



GO BEYOND

PW&C CUSTOMER CONNECT SAF WEBINAR

OCTOBER 22, 2024

**POWERING
SUSTAINABLE
AVIATION™**

SMARTER.
CLEANER.
GREENER.

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P&WC CUSTOMER CONNECT– SUSTAINABLE AVIATION FUEL WEBINAR

KENYA, NOVEMBER 14TH, 2024

AGENDA

High level view on why SAF is needed

What is SAF?

Current operational capability

Overview of industry specifications activities for 100% SAF

P&WC development experience with 100% SAF

Current P&WC activities related to 100% SAF

Key takeaways



IS SAF THE FUTURE?

IATA SUMMARY OF DECARBONIZATION ROADMAPS FOR 2050

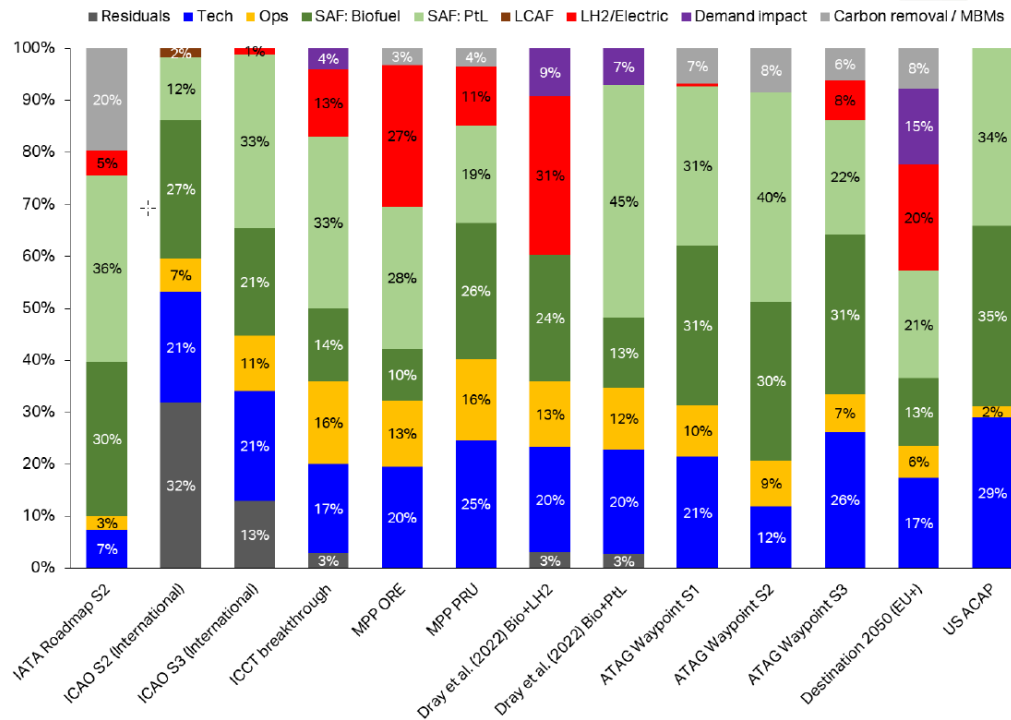


Figure 1: Emissions reduction potential by transition measures in 2050, comparing across all roadmaps except the IEA Net Zero 2050.

Source credit: IATA

Importance of SAF is almost in every decarbonization plan

WHAT IS SAF?

SAF CAN BE PRODUCED FROM A VARIETY OF PATHWAYS

Sustainable Aviation Fuel is almost chemically identical to traditional jet fuel

From resources providing a net reduction in CO₂ emissions compared to fossil fuels



Current most common options → HEFA

Most likely > 2030 to mid-century

Waste oils & Animal fat
tallow

Municipal
Solid
Wastes

Lignocellulose & sugars

Power-to-liquid e-fuels;
green H₂ and CO₂

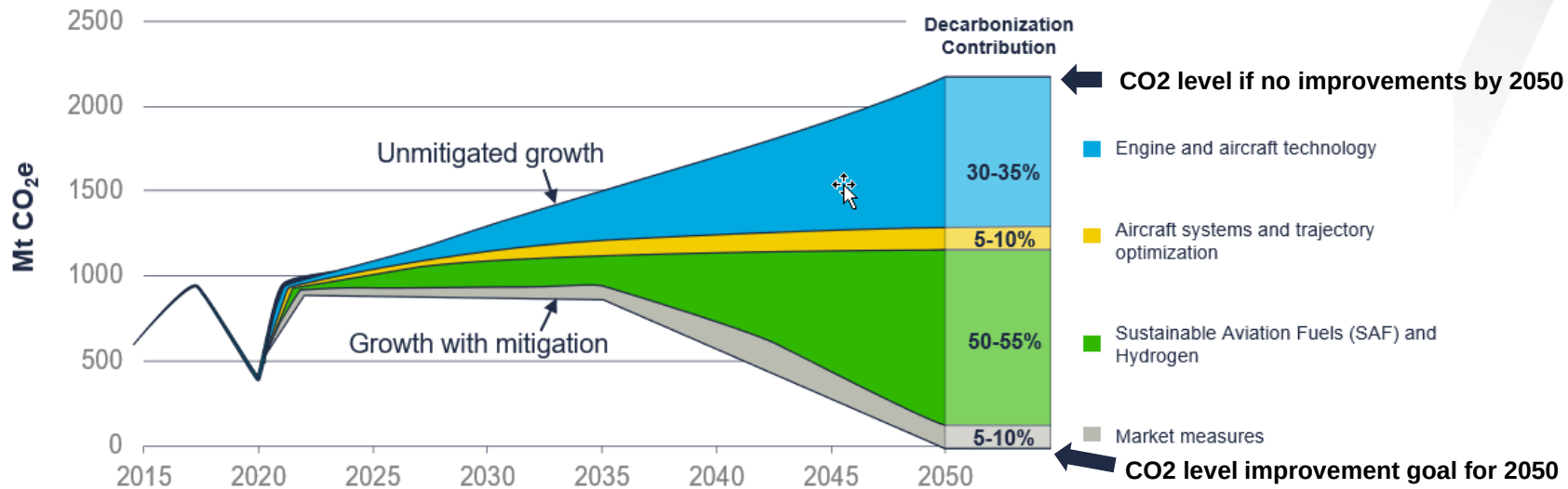
HEFA (Hydrolysis of Esters & Fatty acids)
pathway

Advanced pathways
Alcohol to Jet (ATJ) & Fischer Tropsch (FT)

P&WC monitoring pathways that may influence future specifications

WHY SAF?

INDUSTRY COMMITTED TO NET-ZERO CO₂ BY 2050

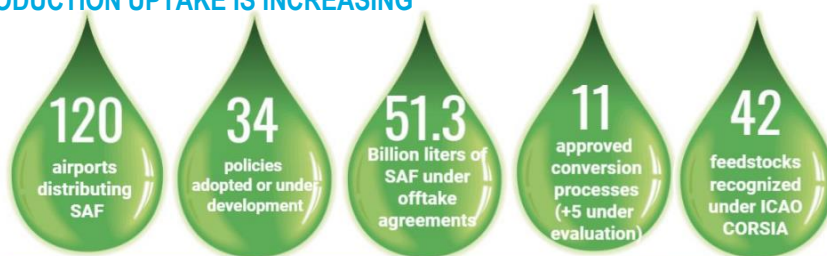


Source: WAYPOINT 2050, ATAG (Air Transport Action Group)
2nd Edition September 2021

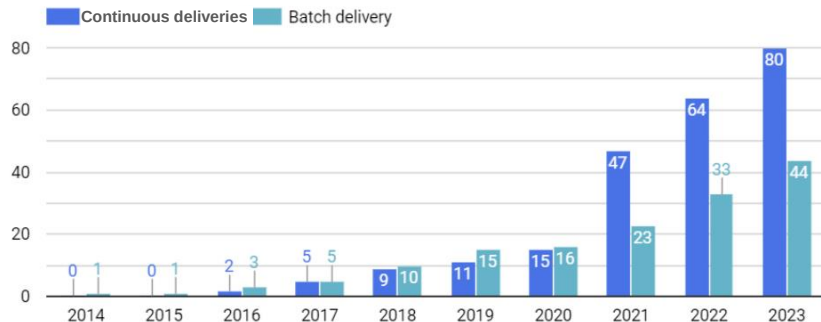
Net-zero CO₂ depends on alternative aviation fuels enabled by energy efficiency

SAF PRODUCTION STATUS WORLDWIDE

PRODUCTION UPTAKE IS INCREASING



- Batch delivery
- Continuous delivery



Steady upward trajectory BUT

Less than 0.5% of world jet fuel consumption is SAF currently

Approaching 100% of consumption needs to be SAF for net zero (currently ~450 billion litres per year)

SAF PLANNED FUTURE PRODUCTION



Planned production facilities (IATA estimates)

Renewable Fuel Projects Operating in 2023



Source: [IATA's Media Briefing on SAF, AGM, June 2023](#)

Projected Renewable Fuel Projects Announced to 2028



Source: [IATA's Media Briefing on SAF, AGM, June 2023](#)

North America and Europe have large engine fleets that would benefit from SAF

SAF REGULATIONS

UN / ICAO → CORSIA / CAEP – REGULATORY FRAMEWORK



Who: All participating states & almost all international routes

When: Agreed in 2016; Voluntary until 2026; Mandatory after 2027

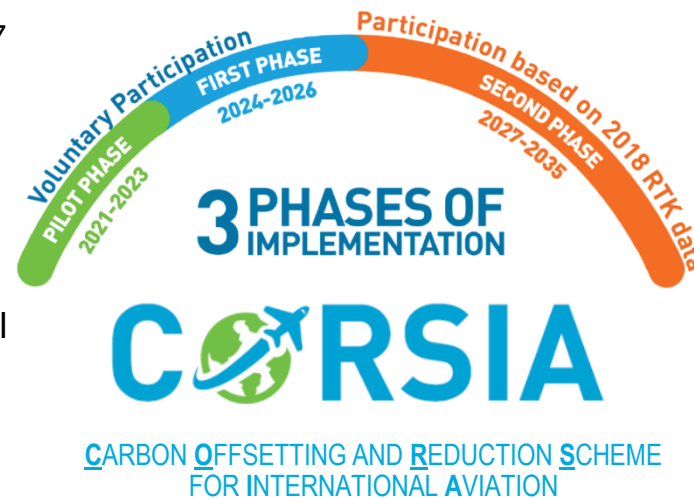
How: Two methods to decarbonize aviation;

1. **Buy offsets** from other industries
2. **Use low-carbon fuels, i.e. SAF**

Approach: Life Cycle Assessment comparison to Fossil Jet Fuel

Caveat: Flights to/from least developed countries representing <0.5% of global aviation business may be exempted depending on host country policy

UN: United Nations, ICAO: International Civil Aviation Organisation, CAEP: Committee on Aviation Environmental Protection



Offsets not seen as aggressive enough to meet 2050 net zero goals

CURRENT P&WC ENGINE OPERATIONAL CAPABILITY

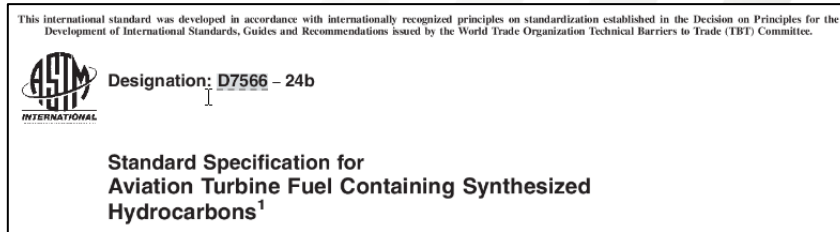
EXAMPLE: PW127 TURBOPROP

Maintenance Manual Section 72-00-00 Approved Fuels Extract

TABLE 14, Fuel Specifications, Which Meet P&WC Minimum Fuel Property Requirements

SPECIFICATION	REVISION	ISSUING AGENCY	FUEL TYPE	GRADE DESIGNATION
CAN/CGSB-3.23	Latest	Canadian General Standards Board	Kerosene	Jet A Jet A-1
CAN/CGSB-3.24	Latest	Canadian General Standards Board	Kerosene	F-34 F-37
			High Flash Kerosene	F-44
D1655 (including D7566 produced fuels recertified to D1655) (See Note 5)	Latest	ASTM International	Kerosene	Jet A Jet A-1
NOTE: 5. Bio-fuels, Semi-synthetic Jet Fuel (SSJF) or Sustainable Aviation Fuel (SAF) complying to ASTM D7566 and re-certified to a listed specification meets P&WC minimum fuel property requirements.				

Note: SASOL also accepted as equivalent to DEF-STAN 91-91 and ASTM D1655 in both semi-synthetic (up to 50% blend) and fully synthetic (up to 100%) forms



D7566 Annex	Synthetic Blending Component Description	Max Blend %
1	FISCHER-TROPSCH HYDROPROCESSED SYNTHESIZED PARAFFINIC KEROSENE (FT-SPK)	50
2	SYNTHESIZED PARAFFINIC KEROSENE FROM HYDROPROCESSED ESTERS AND FATTY ACIDS (HEFA-SPK)	50
3	SYNTHESIZED ISO-PARAFFINS FROM HYDROPROCESSED FERMENTED SUGARS	10
4	SYNTHESIZED KEROSENE WITH AROMATICS DERIVED BY ALKYLATION OF LIGHT AROMATICS FROM NON-PETROLEUM SOURCES	50
5	ALCOHOL-TO-JET SYNTHETIC PARAFFINIC KEROSENE (ATJ-SPK)	50
6	SYNTHESIZED KEROSENE FROM HYDROTHERMAL CONVERSION OF FATTY ACID ESTERS AND FATTY ACIDS	50
7	SYNTHESIZED PARAFFINIC KEROSENE FROM HYDROPROCESSED HYDROCARBONS, ESTERS AND FATTY ACIDS	10
8	ALCOHOL-TO-JET SYNTHETIC PARAFFINIC KEROSENE WITH AROMATICS (ATJ-SKA)	50

Jet A equivalency means vast majority of aeronautical products approved

100% SAF SPECIFICATIONS OVERVIEW

INCREASING SYNTHETIC HYDROCARBON PATHWAYS

Drop-in SAF – 50% Blend available today !

Suitable with existing distribution infrastructure

Compatible with ALL P&W systems, no changes

8 synthetic processes approved to make synthetic Jet A/A-1 blends

P&W participating in 100% drop-in SAF candidate evaluations (ASTM)

Non Drop-in SAF

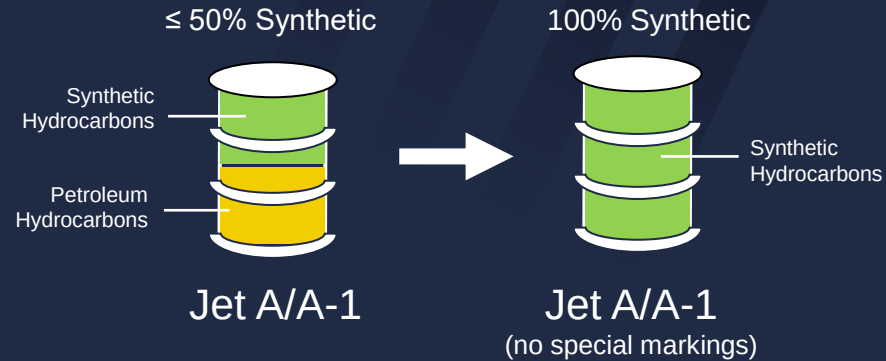
Assume a separate transportation infrastructure (specialty fuel)

Qualified on a “per-engine” basis

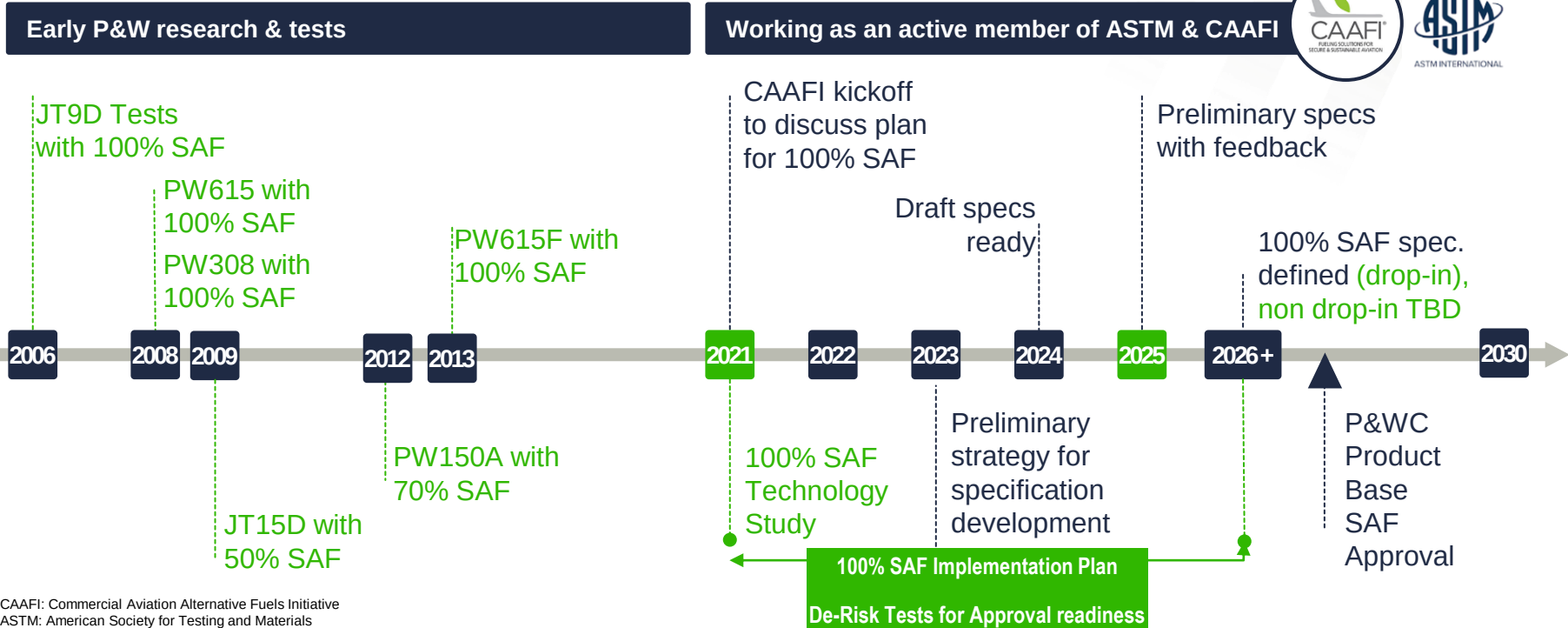
Driver for 100%: lifecycle emissions & contrail mitigation

P&W performing multiple test and demonstration activities

Aligning with ASTM timeline to construct new “Jet X” spec



PREPARING TO BE COMPATIBLE WITH 100% SAF

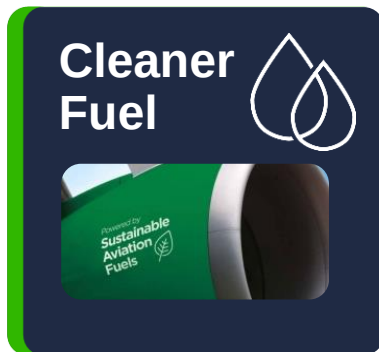


CAAFI: Commercial Aviation Alternative Fuels Initiative
ASTM: American Society for Testing and Materials

WHAT IS P&WC DOING ABOUT SAF?

P&WC NEAR TERM GOALS → 100% SAF IMPLEMENTATION PLAN

Complete risk reduction plan to position P&WC for approval of 100% (drop-in & non drop-in) SAF soon after ASTM specification release (moving target)



Research → Emissions, LCA, Contrails, Elastomers

Engine tests → Tfans, Tshafts, Tprops, APUs

Rig tests → Seals, Fuel Control Units

Test Categories of Interest

Emissions

Operability

Acoustics

Durability

Heat Management

Tfans: Turbo Fans, Tshafts: Turboshfts, Tprops: Turbo Propellers, APUs: Auxiliary Power Units

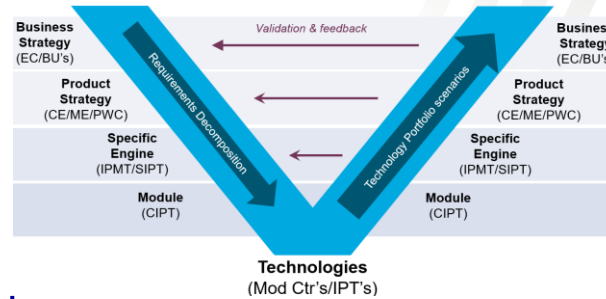
Maximizing Readiness to non drop-in / Minimizing time delays after spec issuance

2023Q1-2024Q1 DE-RISK ACHIEVEMENTS

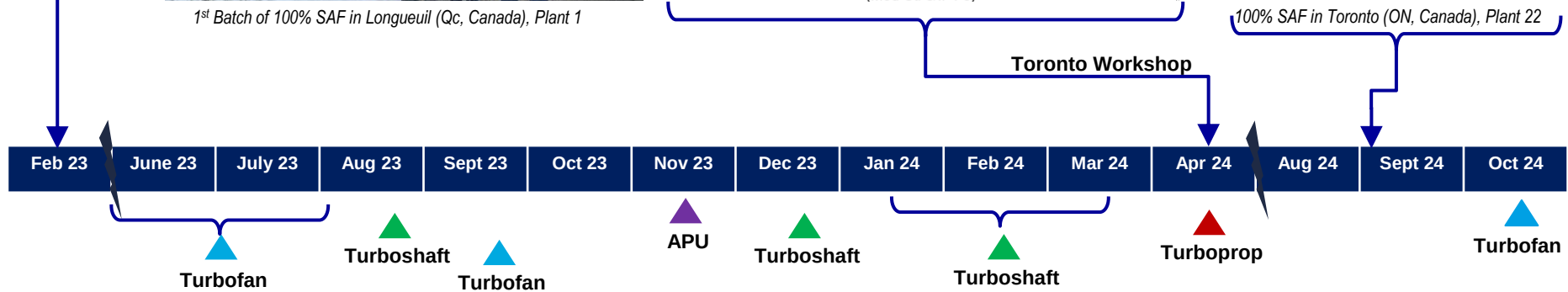
4x ENGINE MODELS, 11x FULL ENGINE DE-RISK TESTS



1st Batch of 100% SAF in Longueuil (Qc, Canada), Plant 1



100% SAF in Toronto (ON, Canada), Plant 22



De-risk readiness plan significantly advanced & continues until 2026+

2022-2024 FLIGHT DEMOS ACHIEVEMENTS

7X: DEMOS



Considerable success in demonstrating feasibility of SAF operation

SUMMARY TAKEAWAYS

WORKING FROM 50% TO 100% SAF



Current Maintenance Manuals allow for up to 50% SAF blends on ASTM D7566 approved pathways

100% drop-in will be indistinguishable from Jet-A → will allow for rapid approval with little or no additional validation required

But supply may be limited

P&WC is significantly advanced in a risk reduction plan to allow full compatibility to 100% non drop-in

More supply potential

No material specification currently exists for 100% non drop-in

PW&C is actively participating in the non drop-in ASTM task force

What are operator / airport concerns, experience and expectations in relation to SAF?



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