EXFAN

NOVEL RECUPERATION SYSTEM TO MAXIMIZE
EXERGY FROM ANERGY FOR FUEL CELL POWERED
GEARED ELECTRIC AIRCRAFT PROPULSION SYSTEM

Newsletter #3
May 2026

FROM DESIGN TO INTEGRATION

8 months of progress in exFan Development

Turning Waste Heat into Useful Power

Unlocking New Energy Pathways for Climate-Neutral Flight

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NOVEL RECUPERATION SYSTEM TO MAXIMIZE EXERGY FROM ANERGY FOR FUEL CELL POWERED GEARED ELECTRIC AIRCRAFT PROPULSION SYSTEM

DR. BELÉN GARCÍA

Project Coordinator
Principal Researcher

cidetec surface engineering

LATEST FROM EXFAN

As exFan continues to move forward, this edition of the newsletter offers a brief overview of recent progress and ongoing work across the project.

Over the past months, the aerodynamic design of the exFan propulsor has been further refined, focusing on the interaction between the fan, the diffusion concept, the integration of the Heat Exchanger (HX) in the flow path, and the variable area nozzle. In parallel, significant steps have been made on HX development through the adoption of a conventional HX design for AM, as well as the definition and design of AM HX concepts. The out-of-bath surface treatment process for aluminium HXs, previously demonstrated at laboratory scale (2–5 L), has been further upgraded during this period to pilot scale (20 L). At the same time, work continues on a detailed simulation model of exFan to support concept validation and improve our understanding of the overall propulsion system behaviour. On the sustainability side, a hydrogen turboprop regional aircraft configuration has been introduced as a benchmark to help contextualise performance across aircraft classes.

Step by step, this work is helping us build knowledge and explore new pathways for future propulsion systems. I would like to warmly thank all partners for their continued commitment and collaboration, and I hope you enjoy reading about the latest progress in exFan.

Finally, I look forward to seeing many of you at the Vienna Aviation Days to exchange ideas and continue shaping the future of more sustainable aviation.

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Heat Propulsor Aerodynamics Design

Smarter Aerodynamics for Better Performance

Progress to Date

WP5 continues to refine the aerodynamic design of the exFan propulsor, evaluating the main interactions between the fan, the diffusion concept, the heat exchanger integration into the flow path, and the variable area nozzle.

Recent progress includes:

- A new tool for heat exchanger evaluation was developed, enabling rapid sizing and performance assessment of different compact geometries.
- The diffuser and fan stage designs were investigated in depth, revealing that a smart distribution of diffusion across the flow-path components, including an inclined heat exchanger arrangement and optimised fan stage geometry, is key to maximising the installed efficiency of the system.
- A variable area nozzle concept was assessed across all flight phases, showing up to 20% improvement in heat rejection at take-off and up to 2% gain in propulsive efficiency, confirming its potential as an effective tool for performance and operability management.

Work is ongoing, with Computational Fluid Dynamics (CFD) investigations and further design refinements planned for the coming months.

Key Achievements

- Development of an ε-NTU based tool to evaluate compact heat exchangers. It allows both sizing and performance assessment (rating) of different plate-fin compact heat exchangers. Although plain-fin configurations exhibit lower thermal performance (lower Colburn j-factor at the same Reynolds number) compared to offset strip-fin and louvred fin geometries, they become advantageous at higher inlet Mach numbers due to their significantly lower Fanning friction factor. As a result, despite requiring a longer heat exchanger to achieve the same thermal duty, plain-fin designs lead to reduced total pressure losses under high-Mach flow conditions.
- Fan preliminary design sensitivity to diffusion: using a 2D throughflow model, the impact of fan-face Mach and stage diffusion on both fan stage and installed performance was investigated. A key finding is the trade-off between intake and annular diffuser pressure losses: lower fan-face Mach reduces diffuser losses but increases intake losses, with the optimal balance found at a fan-face Mach of 0.50.
- Off-design operability assessment: A full performance map was generated for the most promising fan design. Applying a surge margin definition tailored to low-pressure-ratio fans, a surge margin of 26% was obtained at static take-off, confirming satisfactory operability.
- Variable area nozzle concept for performance and operability enhancement: The impact of a variable area nozzle concept on fan surge margin, heat rejection capability, and propulsive efficiency, together with the identification of optimal modulation strategies across flight phases (take-off, climb, cruise) and sensitivity to fan pressure ratio. At a system level, the concept demonstrates significant benefits, including up to 20% improvement in heat flow balance at take-off and up to 2% increase in overall propulsive efficiency depending on operating conditions.

Contribution to the Project

WP5 provides the aerodynamic design of the exFan Heat Propulsor concept. It defines the internal flow-path architecture and ensures the compatibility between fan stage, diffusion concept, heat exchanger, and variable area nozzle across all relevant operating conditions. In addition, WP5 delivers the boundary conditions required by WP6 for the AM heat exchanger optimisation.

Heat Exchanger & Surface Design

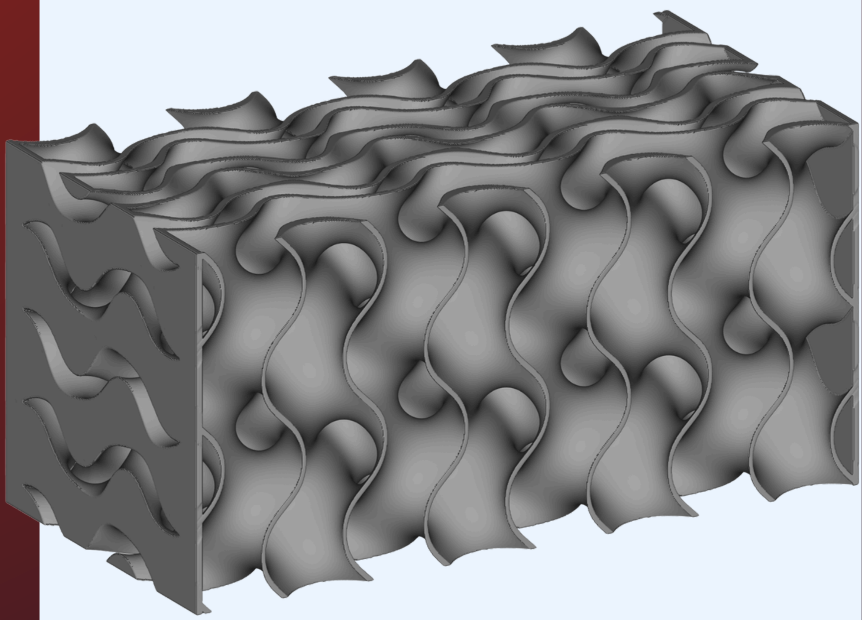
From Conventional Design to Additive Manufacturing

PROGRESS TO DATE

During the past months, the team worked on the adoption of conventional heat exchanger (HX) design for additive manufacturing (AM), in addition to the definition and Design of AM HX.

The out-of-bath surface treatment method developed to reduce roughness and improve the protection of Al HXs, previously demonstrated at laboratory scale (2–5 L), has been further upgraded during this period to pilot scale (20 L). The scale up is currently in progress and will soon be ready for the treatment of the first HX prototypes. This development includes careful monitoring and control of inlet and outlet electrolyte temperatures, as well as pH and conductivity. An automatic dosing system has been incorporated for the periodic addition of compounds to the Ni-P electrolyte baths. In addition, manifolds equipped with open/close valves have been installed in the out-of-bath system to improve flow control and operational flexibility.

EXAMPLE OF AM HX CORE DESIGN



CONTRIBUTION TO THE PROJECT

This will create suitable HX designs for heat rejection, including surface improvements and experimental investigations.

Heat Propulsor Aerodynamics Design

Smarter Aerodynamics for Better Performance

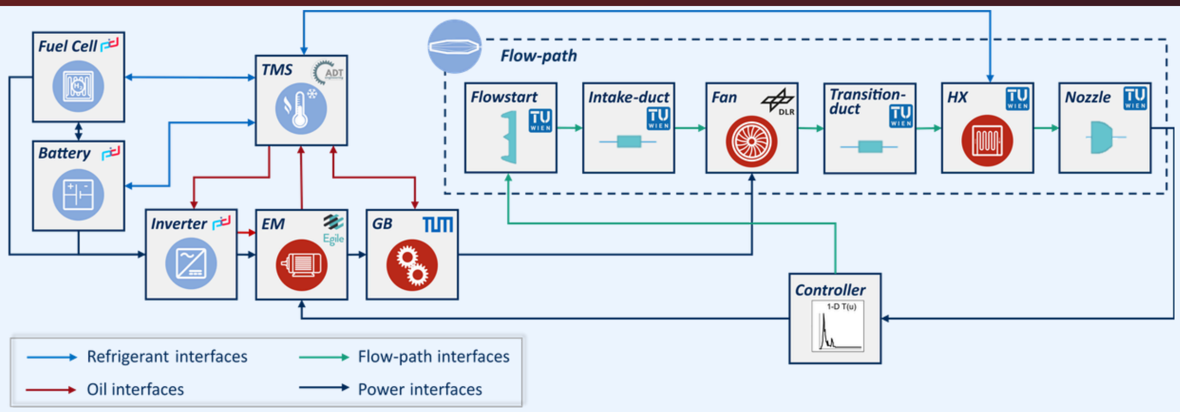
Progress to Date

The goal of this work is to create a detailed simulation model of the exFan to validate the concept and investigate the behavior of the overall propulsion system.

For validation, the model will be capable of calculating thrust versus drag (airflow), the heat transfer characteristics of the heat exchanger, as well as the heat transfer and efficiency of further components (electric motor, battery, fuel cell, gearbox, etc.).

Key Achievements

- To achieve both high result accuracy and high computational efficiency for the overall system model, the model has been built using relationships derived from detailed simulations of the individual components, such as lookup tables and characteristic equations.
- These detailed simulations cover both the flow path and the electromechanical powertrain, including the fuel cell. For each designed component, the behavior has been calculated individually. For the flow path, the focus is on an accurate representation of the flow, the fan, and the resulting thrust depending on the operating point.
- For the powertrain submodels, the main focus is on the resulting efficiencies and the associated heat generation. Based on this, a transient simulation allows the implemented thermal management system to determine the heat rejected via oil and refrigerant and to control the corresponding oil and refrigerant flows.
- The coupled overall system model is currently capable of calculating the thrust at defined operating points, considering the heat supplied to the heat exchanger via oil and refrigerant. The calculation is already largely transient, enabling a realistic representation of the thermal inertia of the overall system.



Contribution to the Project

The main contribution to the overall scope of the exFan is the accurate representation of the transient system behavior of the propulsion system, in particular how the additional thrust generated from component waste heat evolves over the course of a mission profile. The fully coupled system simulation model enables both the validation of the overall concept and the investigation of previously unknown effects. Additionally, the work package produces a geometric representation of the exFan and its components to ensure a functional and integrated preliminary design at its end.

Propulsion System Evaluation

How Green is the exFan Concept?

Progress to Date

A hydrogen turboprop configuration analogous to a regional aircraft was introduced as a benchmark case to contextualize performance across different aircraft classes

Key Achievements

- Hydrogen fuel cell turboprop (ATR72 type) benchmark configuration, similar to a regional aircraft, shows approximately 40% lower CO_2 emissions per passenger-kilometre compared with hydrogen fuel cell turbofan aircraft (A320).
- This difference is mainly attributed to the lower structural mass and reduced energy demand typical of regional turboprop aircraft. However, turboprop and turbofan aircraft serve different mission profiles and flight distances, so this comparison is provided mainly as a benchmark for perspective rather than a direct one-to-one comparison.

Contribution to the Project

Task 9.1 of work package 9 provides the environmental sustainability assessment of the exFAN concept, quantifying the potential environmental benefits of the proposed propulsion architecture compared with conventional and alternative aviation technologies. The results support the project's objective of developing low-carbon aviation solutions by identifying the environmental performance improvements achievable through hydrogen propulsion and advanced aircraft system design.

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Next Phase for the exFan project

Looking Ahead Across Work Packages

In the next phase, the focus shifts from individual components to system integration, bringing together design, simulation, and environmental assessment to validate the exFan concept.

WP5

- Coupled investigation of heat exchanger and flow-path components (diffuser duct and OGV) using CFD results.
- Further refinement of diffuser design to reduce pressure losses while maintaining heat exchanger performance.
- Performance comparison between additively manufactured and conventional compact heat exchanger geometries to assess the potential of AM in terms of thermal and aerodynamic efficiency.

WP6

- The team will put efforts to the manufacturing of conventional HX designs, in addition to simulation of AM HX designs.

WP7

- Since the individual submodels already cover most of the operating range of the exFan, largely also in a transient manner, the next step is to investigate the transitions between operating points within the transient overall system model. The focus is on how these transitions affect quantities such as the progression of component temperatures and the resulting thrust gain due to heat rejected to the heat exchanger. Another objective is the further refinement of the component models. For the powertrain in particular, more detailed or higher-resolution component-level models will be used to better capture the operational behavior and to transfer these effects more accurately to the overall system model. In addition, the flow path model will be continuously refined to better match the defined flow path.
- As the flow path and heat exchanger designs proceed in parallel WPs, the overall concept of the exFan, especially regarding the changing geometric constraints, is adapted to ensure efficient system integration.

WP9

- Updated performance figures for the exFAN propulsion concept are expected from system simulations conducted by TU Wien in May. These updated parameters will be integrated into the LCA model to refine the environmental performance results.
- In parallel, the sustainability assessment will be expanded beyond climate change (global warming potential) to include additional environmental indicators such as energy consumption, materials/resource use, fossil resource scarcity, land use and waste generation providing a more comprehensive environmental evaluation of the technology.

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Upcoming Featured Event

Vienna Aviation Days 2026

The Vienna Aviation Days are back!

In 2026, the event will serve as a platform to connect industry, academia and policymaking to accelerate the development of green aviation technologies. As Europe advances towards climate neutrality, cross-sector collaboration and technological innovation in aviation are more critical than ever.

The Vienna Aviation Days 2026 version will:

- Feature deeper international involvement,
- Display exhibitions of state-of-the-art and future aviation technologies and,
- Showcase how green aviation technologies fit into the European future, as the world is experiencing drastic changes.

The event will create space for discussion, strategic alignment, and practical steps forward.

It is also set to foster synergies between EU-funded projects, industry stakeholders, and policy initiatives, strengthening Europe's competitive and sustainable aviation ecosystem.

Join us to connect, collaborate, and help define the next chapter of sustainable aviation.

REGISTER HERE

EXFAN

Various Communication & Dissemination Activities

NON-SCIENTIFIC PUBLICATIONS

Short Public Summaries of key exFan **Deliverables** are now available on the project website.

Mid-project leaflet – download it here!

exFan featured in the EASN periodic Newsletter issue #1 – 2026 Read it here!

exFan featured in the EASN periodic Newsletter issue #3 – 2025 Read it here!

NETWORKING ACTIVITIES

Live at the Long Night of Research in Vienna

exFan Pitch at the Clean Aviation ìPitch & Connect Networking event

exFan at Aviation Forum Austria 2026

exFan meets Education

MEETINGS

General assembly Meeting 10-11 December 2025

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Project Coordinator
cidetec surface engineering

Technical Coordinator
ADT engineering

Research Coordinator
TU WIEN – TECHNISCHE UNIVERSITÄT WIEN

Project Partners
TUM FZG
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EASN TIS
Fraunhofer IAPT
DLR Deutsches Zentrum für Luft- und Raumfahrt German Aerospace Center
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CONNECT WITH EXFAN

exfan-project.eu

info@exfan-project.eu

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