Challenger 650

Environmental Product Declaration

BOMBARDIER

Exceptional by design

As our world becomes evermore interconnected, and as our collective concern for protecting the environment increases, Bombardier knows it is important to provide its stakeholders with information regarding the environmental performance of its products. With this in mind, Bombardier is proud to release the Environmental Product Declaration (EPD) for the Challenger 650 aircraft. As part of the company's overarching sustainability strategy, Bombardier has committed to communicating the environmental performance of all its aircraft programs through EPDs.

An EPD is a document that provides environmental transparency. It is a globally recognized, standardized and verified way of quantifying and communicating the environmental impact of a product across its life cycle. It is created in accordance with the International Standard ISO 14020:2022, as developed by the International Organization for Standardization. With this EPD, Bombardier is providing its stakeholders with a comprehensive overview of the Challenger 650 aircraft's environmental footprint throughout its life cycle, marking another key milestone in the transparency of the environmental performance of our programs. By making environmental information available to our stakeholders, including operators, this EPD also supports the business aviation industry's broader goals to mitigate its impact on climate change.

Sustainability is entrenched throughout Bombardier's business strategy and operations to ensure the longevity of our industry, and to make a positive, meaningful impact along the way. This document is a part of this vision, and Bombardier is proud to share it with you.

Innovation that inspires. Performance that delivers.

The Challenger 650 aircraft combines world-class interior design with the ultimate value proposition. The aircraft features the widest-in-class cabin, worldwide reach, and the lowest direct operating costs.

Communicating Environmental Performance

Bombardier communicates the environmental performance of its products through Environmental Product Declarations in accordance with the International Standards ISO 14020:2022, ISO 14021:2016 and follows ISO 14044:2006, which specifies requirements for environmental claims, and science-based life cycle analysis data. It summarizes and communicates comparable information about the environmental impact of a product at each phase of its life cycle in a transparent manner.

Challenger 650 aircraft facts and figures

Commercial Name	**Bombardier Challenger 650**
Type Certificate Data Sheet (TCDS) number	**A-131***
Date of certification	**September 1995**
Certification Body	**Transport Canada**
Propulsion system	**Turbofan**
Engine trade name	**General Electric CF34-3B MTO**
Standard accommodation	**10 passengers**
Maximum passenger capacity	**12 passengers**
Maximum takeoff weight	**21,863 kg (48,200 lb)**
Takeoff distance (SL, ISA, MTOW)	**1,720 m (5,640 ft)**
Top speed	**903 km/h (0.85 Mach)**
Maximum operating altitude	**12,497 m (41,000 ft)**
Maximum range**	**7,408 km (4,000 nm)**

*Transport Canada designation.
**Theoretical range with NBAA IFR Reserves, ISA, LRC, 6 pax /2 crew. Actual range will be affected by speed, weather, selected options and other factors.

Challenger 650 aircraft configuration

For this Environmental Product Declaration, the Life cycle assessment was performed on a baseline aircraft configuration and the following standard mission assumptions:

- six (6) passengers
- two (2) crew members
- 786 km/h cruise speed (M 0.74)
- NBAA IFR fuel reserves*
- ISA conditions

Customer-specific options are excluded from the consideration of this study.

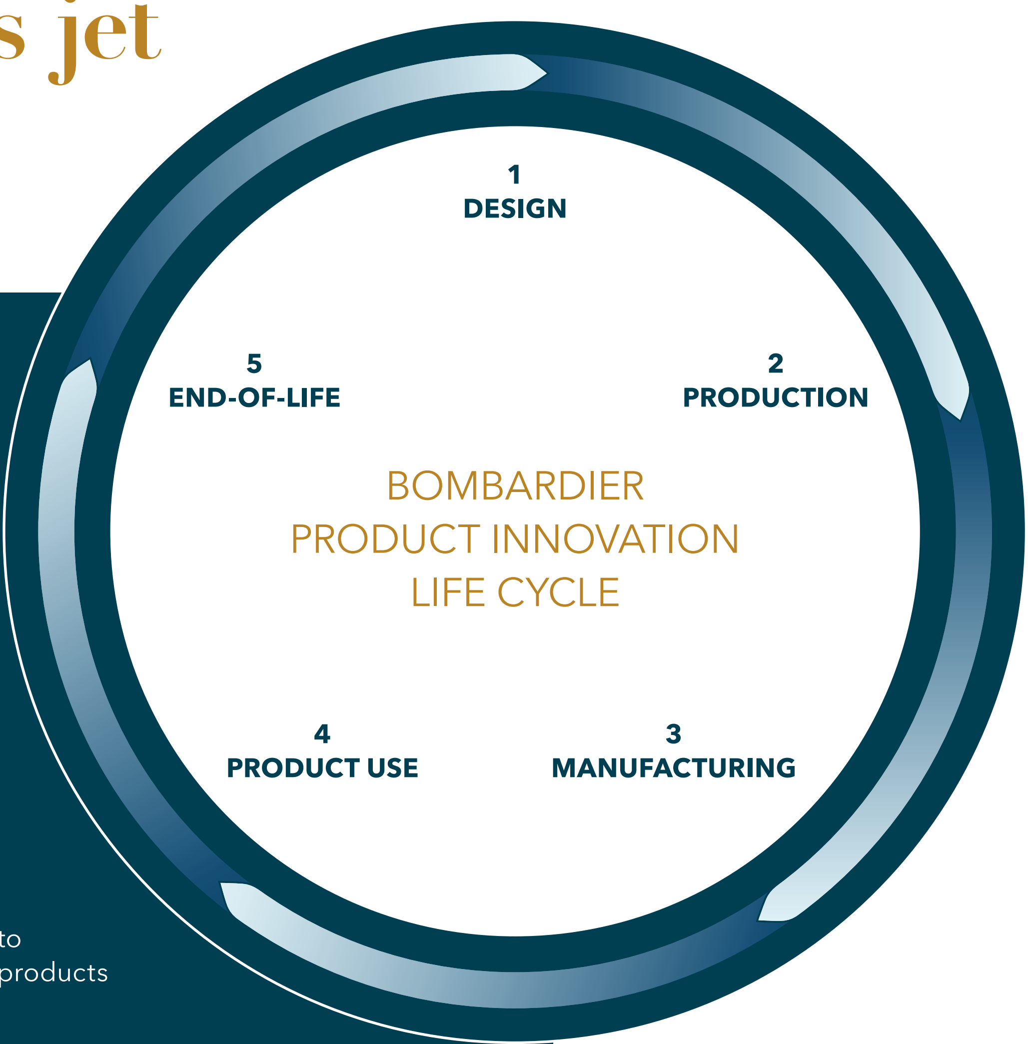
Aircraft category	**Medium****
Configurable cabin zones	**2**
Cabin volume***	**36 m^3 (1,264 ft^3)**

*2.04 litres per functional unit of fuel transported and not considered as burnt during the flight.

**Aircraft with a cabin volume of between 19.8 and 42.5 cubic meters and a flight distance between 5,741.2 and 9,260 kilometers.

***The total accommodation volume includes all pressurized areas accessible to both crew and passengers at all cruise altitudes and without any limitations, with the following boundaries:
- Forward and aft boundaries are respectively the cockpit divider and the rear pressure bulkhead
- Cabin peripheral boundary is the cabin unfinished cross-section, limited to the furnishable area.

Environmental profile of the Challenger 650 business jet



1) DESIGN

We consider safety, environment and efficiency in the design phase of our products to develop innovative mobility solutions.

2) SUPPLY CHAIN AND PRODUCTION

We undertake a rigorous supplier selection process to ensure we source the best products to bring our designs to life.

3) MANUFACTURING AND TESTING

We integrate health, safety and environmental considerations during manufacturing and conduct rigorous product testing.

4) PRODUCT AND MAINTENANCE

We actively engage with customers to achieve the ultimate passenger experience and the best environmental performance.

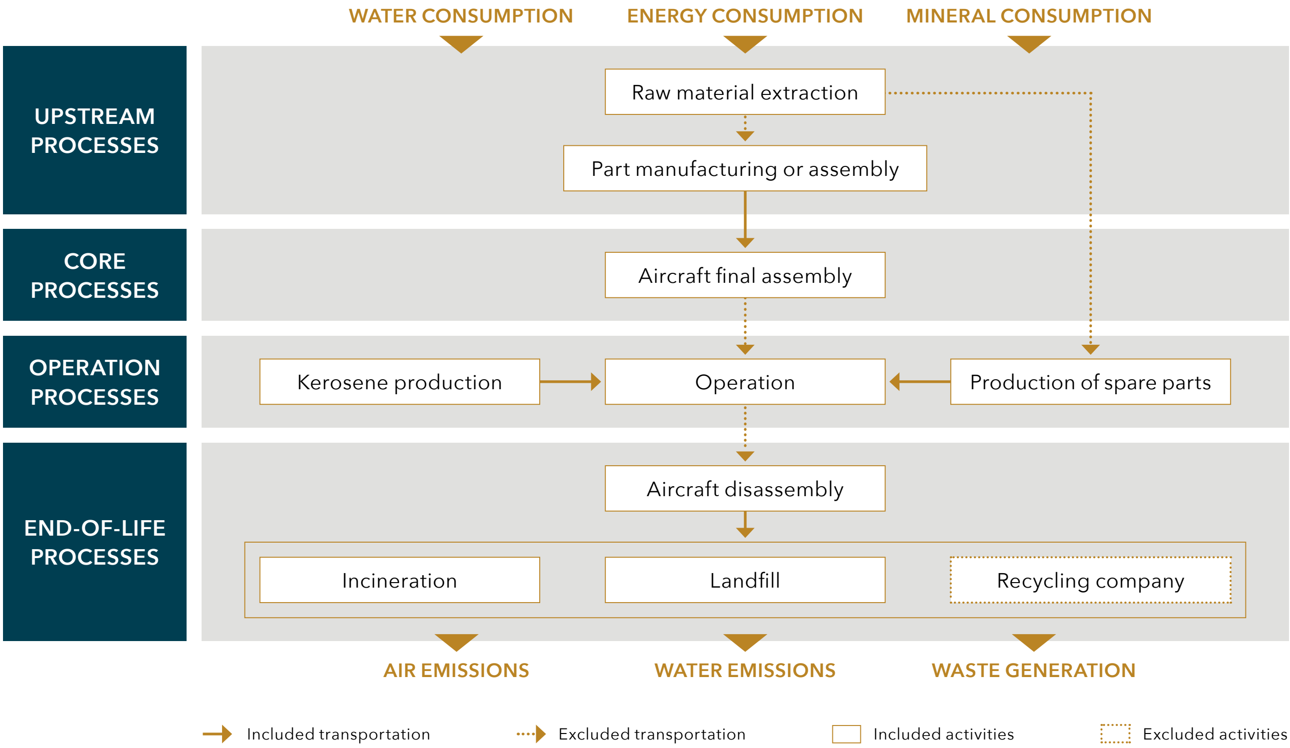
5) END-OF-LIFE

We work closely with the industry towards achieving our goal of increasing recyclability and recoverability rates of all new aircraft.

At Bombardier, life cycle thinking is an integrated feature of the design process, highlighting the significance of different design options and the true overall environmental impact these options offer.

Life cycle assessment

Resource efficiency, waste generation and overall environmental impacts were estimated throughout all life cycle phases of the Challenger 650 business jet, following ISO 14044:2006 methodology. The LCA covers all life cycle stages, from "cradle to grave", including the following system boundaries: Upstream, Core, Operation and End-of-life modules



The results represent a functional unit of transport, one cubic meter of accommodation space for leisure or business purposes over 100 km for a given typical mission length. In the case of the Challenger 650 aircraft, the LCA is based on a typical 1,482 km mission (800 nm).

The LCA was conducted based on the following assumptions: the aircraft will fly 15,600 times over its entire lifetime (i.e. nearly 35,100 hrs) at a maximum of 12,497 m (41,000 ft) of altitude and a cruise speed of 786 km/h (M 0.74). It will consume 1,599 kg (3,525 lb) of fuel per 1,482 km mission (800 nm) mission. The end-of-life phase of the life cycle is modeled according to technology available at time of publication.

All Bombardier sites are ISO 14001-certified

Bombardier's eligible locations are certified or in the process of obtaining their certification by external parties according to the ISO 14001:2015 Standard for Environmental Management.

FLIGHT INFO
02:17 pm
Estimated time of Arrival
02:56 pm
Flight time
2.50 h
Time to destination
0.39 h
1119 mi
279 mi
Local times
02:17 pm
04:17 pm

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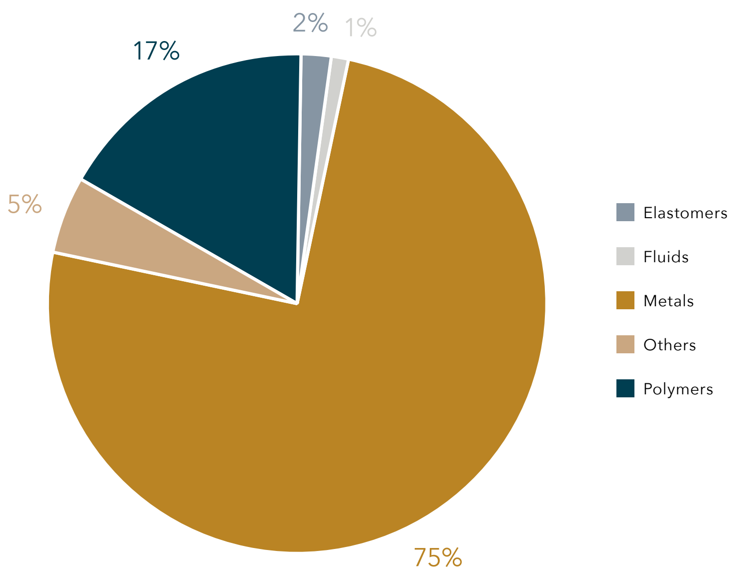
Design, material production and manufacturing life cycle stages

The renewable energy source most used in the product life cycle is solar energy. This is due to the energy offered from the greener grid mix and independent system operators in many U.S. states (for example, Florida), where many Challenger 650 aircraft suppliers are based.

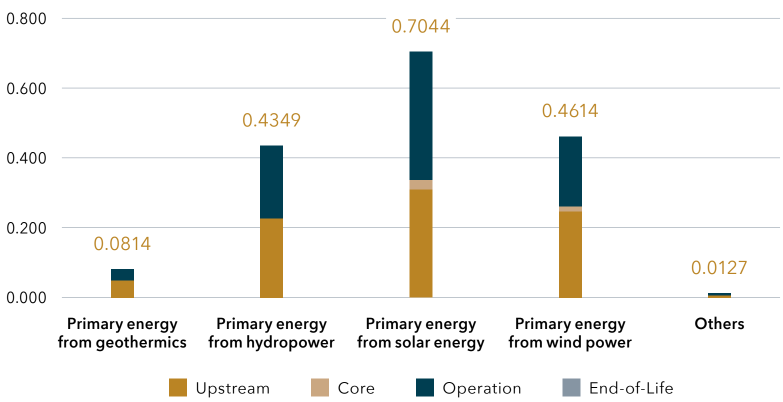
The Challenger 650 aircraft is assembled and completed at Bombardier's Dorval, QC facility.

The following figure shows the typical material composition of a Challenger 650 business jet by weight.

CHALLENGER 650 AIRCRAFT MATERIAL COMPOSITION



RENEWABLE ENERGY RESOURCES CONSUMPTION (MJ PER FUNCTIONAL UNIT)



The three most used renewable energy resources are solar, hydropower and wind. All contributed in manufacturing the Challenger 650 aircraft.

The above graph depicts energy consumed per functional unit of transport, defined as one cubic meter of accommodation space for leisure or business purposes over 100 km for a given typical mission length. In the case of the Challenger 650 aircraft, the LCA is based on a typical 1,482 km mission (800 nm).

Operation life cycle stage

Over the last 40 years, the average fuel efficiency of business jets has improved by 40%. Furthermore, the aerospace industry was the first major industry worldwide to set aggressive commitments in terms of its CO_2 emissions, including carbon neutral growth from 2020 and achieving Net-Zero emissions by 2050*.

Effect of flight mission length on fuel burn

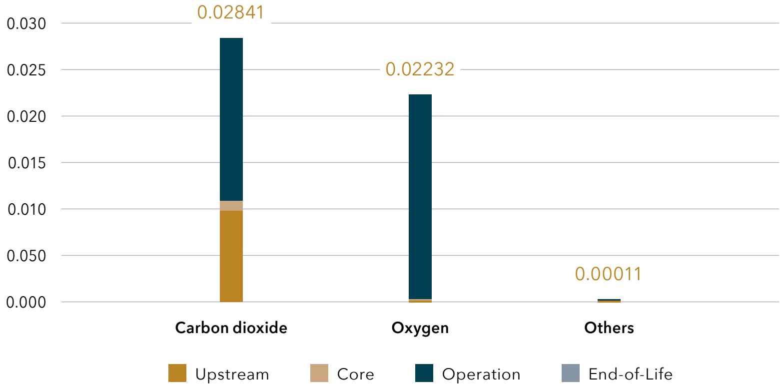
Mission (nm)	Block time (hr)	Fuel burned (litre per functional unit)
600	1.78	3.90
800**	2.25	3.75
1,000	2.73	3.67
2,000	5.09	3.61

*www.ebaa.org/about-business-aviation

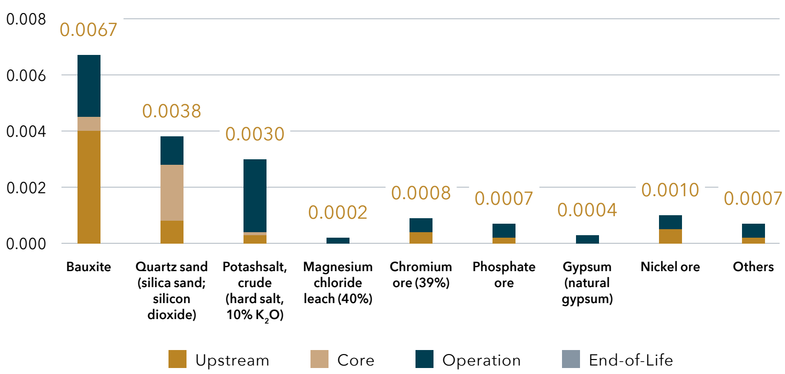
**The LCA was conducted based on a typical 1,482 km mission (800 nm).

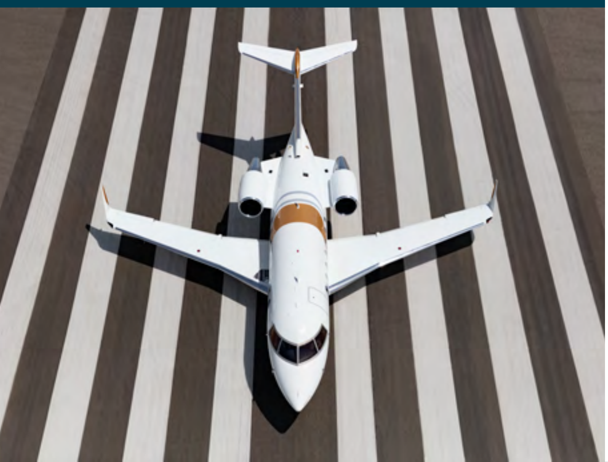
The primary consumption of renewable material resources and non-renewable energy resources occurs during the operation phase. The operation phase of the product life cycle is the phase during which more renewable energy resources are consumed.

RENEWABLE MATERIAL RESOURCES CONSUMPTION (KG PER FUNCTIONAL UNIT)

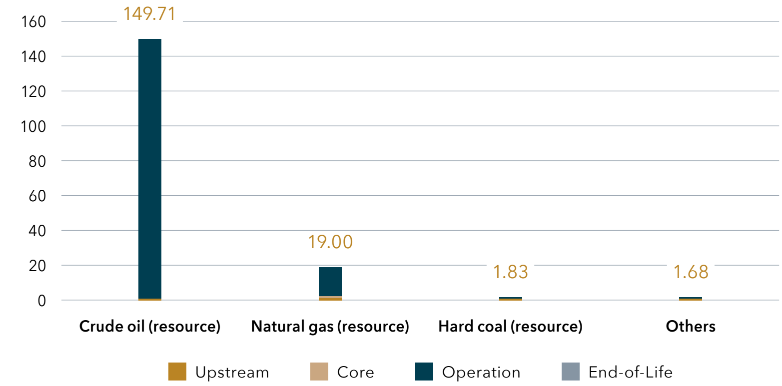


NON-RENEWABLE MATERIAL RESOURCES CONSUMPTION (KG PER FUNCTIONAL UNIT)





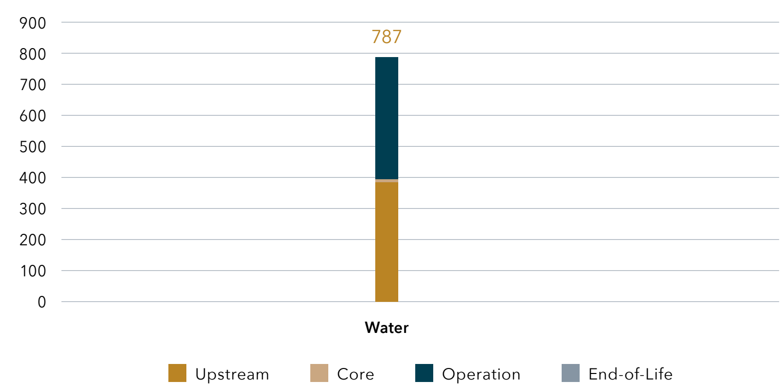
NON-RENEWABLE ENERGY RESOURCES CONSUMPTION (MJ PER FUNCTIONAL UNIT)



Water consumption occurs primarily during the upstream and operation phases.

The upstream phase contributes to 48.74% of total water consumption. The operation phase, which includes maintenance and aircraft use, contributes to 49.88% of total water consumption.

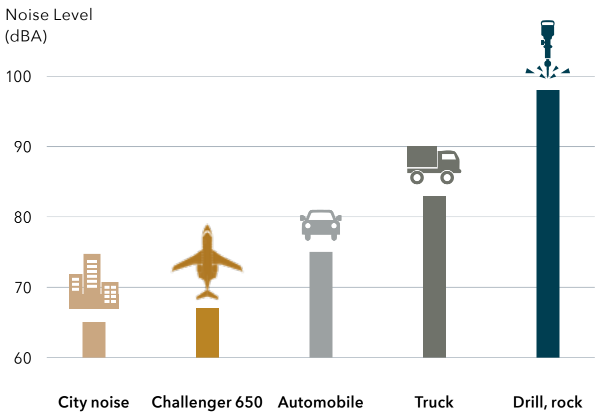
WATER CONSUMPTION (KG PER FUNCTIONAL UNIT)



The above graphs depict material, energy and water consumed per functional unit of transport, defined as one cubic meter of accommodation space for leisure or business purposes over 100 km for a given typical mission length. In the case of the Challenger 650 aircraft, the LCA is based on a typical 1,482 km mission (800 nm).

Noise levels of common urban sources

To provide perspective on the noise level of the Challenger 650 aircraft, the graph below compares the Challenger 650 aircraft noise level to other urban sounds:



A-weighted decibels (dBA) are an expression of the relative sound intensity as perceived by the human ear. The noise level of the Challenger 650 aircraft corresponds to noise under the departure flight path, 6.5 km from brake release.

Community noise certification numbers

The Challenger 650 aircraft, with a 15.1 EPNdB margin to the ICAO Chapter 4 cumulative requirement*, meets the most stringent international noise standards.

Noise	**(EPNdB[1])**
Approach	91.3
Lateral	85.6
Flyover	79.0
Total	255.9

Configuration

MTOW: 48,200 lb
MLW: 38,000 lb
Engine: General Electric CF34-3B MTO (9,220 lbf take-off SLS)

* https://www.easa.europa.eu/en/document-library/type-certificates/noise/easaima023-cl-600-challenger-600-series#group-easa-downloads

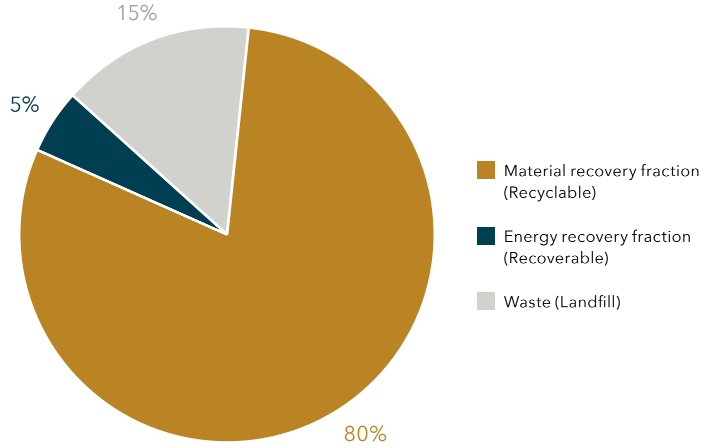
[1] Community noise certification is regulated by the International Civil Aviation Organization (ICAO) and expressed in Effective Perceived Noise in Decibels (EPNdB).

End-of-life stage

Using materials featuring high recyclability rates maximizes the overall recoverability of the Challenger 650 business jet. Material recycling and energy recovery aggregate to an 85% recoverability rate by weight.

Bombardier is involved in research projects to improve the recyclability and recoverability rates of all of its new aircraft.

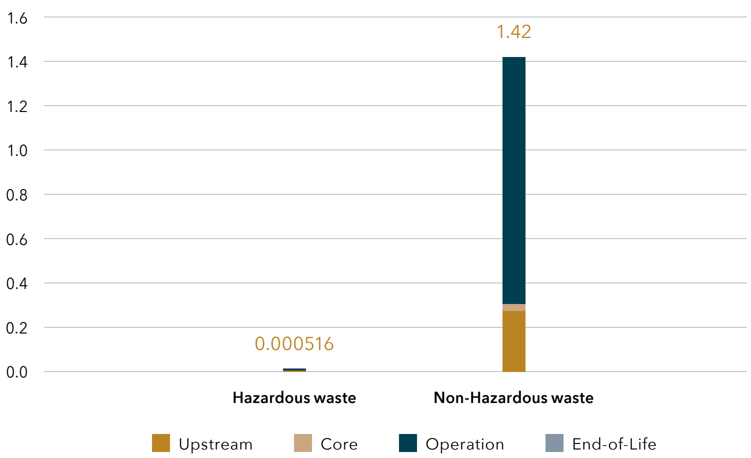
GHALLENGER 650 AIRCRAFT RECYCLABILITY AND RECOVERABILITY RATE BY WEIGHT



Bombardier puts a strong focus on minimizing the use of hazardous materials and related toxic emissions.

99.96% of waste quantity generated over the life cycle of the aircraft is non-hazardous as shown in the graph below:

WASTE GENERATION (KG PER FUNCTIONAL UNIT)



The above graph depicts waste generated per functional unit of transport, defined as one cubic meter of accommodation space for leisure or business purposes over 100 km for a given typical mission length. In the case of the Challenger 650 aircraft, the LCA is based on a typical 1,482 km mission (800 nm).

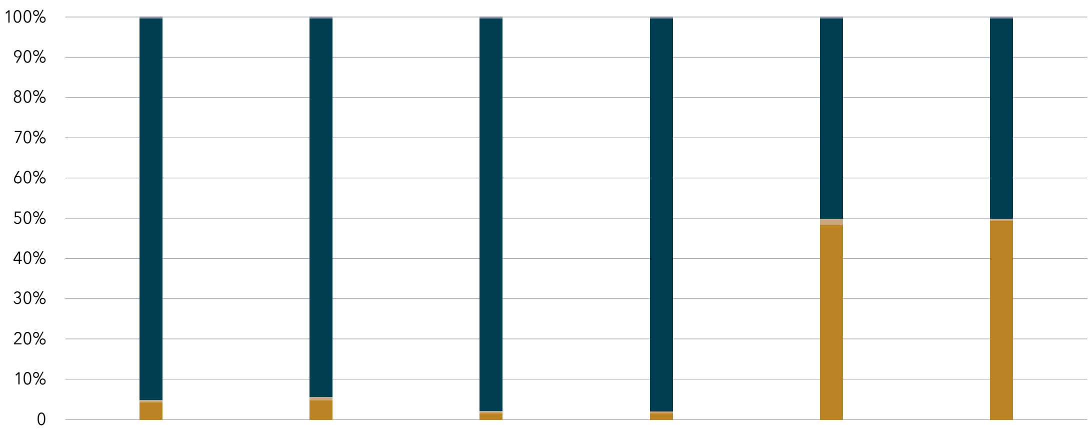
Environmental impact in detail

LCA calculations were performed by using GaBi TS software and databases version 10. CML2001, version August 2016 methodology* is used for the first four impact indicators (Acidification Potential, Global Warming Potential, Eutrophication Potential and Photochemical Ozone Creation Potential). As for Water Scarcity Potential, the WSI (Water Scarcity Index)** is used. All specific data collected through 2023 remains unchanged for 2024 and is valid for a global market.

As for the overall transportation industry, the operation phase is the most significant contributor to all life cycle impact indicators. The table below details Challenger 650 aircraft life cycle impacts, for instance: 95.09% of the Acidification Potential, 97.76% of the Global Warming Potential, 97.89% of the Photochemical Ozone Creation Potential, 94.21% of the Eutrophication Potential, and finally 50.16% of the Water Scarcity Potential.

*https://www.universiteitleiden.nl/en/research/research-output/science/cml-ia-characterisation-factors
**https://sphera.com/wp-content/uploads/2022/02/Introduction-to-Water-Use-Assessment-in-GaBi-2022.pdf

IMPACT INDICATORS



	Acidification Potential [kg SO_2 eq.]	Eutrophication Potential [kg Phosphate eq.]	Global Warming Potential [kg CO_2 eq.]	Photochem. Ozone Creation Potential [kg Ethene eq.]	Total freshwater use [kg]	Water Scarcity Potential [m³ equiv.]
Upstream[1]	3.98E-04	6.76E-05	2.08E-01	2.73E-05	3.81E+02	1.78E-02
Core[2]	4.57E-05	1.27E-05	6.39E-02	5.16E-06	1.08E+01	1.44E-04
Operation[3]	8.59E-03	1.31E-03	1.19E+01	1.51E-03	3.95E+02	1.81E-02
End-of-Life[4]	2.96E-07	2.52E-07	1.56E-04	4.97E-08	8.08E-02	1.30E-07
Total	**9.04E-03**	**1.39E-03**	**1.21E+01**	**1.54E-03**	**7.87E+02**	**3.60E-02**

Note: These results are valid only for this range and this configuration and a typical 1,482 km mission (800 nm). No linear assumption can be made to extrapolate the environmental impact for any other distance, configuration or aircraft type. 1) Raw material extraction and component production. 2) Final assembly and completion. 3) Use, maintenance and spare parts production. 4) Aircraft disassembly and end-of-life processes.

2.01 kg of water are also emitted during the operation phase as part of the combustion. Water vapour emitted was quantified directly from the fuel burned as follows: 1.260 grams of water per kilogram of fuel burned.

Glossary of terms

Life cycle assessment

Life cycle assessment (LCA) is the process used to measure a product's environmental impact at any point for any activity or use over its whole lifetime from raw material extraction through materials processing, manufacturing, distribution, use, repair and maintenance, and disposal or recycling.

Acidification potential

The aggregate measure of the acidifying potential of some substances, calculated through the conversion factor of sulphur oxides and nitrogen and ammonia into acidification equivalents (SO_2).

Global warming potential

Global warming potential is the aggregate measure of the warming potential of greenhouse gases emitted over all phases of the life cycle. It is expressed in CO_2 equivalents.

Eutrophication potential

The aggregate measure of the inland water eutrophication potential of some substances, calculated through the conversion factor of phosphorous and nitrogen compounds (waste water discharges and air emissions of NO_x and NH_3) into phosphorous equivalents.

Photochemical ozone creation potential

The aggregate measure of the ground level ozone creation potential of some substances, calculated through the conversion factor of ethylene equivalents that contribute to the formation of photochemical oxidants.

Water scarcity

The aggregate measure of geographic and temporal mismatch between freshwater demand and its availability. It results in the diminution of groundwater resources, an increase of salinity, nutrient pollution, the loss of floodplains and wetlands and more. It is expressed in m^3 equivalents.

Recyclability and recoverability

The recyclability and the recoverability rate of a new aircraft vehicle are expressed as a percentage of the mass of the aircraft vehicle that can potentially be recycled (recyclability rate), or recovered, or both (recoverability rate).

Environmental Sustainability

At Bombardier, integrating environmental sustainability into our product development function is a fundamental aspect of our process to design state-of-the-art aircraft, and is a core value.

Applying a complete life cycle perspective to aircraft design is central to our product responsibility strategy. Maximizing energy and resource efficiency, eliminating hazardous substances and related toxic emissions, as well as enhancing the overall product recoverability rate, are the result of a high quality working process applied to product design and cascaded to our supply chain.

For more information on Sustainability at Bombardier and Environmental Product Declarations please visit **bombardier.com/en/sustainability**

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Date of publication: version 1.0 was published 2024-03-26.
Last revision: 2024-03-26 (Version 1.0)