Electrified Powertrain Flight Demonstration (EPFD) Project

Executive Summary

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Why EAP?

NASA and industry have identified Electrified Aircraft Propulsion (EAP) for its potential to benefit energy efficiency, mission flexibility, and market growth in the next generation of aircraft. Megawatt (MW)-class EAP technologies are advantageous for large regional turboprops and single-aisle aircraft and can provide significant benefits during the ground taxi and takeoff climb segments of a typical flight profile.

Image Credit: NASA, GE Aerospace, and magniX

Project Summary

The Electrified Powertrain Flight Demonstration (EPFD) project, under NASA's Integrated Aviation Systems Program (IASP), selected GE Aerospace and magniX as cost-share partners to mature and flight demonstrate MW-class hybrid electric aircraft propulsion systems.

Both companies elected to demonstrate on large regional turboprop aircraft their hybrid electric architectures. These Part 25 transport category aircraft provided the necessary size, performance, and operational profile for effective demonstration of their MW-class powertrain architectures through retrofit modifications. EPFD's focus on crewed demonstrations marked a strategic advancement beyond prior EAP efforts. By addressing the aviation environment and practical vehicle-level integration barrier risks, as well as achieving reductions in fuel burn, emissions, and operational costs, this effort will accelerate the regulatory and certification pathways to enable future Entry into Service (EIS) of hybrid electric aircraft.

EPFD's contribution to NASA Aeronautics Research Mission Directorate's (ARMD) **Critical Commitment (Ultra-Efficient Airliners 1.2030)** is defined as demonstrating practical vehicle-level integration of MW-class electrified aircraft propulsion systems to enable future single-aisle systems and potential adoption in developing regional and smaller aircraft markets.

Project Goals & Objectives

- Collaborate with U.S. industry on EAP development, flight testing, flight test instrumentation, and range support to enable rapid technology transition to the U.S. fleet.
- Conduct Technology Maturation and risk reduction ground tests of integrated MW-class powertrain components and EAP systems with U.S. industry to support flight testing.

- Conduct flight testing of crewed aircraft with U.S. industry to demonstrate practical vehicle-level integration of MW-class EAP powertrain systems.
- If possible, within the specified time frame and budget, provide a flexible system architecture to demonstrate additional, emerging EAP technology with flight test insertions.
- Collaborate across NASA ARMD, U.S. industry, and regulations and standards organizations to identify and address gaps in certification requirements through ground and flight testing.

Project Timeline & History

Pre–2019:

NASA established MW-class EAP as a key research thrust. Foundational work examined the feasibility of single-aisle EAP and identified strategies to reduce both technical and integration barrier risks. This period built upon knowledge from prior projects like X-57 and internal system studies that clarified what will be needed to enable EAP for future commercial transports.

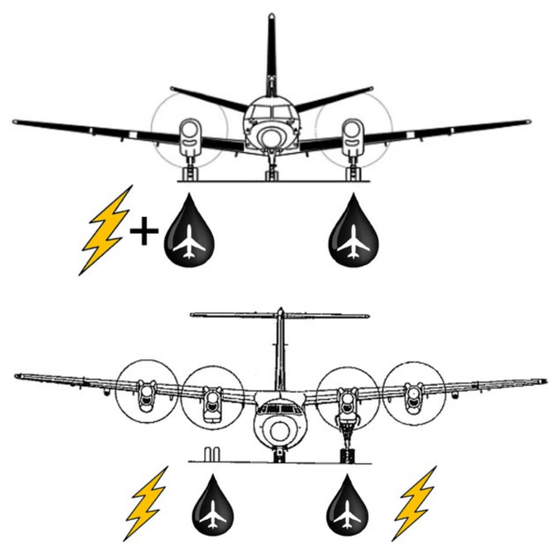
2019–2021:

Following Pre-Formulation in 2019, EPFD was formulated with clear objectives to identify and retire EAP barrier technical and integration risks, conduct ground and flight tests, generate data to advance certification, and accelerate the maturation and transition of integrated MW-class hybrid electric powertrain systems to the U.S. fleet. During this phase, risk-reduction contracts were awarded, industry and regulatory engagement was launched, and Request for Proposals (RFPs) for EPFD contracts were issued.

2021–2024:

On September 30, 2021, NASA awarded contracts to GE Aerospace and magniX for industry-led, cost-shared flight demonstrations of hybrid electric propulsion systems, and both companies marched towards maturing the design of their architectures, including integrated ground and flight test campaigns.

Each company elected to retrofit a regional turboprop aircraft platform aligned with their propulsion architecture: GE Aerospace selected a Saab 340B to modify with a parallel hybrid electric system featuring a traditional CT7 engine and their own hybrid electric propulsion system, while magniX selected a de Havilland Dash 7 to modify by replacing the two outer engines with magni650 electric propulsion units (EPUs).



The parallel hybrid EAP architectures for GE Aerospace's Saab 340B (top) and magniX's Dash 7 (bottom) demonstrator aircraft.

Initial baseline flights of both aircraft were conducted to assess baseline performance and handling qualities, ensuring they aligned with the mission profiles required to validate MW-class hybrid electric flight. These baseline flights were essential to verify safe flight characteristics and operational readiness before hybrid electric modifications began.

During this period, both GE Aerospace and magniX completed high-voltage ground testing of their MW-class hybrid electric propulsion systems under simulated flight conditions at the NASA Electric Aircraft Testbed (NEAT) in Sandusky, Ohio, a state-of-the-art facility where EAP technology can be tested at altitude conditions.

NASA Electric Aircraft Testbed (NEAT) in Sandusky, OH
Photo Credit: NASA

2025:

Ground testing and regulatory standards engagement with the FAA, standards development organizations, and industry continued, and EPFD advanced toward readiness for flight tests.

Enabling Entry-Into-Service Through Barrier Risk Reduction

One of EPFD's primary objectives was to accelerate the development and adoption of MW-class hybrid electric aircraft propulsion technologies by addressing six critical barrier risks to EIS for Part 25 transport category aircraft:

Technical Barrier Risks	Integration Barrier Risks
High-Voltage Operation at Altitude Partial discharge and corona of high power/voltage transmission cables	**Powertrain System Integration** Stability, EMI compatibility, or performance requirements which will require redesign
Battery System Performance Shortfall Aviation grade, state of charge performance across mission, and recharging in flight	**Propulsion System Integration** Operational challenges integrating the turbomachinery with electric machines
Thermal Management Low-grade waste heat requires a low parasitic power Thermal Management System	**Aircraft System Integration** Design challenges integrating EAP with existing aircraft systems

EPFD targeted enabling real-world EIS by validating technical performance, confirming integration feasibility, and providing test data to inform the development of means of compliance for regulations and standards. EPFD's efforts to burn down technical and integration barrier risks to EIS directly supported ARMD's Critical Commitment. They also addressed NASA's goal of maturing MW-class powertrain systems to Technical Readiness Level (TRL) 6.

GE Aerospace: Demonstrating Feasibility for Single-Aisle Hybrid EAP

GE Aerospace is partnering with Aurora Flight Sciences, a Boeing Company, to lead powertrain aircraft integration and flight tests using a modified Saab 340B aircraft. The aircraft was designed to fly with one CT7 engine in its conventional gas turbine configuration and the second CT7 integrated with a MW-class hybrid electric powertrain system. Their demonstrations will establish EAP test methodologies and provide data to inform GE Aerospace's development of next generation narrow-body propulsion architecture.

Artist Concept: GE Aerospace

GE Aerospace's Hybrid Electric Propulsion System at the NASA Electric Aircraft Testbed (NEAT) in Sandusky, Ohio. Photo Credit: GE Aerospace

A key milestone occurred in September 2021, when GE Aerospace completed the world's first ground test of a high-power, high-voltage integrated hybrid electric propulsion system under simulated cruise conditions at over 45,000 feet. This campaign, conducted at NEAT, marked a historic achievement in electric aviation. This testing validated key functions including battery assist, regenerative energy capture, and cross-motor power transfer—pushing the system toward readiness for flight integration.

GE Aerospace also began EAP ground testing at its Electrical Power Integrated Systems Center (EPISCenter) in Dayton, Ohio, to support continued maturation of their architecture.

magniX: Demonstrating Hybrid Electric Readiness for Regional Aircraft

Building on prior demonstrations of electric propulsion systems on Part 23 and Part 27 aircraft, magniX expanded its focus to regional turboprop applications, selecting the de Havilland Dash 7 as a Part 25 platform to extend capabilities toward aircraft carrying up to 50 passengers with a 200 nautical mile range. Their approach is to partner with AeroTEC to integrate two all-electric magni650 propulsion units in place of the Dash 7's outboard Pratt & Whitney PT6A engines to demonstrate a parallel hybrid electric system at the aircraft level.

Photo Credit: NASA/David C. Bowman

As part of EPFD, magniX developed a MW-class hybrid electric powertrain for ground and flight testing. Initial high-voltage altitude tests at NEAT in April 2024 demonstrated the magni650's performance at simulated altitudes up to 27,500 feet. A second testing campaign in October 2024 extended that performance to 30,000 feet, marking a significant milestone toward flight readiness. In June 2024, magniX completed baseline flight tests of the unmodified Dash 7 at Moses Lake, Washington, to collect data supporting integration and future flight testing. The following August, a dedicated aircraft unveiling at Boeing Field in Seattle introduced EPFD's Dash 7 hybrid electric aircraft with its new livery.

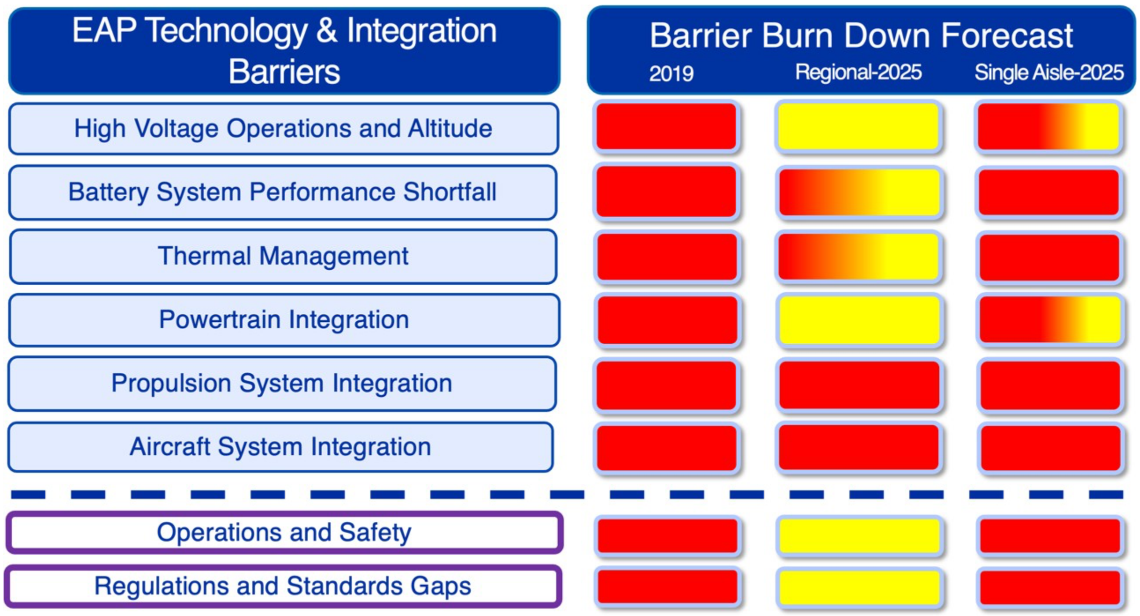
magniX's magni650 Electric Propulsion Unit (EPU)
Photo Credit: NASA/David C. Bowman

magniX also expanded EPFD's technical scope by introducing two additional barrier risks—**Operations and Safety** & **Regulations and Standards Gaps**—acknowledging the broader barriers to EIS for hybrid electric regional turboprop aircraft.

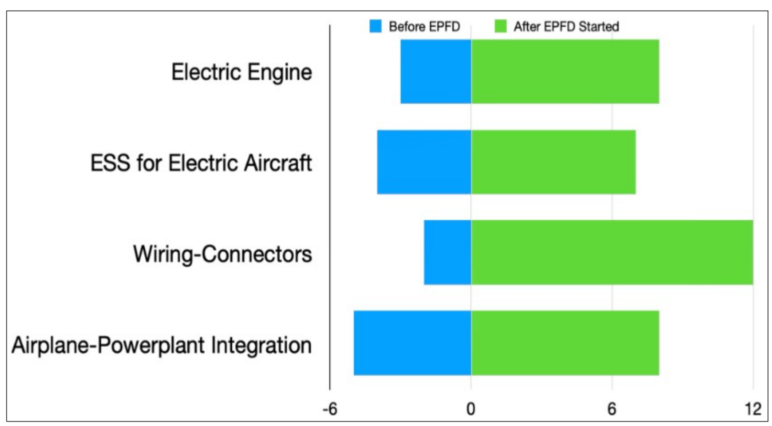
Project Accomplishments

- EPFD brought together EAP innovators, both government and industry, with the FAA and Standards Development Organizations (SDOs), resulting in a collaborative approach to the development of test methodologies.
- EPFD is a test case from which ground and flight test data, along with test methodologies and practices developed by the companies, will be used as a benchmark to inform the formulation of means of compliance of the emerging standards for EAP aircraft systems.

- EPFD leveraged systems analysis to predict the impact and benefits of EAP technology on next-generation commercial aircraft, informing Part 25 industry standards and certification planning to enable continued industry investment beyond the project lifecycle.
- EPFD burned down technical and integration barrier risks to Entry-Into-Service for EAP Part 25 Transport Category Aircraft from 2019 to 2025.



- EPFD influenced over 35 aviation standards, including 10 in 2024 alone. The collaborative approach and engagement with the FAA, SDOs, and industry leaders demonstrated how early prioritization of novel technology gaps provided a focus towards the maturation of the key components of EAP: electric engines, wiring and connectors, energy storage systems, and airplane powerplant integration.



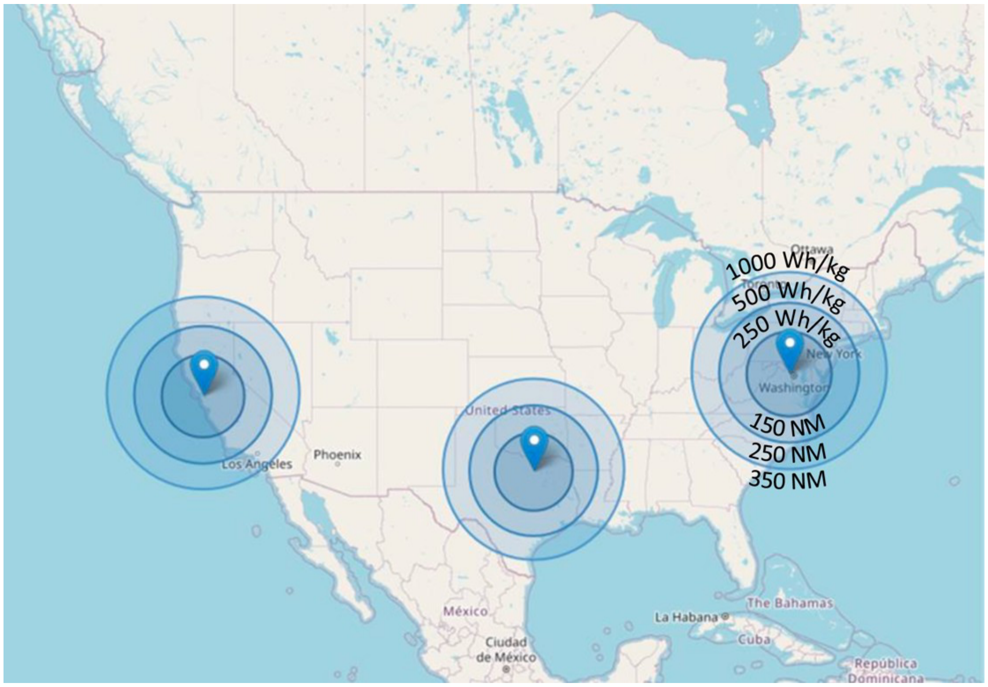
EPFD's Four Highest Priority Regulatory Gaps

Looking Ahead

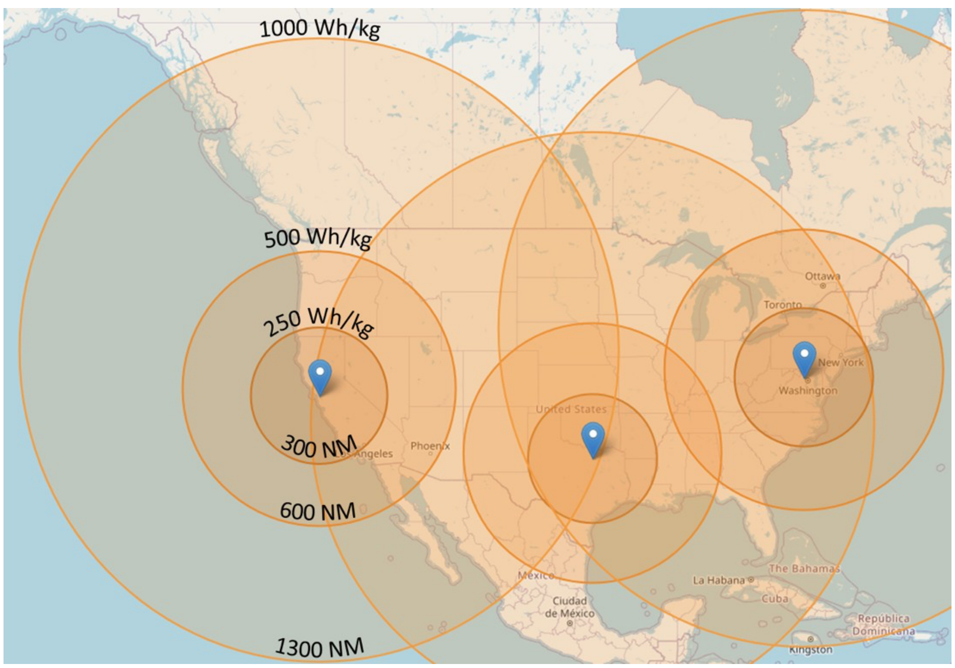
GE Aerospace and magniX are continuing the EPFD effort in pursuit of their visions for making hybrid electric aircraft a reality. These industry efforts are on track for hybrid flight tests later this decade with the goal of reducing technical, regulatory, and operational barriers for future electric aviation markets.

Market Growth Opportunity as Electric Storage System Performance Capabilities Are Realized for Regional Turboprop Aircraft

Near-Term EAP Regional 50-passenger Turboprop Operations Trade Space

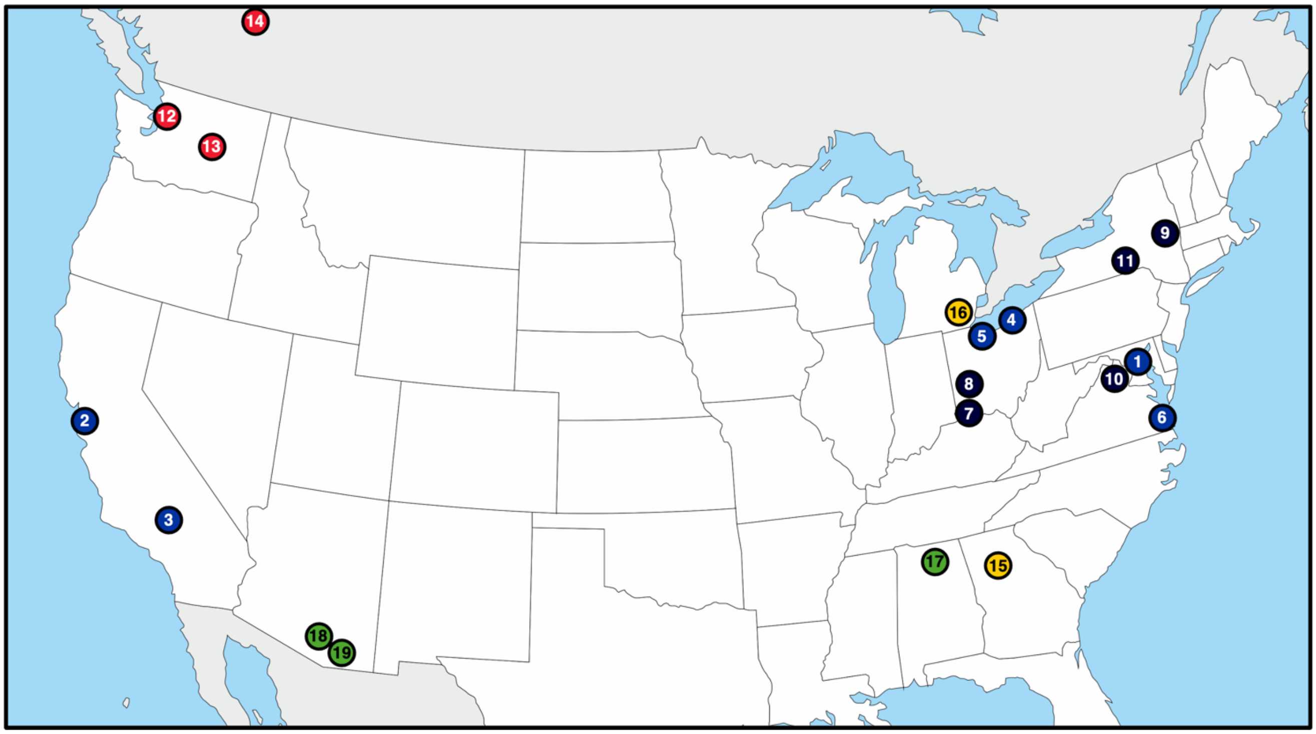


Mid-Term (2035) EAP Turboprop Freighter Operations Trade Space



Fuel savings of 24-52% across 250-1,500 NM missions.
Ranges up to 1,300 NM capture 95% of total annual U.S. regional turboprop cargo operations

Map of EPFD Touchpoints



NASA Centers & Facilities

1 – NASA Headquarters
Washington, DC

2 – NASA Ames Research Center
Moffett Field, CA

3 – NASA Armstrong Flight Research Center
Edwards, CA

4– NASA Glenn Research Center
Cleveland, OH

5 – NASA Electric Aircraft Testbed (NEAT)
Sandusky, OH

6 – NASA Langley Research Center
Hampton, VA

OGA & Partner Sites

17 – U.S. Army Redstone Arsenal
Huntsville, AL

18 – U.S.A.F. Davis-Monthan Air Force Base
Tucson, AZ

19 – Pima Air & Space Museum
Tucson, AZ

GE Aerospace & Partner Sites

7 – GE Aerospace
Cincinnati, OH

8 – GE Aerospace Electrical Power Integrated Systems Center (EPISCenter)
Dayton, OH

9 – GE Aerospace Research
Niskayuna, NY

10 – Aurora Flight Sciences, A Boeing Company
MNZ Airport, Manassas, VA

11 – BAE Systems
Endicott, NY

magniX & Partner Sites

12 – magniX
Everett, WA

13 – AeroTEC Flight Test Center
MWH Airport, Moses Lake, WA

14 – Air Tindi
Yellowknife, Canada

Academic Partner Sites

15 – Georgia Tech
Atlanta, GA

16 – University of Michigan
Ann Arbor, MI