International Transport Forum

The future of e-fuels

Reducing emissions from aviation and maritime shipping

What are e-fuels and are they clean?

Can e-fuels support the decarbonisation of shipping and aviation?

Which policies will help accelerate e-fuel adoption?

At a glance

Governments need to act now to decarbonise the aviation and maritime sectors, each of which accounts for around 3% of global carbon dioxide (CO_2) emissions. Delivering on the goals of the Paris Agreement depends on decarbonising these sectors.

But long-haul aviation and maritime shipping are very difficult to decarbonise. Journeys of 1 000 km are impossible today using electric aircraft or ships. Decarbonising these modes will instead require energy-dense fuels.

What are e-fuels?

Electrofuels (e-fuels) are synthetic fuels produced using electricity as their primary source of energy. They are commonly prefixed with the letter "e" (e.g. e-methanol, e-kerosene, e-diesel) to distinguish between conventional fossil fuel and carbon-based e-fuels.

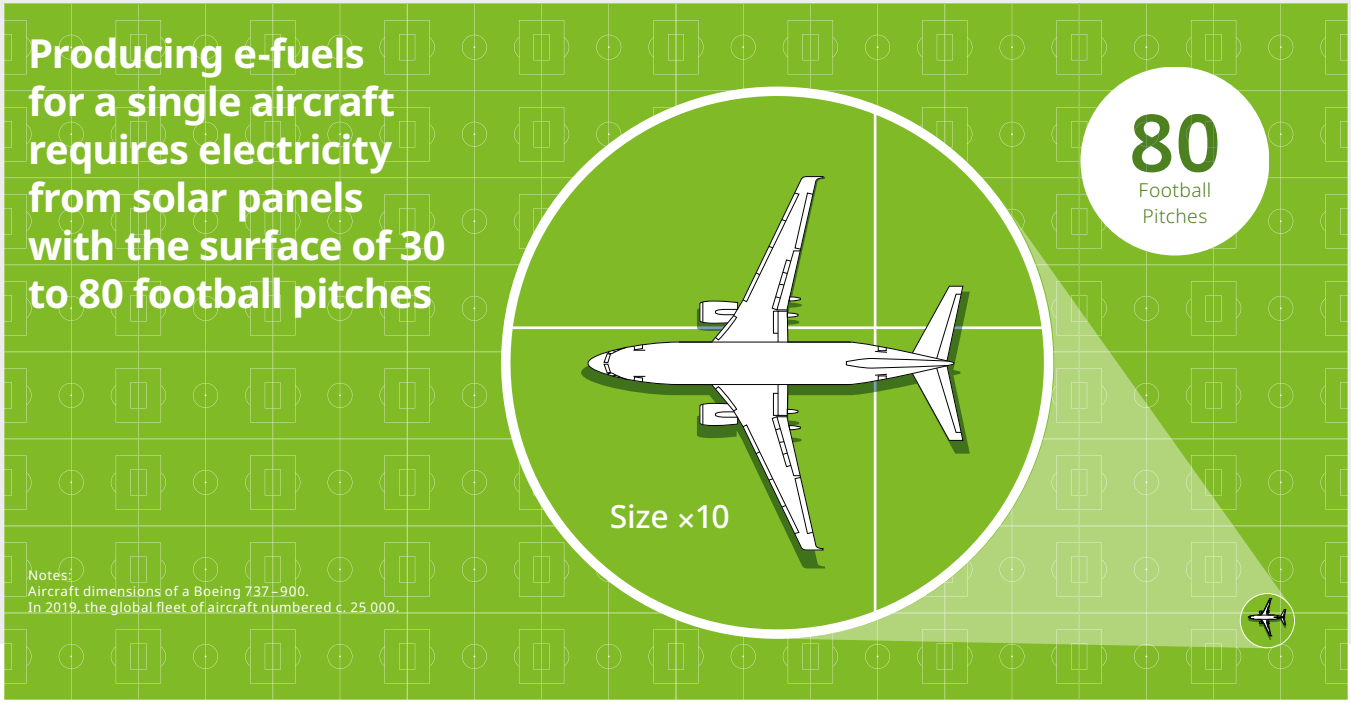
E-fuels can come in many different forms, including hydrogen, ammonia, e-methanol for shipping and e-kerosene for aviation. E-fuels made with renewable electricity can make a significant contribution to decarbonisation.

What are the limitations of e-fuels?

Some "non-drop-in" e-fuels, including hydrogen and ammonia, are not compatible with existing vehicle technologies and infrastructure. Their adoption will likely be slow, and will depend on vehicle fleet turnover and fuel availability.

Pilot projects to use these fuels on specific transport corridors can help to develop technologies while limiting early-stage infrastructure deployment. On the supply side, low-carbon fuels will need to become an attractive option for producers, in order to replace significant amounts of the fossil fuels currently used by ships and aircraft.

Biofuels are also expected to play a role in decarbonising aircraft and ships, but cannot be the only solution because it is difficult to source sustainable feedstocks. Therefore, e-fuels are an essential, complementary technology to decarbonise these modes and reach climate objectives.



Implement targeted policies to scale up the production of low-carbon e-fuels

Currently, e-fuels are not scalable commercially, due to nascent technology and high production costs. It will take at least a decade to reach significant levels of e-fuel deployment.

For this reason, technology-neutral policies may not be sufficient. Governments should implement targeted assistance and incentive programmes to sustain e-fuel technologies' development and scale up production.

"Drop-in" e-fuels, such as e-methanol or e-kerosene, are compatible with existing technology and infrastructure systems. Governments can support their deployment by combining mandates with specific targets.

Governments can also set carbon-intensity targets for fuel sold in their jurisdictions, and allow regulated entities to trade credits to achieve these targets.

Introduce carbon pricing for shipping and aviation to make e-fuels cost-competitive with fossil fuels

Fuel usually accounts for a significant proportion of a transport mode's operating expenses: 20–53% in the case of ships, and around 20–30% for aviation.

Therefore, any low-carbon alternative that is more expensive than fossil fuels will not be a viable option in the shipping or aviation markets of the future without support.

Currently, low-carbon fuels are not cost-competitive with their fossil fuel counterparts. This is why governments must put in place instruments to bridge the price gap between e-fuels and conventional fossil fuels.

Given that international journeys are exempt from taxation, one way for governments to bridge this gap is by assigning a price to greenhouse gas emissions ("carbon pricing") to make low-carbon fuels more cost-competitive.

Scale up electrolyser and renewable electricity generation capacity

E-fuels are produced in an industrial process that converts electrical energy into chemical energy. But e-fuels will only reduce emissions in aviation and maritime shipping if they are made using renewable energy as input.

However, creating enough e-fuel to power an average airliner would require an array of solar panels of between 30-80 football pitches in size (see figure).

Renewable electricity generation must increase to meet demand for e-fuel production.

As all e-fuels require hydrogen (which is made using electrolysers) and electricity as inputs, governments need to work with industry to scale up the production of green hydrogen and renewable electricity.

Regulate the emissions intensity of e-fuels to avoid unintended emissions from other greenhouse gases

Governments will need to analyse the lifecycle emissions of low-carbon fuels to ensure that net-zero emissions are maintained throughout the value chain, including production, transportation, storage and end-use.

However, uncertainties remain for specific e-fuels, such as ammonia, because leakage rates through the lifecycle could offset the climate benefits gained from CO_2 savings.

Burning ammonia does not generate CO_2, but it can generate nitrous oxide (N_2O), which is 300 times more harmful than CO_2 if released. Limiting emissions of these greenhouse gases is possible but must be regulated to ensure compliance.

Governments must issue strict regulations and standards to ensure transparency and meet the sustainability criteria for all types of greenhouse gas emissions, including CO_2 and N_2O, at all stages of the fuel supply chain.

Download our report:
The Potential of E-fuels to Decarbonise Ships and Aircraft

This report examines the potential of novel fuels (including hydrogen, ammonia and synthetic hydrocarbons) to decarbonise aviation and maritime shipping. While these fuels can be produced from renewable sources and could be easier to deploy than other low- and zero-carbon technologies, many uncertainties exist around scaling up their production and use. The report reviews the latest understanding of the production and use of novel fuels in the shipping and aviation sectors and identifies policies needed to accelerate their adoption.

Available for download:
www.itf-oecd.org/potential-e-fuels-decarbonise-ships-aircraft

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