EXFAN

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

PARTNER INSIGHTS

MEET THE PEOPLE BEHIND exFan

Innovation is driven by people, collaboration and expertise.

The exFan consortium brings together universities, research organisations, technology centres, industrial partners and SMEs from across Europe to advance next-generation propulsion technologies for cleaner and more sustainable aviation.

This booklet introduces the organisations behind the project, highlighting their expertise, their contribution to the consortium and their shared vision for the future of sustainable flight.

> TOGETHER, DRIVING SUSTAINABLE AVIATION FORWARD.

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Belén García Blanco

Principal Researcher in Coatings and Surface Treatment Unit

cidetec surface engineering

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MEET THE PEOPLE BEHIND EXFAN

Belén García Blanco



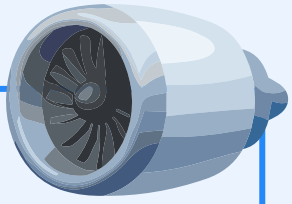
www.surfaceengineering.cidetec.es/

CIDETEC

San Sebastian, Spain

cidetec surface engineering

> "exFan brings together different technologies and areas of expertise to explore new ways of recovering energy and improving the efficiency of future aircraft propulsion systems."



WHAT IS YOUR ORGANISATION'S ROLE IN EXFAN?

CIDETEC Surface Engineering is a leading international technology centre specialised in surface engineering and advanced materials. It is Spain's only technological centre dedicated specifically to Surface Engineering, with a multidisciplinary team and state-of-the-art facilities supporting the development of innovative solutions for demanding industrial applications. Its expertise covers surface preparation, REACH-compliant surface treatments and coatings, post-processing of additively manufactured components, testing and characterisation, as well as the design and scaling of industrial processes. CIDETEC develops multifunctional surfaces with properties such as corrosion and wear resistance, conductivity, omniphobicity and improved durability. Our work focuses on bridging the gap between research and industrial application, developing customised, scalable and sustainable technologies that can ultimately be transferred to industry.

WHY IS YOUR CONTRIBUTION IMPORTANT FOR THE SUCCESS OF EXFAN?

CIDETEC Surface Engineering is the Project Administrative Coordinator of exFan, responsible for supporting effective collaboration across the consortium, organising project meetings and ensuring that the project progresses towards its objectives. In parallel, CIDETEC leads the surface engineering activities within the project, contributing to the design, treatment and characterisation of the heat exchanger surfaces. A key focus is the development of an "out-of-bath" system capable of applying chemical surface treatments to the complex internal geometries of additively manufactured heat exchangers. CIDETEC is optimising chemical polishing and electroless nickel-phosphorus (NiP) deposition processes by adjusting parameters such as temperature, flow rate, electrolyte composition and treatment time. The objective is to achieve homogeneous surface finishing and protection throughout the intricate internal channels of the exFan heat exchangers.

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WHAT DO YOU CONSIDER THE MOST EXCITING OR INNOVATIVE ASPECT OF YOUR WORK IN EXFAN?

Additively manufactured heat exchangers offer major advantages in terms of weight, geometric freedom and heat transfer performance, but their complex internal structures also make surface finishing particularly challenging. CIDETEC brings specialised expertise in surface engineering and chemical treatment technologies that can reach areas inaccessible to conventional mechanical finishing methods. In exFan, this expertise is being used to develop chemical polishing and electroless NiP treatments capable of producing more homogeneous surfaces inside complex heat exchanger geometries. These treatments are intended to reduce surface roughness and improve resistance to corrosion and erosion, while limiting particle accumulation. CIDETEC also provides the facilities and know-how required to optimise, characterise and scale up these processes, helping to bridge the gap between laboratory-scale research and the treatment of full-scale heat exchanger demonstrators.

HOW DOES COLLABORATION WITHIN THE CONSORTIUM BENEFIT YOUR WORK?

One of the most exciting aspects of our work is the development of the out-of-bath approach for treating the internal surfaces of complex additively manufactured heat exchangers. Conventional surface finishing techniques can be difficult or even impossible to apply uniformly to intricate internal channels. The out-of-bath concept overcomes this limitation by circulating the treatment electrolytes through the component, allowing chemical processes to reach otherwise inaccessible surfaces. In exFan, this approach combines chemical polishing with electroless NiP deposition to improve surface quality and protection. The process has already demonstrated the ability to produce homogeneous surface treatments in complex geometries, and it is now being scaled up from laboratory systems to a 20-litre pilot system. This transition towards treating complete heat exchanger prototypes is particularly challenging and exciting at the same time, as it brings an innovative laboratory concept closer to a realistic aerospace application.

LOOKING AHEAD, WHAT IMPACT DO YOU HOPE EXFAN WILL HAVE ON THE FUTURE OF AVIATION?

The multidisciplinary nature of the exFan consortium is essential because the surface treatment cannot be developed independently from the heat exchanger design and its final operating conditions. Close collaboration with the partners involved in additive manufacturing, heat exchanger design, thermal management and testing allows CIDETEC to understand the requirements that the treated surfaces must meet and to adapt the treatment accordingly. The interaction with the partners also provides valuable feedback on how surface finishing influences aspects such as flow behaviour, pressure losses, thermal performance and particle accumulation. At the same time, CIDETEC shares its expertise in surface engineering, chemical processing, and corrosion science and protection with the consortium. This exchange of knowledge helps ensure that the surface treatment is not simply optimised as an isolated process, but as an integral part of the complete heat exchanger solution.

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Lorenz Braumann

Research and Development Engineer

ADT engineering
Advanced Drivetrain Technologies

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MEET THE PEOPLE BEHIND EXFAN

Lorenz Braumann



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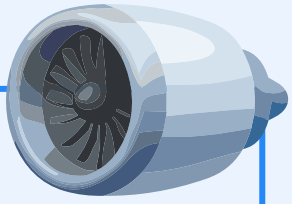
Advanced Drivetrain Technologies GmbH

Vienna, Austria

> Thermal management and heat exchanger integration are one of the most critical challenges of sustainable aviation – exFan will provide solutions for both!



WHAT IS YOUR ORGANISATION'S ROLE IN EXFAN?

ADT is the technical lead of the exFan project with the responsibility that the propulsion system reaches its full potential and defined goals in the specified timeframe of the project. On component level, ADT is responsible for the development of the thermal management system, looking at innovative means to dissipate & recuperate the enormous amount of heat dissipated by aviation fuel cells. The final role of ADT is the lead of exploitation activities: ADT ensures the identification of potential exploitable results and supports the consortium with the creation of business plans for each result.

WHY IS YOUR CONTRIBUTION IMPORTANT FOR THE SUCCESS OF EXFAN?

As technical lead of exFan, ADT makes sure that each partner is aware of what they need to provide within the next month. This is especially important as the optimization of exFan is a highly multidisciplinary challenge that requires many experts from different companies to work in parallel – but also in alignment. For thermal management systems, ADT benefits from previous expertise in the development of cooling systems for large energy storage in harsh environments, where heat dissipation becomes extremely challenging.

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PARTNER INSIGHTS

MEET THE PEOPLE BEHIND EXFAN

Lorenz Braumann

WHAT DO YOU CONSIDER THE MOST EXCITING OR INNOVATIVE ASPECT OF YOUR WORK IN EXFAN?

One key challenge of exFan thermal management is that an aircraft equipped with the exFan should be able to take off even during hot days. The summer of 2026 has shown us how frequent hot days with temperatures beyond 40°C can be. The specific challenge here is that typical PEM-FC operates at around 80°C. As heat transfer via ram air depends strongly on the difference in temperature between the coolant and the outside air, the heat rejection at ground level where ambient temperature is highest is a major problem. This is exacerbated by the high power demand during take-off and the resulting heat generation. ADT is investigating a large range of measures to allow the exFan to take-off on hot days without oversizing the system.

HOW DOES COLLABORATION WITHIN THE CONSORTIUM BENEFIT YOUR WORK?

The collaboration within exFan has supported ADT especially in understanding the interaction between exFan subsystems on the aerothermal, energy and mechanical side. The project has allowed ADT to have collaborations with exFan partners outside of eFan on different topics and technologies.

LOOKING AHEAD, WHAT IMPACT DO YOU HOPE EXFAN WILL HAVE ON THE FUTURE OF AVIATION?

Europe has been suffering from significant turmoil in the last decade, which most recently led to the public focus shifting from sustainability to defence. This year's heat wave has demonstrated the enormous effects of extreme weather events that become more frequent due to climate change. We hope that the heat recuperation developed as part of exFan will become a substantial contributor to making fuel cell aircraft both technically and economically feasible. While the future of aviation will not depend solely on fuel cell aircraft, a significant portion of aircraft emissions can be mitigated through the use of fuel cells and the exFan consortium is willing to user their expertise to make this future come reality.

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Matthias Ronovsky-Bodisch

University Assistant/Researcher

TU WIEN TECHNISCHE UNIVERSITÄT WIEN

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MEET THE PEOPLE BEHIND EXFAN

Matthias Ronovsky-Bodisch



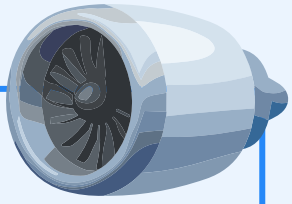
www.tuwien.at/en/

TU Wien

Vienna, Austria

TECHNISCHE UNIVERSITÄT WIEN

> The challenges are huge, but so are the possibilities.



WHAT IS YOUR ORGANISATION'S ROLE IN EXFAN?

In the exFan project, TU Wien contributes to almost all work packages and also serves as the Research Coordinator. As Research Coordinator, TU Wien guides the project with respect and advises the consortium with respect to aircraft system and design interactions and limitations. This helps the exFan project develop an efficient propulsion system.
TU Wien's main task in the project is to design the propulsor air duct together with the DLR. The main challenge to be solved in the exFan project is the optimal integration of the heat exchanger in the air duct. The heat exchanger is responsible for high pressure losses and requires a large installation volume, state of the art design conventions need to be challenged and new solutions found. Further, TU Wien will conduct the tests in order to experimentally validate the benefits of the exFan concept.

WHY IS YOUR CONTRIBUTION IMPORTANT FOR THE SUCCESS OF EXFAN?

Within the exFan project, TU Wien provides not only valuable insight into the interactions between a potential aircraft and the exFan propulsion systems, but also into the aerodynamic simulation, design and testing of the propulsor. Powered by the Austrian Scientific Cluster TU Wien is capable of running large scale CFD simulations. This allows for more detailed investigations, which are especially relevant on the airside of the heat exchanger. Furthermore, our research team has great experience in experimental validations and testing of engine components and models. With this set of skills, TU Wien's Research Group for Aircraft Systems is more than capable of supporting the development of the propulsion system, from the concept study through to the design and validation phases.

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PARTNER INSIGHTS

MEET THE PEOPLE BEHIND EXFAN

Matthias Ronovsky-Bodisch

WHAT DO YOU CONSIDER THE MOST EXCITING OR INNOVATIVE ASPECT OF YOUR WORK IN EXFAN?

For me personally, the most interesting part of the exFan research is to gain an understanding and to investigate all the various interconnections between the systems or components. This ranges from the high level of system design, where, due to snowball effects, a relatively minor change in one system can result in vastly different system performance overall, to small details in the air duct design. As these interactions, ever so small, are the key to developing the exFan propulsion system and one day potentially enabling fuel cell electric flight.

HOW DOES COLLABORATION WITHIN THE CONSORTIUM BENEFIT YOUR WORK?

The exchange of knowledge and discussion of new results are essential to the success of a research project. Each partner has a high amount of expertise on their research topic, but might lack understanding or awareness of the effects on other components. Therefore, I believe that regular exchange among project partners is important. It not only benefits the outcome of the current project, but the gained understanding also contributes to future research and can lead to long lasting partnerships.

LOOKING AHEAD, WHAT IMPACT DO YOU HOPE EXFAN WILL HAVE ON THE FUTURE OF AVIATION?

In my opinion, air travel plays a vital role in connecting people, as it enables them to meet and understand new cultures around the world. Nevertheless, the impact of aviation on the climate cannot be ignored as summers become hotter and extreme weather events become more frequent. Therefore, I hope that exFan can be a contribution toward sustainable air travel. The challenges of fuel cell electric flight are numerous, and reaching competitiveness with conventional propulsion systems is no easy feat. Nevertheless, as long as we keep working, improving the technology and exploiting new synergies as we do in exFan, I believe that one day this dream can become a reality.

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Felix Wohlfahrt
Research Associate

Technische Universität München

FZG

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MEET THE PEOPLE BEHIND EXFAN

Felix Wohlfahrt



www.tum.de/

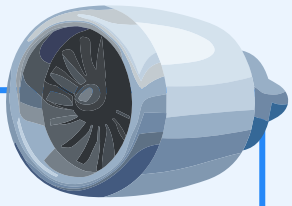
Technical University of Munich

Munich, Germany

Technische Universität München

FZG

> "For us, exFan means moving from component-based design towards optimized, coordinated system design for aviation propulsion."



WHAT IS YOUR ORGANISATION'S ROLE IN EXFAN?

Within exFan, TUM's Institute of Machine Elements (FZG) leads the functional system verification. Together with the other exFan partners, the institute develops a coupled, transient system simulation model to validate the concept and investigate the overall propulsion system. The model considers thrust, component efficiencies, heat generation and thermal management. It aims to assess system behaviour throughout a mission profile, particularly the additional thrust generated from component waste heat.

FZG also develops concepts and designs for the reduction gearbox connecting the high-speed electric motor to the fan and provides gearbox models for geometric and functional integration. This includes investigating the applicability and limits of established design standards and standard solutions under the combined demands of high rotational speeds and high transmitted power.

WHY IS YOUR CONTRIBUTION IMPORTANT FOR THE SUCCESS OF EXFAN?

FZG brings expertise in software development across different areas, for example thermal balance/temperature calculation for gearboxes. In addition, we have design and component knowledge for planetary gearboxes and their application in aviation, as well as experience with high rotational speeds gained from previous projects on power density optimization of electric drivetrains and their design. We also bring general software experience through our own in-house software landscape covering geometry calculation, efficiency, load capacity and quasi-static overall system calculation, as well as gear contact dynamics. This is important because we can combine all of this for the overall system simulation, and develop the architecture for a thermally transient overall system model to better understand the interaction of different effects of heat rejection and heat exchanger coupling in the flow path. FZG is also involved in and driving the mechanical design of exFan's drivetrain components.

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Felix Wohlfahrt

WHAT DO YOU CONSIDER THE MOST EXCITING OR INNOVATIVE ASPECT OF YOUR WORK IN EXFAN?

The most exciting part is the interdisciplinarity. Normally our work is mostly gearbox-related, focused on calculating and predicting efficiency and similar properties. But exFan is a new technology that requires a strong understanding of how individual components are coupled, combining mechanical parts with thermal and flow-related aspects.
It is also great to see how the effects of power density optimization through high-speed drivetrains, which we know from other applications, can be transferred and applied to higher power classes and to aviation. This broadens our perspective beyond pure gear design and lets us contribute to a bigger propulsion system picture.

HOW DOES COLLABORATION WITHIN THE CONSORTIUM BENEFIT YOUR WORK?

Working in this collaboration is very interesting, seeing how other fields tackle problems and understanding how everything is connected. The big benefit comes exactly from this, since a project like exFan is only possible together.
On our own, we could not develop a functioning overall system model — it only works in close cooperation with component experts for fuel cell thermal management, turbomachinery and other powertrain components. Each partner contributes knowledge we do not have, and combining it is what makes the coupled system simulation meaningful and realistic.

LOOKING AHEAD, WHAT IMPACT DO YOU HOPE EXFAN WILL HAVE ON THE FUTURE OF AVIATION?

We hope that exFan can be a first trigger to push fuel-cell-driven, heat-recuperating aviation concepts into the civil aviation industry, in order to increase efficiency and reduce emissions of aviation propulsion systems in the long term. Beyond establishing this exact overall concept, we hope exFan also demonstrates and advances the technological applicability of the individual drivetrain components involved, such as the high-speed gearbox and electric motor.
This way, even if the specific system architecture evolves further, the components and methods developed within exFan can still contribute to future propulsion concepts and help move the industry a step closer toward more sustainable aviation.

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Athanasios Pappas

Project Manager
Technology specialist

IRES
Innovation in Research & Engineering Solutions

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Athanasios Pappas



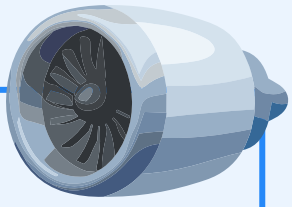
www.innovation-res.eu

IRES

Brussels, Belgium

IRES
Innovation in Research & Engineering Solutions

> Sustainable aviation is not only about reducing emissions during flight. It is about understanding and minimizing environmental impacts across the entire life cycle. Through exFAN, we aim to demonstrate how innovative hydrogen propulsion can contribute to that transition.



WHAT IS YOUR ORGANISATION'S ROLE IN EXFAN?

Within exFAN, IRES is responsible for assessing the environmental performance of the proposed hydrogen-powered propulsion technology through Life Cycle Assessment (LCA). Our assessment addresses two main dimensions. The first concerns the manufacturing of the thermal management system, including the environmental impacts associated with material production and the fabrication of key components, such as heat exchangers. The second focuses on aircraft operation and the upstream emissions associated with fuel production and supply. We evaluate different propulsion and fuel pathways, comparing the exFAN concept with conventional aviation technologies and alternative hydrogen-based systems. Our objective is to quantify the environmental implications of the proposed technology across its life cycle, identify the main sources of impact, and assess its potential contribution to reducing aviation's environmental footprint.

WHY IS YOUR CONTRIBUTION IMPORTANT FOR THE SUCCESS OF EXFAN?

The transition towards sustainable aviation requires more than reducing emissions during flight. A comprehensive evaluation must also consider the environmental impacts associated with producing fuels, manufacturing components, and operating aircraft. IRES contributes the methodological expertise needed to assess these impacts using a consistent life-cycle perspective. For hydrogen-based propulsion, this is particularly important because its overall environmental performance depends strongly on how hydrogen is produced and on the efficiency of the propulsion system. Similarly, improvements in thermal management may reduce operational energy requirements while introducing additional manufacturing impacts through new components and materials. Our work helps quantify these trade-offs, identify environmental hotspots, and determine under which conditions exFAN can deliver meaningful environmental improvements compared with existing and emerging aviation technologies.

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Athanasios Pappas

WHAT DO YOU CONSIDER THE MOST EXCITING OR INNOVATIVE ASPECT OF YOUR WORK IN EXFAN?

One of the most exciting aspects of exFAN is the opportunity to evaluate an innovative propulsion concept that recovers waste heat from hydrogen fuel cells and converts it into useful propulsive power. From an environmental perspective, this creates an interesting balance between operational efficiency and manufacturing impacts. Improving energy recovery can potentially reduce hydrogen consumption during flight, but the additional thermal management equipment also requires materials and energy for its production. Our work examines both sides of this relationship, assessing whether the environmental benefits achieved during aircraft operation outweigh the impacts associated with manufacturing the required equipment. Another particularly interesting aspect is exploring how different hydrogen production pathways influence the overall environmental performance of the technology, highlighting the importance of clean energy supply chains for future aviation.

HOW DOES COLLABORATION WITHIN THE CONSORTIUM BENEFIT YOUR WORK?

The multidisciplinary collaboration within exFAN is essential for conducting a reliable environmental assessment. Our work depends on technical information generated by partners specialising in propulsion systems, fuel cells, thermal management, aircraft modelling, and component development.
These partners provide important inputs, including fuel consumption estimates, system efficiencies, material requirements, and heat exchanger designs, which form the basis of our life-cycle models.
In return, our environmental assessments provide a broader perspective on the implications of different technical solutions, identifying the processes and operating parameters that contribute most significantly to environmental impacts. This continuous exchange between engineering development and sustainability assessment allows environmental considerations to be incorporated into technological decisions, supporting the development of propulsion systems that are not only efficient but also environmentally sustainable.

LOOKING AHEAD, WHAT IMPACT DO YOU HOPE EXFAN WILL HAVE ON THE FUTURE OF AVIATION?

We hope exFAN will contribute to the development of more efficient hydrogen-based propulsion technologies and support the broader transition towards low-emission aviation. By recovering waste heat from fuel cells and using it to generate additional propulsion, the project has the potential to improve energy efficiency and reduce hydrogen consumption during flight. However, the environmental benefits of such technologies must be assessed across their full life cycle. The production of low-carbon hydrogen, the environmental footprint of system manufacturing, and the management of operational and non-CO_2 climate impacts will all play important roles in determining their sustainability. Through our assessment, we aim to provide scientific evidence of exFAN's environmental potential and help identify the conditions under which innovative hydrogen propulsion can contribute most effectively to reducing aviation's climate impact.

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David Ortega

R&D Engineer

Egile

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David Ortega



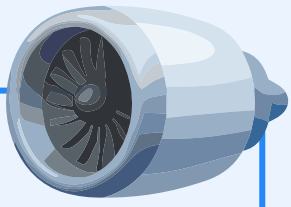
www.egile.es/en

EGILE

Gipuzkoa, Spain

Egile

> We are proud to bring our motor design expertise to exFan to help build a cleaner aviation.



WHAT IS YOUR ORGANISATION'S ROLE IN EXFAN?

At EGILE, our primary contribution to the exFan project focuses on the design and simulation of the electric drive system. Within WP4, we lead the design of the high-performance electric motor tailored to meet the demanding requirements of the propulsion system. Furthermore, as part of WP7, EGILE is responsible for developing the dynamic behavioral submodels that simulate the electric motor's thermal and electromagnetic performance within the overall system. This system-level simulation enables the consortium to accurately evaluate transient responses, optimize power density, and ensure seamless integration between the motor and the heat-recovery propulsion architecture.

WHY IS YOUR CONTRIBUTION IMPORTANT FOR THE SUCCESS OF EXFAN?

EGILE brings over three decades of specialized aerospace heritage and high-precision mechanical expertise to exFan. Our core strength lies in the co-design and industrialization of high-density electric motors engineered to operate reliably under extreme aerospace conditions and severe environmental constraints. By leveraging advanced electromagnetic simulation and robust thermal management strategies, we ensure the electric motor achieves peak efficiency while meeting strict weight and space limitations. Our deep understanding of aerospace standards and precision manufacturing allows us to bridge the gap between theoretical motor concepts and robust, flight-ready hardware essential for the success of the exFan system.

PARTNER INSIGHTS

MEET THE PEOPLE BEHIND EXFAN

David Ortega

WHAT DO YOU CONSIDER THE MOST EXCITING OR INNOVATIVE ASPECT OF YOUR WORK IN EXFAN?

What makes our work in exFan particularly compelling is the opportunity to pioneer next-generation technologies alongside leading industry experts and research institutions. From an engineering perspective, the most exciting aspect is applying cutting-edge thermal management and design methodologies directly to our electric motor architecture. Translating complex research into tangible, high-efficiency propulsion components that actively contribute to shaping the future of zero-emission aviation is exceptionally rewarding.

HOW DOES COLLABORATION WITHIN THE CONSORTIUM BENEFIT YOUR WORK?

Collaborating within the exFan consortium provides an enriching environment for continuous technical growth and knowledge sharing. At EGILE, we firmly believe that learning is an ongoing journey (there is always more to discover), and every technical exchange presents a valuable opportunity to expand our expertise. The flow of insights, research data, and engineering methodologies across the consortium has been exceptionally fluid and transparent. Working alongside specialized multidisciplinary partners allows us to overcome complex technical challenges more efficiently and refine our motor design strategies. Ultimately, we consider this seamless knowledge exchange to be one of the fundamental pillars for driving innovation and advancing the technology toward project success.

LOOKING AHEAD, WHAT IMPACT DO YOU HOPE EXFAN WILL HAVE ON THE FUTURE OF AVIATION?

Hydrogen fuel cells promise zero-emission flight, but they face a major challenge: they run hot, requiring heavy, drag-inducing radiators just to cool down. Instead of discarding that thermal energy, exFan's technology captures it, converting what was once useless waste heat into powerful, extra thrust. By turning a cooling problem into a propulsion solution, we boost aircraft efficiency. This means carrying less fuel, extending flight ranges, and drastically lowering operational costs. We aren't just managing heat in a lab test; we are unlocking the full potential of green hydrogen and bringing zero-emission aviation one step closer to reality.

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Silva Kerkezian & Elena Karittevli

Dissemination & Communication Managers

EASN TIS

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Silva Kerkezian & Elena Karittevli





www.easn-tis.com

EASN-TIS

Belgium, Brussels

> Our vision is to help exFan's innovation reach beyond the project and contribute to the future of decarbonized European aviation.

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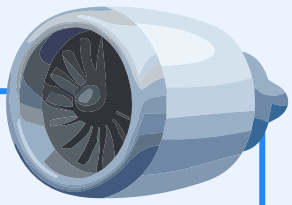

WHAT IS YOUR ORGANISATION'S ROLE IN EXFAN?

Within exFan, EASN-TIS leads WP2 – Dissemination, Communication and Exploitation, supporting the consortium in maximising the visibility, accessibility and impact of the project and its results. Our responsibilities include planning and implementing the project's dissemination and communication strategy, coordinating communication channels and materials, promoting project news, achievements, publications and events, and monitoring the performance of communication activities. In parallel, EASN-TIS contributes to exploitation-related activities and supports the exchange of information with relevant European aviation and hydrogen initiatives.

WHY IS YOUR CONTRIBUTION IMPORTANT FOR THE SUCCESS OF EXFAN?

The development of innovative technologies is only one part of achieving meaningful project impact; these results also need to reach the right audiences and create opportunities for further uptake and exploitation. EASN-TIS brings extensive experience in the dissemination, communication and exploitation of European aviation research, together with access to a broad network of stakeholders across academia, research and industry. Our contribution helps ensure that exFan's developments, research activities and achievements are communicated consistently and effectively. Through dedicated communication channels, dissemination activities, events, publications and exploitation support, we help strengthen the visibility of exFan and facilitate knowledge transfer beyond the consortium.

EXFAN

PARTNER INSIGHTS

MEET THE PEOPLE BEHIND EXFAN

Silva Kerkezian & Elena Karittevli

WHAT DO YOU CONSIDER THE MOST EXCITING OR INNOVATIVE ASPECT OF YOUR WORK IN EXFAN?

One of the most exciting aspects of our work in exFan is the challenge of communicating highly technical and innovative research in a clear, engaging and accessible way. We work closely with the technical partners to understand their progress and translate complex developments in areas such as thermal management, waste-heat recovery and hydrogen fuel-cell propulsion into content suitable for different audiences. This includes preparing communication materials, promoting publications and events, supporting dissemination activities and highlighting key project achievements through exFan's communication channels. Being able to follow the technical progress of the project closely and help make these developments visible to the wider aviation community is one of the most rewarding aspects of our role.

HOW DOES COLLABORATION WITHIN THE CONSORTIUM BENEFIT YOUR WORK?

Close collaboration with the exFan partners is essential for our work, as effective dissemination and communication depend on a continuous exchange of information with the technical teams. Through regular interaction with the consortium, we are able to better understand the progress achieved across the different work packages, identify relevant results and activities to promote, and ensure that the information communicated externally accurately reflects the work being performed. The different expertise represented within exFan also provides valuable perspectives on how technical results can be presented to scientific, industrial and broader audiences. At the same time, communication activities provide partners with opportunities to showcase their work, publications, events and achievements.

LOOKING AHEAD, WHAT IMPACT DO YOU HOPE EXFAN WILL HAVE ON THE FUTURE OF AVIATION?

We hope exFan will contribute to advancing hydrogen fuel-cell-powered aircraft propulsion by addressing one of its key challenges: thermal management and heat rejection. By investigating how waste heat can be recovered and converted into useful thrust through the Meredith effect, alongside the development of lightweight heat exchangers, an advanced thermal management system and optimised operating strategies, exFan can provide valuable knowledge for future aircraft propulsion concepts. From our perspective, we also hope that the project's results will reach the relevant scientific, industrial and wider stakeholder communities and help stimulate further research, collaboration and further uptake of the technologies developed within exFan.

EXFAN

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

PARTNER INSIGHTS

MEET THE PEOPLE BEHIND exFan

Innovation is driven by people, collaboration and expertise.



Heiko Blunk

Head of Part Design Team

Fraunhofer IAPT

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EXFAN

PARTNER INSIGHTS

MEET THE PEOPLE BEHIND EXFAN

Heiko Blunk



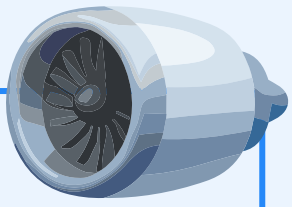
www.iapt.fraunhofer.de

Fraunhofer IAPT

Hamburg, Germany

Fraunhofer IAPT

> Seeing our 3D-printed TPMS structures come to life and undergo rigorous testing by such exceptional partners is incredibly rewarding. No single institution could solve the thermal challenges of hydrogen aviation alone. The collective expertise and close teamwork in exFan is precisely what turns our complex AM-designs into real thrust for the future of flight.



WHAT IS YOUR ORGANISATION'S ROLE IN EXFAN?

In the exFan project, Fraunhofer IAPT is responsible for the complete design, numerical modeling, and additive manufacturing of ultra-compact, high-performance heat exchangers for the novel exFan recuperation system. Within this fuel cell-powered, electric propulsion setup, our team develops advanced thermal architectures capable of handling severe operational demands. Utilizing Laser Powder Bed Fusion (LPBF), we engineer and manufacture both conventional baseline heat exchangers and complex, biomimetic Triply Periodic Minimal Surface (TPMS) designs, such as gyroid and diamond structures. We perform comprehensive CFD simulations and iterative parameter optimizations to tailor internal channel geometries for maximum heat dissipation and minimized aerodynamic drag. Ultimately, IAPT delivers the precision-manufactured metal prototypes that undergo extensive surface treatments, fouling tests, and experimental aerodynamic and thermodynamic testing across the consortium.

WHY IS YOUR CONTRIBUTION IMPORTANT FOR THE SUCCESS OF EXFAN?

Fuel cells produce substantial amounts of thermal energy, generating roughly one watt of waste heat for every watt of electric power. Dissipating this massive heat load without adding crippling weight or aerodynamic drag is the project's primary engineering challenge. Harnessing the Meredith effect to turn this excess heat into net forward thrust requires heat exchangers with exceptional surface-area-to-volume ratios and thin walls. Conventional manufacturing methods simply cannot produce structures with intricate, flow-optimized internal channels. Fraunhofer IAPT's specialized additive manufacturing expertise and additive design methodologies directly enable the fabrication of these complex TPMS geometries in flight-grade metals. By pushing LPBF to its physical limits, we provide the lightweight core component that makes the entire exFan recuperation cycle thermodynamically viable.

EXFAN

PARTNER INSIGHTS

MEET THE PEOPLE BEHIND EXFAN

Heiko Blunk

WHAT DO YOU CONSIDER THE MOST EXCITING OR INNOVATIVE ASPECT OF YOUR WORK IN EXFAN?

The most exciting aspect is taking mathematically complex, TPMS concepts out of theoretical numerical simulations and translating them into physical, flight-ready hardware via industrial 3D printing. Exploring how gyroid and diamond topologies can enhance heat transfer while drastically reducing pressure loss unlocks unprecedented design freedom. Crucially, this work showcases how industrial AM delivers on its promise for the aerospace sector: enabling high-performance, flight-critical hardware that transforms a thermal challenge into net aircraft thrust. Working at the intersection of advanced materials, fluid dynamics, and disruptive manufacturing represents a true paradigm shift in propulsion design, proving that next-generation thermal management can actively contribute to aircraft propulsion rather than merely penalizing performance.

HOW DOES COLLABORATION WITHIN THE CONSORTIUM BENEFIT YOUR WORK?

Developing innovative propulsion technologies requires a tightly synchronized interdisciplinary development loop, and the exFan consortium provides the ideal framework to validate our work:

- Fraunhofer IAPT contributes complex designs, computational fluid and thermal modeling, and LPBF test sample and prototype fabrication.
- CIDETEC takes our raw printed metal components and applies advanced chemical surface treatments, smoothing, and protective functional coatings to minimize boundary layer friction and corrosion.
- ADT conducts comprehensive fouling and contamination tests under realistic operational scenarios to ensure long-term physical robustness and service life.
- TU Vienna mounts our prototypes onto dedicated, test benches to experimentally measure heat transfer rates and pressure drops, providing crucial empirical datasets that validate and refine our numerical simulation models.

This close synergy ensures our additive concepts evolve into viable, real-world aerospace solutions.

LOOKING AHEAD, WHAT IMPACT DO YOU HOPE EXFAN WILL HAVE ON THE FUTURE OF AVIATION?

We envision exFan resolving one of the most critical technological bottlenecks standing in the way of commercial hydrogen aviation: the severe thermal dissipation penalty of megawatt-class fuel cell powertrains. Demonstrating that waste heat can be aerodynamically recuperated to provide supplemental thrust without adding net drag will establish a new design benchmark for future green aircraft. Beyond achieving zero in-flight emissions, the project validates how advanced additive manufacturing can unlock optimized thermodynamic architectures that traditional aerospace manufacturing could never realize. Ultimately, we hope exFan serves as a foundational stepping stone for zero-emission regional and short-to-medium-range commercial aviation, accelerating the timeline toward climate-neutral flight while cementing European leadership in sustainable propulsion and industrial 3D printing.

EXFAN

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

PARTNER INSIGHTS

MEET THE PEOPLE BEHIND exFan

Innovation is driven by people, collaboration and expertise.



Mavroudis Kavvalos

Research Scientist

DLR Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

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EXFAN

PARTNER INSIGHTS

MEET THE PEOPLE BEHIND EXFAN

Mavroudis Kavvalos



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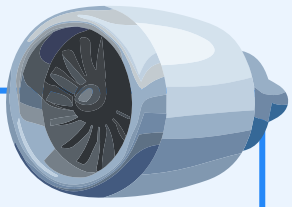
German Aerospace Center (DLR)

Stuttgart, Germany

DLR Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

> "The future of fan design lies beyond the fan itself, but in its seamless integration with surrounding components; exFan is a prime example of this approach in action."



WHAT IS YOUR ORGANISATION'S ROLE IN EXFAN?

DLR is responsible for the aerodynamic design and integration of the electrically driven ducted fan within the heat-integrated propulsor concept. Our activities focus on the design of the fan, intake, and transition duct connecting the fan to the heat exchanger. By combining aerodynamic component design with whole-engine performance analysis and numerical optimization, we investigate how the different components can be designed together to maximize overall installed efficiency (product of propulsive, transfer and installation efficiencies) while ensuring a compact and feasible propulsor flowpath.

WHY IS YOUR CONTRIBUTION IMPORTANT FOR THE SUCCESS OF EXFAN?

Integrating a compact heat exchanger into an electrically driven propulsor introduces significant aerodynamic challenges, particularly due to the different flow velocity requirements of the fan and heat exchanger. DLR brings extensive expertise in turbomachinery aerodynamics, fan design, and propulsion-system integration, supported by advanced numerical simulation and optimization capabilities. Our contribution is essential for ensuring that the individual components operate efficiently as an integrated system, minimizing aerodynamic losses and enabling the practical realization of the proposed propulsion concept.

EXFAN

PARTNER INSIGHTS

MEET THE PEOPLE BEHIND EXFAN

Mavroudis Kavvalos

WHAT DO YOU CONSIDER THE MOST EXCITING OR INNOVATIVE ASPECT OF YOUR WORK IN EXFAN?

One of the most exciting aspects is rethinking the conventional approach to fan design. Rather than optimizing the fan independently, we investigate how the required flow diffusion can be distributed between the intake, fan, and downstream transition duct. This allows us to reduce the flow velocity entering the heat exchanger without relying on an excessively long diffuser.

HOW DOES COLLABORATION WITHIN THE CONSORTIUM BENEFIT YOUR WORK?

The close collaboration between partners specializing in heat exchanger technology, propulsion systems, and aircraft integration allows us to approach the design from a multidisciplinary perspective. In particular, the interaction between fan aerodynamics and heat exchanger requirements is fundamental to our work. The continuous exchange of design requirements, performance data, and technical expertise enables us to identify system-level trade-offs and develop solutions that would be difficult to achieve by considering each component independently.

LOOKING AHEAD, WHAT IMPACT DO YOU HOPE EXFAN WILL HAVE ON THE FUTURE OF AVIATION?

We hope that exFan will demonstrate the potential of highly integrated propulsion architectures to improve the efficiency and feasibility of hydrogen-electric aircraft. By combining efficient electrically driven fans with compact heat exchangers, the project explores opportunities to recover otherwise rejected thermal energy and contribute to additional propulsive thrust. Beyond the specific concept, we expect the developed design methodologies and integration knowledge to support future aircraft propulsion systems, where optimizing the interaction between components will be essential for achieving more sustainable aviation.

EXFAN

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

PARTNER INSIGHTS

MEET THE PEOPLE BEHIND exFan

Innovation is driven by people, collaboration and expertise.



Philipp Jordan

Development Engineer

powerid

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EXFAN

PARTNER INSIGHTS

MEET THE PEOPLE BEHIND EXFAN

Philipp Jordan



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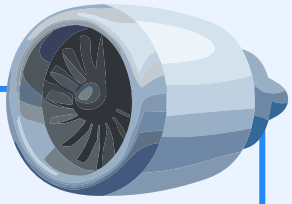
powerid

> exFan is proving that with the right multidisciplinary approach, the immense thermal challenges of hydrogen aviation can be transformed into efficiency advantages.



WHAT IS YOUR ORGANISATION'S ROLE IN EXFAN?

At Power I.D., our core focus within exFan is the energy system simulation of the aircraft, specifically the hydrogen fuel cell, the battery, and all associated auxiliary systems. Because the energy system is the beating heart of the aircraft, we are deeply involved in multiple work packages. In the early phases, we tackled fundamental sizing and feasibility questions: Which fuel cell and battery technologies can actually withstand aviation conditions, and how can they be optimally combined?

Since then, we have moved from fast sizing tools and steady-state models to developing a highly detailed, transient energy system model. Currently, we are simulating novel operational strategies —such as controlled overheating and oxygen injection—to extract the absolute maximum efficiency from the fuel cell and push the technological boundaries of the system.

WHY IS YOUR CONTRIBUTION IMPORTANT FOR THE SUCCESS OF EXFAN?

Ultimately, every component in the exFan architecture relies on power, meaning all system demands and electrical losses converge at our energy system. Simultaneously, the fuel cell is the largest single heat source in the aircraft. Therefore, an exact, robust, and fast simulation of the energy system is absolutely critical to the project's success. This is exactly our core strength. By applying complex multi-physics simulations, we integrate thermodynamics, fluid dynamics, electrical and systems engineering into one cohesive digital model. This level of detail allows the consortium to precisely map thermal management and energy distribution, which is the foundational prerequisite for making exFan's overall propulsion concept viable.

EXFAN

PARTNER INSIGHTS

MEET THE PEOPLE BEHIND EXFAN

Philipp Jordan

WHAT DO YOU CONSIDER THE MOST EXCITING OR INNOVATIVE ASPECT OF YOUR WORK IN EXFAN?

Personally, system simulation is what excites me the most. It is incredibly rewarding to take a highly complex architecture like a fuel cell and its auxiliaries, break it down, and develop the right modelling approaches from scratch. You are never confined to a single discipline; the work constantly crosses over into different engineering fields, keeping it constantly challenging.
Beyond that, I am fascinated by the holistic simulation approach we apply to the entire exFan system—from the electric fan and the drivetrain all the way to the energy system. Capturing the dynamic, transient interactions between all these subsystems is the only way to achieve true global optimization. I believe this fully integrated perspective makes exFan truly unique.

HOW DOES COLLABORATION WITHIN THE CONSORTIUM BENEFIT YOUR WORK?

Close collaboration is the backbone of our progress. Without this continuous exchange of knowledge, we could not have reached our current milestones. Beyond discussing deep technical details, it is often the fresh, interdisciplinary perspectives from our partners that challenge our assumptions and spark new solutions.
As a young professional at the beginning of my career, I am incredibly proud to contribute to a major EU project alongside renowned experts from across Europe. Looking back at my time in exFan so far, I haven't just massively expanded my technical expertise in systems engineering; the consortium's collaborative environment has also allowed me to grow significantly on a personal level. It is a fantastic environment for innovation!

LOOKING AHEAD, WHAT IMPACT DO YOU HOPE EXFAN WILL HAVE ON THE FUTURE OF AVIATION?

I believe exFan will pave the way for the next generation of low-emission, hydrogen-powered aviation. Right now, many promising zero-emission technologies are at a relatively low Technology Readiness Level, which inherently creates a lot of uncertainty regarding which architectures are truly viable for commercial flight.
The exFan project is essential because it helps clear this fog. By rigorously simulating and validating these novel energy and thermal management concepts, we are proving what is physically and operationally possible. We are effectively de-risking the technology and setting clear, actionable paths for subsequent projects to build upon, bringing sustainable aviation one step closer to reality.

EXFAN

NOVEL RECUPERATION SYSTEM TO MAXIMIZE
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PARTNER INSIGHTS

MEET THE PEOPLE BEHIND exFan

Innovation is driven by people, collaboration and expertise.

Project Coordinator
cidetec surface engineering

Technical Coordinator
ADT engineering

Research Coordinator
TU WIEN TECHNISCHE UNIVERSITÄT WIEN

Project Partners
TUM FZG
IRES Innovation in Research & Engineering Solutions
Egile MECHANICS
EASN TIS
Fraunhofer IAPT
DLR Deutsches Zentrum für Luft- und Raumfahrt German Aerospace Center
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