Jet Zero Investment Flightpath

July 2022

UK leading the charge to Jet Zero

“The UK is ideally positioned to lead the global development and deployment of low and zero emission technologies to decarbonise the aviation sector. We are working at speed to develop greener aircraft, produce and use more sustainable fuels, and make our airspace and airports more efficient.”

Rt Hon Grant Shapps MP – Secretary of State for Transport

The UK was the first major economy to set a legally binding net zero target. In July 2021, our Transport Decarbonisation Plan set out our plans to decarbonise the transport sector; in October 2021, the Net Zero Strategy set out our economy-wide plan to achieve Net Zero by 2050.

The Government recognises the challenge of decarbonising the aviation sector and the Jet Zero Strategy sets out a clear framework for how net zero aviation (Jet Zero) can be achieved - securing a more sustainable future for our climate and our aviation industry while boosting UK economic opportunities.

We are already accelerating the development of ultra-efficient and zero-carbon aircraft technologies, and have recently committed to investing a record £685m in aerospace R&D over the next three years.

The use of sustainable aviation fuels (SAF) will be key to achieving our targets and we have committed £165m of funding to support the development of UK SAF plants with a commitment to have at least five commercial-scale UK SAF plants under construction by 2025 – all helping to deliver our target of at least 10% SAF blended into the jet fuel mix by 2030.

The UK has one of the world's most attractive business environments

A bespoke **SAF mandate** under development to promote SAF supply in the UK

£34bn UK aerospace exports in 2019, estimated 13% global market share

Handles over 2 million commercial flights annually

A world-leading target of at least **10% SAF** blended in the UK jet fuel mix by 2030

International leadership at ICAO to promote high sustainability standards and government collaboration

1st in Europe for most attractive renewable investment opportunities

2,430 aerospace companies providing over 254,000 jobs

2nd in G20 for 'ease of doing business'

Potential **£1.7bn** GVA from SAF per annum by 2040

4th in the global innovation index

- Stable regulatory market
- The UK-EU Trade Cooperation Agreement post EU Exit allows zero tariff market access with the EU and further UK Free Trade Agreements enable exports to the rest of the world (currently 70 plus EU) with preferential arrangements
- Most business-friendly employment laws in Europe
- Generous R&D and patent tax reliefs
- Significant commercial advantage from leveraging UK's legal system and language
- World leader in the research and innovation of new technologies, making the UK an ideal location for sustainable air mobility investment with huge growth potential for UK suppliers of all sizes
- The UK is an influential member of the International Civil Aviation Organization (ICAO) co-ordinating global efforts and providing direct support to other states in tackling international aviation emissions
- The UK hosts the Farnborough International Airshow – the global platform for aerospace and defence industries
- The UK CAA has an Innovation Hub to help innovators maximise regulatory readiness for the demonstration of aviation systems

Why invest in UK Jet Zero?

Opportunities in an advanced and growing sector:

£1bn+

Aerospace R&D co-investment with industry over next 3 years

At least **five** commercial-scale UK SAF plants under construction by 2025

£200m

Government funding to accelerate development of SAF plants in the UK

At least **10% SAF**

blended in UK aviation fuel mix by 2030 through a SAF mandate

£300m

Future Flight Challenge to support the future aviation system

Aviation Futures

Dedicated regulatory think tank

- **Largest and most liberal aviation network in Europe and third largest globally**: pre-COVID, the UK handled over two million commercial flights annually, to over 370 direct destinations in over 100 countries
- **World-leading Aerospace sector:** home to large companies such as Airbus, Rolls-Royce, and GKN, and innovative new entrants like ZeroAvia
- **Responsive Regulator: we maintain close working relationships with t**he Civil Aviation Authority (CAA) to ensure that the sector remains at the forefront of innovation. The CAA also offers various “sand boxes” to develop regulation for new technology
- **Leading Export Credit Agency**: UK Export Finance (UKEF) recognised as world leading ECA for Sustainable Deals in 2021-22, and has provided nearly £9bn of support for aerospace exports and exporters in the last two years

Our approach to Jet Zero

We will achieve Jet Zero by having **a clear goal** and delivering through **multiple solutions,** with **three principles** which underpin our approach: **international leadership; delivery in partnership** and **maximising opportunities. Jet Zero** will need to be achieved through a combination of measures which include: **system efficiencies; SAF; zero emission flight (ZEF); markets and removals; and influencing consumers**. The first three focus on maximising emissions reductions through different technological and operational approaches and offer rewarding investment opportunities in major growth markets.

There are also potential investment opportunities in the development of offsetting and greenhouse gas removal technologies, including nature-based measures, but these will be deployed more widely than for aviation alone and therefore are not covered in this flightpath.

System efficiencies

- We will be maximising and making efficient use of our existing airspace, aircraft and airports
- Moving to best-in-class aircraft operations and airspace modernisation could deliver up to **15% of CO_2 savings by 2050**
- In 2019, UK CO_2 emissions per passenger **were 22% lower** than in 1990 due to efficiency improvements

Sustainable Aviation Fuels

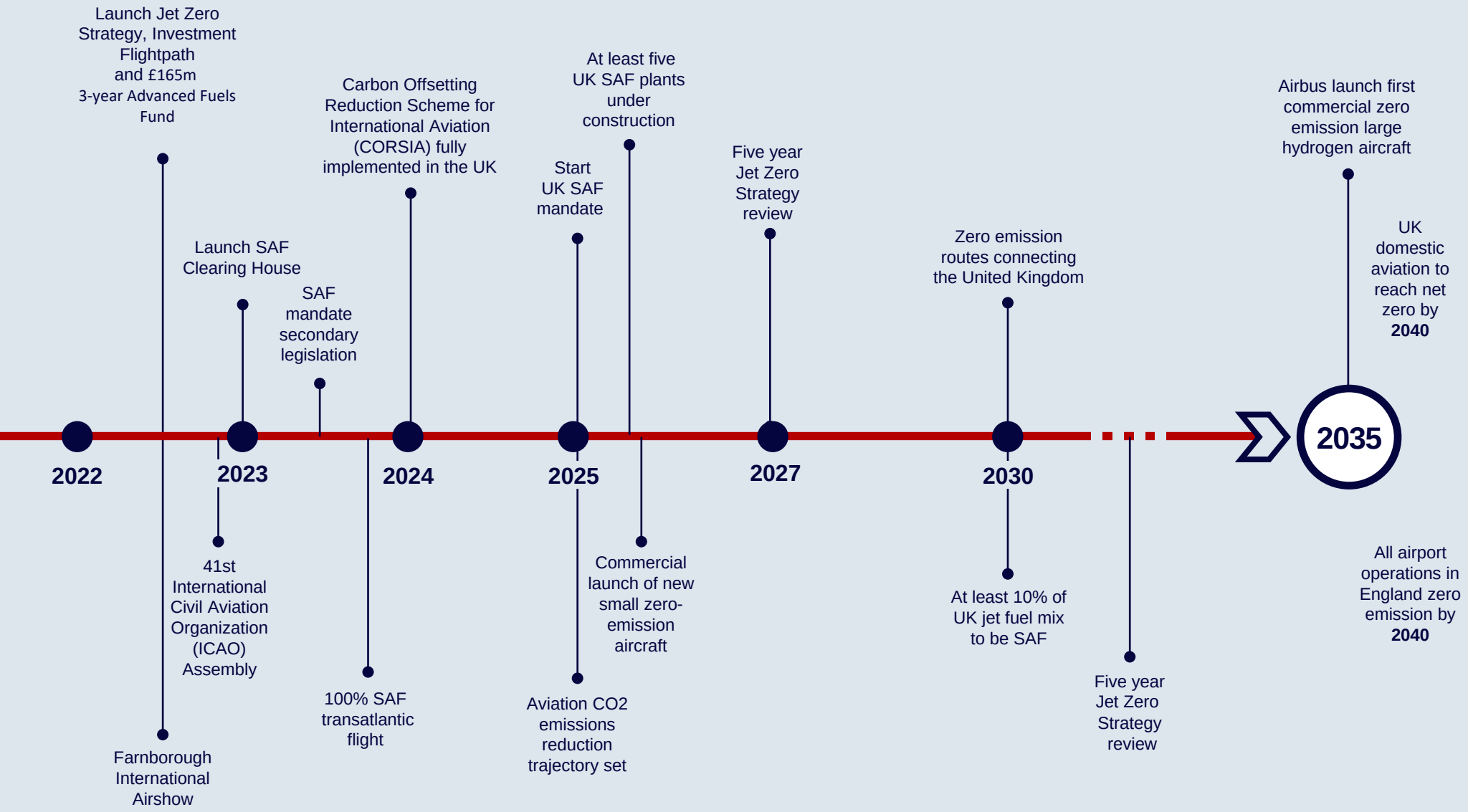
- We will increase SAF uptake, with a target of **at least 10% SAF** blended in the UK jet fuel mix by 2030 through a SAF mandate
- We will kick start private investment into the UK SAF industry through funding, with a commitment to have **at least five UK SAF plants under construction by 2025**
- We will establish world class testing and certifying facilities for SAF, with **£12m** committed over the next three years

Zero emission flight

- We will **grow the UK's market share** in aerospace manufacturing as new aircraft emerge
- We will put in place the policy and regulatory system to **enable zero emission aircraft to enter commercial service**
- We will ensure parallel development of aircraft with the energy and ground infrastructure required for their operation

Our 2035 delivery plan

Critical activities and milestones on a path to developing the UK Jet Zero sector



Key milestones:

- At least five commercial SAF plants under construction in the UK by 2025
- Setting an emission reduction trajectory for aviation from 2025
- At least 10% SAF in the UK fuel mix by 2030
- Zero emission routes connecting all parts of the UK by 2030
- 10GW annual hydrogen production target by 2030
- UK domestic aviation to reach net zero by 2040
- All airport operations in England to be zero emission by 2040

Government and industry working together

Achieving Jet Zero requires all of the sector to work together to develop, test and implement solutions

	What we are delivering	What we look to industry to deliver
Policy	■ Jet Zero Strategy: our framework for decarbonising aviation to achieve net zero aviation by 2050	■ Deliver on our Jet Zero vision through the adoption of new technologies
Systems Efficiencies	■ Increasing the carbon efficiency of our aviation system through funding and policy support, working towards all airport operations in England being zero emission by 2040. Supporting ultra-efficient aircraft development through R&D co-investment	■ Develop and commercialise ultra-efficient aircraft technology in the UK, implement the Airspace Modernisation Programme, and decarbonise airports
Sustainable Aviation Fuels	■ Committing to a UK SAF industry and at least 10% SAF by 2030, driven by a SAF mandate, over £200m capital funding, 100% SAF transatlantic flight competition and a commitment to have at least five commercial SAF plants under construction by 2025	■ Drive progress on SAF commercialisation through take up of capital and further investment in the technologies and feedstocks required to build a thriving UK industry
Zero Emission Flight	■ Supporting the development of new zero-carbon aircraft and infrastructure through the ZEF Delivery Group (DG) and R&D co-investment	■ Develop and commercialise zero carbon aircraft technology in the UK, alongside airport and airfield infrastructure for hydrogen and electric aviation. Grow industry base via infrastructure projects such as the Airbus Zero Emission Development Centre
Markets and Removals	■ Creating successful carbon markets and continuing to invest in the development of GGR technology	■ Make progress on removal and offset activity through CCUS development and engagement with UK ETS and CORSIA
Influencing Consumers	■ Supporting consumers to make sustainable aviation travel choices and working with the CAA later this year to launch a Call for Evidence on environmental information provision	■ Provide standardised information to consumers so they can make informed decisions on aviation travel options
International	■ Leading global efforts to tackle aviation emissions, including through the ICAO	■ Support international collaboration and coalitions as well as UK negotiations and ambitions

Progress highlights:

- In 2020, ZeroAvia completed the world's first hydrogen-powered flight of a commercial grade aircraft
- In 2021, Rolls-Royce broke the World Electric Air Speed record
- Airbus announced plans to bring a large commercial zero-emission aircraft into service by 2035 with ground testing planned for 2023 and flight testing starting in 2026
- British Airways recently began using UK-produced SAF supplied by Philips 66
- IAG will invest $400m over the next 20 years to develop SAF and Virgin Atlantic is targeting 10% SAF use across its fleet by 2030
- Eight UK airports currently hold the Airports Council International Europe Carbon Neutral Accreditation or above
- Extended coverage of aviation activities in UK Green Taxonomy due to be consulted on this year by government

Jet Zero Council

- The Jet Zero Council (JZC) **brings together government, industry and academia** to drive the ambitious delivery of new technologies with the aim of delivering at least 10% SAF in the UK fuel mix by 2030 and zero-emission transatlantic flight within a generation.
- Its objective is to **provide ministerial and senior industry leadership** on efforts to develop and deliver UK capabilities for achieving net zero aviation, to identify the benefits of developing these new industries in the UK, find solutions to overcome barriers faced by industry and opportunities to drive down production costs.
- It will support the development and industrialisation of **zero emission aviation technologies**, the **establishment of SAF**, and a co-ordinated approach to the **policy and regulatory framework** needed to deliver net zero aviation by 2050.
- It has established **two delivery groups** to focus on two key priorities**: Sustainable Aviation Fuels** and **Zero Emission Flight**.
- **Complements existing industry partnerships and initiatives**:
  - Sustainable Aviation
  - Civil Aviation Authority
  - Aerospace Growth Partnership (AGP)
  - Aerospace Technology Institute (ATI)
  - Airspace Change Organising Group (ACOG)

System efficiencies

Quicker, quieter and cleaner journeys

All English airports to be zero emission by 2040, meaning around **60 airports will need to transition. Huge aerospace opportunity, with 39,000 new aircraft** to be built over the next **20 years, worth nearly $3tn.**

What we have done

- As co-sponsors, DfT and the CAA approved ACOG's UK **Airspace Change** Masterplan Iteration 2, that identifies the most beneficial direction for airspace change to take
- We have provided £5.5m of funding to support the **Airspace Modernisation** Programme and enabled sponsors to complete Stage 2 of the airspace change process
- We have supported the aviation workforce to address long term skills shortages and attract the next generation of aviators

What we are doing

- Providing an additional £3.7m of funding to support the **Airspace Modernisation** Programme and enable sponsors to complete Stage 2 of the airspace change process
- Committed £685m (over £1 billion with industry match) over the next three years to **support industrial R&D through the ATI Programme**
- Working towards all airport operations in England to be **zero emission by 2040**

What we have committed to

- Working through ICAO to ensure stringent international **standards for aircraft emissions**
- Ensuring the aviation system has the right policy framework to deliver maximum **operational efficiencies**

System efficiencies case study: Bristol Airport

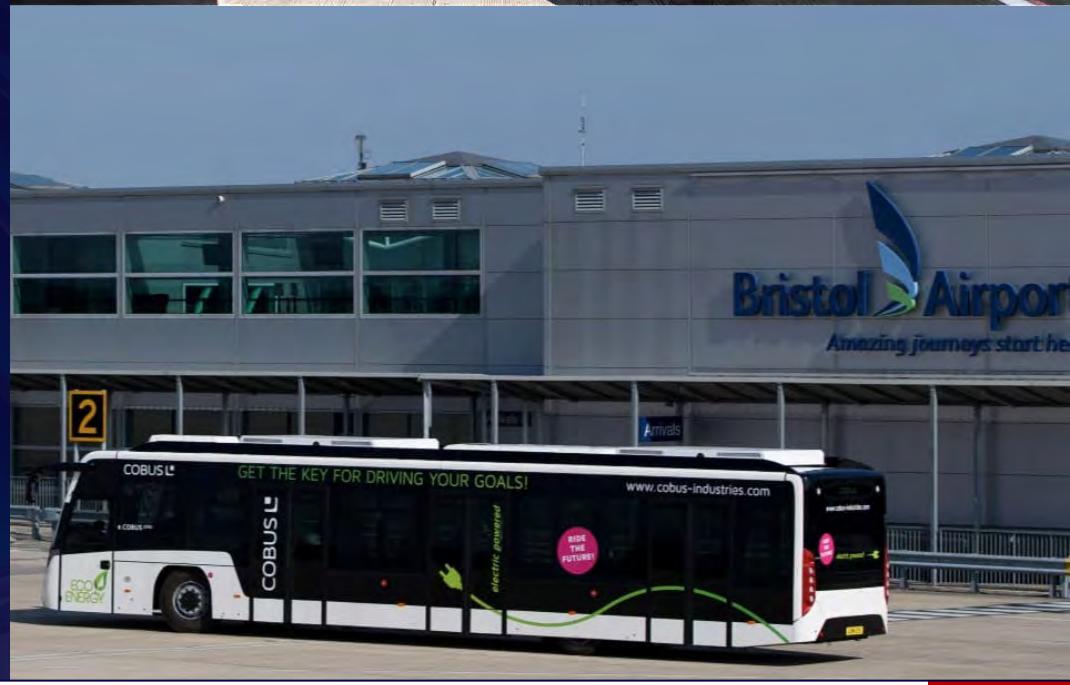
Bristol Airport has set a target of net zero operations by 2030 and net zero for all emissions by 2050.

The Airport was accredited as achieving carbon neutral operations at the end of 2021, five years ahead of the target that Bristol Airport had set. In recent years, the airport has reduced its operational emissions by including installing on-site renewables, greater energy efficiency, introducing electric vehicles, and buying 100% renewable energy through the grid.

As part of efforts to achieve net zero operations by 2030, Bristol Airport has formed a sustainability partnership with easyJet to run a series of initiatives, including what is believed to be the world's most extensive ultra-low emissions aircraft turnaround trial. This trial used the latest electric-powered ground equipment and specialist vehicles, replacing traditional diesel-powered units.

Bristol Airport has created an annual £250,000 Airport Carbon Transition (ACT) Programme, which makes funding available to any company or organisation that brings forwards an innovative way to cut any source of emissions at Bristol Airport. The inaugural awards include exploring on-site carbon sequestration and tackling emissions from employee travel.

Bristol Airport are part of the Hydrogen South West initiative with others including Bristol Port, Easyjet and Airbus.



System efficiencies case study: ultra-efficient aircraft technology

Through the ATI Programme, HMG are co-investing with industry on next generation aircraft technologies. These will make a significant impact to the 2050 emissions trajectory and lead a UK-wide supply chain.

Rolls-Royce UltraFan

Rolls-Royce has developed UltraFan®, the world's largest aero-engine technology demonstrator, which provides a suite of technologies that will deliver a 25% efficiency improvement in fuel burn and significantly reduce NOx and noise.

Bringing these UltraFan technologies to market will safeguard high productivity jobs across the UK in Rolls-Royce and its supply chain and create export opportunities.

Airbus UK Wing of Tomorrow

Airbus is developing its Wing of Tomorrow in the UK - one of the largest R&T programmes in the Airbus Group - to provide next generation composite wings for future aircraft.

The Programme is developing more than 100 new technologies with a strong emphasis on industrial systems.

Sustainable aviation fuels

Establishing a market

We will have at least **five commercial SAF plants under construction in the UK by 2025.** Sustainable Aviation research suggests that a UK SAF industry could potentially support up to **5,200 UK jobs** from the production of SAF, and a Gross Value Added (GVA) of up to **£2.7bn from UK production and global exports by 2035** and we expect this to be even greater over the coming decades.

What we have done

- Confirmed a **SAF mandate** will be introduced in 2025, outside the Renewable Transport Fuel Obligation, to decrease the greenhouse gas intensity of the jet fuel supplied to the UK through SAF
- Funded eight projects from the **£15 million** Green Fuels, Green Skies grant funding competition, to support SAF plants in the UK
- Confirmed our target to see at least **10% SAF** blended in the UK jet fuel mix by 2030

What we are doing

- Second SAF mandate consultation due later this year to confirm specific targets, timescales and scheme design
- Committed **£165m funding** through the Advanced Fuels Fund to accelerate the commercialisation of SAF plants from 2022 to 2025
- Recently launched competition to achieve the **first ever transatlantic flight on commercial aircraft using 100% SAF** by the end of 2023
- Working across government to ensure prospective UK plants can access sufficient sustainable feedstocks

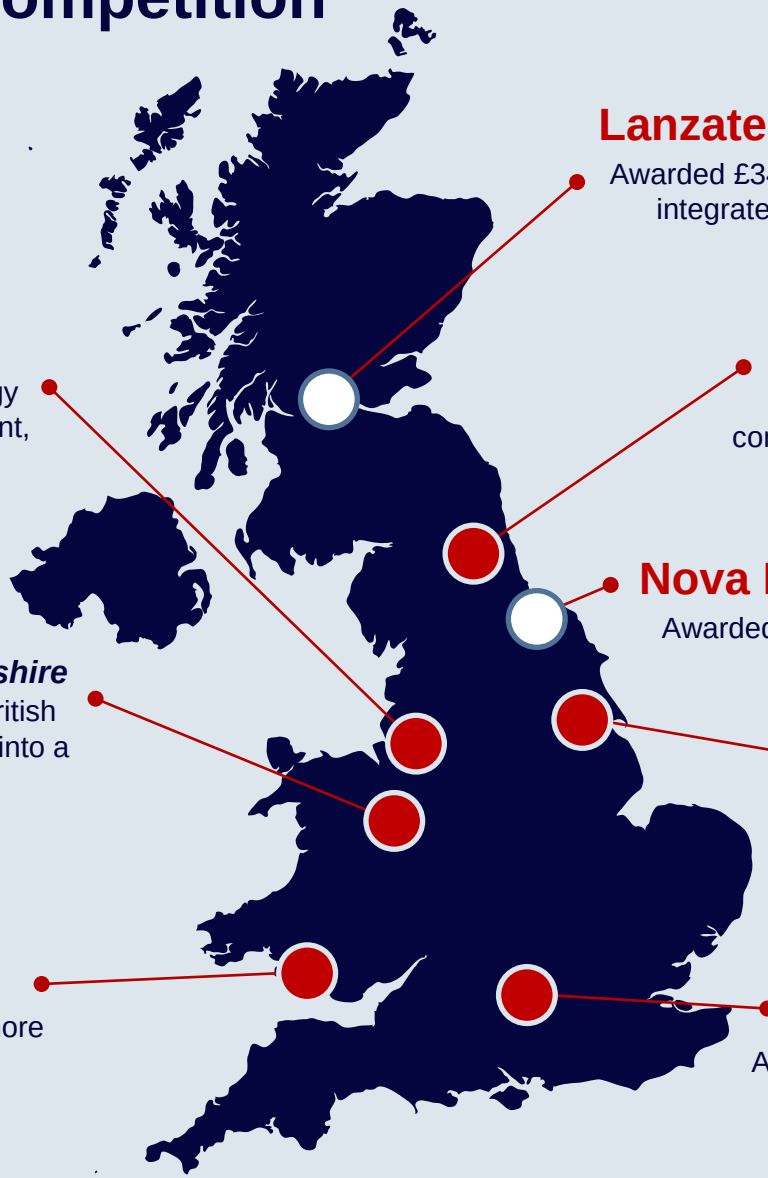
What we have committed to

- We are committed to building a **strong UK SAF industry** and are gathering key evidence to determine the further measures industry or government might take to achieve this. We want to reach a position on how to further stimulate investment in a UK SAF industry by the end of the year
- Establishing a **SAF clearing house,** the first of its kind in Europe, to enable the UK to test and certify new fuels
- Working in partnership with industry and investors, including through the JZC SAF DG, to accelerate UK SAF and enhance fuel security

SAF case study:
Green Fuels, Green Skies competition

Pre-FEED or FEED (Front End Engineering Design)

Feasibility study



Fulcrum *Ellesmere Port*

Awarded £1,372,957. Their project based at the Stanlow Manufacturing Complex will convert residual waste into approx. 100 million litres of SAF. The gasification technology has recently been demonstrated at their Sierra Biofuels Plant, producing high-quality syngas

Advanced Biofuel Solutions Ltd *Cheshire*

Awarded £2,054,000 to work with a British refinery and a British engineering company to build a facility that converts waste into a biocrude that can be upgraded to aviation fuel

Lanzatech UK Ltd *Port Talbot*

Awarded £3,152,619. Their proposed facility will produce more than 100 million litres of SAF annually, using ethanol from agricultural wastes and industry flue gases

Lanzatech and Carbon Engineering *Location TBC*

Awarded £340,674. Their proposed 100 million litre per year facility aims to integrate direct air capture with gas fermentation and then alcohol-to-jet technology to produce SAF

Alfanar Energy Ltd *Tees Valley*

Awarded £2,417,500. Their project, located in Tees Valley, will convert household and commercial waste into approx. 180 million litres of SAF and naphtha

Nova Pangaea Technologies (UK) *Location TBC*

Awarded £484,201. This project aims to build a 100 million litres a year facility that produces SAF from UK-sourced woody residues

Velocys *Immingham*

Awarded £2,381,000. Their facility will convert black bag waste into SAF

Green Fuels Research Ltd *Location TBC*

Awarded £1,940,255. Their project, which includes support from Petrofac and Cranfield University, aims to demonstrate and certify a SAF pathway utilising sewage sludge

Zero emission flight

Taking the lead on zero carbon solutions

FlyZero project estimated that zero emission aircraft could make up to **50% of the global fleet by 2050** and 29,200 aircraft deliveries could be worth between **$1.9 – $2.1tn**.

What we have done

- £15m Fly Zero project explored the design of **zero emission commercial aircraft** and the potential for liquid hydrogen fuel
- Completed the Zero Emission Flight Infrastructure (ZEFI) project, with **15 R&D projects receiving government funding** to support the development of the infrastructure required to aid electric and hydrogen aircraft

What we are doing

- Committed **£685m (over £1 billion with industry match)** over the next three years to support industrial R&D through the ATI Programme
- Established a **Zero Emission Flight Delivery Group** which will provide advice on how government and industry can work together and put the UK in a leading position in the race to achieve zero emission flight

What we have committed to

- Through the Jet Zero Council, targeting **zero emission transatlantic flight within a generation**
- Working with industry to grow the UK's share of the global aerospace market and implement regulations to allow **zero emission aircraft to enter commercial service**
- An ambition for **zero emission routes connecting all parts of the UK** by 2030

Zero Emission Flight case study: zero-carbon emission aircraft technology

Airbus has launched a Zero Emission Development Centre (ZEDC) for hydrogen technologies based in Bristol. This includes the development of a cost-competitive cryogenic fuel system required for the successful entry-into-service of Airbus' ZEROe passenger aircraft by 2035 and to accelerate UK skills and know-how on hydrogen technologies.

The ATI-led **FlyZero project**, funded by government, brought experts from across the UK to explore the potential for zero-carbon emission aircraft. It explored both commercial and technical feasibility and **found that green liquid hydrogen offers the greatest potential for powering future generations of zero emission aircraft**, including those capable of flying transatlantic.

ZeroAvia achieved the world's first hydrogen fuel-cell powered flight of a commercial grade aircraft. The flight also showcased a full zero emission ecosystem, with onsite hydrogen production via electrolysis. ZeroAvia secured further funding to scale up and demonstrate their powertrain on a 19 seater aircraft, shortly to be demonstrated in flight testing at Cotswold Airport.

Strengthening supply chains

Supporting supplier development and export capability

UK Aerospace exports, **worth £34 billion**, represent an estimated 13% of global market share. Domestic production of SAF could support up to **5,200 UK jobs by 2035**

What we have done

- UK Export Finance enhanced its support to attract investment into development of Jet Zero supply chains and export capability
- Launched the Jet Zero Council SAF and ZEF Delivery Groups to support developing industries
- **Supply Chains for the 21st Century** (SC21) and the **Sharing in Growth** (SIG) programmes have effectively helped UK supply chain companies stay competitive

What we are doing

- Working through the Aerospace Growth Partnership to deliver on the Net Zero Transition Plan
- The **Made Smarter** programme helps aerospace manufacturers use technology to becomes faster, more responsive and more efficient suppliers
- **Help to Grow** offers support to SMEs on improving management and better utilising digital technologies

What we have committed to

- Facilitating new opportunities overseas for the UK's net zero supply chains
- Supporting new, industry-led supplier development programme working with up to **100 suppliers per annum** over the next three years
- Deploying a targeted UK offer utilising the full suite of government finance and support to secure export opportunities

Image credits

Slide	Image credit
1	Ultrafan engine, Rolls Royce
5	Hydrogen concept aircraft, Airbus
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11	Ultrafan engine, Rolls Royce
11	Wing of Tomorrow concept, Airbus
12	Phillips 66 Humber Refinery, Phillips 66 Ltd
14	Spirit of Innovation, Rolls Royce
15	Hydrogen concept aircraft, Airbus
15	FlyZero logo, Aerospace Technology Institute
15	Dornier 228 First Electric Propeller Spin aircraft, ZeroAvia
16	Wing of Tomorrow, Airbus
17	100% SAF, Rolls Royce