経済産業省

今後の我が国の航空機産業

- Outlook of Japanese Future Aerospace Industry -

2022.10.21

経済産業省 製造産業局 航空機武器宇宙産業課

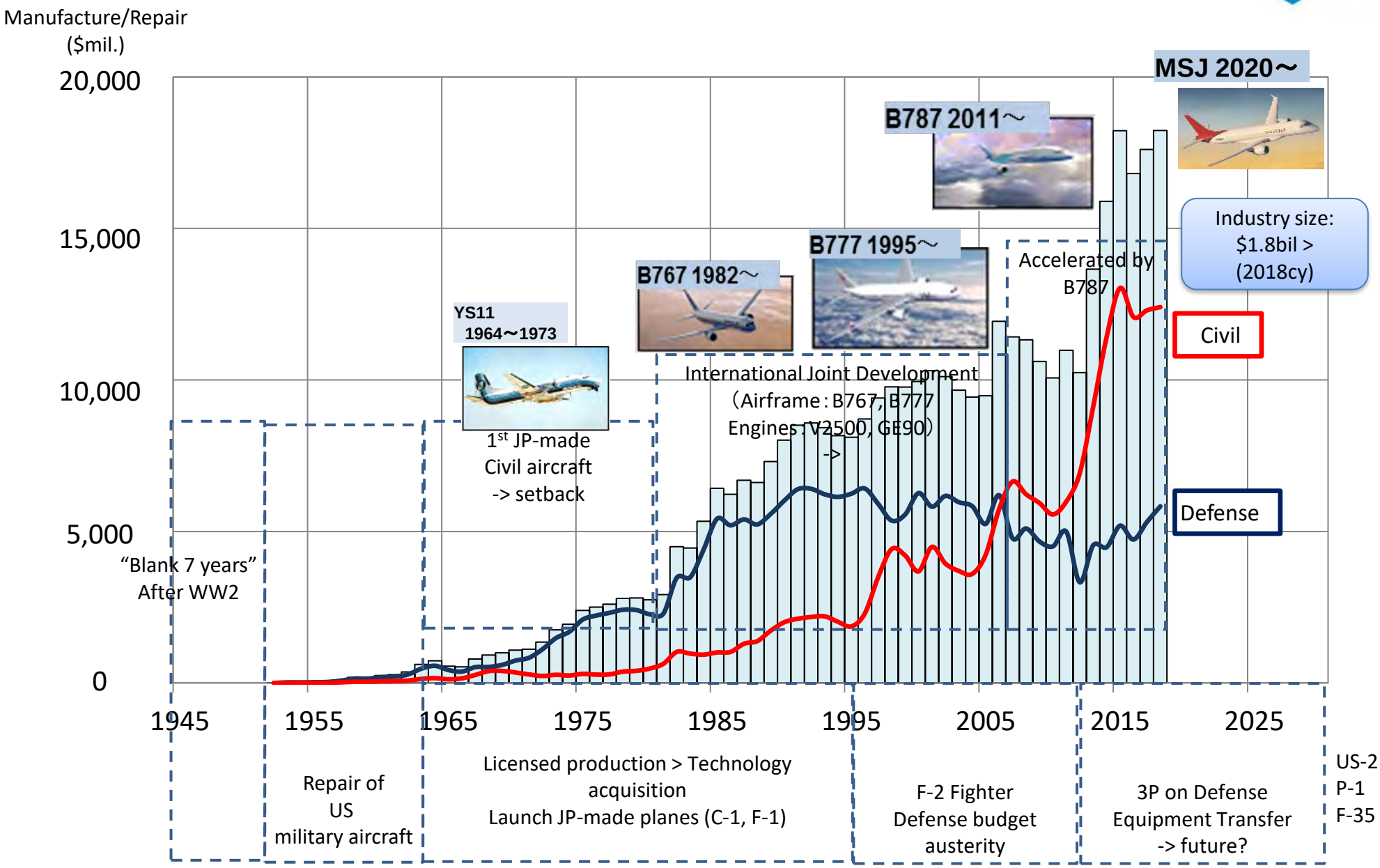
【Today’s Topics】

１．航空機産業のこれまで
- History and Outline of Japanese Aerospace Industry -

２．世界の航空機産業の潮流（市場、環境）

３．今後の方向性、経済産業省の施策

History & Future of Japanese Aircraft Industry

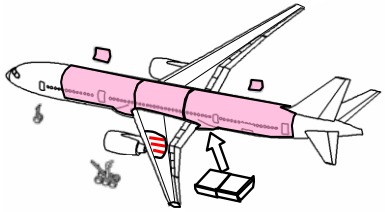


Japan as a Joint Development Partner

- Japan has been participating in international projects working on airframe structure and engine parts for more than 40 years .

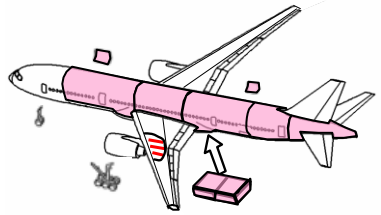
Airframe

B767 (250 seats)



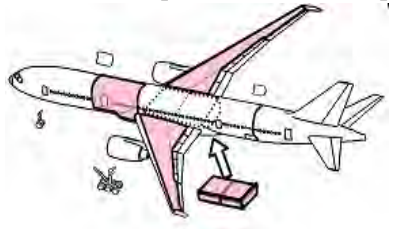
Participation : 15%

B777 (380 seats)



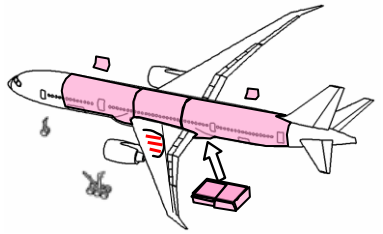
Participation : 21%

B787 (250 seats)



Participation : 35%

B777X (400 seats)



Participation : 21%

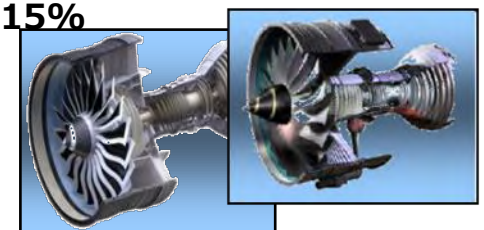
Next Generation

Engine

IAE（JV w/PW etc.）: V2500 (A320 (150 seats))
Participation: 23%

RR:Trent800/ GE: GE90 (B777 (380 seats))
Participation: 9～10%

RR: Trent1000 / GE: GEnX (B787 (250 seats))
Participation: 15%



PW: PW1100G-JM (A320neo (150seats))
Participation: 23%

GE: GE9X (B777X (400 seats))
Paritication: 10.5%

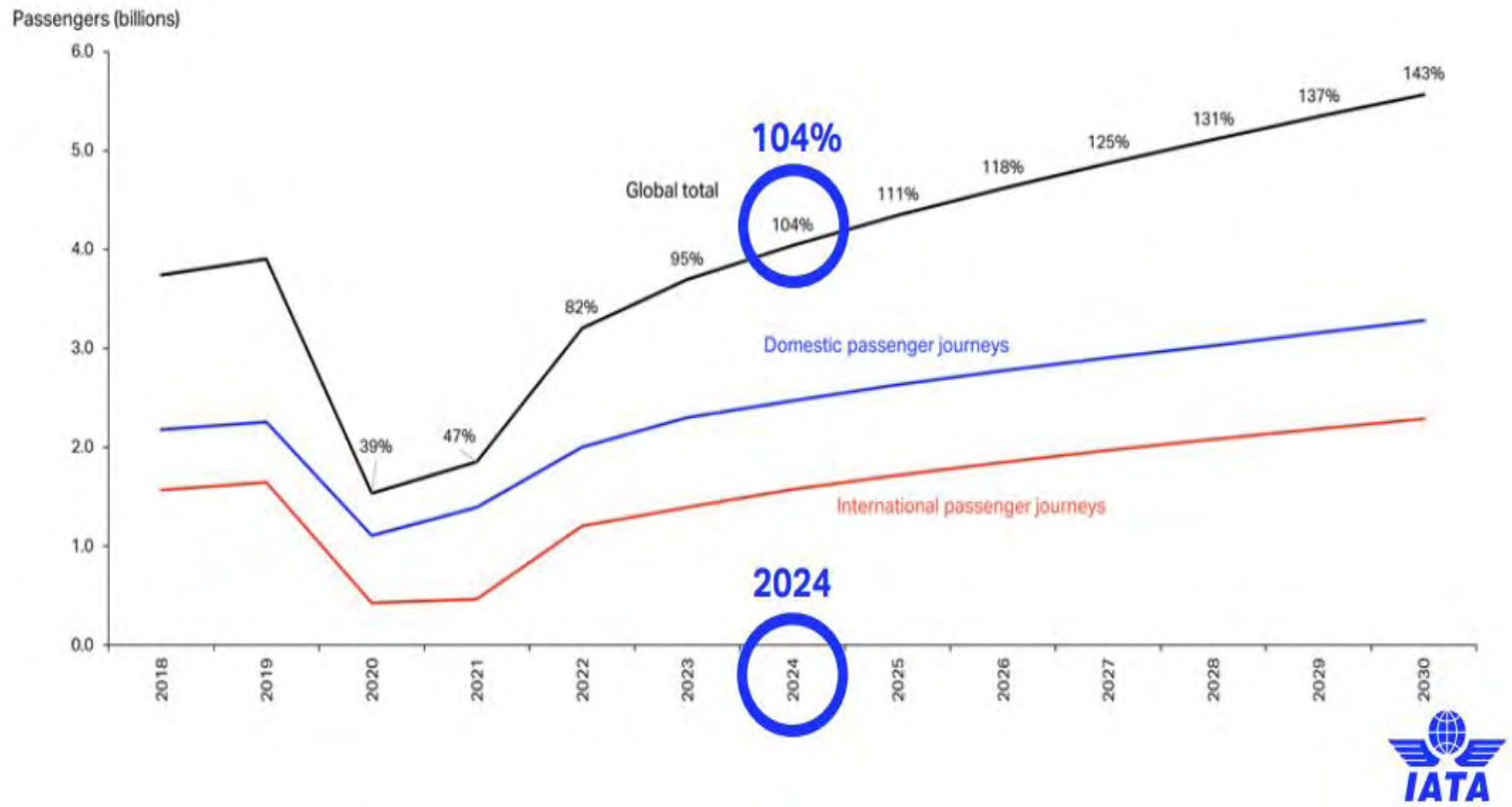
１．航空機産業の歴史

２．世界の航空機産業の潮流（市場、環境）
- Trend of World Aerospace Industry
(Market, Environment) -

３．今後の方向性、経済産業省の施策

Impact of COVID-19 on the aircraft industry

- **Before COVID-19**, global civil aircraft market was prospected to **increase 5% every year**.
- COVID19 caused **sharp decrease** in passenger demand, and significant reduction in production rate by Boeing Airbus etc.,
- **Passenger demand is expected to return to 2019 level in 2024**.(revised downward compared to last year)



Source: The International Air Transport Association (IATA, Jun 2022)

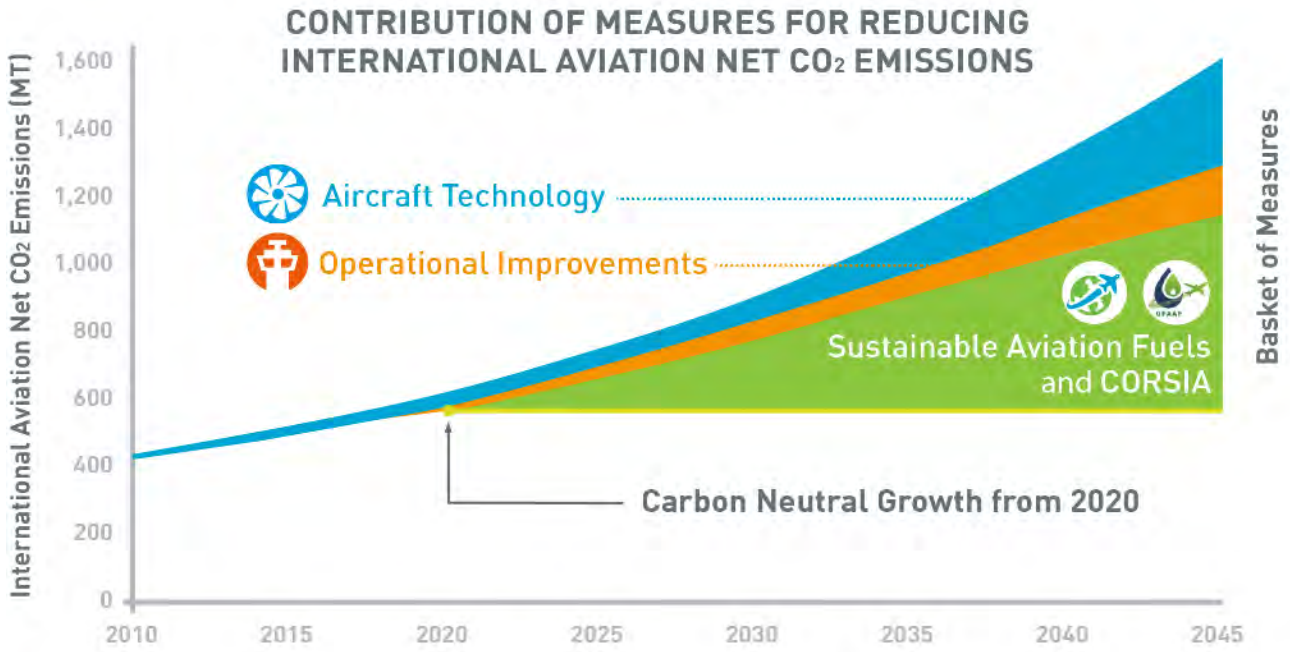
International Goals for CO2 Reduction

- Up to now, **ICAO**, the international organization for the aviation industry, had **set a goal of carbon neutral growth** from 2020 onwards; **limit CO2 emissions** by the international aviation sector **after 2021 to 2019 level** (base emissions).

<Image of projected CO2 emissions from international aviation and emission reduction targets>

Means of achieving goals

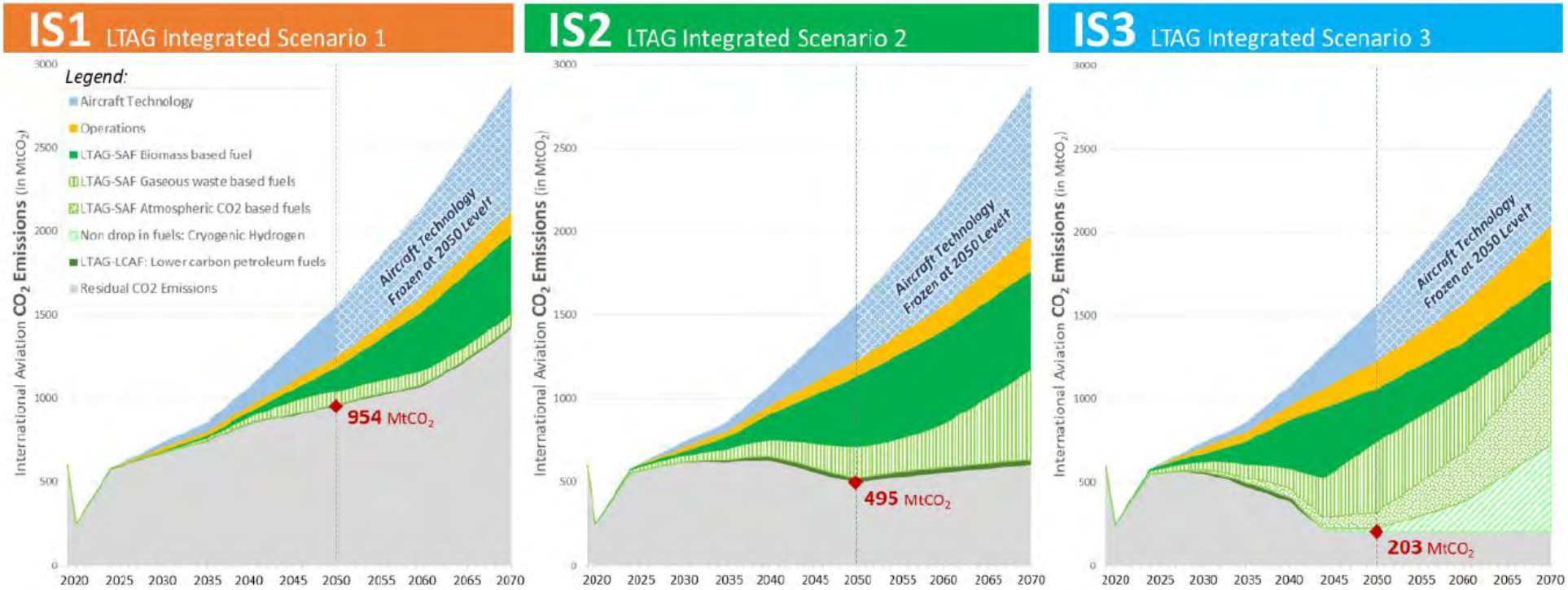
(1) Introduction of new technology (new aircraft, etc.),
(2) Improvement of flight operation methods,
(3) Use of Sustainable aviation fuels,
(4) Use of market mechanisms



Source: International Civil Aviation Organization (ICAO)

ICAO Long-Term Aspirational Goal（LTAG）

- Three LTAG scenarios, discussed at the Task Group under ICAO, was released in this March.
- At the 41st ICAO Assembly, ICAO Member States adopted a collective long-term global aspirational goal (LTAG) of net-zero carbon emissions by 2050.



† Caution required with the interpretation of absolute CO_2 emissions levels after 2050 due to modelling assumptions e.g., frozen aircraft technology after 2050. Under these assumptions, CO_2

Technology assumptions

		Advanced Concept Aircraft (Non Drop-in) airplanes
	Advanced Concept Aircraft (Drop-in)airplanes	Advanced Concept Aircraft (Drop-in)airplanes
Advanced Tube & Wing Airplanes	Advanced Tube & Wing Airplanes	Advanced Tube & Wing Airplanes

An indicative overview of where energy options could be deployed

- **There is no single option** which is able to achieve the international goals for CO2 reduction.
- Each technology should be developed. We would settle down to develop related technologies, **especially the ones Japan has advantages**, even for long term period.

<An indicative overview of where energy options could be deployed in commercial aviation>

	2020	2025	2030	2035	2040	2045	2050
Commuter » 9-19 seats » < 60 minute flights » <1% of industry CO_2	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 CO_2	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 CO_2	SAF	SAF	SAF	SAF potentially some Hydrogen	Hydrogen and/or SAF	Hydrogen and/or SAF	Hydrogen and/or SAF
Medium haul » 100-250 seats » 60-150 minute flights » ~43% of industry CO_2	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 CO_2	SAF	SAF	SAF	SAF	SAF	SAF	SAF

Source: WayPoint 2050 2nd edition (ATAG)

Addressing Significant Changes in Aircraft Structure

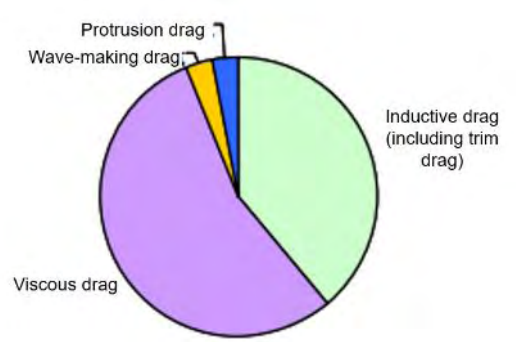
- Zero emission aircrafts for introduction from late 2030s and airframes that aim to further improve fuel efficiency may require significant changes to the structure of the aircraft.
- Accommodating these structures will require **significantly increasing the strength of the structural materials and sophistication of manufacturing technology.**

Blended Wing Body released by Airbus

Transonic Truss-Braced Wing released by Boeing

- Although there are issues regarding the feasibility of the airframe form and many other matters, research on the Blended Wing Body (BWB) as a hydrogen fuel airframe is being conducted in various countries.
- Viscous drag (surface friction drag, etc.) and inductive drag (drag that arises when lift is generated) make up 90% of a passenger aircraft's aerodynamic drag during cruising, so reducing both of these is an effective approach.

Example: Increasing the aspect ratio of the B787's wings has given it lower aerodynamic drag than conventional aircraft.



Source: International Aircraft Development Fund, "Aerodynamic Technology for Achieving Eco-Friendly Aircraft"

１．航空機産業の歴史

２．世界の航空機産業の潮流（市場、環境）

３．今後の方向性、経済産業省の施策
- Future and Related Policies of METI -

✓ **GoJ's commitment on carbon-neutrality by 2050** (October 2020)

Prime Minister Suga declared the goal of realizing a carbon-neutrality by 2050.

✓ **Green Growth Strategy** (December 2020)

METI formulated a **"Green Growth Strategy".**

Focused areas

- hydrogen,
- storage batteries,
- carbon recycling,
- offshore wind,
- SAF
- **aircraft industry**, etc.

Contents

- targets
- timelines
- development of systems
- support measures, etc.

✓ **Green Innovation Fund** (the supplementary budget for FY2020)

Japan established **a fund of 2 trillion yen** to provide continuing assistance to companies taking up the challenge of ambitious innovations.

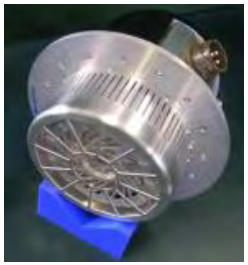
Roadmap (aircraft industry)

- Introduction phase: 1. Development phase → 2. Demonstration phase → 3. Introduction and expansion/ cost reduction phase → 4. Autonomous commercialization phase
- Policy means to be substantiated: [1] goals, [2] legal systems (such as regulatory reform), [3] standards, [4] tax, [5] budget, [6] finance, [7] public procurement, etc.

	2021	2022	2023	2024	2025	-2030	-2040	-2050
Transport-ation	★Regulation Regarding international aviation, ICAO institutionalized not to increase CO2 emissions compared to 2019 (2021-2035)							★Goal Net zero achievement as of 2050 (IATA target)
● Electrification	R & D for **equipment electrification**					**Technology demonstration**	**Technology installation and expanded adoption**	
	R & D for **electrification of propulsion system (hybrid electric)**					**Technology demonstration**	**Technology installation and expanded adoption**	
	* Electrification technology can be installed sequentially from small machines (from the latter half of the 2020s)							
● hydrogen-powered aircraft	R & D for **core technology for hydrogen-powered aircraft**					**Technology demonstration**	**Technology installation and expanded introduction**	
● Weight saving Efficiency	R & D for **engine efficiency (material, design, etc.)**					**Technology demonstration**	**Technology installation and expanded adoption**	
	Technology installation and expanded adoption							
	R & D for **carbon fiber** composite for airframe structure					**Technology demonstration**		**Independent expansion**
	* **Engine, electrification, and hydrogen related technologies are partially complementary to one another.**							
	Strengthen international cooperation with the United States and Europe for the above items							
● Jet fuel	**【Bio jet fuel, etc.】** Establishment of stable fuel manufacturing technology and cost reduction						**Expanding supply** of competitive bio-jet fuel, etc. in response to **trends in the international market for bio-jet fuel, etc.**	
	【Synthetic fuel】 Establishment of integrated manufacturing process from CO2 to synthetic fuel							
	* For bio-jet fuel by culturing microalgae, refer to the implementation plan of the carbon recycling industry.							

Technologies toward carbon neutrality

<Electrification>



Motor

Battery

superconducting electric propulsion system

【NEDO project ¥2.2bil)】

Source: Tamagawaseiki material,Gsyuasa Website,NEDO material

<Hydrogen powered aircraft>

Hydrogen tank

pump

valve

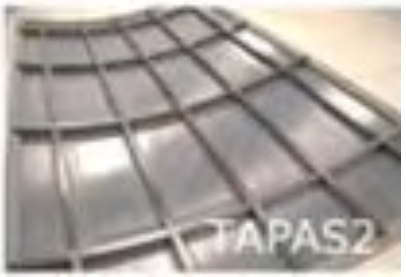
Test hydrogen engine

【GI fund ¥21.1bil】

Source: NEDO material

<Weight saving efficiency>

CFRP（Carbon Fiber Reinforced Plastics)



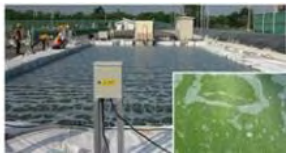
CMC（Ceramic Matrix Composite)

【NEDO project ¥1.3bil】

Source: NEDO material

<Jet fuel (SAF)>

Pilot plant (Nagoya)

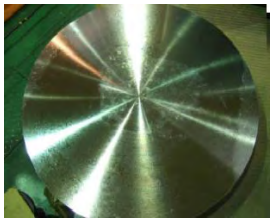


Culture pond (Thailand)

【GI fund ¥30.0bil】

Source: anaWEBsite Website,NEDO material

<Heat resistant alloys>

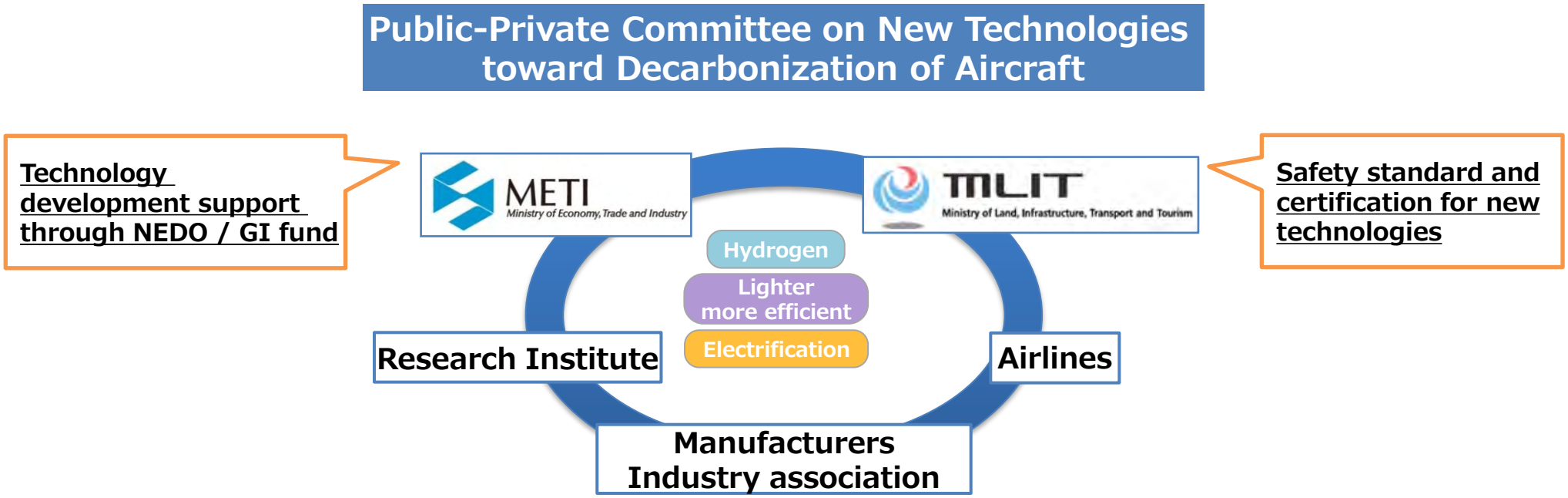


【NEDOproject ¥0.8bil】

Source: NIMS material

Efforts toward implementation of new technologies

- “Public-Private Committee on New Technologies toward Decarbonization of Aircraft” was established in June of this year for development of certification capability and safety standards for new technologies toward decarbonization of aircraft, such as electrification, hydrogen-powered aircraft.
- METI and MLIT intend to plan and implement the comprehensive implementation strategy that integrates technology development and safety standards perspective through the collaboration under the Committee.



Agreement between METI and Boeing on Cooperation in Aircraft Technology

January 15, 2019

State Minister Isozaki, METI
Chief Technology Officer Hyslop, The Boeing Company

Meeting with Boeing on cooperation in future technologies based on the agreement

<focus areas>

- **electric technology**, including advanced lightweight batteries and advanced motors and controllers necessary for electric propulsion systems in aircraft
- **high-rate low-cost composite production technologies**
- **advances in automation** to improve manufacturing productivity.

Revised Agreement

- Based on the long-standing mutual trust between Japan and Boeing in the aircraft field, METI and Boeing have agreed to strengthen cooperation with the aim of creating next-generation aircraft, in order to make Boeing's future aircraft more competitive and to develop Japan's aircraft industry further.

Overview of the agreement

- ◆ METI and Boeing will further pursue technical collaboration in the field of sustainability and investigate the feasibility of electric and hydrogen powertrain technologies in aircraft.
  The parties will collaborate to **explore the technical feasibility of next generation aircraft and assess the market impact of such aircraft**.
- ◆ METI, pursuing the realization of next generation aircraft, will endeavor to provide necessary support, including for research and development, and market and technology assessments.
- ◆ The Boeing Company, utilizing the Boeing Research & Technology– Japan Research Center, will work towards the implementation of applicable technologies.

Signatories;

Hagiuda Koichi, Minister of Economy, Trade and Industry

Greg Hyslop, Chief Engineer, The Boeing Company

✓ **Basic Policy on Economic and Fiscal Management and Reform 2022**

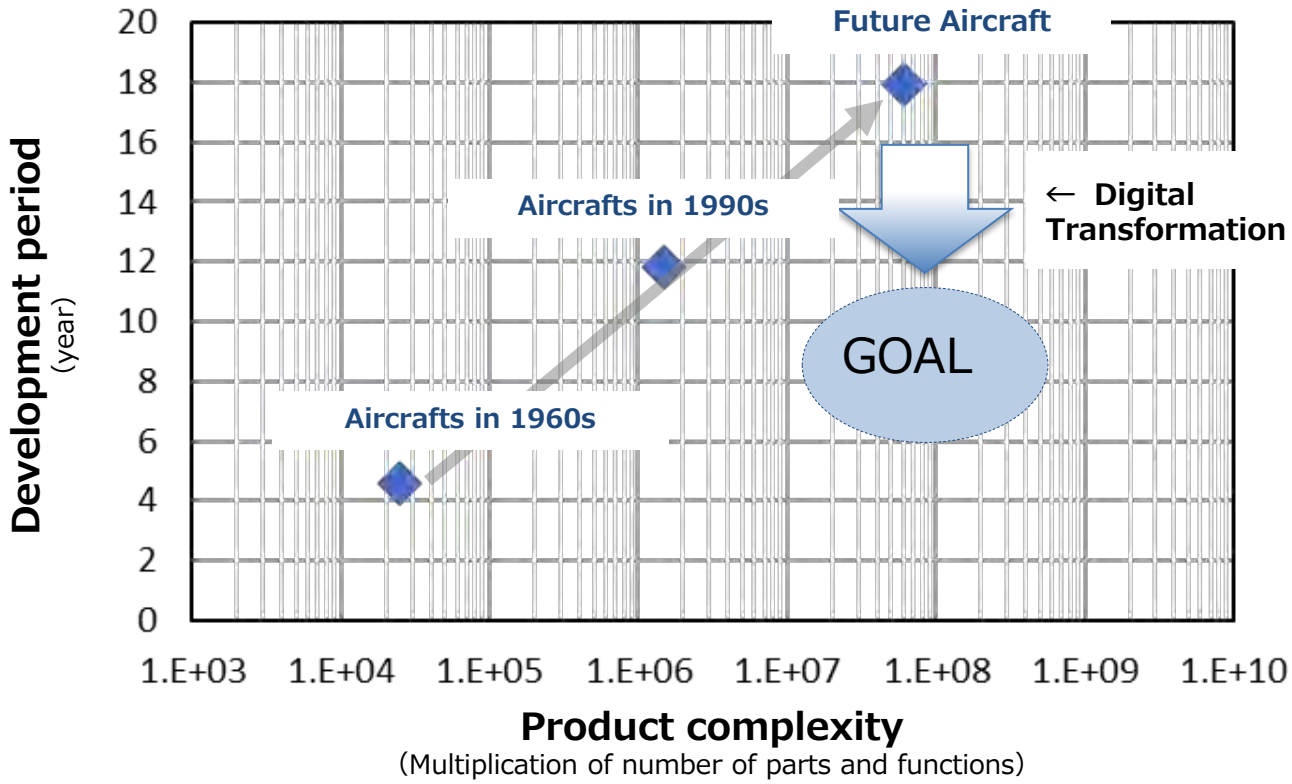
*To raise **a public-private investment of more than 150 trillion yen**, give shape to the vision of "Pro-Growth Carbon Pricing" and examine the issuance of GX Economy Transition Bonds (tentative name).*

✓ **Prime Minister Kishida's remarks** (May 2022)

*In order to realize the growth-oriented carbon price concept, while securing future financial resources, we will **raise the necessary government funds of 20 trillion yen** in advance with **GX economic transition bonds** (tentative name) and provide immediate investment support.*

Increasing risk and cost of aircrafts development

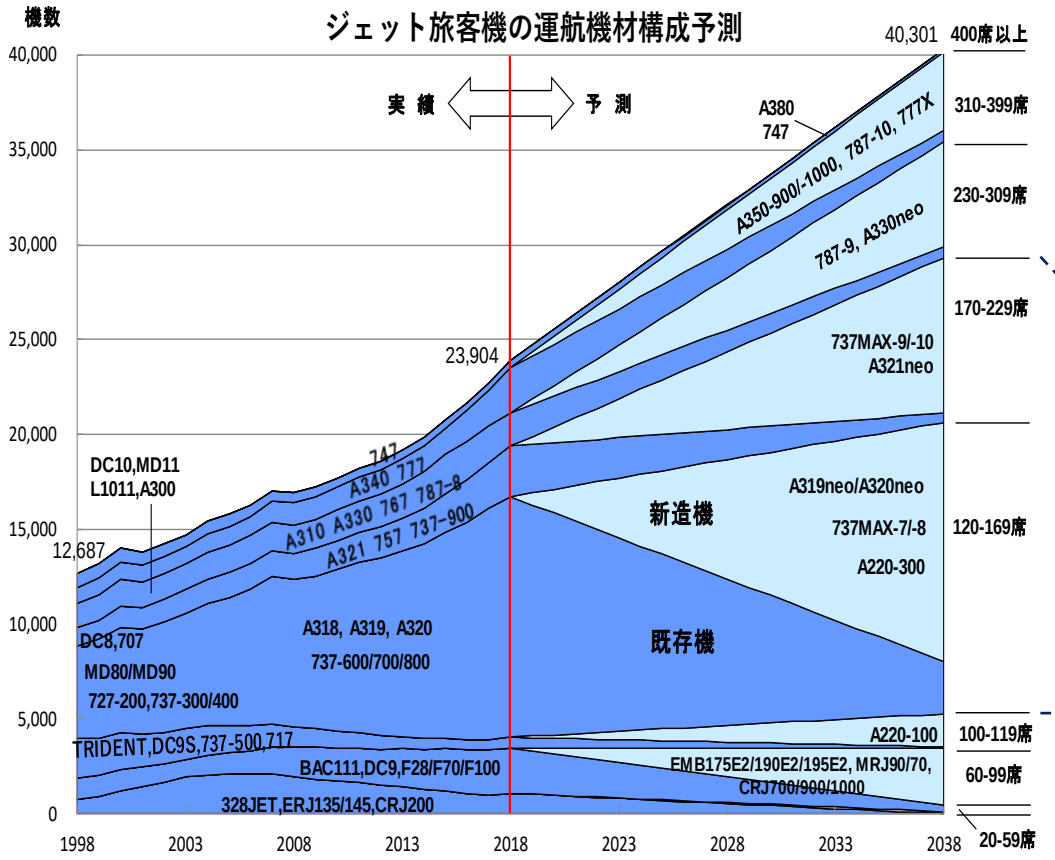
- Development period of aircrafts with complex integration of hardware and software tends to be longer.
- In addition, acquisition of safety certification requires significant cost and time.



出典：Aerospace industries association, Lifecycle Benefits of collaborative MBSE use for early requirement development

Prediction of world's aircraft industry

- Mainly Asia pacific area, demands of air travel were predicted 5% growth continuously. As growth of air travel demands, aircraft manufacturing were also prospected to expand largely, before COVID-19.



(Source) ＪＡＤＣ

Wide body

BOEING

747

777

787

AIRBUS

A380

A350

Narrow body

737

A320

A220

Regional jet

MITSUBISHI AIRCRAFT CORPORATION

Space-Jet

EMBRAER

E-Jet

BOMBARDIER AEROSPACE

CRJ

The Future Manufacturing in Aviation Industry

Example of Automation（Riveting）

Conventional manufacturing method :
Boeing 777

New manufacturing method :
Boeing 777X

Insights from Boeing CEO（@ quarterly earnings call on 28 Apr., 2021）

Extractions from the article of "Flight Global", 29 April 2021

Boeing chief executive David Calhoun believes that the next generation of aircraft will distinguish themselves by the way they are engineered and constructed, rather than through increasingly efficient engines alone.

*… "**I expect the next product will get differentiated in a significant way on the basis of the way it's engineered and built**," Calhoun says. …*