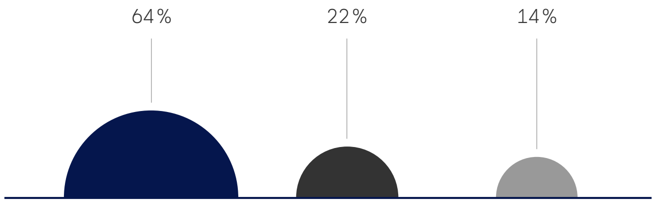
	Total	Long-haul	Medium-haul	Short-haul
Specific fuel consumption (l/100 pkm)	**3.59**	3.32	3.43	5.89
Specific CO_2 emissions (kg/100 pkm)	**9.00**	8.32	8.62	14.83

SHARE OF FUEL CONSUMPTION BY TRAFFIC AREAS[1] 2022



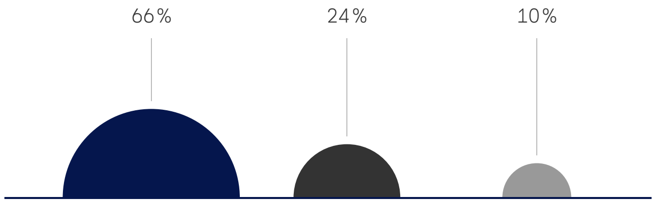
LUFTHANSA AIRLINES

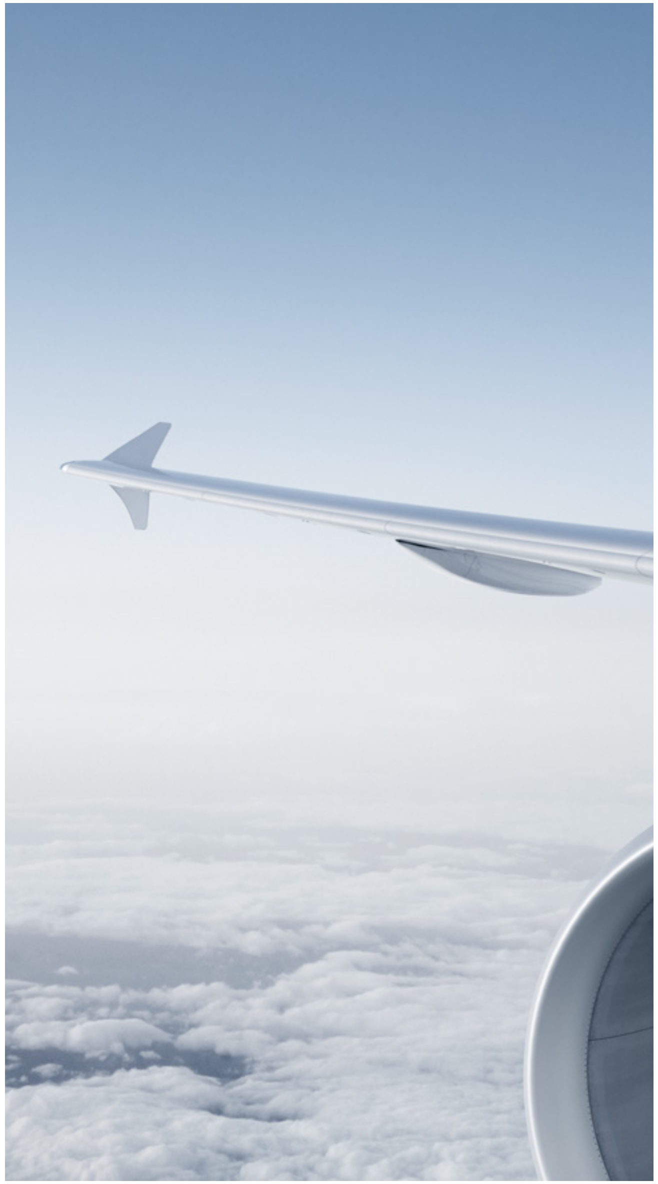
	Total	Long-haul	Medium-haul	Short-haul
Specific fuel consumption (l/100 pkm)	**3.63**	3.42	3.33	6.10
Specific CO_2 emissions (kg/100 pkm)	**9.10**	8.59	8.37	15.35



SWISS

	Total	Long-haul	Medium-haul	Short-haul
Specific fuel consumption (l/100 pkm)	**3.27**	3.09	3.38	4.75
Specific CO_2 emissions (kg/100 pkm)	**8.20**	7.74	8.48	11.93





1 Definition of haul length: long-haul routes: over 3,000 km; medium-haul routes: 800 to 3,000 km; short-haul routes: under 800 km.

Specific fuel consumption and CO_2 emissions

SPECIFIC FUEL CONSUMPTION AND SPECIFIC CO_2 EMISSIONS [1] 2022

- Specific fuel consumption in litres/100 passenger-kilometres (l/100 pkm)
- Specific CO_2 emissions in kilogrammes/100 passenger-kilometres (kg/100 pkm)

AUSTRIAN AIRLINES

	Total	Long-haul	Medium-haul	Short-haul
Specific fuel consumption	**3.79**	3.27	3.65	5.48
Specific CO_2 emissions	**9.48**	8.17	9.15	13.76

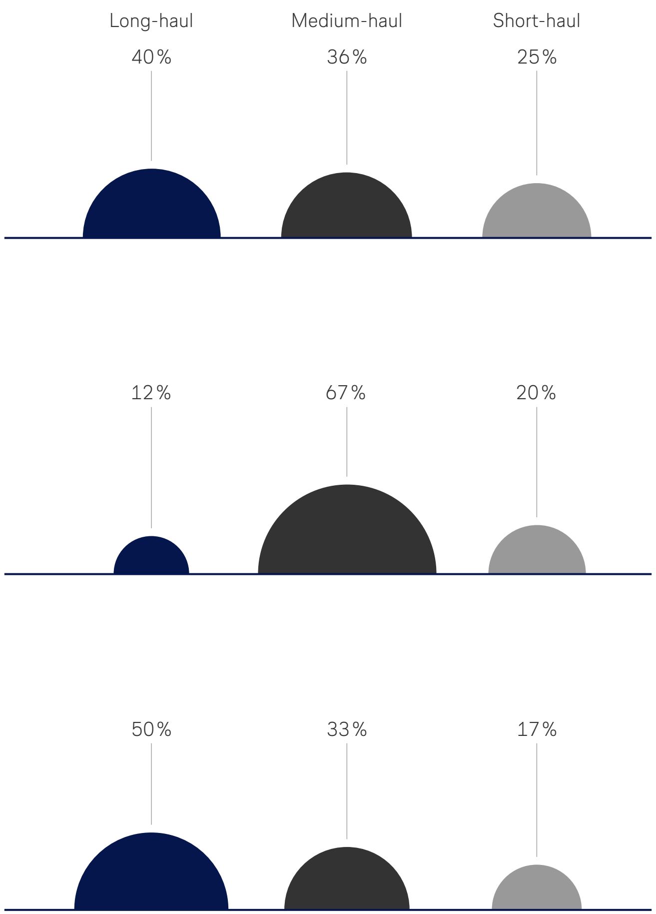
EUROWINGS

	Total	Long-haul	Medium-haul	Short-haul
Specific fuel consumption	**3.71**	2.85	3.44	6.69
Specific CO_2 emissions	**9.37**	7.20	8.67	16.89

BRUSSELS AIRLINES

	Total	Long-haul	Medium-haul	Short-haul
Specific fuel consumption	**3.61**	3.15	3.70	5.90
Specific CO_2 emissions	**9.07**	7.89	9.31	14.86

SHARE OF FUEL CONSUMPTION BY TRAFFIC AREAS 2022



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