



ICAO

UNITING AVIATION

E-GAP



ICAO Global Aviation Partnerships on Emissions Reductions (E-GAP) Multiplying Environmental Action

Project Associate Professor Hiroshi Shibutake,

Center for Aviation Innovation Research, The University of Tokyo



✈ First, JAL, ANA and NCA conducted a test flight with bio jet fuels.

➤ 本邦航空会社の飛行



Type	Boeing 747-300	Boeing 787-8	Boeing 747-8F
Engines	Pratt & Whitney	Rolls Royce	General Electric
Day of flight	Jan 30, 2009	Apr 16, 2012	Aug 02, 2012

**INAF:*****'Initiatives for Next-generation Aviation Fuels'***

- 7 Steering members (UTokyo, Boeing, JAL, NCA, ANA, Narita Airport Corp., Japan Petroleum Exploration)
- 46 member organizations from industry, administration, academy
- 4 subcommittees for 6 raw materials and 6 plenary sessions for 1 year (May 2014-July 2015)
- Reported the Roadmap to establish a supply chain for next-generation aviation fuels by 2020, the year of Tokyo Olympics and Paralympics. (July 2015)
- A committee for implementation was established by JCAB(MLIT) and the Agency for Natural Resources and Energy(METI).

<http://inaf-japan.tumblr.com/tagged/English>





Subcommittee 1:

supply chains using municipal waste for the raw material

Subcommittee 2:

supply chains using oils produced by microalgae
for the raw material

Subcommittee 3:

supply chains using other materials for the raw material

Subcommittee 4:

legal system



SC1 Municipal waste

3 methods on the table

- Waste > gas > FT synthesis > upgrading
- Waste > gas > ethanol > Alcohol to Jet (ATJ)
- Waste > dehydrated pulp > fermentation > ethanol > Alcohol to Jet (ATJ)



Roadmap for Supply of Next-Generation Aviation Fuel Using Municipal Waste

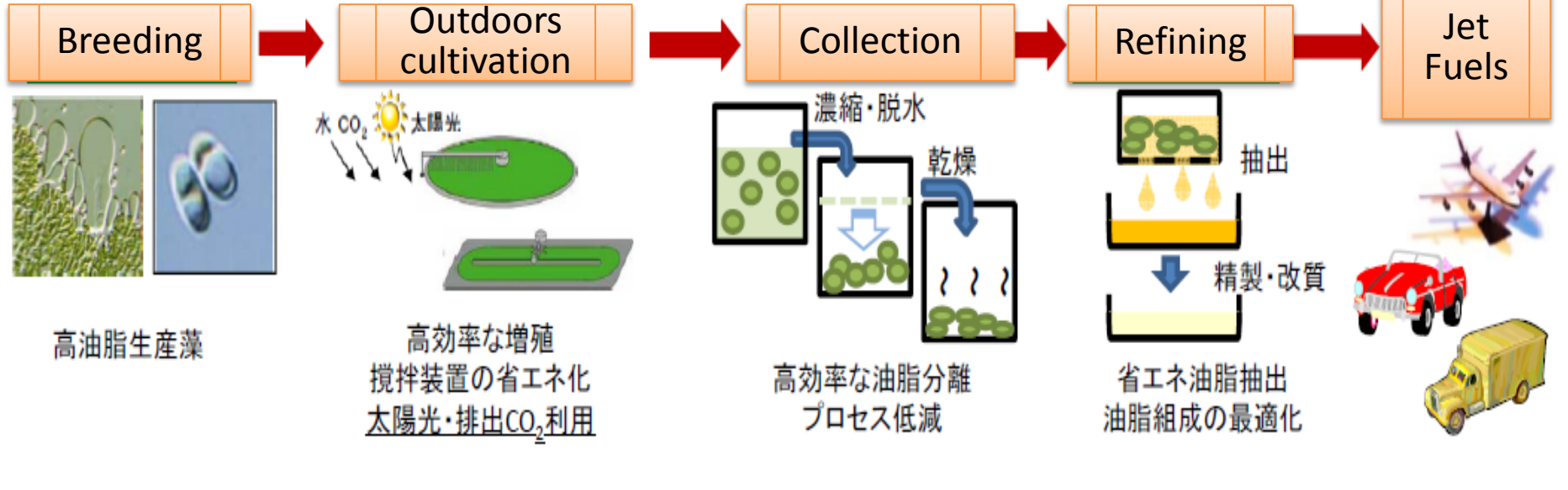
Fiscal Year	Opportunities	Challenges
2015	<p>< Formulation of business plan ></p> <ul style="list-style-type: none"> ● Set up business entity for demonstration project, review plant concept, formulate business plan 	<ul style="list-style-type: none"> ■ Ascertaining the specific properties of the municipal waste serving as a raw material, and selecting cleanup technology
2016	<p>< Design, construction and trial operation of demonstration plant for production of next-generation aviation fuel (1) ></p> <ul style="list-style-type: none"> ● Estimate cost of constructing demonstration plant, and construct the plant 	<ul style="list-style-type: none"> ■ Appropriately managing project
2017	<p>< Design, construction and trial operation of demonstration plant for production of next-generation aviation fuel (2) ></p> <ul style="list-style-type: none"> ● Construct demonstration plant and prepare for trial operation <p>< Increase in production scale (1) ></p> <ul style="list-style-type: none"> ● Launch organization to study commercial plant project 	<ul style="list-style-type: none"> ■ Appropriately managing project ■ Establishing trial operation framework
2018	<p>< Design, construction and trial operation of demonstration plant for production of next-generation aviation fuel (3) ></p> <ul style="list-style-type: none"> ● Trial operation of demonstration plant <p>< Production of next-generation aviation fuel (1) ></p> <ul style="list-style-type: none"> ● Produce next-generation aviation fuel at demonstration plant <p>< Increase in production scale (2) ></p> <ul style="list-style-type: none"> ● Determine scale and site for construction of commercial project, and review systems for collecting municipal waste over a wide area 	<ul style="list-style-type: none"> ■ Appropriately managing project ■ Analyzing results of demonstration plant operation
2019	<p>< Production of next-generation aviation fuel (2) ></p> <ul style="list-style-type: none"> ● Supply alternative aviation fuel which combines the fuel produced at the demonstration plant <p>< Increase in production scale (3) ></p> <ul style="list-style-type: none"> ● Prepare basic design of commercial plant 	<ul style="list-style-type: none"> ■ Appropriately managing project ■ Analyzing results of demonstration plant operation ■ Reflecting the results of analysis of demonstration plant in the basic design for a commercial plant ■ Conducting feasibility study for commercial project
2020	<p>< Production of next-generation aviation fuel (3) ></p> <ul style="list-style-type: none"> ● Operate demonstration plant, conclude operations, and reassess them <p>< Increase in production scale (4) ></p> <ul style="list-style-type: none"> ● Make a determination on investment in commercial project 	<ul style="list-style-type: none"> ■ Reflecting the results of analysis of demonstration plant in the commercial project ■ Soliciting and securing operators, investors and other parties to be involved in commercial project
2021 ~	<p>< Increase in production scale (5) ></p> <ul style="list-style-type: none"> ● Design, construct, operate and maintain commercial plant 	<ul style="list-style-type: none"> ■ Establishing the business entity to produce next-generation aviation fuel using municipal waste as the raw material ■ Advancing the commercial project to be undertaken by the business entity

Notes: This is a roadmap organizing the path and issues to be addressed which are anticipated for producing next-generation aviation fuel and commencing the supply of alternative aviation fuel by FY 2020 on the basis of the review results produced by the First Subcommittee.

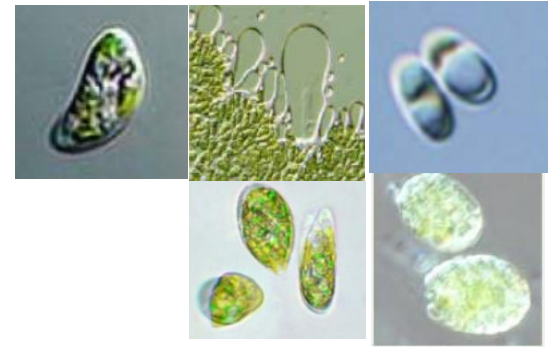


SC2 Microalgae

< 微細藻由来バイオ液体燃料製造工程(例) >



- Repeatable < microalgae existing in the nature are used
- Warm, sunny climate, broad area for growth
- Each microalgae produces different oil content
- Made by/in Japan





Roadmap for Supply of Next-Generation Aviation Fuel Using Oil Produced from Microalgae

Fiscal Year	Opportunities	Challenges
2015	<p><Formulation of business plan (1)></p> <ul style="list-style-type: none"> ● Increase productivity of microalgae cultivation ● Develop a process integrating the extraction of algae oil from cultivation and the production of next-generation aviation fuel from algae oil ● Determine locations suitable for cultivation 	<ul style="list-style-type: none"> ■ Establishing technology for large volume and stable cultivation of microalgae ■ Taking into account that the properties of algae oil produced differ depending on the type of microalgae, and conducting review on sharing processes when producing fuel from each of these algae oils ■ Consolidating the issues to be addressed accompanying importation of algae oil into Japan
2016	<p>< Formulation of business plan (2) ></p> <ul style="list-style-type: none"> ● Increase productivity and formulate business plan which takes into account the integrated process ● Construct a demonstration level large volume cultivation facility at a site suited for cultivation 	<ul style="list-style-type: none"> ■ Consolidating a process for sharing and a process for not sharing the processes for producing fuel from algae oils having different properties
2017	<p>< Design, construction and trial operation of demonstration plant for production of next-generation aviation fuel (1) ></p> <ul style="list-style-type: none"> ● Review technology for low-cost, large volume and stable cultivation of microalgae ● Design and construct demonstration plant for production of next-generation aviation fuel 	<ul style="list-style-type: none"> ■ Appropriately managing project
2018	<p>< Design, construction and trial operation of demonstration plant for production of next-generation aviation fuel (2) ></p> <ul style="list-style-type: none"> ● Conduct trial application of technology for low-cost, large volume and stable cultivation at a demonstration cultivation facility ● Design and construct demonstration plant for production of next-generation aviation fuel 	<ul style="list-style-type: none"> ■ Appropriately managing project
2019	<p>< Design, construction and trial operation of demonstration plant for production of next-generation aviation fuel (3) ></p> <ul style="list-style-type: none"> ● demonstration project Construct and have trial operation of demonstration plant for production of next-generation aviation fuel 	<ul style="list-style-type: none"> ■ Appropriately managing project ■ Analyzing results of demonstration plant operation
2020	<p>< Production of next-generation aviation fuel ></p> <ul style="list-style-type: none"> ● Cultivate microalgae and demonstration facility, and produce next-generation aviation <p>< Increase in production scale (1) ></p> <ul style="list-style-type: none"> ● Increase scale of microalgae cultivation taking into account the scale of the commercial project 	<ul style="list-style-type: none"> ■ Reflecting the results of analysis of demonstration plant in the commercial project ■ Securing site for large volume cultivation
2021 ~	<p>< Increase in production scale (2) ></p> <ul style="list-style-type: none"> ● Advance commercial project which takes into account the scale of microalgae able to be cultivated ● Increase scale of next-generation fuel production by increasing scale of cultivation 	<ul style="list-style-type: none"> ■ Reducing cultivation costs in stages, and improving cultivation productivity by increasing cultivation scale ■ Improving refining efficiency when producing next-generation aviation fuel from algae oil

Notes: This is a roadmap organizing the path and issues to be addressed which are anticipated for producing next-generation aviation fuel and commencing the supply of alternative aviation fuel by FY 2020 on the basis of the review results produced by the Second Subcommittee.



SC3 Other materials

4 materials were picked up

- Natural oils (excluding waste food oil)
- Waste food oil
- Non-edible biomass (cellulosic sugar)
- Woody biomass

... How to collect in a large volume?



Roadmap for establishing a supply chain

Fiscal year	Production of next-generation aviation fuels						Handling in mixture, transport, airports, aircraft
	(Raw material→)						
	Municipal waste	Micro algae	Natural oils	Used food oil	Non-edible biomass	Woody biomass	
	(ASTM standard→) FT-SPK (ATJ *)	HEFA-SPK	HEFA-SPK	HEFA-SPK	(ATJ *)	FT-SPK	
2015	Formulate business plan (demonstration project)						Develop methods for handling next-generation aviation fuels and alternative aviation fuels
2016	Design, construct and have trial operation of demonstration plant for producing next-generation aviation fuels (demonstration project)						
2017							
2018	Produce next-generation aviation fuels (demonstration project)						
2019							
2020	Expand scale of production (commercial project)						
2021 ~							

(Raw material→)
 (ASTM standard→)

• Determine plant size and construction location
 • Verify applicable laws and systems
 • Select and determine technology to be used
 • Verify treatment of intellectual property rights
 • Set up a business promotion framework
 • Determine the defrayment of expenses and assignment of results
 • Plan markets for by-products Etc.
 • Prepare basic design and detailed design
 • Procure materials, equipment, machinery, etc.
 • Manage project
 • Operate plant and establish maintenance system
 • Establish markets for by-products
 • Analyze results of demonstration plant (production process, fuel quality) Etc.
 • Reflect results of analysis of demonstration project in commercial project
 • Reduce production costs through system optimization and development of mass production technology
 • Formulate business plan, and design, construct and have trial operation of commercial plant, produce next-

Acquisition of third-party certification to the effect that ASTM standards are met, public relations activities both inside and outside Japan including plant tours, and calculation of greenhouse gas reduction affect useful for smooth implementation of the business
 Policy initiative premised on roadmap

Notes:

- The size of the plant project increases in order from small to large beginning with lab, bench, demonstration and commercial. Here, an assumption that the size will increase beginning in FY 2021 has been taken into account, and the projects have been arranged so that a demonstration project is implemented by FY 2020 and a commercial project in FY 2021 or thereafter.
- The roadmap for each raw material is based on the results of reviews conducted by each subcommittee (see appendix (only Japanese version) pp. 76, 105, 135 and 136).
- Provisions for the ASTM standard ATJ have not been prescribed in D7566 Annex as of May 2015, but enactment of such provisions is anticipated in 2015 or 2016.



2020 for Japan

- More interactions and exchanges with whole world during the Olympics and Paralympics

1964



First “Olympics and Paralympics”

http://www.joc.or.jp/past_games/tokyo1964/story/vol01_02.html



First Shinkansen ‘Hikari’



YS-11 carried the Flame

<http://blog.goo.ne.jp/mbne230/m/201505>

-2020



“Tokyo”

<http://y-onsensomurie.blog.so-net.ne.jp/2013-09-10>



New Linear Shinkansen is under construction



MRJ is Coming up



ICAO UNITING AVIATION

E-GAP



ICAO Partners multiplying environmentally sustainable aviation action



ICAO Global Aviation Partnerships on Emissions Reductions (E-GAP) Seminar
ICAO Headquarters, Montréal, 16 to 17 September 2015

ENV2015