



NASA Hybrid Thermally Efficient Core (HyTEC) Project Overview ICAS PAPER 2024_[1234]

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Subsonic Airliner Technologies

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



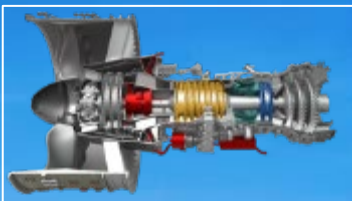
Integrated Aircraft System Efficiency
Propulsion Airframe
Integration Opportunity

Aerodynamic Efficiency
Transonic Truss-Braced Wing
(5-10% fuel burn benefit)

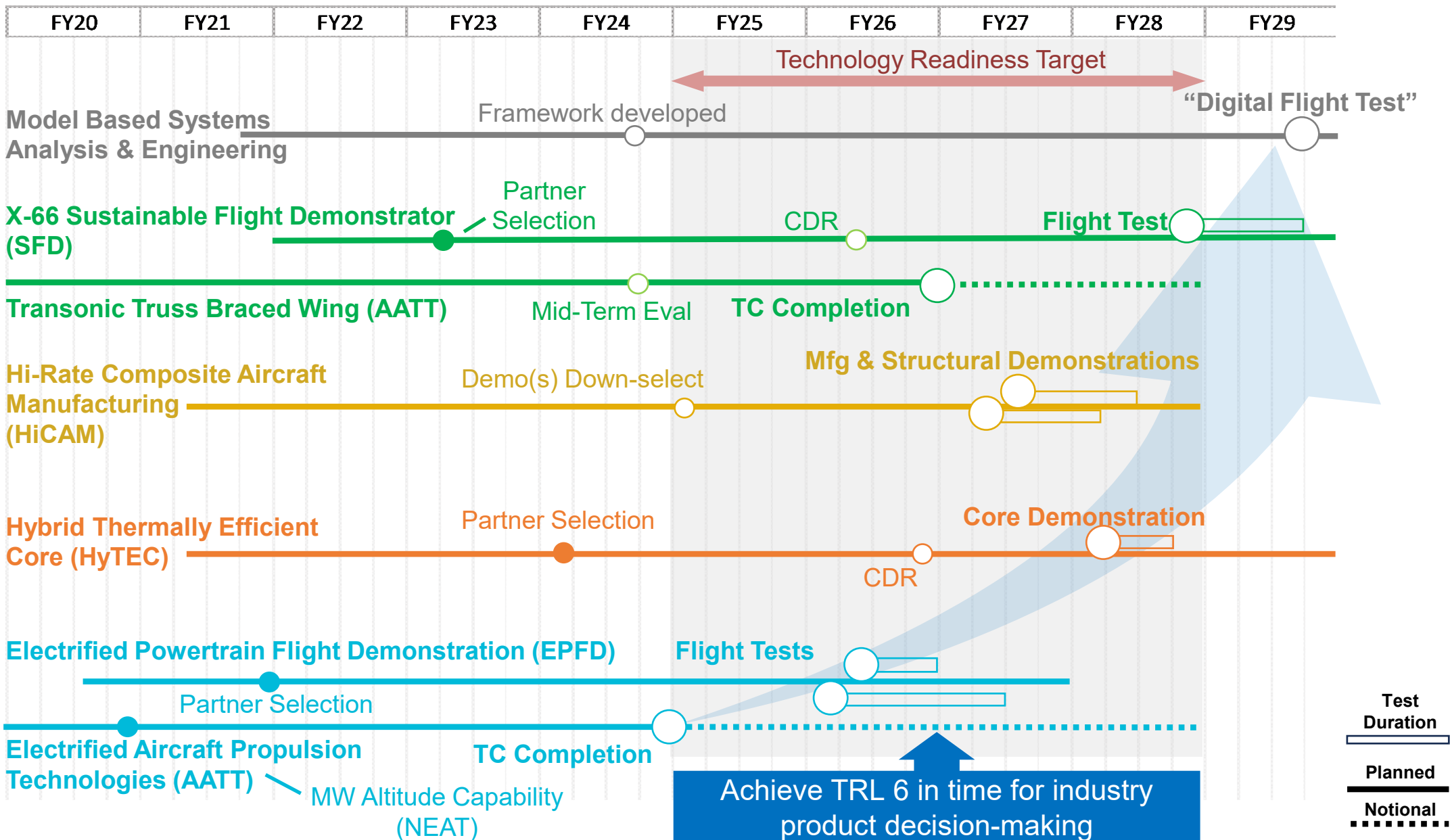
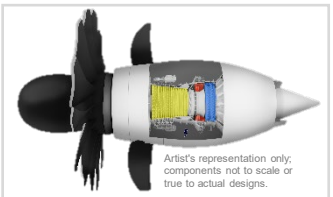
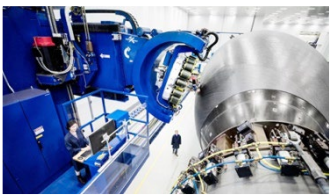
Weight
High-Rate Composites
(4-6x manufacturing increase)

Electrified Aircraft Propulsion
~5% fuel burn and
maintenance benefit

Engine Efficiency
Small Core Gas Turbine
(5-10% fuel burn benefit)



Ultra-Efficient Airliner Integrated Technology Development



Hybrid Thermally Efficient Core



Goal:

- The Hybrid Thermally Efficient Core (HyTEC) Project will accelerate the development of the next generation small-core turbofan engine technologies with improvements in efficiency, durability, performance, hybridization, and sustainability in order to meet the next Entry into Service (EIS) single aisle aircraft expected in the 2030's.

Objectives:

- Achieve **5-10% fuel burn reduction** versus 2020 best in class
- Achieve **up to 20% power extraction** (4 times current state of the art) at altitude to optimize propulsion system performance and enable hybridization
- Demonstrate the effective and efficient operability of high blend (**>80%**) **Sustainable Aviation Fuels (SAFs)** in 2030s EIS combustors.

HyTEC Metrics

- Small core technologies aligned with future single-aisle propulsion products
- Target engine thrust of 25,000 – 35,000 lb_f

Key Performance Parameter (KPP)	Full Success Single Aisle ~2035 EIS
Engine Bypass Ratio	> 15
Engine Overall Pressure Ratio	> 50
HPC Exit Corrected Flow	< 3 lbm/s

Partner with industry to mature and demonstrate promising technologies.

Propulsion Efficiency through High Power Density Core

Small core:

- Low mass flow rate
- Keeping axial configuration of the High Pressure Compressor (HPC)
- Enables higher bypass ratio

Enabling technologies:

- High Pressure Turbine (HPT):
 - Aerodynamic improvements
 - Advanced materials to increase temp capability and reduce cooling requirements
- HPC aerodynamic and operability improvement
- Compact combustor optimization with SAF compatibility
- Electric hybridization

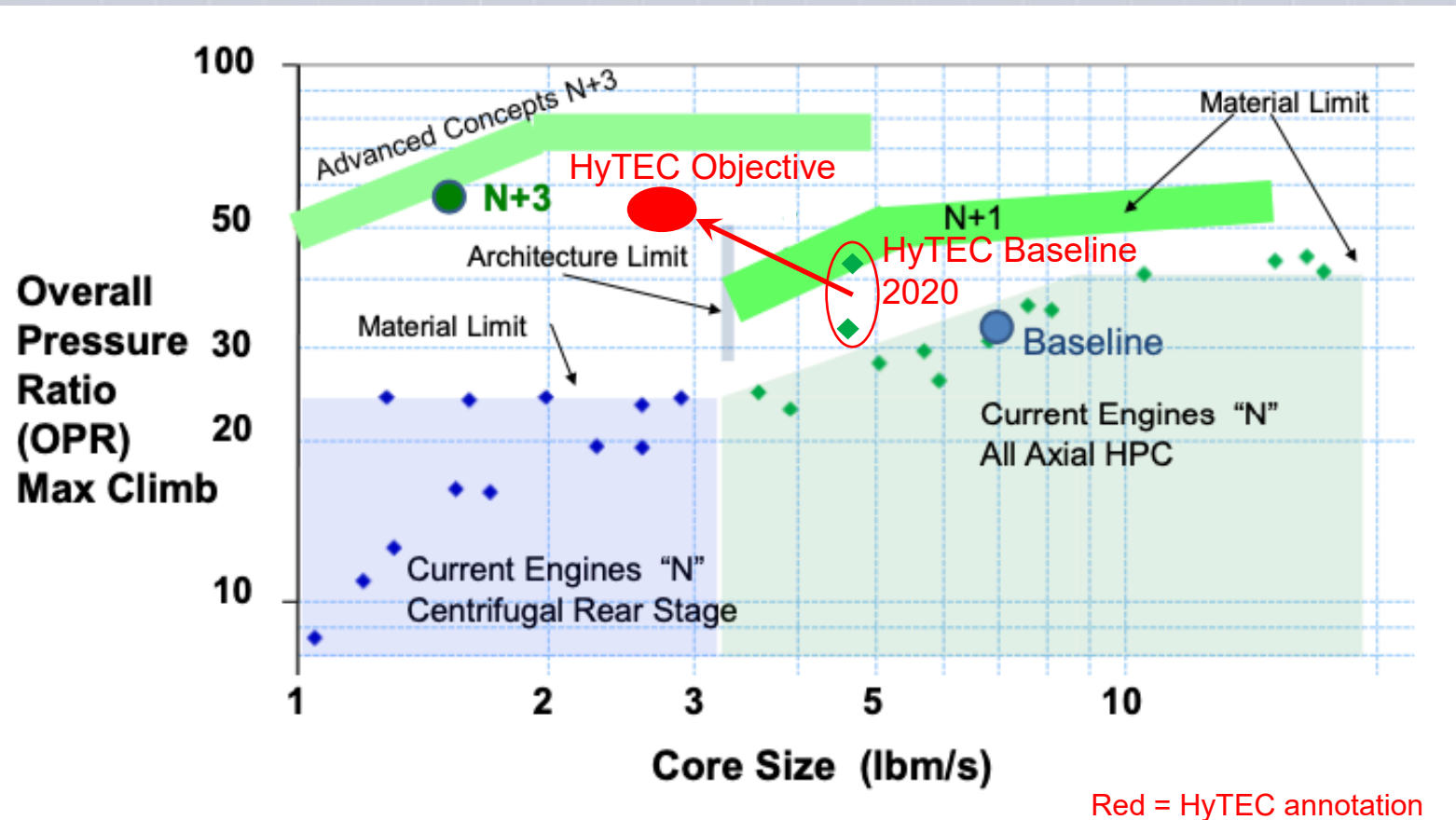
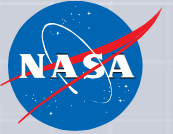


Figure 5 OPR versus Core Size for Generation N, N+1 , N+3

Ref. Lord, W.K. et al.: "Engine Architecture for High Efficiency at Small Core Size,"
AIAA 2015-00071. <https://arc.aiaa.org/doi/10.2514/6.2015-0071>

Develop technologies to overcome scaling barriers for compact core.

Key Performance Parameter (KPP)

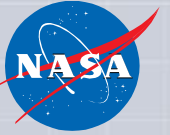


The KPPs define the success criteria of the HyTEC technology development and core ground demonstration.

KPP#	Key Performance Parameter (KPP)	Full Success Single Aisle ~2035 EIS	Min. Success Single Aisle ~2035 EIS
KPP-1	Fuel burn reduction attributed to the high-power density core of the original equipment manufacturer's (OEM) vision turbofan engine	10%	5%
KPP-2	Engine Bypass Ratio	> 15	> 12
KPP-3	Engine Overall Pressure Ratio	> 50	> 45
KPP-4	Durability, measured in operating hours between major refurbishment	Exceed SOA by 5%	Meet SOA of baseline
KPP-5	Degree of hybridization measured by level of power extraction from the turbofan engine at altitude	20%	10%
KPP-6	HPC Exit Corrected Flow	< 3 lbm/s	< 3.5 lbm/s
KPP-7	Combustor operability using SAF is comparable to its performance using Jet-A/A-1 fuel, as measured by lean blowout and ignition performance.	Combustor operability demonstrated with 100% SAF	Combustor operability demonstrated with >80% SAF
KPP-8	Degree of hybridization measured by level of power extraction/insertion from the core.	10%	5%

BOLD: Specific to Core Demonstration Only

HyTEC Phases



HyTEC Project is divided into two Phases of technology development:

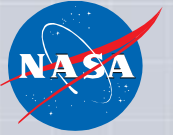
Phase 1

- Address technology challenges through component or sub-system testing and mature a suite of small core technologies to TRL 4-5.
- Lays the groundwork for Phase 2 by maturing promising new technologies that meet HyTEC goals.

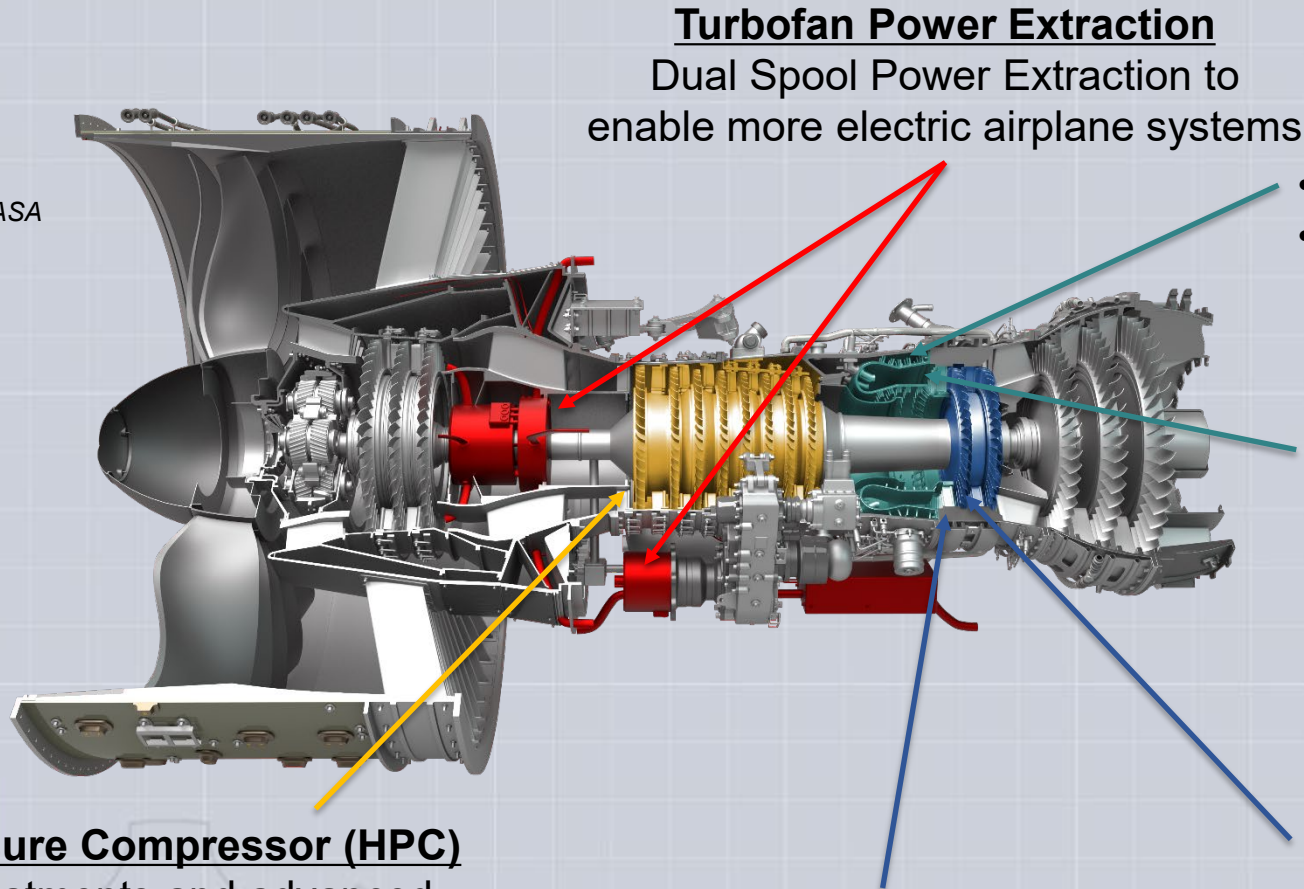
Phase 2

- Goal to integrate successful funded Phase 1 and potentially additional TRL 4-5 technologies into a functional high power density engine core demonstration at TRL 6.
- Accelerate technologies for inclusion into the next EIS single-aisle engines earlier to increase US competitiveness in the global market.

HyTEC Phase 1 Technical Content



Credits: NASA



Turbofan Power Extraction
Dual Spool Power Extraction to
enable more electric airplane systems

Combustion Technologies

- Sustainable aviation fuel compatibility
- Compact design for small core engines

Enhanced Combustor Materials

Ceramic matrix composite (CMC) liners for combustors to increase performance and durability.

High Pressure Turbine (HPT) Materials

- CMCs/Environmental Barrier Coatings (EBCs) for turbine components to increase temperatures and efficiency.

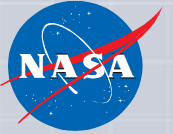
High Pressure Compressor (HPC)

Casing treatments and advanced designs to enable operability with optimized efficiency and performance.

Advanced HPT Aerodynamics

Enable more efficient turbine operation by developing advanced blade and cooling designs and aerodynamic features.

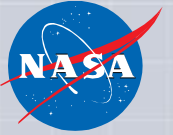
Phase 1 Technology Development Portfolio



GE Aerospace	High Pressure Compressor
	High Pressure Turbine Advanced Aerodynamics
	High Temperature Environmental Barrier Coatings (EBCs)
	Ceramic Matrix Composite Combustor Liner
	Turbofan Engine Power Extraction Demonstration
Pratt & Whitney	High Pressure Turbine Advanced Aerodynamics
	Ceramic Matrix Composite (CMCs) and EBCs
	Sustainable Aviation Fuel (SAF) Combustion Technologies

- Three new high temperature environmental barrier coatings achieved TRL 5 in June 2024.
 - GE small core turbine concept reached TRL 4
 - CMC/EBC Combustor Liner achieved TRL 5

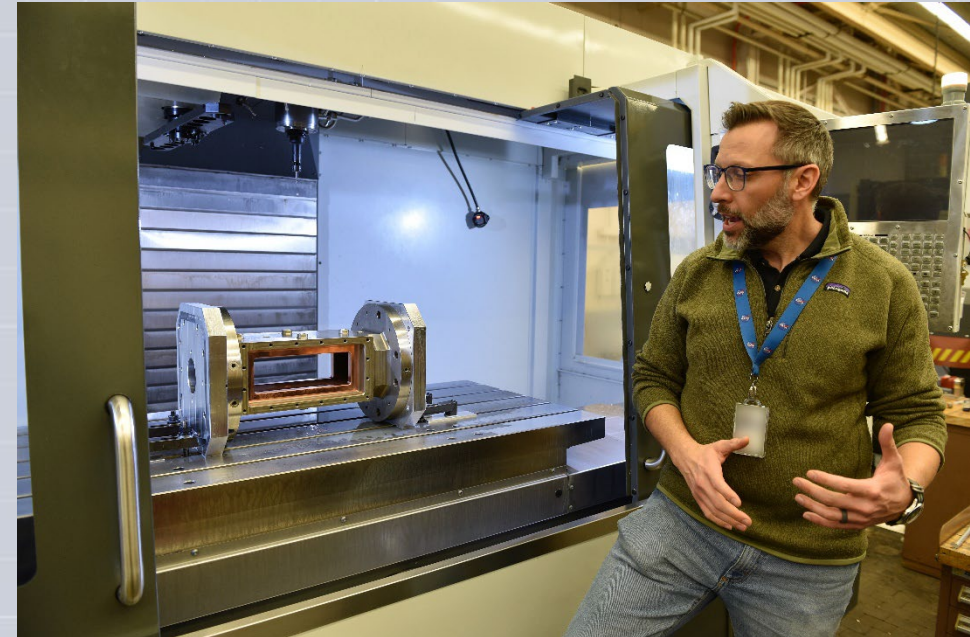
Phase 1 Technology Development Portfolio



Advanced Materials Development: Testing at NASA GRC Facilities

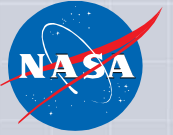


Dr. Michael Presby testing a NASA-developed, high-temperature environmental barrier coating (EBC) deposited on a ceramic matrix composite (CMC). The composite's environmental barrier coating surface temperature is 3,000 degrees Fahrenheit.



Dr. Bryan Harder describes hardware that will allow researchers to test an advanced CMC airfoil with an innovative EBC in a combustion environment. This test will be used to show the capability of these materials prior to a future engine core demonstration.

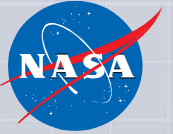
HyTEC Systems Analysis



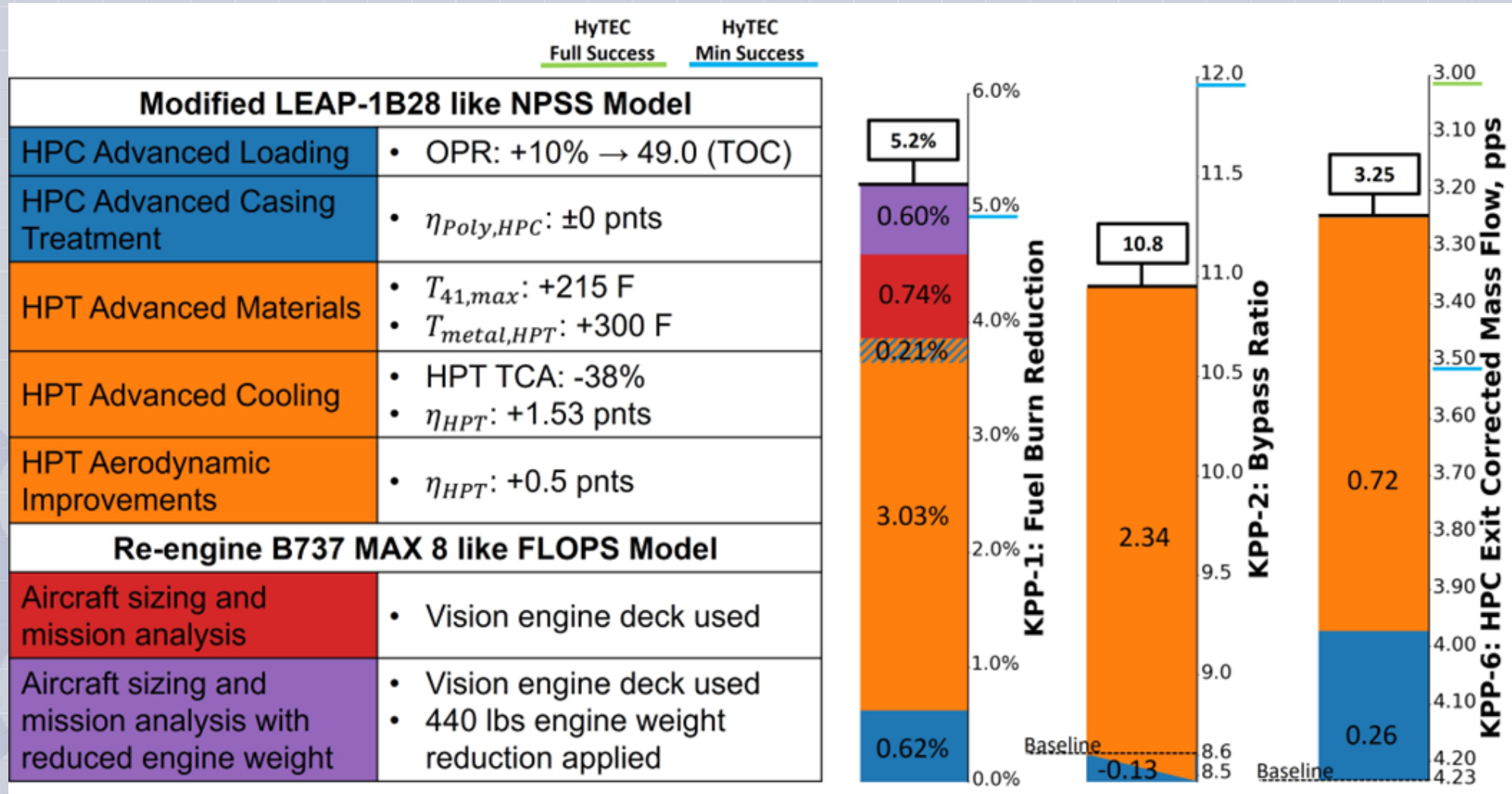
HyTEC 2020 engine baselines from publicly available data.

	GE Baseline	P&W Baseline
Parameter	LEAP-1B28	PW1127G
Type	Turbofan	Geared Turbofan
Net Thrust (lb)	29,317	27,075
Bypass Ratio	8.6	12.28
Overall Pressure Ratio (Top of Climb)*	44.6	46.0
HPC Exit Corrected Flow (lbm/s)*	4.23	4.41
TSFC (lbm/hr/lbf)*	0.56	0.52
Engine Weight (lb)	6,130	6,300
Fan Diameter (in)	69.3	81.0

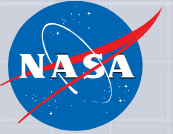
HyTEC Systems Analysis



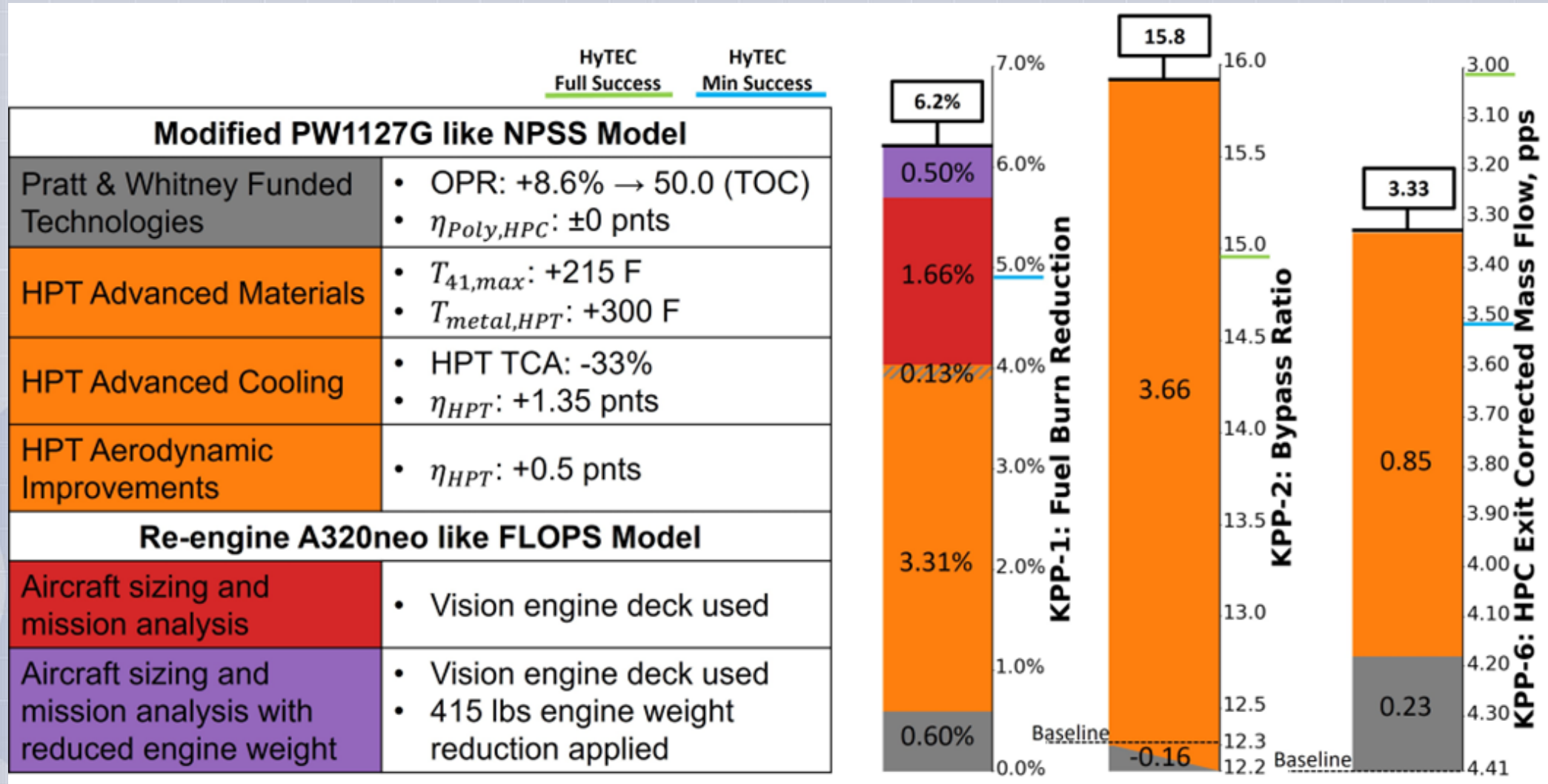
Phase 1 Technology impact on 2020 CFM LEAP baseline.



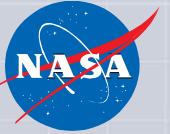
HyTEC Systems Analysis



Phase 1 Technology impact on 2020 P&W 1127G baseline.

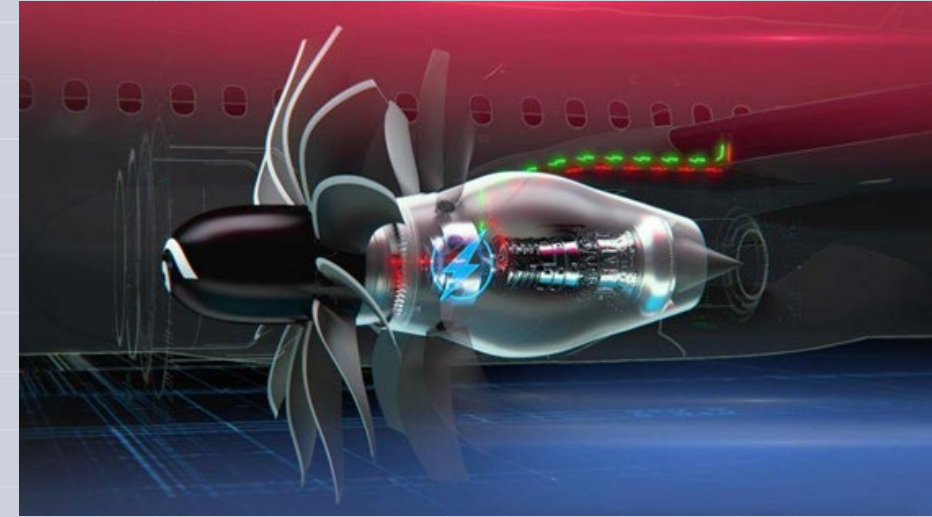


HyTEC Phase 2 Contract Award



Phase 2 Engine Core Demonstration Contract

- NASA selected GE Aerospace of Cincinnati for HyTEC's Phase 2 Integrated Core Technology Demonstration.
- Cost-share contract with a maximum government value of approximately \$68.1 million and a 50% minimum GE Aerospace cost share.
- Five-year performance period that began Feb. 15, 2024.



RISE Engine Concept

To meet the goal of HyTEC Phase 2, GE Aerospace will integrate Phase 1 technologies into an engine core to perform a compact, high-power density core ground demonstration by the end of 2028.

TECHNOLOGIES

Hybrid Electric Technology

Power extraction and insertion
enable hybridization

High-Pressure Compressor

Casing treatments and advanced designs
optimize efficiency and performance

Combustion Technologies

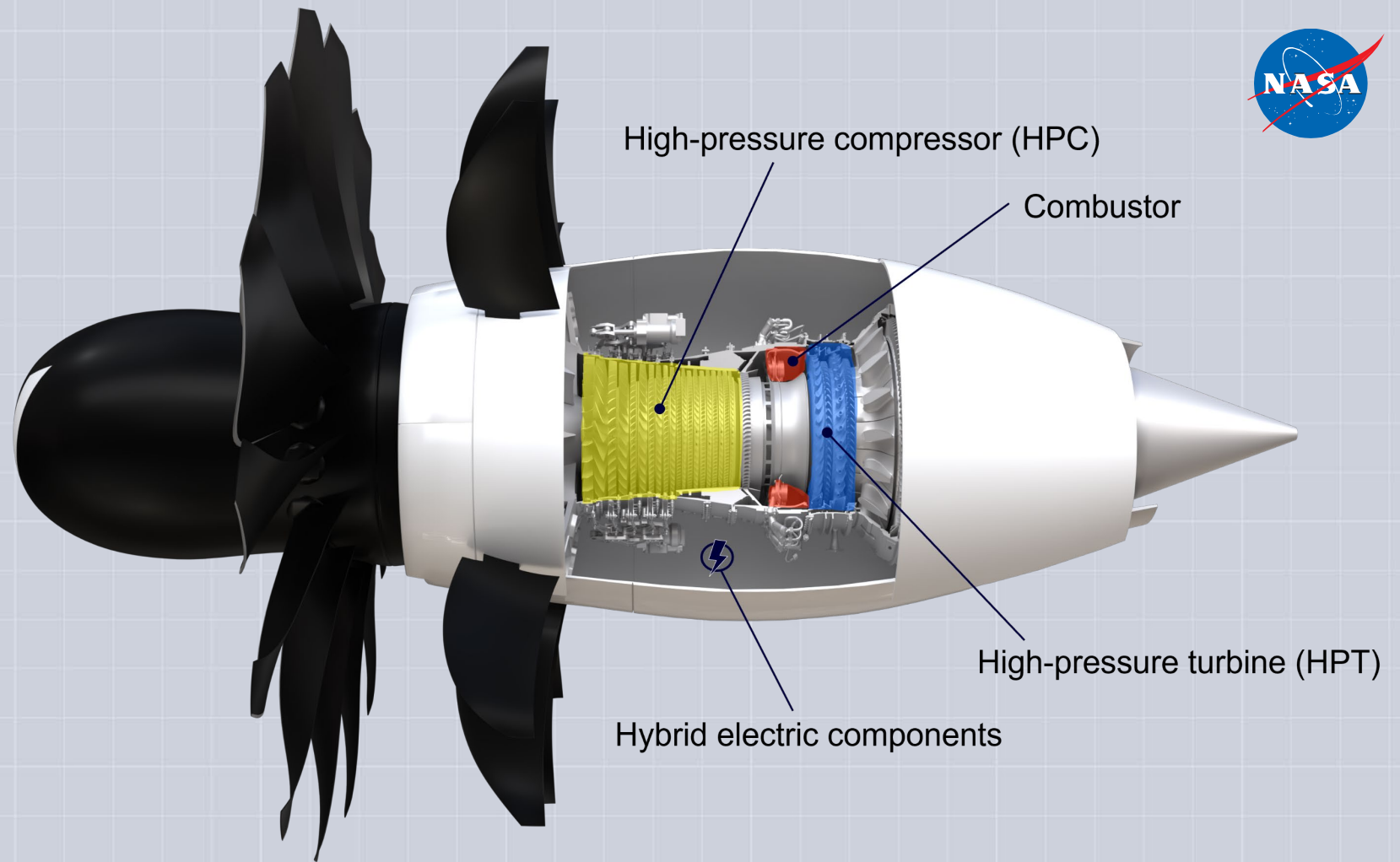
Provide sustainable aviation fuel
compatibility and compact design for
small core engines

Enhanced Combustor Materials

Ceramic matrix composite (CMC) and
environmental barrier coating (EBC)
liners for combustors are used to increase
performance and durability

Advanced High-Pressure Turbine Aerodynamics

Enable more efficient turbine operation by
developing advanced blade and cooling
designs and aerodynamic features



Artist's representation only; components not to scale or true to actual designs.
(Image Credit: GE Aerospace)

HyTEC Phase 2 Technologies

