Boeing’s role in the First Movers Coalition

Robert Boyd

Global Sustainability Policy & Partnerships, Boeing
Fellow – WEF, First Movers Coalition

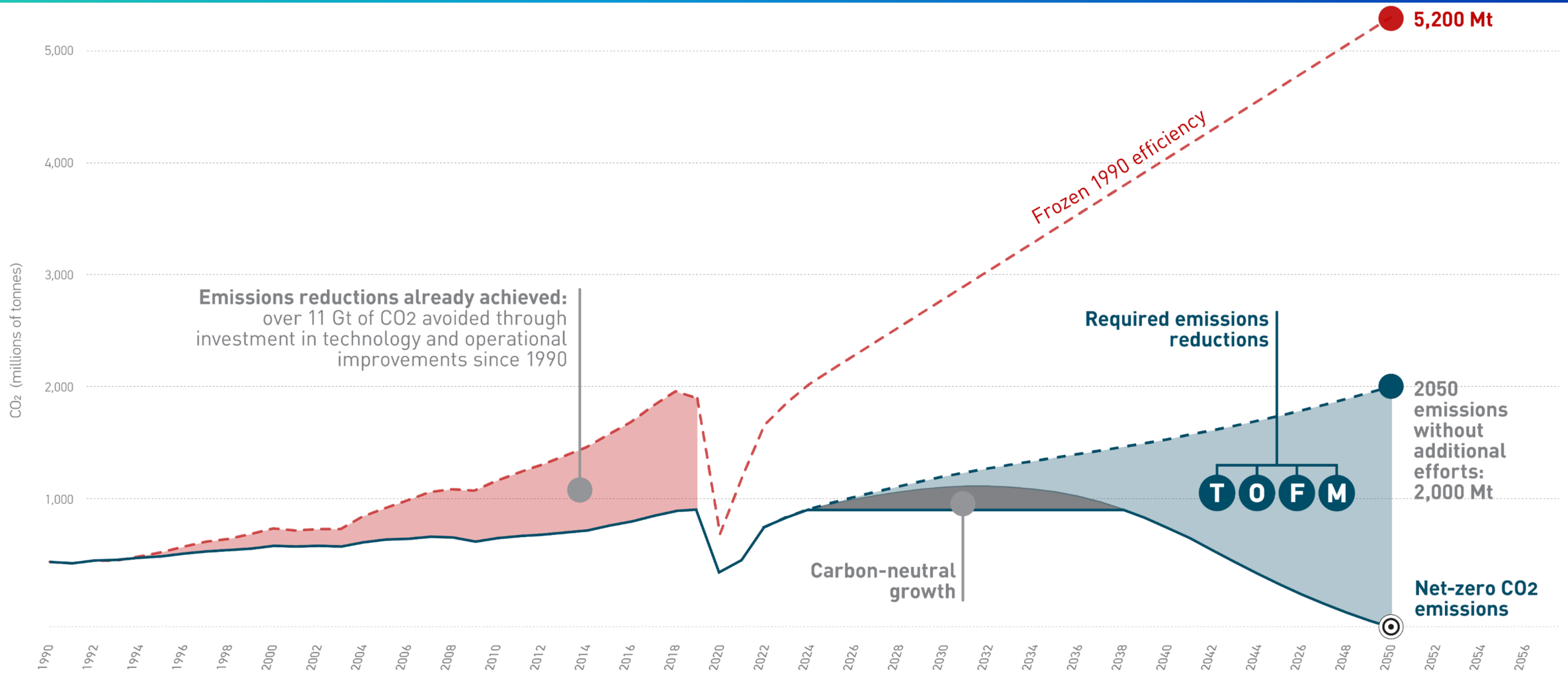
Boeing’s role in the First Movers Coalition

The World Economic Forum, First Movers Coalition is a demand driven initiative aiming to stimulate emerging technologies and the production of Sustainable Aviation Fuel with a life cycle emissions reduction of 85% or greater. First movers are necessary to bring forward technology not yet a commercial reality. What are the details of this program and how does this align with the aviation sectors global commitments for decarbonization?

COPYRIGHT © BOEING 2023

Why? The path to net-zero

SUSTAINABLE AEROSPACE TOGETHER



Net Zero 2050 Long Term Aspirational Goal agreed by Industry and Governments

SUSTAINABLE AEROSPACE TOGETHER

- 2019 (A40) agreement to investigate the feasibility of a LTAG for International Aviation;
- Not all States will be in a position to move at the same pace - some developing States will need longer to reach net-zero and the goal does not place obligations on all States.
- The resolution also outlines the support many developing States will need, including means of implementation such as capacity building and financing the transition.
- **CAAF/3: 2023 –** possibly the next agreement for SAF

Government agreement: Oct 2022

We asked for a long-term climate goal to be agreed by governments and they have responded. We now need to make it happen, together.

The International Civil Aviation Organization (ICAO) 41st Assembly has adopted a goal of net-zero carbon by 2050 for international aviation, backing up the industry goal agreed last year and in line with the Paris Agreement.

FLY NET ZERO

www.aviationbenefits.org/FlyNetZero

Industry commitment: Oct 2021

COMMITMENT TO FLY NET ZERO 2050

5 October 2021

ATAG

As the global community emerges from the pandemic and the aviation sector rebounds from the worst crisis in its history, we will build on the success of previous sustainability efforts to push towards the third era of air transport: net-zero carbon global connectivity.

Scientific consensus shows that the Paris Agreement 1.5ºC goal would greatly reduce the severity of climate change damage. It is imperative that all sections of society and business set course to support achievement of this goal. The collective air transport sector raises its ambition with a new long-term climate commitment:

- **Global civil aviation operations will achieve net-zero carbon emissions by 2050, supported by accelerated efficiency measures, energy transition and innovation across the aviation sector and in partnership with governments around the world.**

This goal is ambitious and challenging for air transport. It will require coordinated efforts within the aviation industry and from partners, particularly strong support from governments and the energy sector. The goal will be underpinned by a commitment to joint and cooperative action between all stakeholders. Waypoint 2050 outlines a number of key elements to achieve the decarbonisation of air transport, including:

1. Increasing use of sustainable aviation fuels (SAF) and a transition away from fossil fuels by mid-century as part of a wider aviation energy shift including low-carbon electricity and green hydrogen.
2. Research, development and deployment of evolutionary and revolutionary airframe and propulsion systems, including the introduction of electric and / or hydrogen powered aircraft.
3. Continued improvements in efficiency of operations and air navigation service providers.
4. Investment in high-quality carbon offsets in the near-term and carbon removal opportunities to address residual CO_2 emissions in the longer-term. In this regard, the industry reaffirms its full support for the International Civil Aviation Organization (ICAO) Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) as an effective transitional measure to stabilise net emissions from international aviation.

Across the sector, we are already undertaking a vast range of activities to reduce aviation CO_2 emissions. Our unwavering commitment to respond to the challenge of climate change has not abated despite the crisis we have faced. To achieve net-zero, the sector will require a supportive policy framework from governments focused on innovation rather than cost-inefficient instruments such as uncoordinated taxes or restrictive measures, as well as a robust and full commitment from the energy industry and other stakeholders. As support at the global level is critical, we urge ICAO member states to support the adoption of a long-term aspirational climate goal at the 41st ICAO Assembly in 2022.

Many long-term solutions require an acceleration of activity in the next decade, particularly the deployment of SAF. Some, such as continued efficiency gains, improvements in air traffic management and the implementation of CORSIA, can provide early climate action whilst longer-term measures are developed.

We are committed to ensuring that aviation in 2050 will be able to meet the needs of over 10 billion passengers, connecting the world safely, securely and importantly, sustainably. Further details can be found at www.aviationbenefits.org/FlyNetZero

Supported by innovation and action throughout the supply chain:

Luis Felipe de Oliveira, Director General
IBAC, Kurt Edwards, Director General
CANSO, Simon Hocquard, Director General; Jan Pie, Chair
IATA, Willie Walsh, Director General; Pete Bunce, President and CEO
AIRBUS, Guillaume Faury, Chief Executive Officer; Christopher Calio, President
BOEING, Stan Deal, President and CEO; Warren East, Chief Executive Officer
ATR, Stefano Bortoli, Chief Executive Officer; Olivier Andriès, Chief Executive Officer
Safran, Gaël Méheut, President and CEO; Francisco Gomes Neto, President and CEO
EMBRAER, John S. Slattery, President and CEO; Stephen Timm, President
Collins Aerospace

FLY NET ZERO

Copyright © 2022 Boeing. All rights reserved.

Decarbonizing Aerospace

SUSTAINABLE
AEROSPACE
TOGETHER

FLEET RENEWAL

OPERATIONAL EFFICIENCY

RENEWABLE ENERGY

ADVANCED TECHNOLOGY

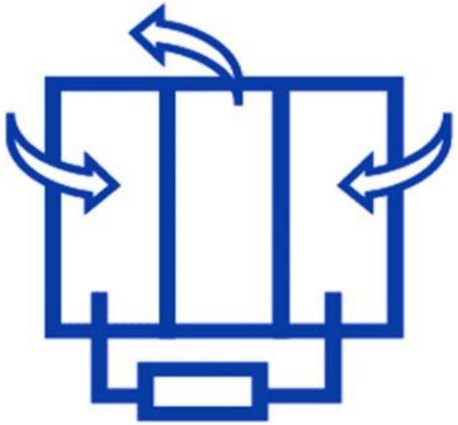
CORSIA Carbon Offsetting and Reduction Scheme for International Aviation

Sustainable energy propulsion options

SUSTAINABLE AEROSPACE TOGETHER

Sustainable Aviation Fuels

LH_2 Direct Combustion



H_2 Fuel Cells

Battery Electric

Copyright © 2022 Boeing. All rights reserved. | BOEING PROPRIETARY | CSM | OCT 2022

Industry View

Our industry requires a ‘SAF &’ approach.

SUSTAINABLE AEROSPACE TOGETHER

		2020	2025	2030	2035	2040	2045	2050
~27% of CO2 emissions	**Commuter** 9-50 seats <60 minute flights <1% of industry CO2	SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF
	Regional 50-100 seats 30-90 minute flights ~3% of industry CO2	SAF	SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF	Electric or Hydrogen fuel cell and/or SAF
	Short haul 100-150 seats 45-120 minute flights ~24% of industry CO2	SAF	SAF	SAF	SAF potentially some Hydrogen	Hydrogen and/or SAF	Hydrogen and/or SAF	Hydrogen and/or SAF
~73% of CO2	**Medium haul** 100-250 seats 60-150 minute flights ~43% of industry CO2	SAF	SAF	SAF	SAF	SAF potentially some Hydrogen	SAF potentially some Hydrogen	SAF potentially some Hydrogen
	Long haul 250+ seats 150+ minute flights ~30% of industry CO2	SAF	SAF	SAF	SAF	SAF	SAF	SAF

Source: ATAG Waypoint 2050 Report

SUSTAINABLE
AEROSPACE
TOGETHER

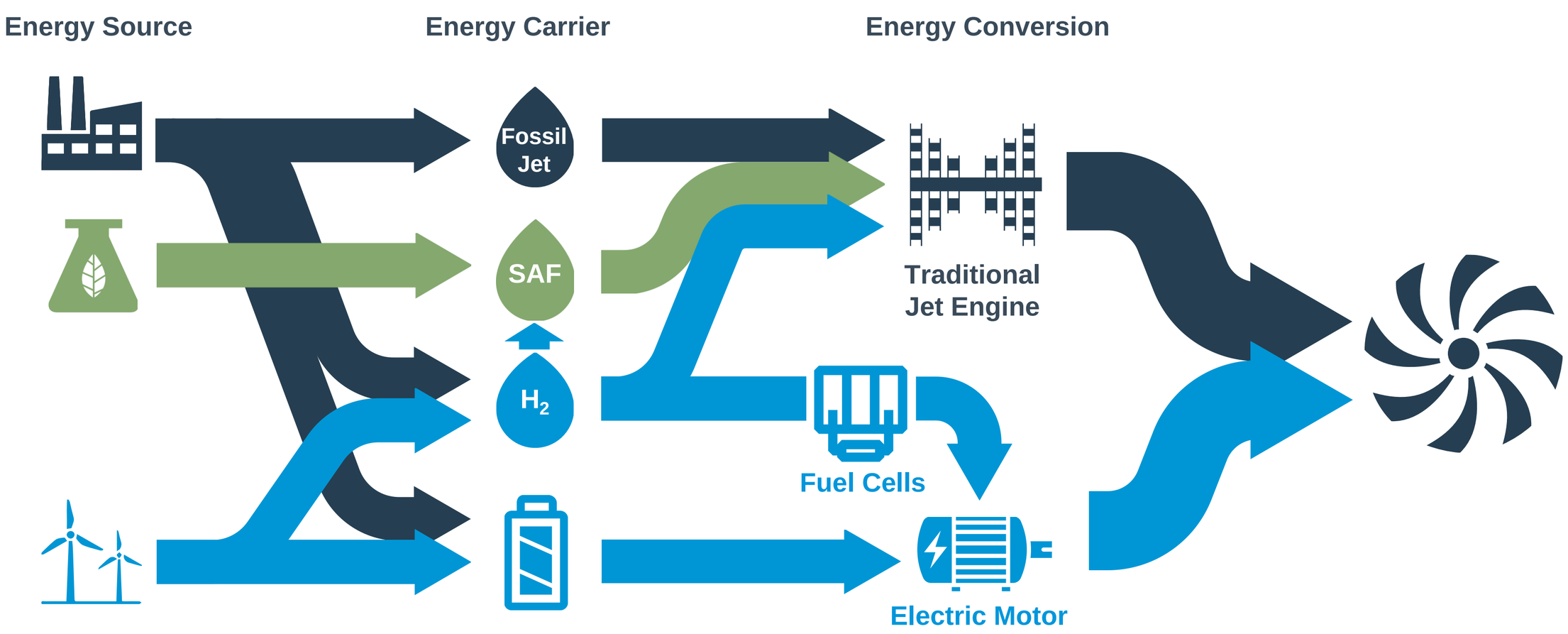
Autonomous,
all-electric air taxi


Boeing Fuel Cell Demonstrator
HK3B Super Dimona
BOEING
Boeing Phantom Works
Hydrogen combustion
World’s first piloted
H2 fuel cell aircraft

Artemis I

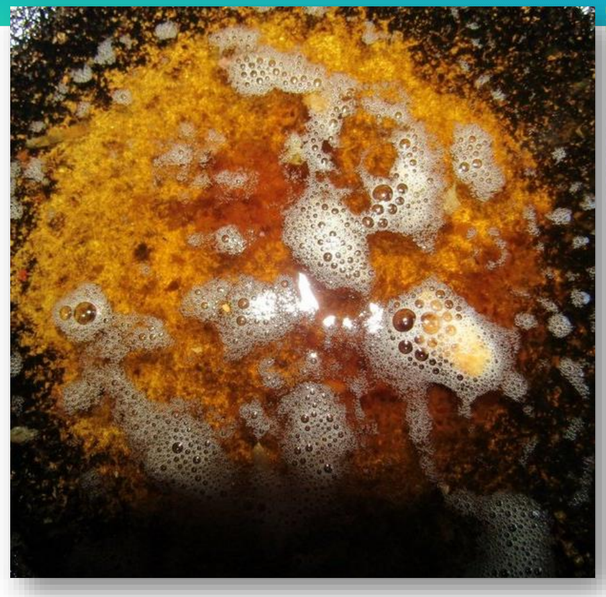
Energy Transition and Technology Landscape

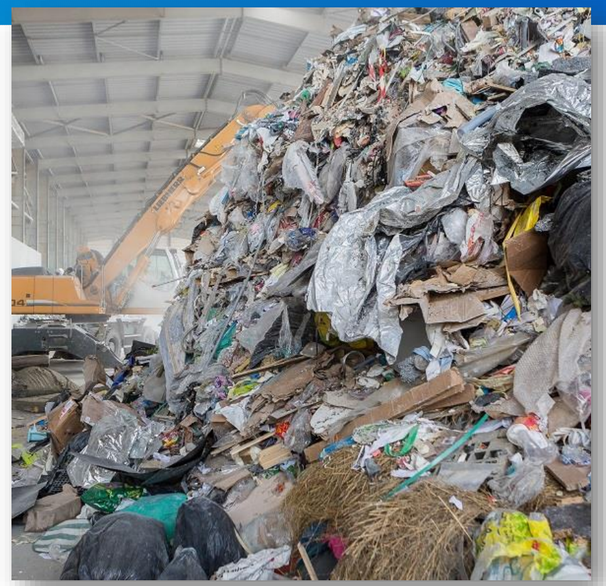
SUSTAINABLE AEROSPACE TOGETHER



SAF Feedstock pathways:
Must rapidly accelerate scalable solutions

SUSTAINABLE AEROSPACE TOGETHER





HEFA	Alcohol-to-jet	Fischer-Tropsch	Power-to-liquid
Now - Proven, scalable technology	**Next** - Near to mid term potential		**Long term** opportunity
Waste and residue lipids (fats, oils, greases), purpose grown sustainable oil energy plants	Gasification of agricultural and forestry residues, municipal solid waste, or sustainable cellulosic crops Crop based sugar alcohols		Renewable energy, industrial gases
Mature Commercial 2016+	Demo proven Early stage Commercial 2025+	First commercial plants in construction Early stage Commercial 2025+	Technology in development **Commercial 2035+**

SOURCE: WEF Clean Skies for Tomorrow Report and Boeing analysis

BOEING PROPRIETARY

WEF: First Movers Coalition (& Boeing)

SUSTAINABLE AEROSPACE TOGETHER

Boeing is the FMC Aviation Sector Champion and co-leads the work program

FMC works with existing initiatives to build on and complement ongoing efforts to accelerate the race to net-zero. The Coalition has different types of partners which all bring unique value to the decarbonization of hard-to-abate industries.

Eight sectors in scope of the FMC, representing >30% of global carbon emissions today & most new tech needs

SUSTAINABLE AEROSPACE TOGETHER

Launched at COP26

Launched at WEF Annual Meeting 2022

Launched at COP27

launched in 2023

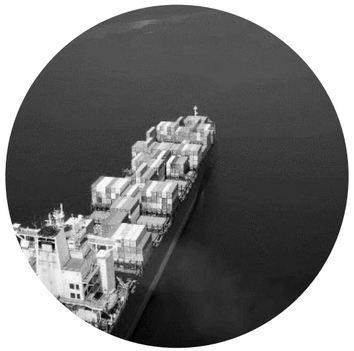
Aviation

Steel

Aluminum

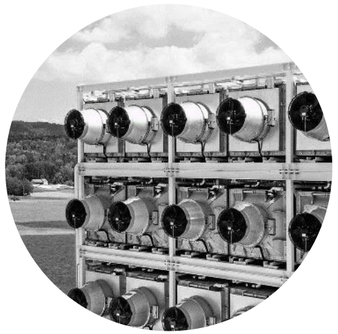
Cement / Concrete

Chemicals
(Plastics – PET, PP and PE)



Shipping

Trucking



Carbon Removal

Driving impact through sector-specific demand commitments

113 **total commitments** from **87 members** from top global corporations and non-profit organizations across **7 sectors**

…resulting in…

$15B **in demand** for near-zero-emission products and services

…supported by…

13 **government partners** representing over 50% of global GDP

Boeing Proprietary

Overview of current members

SUSTAINABLE AEROSPACE TOGETHER

Aluminium – 15 members

- Apple
- Ball Corp
- Bang & Olufsen
- CBA
- Constellium
- Ford Motor Company
- General Motors
- Hydro
- Logitech
- Novelis
- PepsiCo
- Speira
- Trafigura
- Volvo Cars
- Volvo Group

Aviation – 27 members

- Airbus
- American Express GBT
- Apple
- Autodesk
- Aveva
- Bain & Company
- Bank of America
- Boeing
- Boom
- Boston Consulting Group
- Chooose
- Deloitte
- Delta Airlines
- Deutsche Post DHL Group
- Eni
- EY
- FedEx
- Fortescue Metals Group
- Lufthansa Group
- Nokia
- PwC
- Rio Tinto
- Salesforce
- Schneider Electric
- United Airlines
- University of Michigan
- Vattenfall

Carbon Removal – 10 members

- AES
- Alphabet
- Boston Consulting Group
- Drax
- EGA
- Microsoft
- Mitsui O.S.K. Lines
- Salesforce
- SwissRe
- Trafigura

Cement & Concrete – 7 members

- CCC
- Etex
- General Motors
- RMZ
- Vattenfall
- Ørsted
- ZGF Architects

Shipping – 14 members

- A.P. Møller – Mærsk
- Agility
- Aker Biomarine
- Amazon
- BHP
- Fortescue Metals Group
- Höegh Autoliners
- Logitech
- Mitsui O.S.K. Lines
- Rio Tinto
- Schneider Electric
- Trafigura
- Western Digital
- Yara International

Steel – 25 members

- Aker Solutions
- Alfa Laval
- Bharat Forge
- Consolidated Contractors Group
- Ecolab
- EGUI
- Enel
- Engie
- Ford Motor Company
- Fortescue Metals Group
- General Motors
- Iberdrola
- Invenergy
- Johnson Controls
- Mahindra
- Mainstream Renewable Power
- Marcegaglia
- Ørsted
- ReNew Power
- Scania
- Trane Technologies
- Vattenfall
- Vestas
- Volvo Group
- ZF Friedrichshafen AG

Trucking – 15 members

- Agility
- Cemex
- Dalmia Cement
- Fortescue Metals Group
- Heidelberg Cement
- Holcim
- National Grid
- Norge Mining
- PepsiCo
- Rio Tinto
- Scania
- SSAB Swedish Steel
- Toll Group
- Vattenfall
- Volvo Group

October 2023

6 priority activities for FMC in 2023

SUSTAINABLE AEROSPACE TOGETHER

Drive offtake to
accelerate supply availability

Recruit demand
across the value chain to demonstrate market viability

1 **Targeted Recruitment**

Surface supply
to accelerate and catalyze investment decisions

2 **Supplier Database**

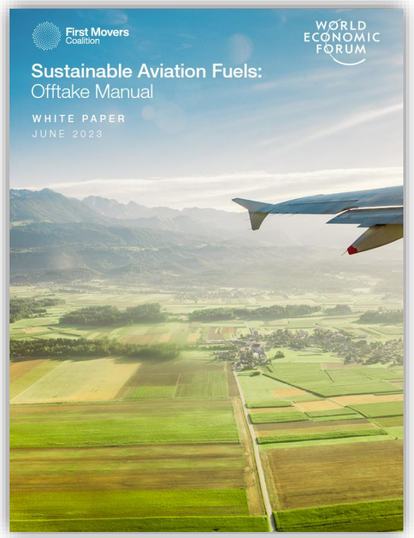
3 **In-Country Workshops**
- ✓ Singapore (June)
- ✓ India (11-12 July)
- → Brazil (9-11 October)
- → USA (23-24 October)

4 **Innovation Challenges**
- → UpLink Sustainable Aviation Challenge (August-January)
- → Near-Zero 2030 Steel Challenge (September-January)

Establish tools
and processes to
streamline procurement

5 **Collaborative RFP**

6 ✓ **Procurement Innovation Dialogues** (14-15 September)



Infrastructure Pillar | Finance Pillar | Government Engagement

Build enabling ecosystem

The FMC Aviation sector is leveraging airline buying power to accelerate the development of next generation SAF

SUSTAINABLE AEROSPACE TOGETHER

In process of recruiting more airlines across new geographies

FMC's access to key stakeholders uniquely positions them to accelerate the development of next generation SAF

27 Total commitments in aviation

… resulting in …

~3.5Mt of demand for near-zero sustainable aviation fuels

Airlines and OEMs

Committed to >5% of fuel demand from sustainable aviation fuels with LCA >85% by 2030

BOEING, UNITED, DELTA, BOOM, AIRBUS, FedEx, DHL, Lufthansa

Airfare/Airfreight purchasers

Committed to partner with air transport operators for >5% of fuel from sustainable aviation fuels with LCA >85% by 2030

RioTinto, BANK OF AMERICA, GLOBAL BUSINESS TRAVEL, pwc, NOKIA, University of Michigan, VATTENFALL, AVENA, salesforce, Schneider Electric, BAIN & COMPANY, AUTODESK, CHOOOSE, BCG BOSTON CONSULTING GROUP, EY, FMG Fortescue, Deloitte., eni

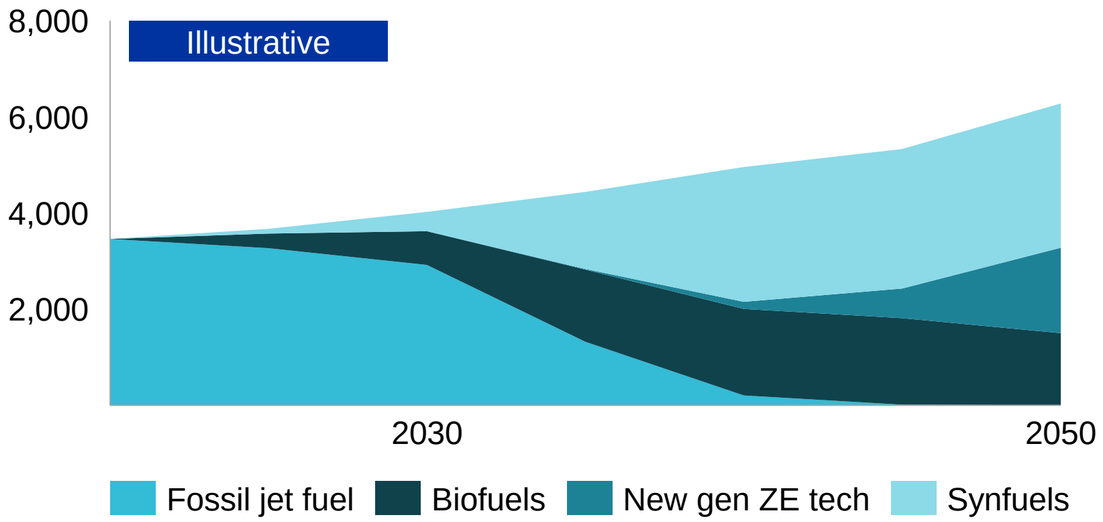
13 Government partners representing 50% of global GDP supporting FMC more broadly

Aviation | Commitment scope

2.5%
global emissions today

SUSTAINABLE AEROSPACE TOGETHER

Energy demand (TWh)



Technologies in FMC scope

- Sustainable Aviation Fuels[1] with LCA GHG reduction ≥ 85%
- New generation near–zero emissions propulsion technologies, incl.
  - Battery–electric
  - Hydrogen turbine and fuel cells

Airline

> By 2030, we will replace at least 5% of conventional jet fuel demand with sustainable aviation fuels (SAFs) that reduce life–cycle GHG emissions by 85% or more when compared with conventional jet fuel, and/or using zero–carbon emitting propulsion technologies

Airfare/airfreight purchaser

> By 2030, we will partner with air transport operators to replace at least 5% of conventional jet fuel used for our air travel/freight with sustainable aviation fuels (SAFs) that reduce life–cycle GHG emissions by 85% or more when compared with conventional jet fuel, and/or zero–carbon emitting propulsion technologies

1. Neat SAF with >85% LCA, using the Schneider–Kildee–Brownley–Brown–Cantwell definition.
Disclaimer: the Climate Pathway scenario is the result of an analysis assuming aggressive cost reductions, progressive technology developments and future breakthroughs, and high investments from 2021 onwards

4 key pathways to produce SAF, with unique challenges and potential

SUSTAINABLE AEROSPACE TOGETHER

	Hydroprocessed esters and fatty acids (HEFA)*	Alcohol-to-jet	Gasification Fischer-Tropsch	Power-to-liquid
Opportunity Description	Mature technology: Safe, proven, and scalable technology	Technology in commercial pilot: Potential in mid-term, given higher GHG reduction possible vs fossil jet fuel; however, significant techno-economical uncertainty		Technology in development: Proof of concept 2025+, primarily where cheap high-volume green electricity is available
Announced global cap.[1]	16.1Mt (88% total)	1.0Mt (6% total)	0.9Mt (5% total)	0.3Mt (2% total)
Feedstock[2]	Waste and residue lipids, purposely grown oil energy plants (e.g., UCO, tallow, etcl)	Agricultural and forestry residues, municipal solid waste, purposely grown cellulosic energy crops (e.g., sugarcane, corn grain)		CO_2 & green electricity; unlimited potential via direct air capture
LCA % reduction[3]	14%-84% *(proven ability to reach 85%)*	13%-73% *(potential to reach 85%)*	86%-100%	98%
Additional abatement levers	• Regenerative agriculture and cattle management • Renewable power • Green H_2 conversion feedstock • Conversion power with green H_2 instead of natural gas		• Electrified transportation • Renewable power	• DAC CO_2 • Green H_2 produced on-site with renewable power

1. WEF: Estimate from as of November 2022 announced projects from public research, not comprehensive; 2. Non-exhaustive; 3. Reduction of LCA emissions from conventional jet fuel at 89 gCO2/MJ (including ILUC); Source: Mission Possible Partnership, Clean Skies for Tomorrow; CORSIA Eligible Fuels – Life Cycle Assessment Methodology report; BCG analysis

Cascade

SustainabilityTogether.aero

SUSTAINABLE AEROSPACE TOGETHER

MIT LABORATORY FOR AVIATION AND THE ENVIRONMENT

IATA

UNIVERSITY OF CAMBRIDGE

Aviation Impact Accelerator

NASA

BOEING

SUSTAINABLE AEROSPACE TOGETHER

sustainabilitytogether.aero