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SAF Mandate: SAF supply and industry certainty in an evolving market

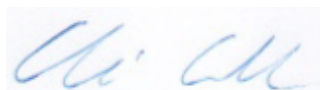
Dear Sir or Madam

Fuels Industry UK represents the six main oil refining and marketing companies operating in the UK. The Fuels Industry UK member companies – bp, Essar, Esso Petroleum, Phillips 66, Shell, and Valero – are together responsible for the sourcing and supply of product meeting over 85% of UK inland demand, accounting for over a third of total primary UK energy¹.

The refining and downstream oil sector is vital in supporting UK economic activity. It provides a secure supply of affordable energy for road and rail transport, aviation, and marine applications, as well as for commercial and domestic heating. It also supplies base fluids for use in lubricants, bitumen for use in road surfacing, and graphite for use in electric vehicle batteries and as electrodes in steel and aluminium manufacture.

Fuels Industry UK welcomes the opportunity to respond to the consultation SAF Mandate: SAF supply and industry certainty in an evolving market. Our response is in Appendix A.

Yours sincerely



Chris Gould
Energy Transition Lead, Fuels Industry UK

¹ Based on the Department of Energy Security and Net Zero Digest of UK Energy Statistics 2024

Appendix A: Fuels Industry UK Response

Q1. Do you expect there to be sufficient non-HEFA SAF (either PtL or non-PtL SAF), domestically and globally, to meet the SAF Mandate targets until 2040? Please provide any supporting evidence including how you expect availability to change over time.

No definitive view

We cannot provide a definitive view for the period until 2040, but we note that we do not expect there to be sufficient non-HEFA SAF, domestically or globally, to meet the UK SAF mandate targets in the near to medium term. A significant increase in the number of projects reaching Final Investment Decision (FID) would be required to address this shortfall. However, we have provided some information on future availability of advanced SAF feedstocks in Appendix B.

We note that the UK and EU SAF mandates started only around 18 months ago, on the 1st of January 2025. In the case of the UK, the SAF mandate legislation was only finalised and confirmed late in 2024. As such, experience with the SAF mandates is still maturing with both fuel suppliers and airlines, making it difficult to provide a definite view of appropriate SAF supply up to 2040. Policy frameworks that provide consistent and durable long term investment signals form the backbone of any business cases to enable FIDs on SAF production facilities, within the UK, the EU, and worldwide, by providing demand certainty for investments.

In addition, the UK revenue certainty mechanism (RCM) legislation will also be introduced at the start of 2027. This seeks to address some of the challenges associated with investment in UK advanced SAF production facilities. The main constraints for these production facilities are bankability, coupled with poor UK competitiveness ², meaning that the HEFA cap and risk of buyout alone is unlikely to drive investments into these facilities.

We also note that the first allocation round (AR1) of the Revenue Certainty Mechanism is to support up to 230kt per annum of SAF production ³. However, even if AR1 is fully subscribed and all projects progress successfully, the volumes supported would still be materially below the non-HEFA volumes required, meaning it will depend on future allocation rounds, imports and other, non-supported non-HEFA investments, as to whether targets can be met.

² <https://www.ippr.org/articles/turning-energy-support-into-investment-leverage>

³ <https://www.gov.uk/government/publications/sustainable-aviation-fuel-saf-revenue-certainty-mechanism-contract-allocation-strategy>

It is therefore difficult to see material quantities of UK produced advanced SAF being available in the market until the beginning of the 2030s, even in an ambitious scenario. To deliver the required volumes of non-HEFA SAF will require multiple new first-of-a-kind (FOAK) production facilities to be operational within a relatively short timescale. Front-End Engineering Design (FEED) studies need to be completed, planning and regulatory approvals need to be obtained, and contracts need to be negotiated (including for feedstocks and RCM support where appropriate) before FIDs can be taken. After this there the construction and commissioning phase will begin, before beneficial operation can be obtained. FOAK projects also face significant technology, construction, commissioning and financing risks and announced capacity should not be treated as equivalent to likely supply. We discuss some of these issues in more detail in our response to the consultation on the UK SAF RCM indicative heads of terms and approach to contract allocation ⁴.

We also believe that current UK policies could be improved by following international examples and distinguish more clearly between existing crop types like “food and feed crops” and other types of crops like intermediate crops, which deliver additional environmental and other co-benefits without resulting in indirect land use change (ILUC). Intermediate crops are highly scalable both in the UK and globally and could be used in existing HEFA production facilities with limited additional costs. Land availability would depend on crop rotation but there would be no negative land use change impacts. Allowing intermediate crops to contribute to SAF targets will help expanding the feedstock base and may offer a safety net should insufficient non-capped SAF be available on the market, preventing a situation in which both buy-out and the revenue certainty mechanism are being passed on to consumers without delivering emission savings.

Finally, we would expect the UK to be largely reliant on imports in order for it to meet its SAF Mandate, in a similar manner to SAF supply in 2025 as outlined by the indicative DfT data available ⁵.

⁴ <https://www.fuelsindustryuk.org/media/fnhblrd2/saf-rcm-support.pdf>

⁵ <https://www.gov.uk/government/statistical-data-sets/sustainable-aviation-fuel-saf-mandate-statistics-data-tables>

Q2. In your view, what would be the likely consequences of maintaining the current approach (no policy change)? Please provide any supporting evidence.

Maintaining the current approach risks creating a prolonged period in which compliance costs increase more quickly than SAF supply develops.

Fuels Industry (formerly UKPIA) discussed the challenges with meeting the UK SAF mandate in detail our response to the June 2023 consultation on the development of the UK SAF mandate ⁶. Our position has not substantially changed from those that we outlined in this response.

The setting of targets needs to provide a clear trajectory for decarbonisation providing certainty for investment in SAF production, and downstream supply infrastructure. Increasing targets to a level which cannot be physically met through scalable and available technology, investment and construction timescales will lead to obligated companies “buying out”. Experience with the RTFO, particularly for development fuels ⁷ suggests that the buy-out costs borne by fuel suppliers will be passed through the supply chain and ultimately to consumers such as aviation users.

Therefore, setting targets that are unachievable, leading to buy-out, increases the cost to the aviation industry, and users with no benefit to the policy objective of reducing aviation GHG emissions. There needs to be transparency for consumers if the government is taking this approach.

We note that the current framework assumes that the HEFA cap and PTL will drive investments and supply. For FOAK facilities, the main constraints however are not demand but bankability, coupled with poor UK competitiveness (the role of a Cross Border Adjustment Mechanism, or CBAM should also be considered to address wider carbon leakage risks). We also note that fuel suppliers will have to pay a levy to finance the RCM. In case of insufficient non-HEFA supply, this would mean that both the cost of levy and buy-out will need to be passed through to consumers.

There also needs to be a recognition that the UK aviation industry does not operate in isolation. To compete at a global level, the UK aviation industry needs to be competitive with other jurisdictions, particularly in the EU. Therefore, higher costs such as those created by an unrealistic and overly ambitious SAF mandate trajectory may lead to the UK aviation industry losing ground to international competitors.

⁶ <https://www.fuelsindustryuk.org/media/nbed53bz/developing-the-uk-saf-mandate.pdf>

⁷ <https://www.gov.uk/government/statistical-data-sets/renewable-transport-fuel-obligation-rtfo-statistics-data-tables>

Q3. If you believe a change to the HEFA cap is required in 2027 or subsequent years to address insufficient supply, what type of change do you think is required? Please provide detail of the change and evidence to support it. If you do not believe a change is required to the HEFA cap, please state why. Please provide any supporting evidence as justification. Consider supply availability, and the impact on investment, industry and the environment in your answer.

We note that the government has not made any announcement on the potential removal of the HEFA cap through this consultation. As such we believe some degree of change in the HEFA cap may be required starting in 2027 in order to address the issue of non-HEFA supply not being available to meet the requirements of the SAF mandate.

Fuels Industry UK (formerly UKPIA) discussed the challenges with meeting the UK SAF mandate in detail our response to the June 2023 consultation on the development of the UK SAF mandate. Our position on the HEFA cap as a policy tool has not substantially changed from those we outlined in this response. However, we also note that any changes to the existing approach need to be balanced against the need for a policy framework that provides consistent and durable long term investment signals.

The current approach may risk of constraining the most commercially available SAF pathways before alternative supplies are available at scale. The HEFA cap and buy-out can create demand but do not in themselves provide long-term revenue certainty required for the non-HEFA projects to secure financing and reach FID.

As such, aligning the HEFA cap with realistic supply expectations and anticipated RCM-supported volumes could help providing a more credible and durable framework, while also preserving incentives to invest in advanced SAF.

One member suggests a multiplier approach could be used with a suitable multiplier applied to the HEFA volume supplied above the HEFA cap; the multiplier can then be adjusted on an annual basis. This effectively results in a partial lifting of the cap while letting the UK keep the cap on paper. Another member disagrees with this suggestion, noting that it may not be technology neutral.

We would also encourage the UK government to look allowing the expansion of feedstocks used in HEFA production beyond segregated oils and fats. This includes intermediate crops (certified against relevant sustainability requirements) or those grown on marginal or degraded land that could expand the feedstock base without triggering Indirect Land Use Change (ILUC). Being used in existing HEFA plants, they could contribute to SAF Mandate targets, minimising the risk of buy-out once the cap on segregated wastes and oils comes into place in 2027.

Q4. What would be the impact on investment in non-HEFA production domestically and globally by any change in the HEFA cap? Please provide evidence including differential impacts of different approaches to changing the HEFA cap. How could a change be implemented that mitigated impacts on non-HEFA production most effectively?

The effect of a change in the SAF mandate HEFA cap cannot be considered in isolation but must also be considered as part of a wider UK, EU and global policy landscape. However, the UK SAF mandate provides a clear demand signal for investment in non-HEFA SAF production, both domestically and globally.

The development and implementation of the SAF RCM to support UK non-HEFA production will have an important aspect to play in this, as will policies in other jurisdictions such as the EU through ReFuelEU aviation ⁸.

Q5. If you believe a change to the Power-to-Liquid (PtL) obligation is required in 2028 or subsequent years to address insufficient supply, what type of change do you think is required? Please provide detail of the change and evidence to support it. If you do not believe a change is required to the PtL obligation, please state why. Please provide any supporting evidence as justification. Consider supply availability, and the impact on investment, industry and the environment in your answer.

Yes

We note that the government has not made any announcement on the potential scrapping of the PtL obligation through this consultation. As such, we believe that some degree of change in the PtL obligation may be required starting in 2027 in order to address the issue of PtL supply not being available to meet the requirements of the SAF mandate.

We understand the policy intent behind the PtL obligation, in that it was intended to create a policy frameworks that provides consistent and durable long term investment signals for the supply and production of this advanced fuel.

However, we note the challenges in producing PtL at scale, including sourcing sufficient appropriate low carbon electricity, and carbon capture facilities. At present, while small scale PtL facilities exist, we do not believe that they are at the scale required in order to start to meet the sub-targets⁹. Any PtL plants reaching FID will still need to be constructed and commissioned before they reach beneficial operation, which is certainly not expected to be before the start of 2028, and is likely to be considerably later.

⁸ https://transport.ec.europa.eu/transport-modes/air/environment/refuelev-aviation_en

⁹ <https://www.safinvestor.com/existing-and-planned-saf-projects/>

We also note that the UK buy-out level is materially lower than comparable EU penalties, meaning that there is a risk that any available supply would be drawn to these markets first, creating a risk of persistent buy-out without physical supply. The UK PtL sub-target should therefore be set by reference to the PtL volumes that the UK is willing and able to support through the RCM.

As we note in our response to Q2, the setting of targets needs to provide a clear trajectory for decarbonisation, as part of a policy frameworks that provide consistent and durable long term investment signals. Increasing targets to a level which cannot be physically met through scalable and available technology, investment and construction timescales will lead to obligated companies “buying out”. Experience with the RTFO, particularly for development fuels suggests that the buy-out costs borne by fuel suppliers will be passed through the supply chain and ultimately to aviation users.

Given that the government looks to continue to have a separate PtL obligation, the government should decide whether persistent “buy-out” is preferable, or whether it adjusts the PtL targets downwards to match available supply and avoid “buy-out” penalties, which are then paid to HM Treasury via the consolidated fund.

Q6. What would be the impact on investment in non-HEFA production domestically and globally by any change to the PtL obligation? Please provide evidence including differential impacts of different approaches to changing the PtL obligation. How could a change be implemented that mitigated impacts on non-HEFA production most effectively?

The effect of a change in the SAF mandate PtL obligation cannot be considered in isolation but must also be considered as part of a wider UK, EU and global policy landscape. However, the UK SAF mandate provides a clear demand signal for investment in PtL SAF production, both domestically and globally.

The development and implementation of SAF RCM to support UK non-HEFA production will have an important aspect to play in this, as will policies in other jurisdictions such as the EU through ReFuelEU aviation.

Q7. Do you think there are additional options for flexibility within the SAF Mandate that should be considered to help support delivery of the mandate while not undermining investment in SAF production? If so, what are these options and what would be their pros/cons. Please provide evidence. Consider supply availability, and the impact on investment, industry and the environment in your answer.

We note the decision already taken by government not to reduce future overall mandate levels. Our comments should therefore be viewed in that context.

There are several additional flexibility measures that could improve delivery of the SAF Mandate whilst maintaining incentives for investment in advanced SAF production. This includes:

- As discussed above, the pace at which the cap tightens should reflect realistic non-HEFA supply expectations and anticipated deployment from projects supported through the RCM. This could be through a compliance mechanism that periodically assesses available non-HEFA SAF supply and adjusts the level that HEFA can count towards targets accordingly. During the FOAK phase of market development, the priority should be maximising SAF availability whilst advanced pathways scale towards commercial maturity.
- Government should expand the range of feedstocks available including for HEFA and co-processing, providing also incentives for those that face higher production costs than HEFA from segregated oils and fats. Intermediate crops, subject to appropriate sustainability criteria.
- The Government should consider how the interaction between the SAF Mandate and the RCM can avoid unnecessary overlapping costs during periods where SAF supply is materially below expectations.

Expanding the range of feedstocks available

As we discuss in our response to the recent call for evidence on the use of crop derived SAF, the range of feedstocks deemed acceptable for use in SAF should be widened. This additional flexibility allows the mandate targets to be met in the most effective manner, whilst not undermining investment in SAF production.

We advocate for the responsible use of resources, with a strong emphasis on safeguarding food security, at the same time as promoting the growth of the overall availability of sustainable biomass that becomes increasingly important to enable effective and affordable pathways to decrease GHG emissions in different sectors. With appropriate governance in place, food production, industrial demand, and energy uses can coexist without creating unsustainable pressures on land or feedstock markets.

A coherent policy approach is essential to ensure that these sectors develop in a balanced and mutually reinforcing way, supporting both sustainability objectives and long-term net-zero ambitions.

Q8. In your view, what impact is the SAF Mandate expected to have on future tankering compared to current practices? Please provide any supporting evidence to highlight the environmental and economic impact.

Fuels Industry UK has highlighted the risks of increased tankering compared to current practices in a number of previous consultations. We believe that the risk is real, and highly undesirable for a number of reasons, including increases costs and carbon emissions ¹⁰.

The aviation industry including airlines is best placed to comment on this issue. However, we note that they have raised concerns regarding the competitiveness of UK aviation, notably through the Jet Zero Task Force ¹¹. Further information can be found in the 2025 annual report ¹².

We also note that the SAF mandate is only one element of additional costs relating to aviation decarbonisation; the impact of the SAF RCM must also be considered. It is possible that the aviation industry will face additional costs through this route, as the RCM comes into effect, adding to the overall cost burden.

Therefore, the combined impact of the SAF Mandate and SAF RCM on the risk of tankering must be considered, rather than looking at the SAF Mandate in isolation.

This risk strengthens the case for aligning mandate ambition with realistic supply availability. A mandate that creates significant UK-specific cost exposure without physical SAF supply could undermine both competitiveness and environmental outcomes.

Finally, we note that the ReFuelEU Aviation directive imposes restrictions on the use of tankering at member state airports. This is something that the UK government may wish to consider in the future as part of a wider review of the aviation sector's competitiveness.

¹⁰ https://www.icao.int/sites/default/files/environmental-protection/Documents/EnvironmentalReports/2022/ENVReport2022_Art38.pdf

¹¹ <https://www.gov.uk/government/groups/jet-zero-taskforce>

¹² <https://www.gov.uk/government/publications/jet-zero-taskforce-2025-annual-report>

Q9. In your view, are there any alternative options which have not been considered in this call for evidence which would help delivery of carbon savings from the SAF Mandate and help maintain investment and supply certainty for industry?

Alignment with other aviation decarbonisation schemes

We note that the UK and EU SAF mandates operate with different trajectories, with the UK trajectory being steeper and more ambitious than that of the EU. Given that SAF is more expensive than its fossil equivalent, this is likely to increase costs for UK aviation users than their equivalents within the EU. A degree of alignment between the UK and EU schemes may make the UK more competitive against European competition whilst maintaining investment and supply certainty.

At a wider level, the global CORSIA (Carbon Offsetting and Reduction Scheme for International Aviation) ¹³ scheme operates to reduce carbon emissions from aviation. Aligning the SAF Mandate with this scheme would ensure that the UK delivers carbon savings; however, this is likely to be at a slower rate than the existing UK or EU schemes (but at lower cost to the aviation sector).

Assessing the opportunities and risks associated with GGRs

We note the 2025 Whitehead report into Greenhouse Gas Removals (GGRs) ¹⁴, and recommendation 6d that the SAF mandate should be renamed the Net Zero Aviation Mandate and that GGRs be included in the SAF mandate. This recommendation was made without significant discussions with fuel suppliers or potential SAF investors and should be treated with caution.

The GGR report has the potential to undermine investment in UK SAF production, and confidence in the SAF Mandate scheme. However, we note the recent publication of the government response to this report ¹⁵ and welcome its recognition and alignment with the issues that we have noted above.

We also note that further government work is expected in this area, which is expected to report by the end of 2027. We would ask that this work continues to take account of the risks identified and is subject to proper consultation with the wider fuel supply and SAF industries before it concludes.

¹³ <https://www.icao.int/CORSIA>

¹⁴ <https://assets.publishing.service.gov.uk/media/68f8d27a0794bb80118bb764/independent-review-of-ggr.pdf>

¹⁵ <https://www.gov.uk/government/publications/independent-review-on-greenhouse-gas-removals-government-response/independent-review-on-greenhouse-gas-removals-government-response>

Hydrogen

The use of CCUS-enabled lower carbon fuels (e.g., blue hydrogen ¹⁶, which can be used to produce methanol, gasoline, and SAF) are not recognised in the SAF mandate. Analysis by the UK government and the Climate Change Committee ¹⁷ has shown that methane reformation with CCUS has among the lowest levelized costs of all lower carbon hydrogen production methods.

The Government's response to the 2nd SAF Mandate consultation ¹⁸ indicates it is considering the eligibility of CCUS-enabled hydrogen in the SAF Mandate. We strongly support this review and urge a swift amendment to the primary legislation ¹⁹ to appropriately make fuels from this pathway eligible under both the RTFO and SAF Mandate. This should include credit for using CCS-enabled hydrogen not only as a finished fuel in its own right, but also in the production of transport fuels.

Supporting the use of all forms of lower carbon hydrogen (LCH) in the production of all transport fuels, including refinery processes, can drive investments in LCH and reduce GHG emissions across all fuel types. This technology-neutral approach is crucial given the blend limitations in gasoline and diesel, which will continue to power many vehicles for the foreseeable future. A GHG-based policy can facilitate this.

We also note there is a policy disconnect between the DESNZ and the DfT. While DESNZ has established a Low Carbon Hydrogen Standard ²⁰, the DfT's SAF mandate policy does not fully align with this standard. This misalignment could hinder the effective integration and incentivisation of lower carbon hydrogen across all industry and transport fuels. Addressing this disconnect is essential to ensure cohesive and comprehensive support for lower carbon hydrogen technologies.

¹⁶ <https://www.nationalgrid.com/stories/energy-explained/hydrogen-colour-spectrum>

¹⁷ <https://www.theccc.org.uk/>

¹⁸ <https://www.gov.uk/government/consultations/pathway-to-net-zero-aviation-developing-the-uk-sustainable-aviation-fuel-mandate>

¹⁹ <https://www.legislation.gov.uk/ukpga/2004/20/contents>

²⁰ <https://www.gov.uk/government/publications/uk-low-carbon-hydrogen-standard-emissions-reporting-and-sustainability-criteria>

Expanding the range of feedstocks available

As we discuss in our response to the recent call for evidence on the use of crop derived SAF, the range of feedstocks deemed acceptable for use in SAF should be widened. This additional flexibility allows the mandate targets to be met in the most effective manner, whilst not undermining investment in SAF production.

We advocate for the responsible use of resources, with a strong emphasis on safeguarding food security, at the same time as promoting the growth of the overall availability of sustainable biomass that becomes increasingly important to enable effective and affordable pathways to decrease GHG emissions in different sectors. With appropriate governance in place, food production, industrial demand, and energy uses can coexist without creating unsustainable pressures on land or feedstock markets. A coherent policy approach is essential to ensure that these sectors develop in a balanced and mutually reinforcing way, supporting both sustainability objectives and long-term net-zero ambitions.

Refinery Co-processing

As noted in the information contained in Appendix B, refineries are well integrated into existing aviation fuel supply chains. In the UK, for example, a number of refineries²¹ co-process lower carbon feedstocks into finished fuels, including aviation fuels. The use of refineries in this respect should be encouraged and developed as far as possible, enabling the energy transition with existing assets.

SAF reporting burden

We would encourage that a rationalisation of the reporting and documentation burdens be considered and included as part of the development of the proposals for the second consultation on the detailed design of the levy in order to reduce the considerable burden on aviation fuel suppliers.

²¹ <https://www.phillips66.co.uk/emerging-energy/renewable-fuels/>

Voluntary SAF

Appropriate voluntary SAF plays a role in enabling aviation decarbonisation. However, under the rules of a number of aviation decarbonisation schemes, such as the Heathrow Incentive²² or CORSIA, SAF is only permitted to count under one scheme (i.e. multiple incentives are not allowed).

Fuel suppliers may therefore have valid and rational reasons to supply appropriate voluntary SAF without claiming certificates under the SAF Mandate.

However, under the SAF mandate legislation²³, if there is no application for certificates, then the SAF becomes obligated in its own right; the relevant clause can be found below.

(8) For the purposes of paragraph (6)(a), the notional amount of relevant aviation turbine fuel, expressed in megajoules, which an aviation fuel supplier has supplied during an obligation period is determined in accordance with the following formula—

$$FN = (MT \times LHV_k) - \sum_i^j (MA_i \times LHV_i \times R_i \times \frac{S_i}{T_i})$$

where—

FN is the notional amount of relevant aviation turbine fuel;

MT is the total mass (in kilograms) of relevant aviation turbine fuel supplied during that period;

LHV_k is the lower heating value of aviation turbine fuel;

i is the first consignment of relevant sustainable aviation fuel supplied during the obligation period for which the supplier has submitted an application for certificates to the Administrator in accordance with article 16;

j is the final consignment of relevant sustainable aviation fuel supplied during the obligation period for which the supplier has submitted an application for certificates to the Administrator in accordance with article 16;

MA is the total mass (in kilograms) of relevant sustainable aviation fuel which was supplied during that period;

LHV is the lower heating value of the relevant sustainable aviation fuel;

R is the percentage of MA which is attributable to a relevant feedstock;

S is the mass of MA (in kilograms) which meets the sustainability criteria; and

T is the mass of MA (in kilograms) which is attributable to a relevant feedstock.

This creates a perverse outcome that does not encourage the use of appropriate Voluntary SAF in the UK.

We believe that there is a need for fairness in the treatment of such voluntary SAF. Appropriate SAF, which is supplied and approved through DfT verification checks, but SAF mandate certificates are not then subsequently claimed, should not be subject to the SAF mandate obligation. The DfT should explore options on how this can be addressed; e.g. through an amendment to the SI, or through another pragmatic approach involving changes to the operation of the scheme.

²² <https://www.heathrow.com/company/about-heathrow/heathrow-sustainability-strategy/our-carbon-strategy/sustainable-aviation-fuel-saf#>

²³ <https://www.legislation.gov.uk/ukxi/2024/1187/contents/made>

Appendix B: Future availability of advanced SAF Feedstocks

We provided information on future availability of advanced SAF in our response to the recent call for evidence on SAF derived from crops ²⁴. In particular, we note a recent study by Imperial College ²⁵, in partnership with Concawe, on this topic and suggest that it could be used to inform the discussion. The study assesses the availability and mobilisation potential of the most important Annex IX-A solid bio-feedstocks under RED II, covering around 80% of the total sustainable biomass considered in Concawe's 2021 Imperial College London (ICL) assessment.

Key findings include:

- Europe's domestic sustainable biomass is sufficient to meet the projected demand for advanced biofuels and competing sectors in both 2030 and 2050 scenarios.
- By 2050, optimal supply chains will increasingly rely on advanced technologies such as Gasification and Fischer-Tropsch (GFT) and Hydrothermal Liquefaction (HTL).
- Refineries will be a cornerstone of economically efficient supply chains. Their existing processing and storage infrastructure makes them ideal sites for integrating future biorefineries at the lowest possible cost, with between 47 and 64 large-scale biorefineries across Europe estimated to be integrated with existing refinery sites by 2050, according to the optimisation modelling results. Geography is a decisive factor in shaping optimal supply-chain configurations and technology choices. For example, Scandinavia could develop into a major hub for decentralised biomass supply and a supplier of biocrude to European areas with limited bioresources but high biofuel demand, such as North-Western Europe. Thanks to its strong port and refinery network, North-Western Europe could, in turn, emerge as a central upgrading hub for producing drop-in biofuels.
- Innovations in agricultural and forestry management and novel energy crops deployment, along with the integration of green hydrogen in biorefineries, will enhance biomass use efficiency and enable Europe to meet biofuel demand with reduced pressure on bio-feedstock availability.

²⁴ <https://www.fuelsindustryuk.org/media/mmnpb3jc/saf-mandate-crop-derived-saf-fuels-industry-uk-response-final.pdf>

²⁵ <https://www.concawe.eu/wp-content/uploads/Sustainable-Biomass-Availability-in-the-EU-Part-I-and-II-final-version.pdf>

We would also recommend a very recent study ²⁶ on advanced lower carbon fuels (LCFs), commissioned by Concawe in collaboration with Utrecht University and TNO, which presents a comprehensive, cost-optimised analysis of sustainable bio feedstock supply chains for advanced biofuel production across the EU-27 + UK for 2030 and 2050.

The study focuses on the main lignocellulosic feedstocks listed under Annex IX of the Renewable Energy Directive. It applies a spatially explicit supply chain optimisation model (based on Mixed-Integer Linear Programming), which integrates high-resolution biomass availability data, geospatial transport modelling, and spatially explicit information on EU industrial and transport infrastructure. The modelling framework also incorporates techno-economic data for two representative conversion process technologies, Gasification and Fischer–Tropsch (GFT) and Hydrothermal Liquefaction (HTL), evaluated under centralised and decentralised configurations.

²⁶ https://www.concawe.eu/wp-content/uploads/Rpt_25-10-2.pdf