
'Sustainable flight is too difficult'
Challenge accepted
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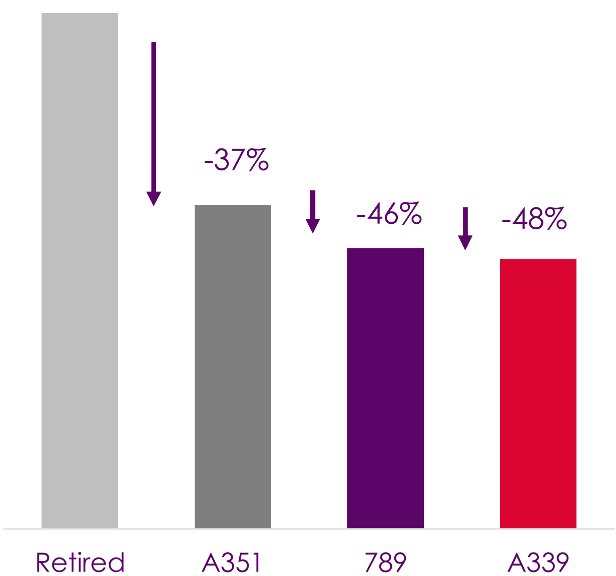
Why it matters

After fleet renewal, SAF is the only lever for in sector emission reductions for long haul aviation

Fleet

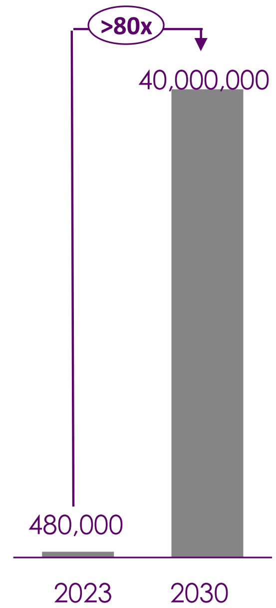
Efficiency gains (CO_2/km)



Declining gains w/o zero emission flight

SAF

Fuel burn (Global Production tonnes)



Supply & mix constrained

Out of sector action

Offsets and removals

Avoided emissions

- Future emissions avoided or reduced
- For example, renewable electricity projects
- Permanence <100s years

Carbon removed

- Existing carbon removed from atmosphere
- For example, reforestation or direct air capture
- Permanence >100s-1000s years

Perception challenge

Key results

100% SAF Equivalent safety to Jet A-1	**0** **Engine or airframe mods**	▪ Demonstrated that a wide-body long haul aircraft (in this case Boeing 787-9 with Rolls-Royce Trent1000 engines) can operate100% SAF at an equivalent level of safety to Jet A-1 ▪ No modification required or made to airframe, engines or any components
64% Reduction in CO_2e	**-95 tCO_2e**	• 95 tonnes CO_2e reduction compared to standard LHR-JFK flight • End to end life cycle analysis completed – providing replicable framework that can be adopted across industry • 64% CO_2e reduction from use of Flight100 SAF blend
+1% Increase in energy	**-350 kgs** **Fuel saved**	▪ Lab analysis findings indicate that Flight100 SAF also delivered a 1% improvement in energy density ▪ 34.6 tonnes of fuel burnt – a saving of 0.35 tonnes vs typical flight with Jet A-1 ▪ At 10% SAF adoption could reduce total UK fuel burn by 12k tonnes and 400k tonnes globally
40% Reduction in particulates	**Likely reduction of radiative forcing contrails**	▪ Flight100 SAF ~40% reduction in particulate matter, increasing to 70% for HEFA component ▪ Demonstrating the potential of SAF to reduce environmental impact of non-CO2 emissions ▪ Reduction in particulates likely to reduce in-flight creation of persistent radiative forcing contrails
0 Contrails	**Predictive modelling accuracy verified**	▪ Flight100 verified the accuracy of contrail creation forecasting ▪ Incorporated Breakthrough Energy open-source model into flight planning ▪ No contrails formed in flight due to higher-than-normal cruising altitude of 40,000 feet
4.4% Fuel reduction through operational efficiencies	**-2.2 tonnes** **Fuel savings**	▪ Flight100 deployed nine ground and flight ops efficiency initiatives avoiding 8.4 tonnes CO_2e ▪ ATM and flight path efficiencies delivered 70% of benefit – highlighting opportunity for international collaboration across air traffic management

Unique Blend of SAF

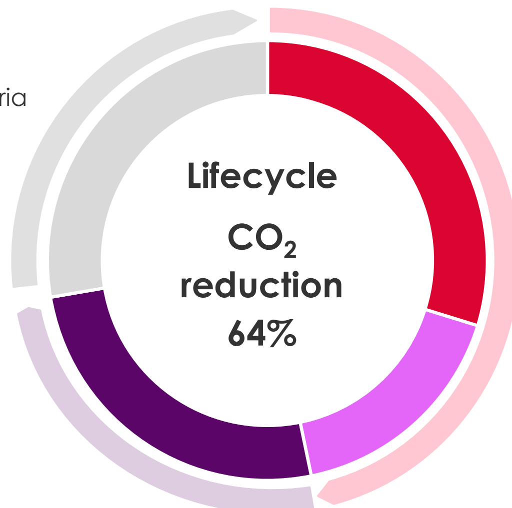
Flight 100 used a mix of 88% HEFA and 12% high aromatic SAK to achieve properties akin to Jet A-1

Renewable feedstocks

- Category 1 waste animal fats (HEFA)
  - Sourced in Portugal and Austria
- Dextrose derived from industrial corn starch (SAK)
  - Sourced in US corn belt

Conversion process

- HEFA SPK from convert feedstocks into aviation fuel
- Virent Synthetic Aromatic Compound
- Bioform process



Blending & distribution

- Blend ratio 88:12
- Fuel distribution direct into wing
- Isolated from fuel farm given off-spec nature

Fuel burn in engine

- SAF properties equivalent to ASTM
- SAK component delivers aromatics and required density

Fuel

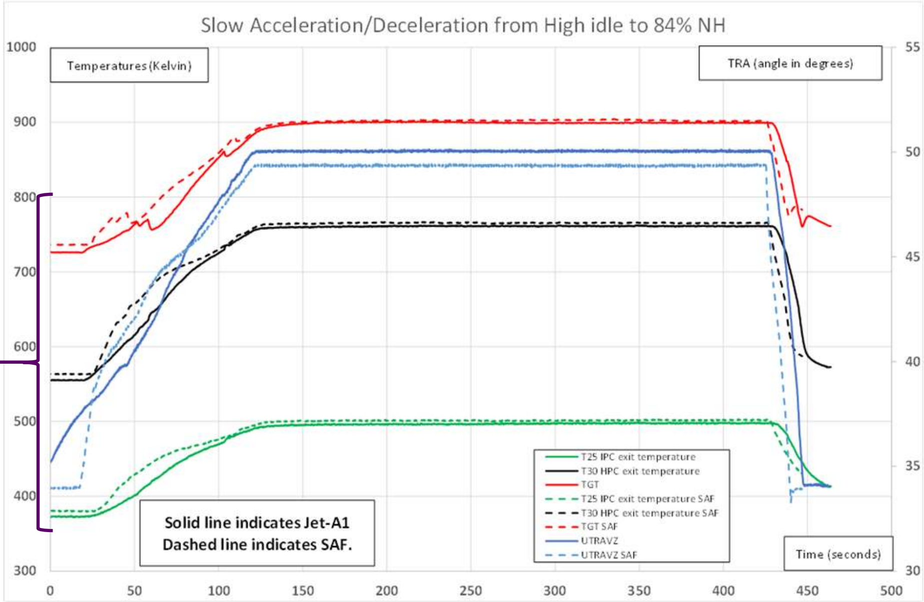
F100 SAF mix within all parameters of ASTM criteria and performed akin to Jet A in the engine

Characteristics vs Jet A

(Fuel testing – Rolls Royce)

Property	Method	Units	ASTM D7566 – Annex 2	ASTM D1655 – Jet A1	F100 SAF
Density at 15°C	ASTM D4052	Kg/m3	730-722	775-840	**777.7**
Aromatics	ASTM D1319	% (v/v)		Max 25	**13.1**
Distillation	ASTM D86	°C			
IBP					**148.9**
T10			205 max		**173.1**
T50			Report		**224.3**
T90			Report		**259.1**
FBP			300 max		**264**
T90-T10			22 min HEFA / 40 min Jet A1		**86**
T50-T10			15 min Jet A1		**51.2**
Kinematic viscosity at -20°C	ASTM D445	cSt	<8cSt	,8cSt	**5.063**
Kinematic viscosity at -40°C	ASTM D445	cSt	Not required for neat HEFA - SPK	<12 cSt for blended (<50%)	**11.672**
BOCLE (lubricity)	ASTM D5001	mm	Max 0.85	Max 0.85	**0.67**

Performance in bench engine test



Engine performance identical between F100 SAF and Jet A1 – only environmental differences observed

Initiatives Breakdown

70% of fuel savings related to opportunities relating to Air Traffic Management – demonstrating the opportunities that exist for airspace modernisation

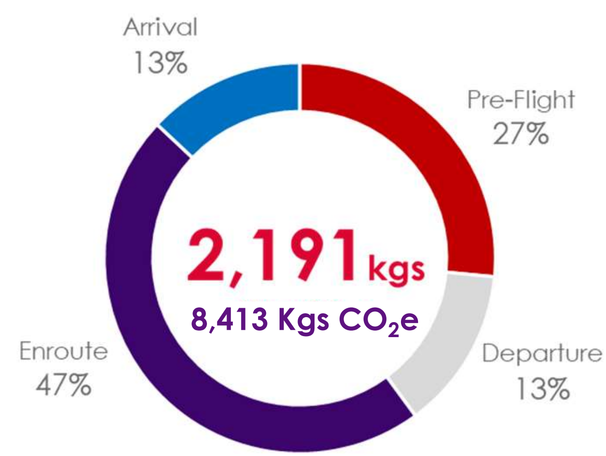
1 Pre-Flight ~581 kgs

2 Departure ~294 kgs

3 Enroute ~1,031 kgs

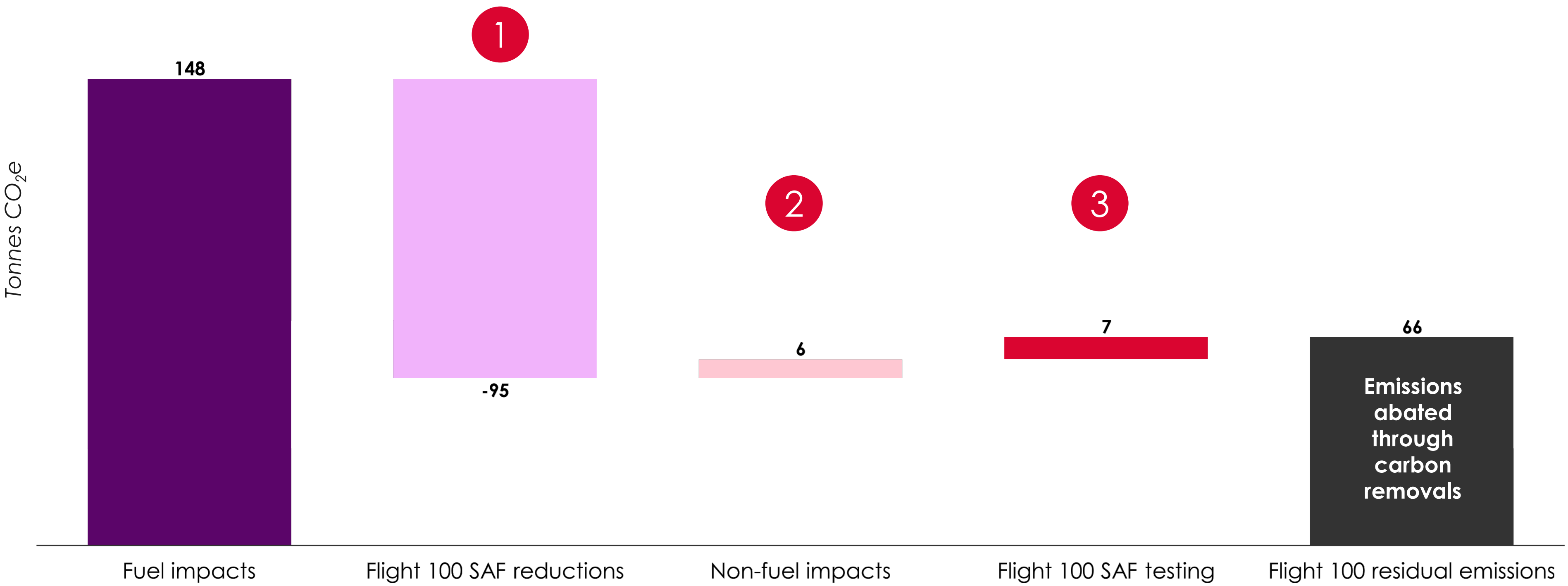
4 Arrival ~285kgs

PRE	**Optimal Stand Allocation**	**Optimised Potable Water Loading**	**Priority Departure**
DEP	**Continuous Climb Operations (CCO)**	**Climb Cost Index Optimisation**	
ENR	**ANSP Supported Efficient Routing**	**Reduced Contingency Fuel**	**Cost Index Re-Optimisation**
ARR	**Continuous Descent Arrival (CDA)**	**ATC Priority**	**Reduced Engine Taxi-In (RETI)**



Flight100 LCA results

Following the use of 100% SAF, Flight100 residual emissions impact was assessed at 66 tonnes CO_2e that could not be mitigated through in-sector measures

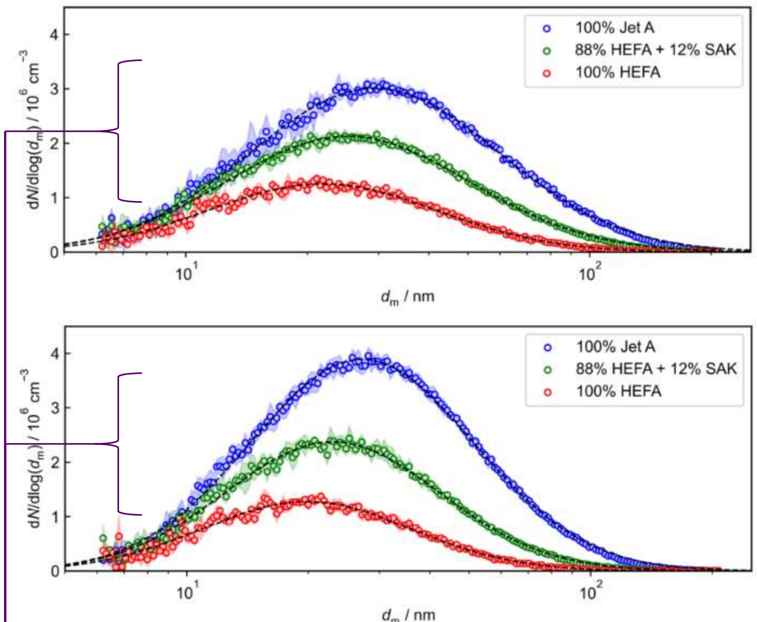


Non CO_2

Material benefits on non CO_2 emissions identified in ground testing and validation of contrail predictive software use

SAF effects on aircraft nvPM emissions

Particulate size and distribution in ground engine testing



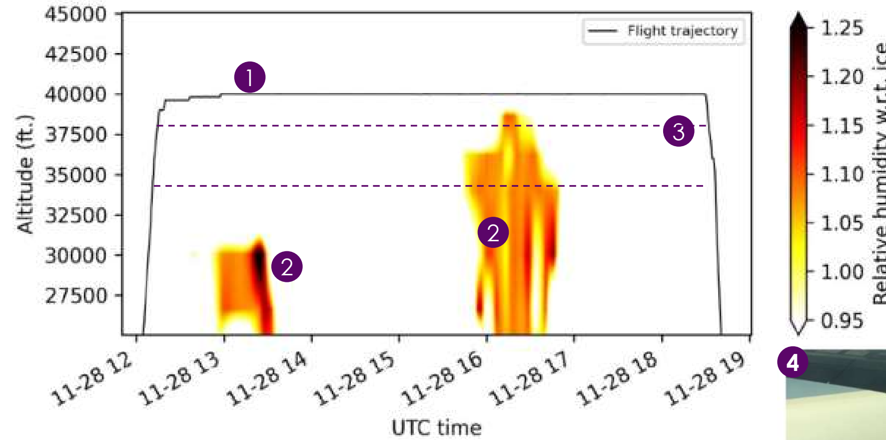
Engine load #1 Lower thrust

Engine load #2 Higher thrust

100% HEFA particulates performance the best (61-70)% vs Jet A due to absence of aromatics
F100 blend – with Virent SPK purposefully high aromatic content improves emission performance vs Jet A by (31-41)%

Contrails

Forecast of areas likely to produce persistent contrails



1. *Shows F100 flight path and altitude*
2. *Shows forecast areas conducive to contrail formation – ice supersaturated regions*
3. *Shows indicative "normal" cruising altitude with commercial operation i.e. higher load factor / cargo*
4. Observed contrails from flights operating at lower altitude vs F100

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What next?

Absence of supply side incentives in the UK creates challenging outlook for meeting mandated volumes by 2030

	US	EU	UK
Mandate?	No Domestic production target of 3bn USG	EU mandate, 6% 2030 No HEFA cap	UK mandate 10% 2030 **HEFA cap from 2027**
Production tax credits	$1.75/USG Inflation Reduction Act credit State tax credits	No tax credits	**No tax credits**
Production grant funding	$290m over 4 years	Innovation fund Government investment e.g. France €200m	£180m GFGS and AFF competitions
Airline incentives	State-level tax credits	20m ETS allowances (to bridge SAF price premium) 50% HEFA, 75% 2G, 95% e-fuels	**No support**
Other support mechanisms	US Renewable Fuel Standard State low carbon fuel standards	Zero rating under EU ETS	Zero rating under UK ETS

UK setting some of the highest sustainability standards and SAF volume requirements – with no supply side policy support