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Economic outlook

- IFPEN
- Biofuels and e-fuels



E-fuels: challenges and opportunities

Focus n°2 :

The role of e-fuels in energy transition scenarios

E-fuels are now recognized as a key option to defossilize transport by 2050, complementing energy saving measures, electrification, and the development of advanced biofuels. The IPCC and COP 28 conclusions confirm the need for CCU (CO₂ capture and utilization) to produce e-fuels as early as 2030. E fuels have been included in the latest versions of all scenarios produced by governments, agencies, NGOs and stakeholder groups. In its [World Energy Outlook 2023 report](#), the IEA estimates the need for hydrogen-based low-carbon fuels at 416 TWh (36 Mtoe) in 2030 and 3566 TWh (307 Mtoe) in 2050 on a global liquid fuel demand of 50 000 TWh (4300 Mtoe) in 2030 and 21 200 TWh (1800 Mtoe) in 2050 (NZE scenario). According to ICAO (International Civil Aviation Organization), e-fuels could account for between 3% and 17% of aviation fuels in 2035, and between 8% and 55% in 2050.

The topic of e-fuels is new, and is addressed in very heterogeneous ways from one scenario to another, from different and complementary angles: contribution of CCU to emissions reduction (taking into account or not e-molecules for chemistry), liquid fuel requirements, etc. The scope, types of e-fuels and assumptions considered vary, sometimes considerably, from one scenario to another, making direct comparisons difficult.

As of 2018-2019, the European Commission has taken into account the use of e-fuels to achieve carbon neutrality by 2050¹. The ambitious incorporation targets set in the regulations adopted in 2023 (ReFuelEU Aviation and FuelEU Maritime) require e-fuels to be taken into account in energy transition scenarios. In February 2024, the European Commission published an Industrial Carbon Management strategy² based on three pillars: CCU (including e-fuel production), CCS and ICR (Industrial Carbon Removal).

In France, the General Secretariat for Ecological Planning (SGPE) expects e-fuels to contribute to reducing industrial CO₂ emissions by 2030. In November 2023, ADEME published a report on e-fuels³ with a projected demand for e-fuels in France of between 10.3 TWh (0.9 Mtoe) and 24.4 TWh (2 Mtoe) for the aviation sector by 2050, and between 10.9 TWh (0.9 Mtoe) and 32.7 TWh (2.8 Mtoe) for the maritime sector. The ADEME report does not take into account the use of e-fuels in other transport sectors by 2050. The ANCRE Alliance, in its November 2023 report⁴, also introduced e-fuels, with consumption projections for the most ambitious scenario in terms of electrification and energy savings rising from around 11 TWh (1 Mtoe) in 2035 to over 35 TWh (3 Mtoe) in 2050.

The United States, India, the European Union, Japan and Canada have included e-fuels in their roadmaps to foster R&I and investment. **Although consumption projections vary widely, and the scenarios are based on different assumptions, they all underline the need to develop e-fuels at the right level,** not as a substitute for other measures, but as a complementary mean of "defossilization". All the scenarios also mention limits to their development: potential competition with other energy products, resources availability (CO₂ and low-carbon electricity), their price and the need for regulations to accompany deployment. In its December 2023 report, The role of e-fuels in decarbonising transport, **IEA stresses the need to strengthen synergies between e-fuels, biofuels and CCS in order to achieve the ambitious targets set. Based on feedback from the first industrial units, it is also needed to clarify the socio-technical criteria that will enable e-fuels to find their relevant place in the energy landscape.**

[Download the sheet](#)

¹ European Commission, [Going climate-neutral by 2050 - A strategic long-term vision for a prosperous, modern, competitive and climate-neutral EU economy](#), November 2018

² European Commission, [Towards an ambitious Industrial Carbon Management for the EU](#), February 2024

3 ADEME, [Electro-carburants en 2050 : Quels besoins en électricité et CO2 ?](#), November 2023 – in French

4 ANCRE, [Scénarios de décarbonation du secteur transport en France et leurs impacts sur la biomasse, l'hydrogène et l'électricité](#), November 2023 – 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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