AIRBUS

Press Release

Innovative aviation liquid hydrogen project launched

Brussels, 16 May 2024 - An innovative aviation hydrogen handling and refuelling project, led by Airbus and supported by academic partners, airport operators and leading hydrogen-industry companies, has been launched to demonstrate small-scale liquid hydrogen aircraft ground operations at three European airports.

The urge to decarbonise our economy and to develop Europe's energy independence is leading to a major trend of hydrogen for mobility and stationary applications. Hydrogen will also be a solution to decarbonise short- and medium-haul aviation and will be crucial for the advancement of low-carbon aviation operations.

The GOLIAT (Ground Operations of LIquid hydrogen AircrafT) project* will receive funding of €10.8 million from the EU's Horizon Europe Framework Programme, over a duration of four years, and will demonstrate how high-flow liquid hydrogen (LH2) handling and refuelling technologies can be developed and used safely and reliably for airport operations.

The GOLIAT consortium consists of 10 partners from eight countries: Airbus (France, Germany, UK), Chart Industries (Czech Republic, Italy), TU Delft (Netherlands), Leibniz University Hannover (Germany), Royal Schiphol Group (Netherlands), Rotterdam The Hague Airport (Netherlands), Vinci Airports (France, Portugal), Stuttgart Airport (Germany), H2FLY (Germany), and Budapest Airport (Hungary).

The group will support the aviation industry's adoption of LH2 transportation and energy storage solutions by:

- Developing and demonstrating LH2 refuelling technologies scaled-up for future large commercial aircraft;
- Demonstrating small-scale LH2 aircraft ground operations at airports;
- Developing the standardisation and certification framework for future LH2 operations;
- Assessing the sizing and economics of the hydrogen value chains for airports.

As a clean and efficient fuel, LH2 offers a promising solution for reducing the greenhouse gas emissions associated with airport operations and their dependence on fossil fuels. LH2's high energy density enables long-range travel for aircraft, yet there are many steps to the widespread deployment of hydrogen at airports, including the need to better understand the operational, regulatory, economic and safety impacts, as well as the capacity and performance of technologies.

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Quotes from partners

Karine Guenan, Vice President of ZEROe Ecosystem, Airbus:
“We continue to believe that hydrogen will be an important fuel for the future of short-haul aviation. We welcome the opportunity to help build the operating case for the widespread daily use of liquid hydrogen at airports.”

Josef Kallo, co-founder and CEO, H2FLY:
"Leveraging our experience in the HEAVEN project, where we completed the world's first piloted flight of a liquid hydrogen-powered electric aircraft, we look forward to contributing our expertise in LH2 operations to GOLIAT. We believe in the potential of hydrogen to transform aviation and are committed to supporting its adoption for a sustainable future. GOLIAT marks another important step in our journey toward decarbonizing the aviation industry, and we are excited to be part of this important initiative."

Jill Evanko, CEO and President, Chart Industries, Inc.:
“It is a privilege to work with the esteemed GOLIAT Consortium partners and progress decarbonization in heavy transport through the value chain,” stated Jill Evanko, Chart’s CEO and President. “With over 158 years of experience in hydrogen technology, process and equipment, we are excited to share our expertise to further progress the liquid hydrogen application in mobility and transport as well as the associated infrastructure.”

Alexei Sharpanskykh, Elise Bavelaar, and Pieter-Jan Proesmans, Faculty of Aerospace Engineering, TU Delft:
“At Delft University of Technology, we are researching various aspects of hydrogen-powered aviation since this energy carrier shows great potential to reduce aviation’s climate impact. To facilitate this transition, we should develop suitable airport infrastructure and operations. As a partner in the GOLIAT project, we look forward to creating operational concepts and computational models for airport ground operations of hydrogen-powered aircraft, considering the airline’s perspective. This way, we can help airports and airlines prepare for future hydrogen aircraft and contribute to a more sustainable aviation ecosystem.”

Richard Hanke-Rauschenbach, Head of Institute of Electric Power Systems, Leibniz University Hannover:
“We are very pleased to join the GOLIAT team and to contribute our expertise on techno-economics of green LH2 supply infrastructures to the project. Such demonstrators are not only an important step towards making H2-powered aviation a reality, but also provide valuable insights for the future development of a cost effective and reliable LH2 supply chain. Identifying the requirements for the infrastructure as early as possible is crucial to the success of our joint efforts towards a more climate-friendly air transport system.”

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Wilma van Dijk, CEO Rotterdam The Hague Airport:
"We are very delighted to be a partner of the GOLIAT project and to host one of the demonstrations at Rotterdam The Hague Airport. As part of the Royal Schiphol Group, we strongly believe that hydrogen, alongside sustainable aviation fuels and electric flight, is one of the potential energy carriers to decarbonize aviation. However, there are many challenges that need to be addressed on multiple fronts in order to fully realise the potential of hydrogen aviation, including refuelling of hydrogen aircraft. As a regional airport, we're at the forefront of hydrogen aviation initiatives, with multiple projects underway in collaboration with various partners in our region. The GOLIAT project aligns seamlessly with our hydrogen roadmap, serving as a crucial step towards the preparation and integration of hydrogen aviation within our airport environment."

Ulrich Heppe, CEO, Stuttgart Airport:
"The decarbonization of aviation poses a significant challenge for all of us. At the same time, we now have the opportunity to collectively contribute to enabling sustainable travel. From the outset, it has been clear to us in Stuttgart that hydrogen will play a central role. At Stuttgart Airport we see our role as an enabler, working with partners to find solutions early on that can be implemented on a large scale. With GOLIAT, we take a major step forward that will empower airports and airlines to transform aviation in the next years."

Kam Jandu, Chief Executive Officer, Budapest Airport:
"To achieve the ambitious goal of climate neutrality, all aviation stakeholders need to reduce their carbon emissions, and this requires effective technological and operational developments. At Budapest Airport, we have set ourselves the goal of achieving net-zero emissions by 2035 at the latest, and we are continuously taking steps to achieve this," said Kam Jandu, chief executive officer of Budapest Airport. He added: "As a responsible airport operator, we are pleased to join the GOLIAT project in line with our sustainability ambitions. We believe that developing a systematic and consistent approach to the introduction of hydrogen at airports is key to the green transformation and decarbonization of aviation."

Nicolas Notebaert, Chief Executive Officer of VINCI Concessions and President of VINCI Airports:
"Committed to support and accelerate on the decarbonation of air transport, VINCI Airports is acting to develop the use of hydrogen in airports. We are pleased to combine our expertise in this innovative airport ground operation for a hydrogen-powered aircraft project. By 2027, the Lyon-Saint Exupery airport will receive and conclude the demo of this pilot project with a firstHydrogen Plane. Meanwhile, airports we operate in Portugal are also

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involved in the technical studies of this project for the future infrastructures that will be required."

The benefits of hydrogen in aviation

Hydrogen is a high-potential technology with a specific energy-per-unit mass that is three times higher than traditional jet fuel. If generated from renewable energy through electrolysis, hydrogen emits no CO2 emissions, thereby enabling renewable energy to potentially power large aircraft over long distances without the undesirable by-product of CO2 emissions.

Because hydrogen has a lower volumetric energy density, the visual appearance of future aircraft will likely change to better accommodate hydrogen storage solutions that will be bulkier than existing jet fuel storage tanks.

Hydrogen has been safely used in the aerospace and automobile industries for decades. The aviation industry's challenge is to adapt this decarbonised energy carrier to commercial aviation's needs.

There are two primary uses for hydrogen:

Hydrogen propulsion: Hydrogen can be combusted through modified gas-turbine engines or converted into electrical power that complements the gas turbine via fuel cells. The combination of both creates a highly efficient hybrid-electric propulsion chain powered entirely by hydrogen.

Synthetic fuels: Hydrogen can be used to create e-fuels, which are generated exclusively through renewable energy.

Notes to Editor:

References:

* Based on the call CL5-2023-D5-01-07 "Hydrogen-powered aviation"

GOLIAT is funded by the European Union. Views and opinions expressed are, however, those of the author(s) only and do not necessarily reflect those of the European Union or the granting authority. Neither the European Union nor the granting authority can be held responsible for them.

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About GOLIAT
In the near future, hydrogen will be a solution to decarbonise short- and medium-haul aviation.

The EU-funded GOLIAT project brings together aircraft manufacturers (Airbus, H2FLY), a technology provider (Chart Industries), research institutions (TU Delft, Leibniz University Hannover), and airport operators (Vinci Airports, Schiphol Airport, Rotterdam Airport, Stuttgart Airport, Budapest Airport) to enable widespread use of hydrogen at airports by:

- Developing and demonstrating liquid hydrogen (LH2) refuelling technologies scaled-up for future large commercial aircraft;
- Demonstrating small-scale liquid hydrogen aircraft ground operations at airports;
- Developing the standardisation and certification framework of future liquid hydrogen operations;
- Assessing the sizing and economics of hydrogen value chains for airports.

Further information can be found on the GOLIAT project card and project updates will be posted on the GOLIAT LinkedIn page.

Information on GOLIAT project members:

About Airbus
Airbus is a leader in designing, manufacturing and delivering aerospace products, services and solutions to customers on a worldwide scale. With around 134,000 employees and as the largest aeronautics and space company in Europe and a worldwide leader, Airbus is at the forefront of the aviation industry. We build the most innovative commercial aircraft and consistently capture about half of all commercial airliner orders. Thanks to our deep understanding of changing market needs, customer focus and technological innovation, we offer products that connect people and places via air and space.

For more information, click here:
https://www.airbus.com/en

About H2FLY
H2FLY was founded by five engineers from the German Aerospace Center in Stuttgart and the University of Ulm. H2FLY GmbH is working to deliver to market the first qualified, fully hydrogen-electric aircraft powertrain. By bringing hydrogen fuel cell technology to the next level, H2FLY plans to unlock the era of emission-free, sustainable air travel. The company develops hydrogen-electric propulsion systems for aircraft and is a global leader in the

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development and testing of such systems. The HY4, designed to be the world's first hydrogen-electric passenger aircraft, first took off in 2016, demonstrating both the feasibility and potential of this technology for the aviation of the future. H2FLY has a powerful network of partners in industry and science and is currently working to accelerate its technology development and commercialization with the support of German and European partnerships. In just a few years, hydrogen-electric aircraft are expected to be able to transport 40 passengers over distances of up to 2,000 kilometres (1,240 miles).

H2FLY was acquired in 2021 by Joby Aviation, a California-based company developing electric vertical take-off and landing (eVTOL) aircraft for commercial passenger service.

For more information, click here:
www.h2fly.de

About Chart Industries, Inc.
Chart Industries, Inc. is a leading independent global leader in the design, engineering, and manufacturing of process technologies and equipment for gas and liquid molecule handling for the Nexus of Clean™ - clean power, clean water, clean food, and clean industrials, regardless of molecule. The company's unique product and solution portfolio across stationary and rotating equipment is used in every phase of the liquid gas supply chain, including engineering, service and repair from installation to preventive maintenance and digital monitoring. Chart is a leading provider of technology, equipment and services related to liquefied natural gas, hydrogen, biogas and CO2 capture amongst other applications. Chart is committed to excellence in environmental, social and corporate governance (ESG) issues both for its company as well as its customers. With 64 global manufacturing locations and over 50 service centres from the United States to Asia, Australia, India, Europe and South America, the company maintains accountability and transparency to its team members, suppliers, customers and communities. To learn more, visit www.chartindustries.com

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About TU Delft
Top education and research are at the heart of the oldest and largest technical university in the Netherlands. Our 8 faculties offer 16 bachelor's and more than 30 master's programmes. Our more than 25,000 students and 6,000 employees share a fascination for science, design and technology. Our common mission: impact for a better society. The Faculty of Aerospace Engineering at Delft University of Technology is one of the world's most highly ranked (and

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most comprehensive) research, education and innovation communities devoted entirely to aerospace engineering and related disciplines such as wind energy.

For more information, click here:
https://www.tudelft.nl/en/

About Leibniz University Hannover

Leibniz University Hannover (LUH) is the second largest university in Lower Saxony, Germany,
with around 27,200 students. More than 3,100 scientists work on nine faculties with more than
150 institutes. The university offers a wide range of study opportunities with around 84 study subjects. The spectrum ranges from engineering and natural sciences, architecture and environmental planning, law, social sciences, economics and business administration to the humanities. Only a few universities in Germany are able to offer a comparable range of subjects.In research, international and interdisciplinary aspects of our core research topics Biomedical Research and Engineering, Quantum Optics and Gravitational Physics, Optical Technologies, Production Engineering, Interdisciplinary Studies of Science and Academia, Energy Research and Teacher Training are continuously being expanded.

For more information, click here:
https://www.uni-hannover.de/en/

About Rotterdam The Hague Airport

Rotterdam The Hague Airport (RTHA) has set ambitious goals for sustainability, innovation, passenger satisfaction, and regional connectivity. Each year, more than two million passengers choose our airport to reach over fifty European destinations, whether for business or leisure. As a member of the Royal Schiphol Group, RTHA contributes significantly to regional development, surpassing its role merely as an aviation hub. In collaboration with our partners, we strive to deliver an exceptional passenger experience and serve as a testing ground for innovation in the aviation industry. Furthermore, our airport is a place of employment, a platform for education,
cooperation, and business support, highlighting the strengths of our region. Additionally, we play a vital societal role by providing a base for trauma helicopters and police services in the area.

For more information, click here:
https://www.rotterdamthehagueairport.nl/en/

About Stuttgart Airport

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Stuttgart Airport has more than 10 million passengers each year. About 55 airlines run flights to more than 100 destinations worldwide. In one of Europe's economically strongest regions, the airport is a major provider of mobility for people and the economy, both from and to Baden-Wuerttemberg. Recognizing its responsibility for the environment, neighbours and society, Stuttgart Airport aims at becoming one of the best-performing and most sustainable airports in Europe - the fairport STR.

For more information, click here:
https://www.stuttgart-airport.com/?cl=en

About Royal Schiphol Group
Royal Schiphol Group is the owner and operator of Amsterdam Airport Schiphol, Rotterdam The Hague Airport and Lelystad Airport, and holds a majority stake in Eindhoven Airport. Airports in the Group create value for society and for the economy, with safety as a key enabler.

For more information, click here:
https://www.schiphol.nl/en/schiphol-group/

About Budapest Airport
Ferenc Liszt National Airport has been voted the best European airport in 2022 among airports with 15-25 million passengers, based on passenger feedback. Budapest Airport also holds the title of best airport in the region, as recognized by Skytrax in 11 consecutive years from 2014 to 2024, also based on passenger ratings. The international aviation research organisation has also upgraded the airport's rating from three to four stars in 2023, based on a review of five hundred performance indicators covering all passenger services. Over the past years, Budapest Ferenc Liszt National Airport has emerged as a leader, becoming the fastest developing airport in the region. Together with its airline partners, it is a key contributor to the development of tourism in Hungary and Budapest. The BUD Cargo City is a focal point for import and export air cargo; Budapest Airport's aim is to become the cargo gateway for East-Central Europe.

For more information, click here:
https://www.bud.hu/en/budapest_airport/facts_about_bud

About VINCI Airports
As the world's leading private operator in its sector, VINCI Airports manages more than 70 airports across 13 countries in Europe, Asia and the Americas. Thanks to its expertise as a global integrator, it develops, finances, builds and manages airports, leveraging its

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investment capacity and know-how in optimising operational performance, modernising infrastructure and steering their environmental transition.

For more information, click here:
https://www.vinci.com/vinci.nsf/en/index.htm

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