



Written on 05 February 2025



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Economic outlook

IFPEN

Biofuels and e-fuels



E-FUELS: CHALLENGES AND OPPORTUNITIES

Focus n°1

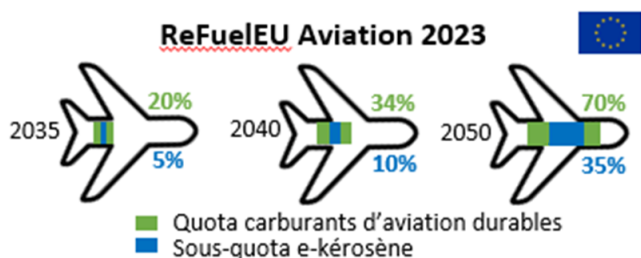
E-fuels, E-molécules: Why accelerate and deploy these sectors now?

- Carbon Capture and Utilization (CCU): a key lever for carbon neutrality

CCU encompasses a set of technologies aimed at capturing CO₂ (from industrial emissions or from the atmosphere) and transforming it into value-added products such as fuels, chemicals, or materials, thereby creating a circular carbon economy. CCU differs from Carbon Capture and Storage (CCS), which seeks to permanently store CO₂ using technological carbon sinks, in a linear economy approach. These are two complementary pathways, each providing distinct services in the pursuit of decarbonization.

The challenge of CCU lies in 'defossilizing' sectors that cannot fully transition to massive electrification and will continue to rely on carbon-containing molecules. Synthetic fuels and chemicals (e-fuels and e-molecules) will replace fossil fuels, especially in long-distance, maritime, and aviation transport. This transformation involves using captured CO₂, hydrogen, and low-carbon energy as raw materials to produce carbon-containing molecules like kerosene, diesel, gasoline, methane, methanol, ethanol, dimethylether (DME), and others. CCU technologies complement those aimed at producing biofuels or other bio-based molecules.

- **Regulation: a key driver for the deployment of e-fuels sectors**



The European Commission is regulating the use of sustainable energies, including e-fuels in aviation and maritime transport. The RED II revised directive mandates the consumption of 1% of sustainable fuels of non-biological origin (e-fuels) in the transport sector by 2030. Initiatives like ReFuelEU Aviation and FuelEU Maritime provide perspectives until 2050 with specific incorporation mandates:

- In the aviation sector, by 2035, 20% of sustainable fuels, including 5% e-fuels, and by 2050, 70%, with 35% being e-fuels.
- In the maritime sector, a minimum of 2% of e-fuels is required by 2034.

In France, the General Secretariat for Ecological Planning (SGPE), in its scenarios published in July 2023, also anticipates a contribution from e-fuels to decarbonize transportation by 2030. As for synthetic chemicals, regulations from both the European and French authorities are yet to be announced.

- **An environmental, economic and sovereignty challenge for France**

In France, with a need to convert approximately 15 Mt of CO₂ into e-SAF by 2050, the volumes of CO₂ targeted by CCU sector¹ are of the same order of magnitude as those aimed for by the CCS sector (15-20 Mt)². France possesses key advantages for developing CCU: an existing industrial network, low-carbon electricity, and technologies developed by French entities across all aspects of the value chain (CO₂ capture, hydrogen production, sustainable liquid fuel production). These represent a genuine opportunity to decarbonize the economy, foster new industries, enhance sovereignty, and export French technologies internationally.

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[Download the sheet](#)

1 According to 'Decarbonization of the Aviation Sector through the Production of Sustainable Fuels,' Academy of Technologies, *February 2023*.

2 Cf CCUS strategy published in the frame of « France 2030 initiative », June 2023 (only [in French](#))

LES BRÈVES

ADEME: French energy transition agency (www.ademe.fr)

ANCRE: French National Alliance of Coordination of Research for Energy (www.allianceenergie.fr)

CBAM: Carbon Border Adjustment Mechanism

CCS: Carbon Capture and Storage

CCU: Carbon Capture and Utilization

COP: Conference of the Parties

DAC: Direct Air Capture

DME: DiMethyl Ether

EU: European Union

EU-ETS: EU Emissions Trading System

FuelEU: European law for shipping decarbonization (Fit for 55)

HTE: High Temperature Electrolysis

ICAO: International Civil Aviation Organization (www.icao.int)

ICM: Industrial Carbon Management

ICR: Industrial Carbon Removal

IEA: International Energy Agency (www.iea.org)

IPCC: Intergovernmental Panel on Climate Change (www.ipcc.ch)

LCA: Life Cycle Analysis

Mtoe: Millions tons of oil equivalent

NZE: Net Zero Emission by 2050 (IEA scenario)

PEM: Proton Exchange Membrane

PEPR: French Priority Research Programs and Equipments

Power-to-X: Approach consisting of transforming electricity into a chemical carrier such as an e-fuel or an e-molecule

RED: Renewable Energy Directive

ReFuelEU: European law for aviation decarbonization (Fit for 55)

R&D: Research & Development

R&I: Research & Innovation

RWGS: Reverse Water Gas Shift reaction

SAF: Sustainable Aviation Fuels

SGPE: French General Secretariat for Ecological Planning

SMF: Sustainable Maritime Fuels

TIRUERT: French incentive tax relating to the use of renewable energy in transport

TRL: Technology Readiness Level

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