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Synthetic fuel challenges for mobility

- **High costs and insufficient supply hinder the adoption of synthetic fuels in shipping and aviation.**
- **Supply of these fuels must also support other sub-sectors (e.g., trucks) and industries, further straining availability.**
- **These fuels are unlikely to be both affordable and sufficiently available by 2030 or 2035**

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Introduction

Fossil fuels have long been the backbone of our global economy, powering industries, transportation, and households. In 2023, they accounted for nearly 80% of the global energy supply, according to the IEA. However, as the world races to achieve net-zero emissions by 2050, our reliance on fossil fuels must drastically decrease. The solution seems simple: replace fossil fuels with alternatives that emit less or no carbon dioxide. But in reality, this transition is anything but straightforward. The path to more sustainable energy involves a complex landscape of alternative fuels, each with unique characteristics. Transitioning to these fuels also requires significant adjustments, such as changes to engines, infrastructure, and storage systems. Additionally, challenges like limited production capacity, high costs, and competition for green electricity and raw materials make the widespread adoption of alternative fuels even more difficult. In some cases, the technologies needed to produce these fuels at scale are still in development. Despite these obstacles, more sustainable fuels—in our report referred to as synthetic fuels—will play a vital role in the global journey toward a net-zero economy. This report dives into the world of these fuels, exploring if there is enough supply of affordable synthetic fuels for the hard to abate sectors in mobility namely shipping, aviation and trucking.

What are synthetic fuels?

Synthetic fuels are man-made fuels that work just like fossil fuels but are created in a different way. They can either be mixed with fossil fuels or used as a complete substitute in engines, like the ones used in cars, trucks, and planes. There are three main types of synthetic fuels, and the way they are made sets them apart:

- Biofuels: These are made from organic waste, such as food scraps, agricultural leftovers, animal manure, and even sewage. Biofuels can be in liquid or solid form. Examples include renewable diesel (HVO), biodiesel (FAME), biogas, ethanol, and Sustainable Aviation Fuel (SAF).
- E-fuels: These are liquid fuels made using renewable energy, water, and CO2. Common examples are e-methane, e-kerosene, e-methanol, e-ammonia, and e-hydrogen.
- Solar fuels: These are created using sunlight. By harnessing solar energy, common materials like water and carbon dioxide are turned into fuels. Examples include methanol, hydrogen, and ammonia.

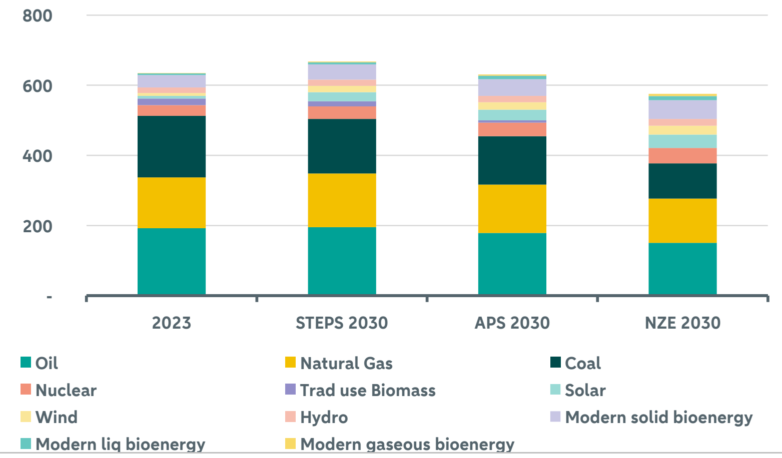
In short, synthetic fuels are a cleaner alternative to fossil fuels and are made in innovative ways to help reduce our dependence on traditional energy sources and reduce emissions. But each fuel has a different carbon footprint. Synthetic fuels can be low carbon fuels, carbon neutral fuels or zero-carbon fuels. The difference is how much CO2 emissions are emitted. Renewable diesel, biodiesel, hydrogen/methanol/ammonia when produced using fossil fuels with carbon capture and storage are examples of low carbon fuels. Renewable diesel's CO2 emissions are highly dependent on the feedstock used. Carbon neutral fuels are fuels that do not increase or decrease the amount of carbon in the atmosphere through their life cycle. Examples are e-methanol and e-kerosine if renewable resources are used in the production process and the carbon captured from the atmosphere is later released back into the air. Zero-carbon fuels are fuels that do not release carbon at the time of usage. For example, hydrogen when produced by electrolysis and renewable electricity and ammonia when produced by renewable electricity and green hydrogen as the source are zero-carbon fuels.

Supply and demand

Now that we know what synthetic flues are, we will take a look at their supply and demand. We start with global energy supply for different scenarios. The IEA in its World Energy Outlook 2024 published three different scenarios for global energy supply and supply per category: Stated Policies (STEPS), Announced Pledges (APS) and Net Zero Emissions (NZE). The three scenarios show that in 2030 oil remains the most dominant energy source, while the share of modern liquid and gaseous bioenergy is very low (see graph below).

Global energy supply for different scenarios 2030

Energy supply EJ, 1 EJ = 1000 PJ

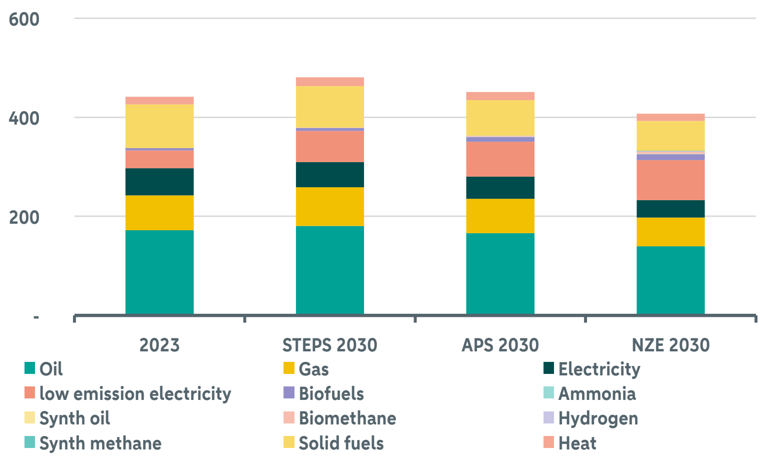


Source: International Energy Agency (2024), World Energy Outlook 2022, IEA, Paris. Note: STEPS = Stated policies, APS = Announced Pledges scenarios, NZE = Net Zero Emissions.

Moving to consumption the graph below shows the overall final energy consumption. It shows that in 2030 demand for oil is the largest followed by solid biofuels, gas and low emission electricity while demand for synthetic fuels (biofuels, e-fuels and solar fuels) remains small.

Global final consumption for different scenarios 2030

Energy supply EJ, 1 EJ = 1000 PJ



Source: International Energy Agency (2024), World Energy Outlook 2022, IEA, Paris. Note: STEPS = Stated policies, APS = Announced Pledges scenarios, NZE = Net Zero Emissions.

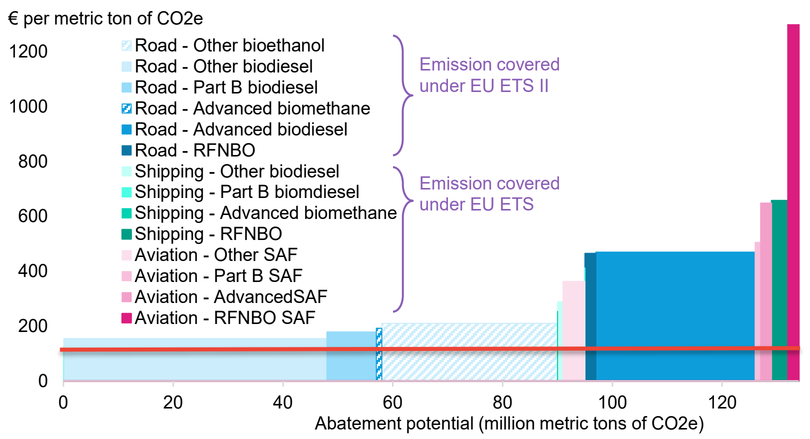
In the Stated Policies Scenario, the IEA expects energy consumption from mobility to rise to 132 EJ by 2030 (an increase of 8% versus 2023) with shipping demand increasing to 12 EJ (up 9% vs 2023) and aviation demand to 17 EJ (up a whopping 31% versus 2023). There is also higher demand from road transport. Despite the higher demand, a part of road transport could use climate-friendly alternatives such as electric vehicles or fuel cell vehicles. However, both shipping and aviation (and part of long-distance trucking) are mostly dependent on low emissions fuels such as biofuels and e-fuels. This is because electrification is currently not an option for maritime shipping and long-distance aviation. If we look at the expected supply for the biofuels (see above), there is not enough availability to fully meet this demand. For 2030 there would only be enough biofuels (liquid and gaseous) for half of shipping or one third of aviation if it is not blended with another fuels. What is more the available supply must also be shared with other sub-sectors, like trucks, and entirely different sectors, such as industry.

Marginal abatement costs 2030 and 2035

Above we showed that supply for fuels with low carbon footprint is limited and will likely not be able to fully meet demand from shipping and aviation. That supply and demand imbalance also results in (further) price pressure. Hence, in this section we look at the costs of these fuels. Recently we published scenarios shaping EU ETS prices (see more here). Our baseline scenario sees EU ETS prices rising to €145/tCO2 by 2030 and €200/tCO2 by 2035, driven mainly by lower supply of allowances and a decline in the Total Number of Allowances in Circulation. However, a recent study of Bloomberg NEF shows that the marginal abatement costs for shipping and aviation are much higher than our forecast for EU ETS prices by 2030 (see graph below for the results). If the marginal abatement cost is higher, this implies that companies can be more cost-effective by simply paying the price for polluting (the ETS price) rather than focusing on reducing emissions via alternative fuels.

Marginal abatement costs for hard to abate subsectors mobility in 2030

2030, in euro per tonne CO2, the red line is our base line for EU ETS prices for 2035

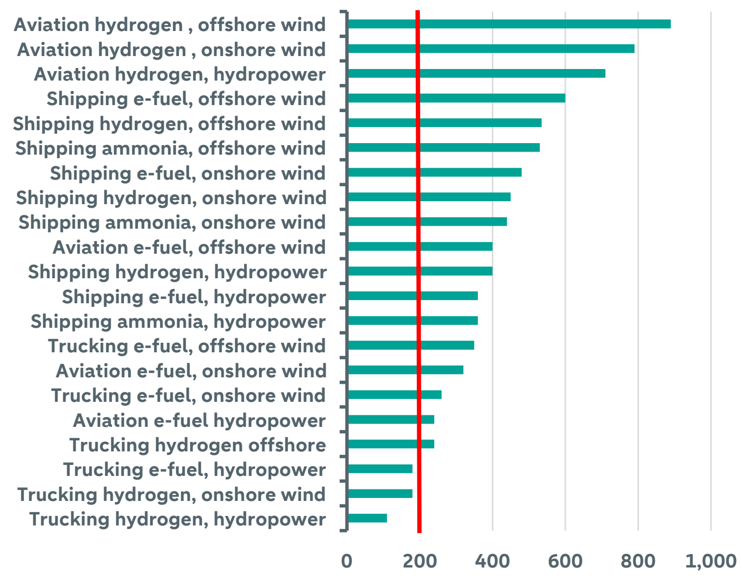


Source: BloombergNEF, Note: Prices data based on today's renewable fuel prices, emission abatement data based on RED III 2030 target and BNEF's view on energy share by sub-sector based on NEO ETS scenario. Hided options with less than 1MtCO2 abatement options. 'Part B' refers to biofuels made from feedstocks listed in part B of Annex IX under the RED III directive.

The same conclusion holds when looking at the longer horizon of up to 2035. The graph below shows the marginal abatement costs for shipping, aviation and trucking in 2035, while the red line is our baseline scenario for the EU ETS prices for 2035.

Marginal abatement costs for hard to abate subsectors mobility in 2035

2035, in euro per tonne CO2; the red line reflects our baseline scenario for EAU prices by 2035



Source: MIT Center for Energy and Environmental Policy Research Working Paper Series November 2022, ABN AMRO Group Economics

Hence, also here, the fuel options for aviation and shipping are more expensive that our baseline for EU ETS prices. This means EU ETS prices are too low to push shipping and aviation towards renewable fuels. That implies that the switch would have to come from other pull factors, such as regulation from governments, consumer pressure and as a way to diversify from competitors showing that higher costs reflect decarbonization efforts. Important to note that the marginal abatement costs tend to decline over time of higher production, more renewable electricity and lower production costs.

Conclusion

The key takeaway is that there are limited affordable solutions for decarbonizing the shipping and aviation sectors. The main challenges are twofold: the high costs of alternative fuels and the insufficient supply, which are somehow also correlated with each other. Additionally, the available supply must be shared with other sub-sectors, like trucks, and entirely different sectors, such as industry. This makes it unlikely that these fuels will be both sufficient and affordable by 2030 or even 2035.

To ensure the availability of enough biofuels and synthetic fuels, three things are necessary: (1) adequate renewable energy production, (2) supportive infrastructure for synthetic fuel production and distribution and (3) government policies that promote and support the development of these fuels. By increasing the availability of synthetic fuels also makes them more affordable.

Until supply is sufficient, government policies should prioritize synthetic fuel access for hard-to-abate sectors, such as aviation and shipping, over other areas like passenger cars. Furthermore, raising the ETS price incentivize the adoption of costlier options for decarbonization, but as we discussed in our previous piece (see more here), higher EU ETS prices are not within our baseline scenario. Governments could complement the EU-ETS price with other instruments such as taxes or regulation to ameliorate the business case for synthetic fuels in the shipping and aviation sectors.

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