REDAC Environment and Energy Sub-Committee

Aircraft Technology Research

By: Levent Ileri and Arthur Orton
FAA CLEEN Program

Date: March 23, 2022

Federal Aviation Administration

Agenda

- **Continuous Lower Energy, Emissions & Noise (CLEEN) Program Overview and Updates**
  - CLEEN Phase I
  - CLEEN Phase II
  - CLEEN Phase III
- **Aviation Sustainability Center of Excellence (ASCENT) Technology Projects Update**

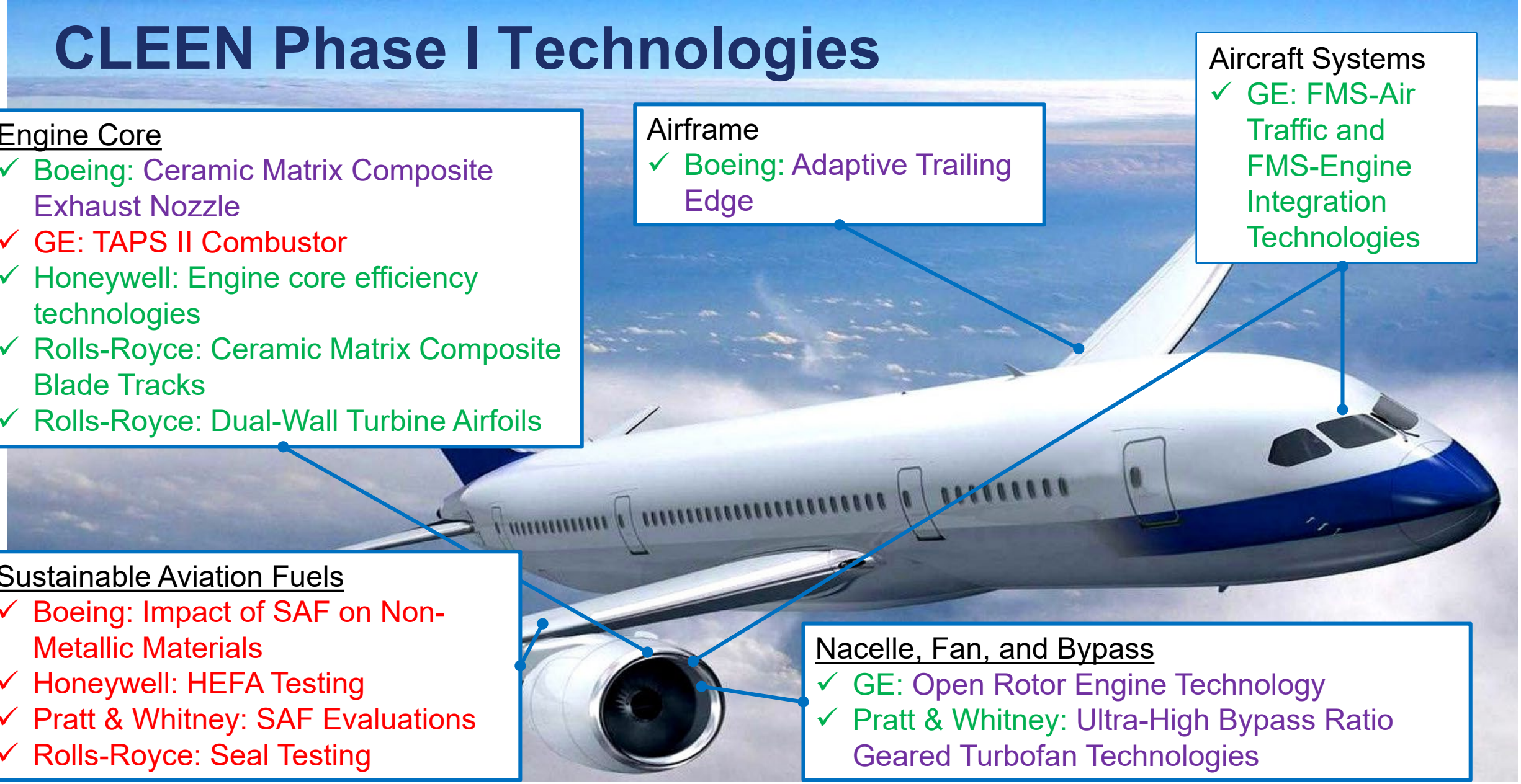
Continuous Lower Energy, Emissions & Noise (CLEEN) Program

- FAA led public-private partnership with 100% cost share from industry
- Reducing fuel burn, emissions and noise via aircraft and engine technologies and alternative jet fuels
- Conducting ground and/or flight test demonstrations to accelerate maturation of certifiable aircraft and engine technologies

	Phase I	Phase II	Phase III
Time Frame	2010-2015	2016-2020	2021-2026
FAA Budget	~$125M	~$100M	~$100M+
Noise Reduction Goal	25 dB cumulative noise reduction cumulative to Stage 5 and/or reduces community noise exposure (new goal for Phase III)		
Fuel Burn Goal	33% reduction	40% reduction	-20% re: CAEP/10 Std.
NO_X Emissions Reduction Goal	60% landing/take-off NO_X emissions (re: CAEP/6)	75% landing/take-off NO_X emissions (-70% re: CAEP/8)	
Particulate Matter Reduction Goal	-	-	Reduction relative to CAEP/11 Std.
Entry into Service	2018	2026	~2031

For more information on CLEEN program: http://www.faa.gov/go/cleen

CLEEN Phase I Technologies



Engine Core
- ✓ Boeing: Ceramic Matrix Composite Exhaust Nozzle
- ✓ GE: TAPS II Combustor
- ✓ Honeywell: Engine core efficiency technologies
- ✓ Rolls-Royce: Ceramic Matrix Composite Blade Tracks
- ✓ Rolls-Royce: Dual-Wall Turbine Airfoils

Airframe
- ✓ Boeing: Adaptive Trailing Edge

Aircraft Systems
- ✓ GE: FMS-Air Traffic and FMS-Engine Integration Technologies

Sustainable Aviation Fuels
- ✓ Boeing: Impact of SAF on Non-Metallic Materials
- ✓ Honeywell: HEFA Testing
- ✓ Pratt & Whitney: SAF Evaluations
- ✓ Rolls-Royce: Seal Testing

Nacelle, Fan, and Bypass
- ✓ GE: Open Rotor Engine Technology
- ✓ Pratt & Whitney: Ultra-High Bypass Ratio Geared Turbofan Technologies

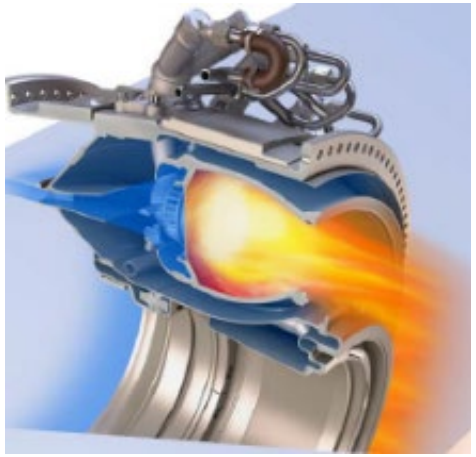
Fuel
Emissions
Noise

✓ Completed Effort

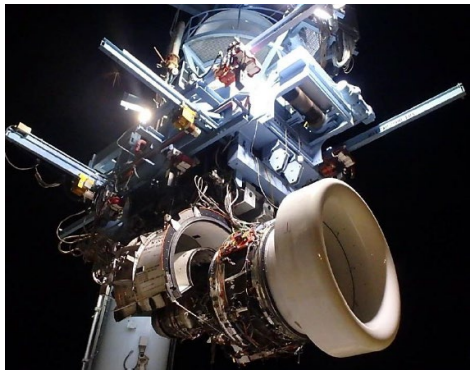
For more information on CLEEN Phase I projects: https://www.faa.gov/newsroom/continuous-lower-energy-emissions-and-noise-cleen-program?newsId=22534

Success Stories from CLEEN I

- GE TAPS II Combustor entered fleet in 2016 on LEAP engine; installed on Airbus 320neo, Boeing 737 MAX, and COMAC C919
  Exceeds CLEEN Phase I NO_X Reduction Goal

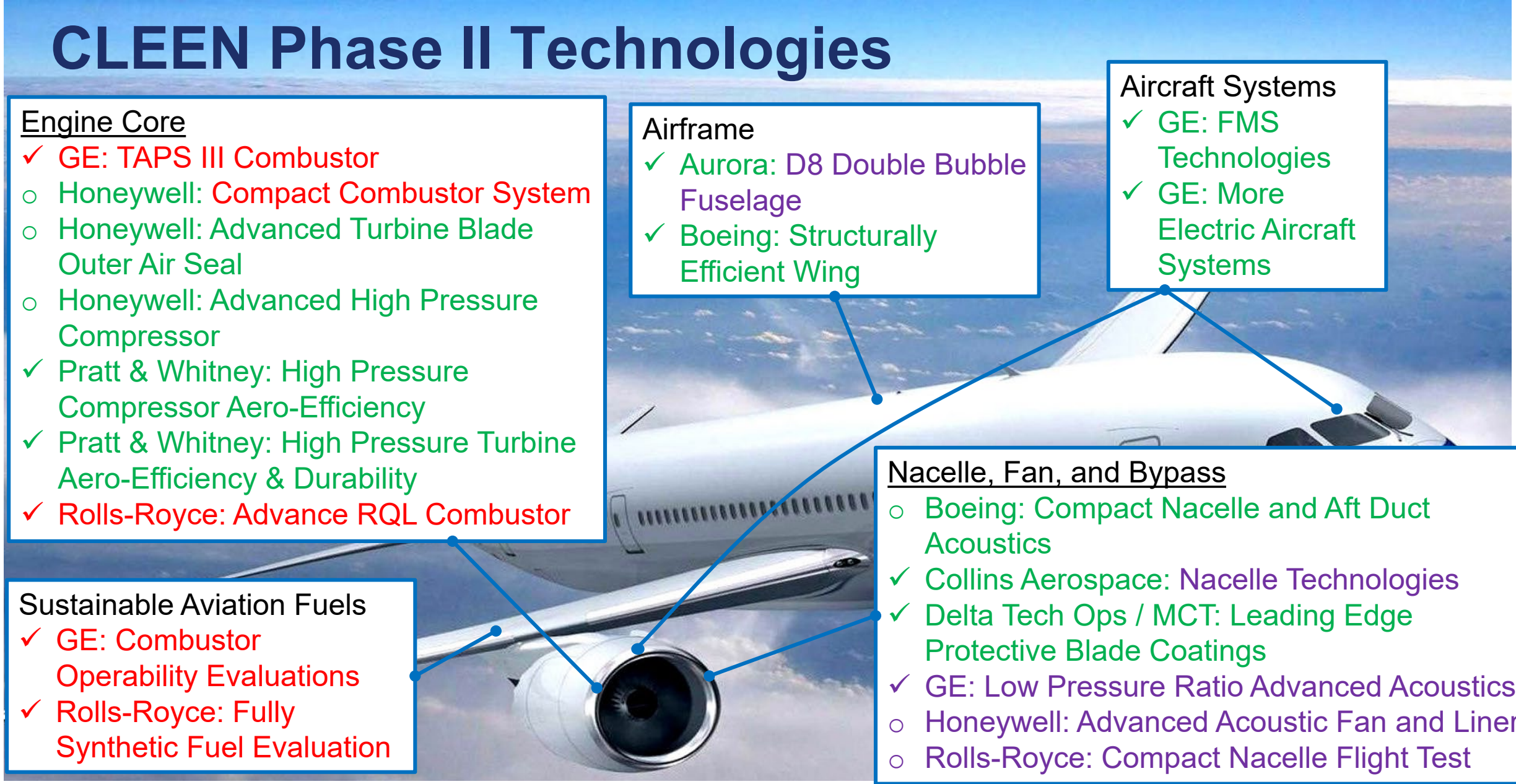


- Pratt & Whitney Gen 2 geared turbofan propulsor technology successfully engine tested
  Enables engine designs that provide 20% fuel burn reduction and 20 dB noise reduction



- Boeing CMC Nozzle flight tested on a 787 aircraft
  Up to 1% fuel burn reduction and 2.3 dB noise reduction

CLEEN Phase II Technologies



Engine Core
- ✓ GE: TAPS III Combustor
- ○ Honeywell: Compact Combustor System
- ○ Honeywell: Advanced Turbine Blade Outer Air Seal
- ○ Honeywell: Advanced High Pressure Compressor
- ✓ Pratt & Whitney: High Pressure Compressor Aero-Efficiency
- ✓ Pratt & Whitney: High Pressure Turbine Aero-Efficiency & Durability
- ✓ Rolls-Royce: Advance RQL Combustor

Airframe
- ✓ Aurora: D8 Double Bubble Fuselage
- ✓ Boeing: Structurally Efficient Wing

Aircraft Systems
- ✓ GE: FMS Technologies
- ✓ GE: More Electric Aircraft Systems

Sustainable Aviation Fuels
- ✓ GE: Combustor Operability Evaluations
- ✓ Rolls-Royce: Fully Synthetic Fuel Evaluation

Nacelle, Fan, and Bypass
- ○ Boeing: Compact Nacelle and Aft Duct Acoustics
- ✓ Collins Aerospace: Nacelle Technologies
- ✓ Delta Tech Ops / MCT: Leading Edge Protective Blade Coatings
- ✓ GE: Low Pressure Ratio Advanced Acoustics
- ○ Honeywell: Advanced Acoustic Fan and Liners
- ○ Rolls-Royce: Compact Nacelle Flight Test

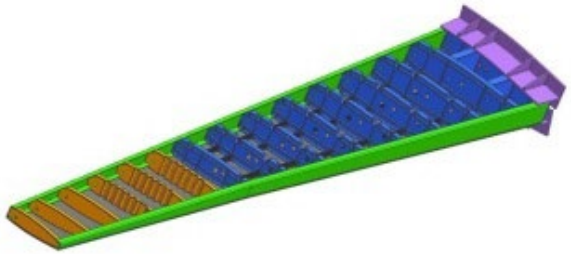
Fuel
Emissions
Noise

✓ Completed Effort
○ Ongoing Effort

For more information Phase II projects:
https://www.faa.gov/ ntinuous-lower-energy-emissions-and-noise am?newsId=22534

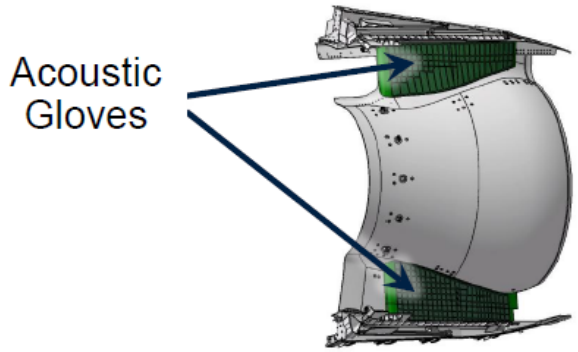
Success Stories from CLEEN II

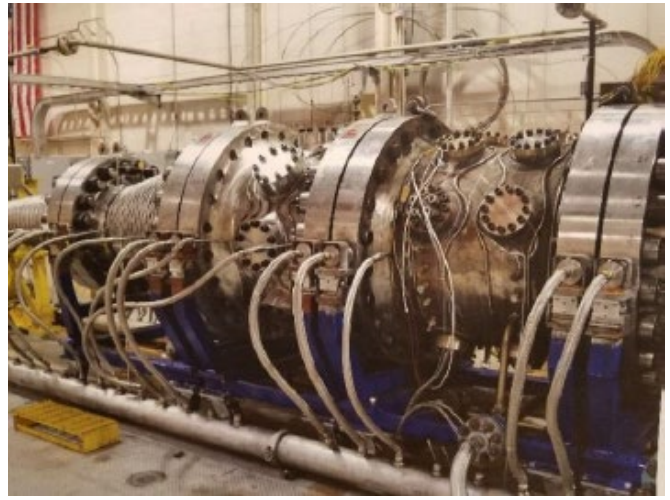
- Delta TechOps/MCT completed in-service flight evaluation of fan blade leading edge protective coating
  Retained efficiency equating to 0.4% to 1% fuel burn savings
- Boeing completed full scale ground test of Structurally Efficient Wing
  3.5% fuel savings through weight reduction
- Boeing completed ground engine test of Compact Nacelle technology
  1% fuel burn reduction; enables more efficient engine designs and improved acoustic treatments
- GE TAPS III combustion system will be implemented in the GE9X-powered Boeing 777X
  Enables NO_X emissions 30% below CAEP/8
- GE completed TRL 6 demonstration of Flight Management System optimization algorithms, including electronic flight bag prototype
  1% fleet-wide average improvement in fuel burn
- P&W high pressure compressor completed ground and flight tests—learnings integrated into GTF product line
  0.8-1.0% fuel burn reduction relative to a state-of-the-art engine



Recent CLEEN Phase II Accomplishments Since Fall REDAC Sub-Committee

- Boeing Aft Fan Duct Acoustics
  - Final reports and briefing complete
  - Exceeded noise reduction target for project:
    - 1.2 EPNdB cumulative for *current* aircraft in a retrofit scenario
    - 1.5 to 2.4 EPNdB cumulative benefit for compact nacelle architectures in *future* aircraft
- Honeywell
  - Initiated compact combustor emissions rig testing at NASA Glenn
  - Completed design reviews for fan and compressor optional technologies

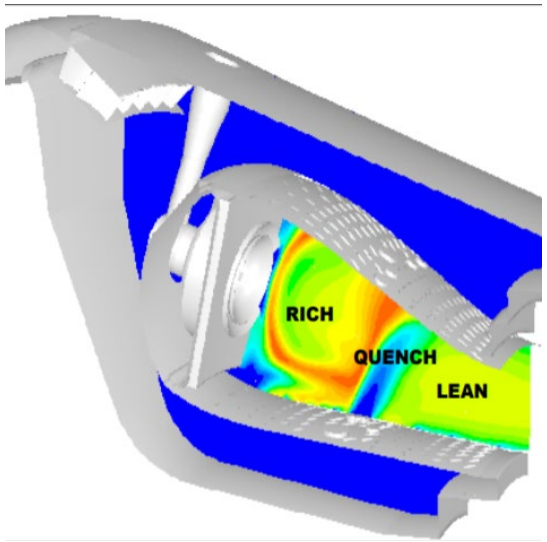




Upcoming CLEEN Phase II Activities

Next 6 Months:

- Rolls-Royce CLEEN Phase II flight test of compact nacelle technology (Q1-Q2 2022)
- Completion of Honeywell CLEEN Phase II compact combustor test at NASA Glenn Advanced Subsonic Combustion Rig (Q2 2022)



Assessment of CLEEN Technologies

Analytical Evaluation:

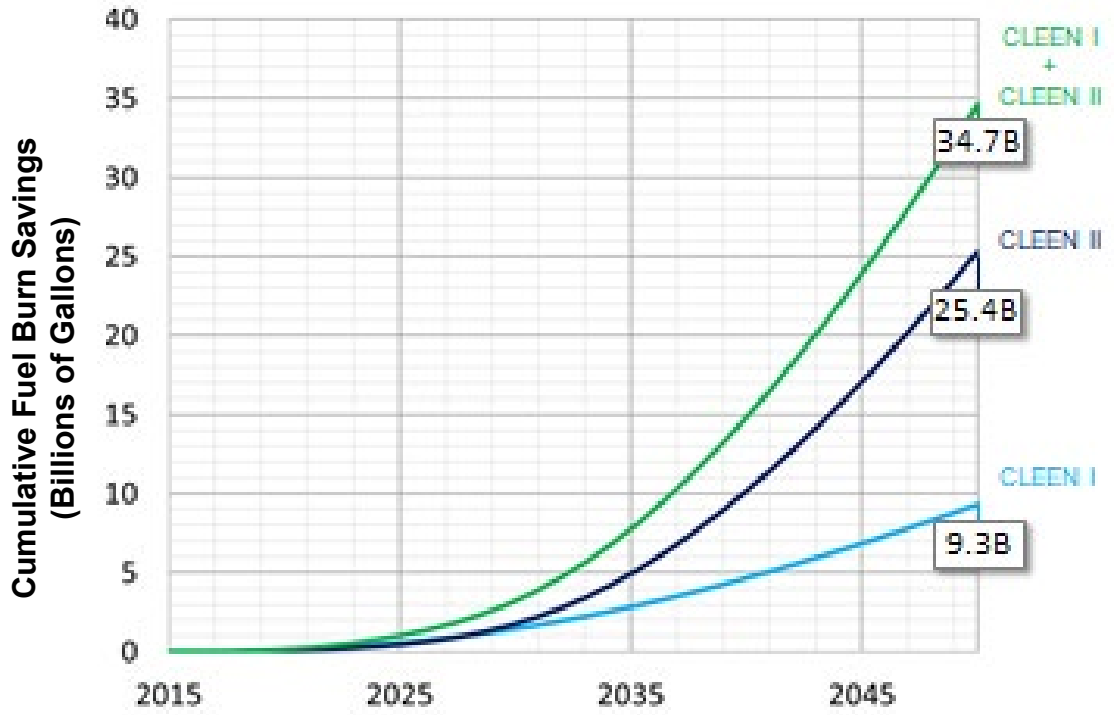
- Conducted by Georgia Tech through ASCENT COE Project 37
- Evaluating impact on fuel burn and noise out to 2050
- Have completed modeling of CLEEN Phase I technologies and all CLEEN Phase II fuel burn reduction technologies

Fuel Burn Benefit:

- 34.7 billion gallons of fuel saved cumulative by 2050 from CLEEN Phase I and II
- CO_2 emissions reduced by 404 million metric tons over this time period – the equivalent to removing 2.9 million cars from the road from 2020 to 2050

Noise Benefit:

- CLEEN Phase I Contributes to 14% <u>decrease</u> in the land area exposed to DNL 65 dB and greater
- CLEEN Phase II noise benefits assessment ongoing



Updated 1/4/2022

CLEEN Phase III

CLEEN Phase III Overview

	Phase III	
Time Frame	2021-2025	
Entry into Service	2031	
FAA Budget	~$100M+	
Vehicle Type	Subsonic	Supersonic
Noise Goal	25 dB cumulative noise reduction relative to Stage 5 and/or reduces community noise exposure	Reduction during landing and takeoff cycle (LTO)
Fuel Burn Goal	-20% re: CAEP/10 Std	-
NO_X Goal	-70% re: CAEP/8 Std (LTO)	Reduction in absolute NO_X emissions
Particulate Matter Goal	Reduction rel: CAEP/11 Std (LTO)	-

- **CLEEN Phase III: Follow-on to CLEEN Phase I and Phase II Programs focusing on aircraft noise, emissions and energy**
- **Purpose:**
  - Mature previously conceived noise, emissions and fuel burn reduction technologies for civil subsonic and supersonic airplanes from TRLs of 3-5 to TRLs of 6-7 to enable industry to expedite introduction of these technologies into current and future aircraft and engines
  - Assess jet fuels that could provide reductions in emissions or improvements in efficiency, including fuels that enable advancements in aircraft and engine design. This includes both conventional and alternative fuels.

The third phase of the CLEEN Program also aims to advance the development and introduction of hydrocarbon jet fuels for aviation that could enable improvements in fuel efficiency and reductions in emissions. This includes fuel blends. The CLEEN Program is interested in fuels that are drop-in compatible with the existing pipeline and airport fueling infrastructure, but have changes in their composition that could help an aircraft meet these CLEEN Program goals.

CLEEN Phase III Technologies

Engine Core
- GE: Compact Core – Low Emissions Combustor
- GE: Advanced Thermal Management
- GE: Hybrid Electric Integrated Generation
- Honeywell: Efficient Green High Pressure Core
- Honeywell: Compact High Work High Lift Low Pressure Turbine (LPT)
- Pratt & Whitney: TALON X+ Combustor

Airframe
- Boeing: Quiet Landing Gear
- Boeing: Quiet High-Lift System

Aircraft Systems
- GE: MESTANG III
- Boeing: Intelligent Operations

Sustainable Aviation Fuels
- Boeing: Higher Blend SAF Qualification
- GE: Higher Blend SAF Qualification

Nacelle, Fan, and Bypass
- America's Phenix: Erosion-Resistant Fan Blade Coating
- Boeing: Advanced Nacelle Next Generation Inlet
- Collins: Large Cell Exhaust Acoustic Technology
- GE: Open Fan
- GE: Advanced Acoustics
- Honeywell: Highly Efficient Fan Module
- Pratt & Whitney: Ultra-Quiet Reduced-Loss Fan Stage
- Safran: A[illegible] Air Inlet Lip Skin

Fuel
Emissions
Noise

Recent CLEEN Phase III Accomplishments Since Fall REDAC Sub-Committee

Awards:

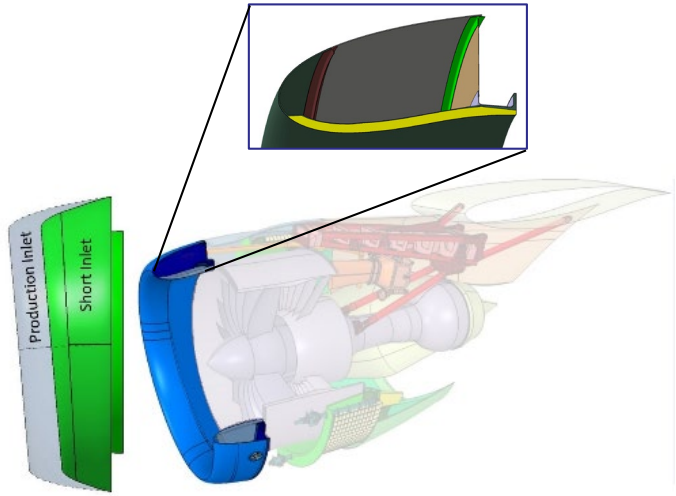
- Completed award to Safran Nacelles

Overall program milestones:

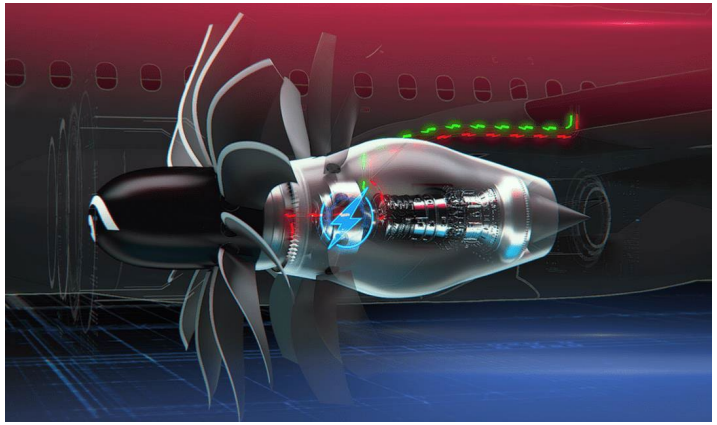
- Completed technical kickoff meetings for all CLEEN Phase III awarded agreements
- Completed first CLEEN Phase III Consortium Meeting November 1-5, 2021
  - Included first public presentations by CLEEN Phase III companies on their work
- Established monthly sustainable aviation fuels (SAF) coordination call with Boeing and GE

Project technical milestones:

- Boeing:
  - Completed conceptual design review for Quiet Landing Gear, Quiet High Lift, and Next Generation Inlet technologies
  - Completed system requirements review for Boeing's Intelligent Operations project
  - Completed Phase 1 of material compatibility testing for SAF project
- Honeywell: Completed conceptual design review for Highly Efficient Fan Module and Efficient Green High Pressure Core projects
- GE: Completed mechanical preliminary design review for Open Fan project



Boeing Next Generation Inlet



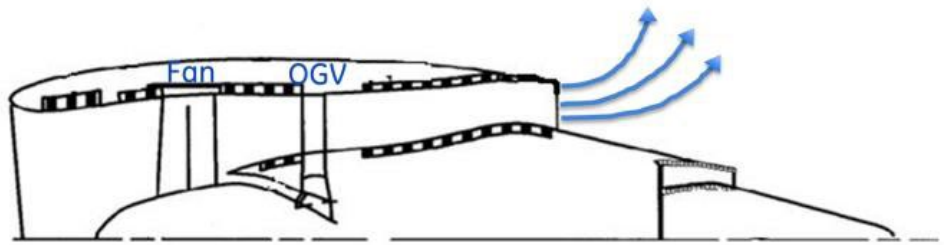
GE RISE concept with open fan

Upcoming CLEEN Phase III Activities

Next 6 Months:

- Award of final remaining agreement under negotiation
- Conduct CLEEN Consortium Meeting May 2-6, 2022
- Continued early stage design reviews/milestones:
  - America's Phenix/MDS: Coating Fluid Erosion Test (March 2022); Complete certification testing for PW2000 blade coating (Summer 2022)
  - Boeing: Quiet Landing Gear / Quiet High Lift PDRs (May 2022), Intelligent Operations Syst. Design Review (July 2022), Phase 2 SAF Material Compatibility
  - GE: Combustor single cup rig testing, Open Fan rig DDRs, Advanced Acoustics CDRs, 100% SAF ASTM Task Force
  - Honeywell: Fan Module Design DDR, Combustor development rig tests, High Pressure Compressor PDR, High Pressure Turbine DDR, Low Pressure Turbine PDR

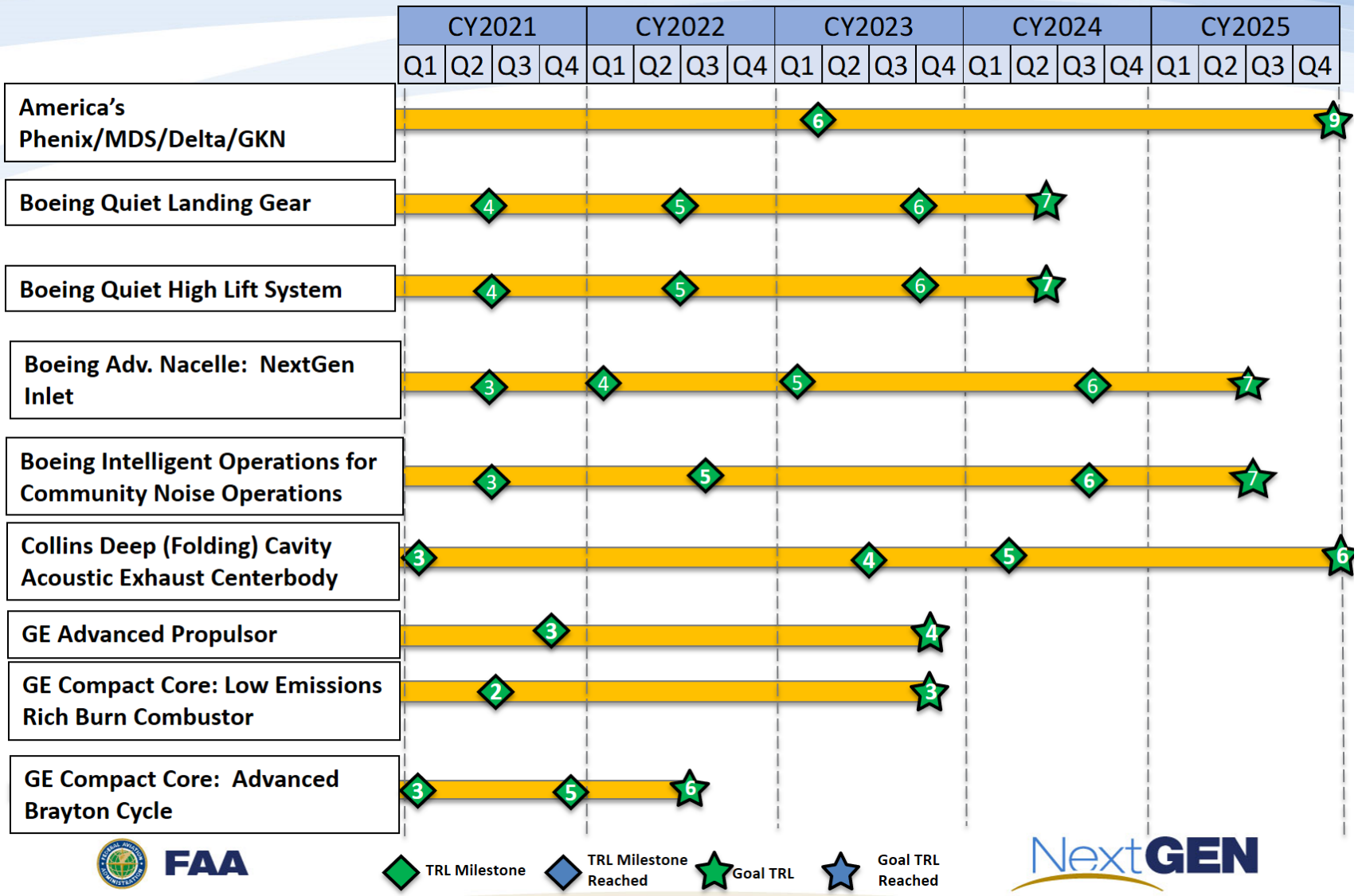
MDS Coating Fluid Erosion Test at Air Force Research Lab



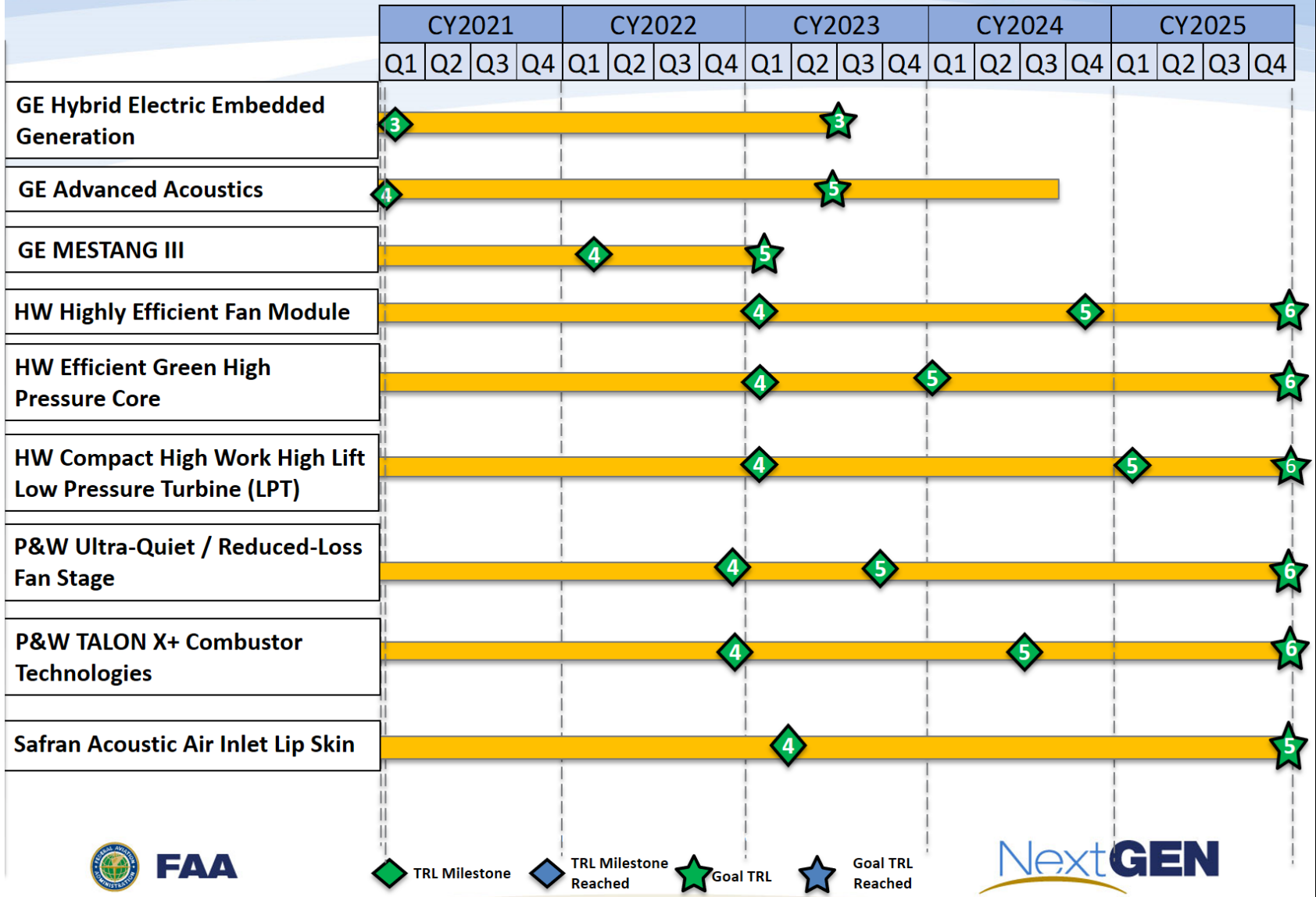
GE Advanced Acoustics: Fan Source Noise Strength Reduction

SAF = Sustainable Aviation Fuel
CDR = Conceptual Design Review
PDR = Preliminary Design Review
DDR = Detail Design Review

CLEEN III Technologies – TRL Milestones



CLEEN III Technologies Continued – TRL Milestones



FAA

NextGEN

ASCENT Technology Projects

- **Now 2 years into execution of the portfolio of environmental technology research projects in our Center of Excellence**
- **Originally set up as an experiment a the direction of the prior Administration to conduct innovation activities in our CoE**
- **Themes:**
  - Noise reduction technology modeling and development
  - System-level modeling and design considerations
  - Propulsion-airframe integration
  - Combustion
  - Turbomachinery
  - Supersonics
- **Overview of projects now available on ASCENT website:** https://ascent.aero/topic/Aircraft-Technology/

ASCENT Aircraft Technology Innovation Portfolio

ASCENT Aircraft Technology Innovation Projects

- **010- Aircraft Technology Modeling and Assessment**
- 037 - CLEEN II System Level Assessment
- 047 - Clean Sheet Supersonic Aircraft Engine Design and Performance
- 050 - Over-Wing Engine Placement Evaluation
- 051 - Combustion concepts for next-generation aircraft engines to reduce fuel burn and emissions
- 052 - Comparative Assessment of Electrification Strategies for Aviation
- 055 - Noise Generation and Propagation from Advanced Combustors
- 056 - Turbine Cooling Through Additive Manufacturing
- **059 - Jet Noise Modeling to Support Low Noise Supersonic Aircraft Technology Development**
- 063 - Parametric Noise Modeling For Boundary Layer Ingesting Propulsors
- **064 - Alternative Design Configurations to Meet Future Demand**
- **066 - Evaluation of High Thermal Stability Fuels**
- **067 - Impact of Fuel Heating on Combustion and Emissions**
- **068 - Combustor Wall Cooling Concepts for Dirt Mitigation**
- **070 - Reduction of nvPM emissions via innovation in aero-engine fuel injector design**
- **071 - Predictive Simulation of Soot Emission in Aircraft combustors**
- **074 - Low Emissions Pre-Mixed Combustion Technology for Supersonic Civil Transport**
- **075 - Improved Engine Fan Broadband Noise Prediction Capabilities**
- **076 - Improved Open Rotor Noise Prediction Capabilities**
- **077 - Measurements to Support Noise Certification for UAS/UAM Vehicles and Identify Noise Reduction Opportunities**
- **079 - Novel Noise Liner Development Enabled by Advanced Manufacturing – [NEW PROJECT]**

ASCENT's aircraft technology innovation research advances the industry state-of-the-art and expands the technical knowledge base.
https://ascent.aero/topic/Aircraft-Technology/

Green = received grant award September 2021 (since last REDAC meeting)

Key Outcomes Thus Far

While many projects were planned as multi-year from the start, we are seeing positive outcomes already:

- **ASCENT 37** has captured the projected fuel burn and CO2 emission benefits of CLEEN Phase II through 2050, helping us understand and communicate the benefits of the program. ASCENT 37 is currently working on fleet-level noise and NOx assessments of the CLEEN Program's benefits.

- **ASCENT 52** has evaluated the energy needs, investment costs and environmental impact of hydrogen and Power-to-Liquid (PtL) fuels. This work provides critical insight into the timelines and trajectories of the investments needed to support these fuels. This knowledge informs policy discussions at both national and international levels.

- **ASCENT 63** has concluded, providing a high fidelity assessment of the noise impacts of a generic boundary layer ingesting propulsor.

Key Outcomes Thus Far (Contd.)

- **ASCENT 64** has provided invaluable modeling and analysis support to our work to inform a long term aspirational goal (LTAG) for CO2 from international aviation at ICAO. Supported this work through approval of LTAG task group final report at Committee on Aviation Environmental Protection (CAEP) 12 Meeting in February.

- **ASCENT 51** has conducted a complete analysis of the impact of water injection technology on engine performance and total NOx emissions for various mission ranges. This included different injection strategies on conventional rich front-end engine combustors in the first two years of the project.

- **ASCENT 55** has developed and fabricated complimentary combustor rig experimental facilities at GT and RTRC, focused on improving understanding of combustion noise. They have conducted experiments and have analyzed the data to support improved combustion noise modeling activities.

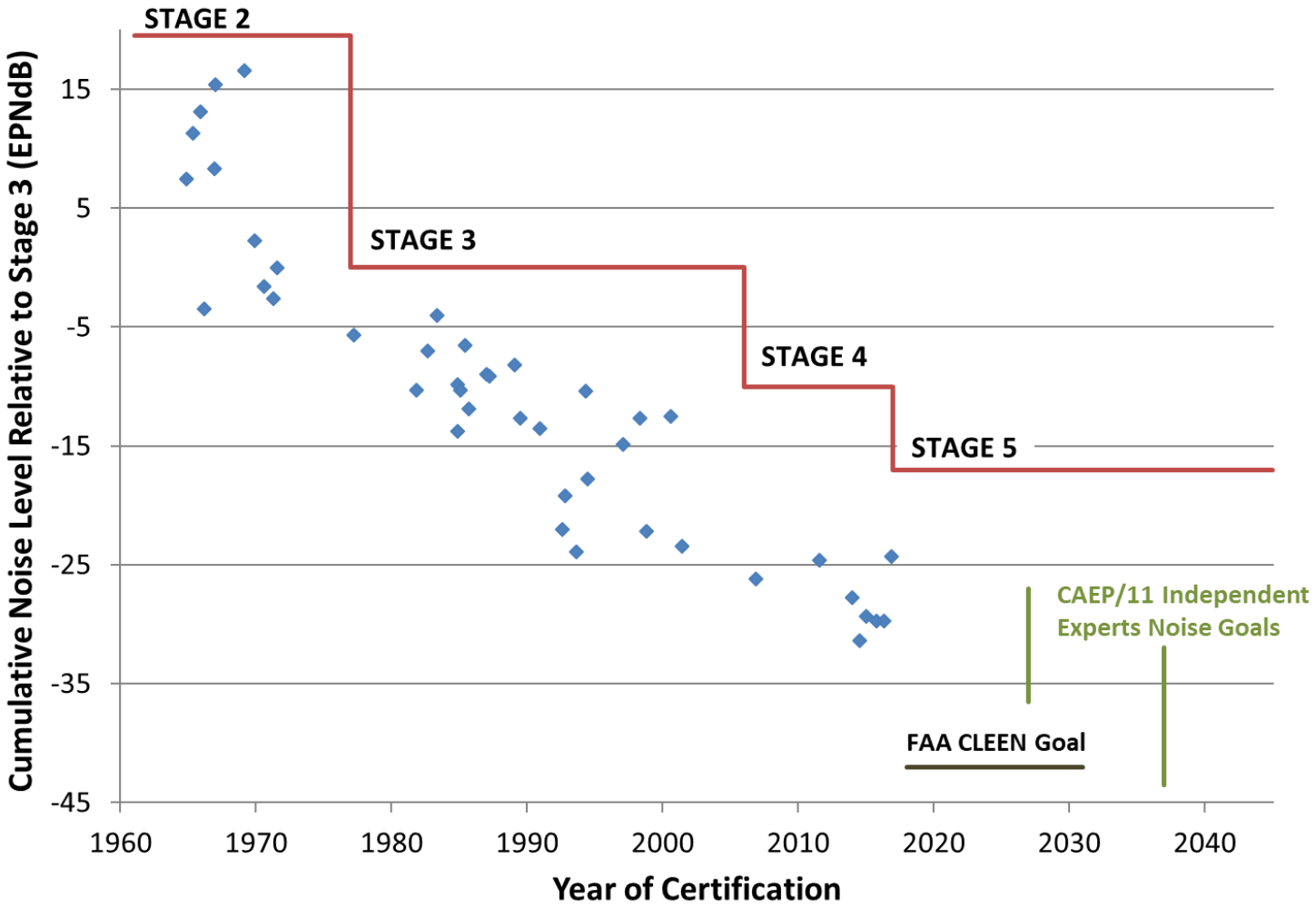
Conclusions

- **CLEEN Phase II is executing its sixth successful year**
  - Thirteen technology projects have reached their maturation goals
  - Remaining CLEEN Phase II technology development projects are on track to finish by end of CY2022
- **CLEEN Phase III continues our efforts to accelerate maturation of environmental aircraft technologies into the fleet (2021-2026)**
  - Eight awards in total, with seven now underway
  - Additional award expected soon
- **Next CLEEN Consortium Meeting:**
  - May 2-6, 2022 (virtual)
- **For more on CLEEN, see our website https://www.faa.gov/go/cleen and recently published Summary and Status Report on all of CLEEN's work to-date**

- **ASCENT projects showing promising outcomes as part of our expanded technology research portfolio**

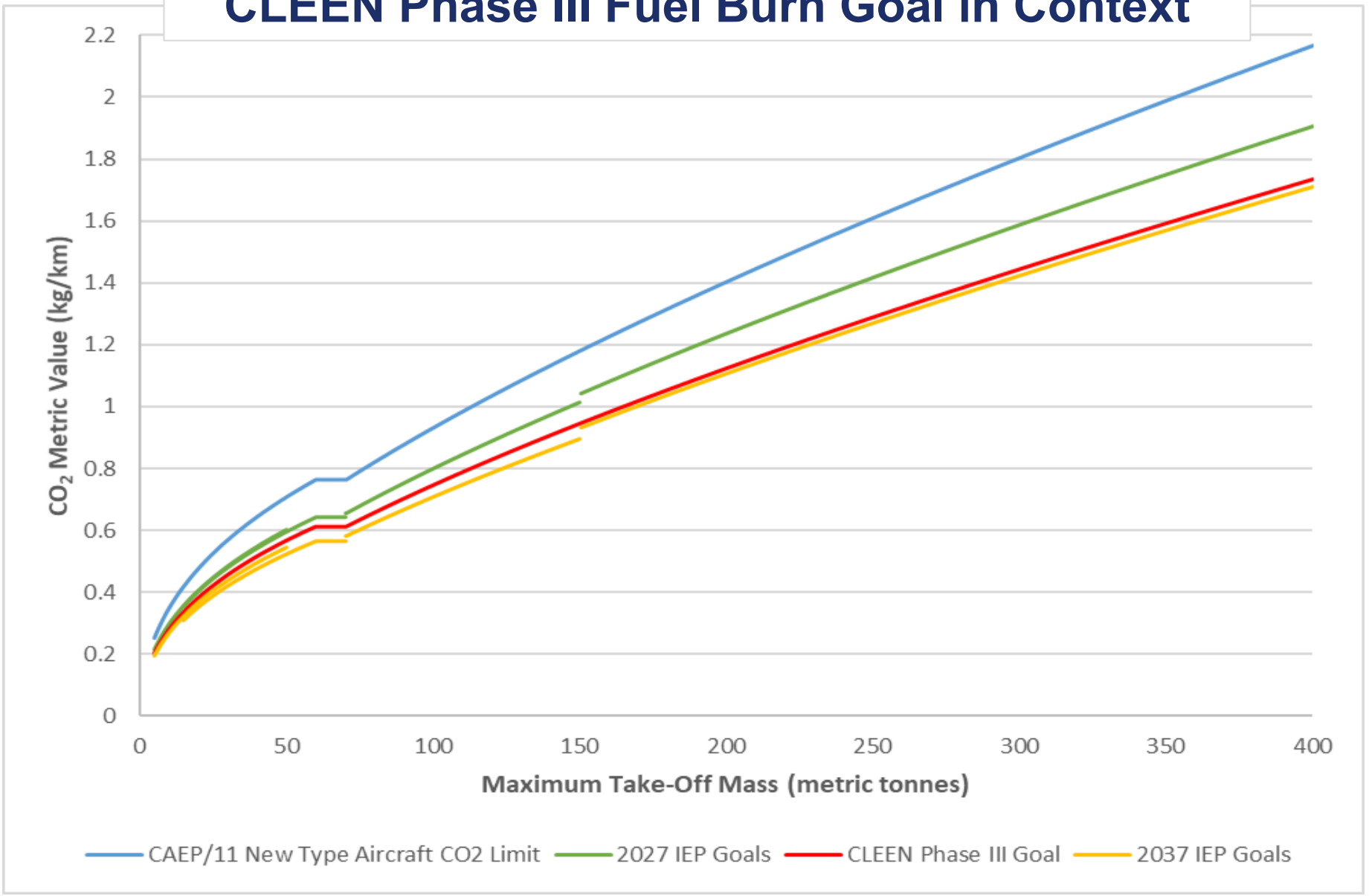
Backup Slides

CLEEN Noise Goal in Context



Back to CLEEN Overview Slide

CLEEN Phase III Fuel Burn Goal in Context



Back to CLEEN Overview Slide

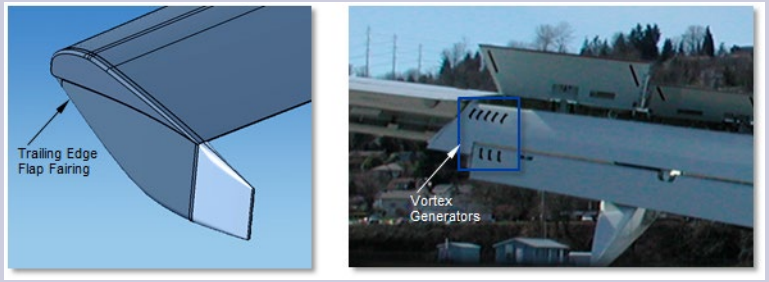
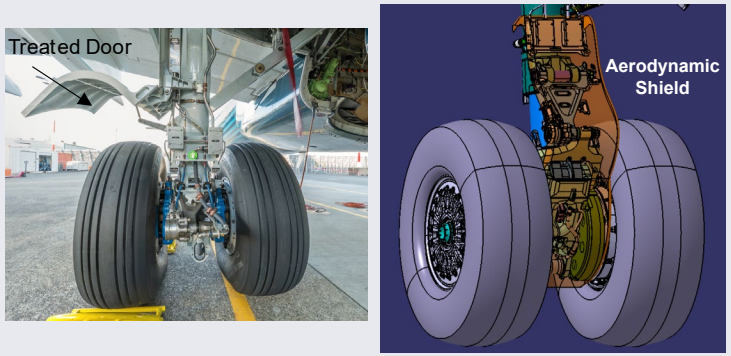
ASCENT Connections to CLEEN Phase III

- **ASCENT 55** – Georgia Tech / RTRC research is improving understanding of combustor noise generation
  - ➢ CLEEN Phase III P&W TALON X+ Combustor
- **ASCENT 68** – Penn State / P&W investigating dirt resistant combustor cooling holes
  - ➢ CLEEN Phase III P&W TALON X+ Combustor
- **ASCENT 76** – GE is providing Georgia Tech with open rotor geometry for parametric noise analysis
  - ➢ CLEEN Phase III GE Open Fan
- **ASCENT 79** – Penn State / RTRC investigating novel noise reduction liners enabled by Advanced Manufacturing
  - ➢ CLEEN Phase III P&W Ultra-Quiet Reduced-Loss Fan Stage

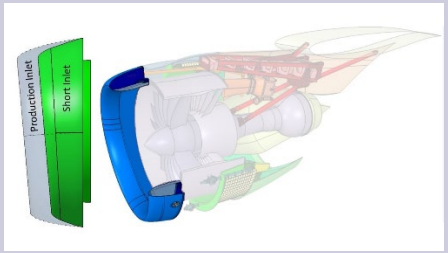
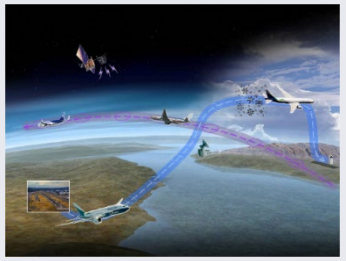
America's Phenix, Delta TechOps, MDS Coating Technologies, GKN Aerospace

Technology	Description	Benefits
Particulate & Fluid Erosion-Resistant Fan Blade Coating for Expanded Applications 	The team of Delta TechOps, GKN Aerospace, MDS Coating and America's Phenix, is developing erosion resistant fan blade coatings for various engine applications. The coatings protect the fan blade's leading edge against particulate and fluid erosion; thus, retaining engine performance, reducing fuel consumption and lowering emissions over an engine's operational tour.	Fuel: 1% or greater fuel burn reduction and corresponding reduction in greenhouse gas emissions via retaining engine performance over an engine's operational tour.

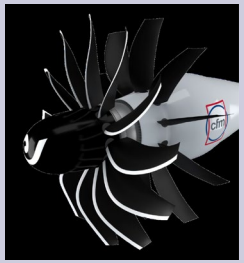
Boeing (1 of 2)

Technology	Description	Benefits
Quiet High-Lift System 	Boeing is developing flap edge fairings and vortex generators for wing high-lift devices in order to minimize noise.	Noise: Up to 0.5 EPNdB noise reduction
Quiet Landing Gear 	Boeing is developing landing gear door noise treatment and aerodynamic shields to reduce aircraft noise.	Noise: Up to 0.5 EPNdB noise reduction

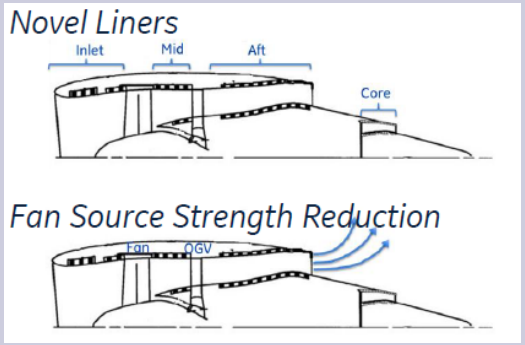
Boeing (2 of 2)

Technology	Description	Benefits
Advanced Nacelle: Next Generation Inlet 	Boeing is developing a new inlet architecture that will reduce weight, drag and noise.	Noise: Up to 1.5 EPNdB Fuel: 2% fuel burn reduction
Intelligent Operations 	Boeing is developing noise-optimized flight path algorithms with integration into the Air Traffic Management System.	Noise: 3-5 dBA peak noise reduction Fuel: 2% fuel savings during take-off; 5% during approach phase
Sustainable Aviation Fuels 	Under CLEEN Phase III, Boeing is supporting qualification of Sustainable Aviation Fuels through lab material compatibility evaluations and flight demonstration. This program will characterize selected new alternative fuel blends and provide test data in support of future ASTM International specifications. Through this effort, Boeing will support continued expansion of certified alternative fuel pathways to promote uptake and sustainability.	Supports > 50% blend levels

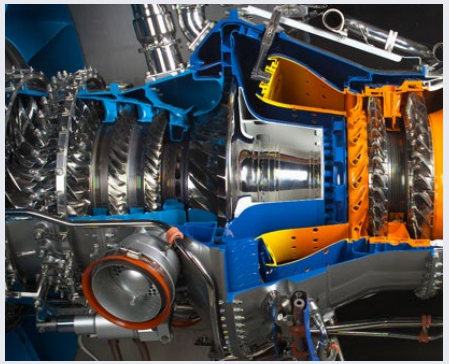
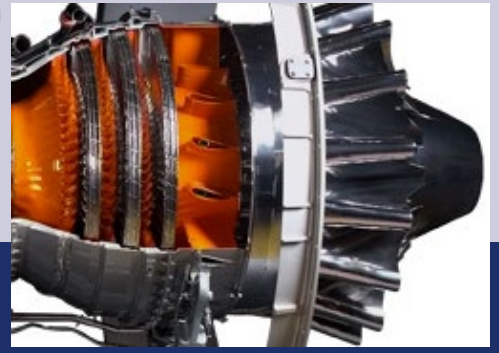
GE Aviation (1 of 2)

Technology	Description	Benefits
Open Fan 	GE Aviation is developing an unducted single fan architecture optimized for noise and fuel burn reduction.	Noise: 13 EPNdB cum margin relative to Stage 5 Fuel: 10+% reduction relative to current LEAP engine
Compact Core – Low Emissions Combustor	GE Aviation is developing combustor technology that will result in reduced NOx emissions.	NOx: Targeting NOx reduction for a future high overall pressure ratio engine cycle, equivalent to 70% margin to the CAEP/8 standard at 30 OPR.
Advanced Thermal Management	GE Aviation is developing advanced thermal management and waste heat recovery systems to facilitate compressor and turbine temperature increases, thereby improving cycle efficiency and reducing fuel burn.	Fuel: Up to 3% reduction relative to traditional architectures
MESTANG III 	GE Aviation is developing more electric aircraft systems that will reduce fuel burn by requiring reduced engine bleed air.	Fuel: 3-6% reduction for mid-size aircraft

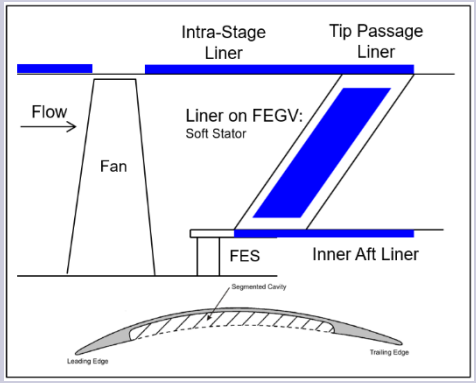
GE Aviation (2 of 2)

Technology	Description	Benefits
Advanced Acoustics 	GE Aviation is developing advanced fan duct acoustic liners and fan/outlet guide vane (OGV) technologies to reduce noise.	Noise: 2 EPNdB cum. reduction from novel liners, 1 EPNdB cum. reduction from fan/OGV designs
Hybrid Electric Integrated Generation	GE Aviation is developing an integrated electric-power generation system within the engine to enable flexibility in electric power generation and optimize engine performance.	Fuel: 3-4% reduction
Sustainable Aviation Fuels	GE will support qualification efforts for alternative jet fuels with unique compositions, including highly cycloparaffinic fuels. Cycloparaffins may provide sufficient seal swell unlike other alternative jet fuels which lack aromatics. GE testing will characterize combustor operability and emissions impact of the fuels.	Supports > 50% blend levels

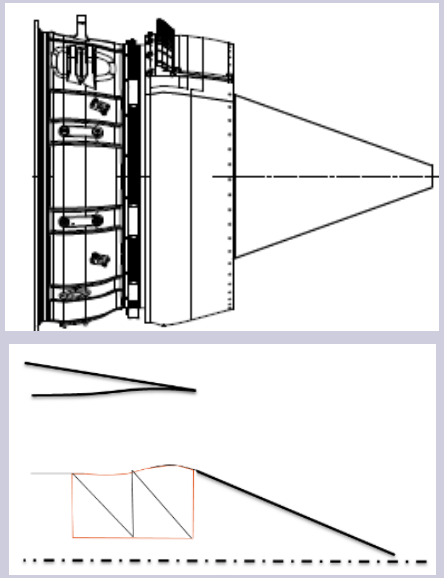
Honeywell Aerospace

Technology	Description	Benefits
Highly Efficient Fan Module 	Honeywell is developing over-the-rotor acoustic treatment, a high efficiency booster, and optimizing the fan exit guide vanes and booster stators for combined noise and efficiency benefits.	Noise: 1.5 EPNdB Fuel: 1.5% fuel burn reduction
Efficient Green High Pressure Core 	Honeywell is developing advanced high pressure compressor, low emission combustor, and efficient high pressure turbine technologies for next generation business jet aircraft.	Noise: 3 EPNdB reduction Fuel: 8.3% fuel burn reduction Emissions: 70% margin to CAEP/8 NOx; 70% reduction in nvPM
High Work High Lift Low Pressure Turbine (LPT) 	Honeywell is developing technologies for a reduced weight, more efficient and quieter low pressure turbine for future business jet class aircraft.	Noise: 0.5 EPNdB Fuel: 2.5% fuel burn reduction

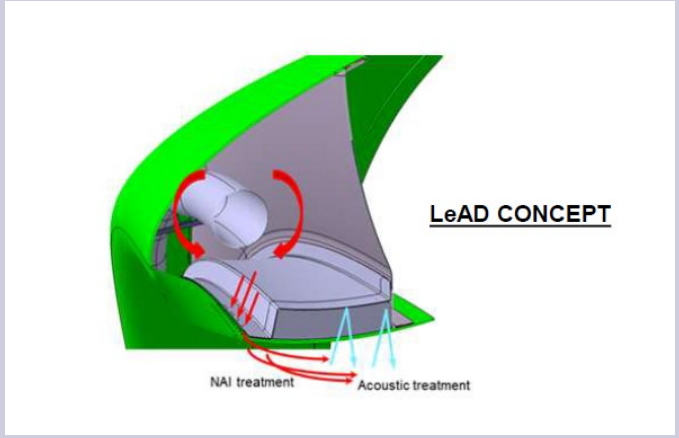
Pratt & Whitney

Technology	Description	Benefits
Ultra-Quiet Reduced-Loss Fan Stage 	Pratt & Whitney is developing a quieter, more efficient fan module including additively manufactured low-loss acoustic liners and reduced solidity, reduced-loss, lower noise fan exit guide vanes. Areas of interest for the advanced acoustic treatment are highlighted in blue.	Noise: Target 3 EPNdB noise reduction combined with P&W combustor technology Fuel: 0.8% fuel burn as part of package with P&W combustor technology
TALON X+ Combustor 	Pratt & Whitney is developing an advanced combustion system based on the TALON X that will simultaneously reduce noise and emissions, while improving temperature pattern factor and enabling improved high pressure turbine design and efficiency.	Noise: Target 3 EPNdB noise reduction combined with P&W fan technology Fuel Burn: 0.8% fuel burn as part of package with P&W fan technology Emissions: deliver 50% margin to CAEP/8 NOx

Rohr, Inc. (Collins Aerospace)

Technology	Description	Benefits
Large Cell Exhaust Acoustic Technology 	Collins Aerospace is developing a novel exhaust noise attenuation feature involving a “large cell” cavity treatment in the exhaust structure.	Noise: Lower noise by 0.9 to 1.5 EPNdB

SAFRAN

Technology	Description	Benefits
Acoustic Air Inlet Lip Skin 	Safran Nacelles is developing expanded acoustic treatment on the inlet lip of the nacelle, enabled by redesigned anti-ice system concepts.	Noise: Lower noise for the same air inlet length; or maintain the same noise for a shorter inlet Fuel Burn: 0.15% reduction