DLR
March 25, 2025 | **Reducing non-carbon dioxide effects in aviation**

In search of the best sustainable fuels for climate-compatible aviation

The EU PACIFIC project is investigating how fuel composition affects aircraft behaviour – from basic experiments and test rig trials to real-world operations.


DLR's Simfuel® platform contains the properties of more than 15,000 fuels and relevant substance groups.

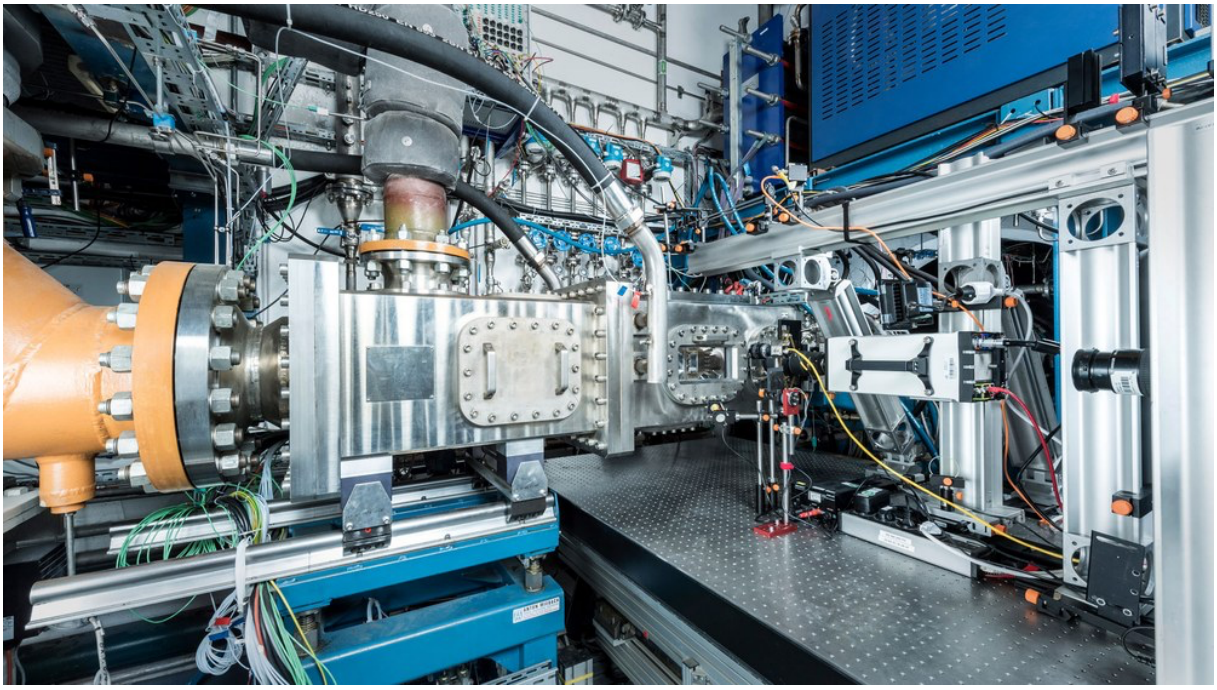
Based on this data, SAFs can be specifically designed to produce less soot during combustion.

- As part of the EU's PACIFIC project, DLR is testing promising sustainable aviation fuels for their potential to reduce the sector's climate impact.
- The findings will help improve digital tools for sustainable fuel design.
- The goal is to minimise soot formation during the combustion of sustainable fuels, leading to fewer ice crystals in condensation trails and a lower overall climate impact.
- Focus: Aviation, climate-compatible flying, sustainable fuels

Sustainable Aviation Fuels (SAFs) will play a central role in reducing the climate impact of aviation over the coming years. A study by the European Union Aviation Safety Agency (EASA) has identified six measures for achieving the fastest possible emission reductions with SAF, including their targeted design to minimise soot formation. But which fuels are best suited for reducing non-carbon dioxide climate effects based on their chemical composition? The EU PACIFIC (Particle emissions, Air Quality and Climate Impact related to Fuel Composition and Engine Cycle) project, led by Airbus, aims to answer this question. The German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) is collaborating on the project along with Rolls Royce, Neste and others, to test and evaluate ten carefully selected SAF variants for their soot formation and reduction potential. The project is receiving around five million euros in EU funding and will run for three and a half years.

Sabine Klauke, Chief Technology Officer at Airbus, says: "Addressing aviation's non-carbon dioxide emissions is crucial to achieving truly sustainable aviation. We are committed to minimising these impacts through science-based approaches and innovative technologies, while maintaining operational efficiency. The PACIFIC project will quantify and measure the non-CO_2 emissions associated with different SAF compositions. Using an innovative ground experimentation process, we will be able to reproduce conditions without delay and repeat them when needed. We look forward to the results of this multi-year project."

Extensive testing on high-pressure test benches and aircraft



Sustainable aviation fuels (SAF) put to the test at HBK1
The three most promising SAF blends being tested under real cruise flight conditions in the High-pressure Combustion Chamber Test Rig 3 (HBK1), operated by the DLR Institute of Propulsion Technology. Researchers are analysing soot emissions in the exhaust gas.
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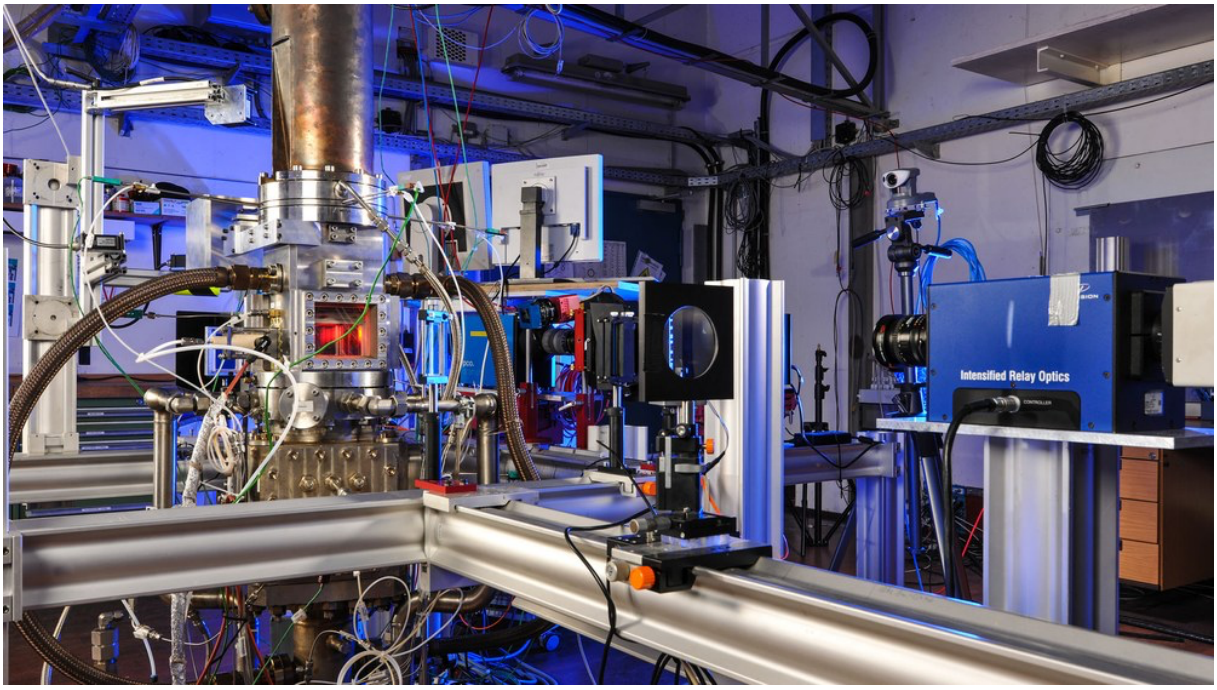
During the project, SAF variants will be examined in detail under realistic conditions for the first time and compared directly with one another. The fuels will first be tested on the single-sector combustor test facility operated by the DLR Institute of Propulsion Technology in Cologne. Researchers will then analyse three selected SAF compositions under real cruising flight conditions in a the high-pressure combustion chamber at the HBK1 test facility. In both test environments, the research team will use a special measurement technique to analyse the soot particles in the exhaust gases – specifically assessing their concentration and size distribution across the different fuels.
Researchers at the DLR Institute of Combustion Technology are contributing their laser diagnostics to these investigations. Selected fuels will also be assessed in collaboration with the University of Helsinki to determine their influence on ice crystal formation. Based on ground measurements, the University of Mainz will then model the climate impact of contrails produced by different fuel compositions. Further ground emission measurements are planned at Airbus in Toulouse using a mobile measurement vehicle from the DLR Institute of Combustion Technology.



Different SAF variants in DLR's single-nozzle sector test rig
DLR is analysing the potential of ten selected sustainable aviation fuel (SAF) variants to reduce soot emissions using the single-nozzle sector test rig at the DLR Institute of Propulsion Technology.
Credit:

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"The climate impact of aviation is driven by both carbon dioxide and non-carbon dioxide effects. The extent of these effects depends on the chemical composition of the fuel, the combustion processes in the engines and the interaction of the emitted pollutants with the surrounding air," says Markus Fischer, DLR Divisional Board Member for Aeronautics. "Through our wide-ranging involvement in the EU's PACIFIC project, we aim – together with our collaborators from industry and research – to maximise the reduction of contrail's warming effect. By selecting and using the most suitable sustainable aviation fuel compositions, we are paving the way for climate-compatible aviation with significantly reduced non-carbon dioxide effects and a reduced carbon footprint."

Data flows into a digital fuel design tool

The DLR Institute of Combustion Technology is working intensively to enable predictions on the tendency of a fuel to produce soot based on their composition. To do this, researchers are using models from the Simfuel® platform and its extensive database, which now includes data on more than 15,000 conventional jet fuels, over 450 novel fuels and various analyses of key molecular groups and models of material properties. Using machine learning models for material and performance properties, this database allows researchers to predict fuel behaviour in technically relevant processes. The project is now expanding the database to include the Yield Sooting Index (YSI) of real fuels – an indicator of a fuel's soot tendency, using laser-based laboratory measurements.
"The basic idea is to investigate the influence of fuel composition from fundamental experiments through to test bench trials and, ultimately, real-world aircraft behaviour," says Georg Eckel, DLR project leader for PACIFIC. "By doing so, we aim to close gaps in our understanding left by previous flight tests. Another major advantage is that DLR will also be able to further develop the DLR Simfuel® design tool platform in the process." The ultimate goal is to design efficient and sustainable

fuels that minimise the climate impact and also improve local air quality at airports. The EU's PACIFIC project is making a valuable contribution in this regard.

Related links

- PACIFIC project website
- FAQ – Sustainable Aviation Fuels (SAF)
- DLR Institute of Combustion Technology
- DLR Institute of Propulsion Technology

Project participants

Airbus, Rolls-Royce Deutschland Ltd & Co KG, Rolls-Royce PLC , Neste Oyj, DLR, Johannes Gutenberg University Mainz, Erdyn Consultants SAS, Helsingin Yliopisto, The Manchester Metropolitan University, The University of Sheffield.