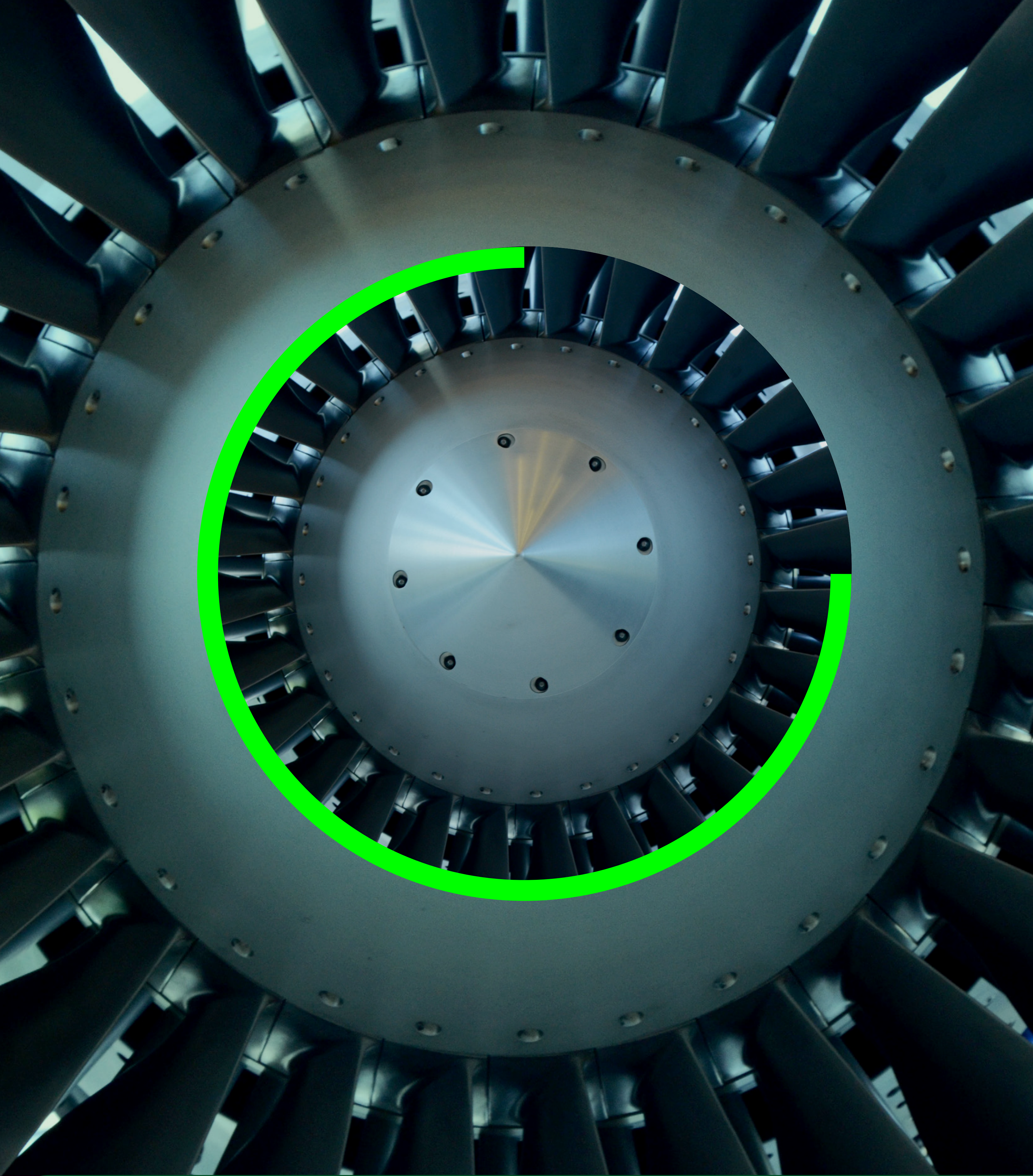


Sustainable Aviation Fuel

Research & Development Priorities to Support a UK Sustainable Aviation Fuel Industry

Why Industry needs Sustainable Aviation Fuel (SAF)

The UK's aviation and aerospace sector contributes over £50 billion to the UK Exchequer.[1,2] The connectivity of the UK via an efficient and sustainable air transport sector is vital to maintain trade and economic growth.

The UK's own fuel resilience is of strategic importance. The UK imports 70% of aviation turbine fuel[3]; we now have an opportunity to invest in indigenous production of sustainable alternatives to ensure fuel resilience and significant import substitution.

In 2009 the aviation industry committed to a number of climate targets, including a cap on net aviation CO2 emissions (carbon-neutral growth) and a reduction in net aviation CO2 emissions of 50% by 2050, relative to 2005 levels.[4]

The UN Body for aviation – the International Civil Aviation Organisation (ICAO) – identified a suite of measures to deliver a global commitment to achieve carbon neutral growth from 2020.

The measures include aircraft efficiencies and the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)[5], a global market-based measure designed to offset international aviation CO2 emissions. Of significance is the growing potential for sustainable fuels (see Figure 1 on page 2). There is now an urgent need to meet the growing demand from airlines for SAF and develop the UK industry.

1. Aviation 2050: the future of UK aviation. A consultation. December 2018.
2. The aerospace industry: statistics and policy. House of Commons Library. Briefing Paper, No. 00928, 8 November 2017.
3. Review of the refining and fuel import sectors in the UK. Department of Energy and Climate Change. 2014.
4. www.iata.org/policy/environment/pages/climate-change.aspx
5. www.icao.int/environmental-protection/CORSIA/Pages/default.aspx

The Department for Transport released new regulations in 2018 to double the use of sustainable renewable fuels by 2020 through the Renewable Transport Fuel Obligation (RTFO). For the first time, the RTFO included aviation fuels to help stimulate the industry in the UK.[6]

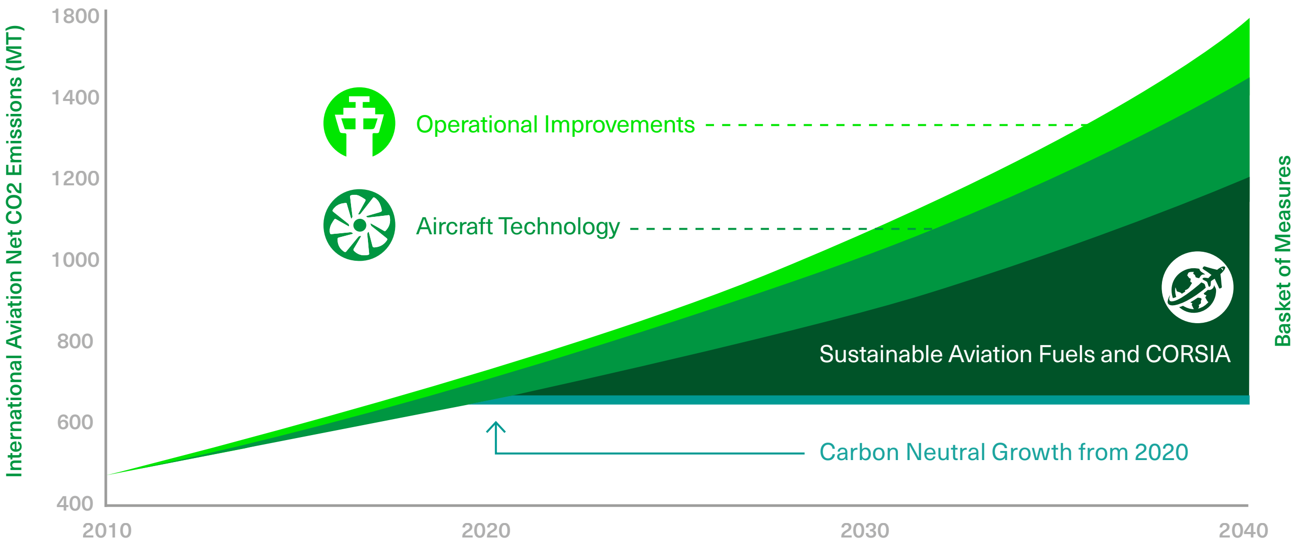
This document is intended to help inform a range of stakeholders across industry, academia and government to help de-risk and expedite the market entry of emerging and new fuels plus support the offtake of SAF on military platforms.

Four themes were identified by the SAF Working Group (KTN, Sustainable Aviation, Department for Transport and Innovate UK):

- Feedstock & Sustainability
- Process & Economics
- Infrastructure
- Technical Specification

Figure 1

Contribution of Measures for Reducing International Aviation Net CO_2 Emissions:



6. www.gov.uk/government/news/new-regulations-to-double-the-use-of-sustainable-renewable-fuels-by-2020

Fig 1. The International Civil Aviation Organisation's (ICAO) suite of measures to deliver a global commitment to achieve carbon neutral growth from 2020
Source: www.icao.int/environmental-protection/Documents/CorsiaBrochure_8Panels-ENG-Web.pdf

1. Feedstock & Sustainability

There are significant gaps in research on feedstock production pathways that may offer efficiency improvements and environmental benefits including minimising land use impacts (both direct and indirect).

- Identifying sustainable feedstock production opportunities that require minimal inputs, are able to tolerate environmental stress whilst minimising environmental impacts (e.g. invasiveness, erosion, displacement effects) plus indirect and direct land use change.
- Identifying availability and suitability of various wastes and residues in the UK and to determine any indirect impacts associated with the diversion of these to SAF production.
- Supply chain optimisation to reduce cost, technology uncertainty and risk, increase yield, and optimise precursors.
- Identifying marginal and contaminated land.
- Pre-treatment of feedstock, e.g. densification and handling of municipal solid waste (MSW).
- Development of sustainability assessment methods in parallel with advances in feedstock development, e.g. for algal production, microbial, cyanobacteria and waste gas technologies.
- Regional availability of feedstocks: MSW, forest/mill residuals, oil crops, and waste industrial gases.
- To increase crop and microbial yield whilst considering: co-production systems, water and nutrient use efficiency, pest and disease resistance.
- Understand the total energy consumption along the supply chain (e.g. from production to transportation) for different feedstock and technology pathways relative to conventional hydrocarbon production.
- Identify energy recovery and re-use (e.g. heat or by-products) opportunities in production processes to improve overall efficiency and environmental impact.

2. Process & Economics

R&D efforts should focus on increasing efficiency and lowering cost of production for biochemical, thermochemical, and hybrid technologies.

- Developing new technology pathways to improve and enhance existing and new technologies with scalability.
- Developing conversion technologies that can produce SAF from multiple feedstocks.
- Techno- and socio- economic assessments of SAF production within a biorefinery.
- Repurposing of existing biorefineries for SAF production.
- Flexible technology development (e.g. can provide renewable electricity, chemicals, biofuel in addition to SAF).
- Accessing scale-up facilities to de-risk new pathways.
- Innovative gas clean-up and deoxygenation technologies. Techno-economic analysis on different UK feedstocks. Region(s) likely to benefit most from producing or consuming SAF (due to the economic, social, and environmental characteristics of sustainable fuel).
- Understanding the environmental (or other) benefits of SAF including monetising the benefits to generate a quantifiable value.
- Life cycle greenhouse gas assessments for novel production pathways.
- Understanding the potential to combine Carbon Capture and Storage alongside SAF refining to deliver fuels with negative carbon emissions.
- Developing international trade opportunities and identifying novel technologies which can be exploited outside the UK.

3. Infrastructure

It is critical to ensure the UK has the infrastructure in place to support the blending, storage and logistics of new fuels whilst maintaining fuel integrity.

- **Transportation and delivery of fuel from production point to point of use (e.g. including production plant to airport or blending facility, traceability, mode of transport, refinery to terminal, storage).**
- **Mapping existing UK jet fuel production infrastructure.**
- **Quality control methods for jet fuel from storage facility to the aircraft.**
- **Identify factors which may cause separation of blended fuels (e.g. longterm storage, temperature, pressure, magnetic field).**
- **Identify efficient fuel supply network entry points (logistics modes) based on SAF production locations and volumes.**

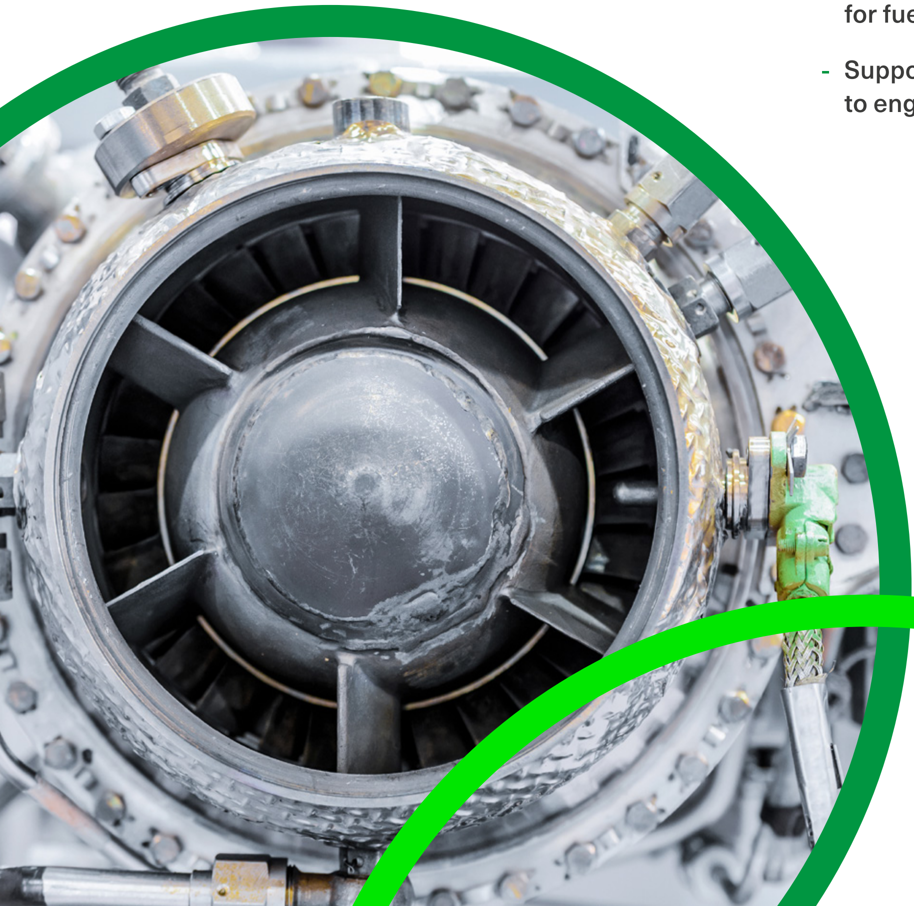
Technical Specification

The UK has considerable strengths in the testing of new, novel aviation fuels with expertise within UK universities and manufacturing, with both Airbus and Rolls Royce having fuel teams in the UK.

However, there is an urgent need to support additional resources and capacity within the UK to co-ordinate and support international fuel testing and evaluation activities. Fuel testing represents a major barrier to entry for new technologies.

This support should include facilitating the approval of new SAF pathways by delivering efficiencies in evaluation of fuel and engine performance and its safety through the certification and qualification process (ASTM D4054 and DEF STAN 91-091).

- **Support and co-ordinate with other international fuel testing and evaluation programmes to facilitate qualification of technologies of strategic importance to the UK.**
- **Facilitate testing of combustion emissions and ascertain the emission profiles and air quality benefits.**
- **Enable the evaluation of fuel and engine system performance and the impact on gas turbine performance and operability.**
- **Facilitate civil and military co-operation with respect to the testing and approval of SAF through the UK DEF STAN 91-091 standard.**
- **Establish a mechanism to enable partnerships between OEMs, airlines, oil companies, airports, universities and SMEs to stimulate innovation and expedite market entry of new jet fuels.**
- **Increase UK capability and strengthen academic expertise in jet fuel specification and performance testing.**
- **Developing new methods in materials testing for fuel systems.**
- **Support for a range of TRL: from the laboratory to engine and emissions testing.**



SUSTAINABLE AVIATION

Sustainable Aviation (SA) is a long term strategy which sets out the collective approach of UK aviation to tackling the challenge of ensuring a cleaner, quieter, smarter future for our industry. SA members wish to work collaboratively with UK universities, policy makers and fuel companies to help to create a new sustainable fuels sector. SA is committed to the highest standards of sustainability with SA members prioritising the use of waste and residue feedstocks.

SA supports the work of the Roundtable of Sustainable Biomaterials (www.rsb.org) which has been recognized as the most robust sustainability certification standard for fuels. Sustainable Aviation produces a number of studies to outline the climate impact of UK aviation and the take up of aviation fuels over the period to 2050, which are published in a series of road-maps.

For further information:

www.sustainableaviation.co.uk/goals/climate-change

Connecting for Positive Change

The Knowledge Transfer Network (KTN) helps businesses get the best out of creativity, ideas and the latest discoveries, to strengthen the UK economy and improve people's lives.

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Connecting with KTN can lead you to potential partners, horizon-expanding events, bespoke support and innovation insights relevant to your needs.

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