ClimAvTech

Climate Friendly Aviation Technologies (ClimAvTech) is a cluster of 13 research and innovation projects funded by the European Union to advance sustainable aviation.

BeCoM Better Contrails Mitigation	EFACA Environmentally Friendly Aviation for all Classes of Aircraft
EXFAN Novel recuperation system to maximize exergy from energy for fuel cell powered geared electric aircraft propulsion system	FFLECS Novel Fuel-Flexible ultra-Low Emissions Combustion systems for Sustainable aviation
FlyECO Future enabLing technologies for hYdrogen-powered Electrified aero engine for Clean aviation	HESTIA HydrogEn combuSTion In Aero engines
H2OPE Hydrogen Optimized multi-fuel Propulsion system for clean and silEnt aircraft	HYLENA HYdrogen eLectrical Engine Novel Architecture
MATISSE Multifunctional structures with quasi solid-state Li-ion battery cells and sensors for the next generation climate neutral aircraft	MINIMAL Minimum environmental impact ultra-efficient cores for aircraft propulsion
Mythos Medium-range hybrid low-pollution flexi-fuel/hydrogen sustainable engine	OVERLEAF PROJECT nOVel low-prEssure cRyogenic Liquid hydrogEn storAge For aviation
TRIATH2LON Thermodynamics-driven control management of hydrogen powered and electrified propulsion for aviation	Funded by the European Union

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Better Contrails Mitigation

BeCoM is a European research project that aims to better predict persistent contrails with the strong support of the enhanced routine humidity measurements at the cruise level, enabling reliable mitigation of aviation's climate impact driven by climate-based policy and regulations. BeCoM will develop and assess measures to largely reduce (>50%) or eliminate the global mean contrail radiative forcing, hence a substantial reduction of aviation's share of global warming to be achievable on a short time horizon. These measures include a reliable forecast of persistent contrails, reduced weather-dependent individual contrail radiative effects, and successful avoidance of strongly warming contrails via trajectory optimization.

To this end, BeCoM focuses on:

1. Enhancing the humidity measurements at cruise levels for assimilation into Numerical Weather Prediction (NWP) models
2. Developing more adequate representation of ice clouds in their supersaturated environment in the NWP models
3. Validation of the predictions to determine and reduce the remaining uncertainties of contrail forecasts
4. Developing a policy framework for effective contrail avoidance through a trajectory optimization approach. BeCoM will develop novel Artificial Intelligence (AI) algorithms to complement the assimilation and validation process.

BeCoM will predict the exact location and time of persistent contrail formation and formulate recommendations on how to implement strategies to enable AirTraffic Management to reduce aviation's climate impact. The BeCoM consortium, composed of one university, three research institutes, two companies and one international association, builds on its knowledge and expertise covering a wide spectrum from atmospheric science, climate research and AI capabilities to aviation operations research and policy development.

Project website: https://www.becom-project.eu/
Twitter: https://twitter.com/BecomProject
LinkedIn: www.linkedin.com/company/becom-project-eu/
Cordis: https://cordis.europa.eu/project/id/101056885

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Environmentally Friendly Aviation for all Classes of Aircraft

The EFACA project consists of 6 main objectives at 3 levels. Level 1 consists of three TRL3 demonstrations of technologies relevant to the greening of aviation: (WP1) bench testing of a gearbox combining input from gas turbine and electric motor for an hybrid turbo-electric propulsion system for a propeller-driven regional aircraft; (WP2) comparative testing of fuel cells with conventional liquid and novel phase cooling, to show the benefits of the latter in higher net power, reduced heat losses, and smaller volume and weight also reengineering of fuel cell and structural components to increase power-to-weight ratio; (WP3) static ground testing of a complete liquid hydrogen fuel system from cryogenic tank to vaporization and combustion in a wide range of operating regimes and simulation of application to the speed and altitude flight envelope of jet airliners. Level 2 consists of two preliminary designs: (WP7) an 80-seat 1000-km range regional propeller driven aircraft including design and integration of hybrid turbo-electric propulsion; (WP8) a 150-seat 2000-km range jet liner with liquid hydrogen fuel including design and integration of cryogenic tanks and fuel system. At level 3 a road map (WP10) for the achievement of the EU environmental targets for aviation synthetizing conclusions in four steps: (i) current status on (WP4) emissions and (WP5) noise versus future targets and gap to be covered; (ii) assessment of relevant technologies to cover the gaps, including (WP6) battery electric and (WP9) sustainable aviation fuels, besides hydrogen (WP7) fuel cells and (WP8) turbines; (iii) most suitable technology for each class of aircraft (light, small and medium regional, single and twin aisle jetliners), and maturation time of the technology; (iv) contribution of each aircraft class to CO_2 and non- CO_2 global and local emissions and noise, leading to (WP10) a comprehensive road map of actions for carbon-free or emissions-free flight.

Project website: https://efaca.eu/
Twitter: https://twitter.com/EFACAProject
LinkedIn: https://www.linkedin.com/company/efacaproject
Cordis: https://cordis.europa.eu/project/id/101056866

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EXFAN

Novel recuperation system to maximize exergy from anergy for fuel cell powered geared electric aircraft propulsion system

With the goal of climate neutral aviation by 2050, new propulsion technologies other than kerosene powered turbine engines are required. One of the possible solutions for aircraft propulsion are hydrogen fuel cells. Fuel cells produce no in-flight CO_2 emissions and are more efficient than traditional turbine engines. On top of that, hydrogen is an abundant and renewable natural resource. However, there are a multitude of challenges, that need to be solved before fuel cell electric aircraft can be a feasible solution for air travel. One of these challenges stems from the problem of heat generation: while turbine engines produce more heat than fuel cells, they are able to easily dissipate the heat as hot exhaust gases. A fuel cell – similar to a battery – gets hot in operation and requires a special thermal management system to keep it at its preferred operating temperature.

exFan investigates a novel solution to this challenge: instead of just rejecting the so-called waste heat and losing all its energy to the environment, exFan will use the ram-jet effect to produce thrust using the energized heated air that exits the heat exchangers. Therefore, the focus of the project is a heat recuperation device using the ram jet effect, called the Heat Propulsor.

The exFan system will be included in a geared electric fan propulsion system of mega-watt class powered by hydrogen fuel cell technology. The heat exchanger will be bionic design duly surface finished to hinder particle accumulation, corrosion, and erosion. Additionally, novel thermal management system will be designed to optimize the heat quality of the waste heat and control the heat flux of the propulsion system. Optimal operation conditions will also be investigated to find best system efficiency. And, a simulation model and functional tests of the exFan-propulsion system on a laboratory scale will be performed.

The breakthrough innovations proposed in exFan project will:

i. Allow European aircraft producers to offer savings in cost operation.
ii. Enable European aeronautics industry to maintain global competitiveness and leadership.
iii. Create significant contribution in the path towards CO_2 and NO_X emission free aircrafts.

Project website: https://www.exfan-project.eu
Twitter: https://twitter.com/exFan2024
LinkedIn: https://www.linkedin.com/company/exfan
Cordis: https://cordis.europa.eu/project/id/101138184

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Novel Fuel-Flexible ultra-Low Emissions Combustion systems for Sustainable aviation

FFLECS (Novel Fuel-Flexible ultra-Low Emissions Combustion systems for Sustainable aviation) is an RIA action funded by Cluster 5 of the Horizon Europe framework. In FFLECS, two ultra-low NO_X combustor architectures developed in two previous EU-funded projects will be further advanced to enable fuel-flexible operation using Synthetic Aviation Fuels (SAFs), hydrogen and their blends. In particular, FFLECS will advance (i) the lean azimuthal flame, a novel combustion system based on flameless oxidation (from the LEAFinnox project), and (ii) the compact helically arranged combustor, a new system which uses interacting lean lifted flames (from the CHAIRlift project). In addition, plasma and electric manipulation of fuel preparation and flame stabilisation mechanism will be investigated to further enhance fuel flexibility.

The specific objectives of FFLECS are to:

1. Investigate the fuel-flexible operation of the LEAF and CHAIR concepts and ex-tend the use of such technologies to low-carbon multi-fuel operation.
2. Investigate the use of electromagnetic interactions to enhance the control over fuel preparation, flame stabilisation and emissions.
3. Develop numerical models and diagnosis tools for the prediction of engine emis-sions and their control.

Experiments on available dedicated rigs and numerical investigations will be performed to provide knowledge at the fundamental and practical levels. These investigations are expected to enable TRL3 and higher developments by the end of the project. FFLECS developments will include new CFD, low-order, and AI models, and novel stabilisation techniques ripe for commercial exploitation.

Project website: https://fflecs.eu/
Cordis: https://cordis.europa.eu/project/id/101096436

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FlyECO

Future enabLing technologies for hYdrogen-powered Electrified aero engine for Clean aviation

FlyECO will deliver transformative technologies to support Integrated Power and Propulsion Systems (IPPS) that contribute to zero-emission and sustainable growth of aviation and has the potential to enable aviation climate neutrality by 2050. The utilization of hydrogen as sole energy source offers the opportunity to eliminate aviation CO_2 emissions. Furthermore, a re-duction in NO_X emissions of at least 50% is enabled by injecting steam produced by a solid oxide fuel cell (SOFC) into the hydrogen-fuelled gas turbine (GT). FlyECO will develop a simu-lation and evaluation framework in which the optimal architecture definition of the IPPS, the key enabling integration technologies and necessary controls concepts can be explored, in-vestigated closely and advanced towards Technology Readiness Level (TRL) 3 through Proof-of-Concept (PoC) demonstrators. A Commuter/Regional aircraft application was chosen as a use case to develop the propulsion system with more than one megawatt power (1 MW+). In particular, the energy management and distribution strategies will be developed for both quasi-steady-state and transient operation. In addition, PoC for the IPPS and the reduction in NO_X emissions will be provided via two demonstrators: a sub-structured test-rig emulating the cycle-integrated hybrid-electric propulsion system and a high-pressure combustor with steam ingestion. The outcome of FlyECO will be comprise of:

- An optimised IPPS architecture for a fully cycle-integrated, hydrogen-powered, hybrid-electric aero engine
- An advanced simulation platform to enable and analyse the impact of SOFC integration on a hydrogen GT
- A validation methodology for novel energy and power management strategies designed and optimised for the IPPS architecture
- A novel controls approach for the IPPS as a hydrogen-based and electrified aero engine, including specialised local control for components and subsystems as well as global control
- A set of key coupling technologies developed to enable the integration of the SOFC with a GT under consideration safe design process in aviation based on ARP 4754A
- Design guidelines for the future development of SOFC technology suitable for this airborne application
- An open-access database on hydrogen combustion with steam injection from second PoC demonstration

The expertise of the well-balanced consortium will allow FlyECO to evaluate, develop and analyse key enabling technologies including:

- Coupling technologies for air supply, as well as hydrogen and steam conditioning systems to enable cycle-integration of SOFC and GT including an integrated thermal management system with heat recuperation
- Electrical components for SOFC integration with localized controls approaches and algo-rithms
- Novel smart control and energy management strategies for coupled GT, SOFC and battery IPPS

Project website: https://flyeco-european-project.eu/ (coming soon)
LinkedIn: https://www.linkedin.com/company/flyeco-project
Cordis: https://cordis.europa.eu/project/id/101138488

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HydrogEn combuSTion In Aero engines

HESTIA aims to increase the scientific knowledge of the hydrogen-air combustion of future hydrogen fuelled aero-engines in order to reduce the climate impact of aviation. Decarbonization is in fact a major challenge, and current combustion chambers are burning hydrocarbon fuels, such as kerosene or more recently emerging SAF products.

Hydrogen is considered today as a promising energy carrier, but the burning of hydrogen creates radically new challenges which need to be understood and anticipated. Therefore, HESTIA specifically focuses on increasing the scientific knowledge of the hydrogen-air combustion of future hydrogen fuelled aero-engines. The related physical phenomena will be evaluated through the execution of fundamental experiments. This experimental work will be closely coupled to numerical activities which will adapt or develop models and progressively increase their maturity so that they can be integrated into industrial CFD codes.

The project objectives are to:

- Further the understanding of the H_2/air combustion through elementary lab scale testing and basic modelling of specific phenomena;
- Develop experimental capabilities and improved modelling methodologies for detailed assessment of H_2/air characteristics in more representative aeronautical conditions;
- Benchmark the performance of incremental and breakthrough injection systems concepts and identify the most relevant concepts.

To achieve these goals, HESTIA will address the following challenges:

- Improvement of the scientific understanding of hydrogen-air turbulent combustion: preferential diffusion of hydrogen, modification of turbulent burning velocity, thermoacoustic, NO_X emissions, adaptation of optical diagnostics;
- Assessment of innovative injection systems for H_2 optimized combustion chamber: flashback risk, lean-blow out, stability, NO_X emission minimization, ignition;
- Improvement of CFD tools and methodologies for numerical modelling of H2 combustion in both academic and industrial configurations.

To this end, HESTIA gathers 17 universities and research centres as well as the 6 European aero-engine manufacturers to significantly prepare in a coherent and robust manner the future development of environmentally friendly combustion chambers.

Project website: https://www.hestia-project.eu
Twitter: https://twitter.com/EuHestia
LinkedIn: https://www.linkedin.com/company/hestia-project/
Cordis: https://cordis.europa.eu/project/id/101056865

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Hydrogen Optimized multi-fuel Propulsion system for clean and silEnt aircraft

Increases in air traffic will increase fossil fuel combustion and acoustic emissions, worsening aviation's environmental impact. To mitigate such effects, **HOPE will design an efficient and fuel-flexible aircraft propulsion system compatible with operations for minimum noise and emissions at all stages of aircraft movement**. The project, co-funded by the EU and UKRI, will deliver an integrated aircraft propulsion system comprising two multi-fuel ultra-high bypass ratio (UHBR) turbofan engines. The combustion system will allow the burning of both 100% SAF and 100% H_2, as well as intermediate energy contributions. In addition, a fuel cell-based auxiliary propulsion and power unit (FC-APPU) will drive an aft boundary layer ingestion (BLI) propulsor based on the tube-and-wing aircraft configuration. This system will minimize the combustion and noise emissions during landing and take-off, allow the retrofitting of the existing aircraft configurations, and de-risk the introduction of 100% hydrogen propulsion in existing tube-and-wing aircraft configurations. HOPE will allow a smooth energy transition of the sector through several green propulsion technologies at different maturity levels.

The project objectives are:

1. To design an A320-/B737-class aircraft with an EIS of 2035, which exploits multi-fuel turbofan engines and a BLI propulsor driven by FC-APPU.
2. To design a multifuel combustion system with high-fidelity CFD simulations, validating the concept with atmospheric and low-pressure tests in terms of emissions and stability.
3. To design with CFD the aft BLI system, followed by manufacturing and wind tunnel testing to assess noise generation and propagation.
4. To assess the costs, benefits and impact of the HOPE novelties on society and the environment, considering air quality, noise, and global climate.

Overall, HOPE targets a 50% cut in CO_2 and NO_X emissions and more than 80% in soot, a reduction in noise near airports of 20%, and in global climate impact of 30%.

Project website: https://hope-eu-project.eu/
LinkedIn: https://www.linkedin.com/company/hope-horizon-europe-project
Cordis: https://cordis.europa.eu/project/id/101096275

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HYLENA

HYdrogen eLectrical Engine Novel Architecture

HYLENA will investigate, develop and optimize an innovative, highly efficient integrated electrical propulsion concept combined with Solid Oxide Fuel Cell and gas turbine, for short and medium range applications. It will achieve significant climate impact reduction by being completely carbon neutral with radical increase of overall efficiency.

The full synergistic use of:

a) an electrical motor (as the main driver for propulsion),
b) a contoured hydrogen fueled SOFC stack (geometrically optimized for nacelle integration),
c) a gas turbine (to thermodynamically integrate the SOFC),

will act as an enabler for hydrogen aviation and will allow for efficient and compact engine concepts. This disruptive propulsion system will be called HYLENA concept in this proposal.

From 2024 to 2027, HYLENA aims to evaluate and demonstrate the feasibility of a "game changing" engine type which integrates Solid Oxide Fuel Cells (SOFC) into a turbomachine, in order to utilize the high exergetic heat generated by the fuel cells on top of its electrical energy. The combination of e-motor, turbomachine and contoured SOFCs fueled with H_2 will deliver high overall efficiency and performance versus state-of-the-art turbofan engines. Indeed, HYLENA Figures of Merit consist of minimizing CO_2 emission; negligible NO_X and an unmatched overall efficiency versus state-of-the-art turbofans which corresponds to an outstanding performance increase. It will also enable to extend the flight range for the same fuel tank size.

The HYLENA consortium consists of one of the biggest aircraft manufacturer (AIRBUS), three major European universities (TUD, LUH, GRENOBLE INP - UGA) and two internationally recognized research institutes (DLR, BHL). The HYLENA consortium is ideally suited and fully committed to reach the project outcomes. In addition, the consortium has established a strong advisory board with stakeholders from various relevant areas to ensure further exploitation to the market and the society. The HYLENA consortium has a close link to the Clean Aviation Joint Undertaking in order to facilitate transfer of knowledge and technology.

LinkedIn: https://www.linkedin.com/company/hylena-project/
Cordis: https://cordis.europa.eu/project/id/101137583

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Multifunctional structures with quasi solid-state Li-ion battery cells and sensors for the next generation climate neutral aircraft

The introduction of hybrid electric aircraft is one of the envisaged ways to innovate the market of civil aviation while striving for climate neutrality by 2050. Hybrid electric propulsion is nowadays considered mainly for aircraft up to regional size with two main options for the onboard electrical power source: conversion - mechanical with a generator or electrochemical a (H_2) fuel cell system - and/or storage in batteries with substantial increase of aircraft empty mass to be expected in either option. Li-ion battery technology is maturing and is expected to reach its theoretical limits in the coming years, while post-Li-ion batteries (e.g. metal-S or metal-O_2) are still far from market. This poses significant challenges for electrifying the propulsion of larger aircraft (from commuter over regional to short-medium range).

Multifunctional electrical energy storage, equivalently referred to as structural batteries, are capable of storing electrical energy while bearing mechanical loads, seamlessly allowing for storage capabilities at zero weight penalty. So far, none of the many concepts investigated over the last decades, have achieved multifunctional efficiency adequate for aeronautic applications and several gaps in research, technology development and, specifically to the aeronautic field, in airworthiness certification have never been tackled.

The HORIZON project MATISSE (Multifunctional structures with quasi-solid-state Li-ion battery cells and sensors for the next generation climate neutral aircraft), building upon the CleanSky 2 project SOLIFLY (Semi-SOlid-state LI-ion batteries FunctionalLY integrated in composite structures for next generation hybrid electric airliner, 2021-2023), addresses the fundamentals of structural batteries by combining research and technology development in the fields of: (a) structural electrochemistry; (b) integration of energy storage into CF composite laminate and sandwich structures; (c) integration of sensing and monitoring micro-electronics for both energy storage and surrounding structure; and (d) manufacturing and certification while exploring the potential of deploying such technology in multiple aircraft categories.

This presentation will provide an overview of the current research performed and preliminary results achieved within SOLIFLY and MATISSE and the way forward to demonstrating the feasibility of aeronautic structural batteries (at TRL4), first (in 2023) within a standard interior aircraft part, i.e. a stiffened composite panel of representative size, and later (in 2025) at full scale in a replaceable wingtip of a fully electric light aircraft, i.e. Pipistrel VELIS Electro.

Project website: https://www.matisse-project.eu/
LinkedIn: https://www.linkedin.com/company/matisse-project/
Cordis: https://cordis.europa.eu/project/id/101056674

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MINIMAL

Minimum environmental impact ultra-efficient cores for aircraft propulsion

Building a sustainable and climate neutral future for aviation is an inevitable requirement for a society with increasing mobility needs. If we are to stabilize the global temperature below the 1.5°C threshold set by the Paris Agreement, rapid action is to be taken. MINIMAL (Minimum environmental impact ultra-efficient cores for aircraft propulsion) will contribute to a radical transformation in air transport by providing disruptive ultra-efficient and low-emission technologies that will, in combination with the aviation ecosystem, sustainably reduce the climate impact of aviation.

The MINIMAL project will, through a joint effort between European engine OEMs, atmospheric scientists, and lead researchers in combustion and propulsion, attack the major sources of non-CO_2 and CO_2 emissions in aeroengines. This is accomplished with the introduction of new propulsion systems based on composite cycle engine (CCE) technology, that provides unparalleled efficiency levels and performance flexibility for climate friendly operations.

The project will provide experimental (TRL 3) proof of concept of cutting-edge technology with the potential to eliminate the large sources of climate forcing; low-NO_X micromix opposed piston hydrogen combustion technology; heat-management system that exploits the cooling potential of hydrogen (intercooling, piston heat recovery). Integration studies on the CCE architectures will allow to quantify the performance on future-looking application scenarios, covering typical missions from short to long ranges. The integration studies are supported by climate impact studies to investigate the interdependencies between non-CO_2 and CO_2 effects during the early stages of aero-thermal-mechanical design and converge into engine options with minimum climate impact.

This presentation will discuss the overall project background, concept, structure, goals and lessons learned to date.

Project website: https://www.minimal-aviation.eu/
Twitter: https://twitter.com/minimal_project
LinkedIn: https://www.linkedin.com/company/minimal-project
Cordis: https://cordis.europa.eu/project/id/101056863

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Mythos

Medium-range hybrid low-pollution flexi-fuel/hydrogen sustainable engine

The project MYTHOS proposes to develop and demonstrate an innovative and disruptive design methodology for future short/medium range civil engines. For a complete decarbonization, this class of engines should be operating using a wide range of liquid and gaseous fuels including Sustainable Air Fuels (SAFs) and, ultimately, pure hydrogen.

To achieve this goal, the MYTHOS consortium develops and adopts a multidisciplinary multi-fidelity modelling approach for the characterization of the relevant engine components, deploying the full power of the method of machine learning. The latter will lead through hidden-physics discovery to advance data-driven reduced models which will be embedded in a holistic tool for the prediction of the environmental footprint of the civil aviation of all speeds. A unique aspect of the project is the high-fidelity experimental validation of the numerical approaches. MYTHOS consortium through this approach will contribute to reduce time-to-market for engines designed and engineered to burn various types of environmentally friendly fuels, such as SAF, in the short and medium term, and hydrogen, in the long term.

The project objectives are to:

- To deliver a disruptive improvement in the regional aircraft propulsive technology allowing a flexible usage of biofuels and H2 up to 100% in fuel blend in line with the objectives of the EU industrial Roadmaps and R&I activities especially linked to the Clean Aviation Partnership SRIA and ReFuelEU Initiative;
- To advance further integrated and reference European models and methods for estimating aircraft emissions inventories for operations in the airport vicinity, when using flexi-fuel engines.

To achieve these goals, MYTHOS will address the following challenges:

- Development of accurate and efficient chemistry mechanisms and surrogate models for drop-in SAFs;
- Development of numerical methods for high-fidelity multi-physics modelling by implementing improved chemistry-turbulence and synthetic turbulence closures;
- Improvement and deployment of high-fidelity experimental measurements and techniques (e.g. high resolved high-speed PIV and PLIF) for model validation;
- Development of efficient algorithms for handling large datasets, based on the hybridisation of linear and non-linear methods for data- and knowledge-driven model order reduction.

The MYTHOS consortium is composed of 5 partners: three Universities, one research institution and one SME. The members are located in three different member states of the European Union: Italy, Germany and Sweden. The consortium was carefully composed to provide the skills and experience required to accomplish the proposed work and cover the technological aspects mentioned in the topic. All partners are suited, qualified, and strongly committed to the tasks they have been assigned in the project. Both for the type of organization and for the domain of work, the consortium partners' competences are complementary to each other. Furthermore, the work has been distributed among the partners to ensure optimal collaboration and exploitation of the different competences.

Project website: https://mythos.ruhr-uni-bochum.de/
LinkedIn: https://www.linkedin.com/company/mythos-horizon-europe
Cordis: https://cordis.europa.eu/project/id/101096286

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nOVel low-prEssure cRyogenic Liquid hydrogEn storAge For aviation

OVERLEAF aims to develop a game-changing Liquid Hydrogen (LH2) storage tank to enable the transition towards H_2 -powered aviation. It will thus contribute towards the goals of the EU Green Deal by 2050 for the aviation sector.

The **low-pressure**, **liquid hydrogen storage system architecture** (**LPH**) will combine **new materials solutions, advanced and flexible manufacturing technologies, and sensors into an optimum configuration design**. The aim is to improve the thermal performance of the storage tank, minimise the pressure inside the inner and the outer tanks and significantly reduce hydrogen leakage during in-service operation compared to SoA available LH_2 storage solutions.

The new LPH storage system will be designed to reach an average gravimetric index (GI) of 40% and overall higher operation flexibility, with an estimated 60% reduction of the total weight/energy consumption and a 25% increase in onboard H_2 storage capacities. Thanks to the low operating pressures (maximum 6 bar inside the tanks) that will be attained within the system, it will be possible to propose new composite-based materials solutions and advanced automated manufacturing processes. This will significantly reduce the overall system's weight, thus, increasing GI. In addition, it will improve the design flexibility of the tanks and their robustness as they are structurally part of the fuselage. Costs will thus be significantly reduced for commercial aircraft compared to state-of-the-art available H_2 storage systems.

Project website: https://overleaf-project.eu/
Twitter: https://twitter.com/overleaf_eu
LinkedIn: https://www.linkedin.com/company/overleafproject/
Cordis: https://cordis.europa.eu/project/id/101056818

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Thermodynamics-driven control management of hydrogen powered and electrified propulsion for aviation

TRIATHLON aims to develop disruptive approaches to design more robust, low-maintenance, low-emission, highly responsive hydrogen-electric powertrains for megawatt class aircraft by using the synergy between powertrain components. The disruptive technologies, that will be developed up to TRL3 within TRIATHLON, will when adopted on the next generation aircraft scheduled to enter service by 2035-2050 contribute to:

1) Reduction of emissions by implementation of NO_x reduction strategies like injection of exhaust water of the fuel cell (FC) into the combustion chamber (CC) and by capturing vented and permeated hydrogen and recompressing it;
2) Elimination of the need for a cryogenic pump by using a high-pressure storage buffer for pressurisation of the fuel distribution system (making the fuel distribution more robust for turbulence as well);
3) Reduction of the power required for hydrogen conditioning using excess heat from FC and CC by means of 3D printed heat exchangers using innovative materials like ceramics, and smart thermal management;
4) Improvement of the gravimetric index of the entire powertrain by providing an effective heatsink to powertrain components, reducing the need for coolant, allowing design of a more compact and lightweight CC, as well as the need for insulation of the hydrogen storage whilst enabling a longer dormancy time.

The expected outcomes of TRIATHLON include:

- Improved FC thermal management to reduce the coolant flow rate.
- Weight reduction of the thermal management system due to lower coolant flow rate and more compact heat exchangers (at least –20% weight versus traditional manufacturing techniques).
- Control of instabilities and emissions associated to hydrogen combustion by means of fuel temperature adjustment and water injection.
- Concept design of a multi-state storage system requiring no cryopump and with no H_2 boil-off to the environment.
- Design of thermal management components using innovative tools based on dynamic simulation of the whole fuel system and its components to assess control approaches and to regulate the powertrain during the flight envelope.
- Improved gravimetric/volumetric energy density of all-composite Cryo-compressed hydrogen (CcH2) storage systems without metallic liners (up to 80g/l for CcH2 vs. 40-60 g/l for gaseous hydrogen (GH2) or liquid hydrogen (LH2)).
- Lower cost of the H_2 fuel system due to the absence of the cryopump (about 100k€ saved).
- Tested heat transfer performance of 3D printed technical ceramic material with different fluids, including cryogenic H_2.

Project website: https://triathlon-project.eu
LinkedIn: https://www.linkedin.com/company/triathlon-project/
Cordis: https://cordis.europa.eu/project/id/101138960

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