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Economic outlook

Issues and Foresight

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 (CO_2 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 2050[1]. 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 strategy[2] 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 CO_2 emissions by 2030. In November 2023, ADEME published a report on e-fuels[3] 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 report[4], 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 (CO_2 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.**

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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
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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