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Key facts from

Opportunities for hydrogen in commercial aviation

A new report from the Commonwealth Scientific and Industrial Organisation (CSIRO) and Boeing.

Globally, there is growing concern over the environmental impacts of aviation. This concern, along with increasing regulations and commitments to lower emissions, is applying pressure on airlines to reassess their business models.

Insights from CSIRO and the International Air Transport Association (IATA):

- Business-as-usual projections show a three-fold growth in CO_2 emissions by 2050.
- Global aviation demand may double to 8.2 billion passengers per year by 2037.
- As of 2009, the IATA adopted a 50% reduction on 2005 CO_2 emission levels by 2050.
- In addition, the IATA is aiming for no net-emissions increases after 2020.

How can the aviation sector emissions targets be met?

To date, the aviation sector has achieved more than 2% annual fuel efficiency improvements and further advancements are expected due to ongoing technological and operational developments.

However, the current limitations in meeting industry emissions targets has prompted a stronger focus on the adoption of sustainable aviation fuels (SAF).

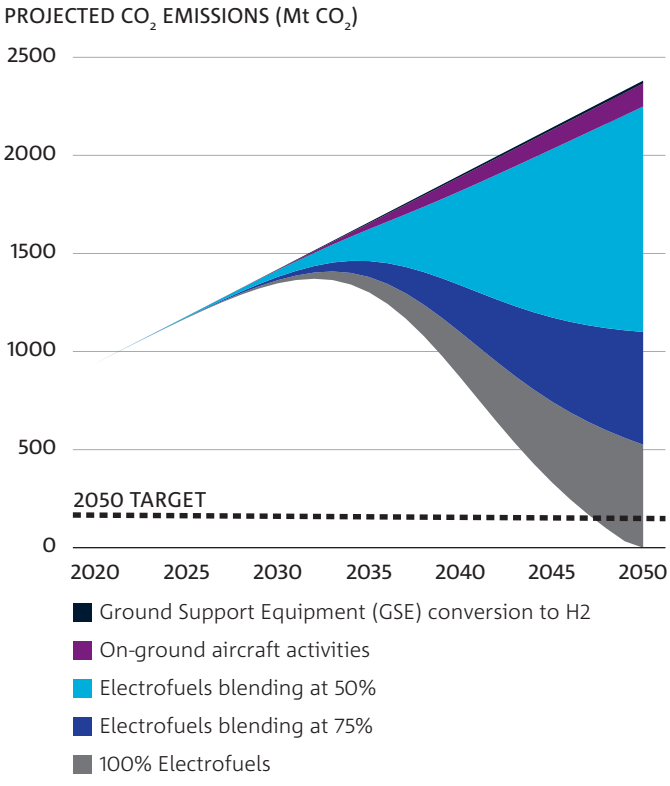
While there is scope for continued development of biofuels, current uptake has been minimal. This has led to the consideration of alternatives such as clean hydrogen and other hydrogen-based fuels.

Hydrogen is just one of a range of sustainable fuels that can make a significant contribution to emissions reduction in the aviation sector.

Why hydrogen?

The global hydrogen industry is accelerating at a rapid pace, driven by:

- increases in technology maturity,
- reductions in the cost of renewable energy sources, and
- growing acceptance of its potential to achieve deep decarbonization both in the electricity sector and beyond.



Potential CO_2 emissions abatement using hydrogen-based technologies

BOEING

Clean hydrogen is derived primarily from the electrolysis of water using zero or low emissions electricity.

Using hydrogen in the aviation industry

Hydrogen can be used within three primary technology categories for the aviation industry, each providing different CO_2 abatement potential over time.

There is an immediate opportunity to introduce hydrogen via niche applications and, beyond that, it could play a key role in facilitating the transition away from conventional jet fuel.

1. Short term (2025): On/adjacent to airport

This involves the replacement of on-airport ground support equipment, currently running on liquid fuels and batteries, with hydrogen powered fuel cell alternatives. Hydrogen used for treating crude or bio-crude oil to produce jet fuel with a lower carbon intensity is also considered as an early-stage application.

While not a large contributor to emissions for the sector, on-airport applications represent a straightforward and near-term opportunity to introduce clean hydrogen. They have the potential to deliver cost savings, reduce dependence on imported fuels and achieve abatement in local ground-based emissions. They can also act as a starting point for the development of sector-wide safety standards, regulations and operating procedures for the storage, handling and use of hydrogen within the airport boundary.

Given the technology maturity and commercial competitiveness of fuel cell airport equipment, on a total cost of ownership basis, the rate of uptake could accelerate after 2025 and replace existing diesel equipment by 2030.

2. Medium term (2035): Existing infrastructure (Electrofuels)

Electrofuels are drop-in fuels produced from hydrogen that has been derived from electrolysis and captured CO_2. Given the low rate of asset turnover within the aviation sector, electrofuels represent a primary way for hydrogen to achieve meaningful decarbonization before 2050.

To date there has been no end-to-end commercial demonstration of electrofuel synthesis, however, there is a strong technology and regulatory base that can be built upon. Scaling-up the electrofuel industry will require a coordinated effort on the part of the broader industry (including upstream oil and gas), governments and research institutions globally. With strategic global investment, it is possible for large-scale electrofuel production to be de-risked, allowing for accelerated uptake from 2030.

3. Long term (2050): Emerging infrastructure

Increasingly stringent environmental regulations could force a complete departure from jet fuel towards 2050, even with the uptake of drop-in electrofuels. Given its unique properties, hydrogen could play a key role in facilitating this transition in relation to both non-propulsion and propulsion aircraft applications.

Electrification of non-propulsion systems, and their ability to be supported by an on-board fuel cell, will require ongoing analysis. However, the use of hydrogen-based systems for applications such as auxiliary power and the taxiing phases of flight may represent nearer-term opportunities.

For propulsion, there is significant potential for hydrogen fuel cells to disrupt the current turboprop market (i.e. for shorter haul flights up to 1000 miles (1600 km) and 100 passengers). But given the power density limitations of existing fuel cell systems, they are unlikely to provide economical solutions for long distance flights with heavy payloads that currently rely on the use of traditional jet engines.

Cryogenic hydrogen has a superior energy density by mass compared with kerosene and other SAF and produces no CO_2 emissions on combustion. Aside from the challenges of storage and handling, the primary obstacle is due to its poor volumetric density. This may lead to a move away from conventional aircraft design to revolutionary aerodynamic models that can accommodate larger volumes of fuel. Coordinated R&D efforts are required in the near-term to enable the deployment of cryogenic hydrogen planes in or around 2050.

Sustainable aviation in the wake of COVID-19

The CSIRO/Boeing report takes a long-term view. It presents a meaningful way to prioritise sustainability in the aviation industry, particularly as the sector recovers from the impacts of COVID-19. The industry is faced with the challenge of meeting low-emissions targets while continuing to instill consumer confidence in passenger safety and health.

As with any new technology, further RD&D and investment is needed to enable hydrogen to play a critical role in the decarbonization of the aviation industry.

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