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**WORKING PAPER**

# ASSEMBLY — 39TH SESSION

## EXECUTIVE COMMITTEE

**Agenda Item 22: Environmental Protection – International Aviation and Climate Change – Policy, Standardization and Implementation Support**

## SUSTAINABLE ALTERNATIVE FUELS FOR AVIATION

(Presented by the Council of ICAO)

**EXECUTIVE SUMMARY**

In response to Assembly Resolution A38-18, which requests ICAO and its Member States to actively participate in furthering the work on sustainable alternative fuels for aviation, ICAO undertook activities to promote and facilitate the emergence of sustainable alternative fuels in aviation. These activities include information sharing, promotion of dialogue between States and stakeholders, the maintenance of the Global Framework for Aviation Alternative Fuels (GFAAF), and the establishment of the Alternative Fuels Task Force within the Committee on Aviation Environmental Protection (CAEP).

Dialogue and information sharing with States and stakeholders, recommendations of the Sustainable Alternative Fuels (SUSTAF) Expert Group, work by ICAO on environmental trends, in particular through the work of the Committee on Aviation Environmental Protection (CAEP), and States' voluntary action plans, have allowed for the identification of challenges and issues that need to be addressed in order to quantify, further facilitate, and promote the emergence of sustainable alternative fuels in aviation.

The next priorities are to address initial economic barriers and to ensure sustainable commercial-scale deployment. Dedicated policies from States are required, including the support of measures and provisions to ensure sustainability.

**Action:** The Assembly is invited to:

a) acknowledge the developments and support the continued work of the Organization in facilitating efforts by States and the industry in the development and deployment of sustainable alternative fuels for aviation;
b) encourage States to develop policies, recognizing the current challenges, that will accelerate the development and deployment of sustainable alternative fuels for aviation;
c) invite States to consider the use of incentives to encourage the deployment of clean and renewable energies sources for aviation, including sustainable alternative fuels; and
d) consider the information contained in this paper for the update of Assembly Resolution A38-18.

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| *Strategic Objectives:* | This working paper relates to Strategic Objective E – *Environmental Protection* |
| *Financial implications:* | The activities referred to in this paper will be undertaken subject to the resources available in the 2017–2019 Regular Programme Budget and/or from extra budgetary contributions. |
| *References:* | A39-WP/55, *Present and Future Trends in Aircraft Noise and Emissions*<br>A39-WP/49, *Consolidated statement of continuing ICAO policies and practices related to environmental protection – Climate change*<br>Doc 10069, *Report of the Tenth Meeting of the Committee on Aviation Environmental Protection* |

## 1. INTRODUCTION

1.1 In October 2013, the 38th Session of ICAO Assembly adopted Resolution A38-18 which requested Member States to develop policy actions to accelerate the appropriate development, deployment and use of sustainable alternative fuels for aviation, as part of a basket of measures to limit carbon emissions from international aviation.

1.2 Progress and achievements since that time have demonstrated that drop-in alternative fuels are a technically sound solution that will not require changes to aircraft or fuel delivery infrastructure. Deploying these fuels in aviation as a means to limit carbon emissions is of particular relevance as aviation, unlike road-transportation for example, has no alternatives to liquid fuels for the foreseeable future. In addition, the concentration of aviation fuel distribution on a limited set of locations can facilitate the deployment of novel fuels for which the aviation sector has confirmed a strong interest.

1.3 Over the past 3 years, the world has seen significant development and deployment of sustainable alternative fuels, including that of clean, renewable sources of energy for aviation. The steps being taken will lead to an increased use of sustainable alternative fuels and solar power for aviation during the coming triennium.

## 2. CURRENT STATUS OF SUSTAINABLE ALTERNATIVE FUEL DEVELOPMENT AND DEPLOYMENT

### 2.1 Current Alternative Jet Fuel Pathways

2.1.1 Today, alternative jet fuel can be produced through the following pathways:

— Fischer-Tropsch Synthetic Kerosene with Aromatics (FT-SKA);

— Fischer-Tropsch Synthetic Paraffinic Kerosene (FT-SPK);

— Hydroprocessed Esters and Fatty Acids (HEFA-SPK);

— Hydroprocessed Fermented Sugar-Synthetic Isoparaffins (HFS-SIP); and

— Alcohol to Jet Synthetic Paraffinic Kerosene (ATJ-SPK).

These methods, approved by the standards-setting organization, American Society for Testing Materials (ASTM) International, enable the conversion of a broad range of renewable sources of biomass into sustainable jet fuel. The addition of the HFS-SIP and ATJ-SPK pathways are new since the 38th Session of the ICAO Assembly. The approval of alternative jet fuel pathways demonstrates the technical feasibility of the development of the fuels; research into additional techniques for producing alternative jet fuels is evolving rapidly. As with the already-approved HEFA-SPK, some of the forthcoming pathways will not require the use of land at all for feedstock production.

### 2.2 Development and Deployment

2.2.1 Since the initial publication of ASTM D7566, *Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons*, which provided the framework for approving alternative jet fuel pathways, and the ICAO Conference on Aviation and Alternative Fuels which launched the Global Framework on Aviation Alternative Fuels (GFAAF), both in 2009, there have been many accomplishments. Of the more than 500 announcements and initiatives recorded in the GFAAF, some of the highlights include:

a) **2010:** First single-engine propeller transatlantic flight from Canada to Germany powered on biofuel;

b) **2011** First commercial flights operated using biofuel;

c) **2012:** *Flightpath to a Sustainable Future*, an ICAO special Rio+20 global initiative, the first-ever series of connecting flights powered by sustainable alternative fuels, on which the ICAO Secretary General, travelled from Montréal, Canada to Rio de Janeiro, Brazil;

d) **2013:** First regular flight operations using alternative fuel began between New York, United States and Amsterdam, Netherlands;

e) **2014:** 21 airlines used alternative fuel on commercial flights;

f) **2015:** Oslo Airport in Norway became the world's first "bioport" by offering 2.5 million litres of aviation biofuel annually to its users;

g) **2016:** Los Angeles International Airport in the United States, will have more than 56.8 million litres of aviation biofuel available over a 3-year period; and

h) **2016:** Fifth pathway for alternative jet fuel approved on 14 April 2016 by ASTM International.

2.2.2 More than 2 200 commercial flights have flown using alternative fuels since 2011, with the expectation that by the end of 2016, the number of such flights will exceed 5 500. The number of announcements for alternative fuel projects has been increasing every year, with more than 140 new announcements since the 38th Session of the ICAO Assembly alone. The significant growth in announcements of alternative fuel projects and initiatives underscore the forthcoming deployment.

2.2.3 Based on the Action Plans on Emissions Reduction submitted by States as of 7 June 2016, 59 States representing 79.2 per cent of global Revenue Tonne Kilometres (RTK) indicated that they will pursue investments in sustainable alternative fuels for aviation. Additional information is presented in A39-WP/54 *States' Voluntary Action Plans on $CO_2$ Emissions Reduction Activities and* A39-WP/51 *Civil Aviation and the Environment*.

## 3. CHALLENGES

3.1 In updating the environmental trends assessment to further account for the potential contribution of sustainable alternative fuels on international aviation $CO_2$ emissions, ICAO developed, with the technical support provided by CAEP, a range of scenarios to reflect the primary factors that will influence the development of alternative jet fuel globally. The bioenergy potential from available land that will not result in the competition with food, and the decisions that direct where that bioenergy is used, will all have an effect on the future availability of alternative jet fuel.

3.2 While substantial progress has been made during the past three years in the development of alternative jet fuels from a technical perspective, significant challenges remain before alternative jet fuels will be available in significant quantities worldwide. These include the need for investment in biorefineries, as well as dedicated policy decisions that will ensure that biofuels are available for aviation. In addition, the price gap with conventional jet fuel remains a key barrier for commercial-scale adoption and deployment. Table 1 illustrates the magnitude of the investments required to achieve a range of emissions reduction scenarios from international aviation.

| Aviation GHG emissions reduction (percentage) | Required AJF production volume in 2050 (Mt/year) | Requirements under linear growth | | Requirements under exponential growth | |
|---|---|---|---|---|---|
| | | Number of new biorefineries/year | Capital investment/yr | Number of new biorefineries/year | Capital investment/year |
| 2 | 30 | 10 | $1B - $3B | <5 (2025) to 30 (2050) | <$1B - $2B (2025) to $3B - $10B (2050) |
| 10 | 130 | 40 | $3B - $14B | <5 (2025) to 200 (2050) | <$1B - $2B (2025) to $15B - $60B (2050) |
| 17 | 220 | 70 | $6B - $25B | <5 (2025) to 300 (2050) | <$1B - $2B (2025) to $30B - $110B (2050) |
| 40 | 570 | 170 | $15B - $60B | <10 (2025) to 1000 (2050) | $1B - $3B (2025) to $80B - $330B (2050) |
| 63 | 870 | 260 | $20B - $90B | <10 (2025) to 1600 (2050) | $1B - $3B (2025) to $130B - $550B (2050) |
| **Average historical global ethanol and biodiesel production** | | **Total annual volumes (Mt/year)** | | 10 (years 1975 - 2000) to 45 (2001 - 2011) | |
| | | **Number of new biorefineries/year** | | 5 (years 1975 - 2000) to 60 (2001 - 2011) | |
| **Projection for average annual investment in petroleum refining in 2035** | | | | $55B | |

**Table 1.** Required fuel production volume in 2050 (based on CAEP/10 Scenario 7 total fuel demand projections), number of new 5000 barrels per day (bpd) facilities required annually (assuming 50 per cent jet fuel share in product slate) and range of annual capital investment required (jet-fuel portion only) for different GHG emission reduction percentages under the simplifying assumption of linear or exponential growth and low GHG intensity of AJF. CAEP expects the long-term development of AJF deployment to resemble an s-curve. Average historical growth for transportation biofuels in terms of annual production volumes and the number of new facilities per year (assuming a 5000 bpd scale for illustrative purposes) and projected petroleum refinery investment in 2035 shown for comparison purposes[1]. All monetary values are shown in US Dollars ($).

## 4. CONCLUSIONS

4.1 There were significant technical achievements over the last three years for sustainable alternative fuels for aviation. While the technological feasibility for alternative jet fuels is proven, in moving forward, there is a need for investment in biorefineries and dedicated policies from States to address the price gap with conventional fuels and to ensure a sustainable commercial-scale deployment.

4.2 Promotion, further information sharing and exchanges between States continue to be pursued through ICAO. Recognizing the substantial progress achieved in recent years, a seminar is planned for early 2017 to serve as an information session for a Conference on sustainable alternative fuels for aviation that will be held in late 2017.

— END —

[1] International Energy Agency, Energy technology perspectives 2015.