GE Aerospace

GE Aerospace FAA CLEEN III Consortium Industry Day

Spring 2024

GE ... creating value now & ahead

GE Aerospace ... defining flight for today, tomorrow & the future

Global leader in attractive, growing commercial & defense sectors

Differentiated technology & service for customers

Running the business with greater focus

GE Vernova ... electrifying & decarbonizing the world

Industry leader supporting customers through the energy transition

Power delivering FCF* from vast services installed base

Renewable Energy transforming now, plus secular tailwinds

New era at GE

Successfully executed spin into three independent entities

Right team embedding lean & decentralization further

Sustainable performance with revenue & earnings growth, FCF conversion*-a)

GE Aerospace launched as independent, public company following spin-off of GE Vernova

We are a world-leading provider of jet engines, components and integrated systems for civil and military aircraft.

We see an industry that matters to the world:

- History of innovation
- Purpose driven people
- Technologies to help enable net-zero flight

Photo courtesy of Boeing featuring Craig Bomben, Boeing's Enterprise Chief Pilot and VP of Flight Operations.

OUR PURPOSE

We invent the future of flight, lift people up and bring them home safely

~3B
Passengers flew with GE technology[-a)] under wing in 2023

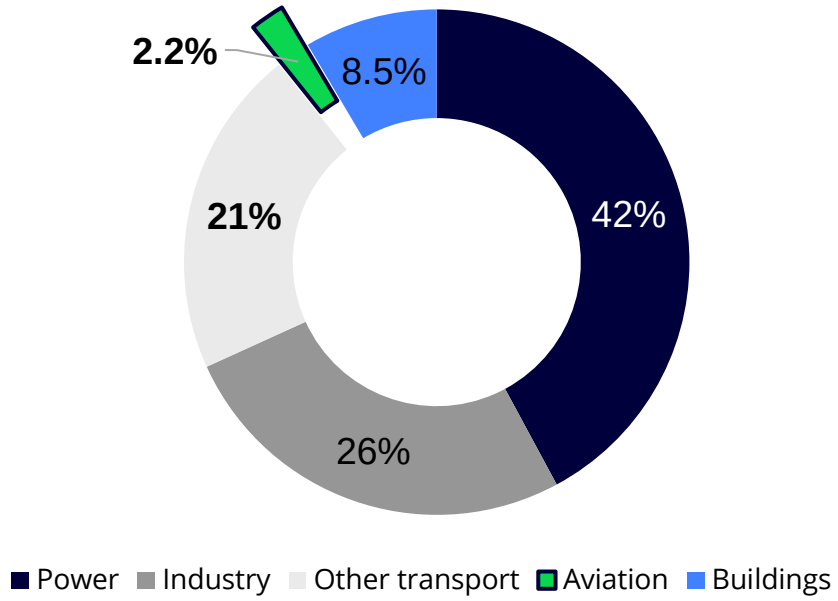
~900K
People flying at any given time on GE[-a)] powered aircraft

3 out of 4
Commercial flights powered by our engines[-a)]

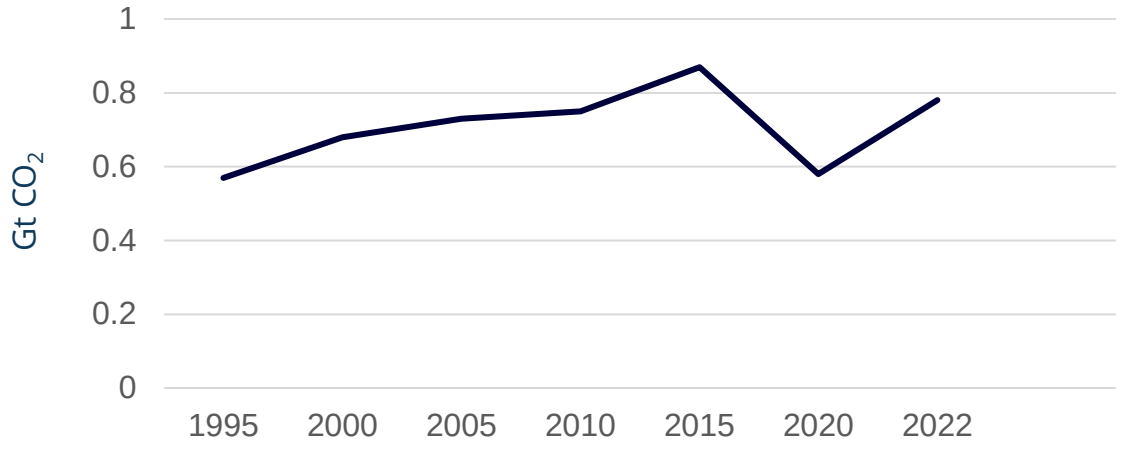
(a – Includes equipment made by CFM & Engine Alliance Joint Ventures
CFM is a 50/50 Joint Venture between GE & Safran Aircraft Engines; Engine Alliance is a 50/50 Joint Venture between GE & Pratt & Whitney

As aviation industry recovers from pandemic, challenge to meet net zero CO_2 emissions target by 2050

Global CO_2 emissions by sector 2022



Aviation CO_2 emissions projected to surpass 2019 peak around 2025



… Innovation to transform air travel at new inflection point

GE Aerospace

SOURCES: International Energy Agency (IEA) CO2 Emissions in 2022: https://www.iea.org/reports/co2-emissions-in-2022, https://www.iea.org/energy-system/transport and https://www.iea.org/energy-system/transport/aviation. This work is derived from IEA material and not endorsed by IEA.

Newest Boeing ecoDemonstrator Explorer studied Sustainable Aviation Fuel (SAF) impact on contrails and emissions in air-to-air flights

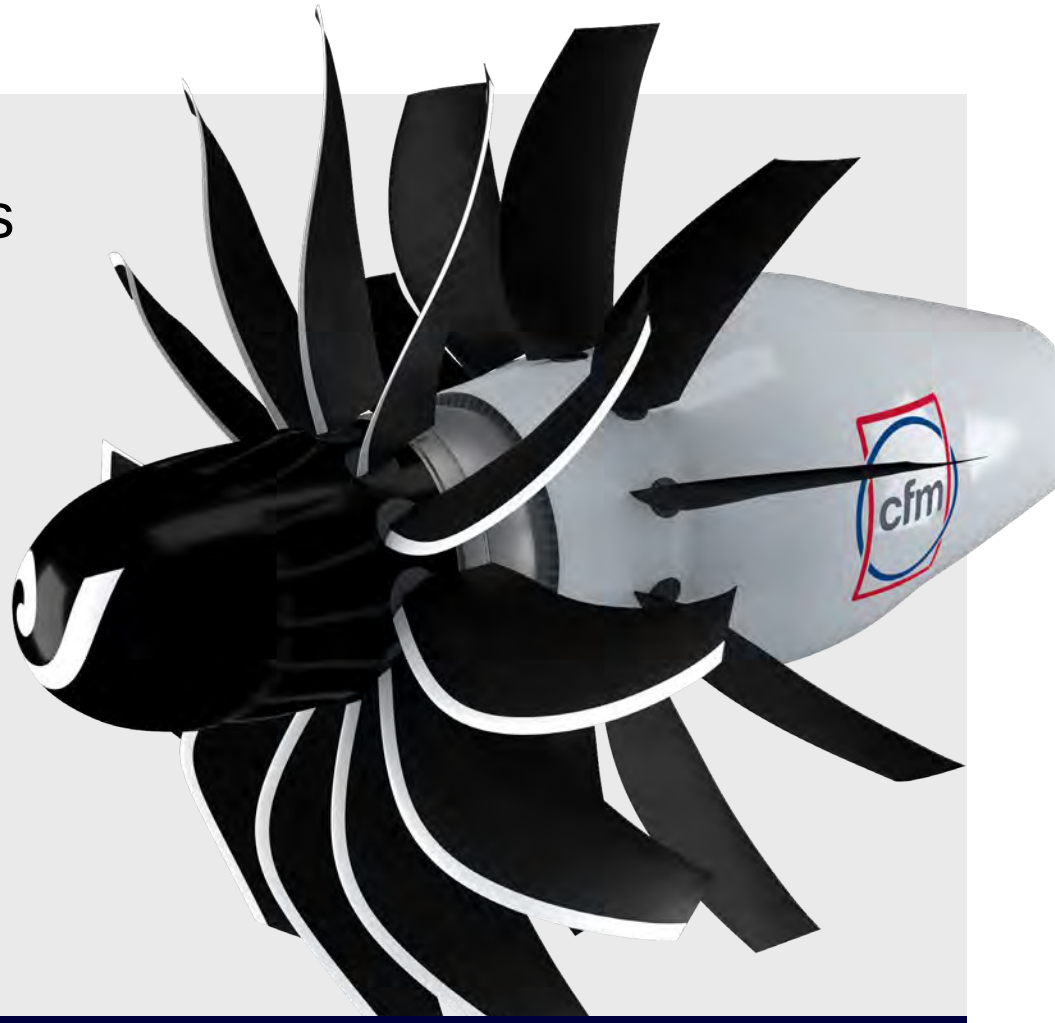
Image courtesy Boeing

- Boeing 737-10 with LEAP-1B engines destined for United Airlines
- Trailed by NASA DC-8 Airborne Science Lab measuring non-CO2 emissions
- Supported by FAA, GE Aerospace, German Aerospace Center (DLR), World Energy
- How SAF can reduce soot & impact contrails
- Three weeks of ground & flight tests October 2023

CFM RISE technology demonstration program

Targeting more than 20% lower CO_2 emissions compared to today's engines

- Advancing open fan architecture
- Propulsive efficiency step change
- Same speed & cabin experience
- Ground and flight tests this decade
- Advanced materials
- Hybrid-electric capability
- Additive manufacturing
- 100% SAF, hydrogen capability
- EIS by mid-2030s



Revolutionary Innovation for Sustainable Engines

*CFM International is a 50-50 joint company between GE and Safran Aircraft Engines.
RISE is a registered trademark of CFM.

More sustainable flight gains altitude in 2023

GE Aerospace made great progress and set numerous milestones in its pursuit of supporting a more sustainable aviation industry in 2023. Working with its partners, the company took many angles of approach, testing 100% sustainable aviation fuel (SAF), pioneering open fan architecture, and investing in hybrid electric technologies that may one day power the future of flight. Explore the highlights below.

100+

tests completed by CFM International[1] as part of its Revolutionary Innovation for Sustainable Engines (RISE) program

$20M

investment planned for facilities and equipment to support increased hybrid electric engine testing at the Electrical Power Integrated Systems Center (EPISCenter) in Dayton, Ohio

1,000+

engineers at GE Aerospace and Safran Aircraft Engines supporting the CFM RISE program around the world

36,000

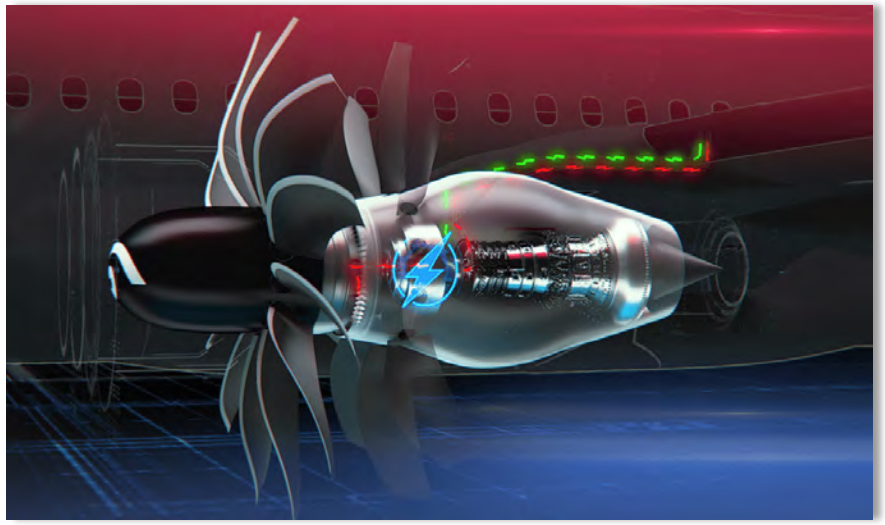
feet, the elevation at which NASA's DC-8 Airborne Science Laboratory conducted contrails research, measuring the impact of non-CO_2 emissions while chasing the Boeing ecoDemonstrator Explorer powered by CFM LEAP engines

100%

SAF used in one of two GE90 engines in a Boeing 777 and in one of four Engine Alliance[2] GP7200 engines in an Airbus A380 — both demonstration flights operated by Emirates and both industry firsts

1 CFM International is a 50-50 joint company between GE Aerospace and Safran Aircraft Engines.
2 Engine Alliance is a 50-50 joint company between GE Aerospace and Pratt & Whitney.

CFM RISE Technologies



Anticipated Benefits

- Noise: 13 EPNdB cum margin relative to Stage 5
- Combined Fuel Burn: 20+% reduction relative to current CFM LEAP* engine
- Targeting NOx reduction for a future high overall pressure ratio engine cycle, equivalent to 70% margin to the CAEP/8 standard at 30 OPR

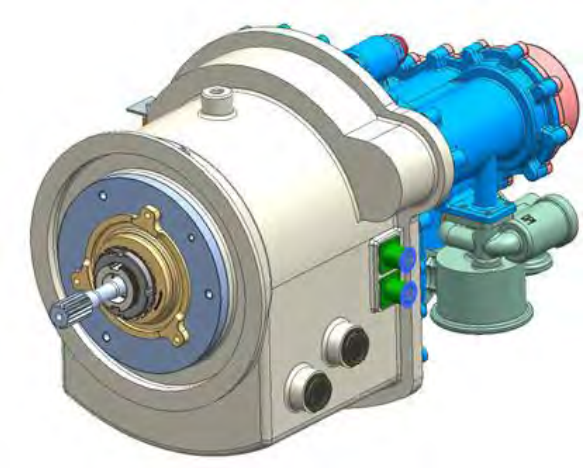
Objectives

- **Open Fan:** develop unducted single fan architecture
- **Low emissions combustor:** develop low NOx and nvPM combustor and enable compact, high OPR core to achieve 20% fuel burn
- Develop **Advanced Thermal Management System** and waste heat recovery system
- **Hybrid Electric Generator:** develop integrated electric-power generation system within the engine

High Level Schedule

	2021	2022	2023	2024	2025
Design	■	■	■		
Fabrication, Procurement, Assembly		■	■	■	
Technology Demonstration				■	■

CLEEN III MESTANG III



Anticipated Benefits

- More Efficient +/- 270Vdc generator with high power density and increased fuel savings
- New cooling method for increased thermal performance
- Self contained oil system

Risk/Mitigation Plans:

- Risk : Oil Pump performance fails to meet requirements
  Mitigation : Lab test with dummy generator

Objectives

Mature a +/- 270Vdc electric generator development as part of an integrated more-electric primary power system

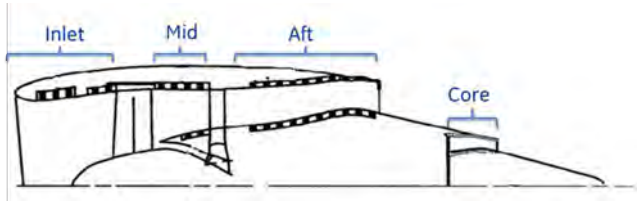
Work Statement

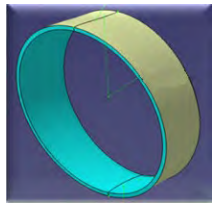
- Design and develop a 90 kW, +/- 270Vdc generator to address requirements of mid-size aircraft, business jets.
- Improved power generation system design with increased power density at lower cost.

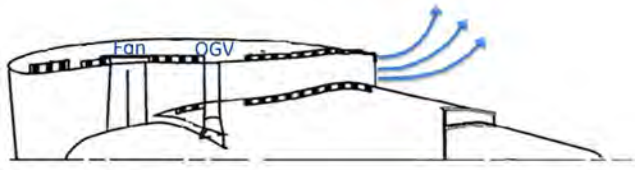
High Level Schedule

	2021	2022	2023	2024	2025
Design					
Fabrication, Procurement, Assembly					
Technology Demonstration					

CLEEN III Advanced Acoustics







Anticipated Benefits

Novel Liners:
2 EPNdB cumulative noise reduction relative to conventional liner w/ neutral performance impact

Fan Source Strength Reduction:
1 EPNdB cumulative noise reduction w/ performance neutral impact

Objectives

- Develop Novel Acoustic Liners.
- Develop Fan Source Strength Reduction Concepts

High Level Schedule

Advanced Acoustics	CY 2021				CY 2022				CY 2023				CY 2024				CY 2025				CY 2026			
Full Scale Hardware Design Phase	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Advanced Acoustic Liner Design																								
Acoustics Design Consensus Review																								
Mechanial Design Consensus Review																								
Acoustics Design Review																								
Mechanical Design Review																								
Advanced Liner Report Generation																								
Fan Source Strength Reduction Concept Design																								
Aero and Acoustic Design Consensus Review																								
Aero and Acoustic Deign Review																								
Fan Source Strength Reduction Report Generation																								

Sustainable Aviation Fuel

Anticipated Benefits

- Advance understanding of fuel composition on combustor performance
- Advance the approval of SAF qualifications
- Accelerate the standardization and the introduction of 100% SAF

Objectives

- Support SAF qualifications – test/demo
- Advance standardization of 100% drop-in SAF

Work Statement

- Evaluate 2 fuels of mutual interest to GE/FAA
- Help develop 100% drop-in SAF ASTM standard

High Level Schedule

Activity	2021	2022	2023	2024	2025
Fuel Testing					
Fuel Specification Development					

GE Aerospace

Thank You!