Sustainable aviation

Facts, figures, Stakeholders map
Interdisciplinary research

L. Joly - Deputy Head of Research - Director of the ISA — 2022 September 1st

Facts and figures

ATS stakeholder map

Interdisciplinary research

Download here : https://oatao.univ-toulouse.fr/28978/

A sourced scientific sum
- 222 pages
- 82 figures and tables
- 250 references

3 core parts
1. Impact on env/climate
2. Technological levers
3. Scenarios

5 take-home messages

take-home messages

- *Aviation impact on climate :*

  2,6% of CO2 emissions (2018)

  5,1% of anthropogenic warming (2000-2018)
- *cumulative CO2 effects*

  Long term contribution to the atmospheric CO2 content
- *Short-term uncertain non-CO2 effects*

  Radiative forcing by contrails + NOx + cloud-aerosol (Lee 2021)
- *Traffic is one major lever of action*

  After all operational and technological gains
- *Uncertainty on non-fossil fuels availability*

  Decarbonization of aviation fuels and production scale-up comes with uncertainty, use competition and side effects

How to get things done ?

How do we get the big ship to make a quick turn?

A turn toward... ? 2050 Net Zero or Stay Grounded ?

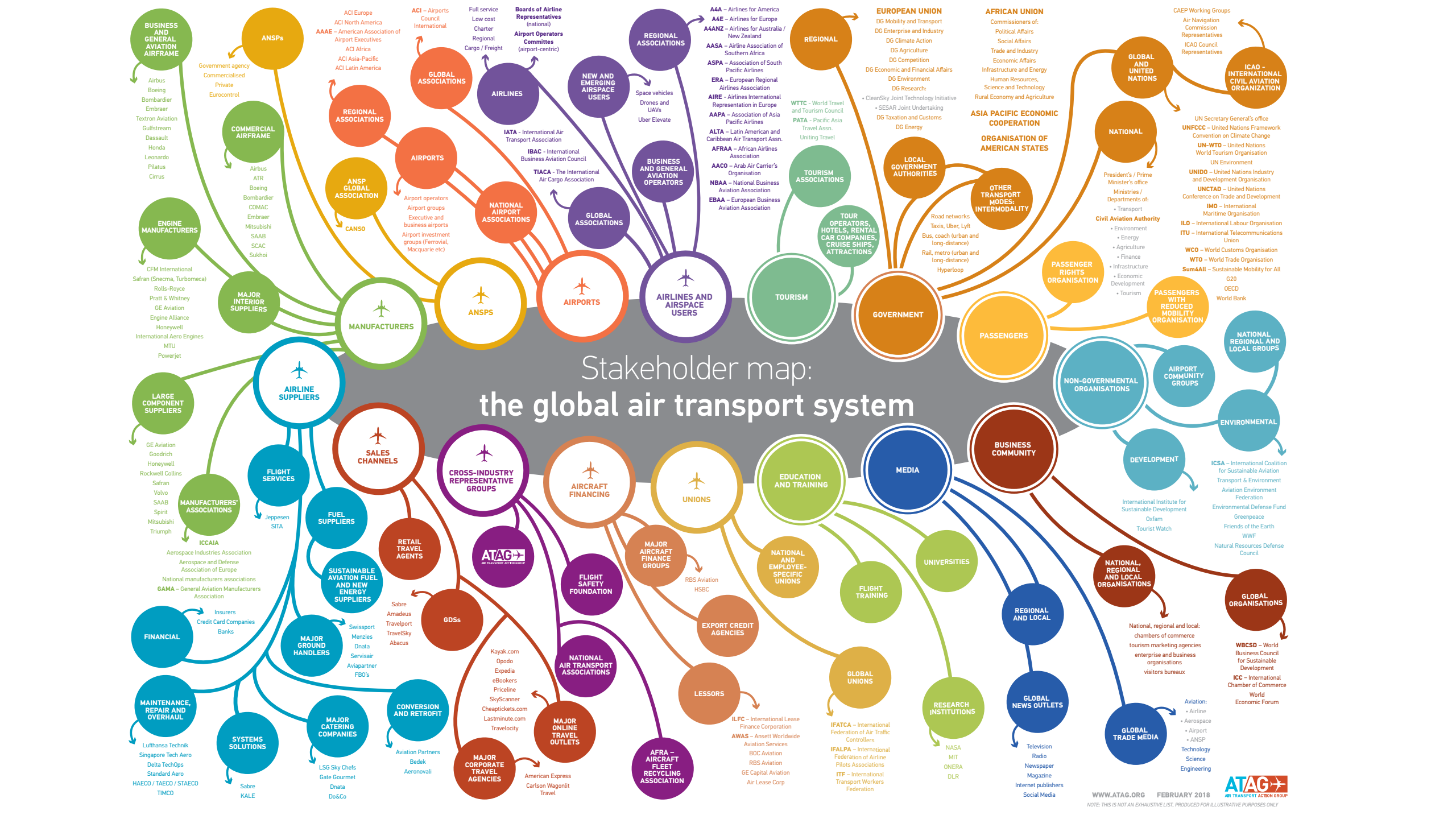
Facts and figures

Aviation (ATS) stakeholder map

Interdisciplinary research

“Remember, always, that everything you know, and everything everyone knows, is only a model. Get your model out there where it can be viewed. Invite others to challenge your assumptions and add their own.”

— Donella H. Meadows, Thinking in Systems: A Primer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Government agency
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Eurocontrol
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WBCSD – World Business Council for Sustainable Development
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The ATS System

A complex intertwined multi-actors **system**

Capital/industrial/HR/material(energy) **intensive**

10 million **jobs** in the industry, 65m supported on a wider scope (2018)

12 millions of **passengers** a day, $3 trillion in the global economy (3,6%)

With socio-economic **inertia** and key to the **global economy**

Associated to **social norms** of freedom, intercultural exchange and trigged by business trips and the Visiting Friends and Relatives (**VFR**) motivation

Hard to abate technology (fly the payload and fuel mass + cell and engine)

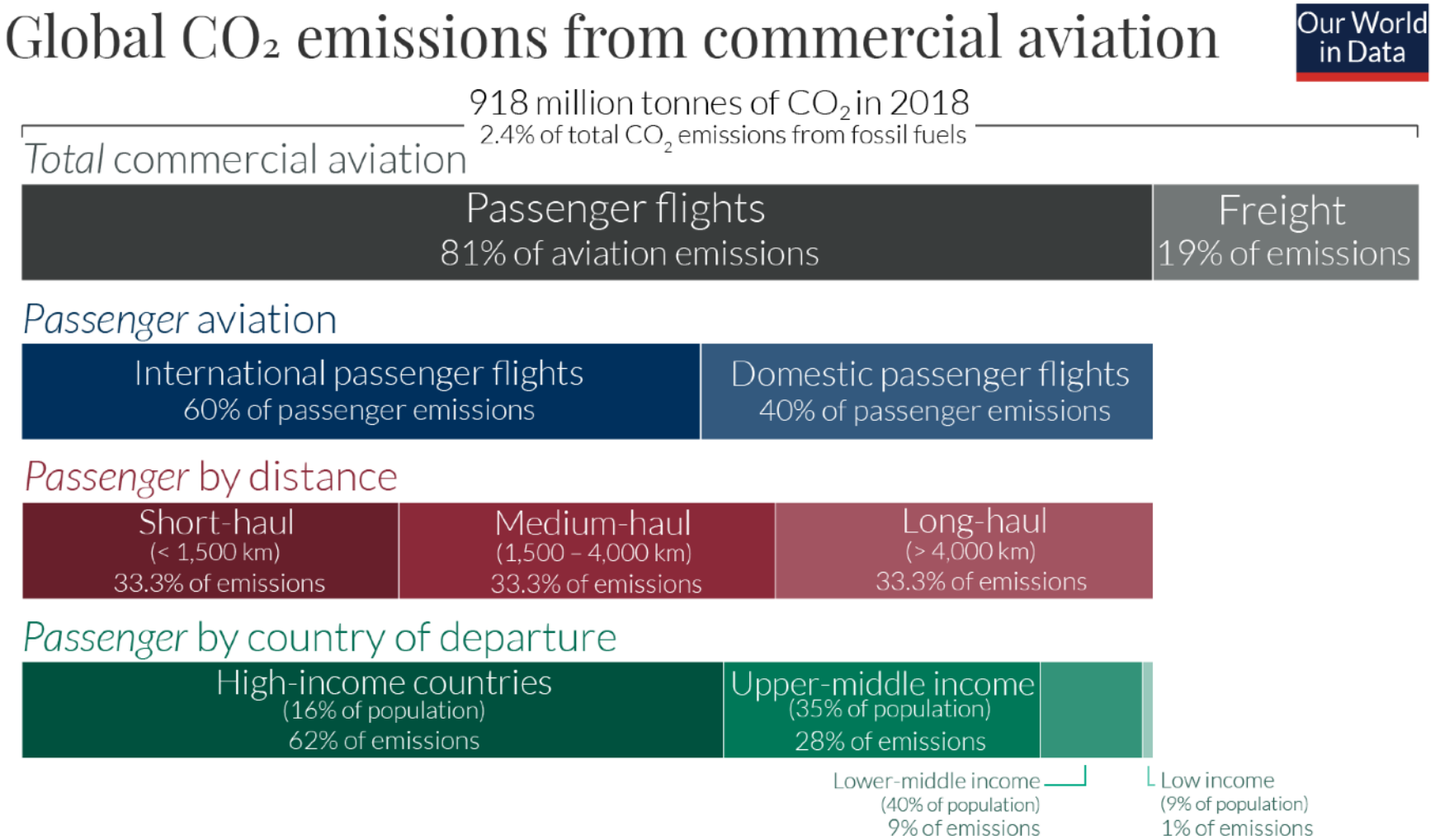
Global issue and multi-scale, some are **local**, stakeholders

Both **high**-tech and **high**ly symbolic

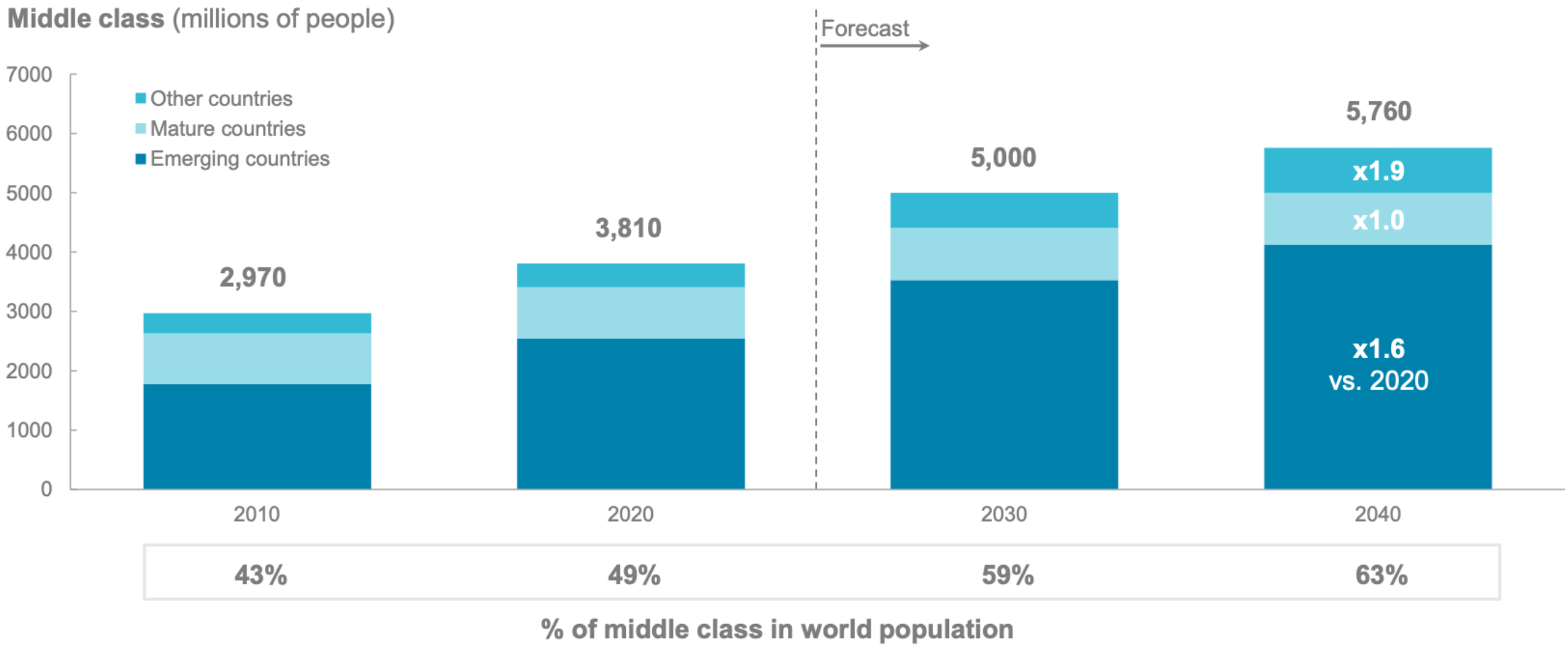
Dependent on the **energy** sector, on which the **tourism** sector depends


Aviation connects and unites us!
Airbus Global Market Forecast 2021 - 2040
AIRBUS

Uses and Users



Middle class will enlarge both in relative and absolute numbers

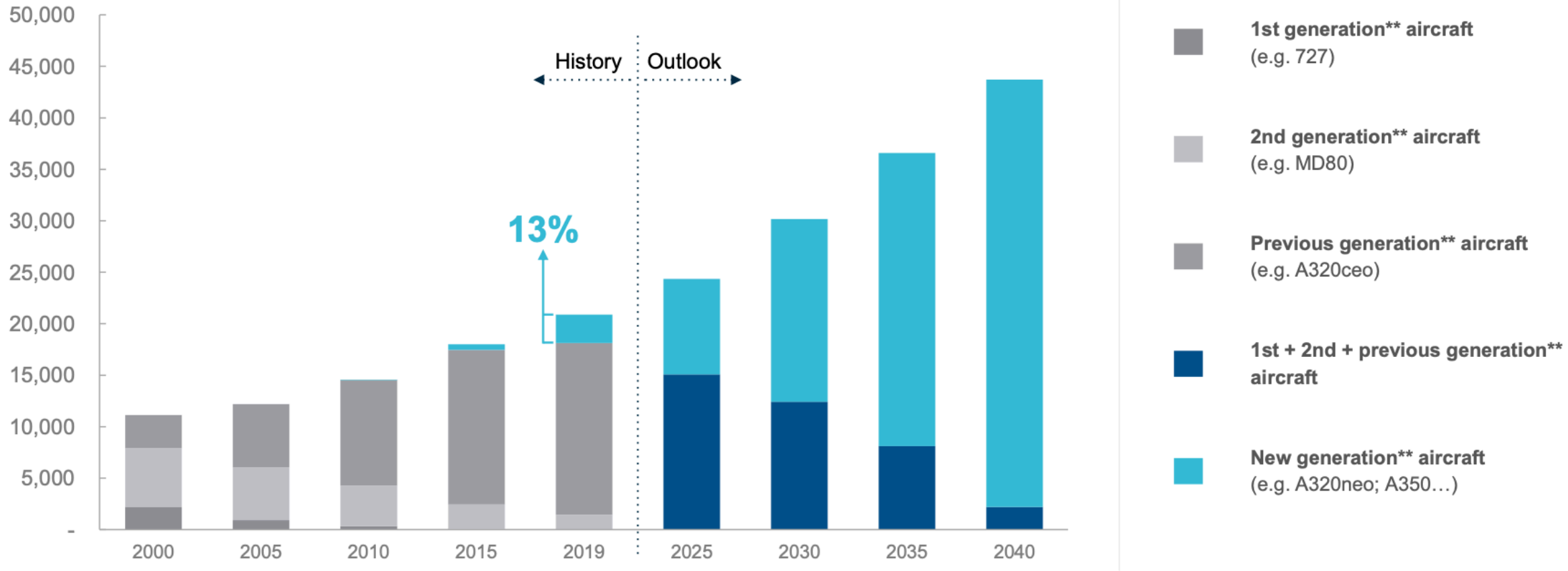


Middle class: Households with yearly income between $20,000 and $150,000 at PPP in constant 2015 US$
Source: Oxford Economics, Airbus GMF

AIRBUS

Only 13% of 2019 fleet in service were new generation aircraft

Number of passenger aircraft in service*

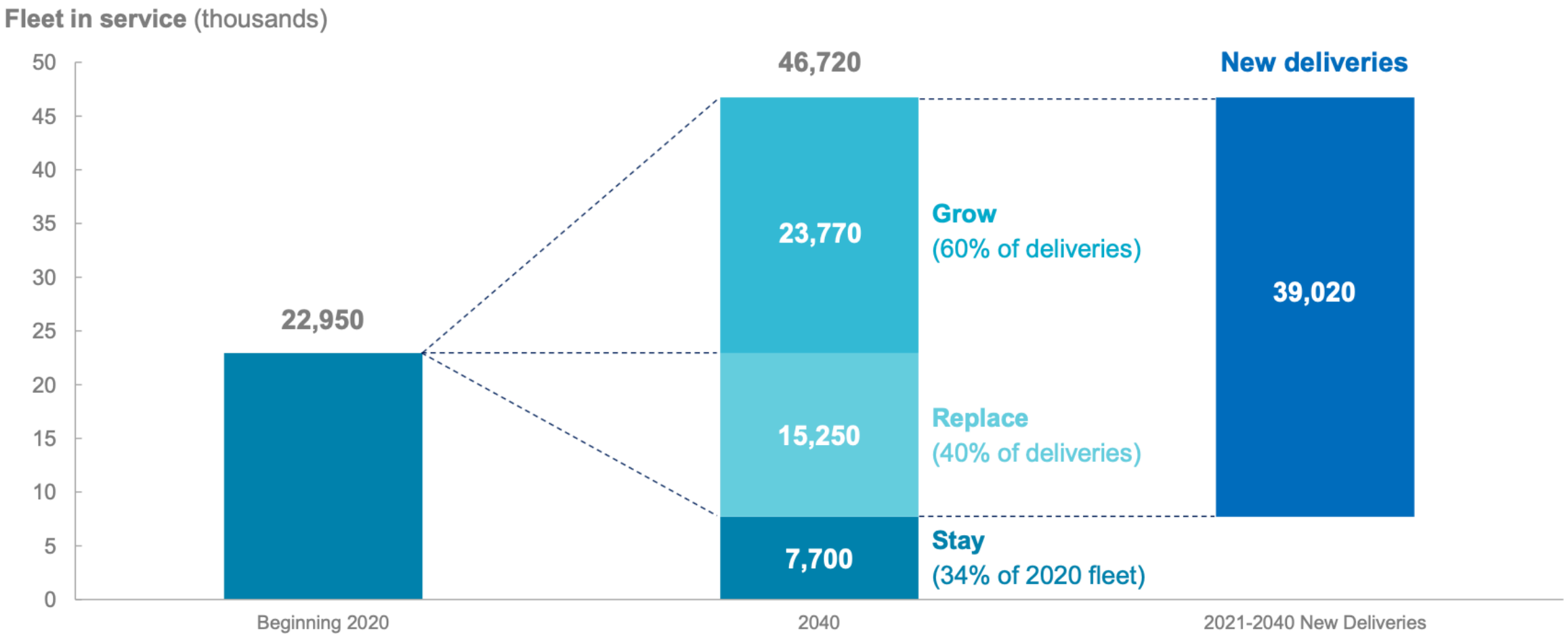


Source: Cirium, Airbus

* Western built passenger aircraft above 100 seats – pax aircraft only / **1st generation: A300, DC 9, DC10, 707, 727, 737, 747 / 2nd generation: A310, MD11, MD80, MD90,737, 747, 757, 767, F100 Previous generation: A320 Fam., A330, A340, 717,737NG, 747, 777 / New generation: A220, A320neo Fam., A330neo, A350, A380, 737Max, 777X, 787 & new programs

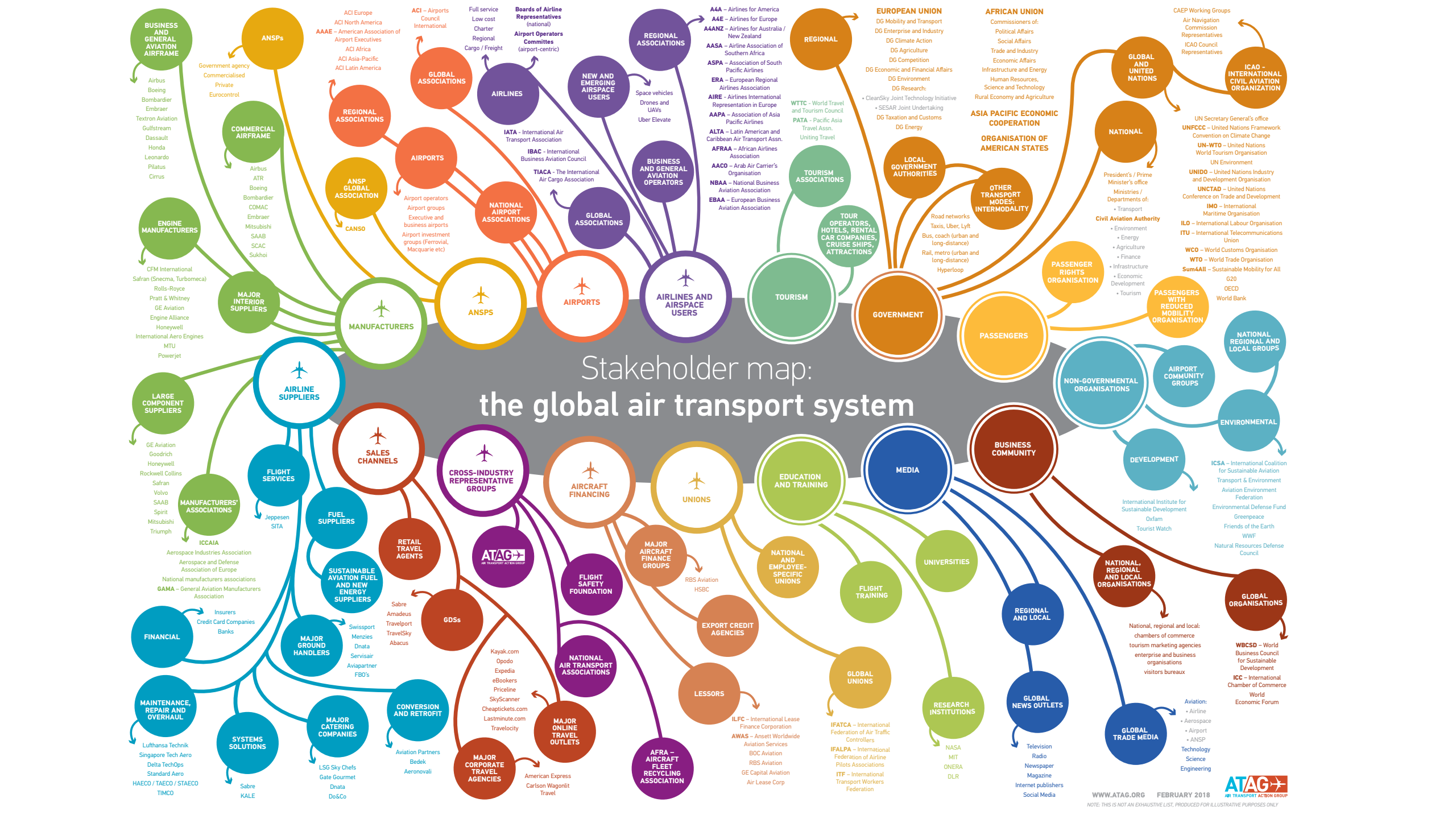
AIRBUS

Demand for some 39,000 aircraft over the next 20 years



Notes: Passenger aircraft (≥100seats) & Freight (>10t) | Rounded figures to nearest 10
Source: Airbus GMF 2021

AIRBUS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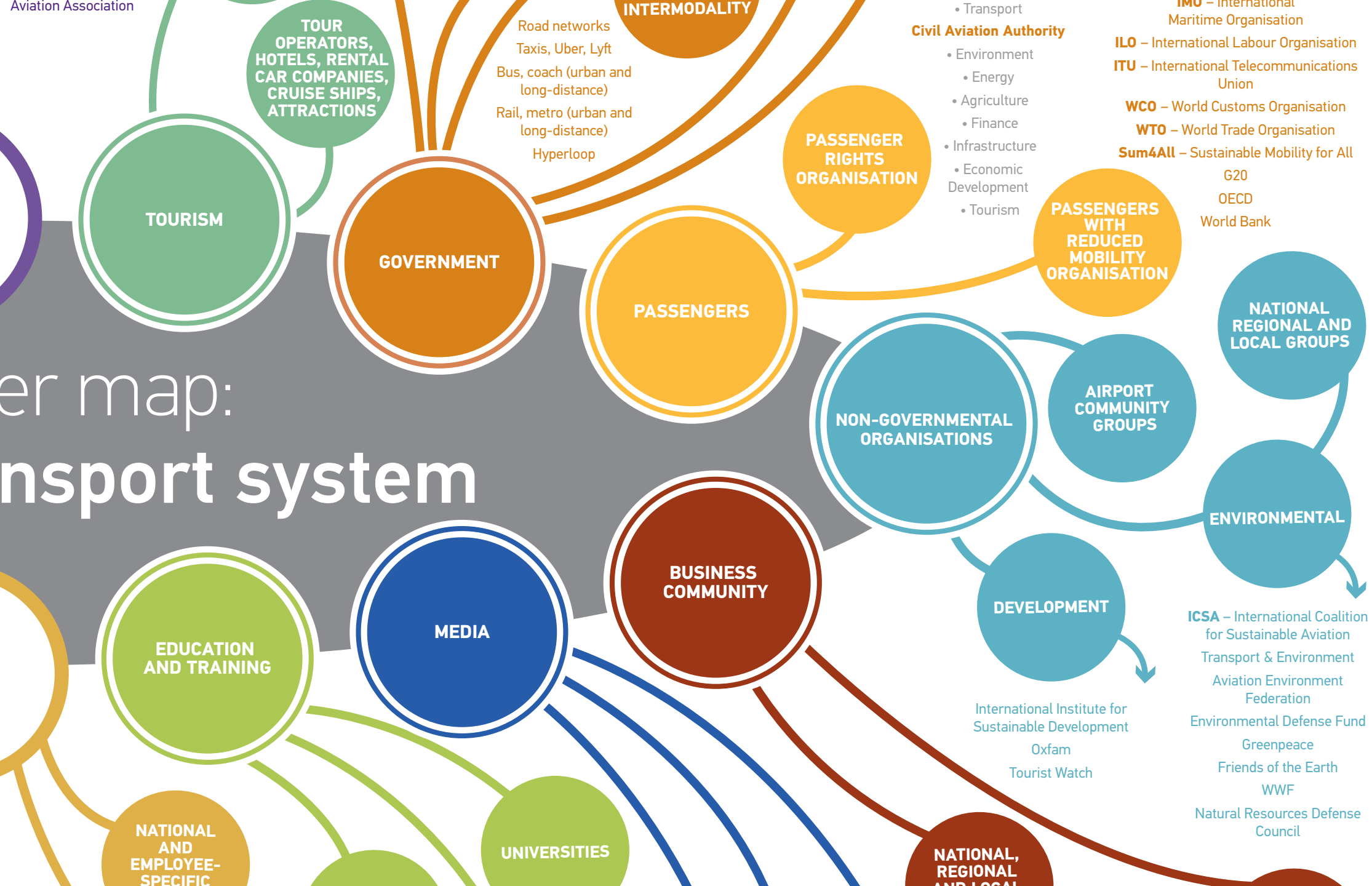
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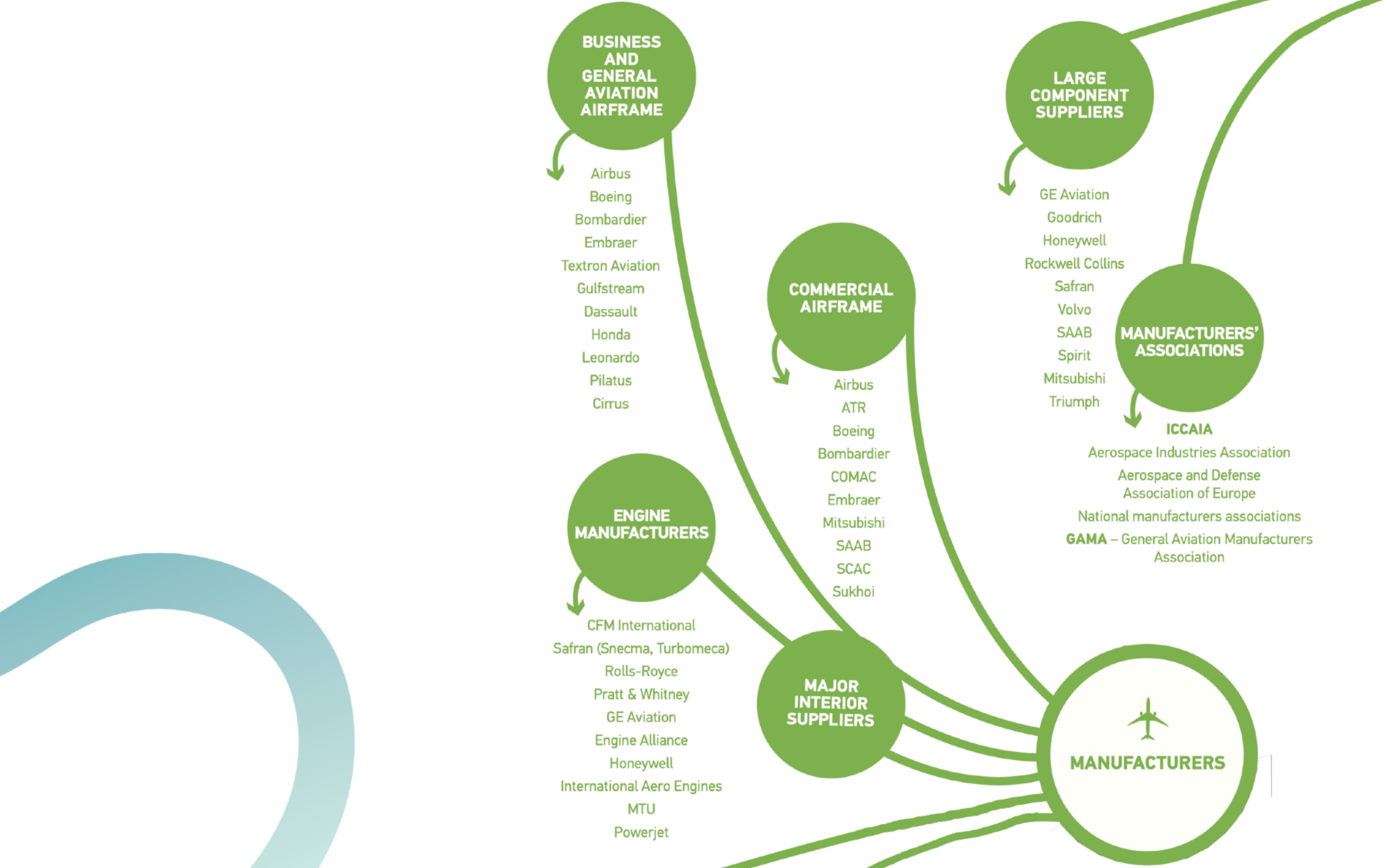
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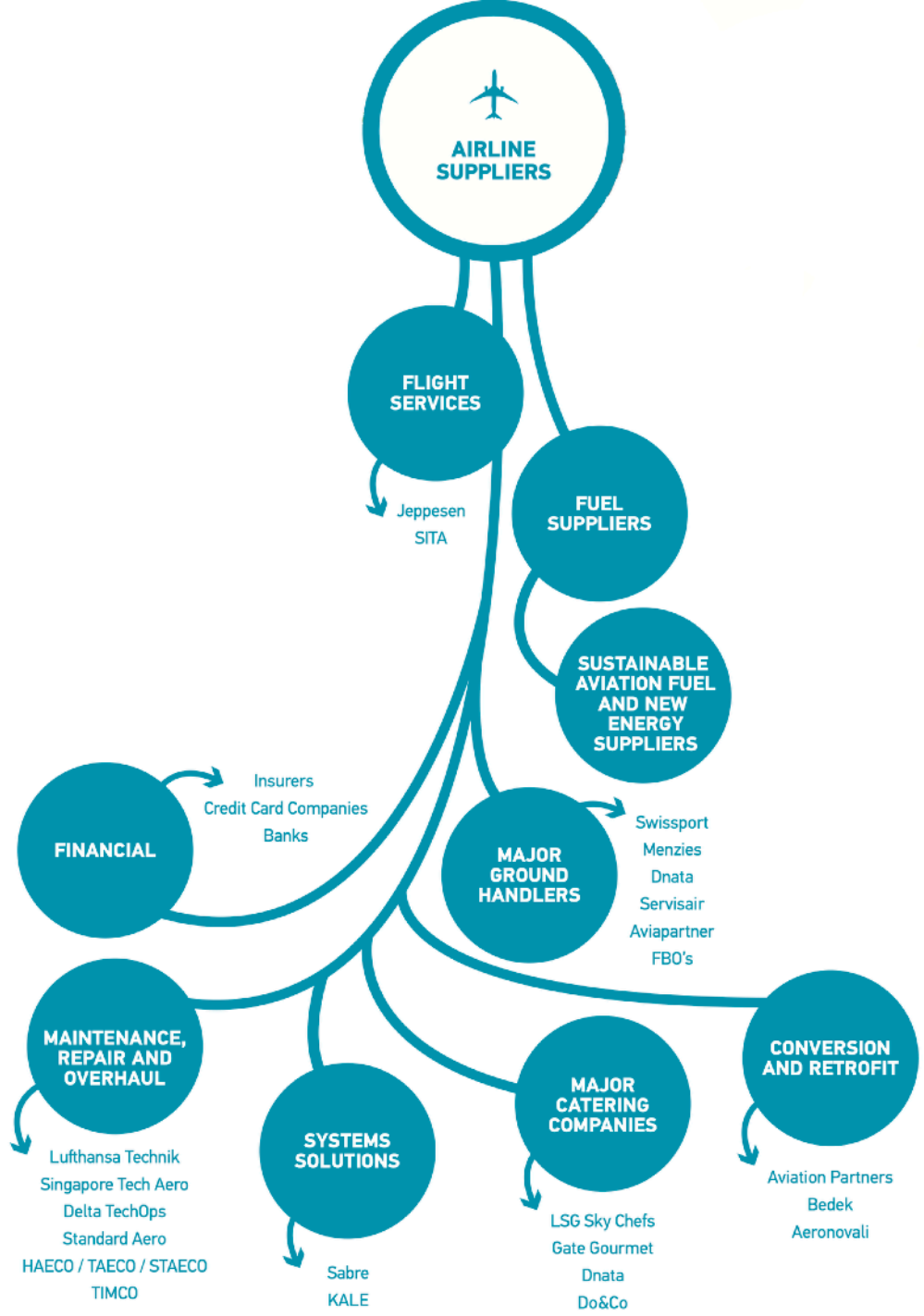
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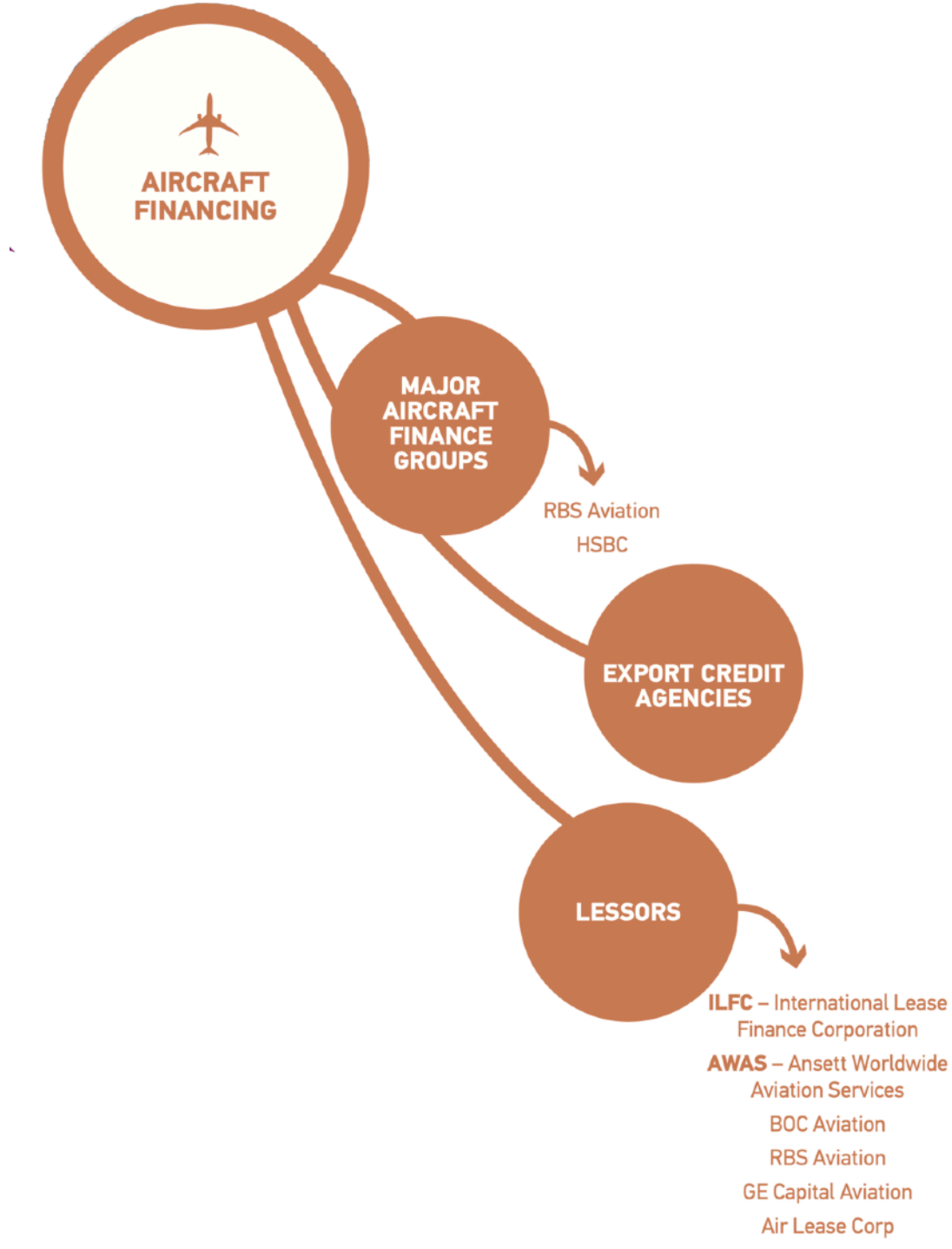
Dnata
Do&Co
CONVERSION AND RETROFIT
Aviation Partners
Bedek
Aeronovali


AIRCRAFT FINANCING
MAJOR AIRCRAFT FINANCE GROUPS
RBS Aviation
HSBC
EXPORT CREDIT AGENCIES
LESSORS
ILFC – International Lease Finance Corporation
AWAS – Ansett Worldwide Aviation Services
BOC Aviation
RBS Aviation
GE Capital Aviation
Air Lease Corp

A JUNGLE OF ACRONYMS

AUTHORITIES

PROFESSIONAL ASSOCIATIONS AND LOBBIES

SCIENCE AND RESEARCH ASSOCIATIONS

International

ICAO

ATAG AIR TRANSPORT ACTION GROUP

IATA

canso civil air navigation services organisation

AIA AEROSPACE INDUSTRIES ASSOCIATION

GAMA

ACI AIRPORTS COUNCIL INTERNATIONAL

AIAA The World's Forum for Aerospace Leadership

EBAA

Europe

EASA European Aviation Safety Agency

EUROCONTROL

ASD AeroSpace and Defence Industries Association of Europe

A4E AIRLINES FOR EUROPE

era european regions airline association

CEAS Council of European Aerospace Societies

PEGASUS

ACARE

EREA

easn european aeronautics science network

Clean Sky

SESAR JOINT UNDERTAKING

FCH

France

dgac

CORAC Aéronautique Environnement Recherche

GIFAS

3AF Association Aéronautique Astronautique de France

AAE ACADÉMIE DE L'AIR ET DE L'ESPACE AIR AND SPACE ACADEMY

MAP OF CIVIL SOCIETY STAKEHOLDERS

Public policies

Travelers, consumers

Industry stakeholders and pro-aviation lobbies

Think tanks, whistleblowers, anti-aviation NGOs and activists

Engineers Scholars Intellectuals

The gateway to environmental law

Facts and figures

ATS stakeholders map

Interdisciplinary research

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THINK THE FUTURE OF FLYING

isae Institut Supérieur de l'Aéronautique et de l'Espace SUPAERO

ENAC

TSE

tbs Business School

METEO FRANCE

CERFACS

UNIVERSITÉ TOULOUSE Jean Jaurès

UNIVERSITÉ TOULOUSE 1 CAPITOLE

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Towards Sustainable Aviation

State variables (current state, target state: net zero in 2050)
Pathway variables: environmental and socio-economic efficiency
Technological innovation to open the space of feasible trajectories
Availability and allocation of decarbonized energy upstream (bio- and e-fuels)
Financing innovation, infrastructure and fleet renewal,
Change in operations and uses, some obsolete and others new
Social, geographical and intergenerational equity

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Institute for Sustainable Aviation

PROGRAM ROADMAP– 2022-26 STRATEGY

LAURENT JOLY

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Programs and instruments

Programs

ASM Aviation Sustainability Metrics
aeroVerse : the aviation digital twin
TSAR Towards sustainable aerial routes
SAFH2 Sustainable aviation fuels and Hydrogen aviation
ERA Electric regional aviation
AFPW Aviation finance path ways

Instruments

PhD and *Master students*
Scientific animation (Seminars, mobility et diffusion)
Industry partnerships
Transfer towards education programs

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AeroVerse: the IAM of aviation.

This program aims to build an Integrated Assessment Model (IAM) for the commercial aviation sector (passengers and freight). Integrated assessment models are now the methodological paradigm for climate (IPCC). They are also at the center of work in industrial ecology.

The IAM of aviation aims at providing a consequential picture of decisions made about energy flows, environmental regulation, taxation, material and financial resource flows, by linking the **physical-technical causal sphere with the socio-economic causal sphere**.

The AeroVerse program therefore aims at assembling and updating by data assimilation a multi-scale numerical twin of aviation, with increasing perimeter and spatiotemporal resolution. This model will be the repository of partial models from other programs and data from the aviation system.

AeroVerse is in a way the foundation program and the receptacle of ISA productions in terms of quantitative modeling.

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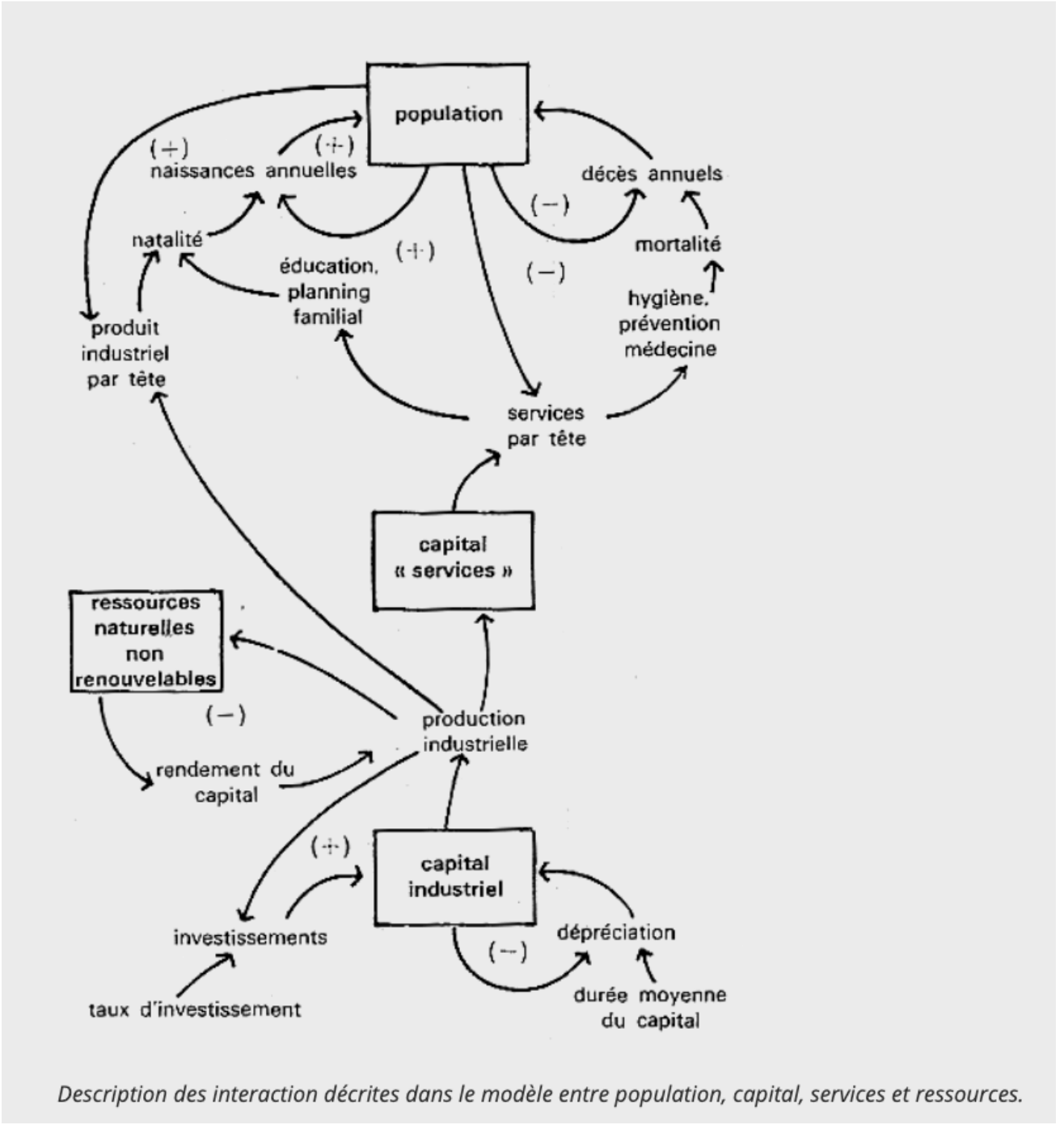
Graph of interactions from the Meadows report 1972



Description des interaction décrites dans le modèle entre population, capital, services et ressources.

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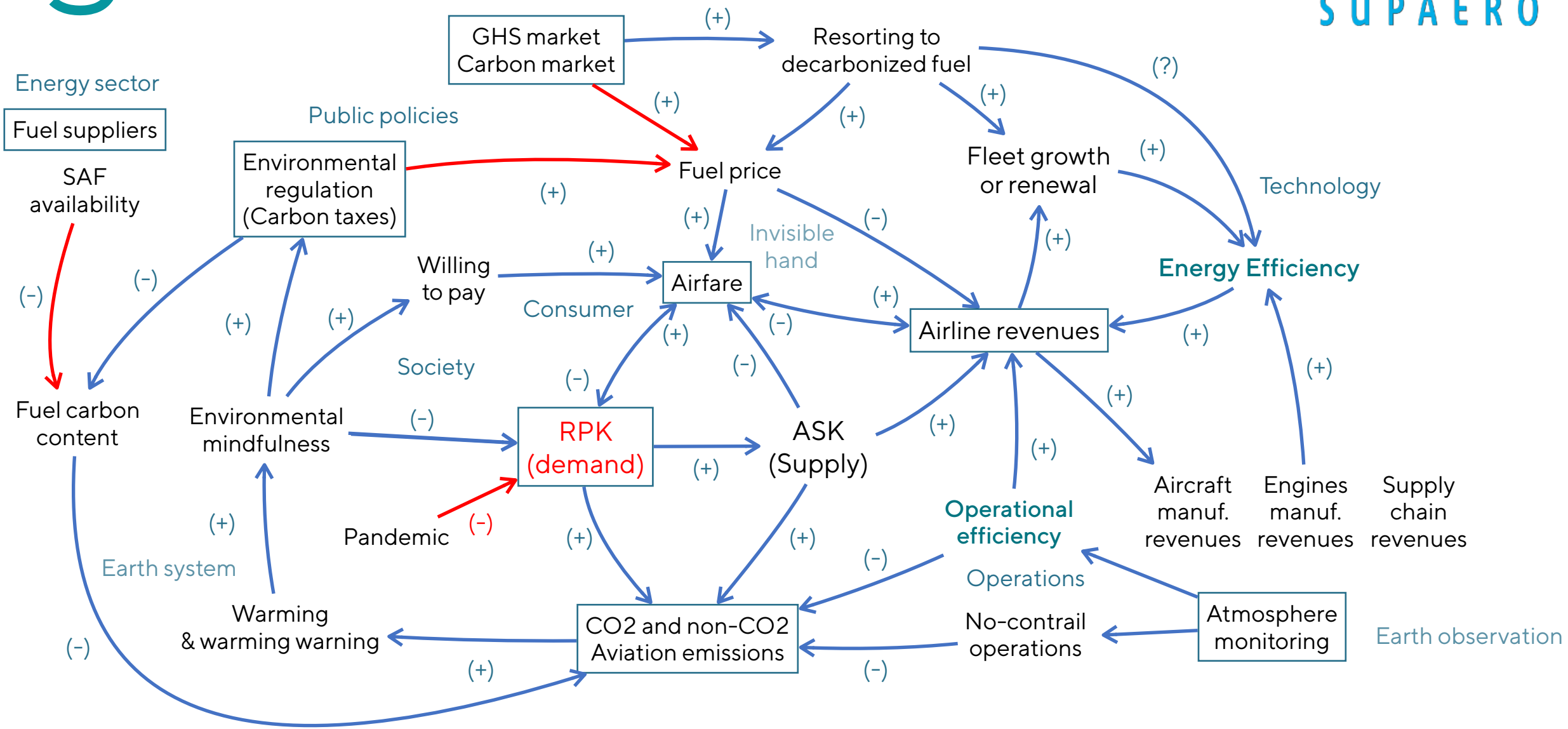
GRAPH OF INTERACTIONS

ISAE SUPAERO Institut Supérieur de l'Aéronautique et de l'Espace



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Thank you