# Commercial Engine Technology Trends

## NAE ASEB Fall Meeting

Frank Preli, Vice President, Technology, Pratt & Whitney

October 8, 2024

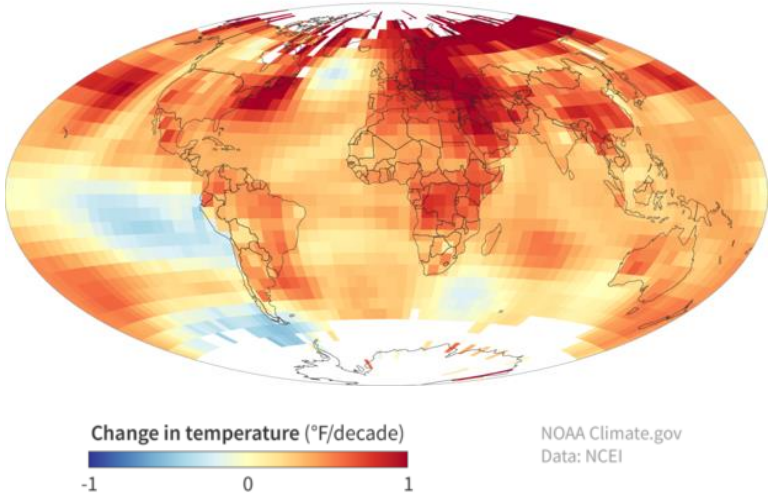
GO BEYOND

# Environmental Impact

## Environmental challenge: ensure climate resilience while reducing aviation emissions

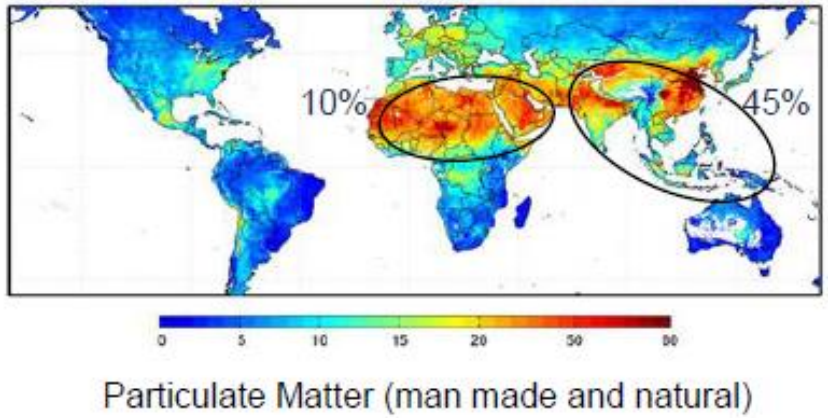
### *Hotter World*

*Increasing temperatures in most locations (1993-2022 shown)*




### *Future Markets*

*Increasing fraction of engine sales in severe operating environments*



# Pratt & Whitney sustainability strategy

## Developing solutions to reduce the environmental impact of products and operations

### Smarter technology

- Best-in-class GTF™ engine family
- Hybrid-electric propulsion
- Hydrogen/Advanced architectures

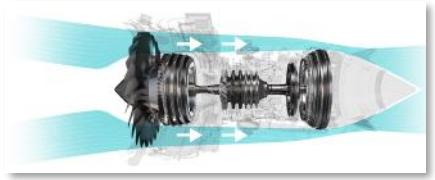
### Cleaner fuel

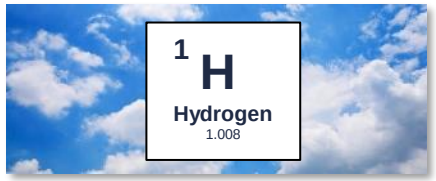
- Towards 100% SAF compatibility
- Shaping industry specifications
- Expanding SAF availability

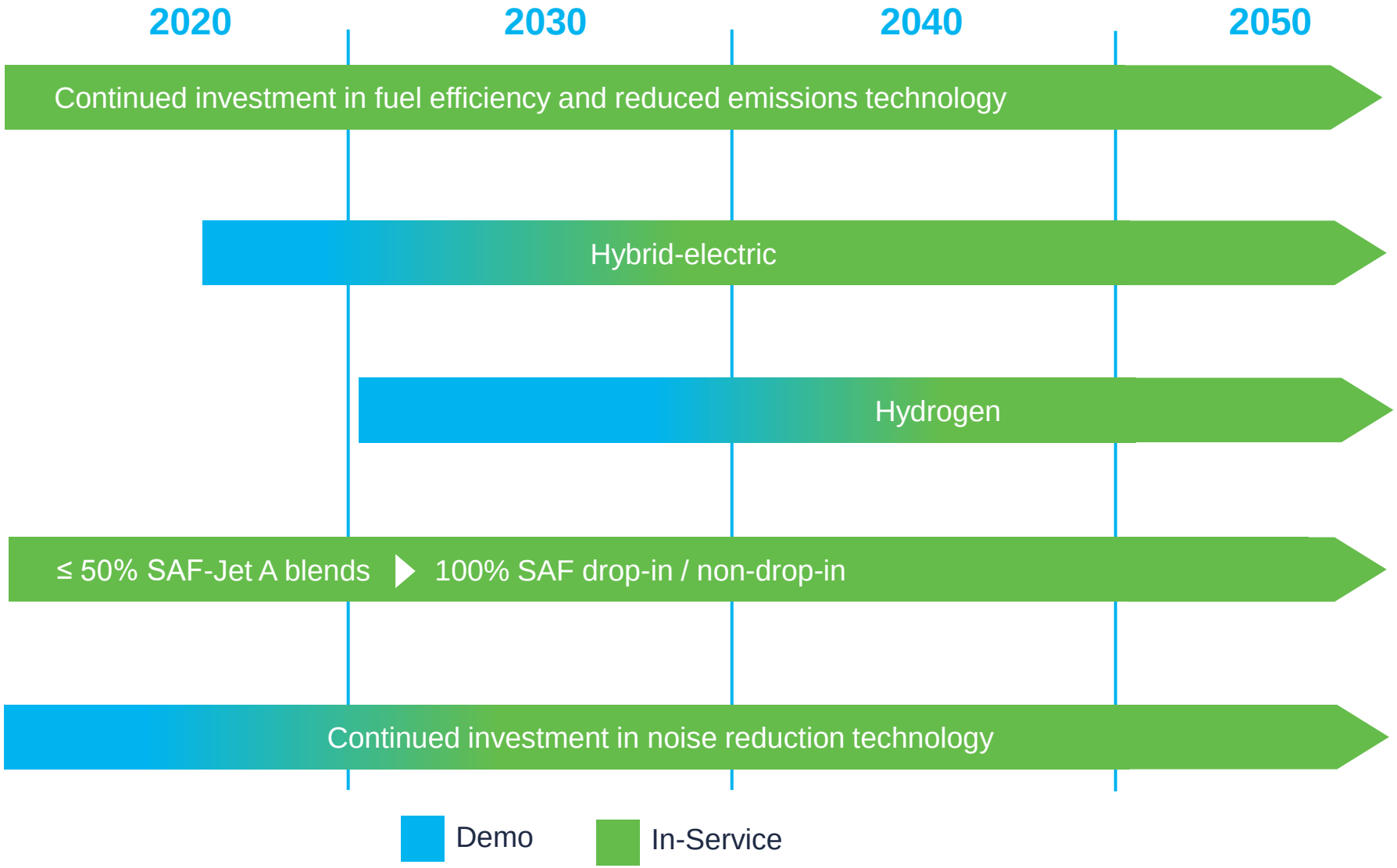
### Greener business

- Environmental footprint reduction
- Materials of concern management
- Modernized manufacturing

# Pratt & Whitney technology roadmap to 2050






Pratt & Whitney
An RTX Business

# Future Generation GTF™ Engine

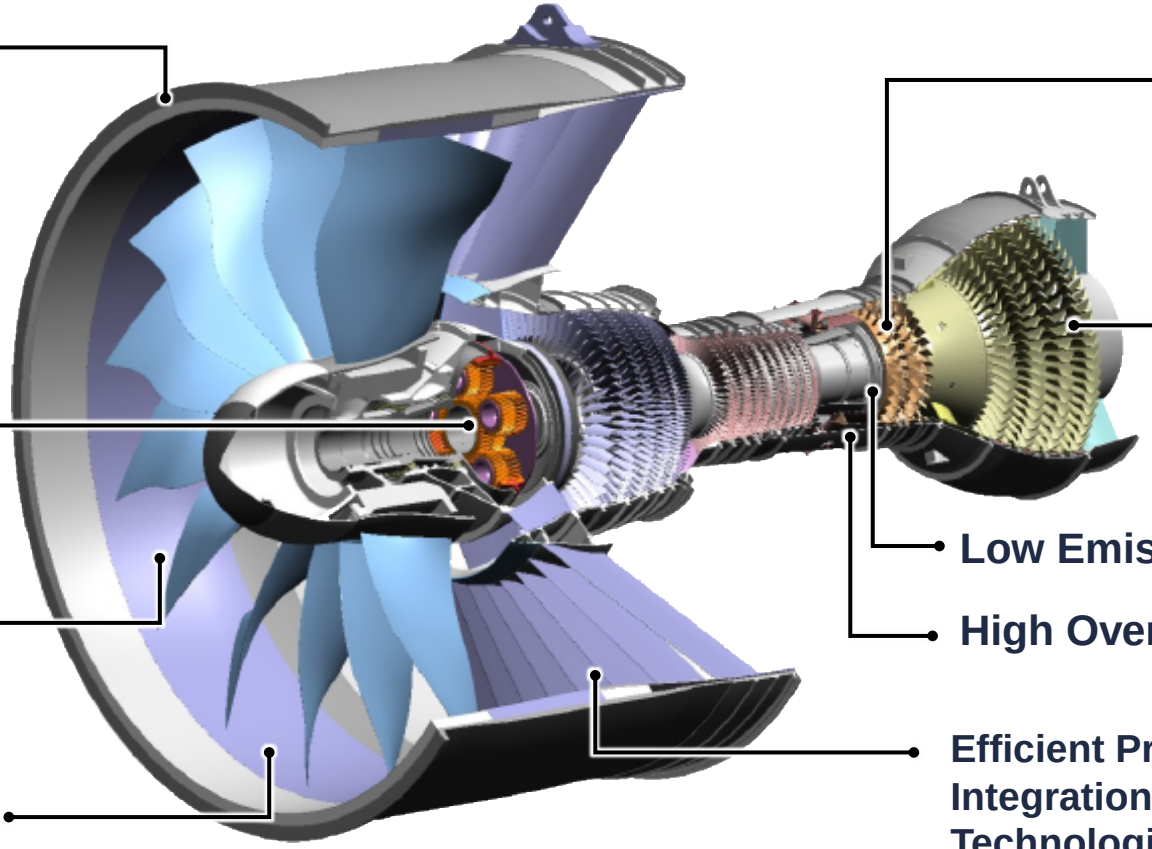
## Technologies for increased efficiency & durability

**Advanced Fan Technologies**
Higher bypass ratio/lower drag
Lower fan pressure ratio

**Fan Drive Gear System**

**Digital Analytics & Advanced Manufacturing Technologies**

**Dirt Rejection**



**High-Temperature HPT**
CMC Materials
Advanced Cooling Technologies

**High-Speed, High-Efficiency LPT**

**Low Emissions Combustor**

**High Overall Pressure Ratio, Small Core**

**Efficient Propulsion-Airframe Integration Sub-Systems & Technologies**

# Advancing hybrid-electric propulsion

## Demonstrating target benefits of hybrid solutions across range of platforms

### eVTOL

**STEP-Tech**

100 to 500+ kW

Collins Aerospace
An RTX Business

### Helicopter

**Airbus PioneerLab**

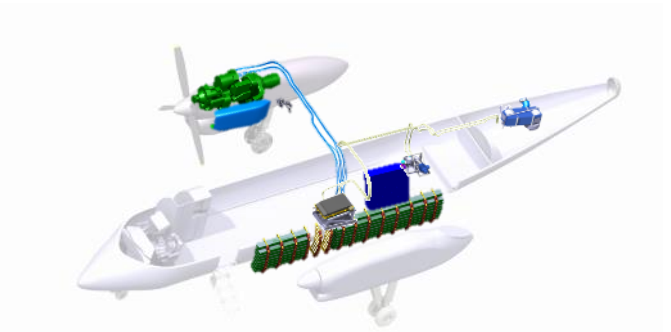
+30% fuel efficiency & $CO_2$ reduction


Image credit: Airbus

### Regional

**Hybrid Electric Flight Demo**

+30% fuel efficiency & $CO_2$ reduction



### Single Aisle

**SWITCH**

+25% fuel efficiency & $CO_2$ reduction

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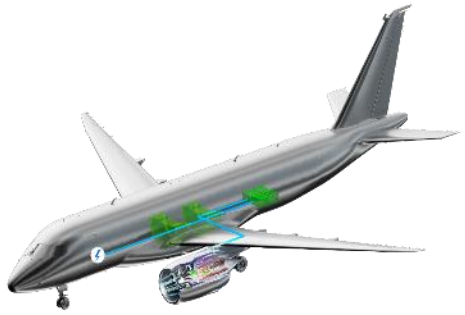


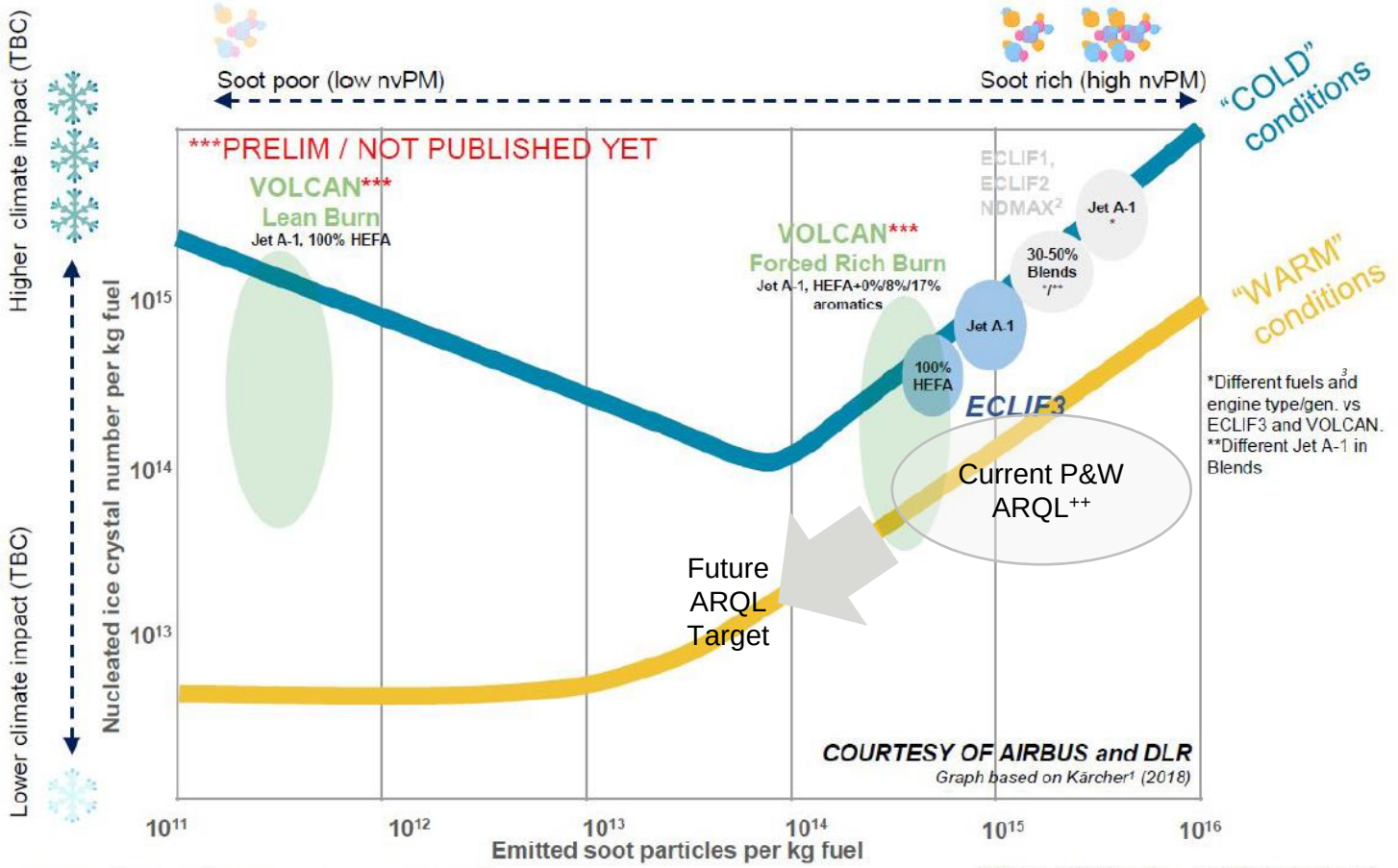
CLEAN AVIATION
Co-funded by the European Union

# Non-$CO_2$ Emissions: Contrails

## Large potential impact and highest uncertainty

HyTEC

ASCENT




Note 1: ECLIF 1, ECLIF2/NDMAX partners were DLR and NASA
Note 2: ECLIF3 partners are Airbus, DLR, Rolls-Royce, NRC, University of Manchester, NESTE
Note 3: VOLCAN is a CORAC-DGAC funded project. Partners are Airbus, DLR, ONERA, SAE, DASSAULT AVIATION
Note 4 : Blue Condor partners are Airbus, AVExperts, DLR

[1]B. Kärcher (2018). Formation and radiative forcing of contrail cirrus. Nature Communications OPEN. DOI: 10.1038/s41467-018-04068-0
[2]Moore et al. (2017) ; Voigt et al. (2021)
[3]ECLIF 3 is published in Märkl et al., (2024)

**Performing the science to inform policy making and drive technology selections**

+ NOTE: additional partners to be announced
++ NOTE: current estimate across GTF family

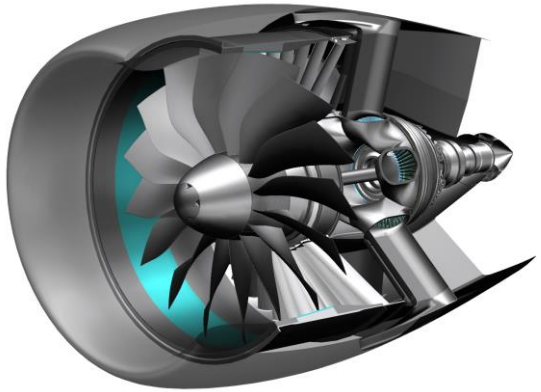
# Hydrogen propulsion

## Developing advanced technologies and systems

### History


Project Suntan

### Opportunities



HySIITE

### Challenges

Airframe integration

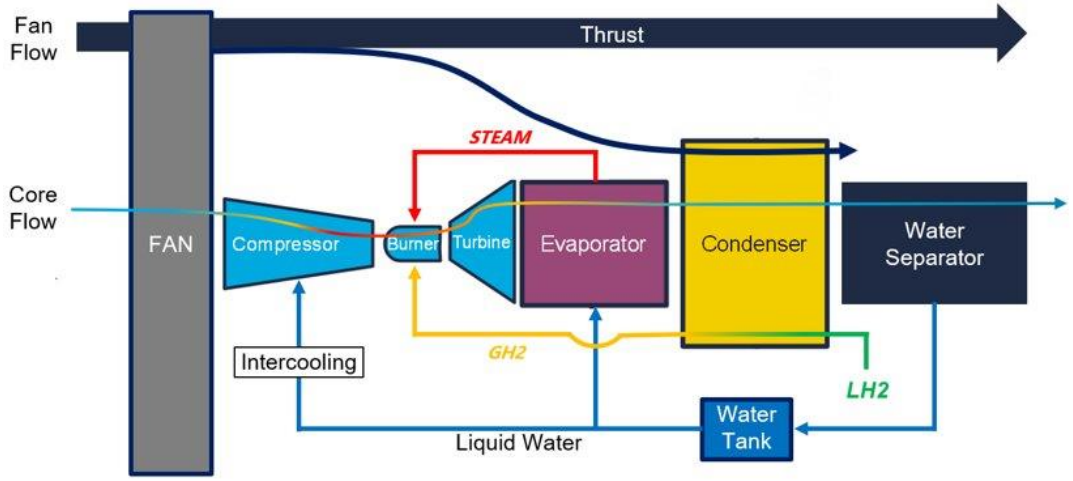
Fuel production and distribution

# Hydrogen-Enabled Efficiency

## Opportunity to fully leverage $H_2$ properties for increased efficiency

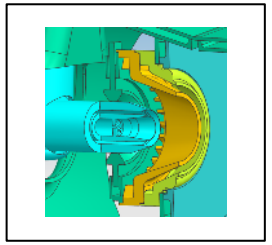
### HySIITE

Hydrogen Steam Injected Intercooled Turbine Engine

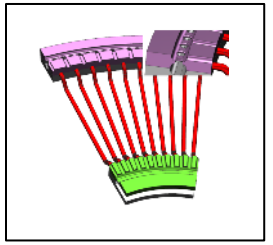



### Focusing on enabling technology

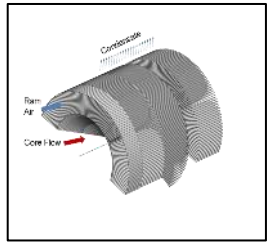
**$LH_2$ Combustor**



**Evaporator**



**Condenser**



Higher specific heat combustion

20x more heat recovery into fuel

2.5x more water generated per unit energy

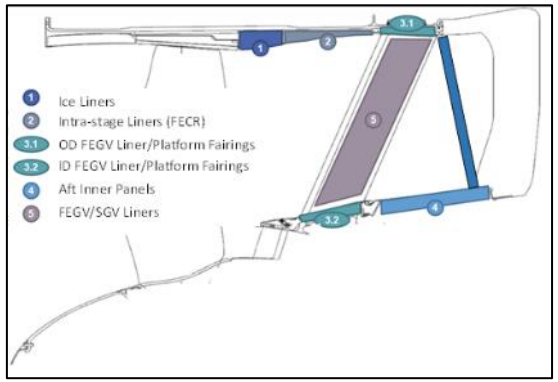
Liquid hydrogen fuel changes phase

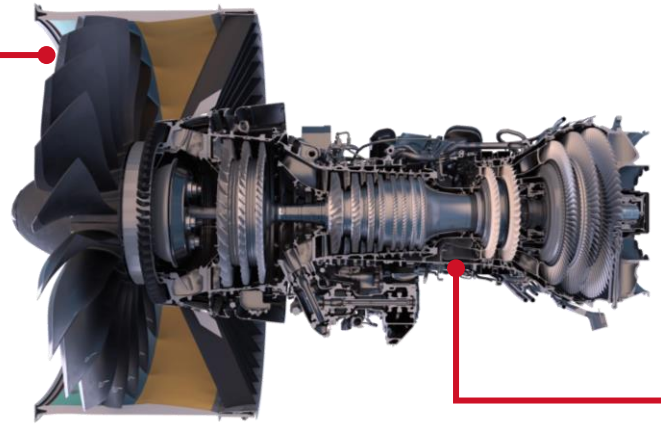
# Noise

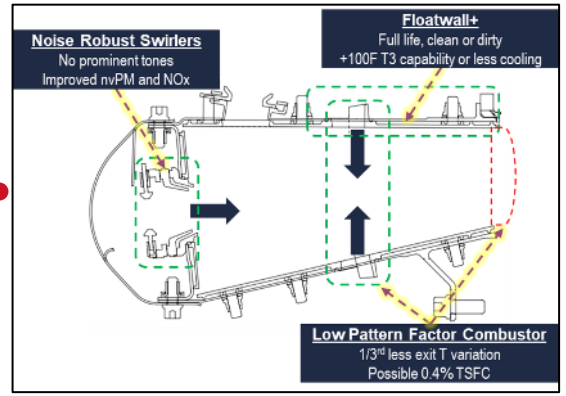
## Noise is a high priority for NGSA; progress required as part of delivering sustainable aviation

**Noise and Emissions Reduction**
(FAA CLEEN III)

P&W CLEEN III goals: 3 EPNdB; -10% nvPM, -5% NOx; -0.8% fuel burn






**Single-aisle and regional jets dominate movements and noise experienced at vast majority of airports**

# Flight Demonstrators & X-Planes

Accelerate demonstration maturation for future systems

## DIU


JetZero BWB

## NASA


Sustainable Flight Demonstrator (X-66)

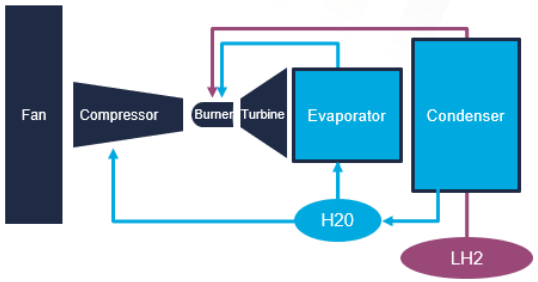
# Partnerships with Other US Government Agencies

Accelerate technology maturation for future propulsion systems

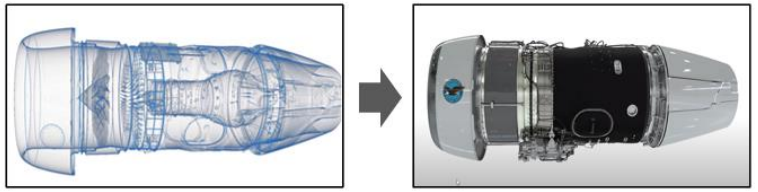
## DoE & ARPA-E

arpa·e
CHANGING WHAT'S POSSIBLE

HySIITE – Hydrogen Engine




## DOD



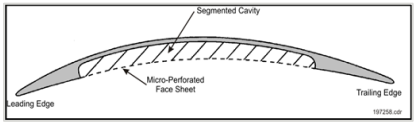
From a concept — To a real engine

Mode-Based Digital Thread


## FAA

CLEEN III

Fan Noise Reduction via Innovative Liners




Combustor (Emissions, Noise & Durability)

Photos, Credit Pratt & Whitney

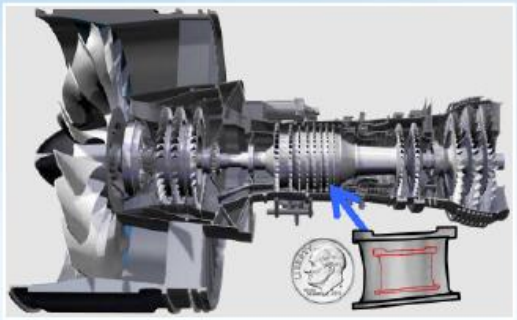
Single Sector 2021-2022 → Multi-Sector and Full Annular 2023-2024 → Engine 2025

ASCENT – Critical program encouraging university/industry collaboration

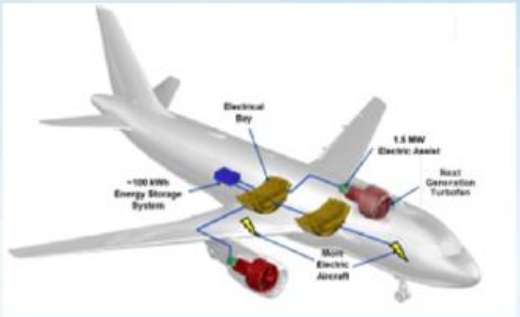
# Subsonic Transport Technologies

## Ensure U.S. industry is the first to establish the new “S Curve” for the next 50 years of transports

**Transonic Truss-Braced Wing**
**5-10% fuel burn benefit**



**Small Core Gas Turbine**
**5-10% fuel burn benefit**




**Electrified Aircraft Propulsion**
**~5% fuel burn and maintenance benefit**


**High-Rate Composite Manufacturing**
**4x-6x manufacturing rate increase**

GTF engines, sub-systems, and nacelle technology.

Phase 1 contracts:
- HPT Aero
- CMC
- SAF Combustor

Supporting NASA objectives via EU SWITCH

Next Gen Thermoset project.


PRATT & WHITNEY
DEPENDABLE ENGINES
GO BEYOND
POWERING SUSTAINABLE AVIATION™
SMARTER.
CLEANER.
GREENER.