Net zero 2050: new aircraft technology

Fact sheet

The aviation industry's net-zero carbon emissions target is focused on delivering maximum reduction in emissions at source, using sustainable aviation fuels (SAF), innovative new propulsion technologies, and other efficiency improvements (such as improvements to air traffic navigation).

This factsheet looks at the timelines for introducing new aircraft and propulsion technologies that will bring us to zero-emissions flight. For further information, please consult IATA's Technology Roadmap and the Waypoint 2050 report from the Air Transport Action Group which outlines these technology pathways in more detail.

Historic trends

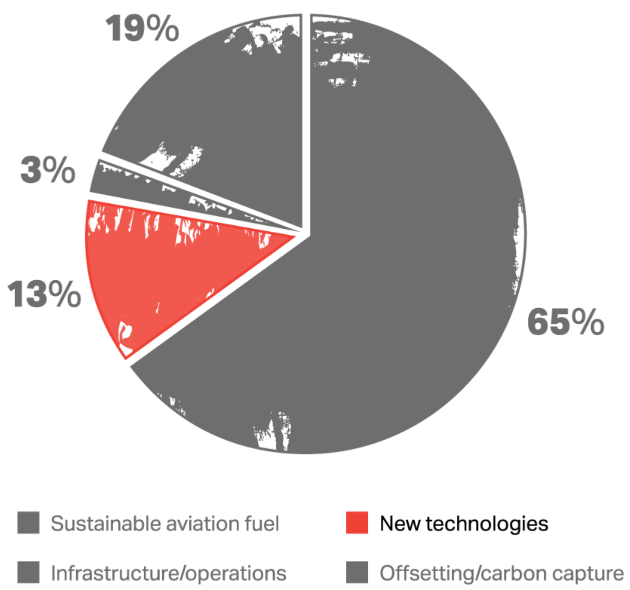
The fuel-efficiency of aircraft has been consistently improving since the first passenger jets were introduced in the 1950s. Each new generation of plane has reduced emissions by around 15-20%. The overall fuel efficiency of the fleet is around 80% better than 50 years ago.

The incremental improvements brought over time have principally come from more efficient engines, better aerodynamics, and reduced weight. The use of composites instead of aluminum in the latest generation of planes has brought weight down, allowing engines to operate more efficiently.

The next quantum leap

The aircraft industry is expected to continue with incremental improvements to existing technology. Geared turbofan engines and further advances in design will drive a further 15-25% fuel efficiency improvements over the next two decades. Towards the end of the next decade, however, radical new propulsion technologies and advanced designs may become viable that offer the chance to move away from traditional jet engine and tube-and-wing flight.

Contribution to achieving Net Zero Carbon in 2050



Hybrid-electric

Hybrid-electric concepts combine the advantages of both combustion and electric engines. The combustion and electric propulsion systems can be used in combination during take-off to provide maximum thrust, and the combustion engine can be throttled back when the aircraft is in cruise flight or descending. Combustion engines could also be smaller and reduce on-board weight. Hybridization is a necessary intermediate step for larger airplanes towards a pure electric propulsion system. Hybrid-electric aircraft on a new airframe body such as the Blended Wing Body can contribute to achieving CO_2 reductions of up to 40%.

Potential entry into service: Small aircraft (15 – 20 seats) with hybrid-electric propulsion could be expected during this decade, regional aircraft in the 2030s and possibly larger ones from 2040.

Fully electric

Instead of combustion engines, electric motors drive conventional propellers or sets of multiple small fans. Electric energy is stored in batteries (which however have a penalizing weight) or potentially in fuel cells. CO_2 emissions during operations are zero for full electric aircraft. Lifecycle emissions strongly depend on the primary energy mix for electricity generation. If fully renewable sources are used, they could be close to zero as well. An additional benefit would be the eradication of non-CO_2 effects (such as contrails and NOx emissions).

Potential entry into service: Small electric test aircraft up to 9 seats are already flying. Electric aircraft up to 19 seats are planned for the later 2020s, and regional aircraft in the 2030s. Norway has the goal of operating all domestic and short-haul flights electrically by 2040.

Hydrogen

[Hydrogen] is a carbon-free fuel that can be used as a propulsion fuel for combustion in conventional engines, replacing jet fuel (including in large aircraft), and also in fuel cells for electrical power. The weight of hydrogen is three times lower than that of an amount of jet fuel with the same energy content, but its volume even in liquid (cryogenic) form is four times larger. Much larger tanks as well as fundamental changes in the aircraft fuel system are therefore needed.

Potential entry into service: One of the biggest challenges for hydrogen use in aviation is its availability at large scale, the need to produce 'green' hydrogen and the existence of appropriate supply infrastructure. Interest is growing however, and technology programs ambitioned potential entry into service around 2035. However, that target has now been delayed by up to a decade as infrastructure development needs to increase.

Advanced aircraft configurations

The development of radical new aerodynamic designs for commercial airplanes could create significant efficiency improvements and make it easier for alternative propulsion systems to succeed. Here are three potential examples:

Canard wing: Already used in military airplanes, canard-wing planes create low-drag through the main wing being set further back behind small forewings. As with other radical designs, canard-wing planes could be in production from 2035-40.

Blended wing: Wide airfoil-shaped bodies and efficient high-lift wings enable significant lift-to-drag ratio improvements compared with conventional aircraft. High fuel savings are generated as the entire plane is designed to generate lift.

Strut or truss-braced wing: Utilizes a structural wing support to allow for larger wing spans without increases in weight. By increasing the span the induced drag is reduced and therefore the engine performance requirements can be reduced. The high wings allow for larger engine sizes, e.g. open rotors.