EXECUTIVE SUMMARY

European Parliament

Research for TRAN Committee – Assessment of the potential of sustainable fuels in transport

Key findings

- Sustainable fuels will be suitable for different transport modes and transport applications, depending on their technical specifications, their sustainability characteristics including **feedstock availability**, their **cost-competitiveness** and their **technology readiness**.
- Given the global limitation of resources, the shift to sustainable fuels should be first driven by a significant increase in **energy efficiency**.
- **Liquid and gaseous sustainable fuels** should be primarily dedicated to transport sub-sectors that cannot be easily electrified, i.e. aviation, shipping, and – possibly – part of heavy-duty road transport. **Direct electrification** from renewable sources is considered as a key option to decarbonise road transport and short-haul shipping. This is not exempt from challenges, e.g. sourcing of raw materials and battery end-of-life treatment.
- **Biofuels** are cheaper than renewable e-liquids, but they face availability limitations exacerbated by competing demand in the bioeconomy and sustainability constraints with respect to land use.
- **Renewable e-liquids** could be among the most relevant options by 2050 if the carbon they use is sustainably sourced, thanks to the fact that they do not require changes to infrastructure or powertrains. Challenges remain with the high reliance on large-scale renewable electricity production, low energy efficiency, high production costs, and low technology readiness of some of their enabling technologies (such as direct air capture).
- **Renewable hydrogen** could technically be a viable fuel for heavy-duty road, short-range aircraft and shipping. Important challenges remain with the low energy density, costs required for infrastructure development and high-risk profiles of related investments.
- **E-ammonia and e-methanol** are cheaper than other e-liquids and are good candidates for maritime. The development of infrastructure needed for their transport, storage and distribution is cheaper than for hydrogen, but still subject to investment risks. Challenges remain with e-ammonia's safety issues and sourcing of renewable carbon for e-methanol.
- **Recycled Carbon Fuels** (RCFs) may contribute to GHG emission abatement in the near term. However, carbon sourcing from processes that still lead to net CO_2 increases will become a limiting factor for RCFs, along with competition from carbon capture.
- **Supporting infrastructure** needed for sustainable fuel take-up is fuel-specific. It requires reinforcing the electricity system, developing a hydrogen network, and adapting the existing oil and liquid infrastructure to accommodate a higher share of biofuels. **Existing policies and the set of policy proposals in 'Fit for 55'** tackle most of the barriers to accelerate the shift to sustainable fuels, the deployment of the required infrastructure and the changes in vehicle powertrain technologies.
- The EU's policy to support sustainable fuels shall seek to further **enhance technological development, foster industrial transformation, and strengthen re-distributional measures without compromising sustainability**.

The present document is the executive summary of the study on Assessment of the potential of sustainable fuels in transport. The full study, which is available in English can be downloaded at: https://bit.ly/3Yw1RPe

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The global context for sustainable fuels in transport

Sustainable fuels, combined with reductions in energy demand, can **significantly reduce GHG emissions whilst not jeopardising other sustainability requirements** regarding biodiversity, water resources, air quality, land use, and material sourcing. The study focuses mainly on the following sustainable fuels: **biofuels** (from oleochemical, biochemical and thermochemical pathways), **renewable fuels of non-biological origin** (RFNBO, including renewable hydrogen, and different e-fuels), **recycled carbon fuels** (RCFs), **fossil and nuclear-based hydrogen,** pursuant to the Taxonomy Regulation. A key alternative to liquid or gaseous transport fuels is **direct electrification**. This is not assessed in detail in this research, but it is still included, given its relevance as a key option for the transition to clean energy and sustainable mobility, especially for road, rail and short-distance shipping, and the implications that it has on the determination of the overall boundary of demand for other fuels.

This study assesses the potential of sustainable fuels to decarbonise the transport sector in the EU and analyses the viability of sustainable fuels and energy vectors for transport against multiple factors: sustainability, scalability, energy efficiency, energy density, feedstock and material availability, cost, technology, market readiness and safety.

Sustainable fuels and decarbonisation in the different transport modes

Most of the transport decarbonisation scenarios examined in this study that are compatible with the Paris Agreement **combine technical energy efficiency improvements and reduced demand for motorised activity with fuel shifts.** As well as reducing GHG emissions, they target decreased pollution, noise and congestion levels, and increased safety.

Decreasing fuel consumption is crucial to afford a long-term supply, given the resource constraints to sustainably produce all fuels. Direct electrification generally plays a large role in the energy efficiency gains of the transport sector, **especially in the road sector**.

The table below illustrates the qualitative evaluation of all fuels and their link with the main transport end-use applications. It is based on the assessments presented along this study, providing insights on which fuel is best suited for which application.

Table ES1 - Match making between fuels and transport modes – Summary of all factors

			Mode and range							
			Aircraft		Maritime transport		Heavy duty road		Light duty road	
Fuels		Feedstock	Short	Long	Short	Long	Short	Long	Short	Long
Biofuels	Biochemical, liquid	Conventional	Low priority	Challenges	Low priority	Challenges	Low priority	Low priority	Low priority	Low priority
		Advanced	Priority (hatched)	Priority (hatched)	Likely (hatched)	Priority (hatched)	Challenges (hatched)	Challenges (hatched)	Challenges (hatched)	Challenges (hatched)
	Biochemical, methane	Advanced	Low priority	Low priority	Likely (hatched)	Likely (hatched)	Challenges	Challenges	Challenges	Challenges
	Oleochemical	Conventional	Low priority	Challenges	Low priority	Challenges	Low priority	Low priority	Low priority	Low priority
		Advanced	Challenges	Likely	Challenges	Likely	Low priority	Challenges	Low priority	Challenges
	Thermochemical, liquid	Advanced	Priority (hatched)	Priority (hatched)	Likely (hatched)	Priority (hatched)	Challenges (hatched)	Challenges (hatched)	Challenges (hatched)	Challenges (hatched)
	Thermochemical, methane	Advanced	Low priority	Low priority	Possible (hatched)	Possible (hatched)	Low priority	Challenges	Low priority	Challenges
	H_2 (biomass gasification)	Advanced	Challenges (hatched)	Challenges (hatched)	Low priority	Low priority	Low priority	Challenges (hatched)	Low priority	Challenges (hatched)
RFNBOs	E-H_2		Possible (hatched)	Possible (hatched)	Challenges (hatched)	Challenges (hatched)	Challenges (hatched)	Possible (hatched)	Challenges (hatched)	Possible (hatched)
	E-hydrocarbons		Priority (hatched)	Priority (hatched)	Likely (hatched)	Priority (hatched)	Challenges (hatched)	Possible (hatched)	Low priority	Challenges (hatched)
	E-methanol		Low priority	Low priority	Likely (hatched)	Priority (hatched)	Low priority	Challenges (hatched)	Low priority	Challenges (hatched)
	E-Ammonia		Low priority	Low priority	Possible (hatched)	Possible (hatched)	Low priority	Low priority	Low priority	Low priority
Others	Fossil H_2 with C sequestration		Possible (hatched)	Possible (hatched)	Challenges (hatched)	Challenges (hatched)	Challenges (hatched)	Possible (hatched)	Challenges (hatched)	Possible (hatched)
	Nuclear H_2		Possible (hatched)	Possible (hatched)	Challenges (hatched)	Challenges (hatched)	Challenges (hatched)	Possible (hatched)	Challenges (hatched)	Possible (hatched)
	RCFs (to drop-in liquid fuels)		Challenges (hatched)	Possible (hatched)	Challenges (hatched)	Possible (hatched)	Challenges (hatched)	Challenges (hatched)	Low priority	Challenges (hatched)
Direct electrification			Challenges (hatched)	Low priority	Priority (hatched)	Low priority	Priority (hatched)	Priority (hatched)	Priority	Priority

Legend: Priority | Likely | Possible | Challenges | Low priority

|||||||||||| < Needs technological progress and/or scale up

Notes:

This table is a qualitative evaluation of a selection of fuels relative to the main transport end-use applications. It is based on the combined assessment of a. the technical feasibility between the fuels and the end-use applications, b. the qualitative evaluation of the availability and sustainability of the fuels relative the possible feedstock, and c. costs considerations. The full analysis is available in chapter 4 of the study.

Even though this table has been based on extensive desk review and literature evidence, it remains the appreciation of the authors and should only support decision makers by providing the broad picture in one visual.

Source: author elaboration developed for this analysis.

Investment needs and financial implications

Despite a projected reduction in absolute energy demand in the transport sector by 2050 in the EU in a Paris Agreement-compliant scenario, **annual expenditures in energy production for the transport sector** could amount to around the same amount as in 2022 by that time. By 2050, these **expenditures are expected to cover e-liquids, electricity, biofuels and hydrogen production**. They account for higher costs of sustainable fuels compared to fossil fuels, even though improvement in technology and learning curves will reduce their costs towards 2050.

Investments in **renewable electricity generation are one of the most important underlying elements** in this transition, both for direct electrification and the production of RFNBOs.

Additional **investments in infrastructure deployment and adaptation, as well as investments in vehicles and new powertrains**, are inevitable, regardless of the mix of alternative solutions deployed. These expenditures can be minimised or optimised with smart choices, e.g. sharing infrastructure with other energy end-uses.

It is expected that large-scale infrastructure and alternative powertrain investments associated with the use of **hydrogen** as a fuel would be far higher than the reuse and repurpose of existing assets for biofuels and e-liquids or the reinforcement of the existing electricity network for direct electrification. **Hydrogen valleys and clusters,** centred on industry, will play a crucial role for renewable hydrogen. These can minimise infrastructure costs while leveraging lower production costs compared to e-fuels. Synergies with maritime transport in port cities are likely to be among the most relevant in transport.

Capital, primarily for technology improvements and infrastructure development, needs to be **mobilised in a timely manner by all stakeholders** both from the public and private sectors. Sustainable fuel production scale-up and the adaptation and deployment of associated infrastructure should go hand-in-hand, with decisions being taken on the match-making between fuels and their applications.

Policy priorities

The Fit for 55 policy proposals are among the most comprehensive ever developed globally. They have the potential to take the EU one step further to **accelerating real-world technology deployment**.

It is recommended that in their final adoption, the level of ambition be at least maintained, if not increased.

This analysis results in several policy recommendations to address remaining gaps and weaknesses:

- Exploring further the recommended pathways for developing and deploying sustainable fuels and matching the different end-use applications.
- Increasing the share of RFNBOs in 2050 for the maritime and aviation sectors, and having large pleasure/luxury boats and private jets spearhead the efforts.
- Ensuring that hydrogen and RFNBOs or RCFs needing large amounts of electricity for their production are subject to additionality requirements when production is scaled up.
- Establishing clear pricing signals via the Emissions Trading System (ETS) and the Energy Taxation Directive (ETD) to remove biases in the fiscal treatment applied to fossil fuels subject to low tax rates, for both domestic and international aviation and maritime transport.
- Complementing carbon pricing with mechanisms supporting innovation and re-distributional measures (to address energy poverty).
- Mobilising research, design and innovation (RD&I) spending on key enabling technologies for a transition of transport to sustainable energy and fuels (e.g. batteries, water electrolysis, Direct Air Capture, electrochemical reduction of CO_2).
- Supporting pilot and demonstration projects to speed up identification of the most suitable sustainable fuels for specific applications, (e.g. methanol, ammonia or e-hydrocarbons for long-distance shipping).
- RD&I agendas should remain open to a possible phase-in of hydrogen use in heavy-duty road, or even in maritime and aviation.

Further information

This executive summary is available in the following languages: English, French, German, Italian and Spanish. The study, which is available in English, and the summaries can be downloaded at: https://bit.ly/3Yw1RPe

More information on Policy Department research for TRAN: https://research4committees.blog/tran/

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