



Department
for Transport

Sustainable aviation fuels mandate

A consultation on reducing the
greenhouse gas emissions of
aviation fuels in the UK



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1 Airbus Beluga refuelling with SAF in Broughton. Image courtesy of Airbus.

2 Rolls-Royce's Testbed 80 Trent XWB in Derby, used to test 100% SAF blends. Image courtesy of Rolls-Royce.

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Ministerial foreword: Secretary of State for Transport, Rt Hon Grant Shapps MP



The past 18 months have been exceptionally challenging for the UK aviation sector, as well as for all those who normally rely on flying to visit family, conduct business or travel on holiday. Despite all this, I have been struck by the commitment that airlines and passengers have shown to placing sustainability at the heart of the sector's recovery. I whole-heartedly share that commitment: ending our contribution to climate change is our ultimate objective – a giant leap into the future towards a cleaner and safer world.

With that in mind, exactly a year ago the Prime Minister launched the Jet Zero Council, to develop UK capabilities to deliver both net zero and zero emission technologies, acting as a catalyst to achieve zero emission flight across the Atlantic within a generation. The Council is looking at both engine technology – supporting the development of electric and hydrogen flight – and at how we can accelerate the production of sustainable aviation fuels (SAF). SAF will play a vital role in decarbonising aviation, particularly for long-haul flights, where it is likely to be the most viable option in the coming decades for driving down net emissions

from flight. To enable aviation to reach net zero, SAF will of course need to be combined with other measures as set out in the Jet Zero Consultation.

The Government made a number of important climate commitments last year through the Prime Minister's Ten Point Plan, including our intention to consult on a mandate for the supply of SAF for flights departing from the UK. Putting a mandate into legislation would aim to provide certainty for industry on the Government's intentions and to guarantee a path towards increasingly high blends of SAF in the coming decades. I am determined that the UK should be a world leader in the production and use of SAF, especially as we look towards our hosting of COP26 in November. As part of that leadership, this consultation explores the possibility of setting a mandate and the key principles that will need to be established in doing so.

To develop the ideas set out in this consultation, my officials have been working closely and rapidly with stakeholders including airlines, fuel producers, suppliers, technical experts, investors, NGOs and others, primarily through the Jet Zero Council SAF Delivery Group I launched in November 2020. I am very grateful for the constructive engagement that everyone has shown throughout this process, and hope that we can maintain an open dialogue as we refine the proposals further. There are many complexities to overcome, including how a mandate might interact with international frameworks as well as our own Renewable Transport Fuels Obligation, how we set a realistic but ambitious target, and how we balance rapid sectoral growth with supporting the technologies that will be most important in the longer term.

Some have also suggested that a mandate alone will not be enough to grow a UK SAF industry quickly. Through this consultation we are also beginning a conversation about whether there is more we can do to provide price certainty for producers looking to build SAF plants and invest in the UK.

With your help I am sure that we will be able to find a way through to a robust and credible approach to supporting SAF, thus building a world-leading UK industry, creating thousands of green jobs and continuing our progress towards delivering Jet Zero.

Executive summary

The context

1. As set out in the recently published Transport Decarbonisation Plan and Jet Zero Consultation, the UK Government is committed to achieving net zero aviation by 2050. We are already taking bold action: we are working with industry through the Jet Zero Council and we continue to support the sector with new policy and funding. Nevertheless, more action is needed to make net zero aviation possible.
2. Sustainable Aviation Fuels (SAF) are one of the key levers available to government and industry to accelerate the transition to net zero aviation. These advanced fuels, obtained from low carbon feedstocks, can be easily combined with existing conventional jet fuel. They can achieve lifecycle emissions savings of over 70% compared with conventional jet fuel, when fully replacing kerosene¹.
3. Despite this potential, SAF production and use is very limited, both in the UK and globally. First-of-a-kind production plants present high capital costs, which result in a very expensive fuel, and the cost constrains demand. In addition, technology risks can affect production, as can the availability of feedstock and local supply chains. These barriers result in a significant economic risk which can disincentivise private investment.
4. In recent years the UK Government has introduced a world-leading programme of interventions that aims to support commercialisation of the domestic SAF industry, deliver carbon savings and maximise the industrial opportunities for the UK. This programme has made available over £65 million for the early development of advanced fuels plants through industry competitions and revenue support through the Renewable Transport Fuel Obligation (RTFO).
5. Supported by this policy, the first few volumes of SAF have been recently delivered to the UK, but industry engagement has made it clear that a more comprehensive policy framework is needed in order to accelerate SAF deployment and truly capture the environmental benefits and green jobs the sector can deliver.

¹ <https://www.iata.org/en/programs/environment/sustainable-aviation-fuels/#tab-2>

Aim of a UK SAF blending mandate and this consultation

6. As announced in the Prime Minister's Ten Point Plan in November 2020, the Government would like to introduce a UK SAF blending mandate. A long-term obligation can generate demand for SAF, provide an incentive to SAF producers (in the form of a tradable credit) and signal to investors the vital role the Government believes the technology will play in the UK.
7. This consultation seeks views on the high-level ambition and design of the proposed SAF mandate, the eligibility criteria SAF will need to meet, the interactions between SAF and other domestic and international policy and the compliance, reporting and verification principles that will steer the subsequent development of the proposed scheme.
8. This consultation also welcome views on how best a SAF mandate could be designed to foster SAF plants development in the UK, and whether it should be complemented by a more comprehensive policy framework.

Summary of consultation content and proposals

Key mandate design principles

9. The Government would like to mandate SAF supply in the UK by introducing a bespoke SAF mandate, separate from the RTFO. This is to ensure the scheme does not create complexity and reflects the polluter pays principle.
10. To prioritise carbon emissions savings achieved through SAF over SAF fuel volumes, we propose to implement this scheme as a greenhouse gas (GHG) emissions scheme, i.e. a scheme that awards a number of credits proportional to the kilograms of CO_{2e} saved. Under such a scheme, SAF whose GHG emissions intensity is below the GHG emissions intensity target and meets the proposed eligibility criteria would generate credits. Jet fuel whose GHG emissions intensity is above the target, or SAF that does not meet the proposed eligibility criteria, would incur an obligation. Throughout the obligation period, credits can be sold or bought to meet the obligation.

Ambition and GHG emissions intensity trajectory

11. We would like to introduce a SAF mandate that is world leading and as ambitious as possible. To that end, this consultation sets out a number of potential SAF uptake scenarios, up to 10% SAF by 2030 and up to 75% SAF by 2050, and the associated GHG emissions intensity targets, that might be appropriate under certain market circumstances. We acknowledge high targets will be contingent on multiple technology and policy developments that could unlock a very rapid roll-out of several SAF plants in the short term, the quick commercialisation of SAF technology not yet proven at scale and the certification of new production pathways. To take into account these uncertainties, we welcome views on the right trade-off between ambition and deliverability at this stage.
12. Depending on the mandate levels chosen initially, we also are open to increasing our targets in the future if the market and the technology develop quickly and SAF costs and carbon abatement costs come down significantly. This is why we have proposed

review points in 2030, for post-2035 uptake, in 2035 for post-2040 uptake and in 2040, for post-2045 uptake, including beyond 2050.

Obligated party and fuel

13. The Government would like the proposed obligation to fall on suppliers of jet fuel to the UK. To define aviation fuel suppliers precisely and to avoid obligating fuel suppliers not interested in delivering SAF to the UK, we welcome views on whether the assessment point under the proposed SAF mandate (i.e. the point that determines who is subject to the obligation) should coincide with the blending point (in line with the RTFO).
14. While it is proposed that all the avtur supplied by the obligated parties to the UK will incur an obligation, we welcome views on whether, in each reporting year, a threshold below which the avtur supplied by an obligated party is not obligated is needed.

Fuel eligibility criteria

15. To count towards the mandate obligation, it is proposed that SAF meets several criteria:
 - SAF will need to meet the Ministry of Defence (MOD) Defence Standard (DEF STAN) 91-091 jet fuel specifications;
 - To avoid direct or indirect sustainability impacts, only waste-derived biofuels, renewable fuels of non-biological origin (RFNBOs), SAF from nuclear energy and recycled carbon fuels (RCFs) will be allowed;
 - Where hydrogen is used as a process input, the hydrogen must be low carbon.
16. To accurately reflect the lifecycle GHG emissions of jet fuel, we would like to use 89 gCO₂e/MJ as the baseline lifecycle GHG emissions intensity. This figure will need to be used to calculate the minimum GHG emissions savings threshold (at least 60%) that we believe SAF should meet to be eligible under a SAF mandate. We welcome views on this threshold and how it should change over time.
17. Obligated parties will need to demonstrate that SAF meets the proposed GHG emissions savings threshold by calculating the GHG emissions intensity with a consistent methodology. We welcome views on what this methodology should be and how it should take into account the differences between different feedstocks and production pathways.

Scaling up SAF technology in the UK

18. To drive the commercialisation of less developed SAF production pathways and to prioritise biofuels use on roads in the short term, we welcome views on whether SAF produced through the hydroprocessed esters and fatty acids (HEFA) pathway should be capped. This could also reduce our reliance on fuel imports.
19. Given the GHG emissions intensity and cost reduction potential of power-to-liquid fuels, the Government would like to promote their accelerated technological and commercial development. This could be obtained, for instance, through the use of a multiplier

system within the mandate or through specific sub-targets. We welcome views on ways to achieve this and the implications for power-to-liquid and other SAF technologies.

20. We are also interested in whether a more comprehensive policy framework is needed to build investor confidence in UK plants and secure investment, allowing the UK to develop a world-leading domestic SAF sector.

Interactions between the SAF mandate and other policies and funding

21. To avoid the double counting of emissions saved through SAF, we propose that any SAF supplied under the mandate would not count towards decarbonisation targets from other legislated GHG obligations, either in the UK or abroad. This means incentives under the RTFO and the SAF mandate cannot both be claimed for the same volume of fuel. In addition, given the introduction of a bespoke support mechanism, to ensure a fair and smooth running of the scheme, we propose to make aviation fuel ineligible to receive certificates under the RTFO once a SAF mandate is in place, likely in 2025.
22. It is proposed that any SAF produced from plants which have benefitted from government support for R&D, feasibility studies, front end engineering design (FEED) work and construction of commercial plants, either in the UK or abroad, would count towards the proposed SAF mandate obligation and can still receive support under the SAF mandate.
23. We are keen to avoid the risk of carbon leakage and we welcome views on how the proposed SAF mandate can decrease the risk of tankering, which could take place when an aeroplane refuels where SAF use is not mandated and jet fuel is cheaper.

Compliance, reporting and verification

24. A buy-out option would allow obligations to be met within a prescribed cost envelope, but could result in payments being made without SAF being delivered or GHG emissions saved. We therefore welcome views on whether buy-out would be beneficial and what other measures or penalties should be in place to deter suppliers from falling short of the proposed GHG emissions targets.
25. We would like the mandate to be based on mass balance principles and we welcome views on the approach to the chain of custody this will require.
26. When submitting claims, obligated fuel suppliers will need to show that the SAF supplied meets the proposed SAF sustainability standards. To do so, we are open to use evidence from voluntary schemes, although we are not proposing their use should be mandatory.
27. We propose that data from voluntary schemes and, more generally, data submitted to claim credits would need to be independently verified before submitting an application for SAF credits. We welcome views on whether verification should be conducted to a 'reasonable' assurance level.

28. We also welcome views on the timescale for reporting and submitting claims, what information from these claims should be publicly released and when this information should be published.

Next steps

29. Given the level of complexity associated with developing policy on SAF support, we anticipate that this consultation is likely to be followed by a second consultation which both reflects findings from the first and addresses more fully the details of administering a mandate.

How to respond

The consultation period began on 23 July 2021 and will run until 19 September 2021. Please ensure that your response reaches us before the closing date. If you would like further copies of this consultation document, it can be found at <https://www.gov.uk/dft#consultations> or you can contact LowCarbonFuel.Consultation@dft.gov.uk if you need alternative formats (Braille, audio CD, etc.).

As a result of the COVID-19 pandemic, the team continues to primarily work remotely for the foreseeable future and to avoid handling physical mails we strongly encourage responses by the online form or by email. If you are unable to respond through the online form or by email, we would invite you to please let us know by asking someone to email on your behalf. If none of the above is possible, then we invite you to provide responses to:

Advanced Fuels Team, Low Carbon Fuels

Great Minster House

33 Horseferry Road

London

SW1P 4DR

When responding, please state whether you are responding as an individual or representing the views of an organisation. If responding on behalf of a larger organisation, please make it clear who the organisation represents and, where applicable, how the views of members were assembled.

We will be hosting consultation event throughout the consultation period. If you would be interested in attending these events, please contact LowCarbonFuel.Consultation@dft.gov.uk.

Freedom of Information

Information provided in response to this consultation, including personal information, may be subject to publication or disclosure in accordance with the Freedom of Information Act 2000 (FOIA) or the Environmental Information Regulations 2004.

If you want information that you provide to be treated as confidential, please be aware that, under the FOIA, there is a statutory Code of Practice with which public authorities must comply and which deals, amongst other things, with obligations of confidence.

In view of this it would be helpful if you could explain to us why you regard the information you have provided as confidential. If we receive a request for disclosure of the information, we will take full account of your explanation, but we cannot give an assurance that confidentiality can be maintained in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not, of itself, be regarded as binding on the Department for Transport (DfT).

DfT will process your personal data in accordance with the Data Protection Act (DPA) and in the majority of circumstances this will mean that your personal data will not be disclosed to third parties.

Confidentiality and data protection

This consultation is carried out by the Department for Transport, working with other government departments, including the Department for Business Energy and Industrial Strategy (BEIS) and Department for Environment, Food and Rural Affairs (DEFRA), on creating a mandate for SAF.

In this consultation we are asking for:

- your name and email, in case we need to ask you follow-up questions about your responses (you do not have to give us this personal information, but if you do provide it, we will use it only for the purpose of asking follow-up questions)

If an organisation we are additionally asking for your organisation's:

- name, for identification
- size, to weight responses accordingly
- country of location, to understand the domestic and international context

Your consultation response and the processing of personal data that it entails is necessary for the exercise of our functions as a government department. DfT will, under data protection law, be the controller for this information. [DfT's privacy policy](#) has more information about your rights in relation to your personal data, how to complain and how to contact the Data Protection Officer.

As sustainable aviation fuels policy has many interactions with other government policy and work, to ensure we develop effective policy, we may share your responses with other government departments, such as BEIS and DEFRA. We will remove your personal details before we share your response with other government departments.

We will not use your name or other personal details that could identify you when we report the results of the consultation. Any information you provide will be kept securely and destroyed within 12 months of the closing date. Any information provided through the online questionnaire will be moved to our internal systems within 2 months of the consultation period end date.

Consultation principles

The consultation is being conducted in line with the Government's key consultation principles which are listed below. Further information is available at <https://www.gov.uk/government/publications/consultation-principles-guidance>

Glossary

ASTM	American Society for Testing and Materials
ATI	Aerospace Technology Institute
AtJ	Alcohol-to-Jet
Avgas	Aviation gasoline
Avtur	Aviation turbine fuel
CCUS	Carbon capture, utilisation and storage
CfD	Contracts for Difference
CI	Carbon intensity
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
DAC	Direct air capture
DEF STAN	Defence Standard
ETS	Emissions Trading Scheme
FEED	Front end engineering design
GFGS	Green Fuels, Green Skies
GHG	Greenhouse gas
HEFA	Hydroprocessed Esters and Fatty Acids
HVO	Hydrotreated Vegetable Oil
ICAO	International Civil Aviation Organization
ILUC	Indirect land use change
MSW	Municipal solid waste
OEM	Original equipment manufacturer
PtL	Power-to-Liquid
RCF	Recycled carbon fuel
RFNBO	Renewable fuel of non-biological origin
RTFO	Renewable Transport Fuel Obligation
SAF	Sustainable aviation fuel
TRL	Technology readiness level

1. Introduction

The UK aviation decarbonisation context

- 1.1 By 2050 the Climate Change Committee expects the aviation sector to be the second largest contributor to UK GHG emissions. Bold action is therefore needed to ensure the sector can decarbonise fully, and the UK Government recognises the need to go further and faster to end the impact aviation emissions have on the environment. We are fully committed to achieving net zero aviation by 2050, as recently set out in the Transport Decarbonisation Plan² and our Jet Zero Consultation³.
- 1.2 However, achieving this ambition presents huge challenges. The continued growth in passenger demand meant that UK aviation fuel use more than doubled from 5.4 Mt in 1990 to 12.2 Mt in 2019, despite significant aircraft efficiency improvements. The technology pathway for clean growth is uncertain, though the best balance between risk and reward is, over the coming decades, to invest across a range of prospective technologies that can reduce and eliminate aviation emissions. There is also a need for strong international coordination, as aviation is a global market – in 2019, 96% of the UK's aviation emissions came from international flights⁴.
- 1.3 The Jet Zero Consultation sets out our preferred approach to decarbonising the aviation sector. It focusses on the rapid development of technologies that maintains the benefits of air travel and maximises the opportunities decarbonisation can bring for the UK. The consultation seeks views across five different measures: improving the efficiency of our aviation system, accelerating the development of SAF, supporting the development of zero emission flight, using markets and removals to drive down emissions, and influencing consumer behaviours. The consultation recognises the instrumental role that SAF will play in achieving net zero aviation but highlights the need to maintain flexibility, as it is too early to know and specify the optimal mix of

² <https://www.gov.uk/government/publications/transport-decarbonisation-plan>

³ <https://www.gov.uk/government/consultations/achieving-net-zero-aviation-by-2050>

⁴ 'International flights' refers to flights departing the UK to an overseas destination. Figure calculated using data from published 2019 economy-wide emission statistics (<https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2019>

). 'UK aviation emissions' include all departing civil aviation flights from the UK, excluding general aviation and military aviation.

technologies that will be required to meet our net zero target by 2050. We expect to have a clearer picture of the solutions that will be required by 2030.

- 1.4 Decarbonising our aviation sector will see new technologies, new companies and new markets emerge, bringing opportunities for our world-class manufacturing sector to continue to lead the global transition to net zero aviation. For example, airspace modernisation will allow the aviation industry to deliver a further £29 billion to the UK economy and create nearly 116,000 more jobs by 2035⁵. The Government is working with all stakeholders through the Jet Zero Council and the Aerospace Technology Institute (ATI) to support aviation decarbonisation technology and infrastructure through £1.95 billion between 2013 and 2026, matched by industry, and £21 million of new funding in 2021/22. Following the Jet Zero Consultation, our final Jet Zero Strategy will be published, setting out an ambitious framework to support the aviation sector to decarbonise.

SAF is a key part of the UK's decarbonisation strategy

- 1.5 "SAF" describes low carbon alternatives to fossil-derived aviation fuel, which can be blended into conventional jet fuel without requiring significant aircraft or engine modifications. When fully replacing kerosene, SAF use achieves, on average, over 70% GHG emissions savings, on a lifecycle basis. It also reduces sulphur dioxide and particulate matter emissions⁶, and potentially other non-CO₂ impacts of aeroplanes, including contrails⁷.
- 1.6 Due to these environmental benefits, interest in SAF has grown significantly over the past few years. Industry and governments globally are expecting SAF will play a key role in the decarbonisation of the aviation sector, likely beyond 2050, alongside other levers such as zero-carbon aircraft and market-based measures. Sustainable Aviation (an industry coalition) shows SAF use in the UK could deliver between 1.2 and 2.8 Mt of carbon emissions savings in 2035⁸, while the Climate Change Committee's 'Balanced Net Zero Pathway' expects that SAF can cover up to 25% of the UK fuel demand in 2050⁹. Our Jet Zero Consultation shows SAF use can reduce UK aviation emissions by up to 36%, providing a vital contribution to our ability to meet net zero by 2050.
- 1.7 SAF can also offer opportunities to strengthen the UK's industry leadership in the aviation and advanced fuels sectors. By replacing conventional jet fuel with SAF, especially if domestically produced, the UK can improve its fuel security while fostering industrial development across the whole country. Not only can SAF use result in new domestic plants being developed across our four nations, but it also gives a route for existing oil refineries to transition towards more sustainable products, strengthening existing supply chains, building new ones and retaining the UK industry's expertise and

⁵ <https://www.ourfutureskies.uk/media/b1nfazlo/our-future-skies-modernising-the-uk-s-infrastructure-in-the-sky-web-version-final-170320.pdf>

⁶ https://www.sustainableaviation.co.uk/wp-content/uploads/2020/02/SustainableAviation_FuelReport_20200231.pdf

⁷ <https://www.nasa.gov/press-release/nasa-dlr-study-finds-sustainable-aviation-fuel-can-reduce-contrails/>

⁸ https://www.sustainableaviation.co.uk/wp-content/uploads/2020/02/SustainableAviation_FuelReport_20200231.pdf

⁹ <https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-Methodology-Report.pdf>

skills. Many SAF projects are also developing within existing industrial clusters, working in synergy with other industries such as low carbon hydrogen, to deliver wider net zero objectives and provide regeneration opportunities and clean growth. Sustainable Aviation research shows domestic SAF production could generate a value added of up to £1,952 million per year for the UK in 2035, potentially supporting between 6,400 and 13,600 jobs¹⁰.

- 1.8 In light of these opportunities, and despite the impact of COVID-19 on the aviation and fuels industries globally, several players have recently committed to SAF research and development, use and production as an opportunity to build back a greener aviation industry. For instance, earlier this year International Airlines Group committed to powering 10% of its flights with SAF by 2030¹¹, and Airbus started blending SAF into the fuel mix used to power its Beluga fleet flying out of Broughton¹².
- 1.9 The Government welcomes these commitments and is keen to continue to work with all stakeholders to ensure SAF production and use can grow quickly. The Government acknowledges SAF will have a key role in driving down carbon emissions in the UK aviation sector and is fully committed to accelerating its technology and commercial development, positioning the UK at the forefront of the transition to SAF and securing thousands of green jobs across the country.

Challenges to SAF development

- 1.10 For SAF to become widespread, in the UK and globally, there are still significant barriers that need to be overcome. In 2020, DfT commissioned a study for a new SAF capital funding competition which also highlighted several challenges SAF plants are facing¹³. Additional feedback on these challenges, and potential solutions, has also been collected from stakeholders through the Jet Zero Council SAF Delivery Group and its subgroups, launched last year (see box at page 20).
- 1.11 SAF production processes present different levels of technical and commercial maturity, with technology readiness levels (TRL) typically ranging between 5 (early demonstration pilots) and 8 (pre-production). Many projects, even those at higher TRL, face significant challenges when trying to bridge the 'valley of death' between demonstration and large scale commercialisation plants, due to the high capital costs of first-of-a-kind commercial plants, which could go even beyond £1 billion¹⁴. This results in high fuel prices (three to eight times the cost of kerosene) and consequently limited demand for SAF, at present, and limited revenues.
- 1.12 Generally, SAF can be produced from three types of feedstock: biomass, including biogenic waste such as used cooking oil, tallow and agricultural residues; non-biogenic waste, including the non-biogenic portion of household or industrial waste, such as

¹⁰ https://www.sustainableaviation.co.uk/wp-content/uploads/2020/02/SustainableAviation_FuelReport_20200231.pdf

¹¹ <https://www.iairgroup.com/en/newsroom/press-releases/newsroom-listing/2021/sustainable-aviation-fuel>

¹² <https://www.airbus.com/newsroom/press-releases/en/2021/04/Airbus-further-reduces-its-Beluga-fleets-environmental-impact.html>

¹³ <https://ee.ricardo.com/downloads/transport/targeted-aviation-advanced-biofuels-demonstration-competition-%E2%80%93-feasibility-study>

¹⁴ https://theicct.org/sites/default/files/publications/Alternative_jet_fuels_cost_EU_2020_06_v3.pdf

unrecyclable plastics, as well as waste fossil gases from industry (e.g. steel mills); and electricity and carbon dioxide captured from the air or waste industrial exhaust streams. This means that SAF volumes will be limited by feedstock availability and costs, economy-wide land use considerations and demand for clean electricity and hydrogen in other sectors. Without secure, long-term feedstock contracts and offtaking agreements in place, investors may be reluctant to invest.

- 1.13 Finally, the operational and technology risks associated with scaling up technologies which have only been proven at a smaller scale bring about additional uncertainties. Production can be well below the plant's planned capacity, particularly during the first few years of operation. During start-up, this can also affect the quality of the final product.
- 1.14 These barriers translate into significant economic risk which disincentivises private investors: financial and revenue uncertainty makes it difficult for SAF producers to build a robust business case and thus for investors to estimate the long-term income a SAF plant may generate. The study commissioned by DfT concluded that investing in SAF plants can be highly challenging, as there is currently insufficient incentive to design plants which focus predominantly on SAF.

UK action to build a thriving SAF industry to date

- 1.15 To tackle these challenges and maximise the opportunities the transition to SAF production and use could bring about, the UK Government has already provided support for SAF production, gradually introducing a world-leading, comprehensive programme of interventions aiming to commercialise the domestic SAF industry and deliver carbon savings.
- 1.16 Since 2018 SAF supply has been rewarded through the RTFO, which provides tradeable certificates for every litre of verified sustainable renewable fuels supplied for aviation in the UK. A recent consultation also explored the option to reward recycled carbon fuels, which can be typically used in aviation, under the RTFO.
- 1.17 The Government has also provided grant funding to businesses through our £25 million Advanced Biofuel Demonstration Competition (announced in 2014) and our £22 million Future Fuels for Flight and Freight Competition (announced in 2017), putting the UK in a strong position to develop advanced fuels capable of decarbonising harder-to-decarbonise transport modes.
- 1.18 These policies have supported the delivery of the first few volumes of SAF to the UK market and the early planning of large-scale advanced fuels facilities capable of producing SAF commercially. We are now building on this ambition through our latest 'Green Fuels, Green Skies' (GFGS) competition, which is providing £15 million in 2021-22 to support the early development of new first-of-a-kind commercial SAF plants in the UK. Alongside the publication of this consultation, the Government has announced eight projects have been shortlisted for funding under the competition, as shown in

Figure 1. These projects have the potential to deliver clean growth and thousands of green jobs.

SAF projects shortlisted as part of the Green Fuels, Green Skies competition

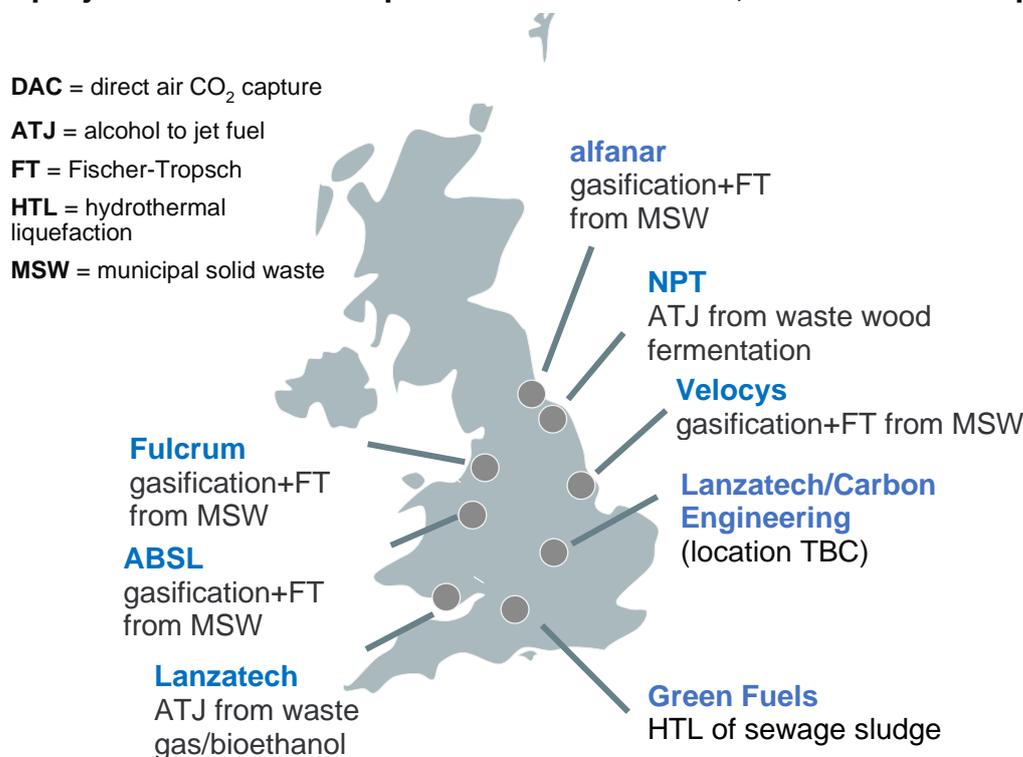


Figure 1 Map of projects shortlisted under the Green Fuels, Green Skies competition

1.19 Additional government funding is also in place to support fuel testing, research and innovation. This includes £3 million support for a new SAF testing and certification clearing house, which will be launched shortly, and funding through the Aerospace Technology Institute (ATI). This programme has recently supported Rolls-Royce to undertake a large civil aero-engine ground test with 100% SAF blends to confirm the capability of their engines to use future lower and zero-carbon aviation fuels¹⁵. The Government has also taken action to ensure SAF can be physically blended in oil pipelines across the UK, after the latest revision of the DEF STAN 91-091 specifications carried out by the Ministry of Defence came into force in November 2020. This revision also paved the way for SAF to be used by the UK's Royal Air Force¹⁶. Our Jet Zero Consultation also included further proposals to accelerate the procurement and use of SAF across government and on UK Public Service Obligation routes.

1.20 Work is also in progress to make SAF available at COP26, and to harness the opportunity of this international summit by promoting policy exchange and collaboration with other countries ahead of the summit in Glasgow later this year. In May, the UK Government launched the Clean Skies for Tomorrow SAF Ambassadors

¹⁵ <https://www.rolls-royce.com/media/press-releases/2021/01-02-2021-business-aviation-rr-conducts-first-tests-of-100-percent-sustainable-aviation-fuel.aspx>

¹⁶ <https://www.gov.uk/government/news/sustainable-fuels-to-power-raf-jets>

group, working with the Mission Possible Partnership to lead by example by innovating and implementing new policy ideas that can support scaling up SAF. In addition, the UK continues to be active at the International Civil Aviation Organization (ICAO) in negotiating for a full set of sustainability criteria for SAF that will underpin its global deployment.

Jet Zero Council SAF Delivery Group

The SAF Delivery Group was established in November 2020, supporting a key Jet Zero Council objective. It aims to support government and industry in working together to establish UK SAF production facilities and accelerate the delivery of the fuel to market.

Over 100 individual stakeholders across a range of backgrounds including SAF producers, fuel suppliers, airports, airlines, academics and investors have met 18 times to support the Government in the development of a UK SAF mandate, and to discuss the commercialisation of the sector as well as the technologies and feedstocks that the UK should prioritise. A summary of all outcomes from the Delivery Group can be found in **Annex A**.

DfT is thankful to the Knowledge Transfer Network (KTN), which has provided the secretariat function, expertly convening meetings and consolidating feedback, and to all stakeholders who have attended. The Government will continue to work closely with industry through the SAF Delivery Group as UK SAF policy progresses.

A dedicated subgroup is also working to secure a supply of SAF for use by departing flights from COP26.

The need for a SAF blending mandate

- 1.21 Existing government policy and funding have supported the development of the early SAF market, but it is evident that additional interventions are needed to accelerate the roll-out of this technology in the UK and ensure its use can meaningfully contribute to delivering net zero emissions. This is why, as part of his Ten Point Plan for a Green Industrial Revolution, in November 2020 the Prime Minister announced the intention to consult on the introduction of a SAF blending mandate in the UK¹⁷.
- 1.22 Alongside the existing interventions and continued support to the sector, a mandate would aim to encourage further development and use of SAF in the UK. By proposing to prescribe mandatory SAF use, we would seek to generate demand for SAF and provide clarity on the role of the technology in meeting decarbonisation objectives. Building on the success of previous government interventions which have attracted private investment into large scale renewable energy projects, the long-term policy framework the proposed mandate aims to introduce will also send a signal to investors, helping to leverage the private financing needed for the technology to scale up.

¹⁷ <https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>

Aim of this consultation and next steps

- 1.23 The Government is minded to introduce a SAF mandate in the UK from 2025. This consultation welcomes views on industry's preferred ambition and targets, as well as the proposed high-level principles underpinning this potential measure and the interactions between this proposed intervention and existing and future UK and international policies.
- 1.24 While the Government is keen to provide stakeholders and the public with a clear sense of direction for the SAF sector at this stage, the limited data and the significant risks of this nascent industry mean there is a high degree of uncertainty associated with SAF supply, production and uptake, both in the UK and globally, and the implications on airlines. This, in turn, makes the analysis underpinned by the current mandate proposal highly uncertain. We have therefore included high-level scenarios for SAF uptake, on which we welcome views through this consultation, supported by evidence.
- 1.25 If we confirm the introduction of a SAF mandate, it is vital that any long-term decarbonisation and industrial policy is supported by robust evidence. Therefore, should a SAF mandate be confirmed in the light of this consultation, the Government will continue to refine its analysis further and aim to release a follow-up consultation on SAF, alongside a full impact assessment, as soon as is feasible. This would be followed by introduction of legislation to implement a SAF mandate. The planned future consultation will confirm our preferred level of ambition and include more specific proposals on the reporting, verification and compliance elements of the proposed mandate, the details of which will depend on the final SAF mandate design.
- 1.26 This phased approach will also allow for appropriate reflection of developments in other policy areas, including DfT's Jet Zero Consultation, BEIS biomass call for evidence and strategy¹⁸ and future policy on GHG removals. As announced as part of the Transport Decarbonisation Plan, we also plan to work with stakeholders to develop a longer-term strategy for the use of low carbon fuels across different transport modes in the period to 2050. The strategy aims to develop a common understanding of the opportunities and risks of transitioning the UK's fuels industry to meet decarbonisation challenges and the policy measures that this transition may require.
- 1.27 We have heard clearly the industry perspective that pace is crucial on this policy. As a future consultation is expected to follow this one, and given that extensive stakeholder engagement has already been conducted through the Jet Zero Council SAF Delivery Group and will continue over the summer, this initial consultation will be open for 8 weeks.

Timeline

A timeline of the work to date and planned next steps is provided below and in Figure 2:

¹⁸ <https://www.gov.uk/government/consultations/role-of-biomass-in-achieving-net-zero-call-for-evidence>

- November 2020: Ten Point Plan announced the intention to consult on a SAF mandate
- November 2020 – June 2021: Jet Zero Council SAF Delivery Group and subgroups convened regularly
- 23 July 2021: SAF mandate consultation opens
- 19 September 2021: SAF mandate consultation closes
- Summer and Autumn 2021: DfT continues to engage with stakeholders through the Jet Zero Council SAF Delivery Group and ad-hoc consultation events
- Autumn and Winter 2021: DfT reviews responses to SAF mandate consultation

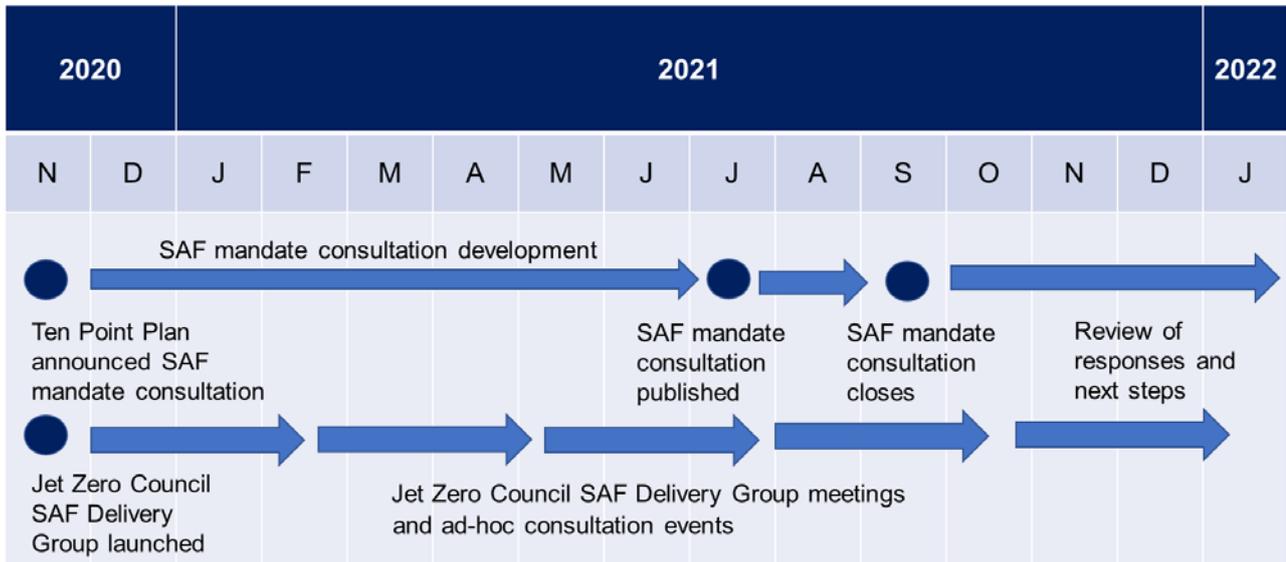


Figure 2 Timeline of SAF mandate consultation development and planned next steps

Should a SAF mandate be confirmed, possibly from 2025, the next steps will entail a potential follow-up consultation.

2. A greenhouse gas emissions scheme to reduce the carbon intensity of jet fuel

The need for a SAF mandate outside the RTFO

- 2.1 SAF supply is currently rewarded under the RTFO. While there is no obligation for them to do so, fuel suppliers can choose to claim under the scheme and be awarded certificates for the volumes of SAF supplied into the UK, when these are obtained from selected feedstocks and meet specific sustainability criteria.
- 2.2 However, the high SAF production costs result in high market prices, which in turn mean demand for SAF remains very low: at the time of writing, no SAF volumes have been claimed under the RTFO. In the absence of guaranteed demand or offtaking agreements, which an obligation to use SAF would encourage, existing renewable fuel producers who could produce SAF may not necessarily do so and new producers are less likely able to secure adequate funding from investors to progress their plant development.
- 2.3 Feedback collected from stakeholders and industry has suggested the RTFO does not provide an effective contribution towards the cost of producing SAF, in particular when fuel is produced through less commercially developed pathways such as biomass gasification or power-to-liquid. As aviation fuel is not currently obligated under the RTFO, there is a risk that without an obligation, only small volumes of the cheapest forms of SAF may be used in the UK.
- 2.4 A global SAF market is also developing abroad in response to other market interventions. SAF supply and production could be prioritised in other countries under local mandates and incentives, potentially disincentivising the supply of SAF in the UK. An obligation to supply SAF in the UK would allow the domestic sector to grow and capture the associated benefits, including carbon savings and green jobs, and remain at the forefront of decarbonising the aviation sector internationally.
- 2.5 Given the environmental and industrial benefits associated with SAF use and production, **the Government recognises the need for SAF in the short, medium and long term to contribute to delivering net zero and the UK's carbon budgets. We are therefore keen to tackle the challenges that are preventing the development of the nascent SAF industry.** As a consequence, **the Government is**

mindful to mandate SAF supply in the UK. A mandate is our preferred option as it could deliver a number of outcomes which could likely not be achieved otherwise through a combination of more dispersed interventions from government (such as funding for SAF plants, already in place) and industry (such as direct offtaking agreements between airlines and fuel producers).

2.6 We expect a mandate would:

- Reduce the carbon impact of flying by introducing the requirement for jet fuel to become more sustainable over time, to be met through a higher SAF blend;
- Generate demand and create an early market for SAF;
- Quantify the Government's expected contribution of SAF to UK aviation decarbonisation, with a clear and evidence-based trajectory for SAF uptake in the short, medium and long term;
- Provide a financial incentive to fuel producers to support SAF supply to the UK, and, consequently, domestic production;
- Contribute to developing SAF technology further, reducing its costs and risks over time and accelerating the development of the UK industry.

2.7 **To introduce the proposed obligation, the Government believes a standalone SAF mandate, outside the RTFO, will be easiest and fairest to implement.** This proposal is also in line with the recommendation by the Climate Change Committee to introduce a bespoke SAF blending mandate¹⁹.

2.8 Under the RTFO Order, suppliers of road transport and non-road mobile machinery fuel who supply petrol, diesel, gas oil or renewable fuel totalling 450,000 litres or more in each obligation period must ensure a proportion of the fuel they supply is renewable. Renewable fuel used in aviation in the UK is also eligible for reward under the RTFO, although fossil aviation fuel is not obligated.

2.9 Simply introducing an obligation to supply SAF under the RTFO would maintain a single policy framework to reward sustainable transport fuels in the UK, with which industry is already familiar. It could also facilitate reporting and compliance processes and timescales as these could easily align under both schemes.

2.10 However, this would still require us to define an additional obligated party. Mandating SAF use could otherwise translate to an obligation on suppliers of road transport and non-road mobile machinery fuel, who may not necessarily supply aviation fuels too. As SAF is more expensive than conventional fossil fuel jet, an obligation under the RTFO could mean that these costs were passed through to the road fuel supply chain and not the aviation fuel supply chain, which would not be in line with the polluter pays principle. Relying on the existing RTFO provisions could also create complexity when these rules need to change to reflect the specific needs of SAF. Finally, the RTFO is a

¹⁹ <https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Aviation.pdf>

scheme based on fuel volumes, while the proposed obligation is based on GHG emissions (see next section).

CONSULTATION QUESTIONS

Q1: Do you agree or disagree that a SAF mandate should be introduced in the UK?

Q2: Do you agree or disagree that an obligation to supply SAF in the UK should sit outside the RTFO?

Prioritising carbon savings rather than SAF volumes

- 2.11 Evidence gathered through the Jet Zero Council SAF Delivery Group has strongly supported the introduction of a SAF mandate in the form of a GHG emission scheme. Such a scheme would prescribe a reduction in the lifecycle GHG emissions intensity of aviation fuel over time (defined as the amount of GHG emissions, on a lifecycle basis, per unit of energy and measured in gCO₂e/MJ) through the use of SAF. It would not mandate a certain percentage of aviation fuel to be SAF over time, which is what a fuel volume-based scheme, like the RTFO, would do.
- 2.12 Lessons learnt from the recently run 'Motor Fuel Greenhouse Gas Emissions' scheme, which rewarded carbon emissions savings rather than renewable fuel volumes during 2019-20, suggest a similar intervention could benefit the aviation market. **To prioritise carbon emissions savings achieved through SAF over SAF fuel volumes, the Government would prefer to implement the proposed SAF mandate as a GHG emissions scheme.**
- 2.13 A GHG emissions scheme will require the definition of the obligated party (see Chapter 2) and the specific eligibility criteria that SAF will need to meet to count towards the proposed obligation (set out in Chapter 3), as well as the introduction of a GHG emissions intensity target that decreases over time in each obligation period (set out in Chapter 4).
- 2.14 Under the proposed mechanism, jet fuel with a GHG emissions intensity below the target and which meets the proposed eligibility criteria will be awarded a number of credits proportional to the amount of CO₂e saved. Jet fuel with a GHG emissions intensity above the target or SAF which does not meet the proposed eligibility criteria will incur an obligation. The compliance value of SAF with lower GHG emissions intensities will therefore be greater: the lower the GHG emissions intensity of the SAF supplied, the higher the number of credits received. This mechanism should encourage supply of SAF with the lowest possible GHG emissions, which we believe a fuel volume-based scheme would not necessarily do.
- 2.15 It is proposed that the SAF mandate will entail a tradable credit scheme which will allow obligated parties to meet the obligation in a flexible and cost-effective way, with measures in place to ensure this happens (as set out at paragraphs 6.3-6.6).

CONSULTATION QUESTION

Q3: Do you agree or disagree that a GHG emissions scheme based on tradable credits should be preferable to a fuel volume scheme when designing a SAF mandate?

THE PROPOSED SAF AMBITION AND GHG INTENSITY TARGETS

We would like to introduce a SAF mandate that is world leading and as ambitious as possible. To that end, this consultation sets out a number of potential SAF uptake scenarios, up to 10% SAF by 2030 and up to 75% SAF by 2050, and the associated GHG emissions intensity targets, that might be appropriate under certain market conditions. We acknowledge high targets will be contingent on multiple technology and policy developments that could unlock a very rapid roll-out of several SAF plants in the short term, the quick commercialisation of SAF technology not yet proven at scale and the certification of new production pathways. To take into account these uncertainties, we welcome views on the right trade-off between ambition and deliverability at this stage.

Depending on the mandate levels chosen initially, we are also open to increasing our targets in the future if the market and the technology develop quickly and SAF costs and carbon abatement costs come down significantly. This is why we have proposed review points in 2030, for post-2035 uptake, in 2035 for post 2040-uptake and in 2040, for post-2045 uptake, including beyond 2050.

Further information on the consultation scenarios and a full set of consultation questions have been set out fully in Chapter 4.

An obligation on suppliers of avtur to the UK

- 2.16 **The Government would like the proposed SAF mandate to fall on suppliers of jet fuel to the UK**, where jet fuel refers to aviation turbine fuel (avtur) used in jet and turboprop aircraft. This would ensure that the GHG emissions intensity of all the aviation fuel mix used in the UK decreases over time, in line with the consultation scenarios set out in Chapter 404. It is proposed that the supply of aviation gasoline (avgas) will not count towards the obligation jet fuel suppliers will incur, as SAF is not a replacement of avgas.
- 2.17 A GHG emissions scheme applying to aeroplane operators could increase the administrative burden on airlines, which would need to prove the SAF supplied was in line with the GHG emissions targets and sustainability requirements underpinned by the proposed mandate, despite not having control over the production or distribution of SAF.
- 2.18 Several parties are involved with the production, blending, transport, storing and handling of SAF before the fuel is ultimately uplifted into an aircraft at a UK airport. An obligation on aviation fuel suppliers would therefore require a more precise definition of what fuel incurs an obligation and who should be responsible for meeting that.
- 2.19 Under the RTFO, road fuel incurs an obligation at the point when it becomes liable for excise duty in the UK - the 'duty point'. Depending on jet fuel use, a requirement to pay fuel duty may apply²⁰. To ensure all aviation fuel, regardless of its use and its dutiable

²⁰ Avtur is subject to fuel duty when it is used for 'private pleasure flying'. This includes, but is not limited to, avtur used in corporate jets, helicopters and recreational flights without paying customers. Avtur not subject to fuel duty includes aviation fuel used domestically by a company providing a transportation service for passengers or goods, or for emergency, training, research and survey purposes, as well as aviation fuel used on international flights. Guidance available at: <https://www.gov.uk/government/publications/excise-notice-554-fuel-used-in-private-pleasure-craft-and-for-private-pleasure-flying>

status, decreases its carbon intensity over time as a result of the proposed scheme, **it is proposed that all avtur supplied to the UK will incur an obligation.** This would maximise the carbon savings achieved through the proposed SAF mandate and will contribute to the decarbonisation of both commercial and general aviation.

- 2.20 However, given commercial flights make up the vast majority of air traffic and use larger fuel quantities than any other jet fuel users **we welcome views on whether we should introduce, in each reporting year (see paragraph 7.11), a threshold below which the avtur supplied is not obligated.** For example, under the RTFO, only the road fuel exceeding 450,000 litres per annum incurs an obligation while the Oil Stock Order 2012 makes reporting of certain oil stocks, including aviation fuel, mandatory for those supplying beyond 50,000 tonnes of aviation fuel per year in the UK²¹.
- 2.21 We will need to understand how this threshold interacts with the proposed GHG emissions intensity and we also acknowledge **this potential threshold may need to distinguish between dutiable fuel and non-dutiable fuel.** This threshold could be designed, for instance, in a way that does not put an obligation on suppliers of jet fuel which will be used by emergency services, for which fuel duty does not apply, but would still put an obligation on fuel used by private or corporate jets, for which fuel duty applies, even if used in small quantities. We welcome views on this proposal.
- 2.22 The definition of the obligated fuel is strictly related to the definition of the obligated party. Under the RTFO, the owner of the fuel at the duty point is responsible for meeting the obligation. For aviation fuel subject to fuel duty, it is proposed the owner of the fuel at the duty point will be responsible for meeting the obligation, in line with the RTFO. For fuels which are not typically subject to excise duty, an alternative 'assessment time' will need to be introduced. This is also the point at which it must be demonstrated compliance with the carbon and sustainability criteria, and the point at which the obligation is calculated.
- 2.23 Under the RTFO, any supplier of renewable fuels who owns the fuel at the alternative assessment time may apply to receive RTFCs, regardless of whether they have an obligation under the RTFO Order. After previous consultations, for avtur, the assessment time under the RTFO has been set at the blending and certification point i.e. the point where renewable fuel is blended with fossil fuel and certified to meet the appropriate aviation fuel specifications and a refinery certificate of quality is issued²². The owner of the fuel at the point of blending and certification is therefore eligible to claim RTFCs, but as this may be outside the UK, the owner of the fuel will need to prove SAF is supplied at or is for delivery to the UK.
- 2.24 An approach to the assessment time consistent with the RTFO replicated under the proposed SAF mandate would prevent double claiming, which could otherwise happen should different parties be able to claim credits or certificates under different schemes (see Chapter 5).

²¹ <https://www.legislation.gov.uk/ukxi/2012/2862/article/16/made>

²² A refinery certificate of quality is typically produced at the point of manufacture of the fuel and is the definitive original document that describes the quality of a batch of aviation fuel across all the properties listed in the latest relevant jet fuel specifications.

- 2.25 However, as an obligation on all jet fuel supplied is now proposed, a similar approach would require the party that blends SAF into jet fuel to comply with a UK mandate. A party that does not produce SAF may not be captured by this obligation, while a party that blends SAF abroad may not know whether the blended SAF, de facto jet fuel, is going to be used in the UK at that stage – SAF can be traded multiple times throughout the supply chain.
- 2.26 As a consequence, **the Government welcomes views on where the assessment point under the proposed SAF mandate should be placed** to ensure only those who are supplying jet fuel, and SAF, to the country incur an obligation and can claim credits effectively. To avoid the risks that a separate assessment point between the SAF mandate and the RTFO would bring about, it is also proposed that aviation fuel will no longer be eligible under the RTFO once a SAF mandate obligation is in place (this proposal is discussed in detail in Chapter 5).

CONSULTATION QUESTIONS

- Q4: Do you agree or disagree that the proposed SAF mandate obligation should be placed on fuel suppliers that supply aviation fuel (avtur) to the UK?**
- Q5: Should the obligation apply to all avtur supplied into the UK, regardless of whether this is subject to fuel duty or not?**
- Q6: If the obligation applies to all avtur supplied into the UK, should there be a threshold below which fuel is not obligated, in a certain obligated period? Should this threshold distinguish between dutiable and non-dutiable fuel?**
- Q7: Where do you think the assessment point should be placed for jet fuel not subject to fuel duty, and how is this going to affect the definition of the proposed obligated party (aviation fuel suppliers to the UK)?**

3. Fuel eligibility and sustainability criteria

Technical eligibility criteria

- 3.1 As previously mentioned, 'SAF' refers to alternative, sustainable jet fuel replacements that could be blended into existing aircraft without significant engine modifications. Conventional kerosene-based fuels are subject to stringent safety and testing requirements and it is vital that any fuel replacement in the form of SAF meets equally stringent safety requirements when blended into jet fuel.
- 3.2 One of the most common and used aviation fuel standards for commercial jet fuel is the American Society for Testing and Materials (ASTM) D1655 Standard Specification for Aviation Turbine Fuels²³, supplemented by the D7566 Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons²⁴. This includes a list of SAF production pathways that are approved and can be dropped into fossil jet fuel, up to certain maximum blend levels to ensure the blend performs as safely as conventional fuel. Once SAF is blended and is certified to meet all requirements of the ASTM D7566 specification, the fuel can be considered to meet the requirements of specification ASTM D1655 and is de facto equivalent to jet fuel²⁵.
- 3.3 In the UK, the Ministry of Defence (MOD) Defence Standard (DEF STAN) 91-091 also allows SAF that meets the ASTM D7566 specification and is blended up to a prescribed maximum blend level to be used in an aeroplane²⁶.
- 3.4 As of June 2021, there are eight SAF pathways which have been certified under the ASTM specification. These are listed in the table below:

Fuel Name	Sample feedstock	Date certified	Maximum blend level
Fischer-Tropsch - Synthetic paraffinic kerosene (FT-SPK)	MSW, agricultural and forest residues	2009	50%
Fischer-Tropsch - Synthetic paraffinic kerosene with added aromatics (FT-SPK/A)	MSW, agricultural and forest residues	2015	50%
Hydroprocessed Esters Fatty Acids - Synthetic	Vegetable and animal fats and oils	2011	50%

²³ASTM D1655 Standard Specification for Aviation Turbine Fuels

<https://www.astm.org/Standards/D1655.htm>

²⁴<https://www.astm.org/Standards/D7566.htm>

²⁵ATA Guidance Material for Sustainable Aviation Fuel

²⁶<https://www.gov.uk/guidance/uk-defence-standardization>

paraffinic kerosene (HEFA-SPK)			
Hydroprocessing of Fermented Sugars - Synthetic Iso-Paraffinic fuels (HFS-SIP)	Sugars	2014	10%
Alcohol-to-Jet Synthetic Paraffinic Kerosene (ATJ-SPK)	Starches, sugars, cellulosic biomass	2016	50%
Co-processing of up to 5 vol% fats and oils in a refinery to produce kerosene	Vegetable and animal fats and oils	2018	5% (refinery input) ²⁷
Catalytic Hydrothermolysis Synthetic Kerosene (CH-SK)	Renewable fats, oils and greases	2020	50%
Hydroprocessed Esters and Fatty Acids Synthetic Paraffinic Kerosene (HC-HEFA-SPK)	Hydrocarbon-rich algae oil	2020	10%

3.5 A few more pathways are currently engaged in the ASTM certification process, as per the table below²⁸.

ASTM progress	Pathway	Feedstock
Phase 2 Testing	Hydro-deoxygenation Synthetic Kerosene (HDO-SK)	Sugars and cellulotics
	Hydro-deoxygenation Synthetic Aromatic Kerosene (HDO-SAK)	Sugars and cellulotics
Phase 1 OEM Review	High Freeze Point Hydroprocessed Esters and Fatty Acids Synthetic Kerosene (HFP HEFA-SK)	Renewable fats oils and greases
	Integrated Hydrolysis and Hydroconversion (IH ²)	Lignocellulosics
Phase 1 Testing	Alcohol-to-Jet Synthetic Kerosene with Aromatics (ATJ-SKA)	Sugars and lignocellulosics
	Alcohol-to-Jet (ATJ)	Sugars

3.6 **To count towards the mandate obligation, it is proposed that the SAF supplied in the UK meets the DEF STAN 91-091 specification**, as this is the recognised jet fuel specification for the UK. As the DEF STAN 91-091 refers to ASTM de facto we expect this requirement means that, to be eligible under the SAF mandate, SAF will need to be produced through one of the pathways listed in the relevant D7566 Annex (on top of the sustainability criteria set out in the next section). Evidence that SAF meets such standards may be required when claiming credits under the scheme (see Chapter 7).

²⁷ The limit is 5% by volume of the refinery input, whereas for other fuels the blend limit is expressed as a blending percentage in fossil kerosene

²⁸ <https://cdn.ricardo.com/ee/media/downloads/final-report-aviation-abdc-feasibility-study-issue-v1-0.pdf>

- 3.7 As SAF production pathways under certification and potentially new pathways become certified as safe to use in aircraft in the future, or if SAF blend limits are revised upwards, referring to existing MOD fuel specifications would ensure any changes are automatically transposed into a UK SAF mandate, as long as the feedstocks such fuels use are sustainable and deliver carbon savings, in line with the other sustainability requirements SAF will need to meet. These are discussed in more detail in the next section.

CONSULTATION QUESTION

Q8: Do you agree or disagree that only certified SAF that meets the DEF STAN 91-091 specification should be eligible under the proposed SAF mandate?

Summary of sustainability criteria

- 3.8 **The Government would like to introduce a SAF mandate which delivers fuels with the highest sustainability credentials. To receive credits under the proposed mandate, SAF will therefore need to adhere to strict sustainability criteria.** These will ensure significant GHG emissions savings are delivered and will prevent negative environmental consequences such as the loss of biodiversity, deforestation and the clearance of land with high carbon stock (e.g. dry peatland) that could be associated with the cultivation of raw materials used in certain SAF production.
- 3.9 While it is advantageous to maximise coherence of sustainability criteria with other schemes and to build on existing criteria (such as those prescribed by the development fuel category of the RTFO), a standalone SAF mandate would require its own set of sustainability criteria to reflect the specificities of the SAF market and to ensure clarity for fuel suppliers.
- 3.10 In this respect, the proposed mandatory sustainability criteria for the SAF mandate are:
- Fuels must achieve a minimum GHG emissions saving on a lifecycle basis;
 - Fuels must be made from sustainable wastes or residues, RCFs, RFNBOs or nuclear energy (SAF produced from food or feed crops will not be allowed);
 - Waste use must comply with the waste hierarchy²⁹;
 - Feedstocks, including residues, should not be obtained from land with high biodiversity value or land with high carbon stocks in or after January 2008;
 - SAF production must not direct renewable electricity away from existing applications;
 - Where hydrogen is used as a process input, the hydrogen must be low carbon.
- 3.11 We expect these criteria would allow us to restrict SAF production to feedstock and process inputs that deliver genuine GHG emissions savings, when taking into account their supply chains and direct and indirect sustainability and land use impacts. These criteria would also allow us to convert waste that could have not been recycled or used anywhere else in the economy (e.g. unrecyclable plastics) into a sustainable fuel. We

²⁹ <https://www.gov.uk/government/publications/guidance-on-applying-the-waste-hierarchy>

would like to seek views on the proposed sustainability criteria, which are discussed in more detail below.

Feedstock requirements

- 3.12 **It is proposed that only waste-derived biofuels, RFNBOs, SAF from nuclear origin and RCFs can contribute towards the SAF mandate obligation, as these fuels can deliver high carbon savings and do not typically present significant direct or indirect land use or wider environmental impacts.** Each of these renewable aviation fuels will play a strategic role in the short- and long-term SAF market and their inclusion is therefore critical for achieving the domestic production potential.
- 3.13 We are not proposing to extend eligibility to crop-derived biofuels, which could lead to modest GHG emissions savings or, in some instances, to an increase in carbon emissions when taking into account their indirect land use change impact.
- 3.14 We have identified feedstocks that we anticipate could meet this requirement in Annex B.

Biofuels derived from wastes and residues

- 3.15 A biofuel is a renewable transport fuel that is wholly derived from biomass. The definition of a waste is any substance or object which the holder discards or intends or is required to discard, excluding substances that have been intentionally modified or contaminated for the purpose of transforming them into a waste. The waste and residue feedstocks that are expected to be eligible under the SAF mandate include:
- 'ligno-cellulosic material' - material composed of lignin, cellulose and hemicellulose such as biomass sourced from forests and forest-based industries' residues and wastes;
 - 'non-food cellulosic material' - feedstocks mainly composed of cellulose and hemicellulose, and having a lower lignin content than ligno-cellulosic material; it includes food and feed crop residues (such as straw, stover, husks and shells), industrial residues (including from food and feed crops after vegetal oils, sugars, starches and protein have been extracted), and material from biowaste;
 - 'residues from agriculture, aquaculture, fisheries or forestry' - residues that are directly generated by agriculture, aquaculture, fisheries or forestry; they do not include residues from related industries or processing;
 - 'processing residue' - in relation to a production process, a substance that is not the end product sought directly from the process, the production of which is not a primary aim of the process, and in respect of which the process has not been deliberately modified in order to produce it;
 - 'segregated oils and fats' - a material that is capable of being used as a transport fuel directly, after extraction, or after conversion by transesterification, into a usable fuel;

these include waste vegetable oils, fish oils, used cooking oils and animal fats (tallow and greases)³⁰.

- 3.16 Those handling materials considered waste under section 37 (1) of the Waste and Emissions Trading Act 2003³¹, such as those who process it, should also have regard to their duty to apply the waste hierarchy when passing it on for further processing or use in fuel production.

RFNBOs and SAF from nuclear electricity

- 3.17 RFNBOs are renewable liquid or gaseous transport fuels for which none of the energy content of the fuel comes from biological sources. **We propose to include such fuels as they are attractive for their likely low land use impact (they do not use biomass as a feedstock) and potential for carbon neutrality under certain circumstances.**

- 3.18 These fuels are considered renewable where the energy content of the fuel comes from renewable energy sources (excluding bioenergy sources). As the available energy source of RFNBOs comes from the process energy, the input feedstocks must contain no usable energy. In practice, this means that the feedstock must be either water and/or carbon dioxide. These fuels are also known as ‘power-to-liquid’ fuels or ‘electrofuels’.

- 3.19 Under a SAF mandate, **we also propose to include nuclear power as an eligible energy source from which a fuel of non-biological origin can be obtained.** We expect such fuels to be treated in a similar way to RFNBOs, so it will be necessary to reflect their detailed fuel production process in the GHG emissions calculation methodology.

Recycled carbon fuels

- 3.20 RCFs are fuels produced from fossil wastes that cannot be avoided, reused or recycled and have the potential to reduce GHG emissions. Including RCFs in the SAF mandate would allow fuel suppliers to exploit biogenic waste that is difficult and costly to separate from residual waste, as well as industrial gases, in turn bring greater quantities SAF to market.

- 3.21 The feedstocks proposed as being eligible are:

- The fossil component of refuse derived fuel from the mechanical treatment of municipal solid waste streams, which would be inherently mixed with biological material³²;
- Industrial waste process gases that are only suitable for incineration for energy recovery.

³⁰ While it is proposed that these feedstocks are eligible, their use may be capped as set out in Chapter 4

³¹ <https://www.legislation.gov.uk/ukpga/2003/33/section/37>

³² As set out in the government response to the RTFO consultation, we continue to assess evidence from stakeholders on the conditions this feedstock will need to meet to be eligible under the UK’s renewable transport schemes

3.22 We recognise that, although there is a strategic role for RCFs, they pose different sustainability questions to the other fuels considered. This will need to be reflected in the sustainability requirements and GHG emissions methodology. We will continue to develop these in line with new evidence and research.

Land use criteria

3.23 We are not expecting to set out land use requirements that would ensure that the feedstock used to produce SAF does not have negative impacts on land with high biodiversity value or carbon stock. This is because, as highlighted above, we would like to focus on waste-derived biofuels, RFNBOs, SAF from nuclear origin and RCFs, given their low land use impact.

3.24 Whilst we are keen not to support biofuels produced from agriculture, forestry, aquaculture or fisheries products, we recognise that wastes and residues from crops and forestry constitute a valuable biomass resource which could be used to produce SAF. **However, to ensure these residues have not been sourced from areas of land with high biodiverse value or high carbon stocks, we propose to introduce land use criteria for such residues only.**

3.25 **For residues from agriculture, aquaculture, fisheries or forestry, the following land criteria are proposed:**

- The feedstock must not be obtained from land with high biodiversity value in or after January 2008 including land designated for nature protection purposes;
- The feedstock must not be obtained from land with high carbon stock or land that was undrained peatland in January 2008 unless the land's status remains unchanged when the raw material is obtained.

3.26 While acknowledging the impact indirect land use change has on the overall sustainability of a fuel, we consider it unnecessary to include a specific indirect land use change criteria in the proposed SAF mandate since it is implicit in our choice to limit the fuels to waste-derived biofuels, RFNBOs, SAF from nuclear origin and RCFs, which do not typically present significant ILUC impacts.

Additionality of clean electricity and grid decarbonisation

3.27 As we develop our sustainability criteria further, we will also look at ways to ensure the electricity used to produce SAF is clean and additional.

Low carbon hydrogen requirements

3.28 Where hydrogen is used as an input which contributes to the fuel's energy content, it is necessary to assess the sustainability of the hydrogen production process. **We propose that under a SAF mandate, hydrogen must be low carbon.** For instance, nuclear power is a low carbon energy source which can offer significant GHG savings

and research suggests that it will be important for generating hydrogen for SAF in the future³³.

CONSULTATION QUESTION

Q9: Do you agree or disagree with the sustainability criteria set out here? If you do not agree, what alternative or additional criteria would you recommend?

Q10: Do you agree or disagree with the feedstocks set out here and listed in Annex B? If you do not agree, what alternative or additional feedstock(s) would you recommend?

Minimum carbon savings

- 3.29 To allow the effective and consistent calculation of GHG savings, the GHG emissions intensity of SAF must be compared to a fixed fossil fuel comparator. A fuel's GHG emissions intensity is a measure of the GHG emissions generated per unit of energy contained in the fuel, expressed in gCO₂e/MJ.
- 3.30 The ICCT suggests the GHG emissions intensity of conventional jet fuel, which depends on the region, crude oil well and refinery where jet fuel is produced, ranges from 85 to 95 gCO₂e/MJ³⁴. The internationally agreed figure adopted by ICAO as the baseline value in CORSIA (Annex 16 – Environmental Protection, Volume IV) is 89 gCO₂e/MJ³⁵. **It is proposed 89 gCO₂e/MJ is also used as the baseline lifecycle GHG emissions intensity to represent jet fuel under the SAF mandate.** This figure is accepted on an international level and accurately represents real world GHG emissions.
- 3.31 This fossil fuel comparator deviates from the RTFO and the GFGS competition, for which a value of 94 gCO₂e/MJ, based on road transport fuel, is used³⁶. While a different fossil fuel comparator will not promote harmonisation between existing UK measures and schemes, moving away from the 94 gCO₂e/MJ comparator more accurately reflects jet fuel emissions. Where fuel suppliers are subject to calculating GHG savings against two different fossil fuel comparators, we expect the additional administrative burden to be minimal.
- 3.32 As indicated earlier, **it is proposed that SAF meets a minimum GHG saving threshold, on a lifecycle basis**, to be eligible to contribute to the proposed SAF mandate obligation. This is to ensure SAF achieves meaningful GHG savings compared to fossil fuel use and contributes effectively to the decarbonisation of aviation. An ambitious minimum threshold, combined with the GHG emissions

³³ <https://www.nnl.co.uk/wp-content/uploads/2021/06/NNL-UK-Energy-System-Modelling-for-Net-Zero.pdf>

³⁴ <https://theicct.org/sites/default/files/publications/Alt-aviation-fuel-sustainability-mar2021.pdf>

³⁵ <https://www.icao.int/environmental-protection/CORSIA/Documents/>

³⁶ Since 2011, the RTFO has used a fossil fuel comparator of 83.8 gCO₂eq/MJ in line with the RED framework. In the government response to the RTFO consultation, we have confirmed we will proceed with the increase of the fossil fuel comparator to 94 gCO₂eq/MJ to better represent real world GHG emissions and to keep in line with the RED II framework.

approach the proposed mandate could introduce, will ensure that the market constitutes the most sustainable SAF and GHG savings are maximised.

3.33 For reference, the thresholds under the GFGS competition and RTFO schemes for waste-derived biofuels and RFNBOs are set out in the table below (noting that a higher fossil fuel comparator is used) and are compared to CORSIA:

	GFGS	RTFO	CORSIA
Fossil fuel comparator	94 gCO ₂ e/MJ	94 gCO ₂ e/MJ ³⁷	89 gCO ₂ e/MJ
Minimum GHG saving	70%	65%	10%
Maximum GHG intensity of fuel	28.2 gCO ₂ e/MJ	32.9 gCO ₂ e/MJ	80.1 gCO ₂ e/MJ ³⁸
Minimum GHG saving aligned with the proposed fossil fuel comparator (89 gCO ₂ e/MJ)	68%	63%	10%

3.34 **We anticipate that the minimum GHG saving threshold all SAF will need to meet to be eligible under the SAF mandate should be at least 60% using a fossil fuel comparator of 89 gCO₂e/MJ.** We acknowledge this threshold will depend on the GHG methodology used to calculate it and could be, for example, aligned with the RTFO should its GHG methodology be used (see next section). We welcome initial views on what this threshold should be at this stage to ensure we develop a proposal which is as ambitious as possible.

3.35 As carbon capture, utilisation and storage (CCUS) technology develops and is introduced more widely into the SAF production process, it is expected the GHG emissions intensity of SAF will decrease over time. **The Government welcomes views on whether it will be necessary to set out at this stage how the minimum GHG saving threshold should reflect the expected changes in carbon intensity over time.** Raising this threshold over time would ensure that the SAF mandate continues to support the delivery of the most sustainable fuels to the market.

CONSULTATION QUESTIONS

Q11: Do you agree or disagree that the baseline lifecycle GHG emissions intensity for aviation fuels for reporting purposes under a UK SAF mandate should be 89 gCO₂e/MJ? If you do not agree, what should the baseline emission be and/or how should it be calculated?

³⁷ As set out in the government response to the RTFO consultation

<https://www.gov.uk/government/consultations/amending-the-renewable-transport-fuels-obligation-rtfo-to-increase-carbon-savings-on-land-air-and-at-sea>

³⁸ This includes ILUC

Q12: What should the minimum carbon intensity reduction SAF will need to meet be (subject to the final GHG methodology used)?

Q13: Are there any land use (direct or indirect) or other implications associated with the feedstocks set out earlier that we should reflect in the eligibility criteria and minimum GHG emissions threshold?

Q14: As more CCUS becomes available and the GHG emissions intensity of fuels can decrease further, should the envisaged minimum GHG emissions intensity threshold be raised up over time?

Greenhouse gas emissions methodology

3.36 **Fuel suppliers must be able to demonstrate that their fuel achieves the minimum level of GHG savings through an assessment of the carbon intensities of feedstock cultivation, fuel processing and/or transport.** To ensure that suppliers are able to calculate carbon savings in an accurate and consistent manner, a SAF mandate requires these savings to be calculated with a prescribed GHG emissions calculation methodology.

3.37 The GHG emissions methodology prescribed by the SAF mandate could use or expand on existing methodologies developed under existing schemes. This has the advantage of reducing administrative burden for fuel suppliers operating under more than one scheme. Two schemes where existing methodologies have been set out in detail are the RTFO, which focuses on biofuels in general, and CORSIA, which focuses solely on SAF. In practice, there are limited differences since they both account for the full supply chain of fuel production and use. One critical difference, however, is the inclusion of ILUC emissions in the lifecycle carbon intensity of the fuel under CORSIA (see box at page 51); this is because, while sustainability and land use criteria apply under CORSIA, some of the eligible feedstocks may result in ILUC.

3.38 It is important that the GHG emissions methodology takes into consideration the different fuels, feedstocks, power sources and production pathways. In this respect, it may be necessary to include separate methodologies for waste-derived biofuels, RFNBOs, SAF from nuclear energy and RCFs. The Government welcomes views on how GHG savings should be calculated.

CONSULTATION QUESTIONS

Q15: What GHG methodology should be used to calculate the carbon intensity of fuel?

Q16: How should the GHG methodology vary to take into consideration the different fuels, feedstocks, power sources and production pathways?

SAF that does not meet proposed eligibility and sustainability criteria

3.39 **It is proposed that SAF that does not meet the feedstocks, carbon and sustainability criteria proposed above is treated in the same way as conventional jet fuel and would therefore become subject to an obligation under the proposed**

scheme. This should minimise the risk such fuels may be supplied in the UK and result in increased emissions.

CONSULTATION QUESTION

Q17: Do you agree or disagree that SAF that does not meet the proposed eligibility and sustainability criteria should incur an obligation?

4. Overarching trajectory

Potential scenarios for SAF ambition

- 4.1 With few SAF plants currently operational or being commissioned globally, evidence on technology, costs and potential future growth rates is significantly limited. Choosing a level of ambition for SAF uptake which is both ambitious and deliverable therefore comes with substantial uncertainties and risks. However, lessons learnt from the renewable electricity sector show the importance of providing industry with a long-term vision, so that plants can be more confidently built and technology can scale up.
- 4.2 This section sets out some high-level scenarios for SAF uptake in the short and long term, translated into equivalent GHG intensity reduction targets. To determine these scenarios, the Government has reviewed data and feedback gathered from stakeholders, including through multiple meetings of the Jet Zero Council SAF Delivery Group, and from existing publications, including the modelling produced by the Climate Change Committee³⁹ and Sustainable Aviation's roadmap⁴⁰. We have also incorporated independent external analysis from E4tech.
- 4.3 Our modelling exercise has taken into consideration:
- the potential evolution of SAF technology and costs,
 - the prospective SAF plants that could develop in the UK, including those already under development,
 - the interactions between sustainable road and aviation fuels,
 - the implications of a faster roll out of electric vehicles expected following the recently introduced 2030 phase-out date for new petrol and diesel cars and vans,
 - the availability of sustainable feedstocks and fuels that could be imported from abroad, and
 - the opportunities for existing domestic refineries and infrastructure to move towards more sustainable products.
- 4.4 Five main scenarios for the uptake of SAF as a percentage of the total liquid fuel⁴¹ demand expected by the Government are set out in Figure 3 and the table below, alongside a 'no intervention' reference scenario. It is important to note that these scenarios do not represent the GHG emissions intensity target which the Government would like to set into legislation should a mandate, in the form of a GHG scheme, be

³⁹ <https://www.theccc.org.uk/publication/sixth-carbon-budget/>

⁴⁰ https://www.sustainableaviation.co.uk/wp-content/uploads/2020/02/SustainableAviation_FuelReport_20200231.pdf

⁴¹ By liquid fuel, we mean SAF and conventional jet fuel, i.e. liquid fuel that can be 'dropped into' existing engines without significant modifications. Liquid hydrogen, for instance, is excluded.

introduced, set out in Figure 4 and the table below. They also are not an accurate forecast of SAF production and use in the UK. These scenarios are to be considered only as an indicative representation of the ambition the Government believes could be possible for SAF uptake on the back of certain market, technology and policy conditions, and are subject to substantial uncertainty.

SAF uptake as a % of total aviation fuel demand in the UK

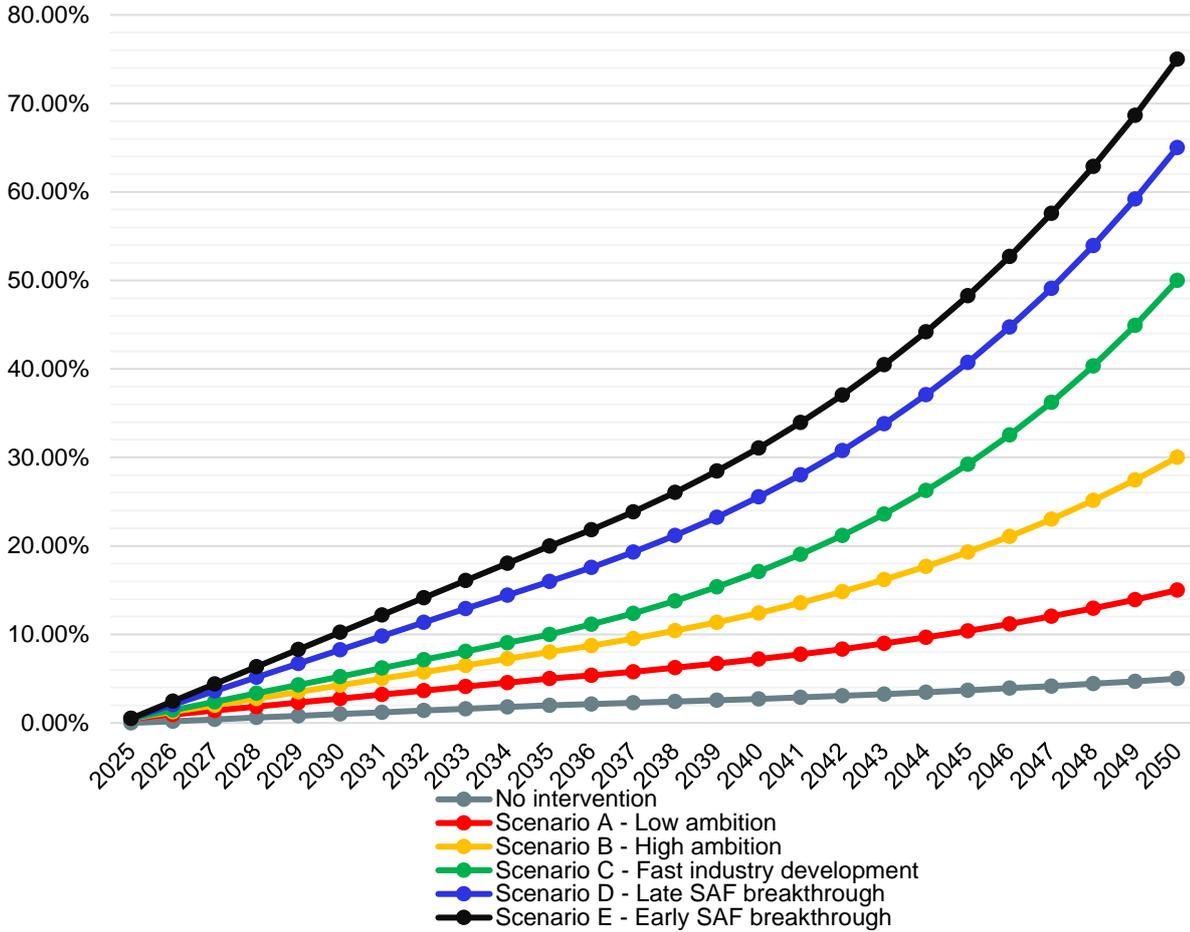


Figure 3 High-level scenarios for SAF uptake ambition

	2025	2030	2035	2040	2045	2050
No additional intervention	0.0%	1.0%	2.0%	2.7%	3.7%	5.0%
A	0.5%	2.8%	5.0%	7.2%	10.4%	15.0%
B	0.5%	4.3%	8.0%	12.4%	19.3%	30.0%
C	0.5%	5.3%	10.0%	17.1%	29.2%	50.0%
D	0.5%	8.3%	16.0%	25.5%	40.7%	65.0%
E	0.5%	10.3%	20.0%	31.1%	48.3%	75.0%

- 4.5 **No additional intervention scenario:** under no additional policy intervention, it is unlikely that all the existing SAF plants already developing in the UK will be able to secure adequate private financing to progress to commercialisation; even if this happens, it is unlikely that plants' completion will happen before 2025, due to the technology and production ramp-up challenges envisaged for these first-of-a-kind projects. It is also unlikely that the existing policy framework will secure additional SAF plants in the UK. As a result, it is expected only small volumes of SAF may be either imported or co-processed in existing domestic refineries should the existing policy framework, primarily reliant on the RTFO, remain in place.
- 4.6 **Scenario A – Low ambition:** this scenario assumes a low uptake of SAF in both the short and long term. Under this scenario, it is expected that fuel production will be primarily optimised for road transport, whose demand for feedstocks is as set out in the 2019 Energy and Emissions Projections (EEP). Under this scenario, most of the existing (non-HEFA) SAF plants developed in the UK are assumed to gradually come online between 2025 and 2030; however, these are unlikely to produce enough fuel to cover more than 2-3% of aviation fuel demand in 2035. The contribution of HEFA will likely be marginal both in the short and in the long term. Beyond 2035, it is expected that domestic supply of SAF could increase by c. 7% per annum on average, across all SAF pathways. We estimate this ambition could mean up to c. 25 large-scale plants will be operational in the UK by 2050.
- 4.7 **Scenario B – High ambition:** this scenario assumes an ambitious uptake of SAF that achieves a 30% uptake in the long-term. This scenario is slightly more ambitious than the 'Carbon Budget 6: Balanced Pathway' modelled by the Climate Change Committee and roughly in line with Sustainable Aviation's roadmap. The percentage uptake of SAF in 2050 aligns with the 'high ambition' scenario in the Jet Zero Consultation. Under this scenario, it is expected all the (non-HEFA) SAF plants currently developing in the UK will become operative by 2030 and they will continue to expand beyond that date, covering c. 4-6% of fuel demand in 2035. More HEFA should become available at that point, as competing demand for feedstocks for renewable road transport fuel will reduce with higher uptake rates of electric vehicles. After 2035, it is expected domestic SAF supply across all pathways could increase by c. 9% per annum, although HEFA availability in the long term will likely be limited by feedstock constraints. We estimate this ambition could mean up to c. 50 large-scale plants will be operational in the UK by 2050.
- 4.8 **Scenario C – Fast industry development:** under this scenario, half of the UK aviation fuel demand in 2050 is met through SAF. This scenario assumes a very high ramp-up of plants post-2025, with c. 6-8% of total 2035 fuel demand met by domestically produced (non-HEFA) SAF, from a wide range of SAF pathways, and a further 2-4% from HEFA. After 2035, it is expected that total domestic supply of SAF could increase by c. 11% per annum. We estimate this ambition could mean up to c. 85 large-scale plants will be operational in the UK by 2050.
- 4.9 **Scenario D – Late SAF breakthrough⁴²:** this scenario assumes a very high number of plants will develop post-2025 with a high success rate, with domestically produced

⁴² Both Scenario D and Scenario E are slightly different from the 'SAF breakthrough' scenario in the Jet Zero Consultation, as these more accurately reflect that SAF breakthroughs could happen either in the short term or in the long term.

(non-HEFA) SAF reaching c. 8-10% of total aviation fuel in 2035 and an additional c. 2-4% of aviation fuel demand to be met through HEFA. After 2035, it is expected that domestic SAF supply could increase by c. 9% per annum. We estimate this ambition could mean over 100 large-scale plants will be operational in the UK by 2050.

4.10 **Scenario E – Early SAF breakthrough:** this scenario assumes a very high number of plants beginning to develop before 2025 with a very high success rate, with up to c. 20 large-scale plants already operational by 2030 and achieving up to c. 125 large-scale plants in 2050. Beyond 2035, supply across all pathways could increase by c. 9% per annum. Under this scenario, SAF breakthroughs will primarily happen in the short term.

4.11 Across the five main scenarios, high-level analysis suggests that these SAF volumes could result in a £4-14 (2-7%) increase in the cost of a medium-haul return ticket in 2030 and a £10-60 (5-30%) increase in 2050, compared to today's price⁴³.

Modelling the carbon intensity reduction target

4.12 These scenarios for SAF ambition have been translated into equivalent GHG emissions reduction trajectories, which represent the target aviation fuel suppliers would need to meet. These trajectories have been calculated based on the expected carbon savings eligible SAF could bring about and an approximate mix of SAF production pathways that could be expected in the UK, based on global and domestic industry trends and independent external analysis.

⁴³ Cost increase expressed in real, 2020 undiscounted prices. Today's price for a medium-haul return trip (approx. 3,000km) assumed to be £200 per passenger. It is assumed that 100% of additional costs to airlines of using SAF are passed through to the consumer.

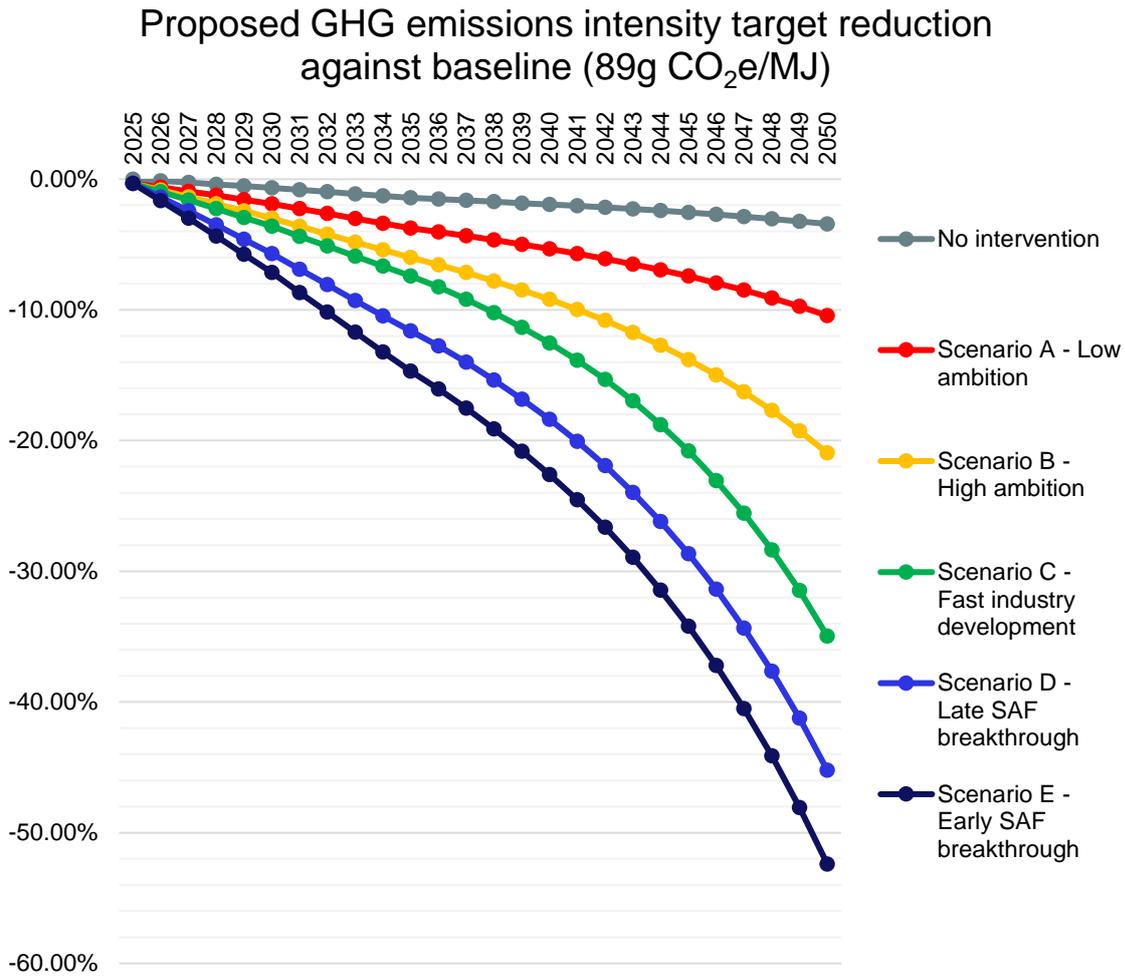


Figure 4 Proposed GHG emissions intensity target reduction

	2025	2030	2035	2040	2045	2050
No additional intervention	89.00 gCO ₂ e/MJ	88.40 gCO ₂ e/MJ	87.72 gCO ₂ e/MJ	87.28 gCO ₂ e/MJ	86.73 gCO ₂ e/MJ	85.96 gCO ₂ e/MJ
A	88.71 gCO ₂ e/MJ	87.32 gCO ₂ e/MJ	85.67 gCO ₂ e/MJ	84.25 gCO ₂ e/MJ	82.39 gCO ₂ e/MJ	79.71 gCO ₂ e/MJ
B	88.71 gCO ₂ e/MJ	86.35 gCO ₂ e/MJ	83.67 gCO ₂ e/MJ	80.81 gCO ₂ e/MJ	76.71 gCO ₂ e/MJ	70.36 gCO ₂ e/MJ
C	88.70 gCO ₂ e/MJ	85.79 gCO ₂ e/MJ	82.41 gCO ₂ e/MJ	77.85 gCO ₂ e/MJ	70.48 gCO ₂ e/MJ	57.88 gCO ₂ e/MJ
D	88.70 gCO ₂ e/MJ	83.92 gCO ₂ e/MJ	78.66 gCO ₂ e/MJ	72.64 gCO ₂ e/MJ	63.49 gCO ₂ e/MJ	48.75 gCO ₂ e/MJ
E	88.70 gCO ₂ e/MJ	82.64 gCO ₂ e/MJ	74.72 gCO ₂ e/MJ	68.89 gCO ₂ e/MJ	58.56 gCO ₂ e/MJ	42.37 gCO ₂ e/MJ

Views on preferred scenario and SAF growth over time

- 4.13 While these scenarios entail different milestones and SAF uptake rates, all of them assume **the proposed SAF mandate would start in 2025**. Given current market developments and industry announcements, and considering the expected commissioning dates of the prospective UK SAF plants supported by the GFGS competition, it is believed that a mandate starting in 2025 would allow the first large-scale SAF plants to become operational, both in the UK and globally. This will also mitigate the potential risk that, in the absence of SAF plants, an obligation introduced too early drives the use of unsustainable feedstocks and fuels.
- 4.14 This timescale would also ensure the follow-up public consultations needed to design this policy, if confirmed, can be conducted, additional evidence can be gathered, mandate trajectories can be refined and subsequently introduced in legislation. A starting point in 2025 would give time to industry and investors to prepare and familiarise themselves with the proposed scheme and incentive system while transitioning away from the RTFO (see Chapter 5).
- 4.15 Beyond 2025, these ambition trajectories grow at different rates. Across all scenarios, the SAF uptake trajectory grows linearly from 2025 to 2035, to take into account the gradual commissioning of SAF plants and the gradual progress to name-plate capacity after a few years from the plant becoming operational. Once the market is more mature, it is expected more plants will become operational and will be able to reach nameplate capacity more quickly. As SAF costs are also expected to come down, to a certain extent, it is assumed an exponential trajectory from 2035 to 2050 could be more realistic and feasible at that stage.
- 4.16 In the long term these scenarios offer a wide range of options (5-75% of fuel volumes to be SAF in 2050) which reflect the high degree of uncertainty. These uncertainties are particularly evident for scenarios C, D and E, whose feasibility at this stage looks contingent on multiple optimistic market and technology breakthroughs happening all together, including the rapid certification and commercialisation of several non-ASTM approved pathways, the revision of blend limits (currently SAF cannot exceed 50% of fuel volumes, as set out at paragraphs 3.3-3.4) and the high success rates of SAF plants across all production pathways. While the Government is supporting technology and industry development with an aim to commercialise the UK SAF industry as quickly as possible, these scenarios entail substantial uncertainties at this stage.
- 4.17 Scenarios C, D and E also imply a higher dependence on HEFA than Scenarios A and B, but feedstocks could be instead limited or constrained by demand for renewable fuel in road transport both in the UK and abroad, often on the back of higher incentives in the road transport fuel market which could result in plants optimising renewable diesel, rather than jet fuel, production.
- 4.18 In the long term, there are also uncertainties as to whether SAF will benefit from the same economies of scale and cost reduction curves seen for offshore wind and renewable energy technology.

- 4.19 There are also uncertainties in demand for conventional liquid fuel out to 2050. When zero emission aircraft enter service, and as aircraft efficiency continues to improve, the conventional, liquid fuel volumes required by aeroplanes will start to decrease. Depending on how quickly this happens, there could be less need for drop-in fuel in the long term. The Jet Zero Consultation sets out various scenarios for zero emission aircraft entering service. These range from no zero emission aircraft in 2050 in the ‘continuation of current trends’ scenario to 53% of Air Traffic Movements being made by zero emission aircraft in 2050 in the ‘high ambition with a breakthrough on zero emission aircraft’ scenario⁴⁴. The future energy demands for the aviation sector will be dependent on how these technologies develop over the coming years.
- 4.20 **The Government would like to introduce a carbon intensity target which is as ambitious as possible and that could deliver a world-leading UK industry.** Building on the potential scenarios set out in this section, we welcome evidence from stakeholders on what SAF uptake trajectory can convey this ambition and what market, policy and technology circumstances will unlock such ambition. We will review feedback and evidence and, should a SAF mandate be introduced, propose our preferred trade-off between ambition and feasibility in our next consultation.

CONSULTATION QUESTIONS

Q18: Do you agree or disagree that a SAF mandate should start in 2025?

Q19: Do you agree or disagree that the targets should assume a linear growth up to 2035 and an exponential growth after 2035?

Q20: What scenario do you think represents the best trade-off between ambition and deliverability? What evidence can you provide to support your position?

Going higher at future review points

- 4.21 It is the Government’s ambition to go further and faster and develop a strong SAF sector in the UK as quickly as possible. This is why one of our scenarios includes an ‘early SAF breakthrough’ that could see up to 10% SAF by 2030 and up to 75% SAF in 2050. However, based on current evidence, we acknowledge such a level of ambition may be achievable under certain circumstances but may be very optimistic at this stage.
- 4.22 While acknowledging the urgency of climate change and the role SAF can play, we understand the implications of setting too high a target at this stage in the short term as it could encourage use of unsustainable feedstocks, either in the UK or replacing the fuel diverted to the UK. Should SAF not develop as quickly as expected and should penalties or buy-out be introduced (see paragraphs 6.3-6.6), there is also a risk that high, undeliverable targets could translate to high costs passed on to the aviation supply chain to cover the cost of those penalties or buy-out, without delivering additional fuel volumes or GHG emissions savings. We are keen not to set targets that would have to be revised down at a later stage should they prove unfeasible.
- 4.23 We expect some stakeholders may therefore prefer to see a more conservative approach to SAF in the short term, at least until the technology has been successfully proved at scale. If stakeholders endorse this approach, it is important to note that **we**

44 An Air Traffic Movement is a landing or a take-off

are open to raise ambition in the future should the market and the technology develop quickly and SAF costs and carbon abatement costs come down significantly. This is to ensure the UK can capitalise on the opportunities this industry can bring about and can develop a world-leading SAF sector.

- 4.24 As trailed in the Jet Zero Consultation, **the Government is therefore minded to introduce several review points in the next decades when a higher SAF uptake ambition will be considered.** Taking into account a typical 5-7 year development timescale of SAF plants, to allow us to monitor market developments and gather robust information that could inform policy changes, and to provide industry with long-term signals, we expect reviews could happen roughly every five-to-ten years. **This means we would like to introduce review points in 2030, for post-2035 uptake, in 2035 for post-2040 uptake and in 2040, for post-2045 uptake, including beyond 2050.** It is assumed an obligation will continue to apply beyond this date, but there are too many uncertainties at this stage to understand the demand for liquid aviation fuel, and how much of this could be covered by SAF, beyond that point.
- 4.25 It is expected that these review points will take into consideration the following factors in deciding whether ambition should be revised upwards:
- Overall reduction in the carbon intensity of jet fuel over time and performance of the proposed SAF mandate;
 - Number, capacity and success rate of UK plants' development;
 - Availability of sustainable feedstocks, including municipal solid waste and large quantities of excess electricity and green hydrogen, and development of domestic supply chains;
 - SAF technology development, including TRL of existing and new production pathways, as well as their ASTM-certification status;
 - Global SAF developments, including number of plants abroad, competition for resources and technology roll-out;
 - SAF costs, carbon pricing and carbon abatement costs;
 - Availability and costs of other aviation decarbonisation technology on both short- and long-haul routes, including electric and hydrogen aircraft, and their impact on drop-in fuel demand;
 - Costs and availability of carbon removals.
- 4.26 While it is difficult to pre-empt the outcome of these reviews and determine how and when the ambition could change, depending on the mandate level chosen initially, it is believed these review points could allow the SAF mandate ambition to evolve gradually, as shown (illustrative example) in Figure 5. The GHG emissions intensity trajectory underpinned by this ambition would then evolve accordingly.

SAF uptake as a % of total aviation fuel demand in the UK

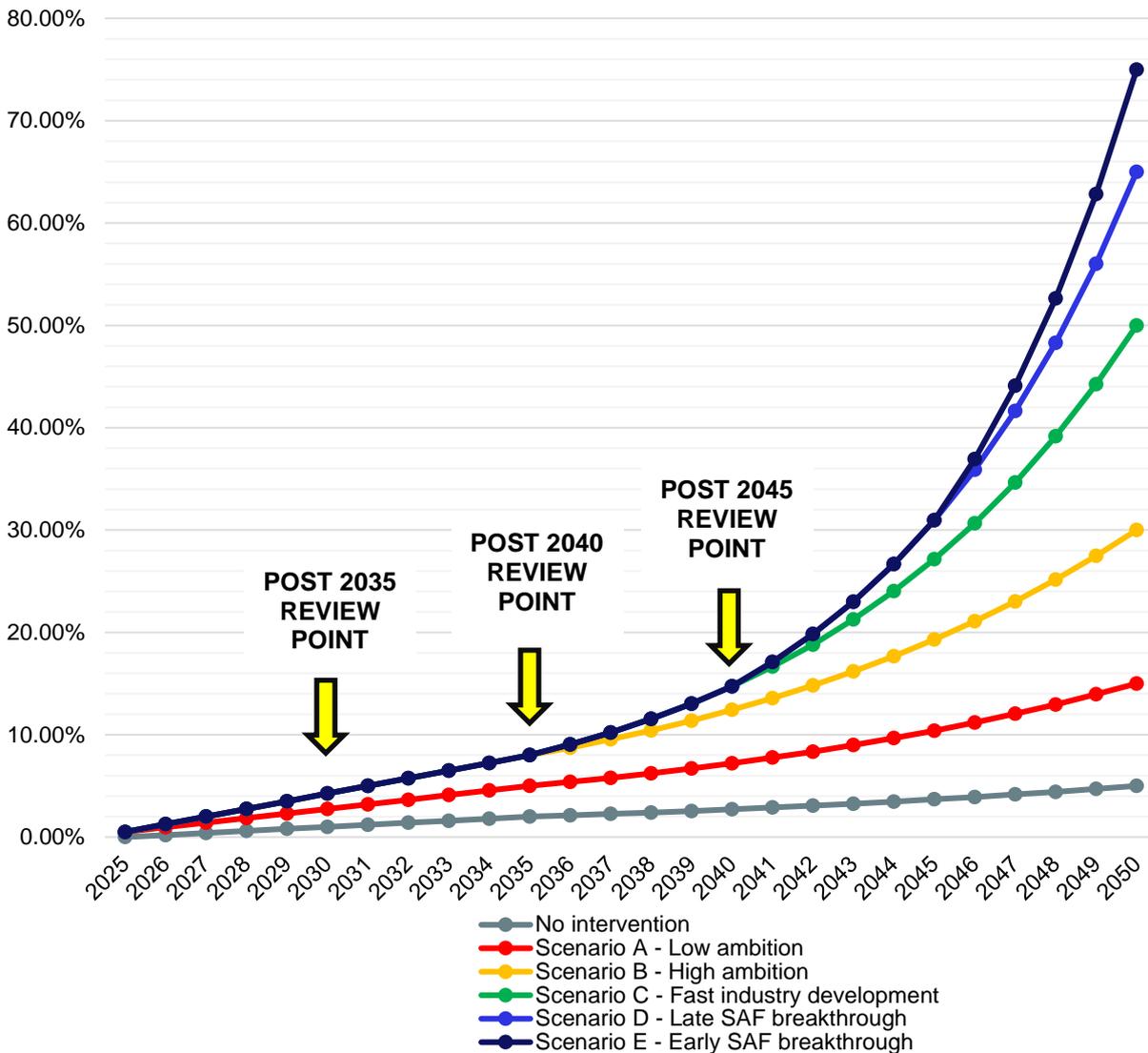


Figure 5 How the potential SAF ambition could change at future review points (indicative only)

CONSULTATION QUESTION

Q21: Do you agree or disagree that we should include review points in 2030, 2035 and 2040, depending on initial mandate levels?

Delivering this ambition and promoting innovation

4.27 The Government acknowledges that SAF may need further technology and commercial development to confidently meet the scenarios set out above. At present, HEFA is the only commercial SAF in production, with existing facilities already supplying SAF to the UK and globally. All other ASTM-approved pathways still face significant challenges and high production costs.

4.28 This means a SAF mandate, in the short term, could drive an increased supply of HEFA. Relying on this fuel could also divert used cooking oil (the feedstock primarily used to produce HEFA) away from the renewable diesel (HVO) production process. When

plants increase the product slate of HEFA over HVO, their overall fuel yield decreases and production costs increase⁴⁵. This means pivoting this feedstock away from use in road transport at this stage will make economy-wide decarbonisation more expensive.

- 4.29 **HEFA supply will be, to some extent, part of the UK fuel mix, but the Government welcomes views on whether HEFA use in SAF should be capped and, if so, how this potential cap should evolve over time as demand for HVO decreases in road transport.**
- 4.30 A cap would also allow the UK to diversify its SAF portfolio, mitigating the risks of feedstock competition, sustainability impacts and supply chain disruptions or bottlenecks that could happen when relying on one specific feedstock or production pathway. This cap could in turn favour the development of domestic supply chains and accelerate the deployment of non-HEFA technologies, especially those least developed to date.
- 4.31 In particular, many of the Jet Zero Council SAF Delivery Group members have stressed the opportunities of power-to-liquid technology, which could breakthrough post 2030 and deliver most of the GHG emissions savings in the medium-to-long term as a result of its very low carbon intensity, typically lower than all other SAF pathways⁴⁶ when additional CCUS is not involved. Analysis from the Clean Skies for Tomorrow coalition has shown the potential for the cost of power-to-liquid SAF to reduce by nearly 70% by 2050⁴⁷. The Government is keen to capitalise on the opportunities these innovative fuels could bring to the UK.
- 4.32 As set out at paragraph 2.14, under the proposed scheme, SAF delivering higher carbon savings (such as power-to-liquid fuels) will receive a higher level of reward (in the form of a higher number of tradable certificates) than an equivalent volume of fuel with a higher GHG emissions intensity. However, power-to-liquid fuel costs are significantly higher than the cost of SAF produced through any other pathway and the production of these fuels is not expected to be widespread until the late 2030s, given their carbon emissions reduction potential. **The Government therefore welcomes views on how to accelerate technological and commercial development of power-to-liquid fuels specifically. This could be achieved, for instance, through the use of a multiplier system within the mandate, similar to the double reward certain waste fuels obtain under the RTFO, and/or through specific sub-targets that could ring-fence a specific quantity for power-to-liquid technology.**
- 4.33 It is believed such an approach would foster innovation, not only in SAF but also in carbon capture technology, given power-to-liquid routes could likely be easily integrated into DAC plants as this technology develops further. Should these fuels scale up more quickly, their development could also allow a quicker upward revision of our SAF ambition, as set out at paragraph 4.25. We are also keen to understand

⁴⁵ <https://www.iata.org/contentassets/d13875e9ed784f75bac90f000760e998/safr-1-2015.pdf> Fig.15, page 32

⁴⁶ https://www.umweltbundesamt.de/sites/default/files/medien/377/publikationen/161005_uba_hintergrund_p tl_barrierrefrei.pdf

⁴⁷ <https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/scaling-sustainable-aviation-fuel-today-for-clean-skies-tomorrow#>

how the SAF mandate more in general can foster the development of SAF with the lowest GHG intensity across all production pathways.

CONSULTATION QUESTIONS

Q22: Should the amount of HEFA that can be claimed under the SAF mandate be capped over time? If this is the case, how could the cap work in practice, given the scheme will be based on GHG emissions savings? How should the cap be calculated?

Q23: How can the innovation and roll-out of power-to-liquid fuels be accelerated? Should a sub-target and/or a multiplier be introduced?

Q24: How can SAF produced through pathways other than HEFA and power-to-liquid be accelerated?

5. Interactions with other domestic and international policy

Double counting and double claiming under multiple schemes

- 5.1 The UK and foreign governments support the production of renewable fuels through different schemes. Currently, renewable fuels and feedstocks are allowed to receive incentives in more than one country or sector. The changes confirmed in the government response to the consultation 'Targeting net zero – next steps for the Renewable Transport Fuel Obligation'⁴⁸ limit the opportunity for a fuel to count twice towards different targets: this means SAF use could not count towards meeting both the development fuel target under the RTFO and the proposed SAF mandate obligation.
- 5.2 The government response also suggests renewable fuel eligible under the RTFO cannot receive any other rewards under different GHG reduction schemes, including in other countries, even when it is counted towards the RTFO target only. Exceptions include financial support to develop fuels and technologies e.g. laboratory scale testing and support for construction of demonstration scale production. This means that fuels produced in a plant that has received funding from the Future Fuels for Flight and Freight Competition, for example, would remain eligible to claim support under the RTFO.
- 5.3 On top of the RTFO, SAF use in the UK can be rewarded through the UK Emissions Trading Scheme (ETS) and CORSIA.

CORSIA

In 2016 and with significant UK input, the International Civil Aviation Organization (ICAO) adopted the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), aiming to stabilise net CO₂ emissions from international civil aviation at 2020 levels from 2021^{49,50}. This is expected to be achieved through a mixture of in-sector reductions through advances in technology, operations and infrastructure, as well as offsetting. The UK is currently among 88 states participating in the pilot phase (2021-2023), which will be followed

⁴⁸ <https://www.gov.uk/government/consultations/amending-the-renewable-transport-fuels-obligation-rtfo-to-increase-carbon-savings-on-land-air-and-at-sea>

⁴⁹ <https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx>

⁵⁰ The ICAO Council agreed in June 2020 to change the baseline to 2019 emissions only for the Pilot Phase. The CORSIA periodic review in 2022 will consider whether to extend the baseline change to the subsequent phases.

by a further voluntary phase and a mandatory phase from 2027 where all ICAO Member States will be required to participate, subject to some exemptions⁵¹.

CORSIA applies to aeroplane operators (AOs), which are able to reduce the number of CORSIA Emissions Units required to be cancelled at the end of the compliance cycle through the use of a “CORSIA eligible fuel” (CEF). The emissions reductions claimed are proportional to the lifecycle emissions of the CEF and its volume.

For a SAF to be a CEF, it must meet certain technical, feedstock, and sustainability criteria – these will need to be certified by an independent approved Sustainability Certification Scheme (SCS). A minimum life cycle emission value of at least 10% less than the fossil counterfactual also applies – this is inclusive of ILUC emissions.

The Government recently consulted on how CORSIA should be implemented in the UK, which included possible options for interaction between CORSIA and the UK Emissions Trading Scheme⁵². Later this year, we will consult again on detailed proposals for implementing CORSIA offsetting in the UK.

- 5.4 Unlike the RTFO and the proposed SAF mandate, under CORSIA the obligation is placed on AOs rather than fuel producers. To claim SAF under CORSIA, the fuel producer must have the fuel certified for CORSIA eligibility by a CORSIA-eligible SCS, as described in the box above.
- 5.5 The AO claiming the use of the CEF must report to its CORSIA administering state⁵³ the information defined in the CORSIA SARP (Appendix 5, Tables A5-1 and A5-2)⁵⁴. The administering state also needs to report CEF use to ICAO (Table A5-6). A UK SAF mandate would not change this process.
- 5.6 CORSIA includes a requirement that an AO cannot claim emissions reductions in multiple schemes, meaning that emissions reductions from SAF cannot be claimed in both UK ETS and CORSIA, for example.

UK ETS

At the start of this year, jointly with the devolved administrations, we introduced the UK Emissions Trading Scheme (UK ETS), replacing the UK’s participation in the EU ETS. The UK ETS works on the ‘cap and trade’ principle, where a cap is set on the total amount of certain greenhouse gases that can be emitted by sectors covered by the scheme and which decreases over time. The UK ETS covers all domestic flights, flights from the UK to the EEA and flights between the UK and Gibraltar. In 2019, these flights made up 44% of all commercial flights to and from UK airports.⁵⁵

⁵¹ <https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-FAQs.aspx>

⁵² <https://www.gov.uk/government/consultations/implementing-the-carbon-offsetting-and-reduction-scheme-for-international-aviation>

⁵³ <https://www.icao.int/environmental-protection/CORSIA/Pages/AeroplaneOperators.aspx>

⁵⁴ <https://www.icao.int/environmental-protection/CORSIA/Pages/SARPs-Annex-16-Volume-IV.aspx>

⁵⁵ Internal DfT analysis of CAA airports data.

The UK ETS will be the world's first net zero carbon cap and trade market, and a crucial step towards achieving the UK's net zero carbon emissions by 2050. The emissions cap is 5% tougher than the EU equivalent and the first auction on 19 May cleared at £43.99/tCO₂. The Government, along with its partners in the devolved administrations that make up the UK ETS Authority, will be consulting shortly on putting the scheme on a clear net zero trajectory.

We are committed to incentivising SAF use under the UK ETS. As detailed in the UK Government and devolved administrations' response to 'The future of UK carbon pricing' consultation in 2020⁵⁶, our initial policy approach is to align with EU ETS monitoring, reporting and verification rules in order to ensure continuity for participants, particularly as many aircraft operators still have EU ETS obligations. The UK Government and the devolved administrations are currently reviewing certain aspects of UK ETS aviation policy to enhance its effectiveness. As part of our review, we will consider the outcome of this consultation to ensure that policies on SAF remain aligned and the UK ETS incentivises SAF uptake in the future. These interactions will be explored as part of a UK ETS consultation later this year, followed by more detailed policy proposals in 2022.

- 5.7 In line with the approach set out in the government response to the RTFO consultation, the Government would like to require that any SAF supplied to meet the proposed standalone SAF mandate cannot be claimed under the RTFO, and the other way around.** This is to ensure carbon emissions reductions are only accounted for once. Any SAF claimed under a SAF mandate would therefore not be able to receive a double reward under the RTFO, and the other way around, regardless of the party submitting the claim. This proposal has some implications on how aviation fuels are rewarded under the RTFO and the SAF mandate (see next section).
- 5.8 It is proposed any emissions reductions claimed under a SAF mandate cannot also be claimed under another GHG scheme to ensure that they are only claimed once. We welcome views on how the UK ETS, CORSIA and proposed SAF mandate could be used together to continue to incentivise SAF uptake, while preventing double counting of emissions reductions.**
- 5.9 It is important to note that sustainability standards and fuel eligibility criteria under these schemes may differ, which may mean that certain SAF could be eligible under one scheme, but not eligible under the other. It is also important to recall that CORSIA already has provisions in place to ensure double counting of emissions reductions is avoided.
- 5.10 It is proposed any SAF produced from plants who have benefitted from government support for R&D, feasibility studies, FEED and construction of commercial plants, either in the UK or abroad, can count towards the proposed SAF mandate obligation and can receive credits under the SAF mandate.** This would mean that fuels supported through the Green Fuels, Green Skies competition or fuel produced by clusters receiving funding under the GHG removals or hydrogen from bioenergy with CCS programmes run by the Department for Business, Energy and

⁵⁶ <https://www.gov.uk/government/consultations/the-future-of-uk-carbon-pricing>

Industrial Strategy, for instance, would continue to remain eligible under the proposed SAF mandate.

- 5.11 We will continue to explore how the incentives under the proposed SAF mandate interact with revenue streams from other government subsidy programmes and the possibility to combine support from different sources. While we aim to maximise the benefits of government intervention, we will consider the importance of avoiding double subsidisation or overcompensation. We will consult on further detail if appropriate.

CONSULTATION QUESTIONS

Q25: Do you agree or disagree that SAF GHG emissions reductions should be claimed only once under different schemes?

Q26: How could the UK ETS, CORSIA and proposed SAF mandate be used together to continue to incentivise uptake, while preventing double counting of emissions reductions?

Q27: Do you agree or disagree that SAF that has been produced on the back of industrial plants or clusters which have received competition funding from government can be claimed under the proposed UK SAF mandate?

Aviation fuels under the RTFO

- 5.12 To avoid double counting and double claiming between the SAF mandate and the RTFO, SAF suppliers would technically be able to choose between what scheme they would like to claim a certificate or a credit from, and would not be able to claim the same consignment of SAF under the other scheme.
- 5.13 Ensuring the same batch of SAF is not claimed under both schemes by the same supplier will, however, result in administrative challenges. These could be exacerbated if the assessment point between the RTFO and the SAF mandate is different, as it becomes easier for multiple parties to use the same fuel batch to claim a credit or certificate under the SAF mandate and RTFO, respectively, given the owner of the fuel at the assessment point may be different.
- 5.14 In addition, renewable fuel which does not meet the RTFO criteria is obligated under the RTFO, and paragraph 3.39 sets out an equivalent proposal under the SAF mandate, which would mean that SAF that does not meet the proposed sustainability criteria set out in Chapter 3 incurs an obligation. Different eligibility criteria under different schemes could therefore create administrative complexity.
- 5.15 **The Government would therefore like to make aviation fuel ineligible to receive certificates under the RTFO once a SAF mandate is in place**, likely in 2025 as set out in paragraph 4.13. This means that the SAF mandate would become the only scheme under which fuel suppliers will be able to claim SAF use and receive a reward, in the form of a credit, in the UK (UK ETS and CORSIA apply to airline operators and aeroplane operators, respectively).
- 5.16 Acknowledging aviation fuel was included under the RTFO only in 2018, the Government believes the introduction of a standalone mandate to support SAF uptake that takes over from the RTFO is the best approach to ensure the new scheme's

integrity. The envisaged four-year time lag before this change comes into force should allow industry to transition towards the new scheme without significant complexities.

CONSULTATION QUESTION

Q28: Do you agree or disagree that SAF should no longer be rewarded under the RTFO when and if a SAF mandate is in place?

Interactions with foreign mandates and tankering

- 5.17 The UK Government is keen to see the SAF market develop globally and looks with interest at the foreign government interventions aimed at encouraging this. To achieve the outcomes set out at paragraph 2.62.3, it is essential that any potential SAF mandate introduced in the UK interacts smoothly with equivalent policy of other countries and international obligations, and the other way around. In particular, it is important that any SAF mandate introduced in the UK or elsewhere does not result in an increase in carbon emissions outside the region where a SAF mandate is implemented.
- 5.18 In 2018 DfT commissioned a study on carbon leakage in aviation which explored the impact climate change policy, including the use of SAF, has on carbon emissions, airlines and passengers⁵⁷. The study showed that if refuelling at a UK airport becomes more expensive as a result of SAF policy introduced unilaterally by the UK, airlines may decide to take on additional fuel on inbound trips to the UK to cover the outbound trip from the UK by refuelling elsewhere – this is known as ‘tankering’ which can result in carbon leakage, even when taking into consideration the carbon emissions saved through SAF use.
- 5.19 A similar study has been conducted by the ICCT to explore the potential impacts of tankering that could result from unilateral use of SAF in the EU. The study showed up to 80% of international flights and a third of all flights to and from EU airports could carry excess fuel in 2035, resulting in additional carbon emissions that will offset the carbon benefits of SAF policy and reduce its uptake. Specifically, the study concluded that half of the tankered flights and excess fuel use in 2030 in the EU could come from the UK in the absence of an equivalent SAF mandate here.
- 5.20 Given tankering could mostly take place on short-haul routes between 900 and 1,700 km, according to the ICCT study above, it is believed that a UK SAF mandate and an EU-wide mandate implemented at similar timescales will reduce the risk of tankering. In addition, the above study and additional evidence collected through the Jet Zero Council SAF Delivery Group suggest that if an obligation is placed on all fuel supplied, the risk of carbon leakage reduces.
- 5.21 To reduce this risk further, through the Jet Zero Consultation we are also proposing to seek a voluntary agreement from all airlines to avoid tankering where there is no practical reason to carry additional fuel (this proposal is currently being consulted on as part of the separate Jet Zero Consultation). In this consultation, **the Government**

⁵⁷ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/763260/carbon-leakage-report.pdf

welcome views on whether some additional provisions under the proposed SAF mandate may be needed to decrease even further the risk of tankering that mandatory SAF use could result in.

CONSULTATION QUESTION

Q29: What provisions should the UK SAF mandate include to reduce the risk of tankering even further?

6. Delivering SAF to the market

Building a strong UK industry

- 6.1 The Government believes the proposed SAF mandate will be a key policy tool to drive growing SAF demand and create a flourishing market in the UK. However, through the Jet Zero Council SAF Delivery Group, some investors and potential UK SAF producers have asserted that while a mandate would secure demand, it does not determine the price that a plant owner may receive for their finished fuel, as the value of both the fuel itself and tradable credits under a mandate may fluctuate over time. Alongside the high capital and operational costs faced by developers considering building commercial scale SAF facilities, revenue uncertainty adds additional risk to projects which may limit the attractiveness to investors and increase the overall cost of finance. If these risks could be further mitigated, more projects may become viable.
- 6.2 We are keen to understand how we can build investor confidence in UK plants and secure investment, allowing the UK to develop a world-leading domestic SAF sector and delivering thousands of green jobs. We therefore welcome views on what, if any, additional interventions may be needed to provide more certainty for developers and investors considering building plants in the UK. We will consult on further detail if appropriate.

CONSULTATION QUESTIONS

Q30: Do you consider a more comprehensive policy framework beyond a SAF mandate is required to build a successful UK SAF sector?

Q31: If you believe this is the case, how can this policy framework be designed?

Please provide any evidence you may have available to support your answers.

Noncompliance and buy-out mechanism

- 6.3 The Government acknowledges future market developments or other external circumstances could mean fuel suppliers may not be able to produce sustainable fuel or buy credits, thus failing to meet (part of) their proposed obligation.
- 6.4 Under the RTFO, suppliers can pay a fixed sum for each litre of fuel for which they wish to 'buy-out' their obligation. Under the 2019 GHG emissions scheme, where a supplier failed to redeem sufficient GHG emissions credits to meet their obligation (in kgCO_{2e}) they had pay a buy-out price of 7.4 pence per kg of CO_{2e} saving not delivered, equivalent to £74 per tonne of CO_{2e}. This mechanism also protects motorists from exceptional spikes in the price of renewable fuels that may be passed through the road fuel supply chain.

- 6.5 However, a buy-out results in lost GHG emissions savings. Recent spikes in the cost of biofuels relative to petrol and diesel have increased the risk that road fuel suppliers will simply ‘buy-out’ of their obligation without supplying additional renewable fuel. To mitigate this risk, in 2020 the Government had to increase the RTFO buy-out price⁵⁸.
- 6.6 Should suppliers fail to produce SAF, an equivalent buy-out under the SAF mandate would allow them to fulfil their obligation, but this would result in a loss of additional carbon emissions savings. **The Government welcomes views on what measures or penalties should be in place to deter suppliers from falling short of the proposed carbon intensity targets and whether buy-out should be allowed.**

CONSULTATION QUESTIONS

Q32: Should buy-out be allowed? If so, how should the buy-out price set to encourage actual supply of SAF and delivery of GHG emissions savings? How should the buy-out evolve over time?

Q33: What penalties should be introduced in addition/alternatively to a buy-out to ensure sustainable SAF, that meets the proposed criteria, is supplied?

⁵⁸ <https://www.gov.uk/government/consultations/increasing-the-renewable-transport-fuel-obligation-buy-out-price-for-biofuels-suppliers/increasing-the-renewable-transport-fuel-obligation-buy-out-price-to-ensure-continued-greenhouse-gas-savings>

7. Scheme practicalities, reporting and verification

Mass balance and chain of custody

- 7.1 Under the RTFO, 'mass balance' (or a more stringent system) is the only chain of custody system permitted, where a chain of custody is defined as the system that allows to link the final product (in the case of the RTFO, a biofuel) with the raw materials used to produce it (the feedstocks and their sustainability criteria).
- 7.2 Such a system ensures that, for each unit of biofuel claimed under the RTFO, an equivalent amount of feedstocks with the same sustainability characteristics of the final biofuel has been effectively used in the fuel market, even if those feedstocks have not been physically separated during the production process.
- 7.3 **The Government is minded to require a mass balance approach for the SAF mandate** too. This will create consistency throughout the supply chain and will facilitate the flow of information needed to verify the correct application of mass balance – it is likely that UK road fuel suppliers, many of which may be obligated under the proposed SAF mandate too, are already familiar with existing mass balance practices. A mass balance approach is also preferred as in less stringent chain of custody systems, such as book and claim, it would not be possible to track a given consignment of SAF throughout the supply chain in order to verify its origin and sustainability.
- 7.4 To ensure the fuel delivered under a mass balance approach is truly sustainable, there is a need to track sustainability data throughout the supply chain and back to the original source of the fuel. To allow this information to be verified, credible and adequate evidence must therefore be in place at each stage of the supply chain and this needs to flow smoothly from the owner of the feedstock used to produce a sustainable fuel to the obligated party that incurs an obligation. The chain of custody typically stops at the assessment point, which, under the RTFO, for road transport fuel, coincides with the duty point.
- 7.5 When there is no duty point, as set out at paragraphs 2.22-2.26, an equivalent assessment point is introduced, but if this is not in the UK, the chain of custody should show the fuel has been supplied to the UK. This would require the definition of an end point of the chain of custody, regardless of the assessment point. This could be placed, for instance, at the aircraft, rather than at the airport. The extension of the chain of custody beyond the assessment point will require the information collected throughout the supply chain to take into consideration all transport losses associated to the delivery of SAF to the aircraft, including evaporation, spillage and tank residues, even if the obligated party may not be in possess of this information. This end point could guarantee SAF has been delivered to a specific plane, but may be unpractical, given

the difficulty in tracking SAF molecules, and may overcomplicate the implementation of a SAF mandate. **The Government welcomes views on the approach to the chain of custody the proposed SAF mandate will require.**

CONSULTATION QUESTIONS

Q34: Do you agree or disagree that a mass balance approach should be the only chain of custody system permitted under the proposed SAF mandate?

Q35: Where do you think the chain of custody will need to end? Please refer to any evidence to support your position.

Annual reporting

7.6 The Motor Fuel (Road Vehicle and Mobile Machinery) Greenhouse Gas Emissions Reporting Regulations 2012, also known as GHG Reporting Regulations, introduced reporting requirements for fuel suppliers for road transport and non-road mobile machinery⁵⁹. This reporting obligations continue to apply and suppliers are required to submit information to the Department for Transport on the volume of all fossil, renewable or partially renewable fuels, including those covered by the RTFO Order.

7.7 Data reported under the RTFO can be used to fulfil the reporting obligations of the GHG Reporting Regulations where fuels are covered by both sets of legislations, to maximise efficiency and eliminate the need to report similar information to the same RTFO Administrator twice. This information includes the volumes of fuel supplied and its classification (fossil, renewable, partially renewable), and, for biofuels only, the GHG emissions intensity and sustainability information of the renewable fuel.

7.8 The on-going reporting requirements of the GHG Reporting Regulations currently do not apply to aviation fuel suppliers, while the reporting requirements of the RTFO for aviation fuel apply only to those suppliers who chose to opt-in and claim RTFCs for renewable jet fuel. For an effective and smooth delivery of the proposed SAF mandate, it is envisaged a similar reporting requirement on all aviation fuel (SAF and conventional) will need to be introduced so that the proposed obligation on aviation fuel suppliers can be calculated accurately.

7.9 This reporting could include:

- The lifecycle GHG emissions intensity of the aviation fuel supplied – for biofuels, renewable and partially renewable fuels this will need to be calculated in line with the methodology that a SAF mandate will introduce, discussed at paragraphs 3.36-3.38;
- The aviation fuel volume (or mass) supplied;
- The energy content of the aviation fuel, expressed as the lower heating value;
- The country of origin of the aviation fuel.

7.10 The annual obligation period under the GHG Reporting Regulations and under the RTFO has been harmonised and, since 2019, it has been set on a calendar year basis from 1 January to 31 December. Under the RTFO, suppliers can report monthly. There

⁵⁹ <https://www.legislation.gov.uk/uksi/2012/3030/contents/made>

are also some reporting requirements on aviation fuel suppliers under the Oil Stocking Order 2012.

- 7.11 **It is the Government's intention to ensure any additional reporting requirements under the proposed SAF mandate minimises administrative burdens on aviation fuel suppliers, while ensuring information is collected timely so to allow a smooth and effective running of the scheme.** This could mean, for example, that the reporting calendar of the SAF mandate will align with the RTFO one.

CONSULTATION QUESTIONS

Q36: Do you agree or disagree that obligated suppliers will need to report annually information on the aviation fuel supplied to the Department for Transport, regardless of whether they claim SAF credits?

Q37: Do you have views on what information obligated fuel suppliers should report?

Q38: Do you have views on the reporting calendar?

Submitting claims

- 7.12 Data to meet the proposed annual reporting obligations will be collected on top of the information SAF suppliers will need to submit to DfT to claim credits under the proposed SAF mandate. To submit claims, obligated party may be required to provide data and evidence on:

- The SAF volume (or mass) supplied;
- The energy content of the SAF supplied, expressed as the lower heating value;
- The lifecycle GHG emissions intensity of the fuel, which will need to be calculated in line with the methodology that a SAF mandate will introduce, discussed at paragraphs 3.36-3.38;
- The country of origin of the SAF supplied;
- The feedstock(s) used, including origin;
- The SAF production process/pathway used.

- 7.13 The information the Government is minded to require all aviation fuel suppliers to report annually and the information those suppliers will need to provide to claim credits are aligned. In most cases, it is expected that aviation fuel suppliers that supply SAF will meet the proposed reporting requirements through the information supplied in their applications for credits throughout the year, without the need to submit a separate annual report.

- 7.14 **It is proposed that aviation fuel suppliers can apply for credits how often they choose, at any time within the given reporting period.** In line with the RTFO, it is proposed this information will need to be provided per administrative consignment, i.e. any amount of product with an identical set of sustainability characteristics. Once data is complete for one or more administrative consignments, SAF suppliers would be able to choose to apply for credits or hold data for a future application. Credits will be issued by DfT on a monthly cycle and it is expected a cut-off date could be in place, beyond which applications will be processed the following month.

CONSULTATION QUESTION

Q39: Do you have views on what the timescale for submitting claims and the information/evidence required by this process should be?

Voluntary schemes

- 7.15 **It is proposed that obligated fuel suppliers will need to show that the SAF supplied meets the proposed SAF sustainability standards and will need to have their claim data independently verified before submitting an application for credits**, as it already happens under the RTFO.
- 7.16 When submitting a claim under the RTFO, to provide evidence of compliance with the sustainability criteria of the scheme, including GHG emissions, land-use, mass balance and chain of custody criteria, fuel suppliers can rely on so-called ‘voluntary schemes’. These schemes produce documentation demonstrating that a consignment of biofuel, renewable fuel or feedstock from a certain fuel supplier meets the requirements of the RTFO, following the feedstock or biofuel along the chain of custody. This is the recommended option for demonstrating compliance with sustainability criteria under the RTFO.
- 7.17 Not all the sustainability criteria of the RTFO may be covered by voluntary schemes, and not all voluntary schemes cover the full chain of custody. Where this is the case the supplier will need to ensure that evidence is available back to the point at which the voluntary scheme operates and additional information and evidence should be provided by the party claiming RTFCs, either through other voluntary schemes or through providing their own evidence, to ensure the fuel meets all the RTFO sustainability criteria.
- 7.18 Similarly, under CORSIA, airlines must use voluntary schemes (referred to as ‘Sustainability Certification Schemes’) to certify that the fuel they use to offset CORSIA obligations meets the CORSIA sustainability criteria and its lifecycle emissions have been calculated in line with the methodology prescribed by ICAO. Such certification schemes need to be approved by ICAO⁶⁰.
- 7.19 **The Government is minded to allow certifications from voluntary schemes that show the SAF supplied under the proposed UK SAF mandate meets its prescribed sustainability criteria**, set out in Chapter 3. While acknowledging that different schemes (e.g. RTFO, SAF mandate, CORSIA) may present different sustainability criteria, and a fuel may therefore be eligible under one but not the other scheme, it is envisaged a consistent approach to sustainability certification, reliant on voluntary schemes, will simplify the administrative burden on fuel suppliers, on which the SAF mandate obligation is proposed.
- 7.20 In line with the RTFO, **it is not proposed that reliance on voluntary schemes will be mandatory**, so that fuel producers can have flexibility to bring their preferred evidence to show compliance with the sustainability criteria set out in Chapter 3. It will, however, be the SAF supplier’s responsibility to provide adequate information that can

⁶⁰ <https://www.icao.int/environmental-protection/CORSIA/Pages/CORSIA-Eligible-Fuels.aspx>

confirm the sustainability criteria have been met as deemed satisfactory by the Department for Transport.

7.21 In particular, it is envisaged DfT will need specific evidence that:

- The minimum GHG emissions reduction threshold has been met i.e. the GHG intensity of the SAF supplied is below the maximum GHG intensity allowed and has been calculated in line with the GHG emissions methodology that will be used by the SAF mandate (not yet defined as discussed at paragraphs 3.36-3.38);
- The feedstocks used to produce SAF are included in the list of eligible feedstocks that will be approved under the SAF mandate, as discussed at paragraphs 3.12-3.22;
- The land criteria set out at paragraphs 3.23-3.26 have been met.

CONSULTATION QUESTIONS

Q40: Should certification provided by voluntary schemes count as evidence of compliance with the sustainability criteria of the SAF mandate? If so, do you think this step should or should not be mandatory?

Q41: What information should the obligated party provide, either through verifiers or other means, to demonstrate compliance with the sustainability criteria?

Verification

7.22 On top of the proof of sustainability supplied by a voluntary scheme or the provision of evidence deemed acceptable by the Department for Transport, **it is proposed that independent verification or assurance is also needed for fuel suppliers submitting claims under the SAF mandate.**

7.23 Under the RTFO, this needs to be conducted by a qualified and competent party in line with the International Standard on Assurance Engagements (ISAE 3000, Revised) to at least the 'limited' assurance level defined by this (or another equivalent) standard⁶¹. When aviation fuel became eligible under the RTFO in 2018, respondents to a previous government consultation highlighted the proposed 'reasonable' assurance would create disproportionate administrative burden⁶².

7.24 As we introduce a standalone SAF mandate, with an aim to reduce risks and improve the credibility and effectiveness of the new scheme, **we welcome again views on whether verification should be conducted to a 'reasonable' assurance**, which already happens in some circumstances under the RTFO.

CONSULTATION QUESTION

Q42: Do you agree or disagree that claims for credits under the SAF mandate should be verified? If so, should these be verified to a 'limited' or 'reasonable' assurance?

⁶¹ <https://www.iaasb.org/publications/international-standard-assurance-engagements-isaie-3000-revised-assurance-engagements-other-audits-or-0>

⁶² https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/644843/renewable-transport-fuel-obligations-order-government-response-to-consultations-on-amendments.pdf

Statistical releases and market information

- 7.25 The Department for Transport regularly releases reports with key information provided under the GHG Reporting Regulations and the RTFO⁶³. This information includes, for instance, the sustainability characteristics of biofuels supplied under the RTFO, the proportion of the different types of fuel supplied, the average carbon emission savings. This data is typically aggregated or presented for each fuel suppliers depending on the statistical release.
- 7.26 The Government is keen to continue to provide transparent access to information collected as part of the proposed SAF mandate, where this information is not commercially sensitive. **We welcome views on what information should be ideally released and when this should be best published.**

CONSULTATION QUESTION

Q43: What data related to the SAF mandate should DfT make publicly available? How often should this information be published?

⁶³ <https://www.gov.uk/government/collections/renewable-fuel-statistics>

Public Sector Equality Duty

The Public Sector Equality Duty (PSED) came in to force in April 2011 (s.149 of the Equality Act 2010) and public authorities are now required, in carrying out their functions, to have due regard to the need to achieve the objectives set out under s149 of the Equality Act 2010.

In this regard, an initial assessment has identified that, as a consequence of our proposals, if the cost of SAF is partially or fully passed on to passengers, aviation ticket prices may increase over time. We are interested in understanding the level of extent to which a potential ticket price increase may disproportionately affect those with protected characteristics, so we can continue to mitigate such impacts as SAF policy is implemented.

To support a robust PSED assessment informed by evidence, we invite comment on how the proposed SAF mandate may impact equality and how it could achieve the objectives set out under s149 of the Equality Act 2010 to:

- eliminate discrimination, harassment, victimisation and any other conduct that is prohibited by or under the Equality Act 2010;
- advance equality of opportunity between persons who share a relevant protected characteristic and persons who do not share it;
- foster good relations between persons who share a relevant protected characteristic and persons who do not share it.

What will happen next

A summary of responses, including the next steps, will be published on the DfT website. Paper copies will be available on request.

If you have questions about this consultation, please contact:
LowCarbonFuel.Consultation@dft.gov.uk

Annex A: Jet Zero Council SAF Delivery Group outputs

A.1 The table below summarises the feedback received to date from stakeholders through the mandate, technology and commercialisation subgroups of Jet Zero Council SAF Delivery Group. This content reflects individuals' considered opinion presented during meetings and, as such, should not be seen as pre-empting the outcomes of this consultation, which will take into account a wider range of views, evidence and data.

Mandate subgroup
<p>Ambition</p> <ul style="list-style-type: none"> - On the proposed overarching trajectory, a range of views were offered: <ul style="list-style-type: none"> o Most attendees voted for 5% by 2030 (ranging from 5% to 35%) o Most attendees voted for 40% by 2050 (ranging from 30% to 100%) - On the design of the mandate, 50% stated their preference for an emissions-based scheme and 50% preferred a volume-based scheme, although many agreed an emissions-based scheme could reduce emissions faster and could create a level playing field by removing focus on individual technology or feedstock
<p>Obligation</p> <ul style="list-style-type: none"> - Concerns were raised over a domestic only mandate given long-haul travel generates the highest carbon emissions - The majority view was that fuel suppliers should be obligated, noting the need to understand the impact of a supplier or airline obligation, any costs passed onto the passenger and the potential for refuelling outside UK
<p>Scheme design and interactions</p> <ul style="list-style-type: none"> - Many agreed the UK SAF mandate should consider EU SAF mandate and CORSIA developments to avoid competitive distortion and carbon leakage, although many questions remain on how this can be achieved in practice - Many agreed the contribution of CORSIA and the EU ETS in incentivising SAF uptake is currently small - Tankering may happen (resulting in carbon leakage), requiring action from governments to minimise this risk - A UK mandate should not aim to drive SAF imports but focus on domestic production - Passengers should ultimately pay for the cost of SAF and measures to support its uptake

Technology subgroup
<p>Technology uptake and potential</p> <ul style="list-style-type: none"> - Maintaining diversity in the technology and feedstock to use all possible resources will support growth of the industry and ensure UK production can be maintained through 2030-2040 - Most ASTM approved pathways are technically feasible in the next 5 years - Fischer Tropsch, HEFA and Alcohol-to-Jet (AtJ) are the nearest opportunities and scalable within 5 years, while pyrolysis may be available within 5-10 years - SAF from CO₂ (e.g. from DAC or BECCS process) could be commercially feasible by 2030 - HEFA and AtJ are 'quick wins' due to technology maturity - HEFA co-processing of 50 kt/year by 2030 is achievable - Co-processing should gradually move to full processing as demand for biodiesel and petrol decline - Existing refineries offer low CAPEX production opportunity for SAF in the UK, including blending infrastructure
<p>Feedstock implications</p> <ul style="list-style-type: none"> - The uptake of feedstocks depends on multiple factors including changes in demand, availability, sustainability requirements and incentives (including for road vehicles) - There is strong UK capability in ethanol production - By 2030, DAC and Power-to-Liquid (PtL) will be demonstrated at scale. Combined with CCS, the CO₂ can be used or stored to reduce the carbon intensity of the SAF production process
<p>Policy approach to technology/feedstock</p> <ul style="list-style-type: none"> - Policy should allow for a portfolio approach with a mix of technology options, providing an opportunity for new, viable pathways to meet ASTM approval - A too prescriptive target or regulation could exclude technologies that may develop in the future - Sub-targets could be included, e.g. '25% by 2050 of total SAF production from PtL'
<p>Non-DfT levers</p> <ul style="list-style-type: none"> - Hydrogen, BECCS, DAC, CO₂ abatement policies and incentives will influence the commercial feasibility of SAF - BECCS and SAF compete for same feedstocks: SAF should take priority - Environmental permitting and planning policies may need to be adapted to accommodate SAF plants - Point source capture of CO₂ is cheaper to use; additional incentives are required to capture from mobile sources
<p>Sustainability standards</p> <ul style="list-style-type: none"> - Policy should not necessarily develop new sustainability standards and should aim to be consistent nationally and internationally - For UK airlines, alignment with CORSIA would be helpful as they will be reporting against UK and EU ETS schemes at the same time - However, CORSIA has a carbon intensity threshold of 10% below the fossil fuel benchmark which is different to existing UK or EU regulations - Indirect land use change should be included in any reported GHG saving - An outcome-based set of sustainability metrics should be implemented, covering GHG intensity and sustainability criteria such as pollution or social impacts - Voluntary schemes such as RSB and ISCC will have a role

Commercialisation subgroup
Certainty and sustainability of feedstock supply <ul style="list-style-type: none"> - Reserving feedstock for aviation and unlocking waste from existing long-term contracts will help projects access feedstocks where there is competition with other sectors - Government should be working with local authorities to support the planning approval of SAF plants
Fuel offtake contracts <ul style="list-style-type: none"> - Government/MOD procurement of SAF should be encouraged - Offtake agreements between airlines and fuel producers are necessary but alone may not provide enough reassurance to investors that plants will be built
Price stability <ul style="list-style-type: none"> - The price of the certificates (either under the RTFO or under a separate SAF mandate) can change and a mandate alone may thus not guarantee price stability, which is required by private investors to provide funding for SAF plants - Many agreed CfDs, potentially funded by passengers, could be an option, although many also acknowledged the SAF industry may be too immature for CfDs and is very different from the offshore wind industry - Questions were raised on how CfDs could work in practice to support price stability when there are several ways and technologies to make SAF - CfDs alone will not make projects 'bankable' without feedstock security and offtaking agreements in place
Interactions between SAF mandate and RTFO <ul style="list-style-type: none"> - The existing RTFO policy should not be removed until a long-term replacement is implemented

Annex B: List of potentially eligible feedstocks

Waste-derived biofuels

Waste and processing residues

Material	Description
Bracken	Cut to reduce fire risk and/or invasiveness, and not deliberately grown for the purpose of biofuel production.
Brown grease	Brown grease is the grease that is removed from wastewater sent down a restaurant's sink drain. This is a waste.
Cashew nut shell liquid	Cashew nut shell liquid (CNSL) is a process residue. The material is squeezed from the shells of cashew nuts after the edible portion has been removed. There are other potential uses which may be affected by large scale use of CNSL for biofuel, therefore DfT will be keeping this decision under review.
Category 1 & 2 farmed salmon oil	The oil must be unsuitable for food/feed.
Crude glycerine	Crude glycerine is treated as a process residue on the basis that refined glycerine is a product.
Empty palm fruit bunches	Empty fruit bunches from palm are a process residue. The palm fruits are separated from the bunches at the palm oil mill; and the bunches can then receive further treatment to extract low grade oil residues.
Ethanol used in the cleaning / extraction of blood plasma	Contaminated bio ethanol used as a washing liquid that cannot be used for food, feed or subsequent pharmaceutical purposes and would otherwise be disposed of.

Ethanol used in the extraction of ingredients from medicinal plants	Contaminated bio ethanol used in the extraction of ingredients from medicinal plants that cannot be used for food, feed or subsequent pharmaceutical purposes and would otherwise be disposed of.
Food waste (unsuitable for animal feed)	Whether from manufacturers, retailers or consumers, this will be a waste. This may include food that is: i) out of date (food that has exceeded its shelf life) ii) out of specification (food that fails to meet the required end of use specification). As with all wastes, this material must be unsuitable for other non-energy uses. Examples include beer residue, coffee pulp and protamylasse ('potato juice').
Grape marc and wine lees	Grape marc and wine lees are processing residues from the wine making industry.
Manure	Manure is treated as a waste/residue in the GHG calculations.
Municipal grass cuttings	Grass cuttings collected from municipal sites such as sports grounds or roadside verges, where animal feed is not a possible end use, due to contamination and/or site location.
Organic municipal solid waste (MSW)	This is a waste. Only the biomass portion of MSW counts as a renewable fuel.
Pot ale	Liquid remaining after the distillation of grain in the manufacture of whisky.
Poultry feather acid oil	This is the oil extracted from poultry feathers after acid treatment to remove edible protein. This material is a waste if it can be demonstrated that there are no other non-energy uses for the material. Suppliers must also comply with relevant animal by-product regulations.
Rapeseed residue	Rapeseed distillation residue from the oleo-chemical industry, exceeding 50% erucic acid.
Renewable component of end-of-life tyres	Tyres are manufactured from a mixture of non-renewable petroleum products and natural rubber. Suppliers of fuel made from end-of-life tyres will need to have a Fuel Measurement and Sampling (FMS) regime in place. They will need to demonstrate how they have apportioned the renewability of the material to the different co-products from their process. End-of-life tyres are a waste.
Sewage sludge	Sewage sludge is a remainder of the waste water treatment process. This material is a waste.
Sewage system FOG	Fats, oils and grease ("FOG") are materials extracted from sewers and waste water treatment works, and are often referred to as "fatbergs". This material is a waste.

Soapstock acid oil contaminated with sulphur	Refiners of vegetable or animal oils who use chemical extraction processes to refine their oils will produce acid oils from the neutralisation of the soapstocks. These acid oils may contain residues of either sulphuric or phosphoric acid (in the form of excess acid or the resulting salt). The presence of the contaminants means that this material is unsuitable for other uses (for example, animal feed), and it is therefore a waste. Suppliers of fuel made from this material should be able to demonstrate that the material was produced by a refiner who used these methods of extraction, and may be asked to produce evidence that it was unfit for consumption.
Spent bleaching earth	Bleaching earth is used to bleach oil as part of the production process. Oil extracted from spent bleaching earth is included in this category. Note that the GHG calculation must include the extraction of the oil from the spent bleaching earth.
Sugar beet betaine residue	High colour (>20,000 ICUMSA) residual extract following the recovery of betaine through chromatography separation of sugar beet molasses. The extract must contain <0.1% betaine and be unsuitable for animal feed.
Sugar beet tops, tails, chips and process water	Residual streams from the processing of sugar beet that have no other economically viable end uses. Note: This material does not include the 'crown' of the sugar beet, which is not eligible for double counting.
Tall oil pitch	The residue from the distillation of tall oil.
Tallow (processed animal fats) category 1	Category 1 tallow is processed animal fat produced in the meat rendering process. It has a significant economic value but its legally permissible end uses are, at present, generally limited to energy generation.
Used cooking oil (UCO)	Commonly called 'UCO' or 'WCO' (waste cooking oil), this is purified oils and fats of plant and animal origin. These have been used by restaurants, catering facilities and kitchens to cook food for human consumption. They are wastes as they are no longer fit for that purpose and are subsequently used as either feedstock for the production of biodiesel as fuel for automotive vehicles and heating or as a direct fuel.
Waste pressings from production of vegetable oils	When a vegetable material such as olives is pressed to produce vegetable oil, the pressed material consisting of pips, skins, flesh etc. remains. This may be used as a fuel. The purpose of the process is to produce oil; the pressings are therefore wastes. An example would include spent husk oil. As with all other materials on this list, the material must be unsuitable for other non-energy applications, including animal feed.
Waste slurry from the distillation of grain mixtures	A mixture of grain residuals and water arising from a wet milling ethanol process, after a solid / liquid separation step. Grains used in this process are mixtures of wheat, rye, triticale, barley, oats and corn. The dry matter

content of the material must not exceed 15%. Total suspended particles larger than 5 microns in diameter must not exceed 10%.

Waste starch slurry	A mixture of starch and water arising from the wet milling of wheat or corn. The dry matter content of the material must not exceed 20%. Total suspended solid particles larger than 5 microns in diameter must not exceed 10%.
Waste wood	The treatment of waste wood in the RED GHG calculations makes clear it is to be treated as a waste/residue. Processors of this material need to be clear on the differences between waste wood and forestry residues.

Agricultural residues

Material	Description
Arboricultural residues	Arboricultural residues meet the same criteria as forestry residues.
Bagasse	Bagasse results from crushing sugarcane or sorghum.
Cobs	Cobs cleaned of kernels are treated as agricultural residue.
Forestry residues	Biomass fraction of wastes and residues from forestry and forest-based industries, namely, bark, branches, precommercial thinnings, leaves, needles, tree tops, saw dust, cutter shavings, black liquor, brown liquor, fibre sludge, lignin and tall oil.
Husks	Processors of this material need to be clear on the differences between forestry residues and waste wood.
Nut shells	Nut shells are a waste product of the food industry and rich in lignin.
Straw	Straw is an agricultural crop residue.

Renewable fuels of non-biological origin

Material	Description
Carbon dioxide	Carbon dioxide can be from either fossil or biological origin. To be a qualifying feedstock for a RFNBO, the carbon dioxide must be an existing source that has not been deliberately created in order to make the fuel.
Water	Water is a feedstock for RFNBOs as it contains no available energy.

Recycled Carbon Fuels

Material	Description
Refuse derived fuel	The fossil component of refuse derived fuel from the mechanical treatment of municipal solid waste streams, which would be inherently mixed with biological material.
Industrial waste gases	Industrial waste process gases containing carbon monoxide, that are only suitable for incineration for energy recovery.

Annex C: Summary of consultation questions

For each of the following questions, please set out the reasons for your answers, including the impacts of any alternative that you may propose and any anticipated implications. Please also provide any supporting evidence you may have.

A greenhouse gas emissions scheme to reduce the carbon intensity of jet fuel

1. Do you agree or disagree that a SAF mandate should be introduced in the UK?
2. Do you agree or disagree that an obligation to supply SAF in the UK should sit outside the RTFO?
3. Do you agree or disagree that a GHG emissions scheme based on tradable credits should be preferable to a fuel volume scheme when designing a SAF mandate?
4. Do you agree or disagree that the proposed SAF mandate obligation should be placed on fuel suppliers that supply aviation fuel (avtur) to the UK?
5. Should the obligation apply to all avtur supplied into the UK, regardless of whether this is subject to fuel duty or not?
6. If the obligation applies to all avtur supplied into the UK, should there be a threshold below which fuel is not obligated, in a certain obligated period? Should this threshold distinguish between dutiable and non-dutiable fuel?
7. Where do you think the assessment point should be placed for jet fuel not subject to fuel duty, and how is this going to affect the definition of the proposed obligated party (aviation fuel suppliers to the UK)?

Fuel eligibility and sustainability criteria

8. Do you agree or disagree that only certified SAF that meets the DEF STAN 91-091 specification should be eligible under the proposed SAF mandate?

9. Do you agree or disagree with the sustainability criteria set out here? If you do not agree, what alternative or additional criteria would you recommend?
10. Do you agree or disagree with the feedstocks set out here and listed in Annex B? If you do not agree, what alternative or additional feedstock(s) would you recommend?
11. Do you agree or disagree that the baseline lifecycle carbon intensity for aviation fuels for reporting purposes under a UK SAF mandate should be 89 gCO₂e/MJ? If you do not agree, what should the baseline emission be and/or how should it be calculated?
12. What should the minimum carbon intensity reduction SAF will need to meet be (subject to the final GHG methodology used)?
13. Are there any land use (direct or indirect) or other implications associated with the feedstocks set out earlier that we should reflect in the eligibility criteria and minimum GHG threshold?
14. As more CCUS becomes available and the carbon intensity of fuels can decrease further, should the envisaged minimum carbon emissions intensity threshold be raised up over time?
15. What GHG methodology should be used to calculate the carbon intensity of fuel?
16. How should the GHG methodology vary to take into consideration the different fuels, feedstocks, power sources and production pathways?
17. Do you agree or disagree that SAF that does not meet the proposed eligibility and sustainability criteria should incur an obligation?

Overarching trajectory

18. Do you agree or disagree that a SAF mandate should start in 2025?
19. Do you agree or disagree that the targets should assume a linear growth up to 2035 and an exponential growth after 2035?
20. What scenario do you think represents the best trade-off between ambition and deliverability? What evidence can you provide to support your position?
21. Do you agree or disagree that we should include review points in 2030 and 2040, depending on initial mandate levels?
22. Should the amount of HEFA that can be claimed under the SAF mandate be capped over time? If this is the case, how could the cap work in practice, given the scheme will be based on carbon emissions savings? How should the cap be calculated?
23. How can power-to-liquid fuels innovation and roll-out be accelerated? Should a sub-target and/or a multiplier be introduced?

24. How can SAF produced through pathways other than HEFA and power-to-liquid be accelerated?

Interactions with other domestic and international policy

25. Do you agree or disagree that SAF GHG emissions reductions should be claimed only once under different schemes?

26. How could the UK ETS, CORSIA and proposed SAF mandate be used together to continue to incentivise uptake, while preventing double counting of emissions reductions?

27. Do you agree or disagree that SAF that has been produced on the back of industrial plants or clusters which have received competition funding from government can be claimed under the proposed UK SAF mandate?

28. Do you agree or disagree that SAF should no longer be rewarded under the RTFO when and if a SAF mandate is in place?

29. What provisions should the UK SAF mandate include to reduce the risk of tankering even further?

Delivering SAF to the market

30. Do you consider a more comprehensive policy framework beyond a SAF mandate is required to build a successful UK SAF sector?

31. If you believe this is the case, how can this policy framework be designed? Please provide any evidence you may have available to support your answers.

32. Should buy-out be allowed? If so, how should the buy-out price be set to encourage actual supply of SAF and delivery of carbon savings? How should the buy-out evolve over time?

33. What penalties should be introduced in addition/alternatively to a buy-out to ensure sustainable SAF, that meets the proposed criteria, is supplied?

Scheme practicalities, reporting and verification

34. Do you agree or disagree that a mass balance approach should be the only chain of custody system permitted under the proposed SAF mandate?

35. Where do you think the chain of custody will need to end? Please refer to any evidence to support your position.

36. Do you agree or disagree that obligated suppliers will need to report annually information on the aviation fuel supplied to the Department for Transport, regardless of whether they claim SAF credits?

37. Do you have views on what information obligated fuel suppliers should report?

38. Do you have views on the reporting calendar?
39. Do you have views on what the timescale for submitting claims and the information/evidence required by this process should be?
40. Should certification provided by voluntary schemes count as evidence of compliance with the sustainability criteria of the SAF mandate? If so, do you think this step should or should not be mandatory?
41. What information should the obligated party provide, either through verifiers or other means, to demonstrate compliance with the sustainability criteria?
42. Do you agree or disagree that claims for credits under the SAF mandate should be verified? If so, should these be verified to a 'limited' or 'reasonable' assurance?
43. What data related to the SAF mandate should DfT make publicly available? How often should this information be published?