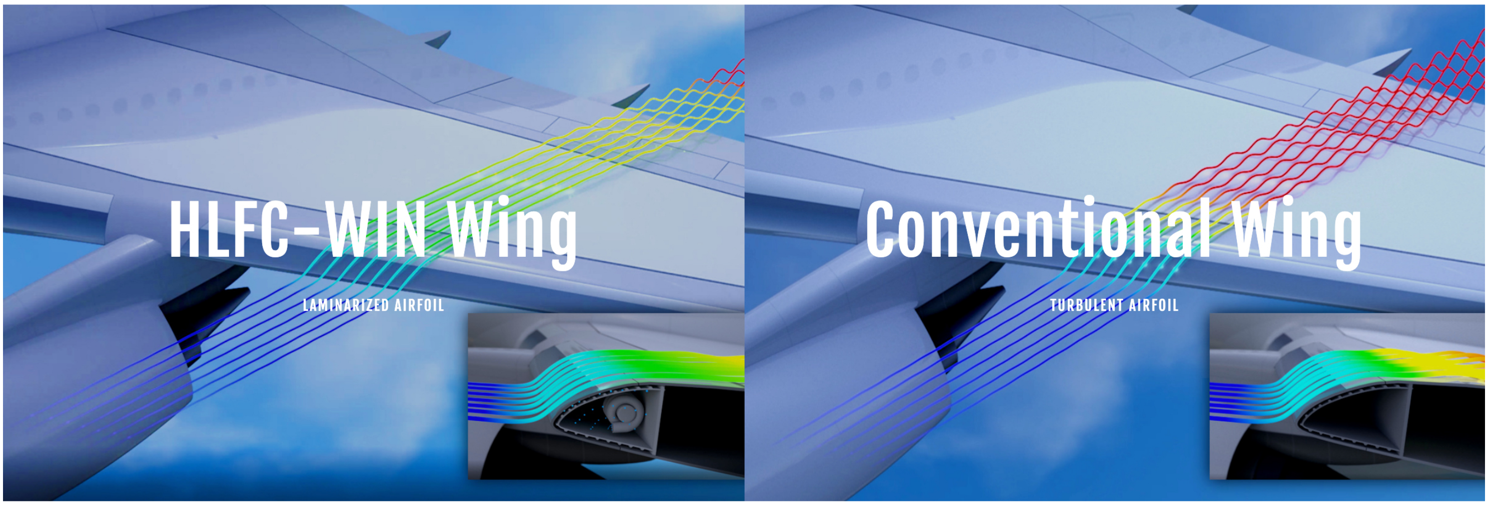


DEDICATED TO CHANGE

Aerodynamic efficiency as key enabler for flying greener.

With the thriving aviation industry and the ever-increasing air traffic, it is up to the aeronautical community **to take responsibility by developing new and innovative technologies** that are environmentally friendly.

One major field of research and development of environmental friendly aircraft is higher **aerodynamic efficiency**. The objective is to reduce the drag for the lift needed. Drag is the aerodynamic force that the engines have to overcome in order to propel the aircraft. Therefore, less drag results in less fuel consumption, which in turn reduces the CO2 and NOX emissions.

Various ideas and concepts exist, which potentially increase the aerodynamic efficiency of transport aircraft. The **Holy Grail for aerodynamicists is the application of laminar flow control.** Laminar flow occurs when a fluid flows in smooth parallel paths or layers with no disruption in-between. Its counterpart is turbulent flow, which is characterized by irregular fluctuations in all directions. For objects moving through fluids where the flow is turbulent, such as wings moving through air, the associated drag is up to ten times higher compared flow that is fully laminar.

Looking at the airflow around today's conventional wings, a transition from laminar to turbulent occurs very close to the leading edge. Consequently, most of the wing area is covered with turbulent flow. Since the wings account for about 18% of the total aircraft drag, the application of laminar flow control will have a significant positive impact on aerodynamic efficiency.

For future mid- to long-range aircraft, Hybrid Laminar Flow Control (HLFC) is the most promising technology of all available flow control methods. By combining boundary layer suction over the first 15-20% of the wing chord with an airfoil design optimized for HLFC, the transition from laminar to turbulent is relocated downstream to 50% of chord length. This leads to a significant **drag reduction in the order of 5-8%** which in turn improves the fuel efficiency by 4-7% per flight. On a typical long-haul missions such as from Frankfurt (FRA) to Los Angeles (LAX), a distance of over 9000 km, today's aircraft burn more than 60 tons of fuel. An aircraft with HLFC applied on the wings would require somewhere between 2 to 5 tons less, each flight. **Scaled to annual values, HLFC is able to save 1 to 2 thousands of tons of fuel per aircraft. That translates to more than 3 thousand tons of CO2 saved.**

8%
DRAG REDUCTION

2–5T
LESS FUEL

FRA to LAX
9297 KM

15T
LESS CO2

0,22T
LESS NOX

Why now?

The first concepts of laminar flow control on transport aircraft date back several decades. Since

"From all the other technologies

then research has been conducted and numerous development projects have been carried out. The principle that laminar flow reduces aircraft drag has been proven both under laboratory conditions and with prototypes in flight. The remaining **challenge however is to develop an integrated system including all involved disciplines** in order to reach a benefit for the operator on an overall aircraft level, i.e. a business case. The application of HLFC on the wing requires a microperforated leading edge skin, a load-bearing substructure with integrated ice protection and an economic manufacturing process achieving, gaps and steps with tight tolerances associated with laminar flow. Beyond that an HLFC wing needs to be fully operational under all flight and weather conditions with appropriate maintenance and repair effort throughout the aircraft's lifecycle. **With today's advanced manufacturing skills, sophisticated system knowledge and the expertise of the partners on board, this challenge will be tackled in HLFC-WIN**. In this project, we focus on a successful overall integration of HLFC on the wing upper side and aim to develop an economically friendly design by including lifecycle analyses as early as possible into our workflow.

"From all the other technologies, especially in aerodynamics, you can´t find anything comparable."

— Ali Pohya (DLR)

IMPA

BASED ON

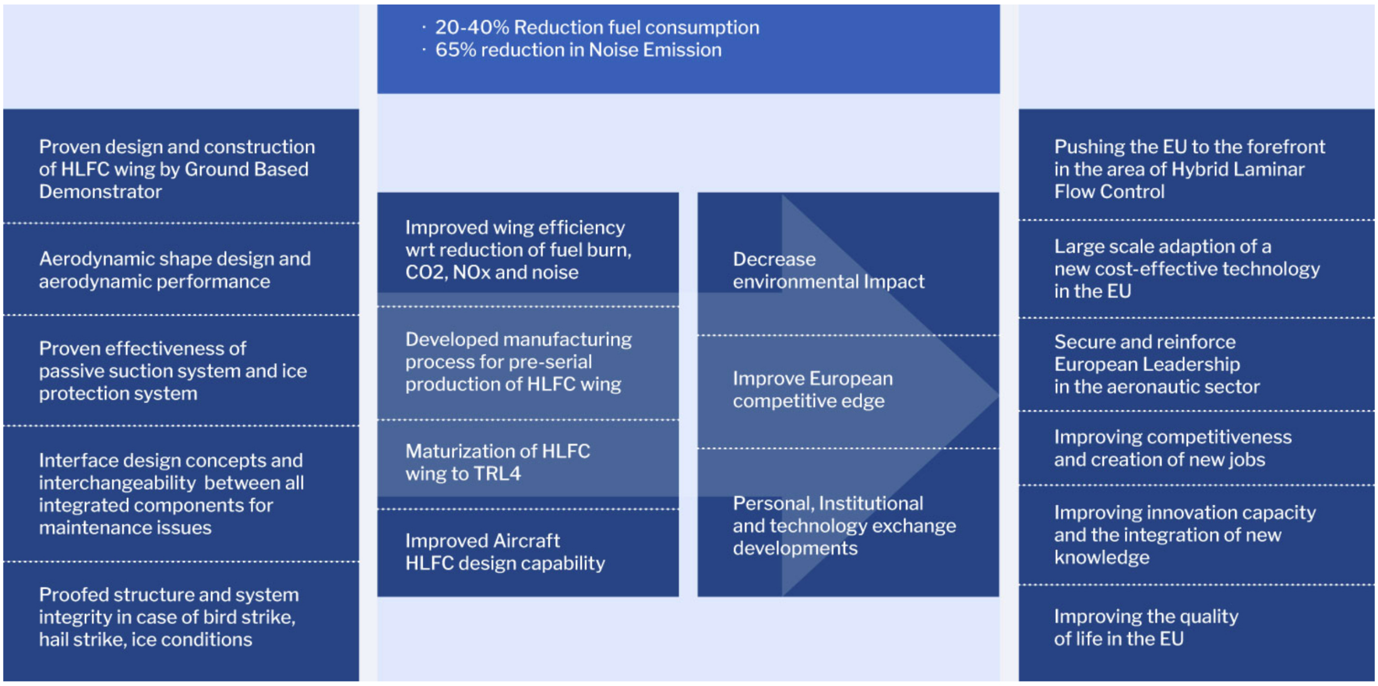
The impact of the HLFC-WIN project.

HLFC-WIN addresses the vision of Clean Sky 2 and the overarching Flightpath 2050 by targeting a decrease of the environmental impact in terms of emissions as well as by strengthening Europe's aeronautical research and technology capabilities to a strategically advantageous position in the increasingly competitive global landscape. An overview of the HLFC-WIN impact is displayed in the following chart. Considering the resources, background and expertise of the participants (AERNNOVA, DLR, ONERA, SONACA and Airbus as Topic Leader), three levels of results are indicated.

The scientific and technological objectives are the immediate term results (outputs). The project goals are the medium-term consequences (outcomes) and the impacts are the long-term consequences of the implementation of the HLFC-WIN project results. To summarize, HLFC-WIN is expected to have a beneficiary impact on the following:

- Technology development and innovation
- Environmental protection
- Strengthening the competitiveness of the European aircraft industry
- Scientific and cultural change
- Providing financial impact
- Creating EU added value.

APPLICATION OF HLFC-WIN SHOWS THE MAIN OUTPUTS/OUTCOMES/IMPACTS



OUR APPROACH →

← ENVIRONMENTAL IMPACT

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