

GE Aerospace

FAA CLEEN III Consortium
Industry Day, Fall 2023





At GE Aerospace,
we **invent the future** of flight,
lift people up
And bring them **home safely**



— GE Aerospace: See what we're doing today for the benefit of us all tomorrow

Landmark technologies

Developing and maturing technology solutions to reduce aircraft and engine emissions with ambition to be net zero by 2050 for use of sold products

Working across industry

Partnering globally to shape and contribute to industry dialogue and actions

Operational commitment

Accelerating efforts to achieve carbon neutrality goal in our facilities by 2030

Technologies to help meet industry net-zero ambition

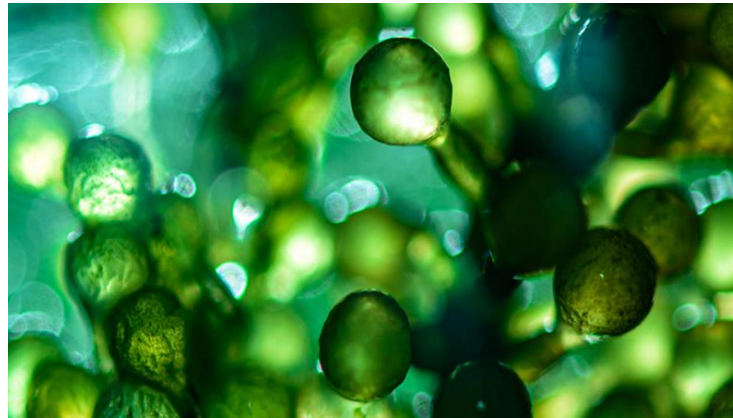
Now

Renewed commercial engine portfolio, plus services technologies, reduce existing fleet CO2 emissions



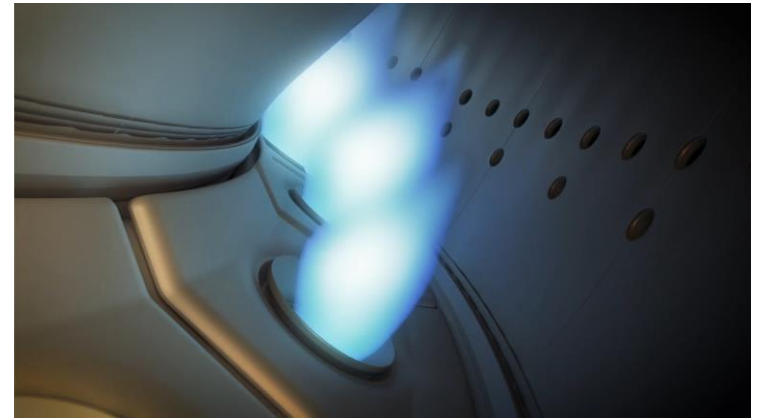
Near

100% Sustainable Aviation Fuel (SAF) standards and greater SAF adoption to reduce lifecycle CO2 emissions

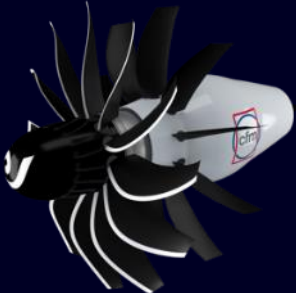
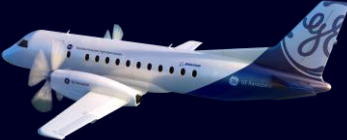


Next

Breakthrough technology demonstrators ... CFM RISE*, hybrid electric, hydrogen combustion



Aviation's next era building on a decade of product renewals

	Legacy (1980s to 2050s)	Next generation (2010s to 2070s)	Future of flight (2030s to 2090+)
Narrowbody	 CFM56 1+ billion flight hours	 LEAP 15% better fuel efficiency vs. CFM56	 CFM RISE™ >20% efficiency vs. today's engines
Widebody	 CF6 Most produced widebody engine	 GENx 15% better fuel efficiency vs. CF6	 Hydrogen demonstrator
Big Twins	 GE90 1 st for composite fan	 GE9X 10% better fuel efficiency vs GE90	
Regional/BGA	 CF34 Regional workhorse	 Passport 17%+ better fuel efficiency vs. CF34-3	 Hybrid-electric demonstrator

CFM is a 50/50 Joint Venture between GE and Safran Aircraft Engines. RISE is a registered trademark of CFM.

CFM International's RISE program

Revolutionary Innovation for Sustainable Engines

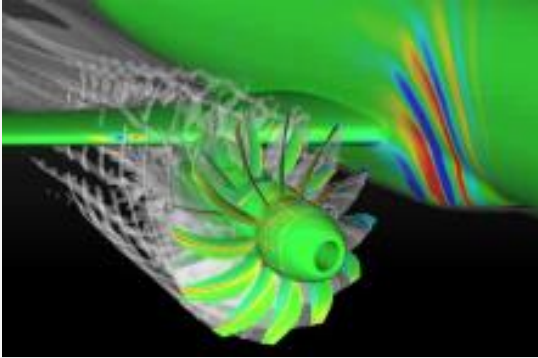
The RISE program represents our most comprehensive set of technology demonstrations to help the industry reach its goal of net zero carbon emissions by 2050:

- Pioneering technologies
 - Open fan
 - Compact core
 - Hybrid electric
 - 100% Sustainable Aviation Fuel compatibility
- 100+ tests completed
- 20% better fuel efficiency target vs. engines today
- On track for ground and flight testing by mid-decade



CFM's RISE program

Uncompromising new technologies



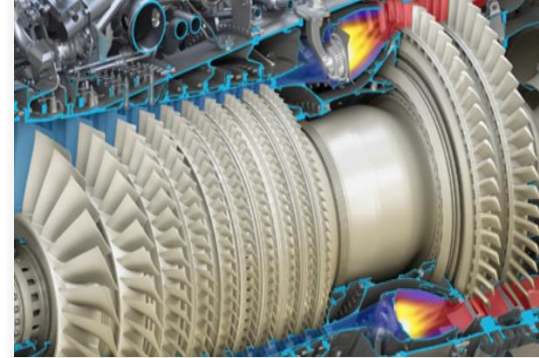
- Next-generation architecture
- Step-change in efficiency vs. ducted fans
- Targeting lower noise level vs current engine

Open fan



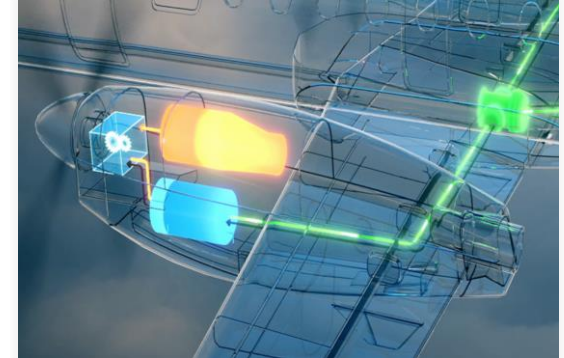
- RISE technologies to be 100% SAF certified
- Developing key H2 propulsion building blocks
- Ground & flight tests planned of H2-powered engine

Alternative fuels



- Next-generation compressor technologies & materials
- Increased thermal efficiency
- Higher operating pressure

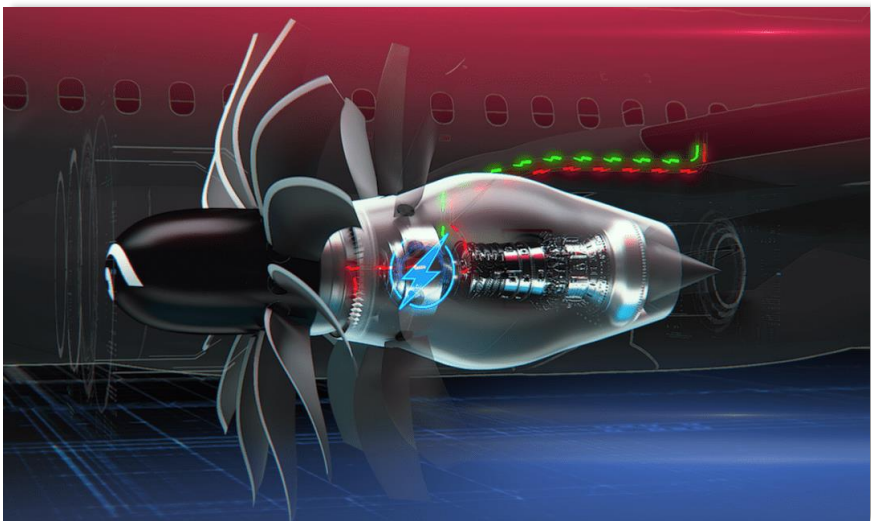
Compact core



- Developing MW-class hybrid electric powertrain
- Advancing higher power density / lower weight components
- Decade+ of experience

Hybrid electric

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

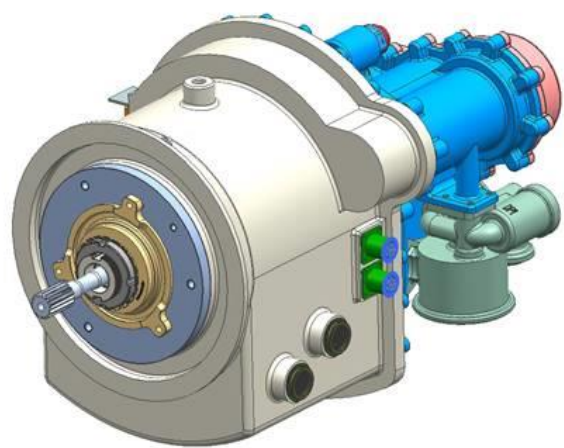
Objectives

- **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
Design				
Fabrication, Procurement, Assembly				
Technology Demonstration				

Sustainable Aviation Fuel

What is drop-in Sustainable Aviation Fuel (SAF)?

Requires no engine, aircraft, or infrastructure changes



Chemically the same as conventional jet fuel



Can be used in aviation equipment **Today**





GE

aval only

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Anticipated Benefits

- Advance understanding of fuel composition on combustor/fuel system performance
- Advance the approval of practical candidate SAF
- Accelerate the standardization and therefore the introduction of 100% SAF

Objectives

- Support qualification of candidate SAF – test/demo
- Advance standardization of 100% SAF

Work Statement

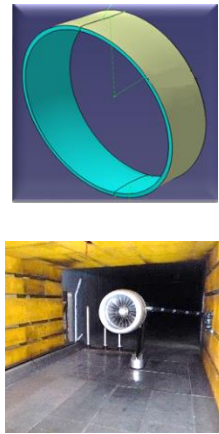
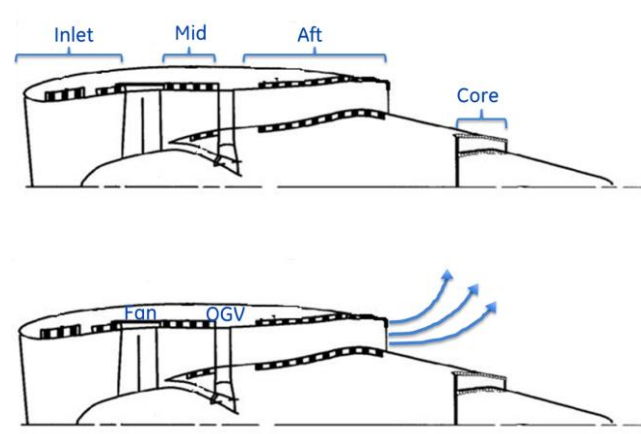
- Evaluate CPK-0 and a TBD SAF for combustor and fuel system performance
- Help develop ASTM standard for 100% drop-in SAF

High Level Schedule

	2021	2022	2023	2024
Fuel Testing*				
Development of Fuel Specification for 100% SAF				

*Delayed due to fuel availability

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

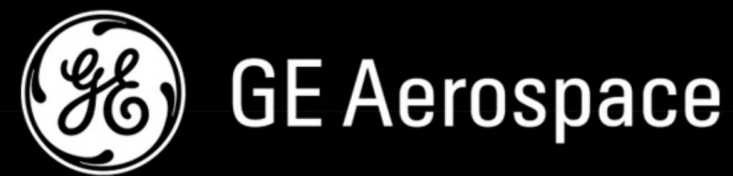
Objectives

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

High Level Schedule

	2021	2022	2023	2024	2025	2026
Rig Scale Technology Demonstration*						
Full-Scale Design						
Full-Scale Fabrication, Procurement, Assembly						

* Delayed due to facility availability



Thank You!