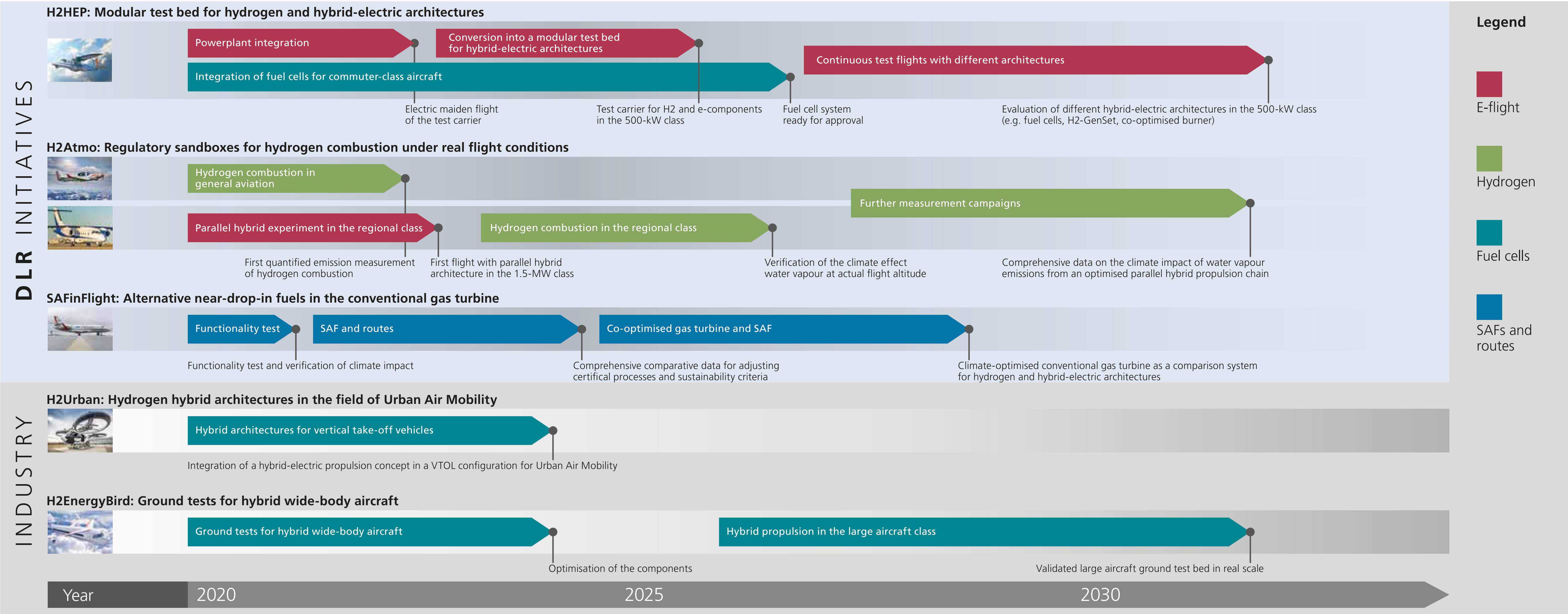
Demonstrator Roadmap towards Zero Emission Aviation

The road to Zero Emission Aviation

Many challenges on the path to emission-free aviation by 2050 can only be solved through cooperation between industry and research. Technological fields of action include synthetic fuels, hydrogen in gas turbines and hydrogen fuel cells, revolutionary gas turbine cycles, electric propulsion systems and climate-optimised routing.

For the successful implementation of emission-free aviation, technologies must be demonstrated quickly in order to quantify their individual potential and point out the direction of development. To this end, the DLR proposes the following demonstrator roadmap, developed in collaboration with the German aviation industry.



H2HEP: Modular test bed for hydrogen and hybrid-electric architectures.

Fuel cells can become a pioneering energy source, especially for smaller aircraft classes. A modular demonstrator makes it possible to test different propulsion concepts with the same aircraft. The aim is to initially realise the fully electric maiden flight of a test carrier and thus provide the German industrial and research landscape with a unique testing opportunity for hybrid-electric architectures. The integration of fuel cells and hydrogen storage also pose major technological challenges for the realisation of hydrogen propulsion systems.

Result: Evaluation of hybrid-electric architectures in the 500-kW class.

H2Atmo: Regulatory sandboxes for hydrogen combustion under real flight conditions.

Flight physics studies identify the use of direct hydrogen combustion in combination with parallel hybrid-electric propulsion as a promising architecture for regional aircraft. At the same time, atmospheric hydrogen emissions and the associated climate impact urgently require research to ensure direct hydrogen combustion can achieve emission-free operation, in the net balance. Two research programmes initiated with the DLR aim to quantify the effect of water vapour in the atmosphere as quickly as possible and, in the long term, to develop a parallel hybrid architecture based on hydrogen combustion for regional aircraft.

Result: Comprehensive data on the climate impact of water vapour emissions from an optimised parallel hybrid propulsion system.

SAFinFlight: Alternative near-drop-in fuels in the conventional gas turbine.

Currently, mixtures of synthetic and conventional fuels are permitted up to a maximum blending ratio of 50 percent. Alternative fuels requiring minor optimisations in aircraft and fuel design are known as near-drop-in fuels. There is currently no approval for such fuels. In addition, co-optimisation of fuel and combustion technology can significantly reduce CO_2, soot and particle emissions as well as NO_x emissions.

Result: Climate-optimised conventional gas turbine as a comparison system for hydrogen and hybrid-electric architectures.

H2Urban: Hydrogen hybrid architectures in the field of Urban Air Mobility.

Industry is working on a fully electric VTOL flight demonstrator for Urban Air Mobility. In order not to make the potential market launch of such a vehicle directly dependent on the evolution of battery technology, industry intends to integrate hybrid-electric propulsion based on a fuel cell on a VTOL platform and to study it in flight. The VTOL-specific integration aspects are to be addressed.

Result: Integration of a hybrid-electric propulsion concept in a VTOL configuration for Urban Air Mobility.

H2EnergyBird: Ground tests for hybrid wide-body aircraft.

Setup of the prototype for the secondary energy system for a large commercial aircraft with a fuel cell architecture in cooperation with several industrial partners as a jointly used research infrastructure. This aims to investigate taxiing on the ground, the cabin power supply including avionics, emergency power generator functions, highly integrated electric flight control drives. It also aims at performance and weight-optimised decentralised hydraulic power packs under real performance aspects. This is a necessary first step towards preparing a corresponding real-scale hybrid drive in the large aircraft class. In addition, cabin systems and air conditioning systems can be tested under simulated altitude conditions. This real-scaled prototype will also be used to clarify various certification issues and to develop propulsion systems for wide-body aircraft.

Result: Validated large aircraft ground test bed in real scale.

Overview of the DLR

The DLR is the Federal Republic of Germany's aerospace research centre. We conduct research and development in the fields of aeronautics, space, energy and transport, safety, security and digitalisation. On behalf of the Federal Government, the DLR Space Agency is responsible for planning and implementing German space activities. Two of the DLR project management agencies oversee funding programmes and support the transfer of knowledge.

Climate, mobility and technology are changing globally. The DLR uses the expertise of its 54 institutes and facilities to develop solutions to these challenges. Our more than 9,000 employees share a common mission: we explore the Earth and space and develop technologies for a sustainable future. In this way, we contribute to strengthening Germany as a knowledge and business location.

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