

Flight100 Fact Sheet

Flight100	
VS#100	<ul style="list-style-type: none"> ▪ 28th of November, Virgin Atlantic will operate 100% sustainable aviation fuel (SAF) flight between London Heathrow and New York JFK ▪ First time 100% SAF has been flown in both engines, by a commercial airline, for long haul flight ▪ Will be flown on G-VDIA – one of our 17 Boeing 787s ▪ Departing LHR at 11:30 and arriving into JFK at 14:40 (local) ▪ This is a non-commercial flight – no revenue paying passengers or cargo carried
Regulatory approvals	<ul style="list-style-type: none"> ▪ CAA permit to fly (PtF) approval received on Mon 6 Nov. EASA and Canadian overflight received on same day. FAA overflight approval received on 14 Nov. ▪ The PtF is the lead approval for the flight that allows us to operate Flight100 under the specific conditions stated (i.e. 100% SAF)
Prior 100% SAF flights	<ul style="list-style-type: none"> ▪ United & Emirates have flown 100% SAF in single engine. United in Dec 21 Chicago to Washington. Emirates Jan 23 circling Gulf from Dubai. ▪ US and UK air forces have flown 100% in both engines in military aircraft. US unmanned (Air Company fuel) in June 2022. RAF (with Airbus) Nov 2022 (A330MRTT) – 90 min flight with observers. ▪ ATR, BRA, Neste flew first commercial flight on 100% SAF both engines in Sweden (June 2022). ▪ On 20 November 2023 – OEM Gulfstream operated 100% transatlantic with business jet. ▪ On 22 November 2023 – Emirates operated A380 demonstration flight DXB – using 100% SAF in 1 of 4 engines
Consortium	<ul style="list-style-type: none"> ▪ OEMs – Rolls Royce & Boeing ▪ Academia – Sheffield University (SAF testing), Imperial (non-CO2) ▪ RMI – non-CO2 ▪ ICF – emissions baselining and analysis (also purchasing scope 3 certificates for emission reductions) ▪ DFT – set and co-funding the project
Return to service	<ul style="list-style-type: none"> ▪ 24 hour return to service process – departing JFK for LHR on Wed 29 Nov 19:00 ▪ Return to service will involve draining the engines of remaining SAF, refuelling with Jet-A fuel, and tests on engines, fuel systems and APU ahead of departure
The SAF	
SAF Blend	<ul style="list-style-type: none"> ▪ 70 tonnes used for flight and testing ~45 tonnes expected for flight ▪ Greenhouse Gas emission reduced expected to be up to ~70% vs fossil ▪ Blend of x2 types of SAF: <ul style="list-style-type: none"> ○ 88% made from HEFA produced and supplied by Air BP from EU – contractual provision on no palm, feedstocks EU sourced ○ HEFA = Hydro processed Esters and Fatty Acids – used cooking oil, waste animal fat and tallows (fats/tallows use for feed / food are prohibited as eligible feedstocks) ○ 12% Synthetic Aromatic Kerosene (SAK) – produced by Virent in the US. Dextrose feedstock derived from waste corn (extracted when separating proteins needed for animal feed) ▪ SAF testing undertaken – demonstrates it sits within the normal range of Jet A properties – it looks, smells and performs akin to Jet A
Transportation & blending	<ul style="list-style-type: none"> ▪ Virent fuel shipped from Wisconsin, US to UK, Air BP volumes shipped from EU. Virent SAF for engine test & rehearsal flight flown due to time criticality. ▪ AirBP responsible for blending the SAF at their Isle of Grain facility and transporting to Heathrow in 2 tankers. ▪ All SAF transportation emissions including in our LCA analysis and will be mitigated via biochar removals.
Approvals & blending cap	<ul style="list-style-type: none"> ▪ Current blending limited up to 50% with Jet A – blending seen closer to 10-30% due to variance in Jet A spec ▪ More than 7 types of fuel approved as SAF in accordance with American Society for Testing and Materials (ASTM) standards – used for all global fuel certification ▪ Virent SAF is not yet ASTM approved – currently in the approval process with a high Technical Readiness Level – approval expected in next ~6 to 12 months. ▪ SAF blend used on Flight100 – has been properties tested, engine tested and APU tested – it performs akin to Jet A
Emissions analysis	
LCA "First"	<ul style="list-style-type: none"> ▪ Working with ICF, Virgin Atlantic have conducted a first-of-a-kind Life Cycle Analysis of the end-to-end journey of a flight to assess the emissions impact i.e. full supply chain impact of operating a single flight ▪ Includes travel to airport, operational, cargo, fuel (burn, production, transport) inflight and down-route crew transport, aircraft embodied emissions and waste plus non-CO2 impact ▪ Baselining took place on LHR-JFK flights in normal operation Sept – Nov 22
Impact	<ul style="list-style-type: none"> ▪ 97% of the baseline is fuel - in flight fuel burn and upstream fuel impacts i.e production, transportation

Flight100 Fact Sheet

- Single flight LHR-JFK produces 152 tonnes of CO₂e (end-to-end emissions). In simple terms 1 tonne of fuel burnt emits 3 tonnes of CO₂.
- CO₂e refers to CO₂ equivalent, the measurement of the total greenhouse gases emitted, expressed in terms of the equivalent measurement of carbon dioxide. CO₂ only measures carbon emissions and does not account for any other greenhouse gases

- | | |
|--------------|---|
| 100% SAF LCA | <ul style="list-style-type: none"> LCA analysis to be replicated for Flight100 to measure and quantify impact Residual emissions (not addressed by SAF) to be mitigated through biochar removals - currently estimated c.60 tCO₂e Validation of results in partnership with ICF |
|--------------|---|

- | | |
|-----------------|---|
| Carbon removals | <ul style="list-style-type: none"> Once final validation of LCA complete post flight, residual emissions will be mitigated using UK-based biochar carbon removals credits, which will be retired to compensate these emissions Biochar project is Carbon Hills in Wales – proximity to our call centre location 2023 vintage – produced through pyrolysis (woody biomass heated in oxygen-limited environment) – used as soil amendment in agriculture and horticulture. Removal certified to 100 years – in reality closer to 1000 years |
|-----------------|---|

Inflight and on the ground

- | | |
|--|---|
| Total fuel efficiency Savings across Flight100 | <ul style="list-style-type: none"> Within initiatives on the flight – operational efficiencies estimated at ~3,242 kg. Equivalent to 10,244 kgCO₂ emissions from Jet A fuel. Of these savings, ~36% we already achieve through BAU deployed initiatives, 64% are additional Over a one-year period of LHRJFK flying on our network, these initiatives would effectively save c.6,000 tonnes of fuel burn (additional savings only). |
|--|---|

- | | |
|-----------------------|--|
| Reduced potable water | <ul style="list-style-type: none"> The amount of potable water carried onboard will be reduced by using an internal model to estimate the optimum amount of water to be loaded based on accurate numbers onboard. Flight100 forecast to save c. 39kg of SAF burn |
|-----------------------|--|

- | | |
|-------------------|---|
| FliteDeck Advisor | <ul style="list-style-type: none"> Jeppesen FliteDeck Advisor (FDA) is an app provided by Boeing and deployed across our 787-9 fleet as a BAU initiative. A mobile flight optimisation app that gives pilots optimum cost index to fly, typically saving 2.1% of fuel burn vs. typical flight plans. Flight 100 forecast to save c. 922 kg of SAF burn |
|-------------------|---|

- | | |
|---------------------------|---|
| Cost Index (CI) climb FDA | <ul style="list-style-type: none"> New function on the FDA app to calculate the most fuel-efficient cost index when the aircraft is climbing, allowing the aircraft to optimise performance and reduce fuel burn. Typically saves c. 2% of climb fuel per flight. Flight100 forecast to save 189 kg of SAF burn |
|---------------------------|---|

- | | |
|-------------------------------|---|
| Reduced engine taxi in (RETI) | <ul style="list-style-type: none"> Using single engine on our twin-engine aircraft to taxi into the arrival gate at JFK. Will not be deployed at LHR for take off to allow both engines to run on SAF pre-flight Flight100 forecast to save 127 kg of SAF burn |
|-------------------------------|---|

- | | |
|--------------------|--|
| Continuous descent | <ul style="list-style-type: none"> Continuous descent approach (CDA) is when the aircraft will descent from top of descent to the runway without having to level off (which increases fuel burn) Flight100 is forecast to save 304 kg SAF subject to ATC dependency. |
|--------------------|--|

- | | |
|-----------------------|--|
| APU runtime reduction | <ul style="list-style-type: none"> Auxiliary Power Unit (APU) is a small engine in the back of the aircraft that provides power when the engines are off. APU runtime and fuel burn can be reduced by utilising airport provided ground power units (GPU) to provide power, and preconditioned air (PCA) to cool/warm the aircraft. APU must be switched on to start the engines (typically 10 minutes prior to departure) Flight 100 is forecast to save 358 kg of SAF burn |
|-----------------------|--|

- | | |
|--|---|
| Direct routing / in flight route maximiser | <ul style="list-style-type: none"> Working with Air Traffic Control (ATC) (NATS and FAA) Flight 100 will fly an as efficient routing as possible. Including in-flight refuelling to response to conditions e.g. weather, traffic etc. Flight100 forecast to save 1,000 kg of fuel |
|--|---|

Non CO₂ effects

- | | |
|----------|--|
| APU Test | <ul style="list-style-type: none"> University of Sheffield have carried out particulate tests on APU emissions, comparing Flight100 SAF to fossil Jet. Whilst Virent SAK is purposefully high aromatic, it only has a single hydrocarbon ring vs fossil jet which has a double ring reducing particulates. Initial finding – 60%-70% in particulates using Flight100% SAF – relevant to NO_x, SO_x and local air pollution |
|----------|--|

- | | |
|-------------------|---|
| Baseline tracking | <ul style="list-style-type: none"> Working with Imperial College London (ICL) to track a sample of 10 Virgin Atlantic LHRJFK flights between 2019 and 2021, validating contrail forecasting model predictions with satellite observations. Comparing flight data with ICL model to validate and improve the accuracy of contrail forecasting tool. Contrail forecasting model shows good accuracy of contrail prediction vs. observed satellite imagery. |
|-------------------|---|

Flight100 Fact Sheet

Avoidance	<ul style="list-style-type: none"> Satellite imagery provides robust contrail observation and validation method under clear-sky conditions and where existing contrail cirrus exists, but ability to link to individual flights more difficult
Pilot reporting	<ul style="list-style-type: none"> Breakthrough Energy contrail forecasting model manually integrated into existing flight planning process, allowing flight plans to identify contrail formation and divert. Flight plan diversion parameters defined, +/- 4,000 feet altitude change, and max parameters of 200 kg additional fuel burn to deviate. Flight planning contrail avoidance process being tested with flight planners before flight. Contrail avoidance in flight planning for Flight 100 will be deployed, depending on conditions on the day will determine whether to deviate flight plan to avoid contrail formation or not required. Post-flight analysis will be conducted to validate any potential contrail formation and/or avoidance through flight plan deviation, using satellite imagery and pilot observations vs. forecast contrail prediction modelling
Contrail Impact Task Force	<ul style="list-style-type: none"> Working with Rocky Mountain Institute (RMI), Virgin Atlantic have developed a pilot reporting form (PIREP), allowing pilots to report observed contrails in flight. PIREP form collects information about contrail information from the flight deck, including specific flight no, time, location, estimated altitude and persistence of contrail. PIREP will be deployed for Flight 100, allowing nearby Virgin Atlantic flight crews to report contrails from Flight 100 (and other flights), supporting the validation of contrail formation, and testing feasibility of methodology in real world application
Contrail Impact Task Force	<ul style="list-style-type: none"> Virgin Atlantic is a founding member of the Contrail Impact Task Force (CTIF), a cross-sector task force of aviation industry, tech sector, and academic leaders, brought together by RMI, to explore opportunities to address the warming impact of certain contrails. CTIF aims to share latest scientific impact of contrails, develop actionable strategies to mitigate contrails, analyse operational and financial challenges of implementing solutions and establish a roadmap for implementation and validation of contrail mitigation tools.

Journey initiatives

Airport	<ul style="list-style-type: none"> Targeting 100% online check in for all observers to reduce paper usage. Complimentary Heathrow Express tickets for all observers to encourage train travel to the airport rather than cars.
Clubhouse	<ul style="list-style-type: none"> Already zero waste to landfill, with a 70% plant-based menu. Showcasing two of our Clubhouse suppliers on the day: (1) Symplicity Foods who provide a natural, zero waste alternative to the current plant-based 'meat' market and (2) Full Circle Farms who provide fresh produce from their regenerative farm in West Sussex. Expanding our Thoughtful Food programme to include our Clubhouse in 2024 and new carbon criteria.
Waste	<ul style="list-style-type: none"> Waste segregation trial to support IATA initiative – on Flight100 and for 2 week period in Dec (LHR-JFK only) Results will be used to lobby for change to international waste regulations which prevent recycling of international catering waste We already reuse, refurbish and recycle all our headsets, blankets and amenity kits through a specialist recycler.
Plastics	<ul style="list-style-type: none"> Building on the success of our 90% reduction in flown single-use plastic items, where we removed or replaced 60m items with alternatives, such as wine bottles with cans, plastic cutlery with pressed board, and plastic meal containers with bagasse. Rotable cup trials: lifecycle analysis of rotable cup vs single-use cups in Economy to inform future decision making for onboard single use plastic reduction. Trialling a paper wrap for our blankets to remove the plastic bag LCA based analysis will assess any benefit to paper vs plastic
Onboard Food	<ul style="list-style-type: none"> Thoughtful Food programme ensures our caterers consider people and planet in all our onboard meal offering. Preorder – preselect: All observers will additionally be asked to pre-order their meals to reduce weight and waste. We currently offer POPS as standard in Upper, Premium, and Economy Delight on all flight ex UK, US and Caribbean. We plan to roll this out through Economy by end of H1 2024.
Cargo	<ul style="list-style-type: none"> Customers Kuehne + Nagel and Bakkafröst are shipping 4 tonnes of salmon on Flight100 Not revenue cargo – K&N are purchasing scope 3 emissions from the flight K&N are one of our top cargo customers and have partnered with us to support scale up by purchasing environmental benefits / SAF premium of the fuel for Flight100