# MUFG TRANSIT

## APAC Low-Carbon Energy

Volume 3, Nov 2023
ESG Finance Department

**MUFG Bank, Ltd.**
A member of MUFG, a global financial group

# Table of Contents

# MUFG's Global ESG Expertise

## APAC

**Colin Chen**
Managing Director, Head of ESG Finance, APAC

**Amanpreet Singh**
Director, Deputy Head of ESG Finance, APAC

**Angkana Meeploy**
Director, ESG Finance, APAC

**Archana Khemka**
Director, ESG Finance, APAC

**Serena Lum**
Analyst, ESG Finance, APAC

## Japan

**Haruka Yamamuro**
Managing Director, Project Finance, Oceania

**Shareef Omar**
Head of ESG Finance, Oceania

**Miyuke Zeniya**
Chief Sustainability Officer, Japan

**Tomohiro Ishikawa**
Chief Regulatory Engagement Officer, Japan

**Daisuke Nishiyama**
Managing Director, Head of Sustainable Business Division Japan

## Americas

**Hailey Orr**
Director, Capital Markets Strategist, Americas

**Leanne Rakowitz**
Director, Head of ESG Coverage, Americas

**Tobi Petrocelli**
Director, Head of Environmental & Sustainability Management, Americas

**Beth Gilroy**
Director, Environmental & Sustainability Management, Americas

## EMEA

**Stephen Jennings**
Head of Energy & Head of Sustainable Business Division, EMEA

**Amanda Kavanaugh**
Head of ESG Business Coordination and Strategy, EMEA

**Amanda Vainio**
Vice President, Sustainable Finance, EMEA

**Ehsan Khoman**
Head of Commodities, ESG and Emerging Market Research, EMEA

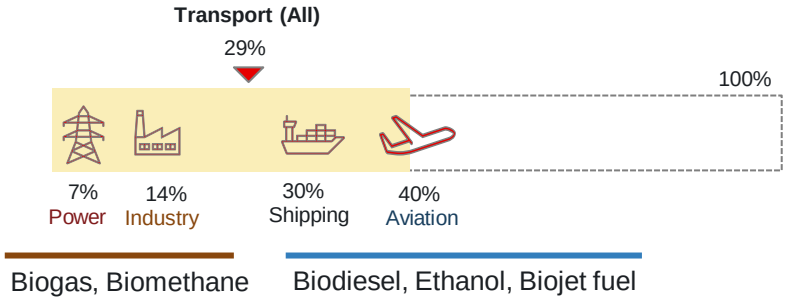
# Section I: Unlocking the Potential of Biofuels

# Introduction to Biofuels I Cleaner source of energy to fulfill industrial needs

**A continuous rise of global demand for biofuels calls for a diversification of feedstocks in anticipation of the supply shortage**

## A rise in industry demand for biofuels

**IEA's bioenergy requirement for Net Zero Equivalent (NZE) scenario by 2060:**




**28%** Projected growth in global demand for biofuels from 2021-2026

**>3x** Increase in production of biofuels required to maintain net-zero trajectory by 2050

## Shortage of traditional feedstock to meet rising demand

**Simplified value chain of biofuel production:**

**Feedstocks**

Traditional

*Manufactured via edible sources*
Feedstock: animal/plant matter
e.g. sugarcane, rice, corn, oil

**Production technologies**

*Eg. Anaerobic digestion, pyrloysis, gasification etc.*

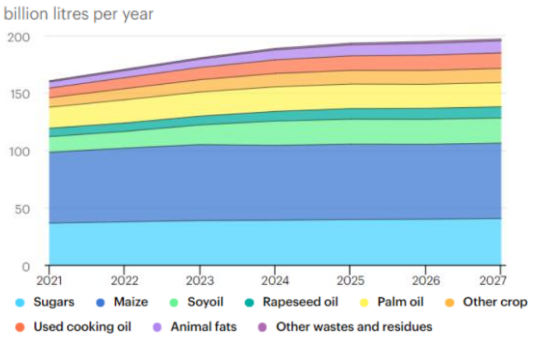
**Biofuels**

+

Next-generation biofuels

*Manufactured via non-edible sources*
Feedstock: algae, agricultural/municipal waste, woody biomass etc.

**Total biofuel production by feedstock:**




*Source: IEA (2021)*

According to IEA, biofuel production from traditional feedstocks would plateau 2025 onwards due to feedstock crunch

*Source: MUFG compiled from Eco-Business, IEA, Nikkei Asia, WEF and various public sources*

# Global Biofuel Landscape I Policies in action to shape uptake of biofuels

**Combination of fiscal incentives and policy mandates are deployed to promote adoption and scaling up of biofuels**

## USA

*Global top producer of biofuels*

Supply-side policies to incentivise & stimulate biofuel production by securing feedstock supply at beginning of supply chain

### Biomass Crop Assistance Program (BCAP)

- Qualified advanced biofuel feedstock producers eligible for reimbursement of 50% of cost establishing a biomass feedstock crop
- Annual payment up to 5 years for herbaceous & 15 years for woody feedstocks

### Inflation Reduction Act (IRA)

Production tax credits (PTC) to drive expansion of biofuels

- 2nd Generation biofuels credit of up to $1.01/gal for qualifying renewable feedstock & algae family
- $1/gal federal biomass-based diesel blending credit
- $1.25/gal SAF blending credit

## Brazil

*Global 2nd largest producer of biofuels*

Demand-side mandates as mechanism to boost industry uptake, unlocking biofuel adoption

### RenovaBio programme

- Ethanol blending of 27% required
- Biodiesel blending of 15% required
- Preferential tax treatment for ethanol compared to gasoline

## European Union (EU)

### "Fit for 55" package

- ReFuelEU Aviation initiative
  - Proposed 2% SAF blending mandate by 2025

### Renewable Energy Directive

- Minimum sub-target for advanced biofuels, reaching 3.5% in 2030
- Imposed limit on use of crop-based biofuels (maximum of 7%) to progressively phase-out those posing high indirect land use change (ILUC) risk

**Global Biofuels Alliance established in 2023 G20 New Delhi summit**

Aims to help boost global efforts to meet net-zero goals by emphasiszing on affordability & sustainablility aspect in use of biofuels

## Japan

### Ministry of Economy, Trade and Industry (METI) Biofuel Standards for 2023-2027

- Added new biomass feedstock deemed inedible e.g. Empty fruit bunch, pellets, husks for existing Feed-in-Premiums(FIPs)/Feed-in-tariffs(FITs)

## India

### National Policy on Biofuels

Mixture of both demand & supply-side policies

- 20% ethanol blending by 2025-26
- 5% diesel blending by 2030
- Guaranteed buyback via ethanol purchase agreements with cellulosic ethanol suppliers to attract greater investment
- Research & innovation grant
  - Award USD 300m to <20% project costs to 2024 for companies establishing commercial & demonstration scale ethanol production projects using agricultural residues

*Source: MUFG compiled from Argus Media, S&P and various public sources*

# ASEAN Biofuel Landscape I Recognizing importance in the energy mix

**Legislated blending mandates for biofuels are on the rise across ASEAN member states**

| Market | Main Feedstocks | Co-blending mandate | Energy transition policies |
|---|---|---|---|
| **Indonesia** | Palm Oil, rice husks, rubber wood | 40% biodiesel (B40) by 2030, 50% ethanol (E50) by 2050 | **New Electricity Business Plan (RUPTL) 2021-2030**<br>• Biomass co-firing rate for existing coal-fired power plants("PLTU"s) raised to 10-20% in future with plans to make it **mandatory** for PLN & IPPs<br>• Target 17.6% of renewables comprised out of biomass by 2030 |
| **Malaysia** | Palm Oil | B20, E10 | **National Energy Transition Roadmap 2023**<br>• Bioenergy included as one of energy transition levers<br>• Biomass co-firing pilot phase to commence in 2024, scale-up to >15% co-firing capacity by 2027 |
| **Philippines** | Coconut oil, sugarcane | B10 & E20 by 2040 | **Biofuels Act**<br>• Mandate various minimum %s of eligible locally-sourced biofuels blended into liquid fuels for motors & engines<br>• Regulation accompanied by incentive scheme comprising fiscal support |
| **Thailand** | Rice, sugarcane, palm oil, | B20, E85 | **Alternative Energy Development Plan (AEDP) 2021**<br>• Biomass energy included in national feed-in-tariff scheme to target investors<br>• Target 20-25% biofuel share in total energy demand by 2025 |
| **Vietnam** | Rice, sugarcane | B10, E10 as 25% share in transport sector fuel demand by 2050 | **Vietnam Renewable Energy Development Strategy 2016-2030**<br>• Target 25% biofuels in total vehicle consumption by 2050 |

*Source: MUFG compiled from Argus Media, DCCEEW, Reuters and various public sources*

# APAC Biofuel Landscape I A mixed landscape for mandate development

**Other APAC markets implemented similar blending mandate schemes with policy hesitation over sustainability concerns observed**

| Market | Main feedstocks | Policy description |
|---|---|---|
| **Australia** | Sugar cane, sawmill residues, municipal solid waste, oilseeds, used cooking oil(UCO) | • Biofuels mandate introduced in New South Wales & Queensland<br>• Dec 2022: Exclusion of native forest wood waste as eligible biomass due to concerns over sustainability issues |
| **China** | UCO, animal fat, ethanol | • 2020: suspended bioethanol E10 blending rate from five-year plan due to shortage of feedstock supply |
| **Hong Kong** | Waste vegetable oils, animal fats | • NA |
| **India** | Ethanol | • National Biofuels Policy amended in 2022 target 20% ethanol blending rate & construction of 500 biogas plants under Gobardhan scheme |
| **New Zealand** | Sawmill residues, tallow | • Scraped planned biofuels mandate for Apr 2023 due to political concerns over price increase in fuels |
| **South Korea** | Imported UCO | • Renewable Fuel Standard program mandates mixing of biodiesel when supplied to petroleum refiners, importers/exporters |
| **Taiwan** | Cooking oil, municipal & agricultural waste | • 2050 Net Zero Transition "Forward-looking Energy" Key Strategic Action Plan include large-scale special firing system for biomass |

The ruling Labor Party revised a key regulation, rejecting eligibility of woody biomass sourced from native forests under Australia's Renewable Energy Target from 2023

This comes in context of the community voicing out concerns, what with Eastern Australia recently highlighted as a global deforestation hotspot

Grain reserves in China were on the decline since 2016 once the bumper harvest trend came to an end, according to China's state council

Imposing a blending requirement would add more pressure to a limited stock & pose a threat to food security

The government under new prime minister Chris Hipkins retracted the mandate previously under Sustainable Biofuels Obligation

Since cost of biofuels is higher than regular fuels, higher pump prices would place extra pressure on household cost of living

*Source: MUFG compiled from Argus Media, DCCEEW, Reuters and various public sources*

# Sustainable Biofuels in ASEAN I A region known for agricultural 'food' production

**Further policy adjustment is expected, paving the way for more sustainable use of the agricultural outputs**

## Food security

Biofuel production from traditional feedstocks like palm, rapeseed, soy, corn, wheat directly compete with crops for national food supply

**Example measure to address potential food scarcity**

- Thailand reduced its mandatory biodiesel blending ratio early 2022 in response to shortage of vegetable oil & surge in global prices

**Indonesia & Malaysia** produce ~85% of global palm oil as of 2020

## Threat of deforestation & loss of biodiversity

Arising from rapid expansion of plantations in Southeast Asia, in particular palm oil

**Drivers towards more sustainable practice e.g. Palm Oil Industry**

- **Obtaining sustainable certifications e.g. R**oundtable on Sustainable Palm Oil (RSPO), Malaysian Sustainable Palm Oil (MSPO) Certification Scheme:
- **Introduction of national restrictions e.g.** Malaysia's plantations capped at 6.5 million hectares to boost palm oil productivity of existing plantations
- **Strong foreign policy signals e.g.** Revised EU Renewable Energy Directive aims to phase-out palm oil by 2030

**Vietnam & Thailand** are world's 5th & 6th largest rice producers as of 2022

## Consideration of viable alternative feedstock sources e.g. used/recycled cooking oil & agricultural waste

However, aggregation, bulk supply & collection of such feedstocks to processing companies require vast logistical networks

**Example policy to incentivise and streamline feedstock process**

- In Punjab, India, unutilised organic waste serves as income source for farmers as such raw material is used for biomass-based cogeneration plants in the government's infrastructural push to switch to faster & cheaper methods of feedstock collection

*Source: MUFG compiled from ASEAN Energy, Eco-Business, IEA and various public sources*

# Case study of Singapore I A biofuels processing & trading hub in the making

**Singapore is well placed to become a biofuels hub**

- Government seeks to establish trading hub for biofuels while promoting its adoption across Singapore's high-emitting sectors such as **Power generation, Transport , Heavy industry**
- Potential mass production (purification, separation) & distribution of biofuels at a much lower cost underscores Singapore's competitive edge by having well-established chemical & refining industries and leading global positioning in both maritime & aviation sectors
    - A **global aviation hub** with Changi Air Hub being one of the world's top busiest airports
    - As a **global maritime hub**, Singapore is the **world's top bunkering port** & busiest container transhipment port
- Research & Development

Ministry of Trade and Industry (MTI) & National Climate Change Secretariat (NCCS) have called for a study tender to examine potential sources of biofuels such as food waste & animal fats locally & from up to 8 countries

## Waste-to-energy(WtE)

- Home to 4 WtE plants (TuasOne, Keppel, Tuas South Incineration & Senokko)
- From 2025, Tuas Nexus Integrated Waste Management Facility to treat food waste & used water to produce biogas, generating electricity to run facility

## Shipping

- Maritime Port Authority(MPA) has been facilitating use of cleaner fuels such as biofuels to support maritime decarbonization
    - MPA developed framework (provisional standard on marine biofuel specifications up to B50 Blends) allowing licensed bunker suppliers to supply biofuel within Port of Singapore to vessels
    - >140,000 tonnes of biofuel blends have been supplied across >90 biofuel bunkering operations

## Sustainable Aviation Fuel (SAF) Hub

*Sustainable Air Hub Blueprint to release by Dec 2023*

- May 2023: Neste opened world's largest renewable diesel refinery, Tuas South Refinery
    - Supply up to 1m tons of SAF annually
    - Established integrated SAF supply chain to Singapore Changi Airport
    - Developing new solutions such as algae as feedstock
- Nov 2023: Civil Aviation Authority of Singapore (CAAS), GenZero, & Singapore Airlines completed 20-month SAF pilot to prove operational readiness

*Source: MUFG compiled from CAAS, MPA, MOT and various public sources*

# APAC Biofuel Market Activity

| | Date | Developers | Project type | Project Details | Market Impact |
|---|---|---|---|---|---|
| AUSTRALIA | Feb-23 | Genesis Energy, Fonterra | Agreement | Collaboration to explore viability of biomass as a substitute for coal | |
| | May-23 | Renergi | Investment | Australian Renewable Energy Agency (ARENA)-backed Renergi installed innovative biomass pyrolysis plant that processes municipal solid waste to produce bio-oil, biochar | |
| CHINA | Nov-23 | National Energy Administration | Pilot | Announcement to launch series of pilot projects to spur domestic production & consumption of biodiesel | |
| HK | Jul-23 | Banle Energy, ASB Biodiesel, Seven Seas Oil | Investment | Completed very first B24 biofuel bunkering operation in Hong Kong | |
| INDIA | Aug-21 | Mitsui & Co. | Investment | Mitsui invested INR300mil in Biomass supply chain management company - Punjap Renewable Energy System | |
| | Mar-23 | Asian Development Bank, SAEL Energy Solutions LLP | Investment | Construction of five biomass power plants with a capacity to generate 544 GWH of energy per year. | |
| | Jul-23 | Indian Oil Corp. Ltd., Praj Industries Ltd. | Agreement | Strengthen biofuel production capacities in India | |
| INDONESIA | Feb-22 | IHI, Institut Teknologi Bandung(ITB) | Study | Joint study to cut $CO_2$ emissions by harnessing agricultural residues | |
| | Mar-22 | Mitsubishi Power, PT PLN, ITB | MOU | Promoting the adoption of biomass co-firing at Indonesia's thermal power plants | |
| | Sep-22 | Kansai Electric Power, Medco Power | | Examine possibility of applying decarbonization technologies (biomass combustion & carbon capture) in thermal power plants | |
| | Sep-23 | Pertamina | Announcement | Increase ethanol blending by mixing its gasoline products with bioethanol in 2024 | |
| MALAYSIA | Mar-23 | Chitose | Investment | Launched world's largest facility of microalgae biomass production | |
| | Apr-23 | Osaka Gas, IHI, Petronas | Feasibility study | Produce e-methane from unutilized biomass, such as unutilized forest resources & agricultural residues | |
| | Jun-23 | IHI, TNB Genco | | Accelerate introduction of ammonia & biomass combustion technologies in TNB Genco's existing power plants | |
| | Jun-23 | EcoCeres | Investment | Biofuel production facility for hydrotreated vegetable oils & SAF with annual targeted capacity of 350k mt | |

**Legend:** Increase in demand  Increase in supply

*Source: MUFG compiled from Genesis Energy, IHI, Mitsui & Co., Reuters and various public sources*

# APAC Biofuel Market Activity

| | Date | Developers | Project type | Project Details | Market Impact |
|---|---|---|---|---|---|
| NZ | Jul-23 | BP, StraitNZ | Agreement | BP Marine to provide long-term supply of B24 marine biofuel to StraitNZ | Increase in supply |
| PHILIPPINES | May-21 | Prime Infrastructure | Feasibility study | Evaluate feasibility of establishing biorefinery in Luzon for municipal solid waste | Increase in supply |
| SINGAPORE | Jul-23 | Vitol | Investment | Targets biofuel expansion in Singapore in 2024 with delivery of specialized bunker barges | Increase in supply |
| S KOREA | Dec-22 | GS EPS Co., LG Chem Ltd | Investment | New biomass power plant to produce industry-usable steam & electricity using wood chips by early 2026 | Increase in demand |
| | Sep-23 | LG Chem Ltd., Eni Sustainable Mobility | | Become the first hydrogenated vegetable oil (HVO) facility with its entire supply chain from feedstock to finished products based in Korea | Increase in supply |
| TAIWAN | Jul-23 | J & V Energy Technology | Investment | Announced plan to construct 1st agricultural residue-based biomass fuel power plant in Pingtung by end-2023 | Increase in demand |
| | Aug-23 | Taiwan Power Company | Announcement | Actively promoting biomass power generation through biogas power generation systems | Increase in demand |
| | | Taiwan Sugar Corporation | | Actively promoting biomass power generation through coal-fired power generation units | Increase in demand |
| THAILAND | Jan-22 | Marubeni, Mitr Phol Sugar Corp | MOU | Develop raw materials for bio-based products by utilising agricultural residues & also renewable energy | Increase in supply |
| | Nov-22 | Sumitomo Corp, Global Green Chemicals (GGC) | | Promote utilization of woody biomass & bioethanol made from sugarcane especially in Thailand & consider production of 2nd-generation bioethanol | Increase in supply |
| VIETNAM | Aug-22 | J-Power, Vinafor | MOU | Explore business opportunities for biomass in Vietnam | Increase in supply |
| | Sep-22 | eRex | | Transition of coal-fired power plants & construction of new biomass power plants | Increase in demand |

**Legend:** Increase in demand  Increase in supply

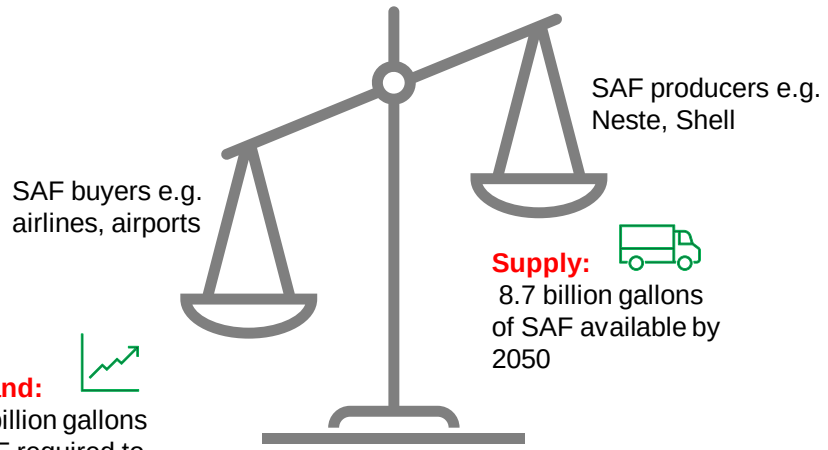
*Source: MUFG compiled from Bioenergy International, Erex, Marubeni, Offshore Energy and various public sources*

# Section II: Sustainable Aviation Fuel

# Introduction to Sustainable Aviation Fuel I A race to secure feedstock supply

**Biofuels serve as a widely-explored solution in the decarbonization pathway for the global aviation industry**

Sustainable Aviation Fuel (SAF), a drop-in fuel solution that provides a lifecycle carbon reduction of up to **80%** compared to conventional jet fuel without modification of existing aircraft engine

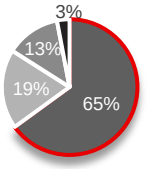



## Scaling up production faces headwinds

- **Production costs of** SAF currently estimated to be around 3-6 times the market rate for traditional aviation fuel
- **Limited availability of feedstock** for other uses such as food, road transport, marine fuel & petrochemicals
- **Technical & regulatory** approvals to overcome while in process of exploring more advanced generations of feedstock for SAF production

## Association of Asia-Pacific Airlines (AAPA)

**AAPA leaders pledged to work together to strive for a SAF utilisation target of 5% by 2030**


International Air Transport Association (IATA) projects SAF to contribute ~**65%** of emission reductions in required by aviation to reach net-zero in 2050

- SAF
- Carbon capture & Offsets
- New Technology, Electric, Hydrogen
- Infrastructure, Operational efficiency

*Source: MUFG compiled from IATA, Nikkei Asia and various public sources*

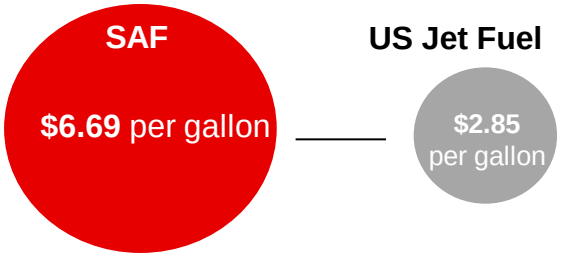
# Introduction to Sustainable Aviation Fuel I Technologically ready but costs remain steep

**Bringing down the price of SAF relative to conventional fuels still a feat given costly technological production pathways**

## 4 key technical pathways to produce SAF*:

| Pathway | Feedstock examples | Technological maturity | Cost ($/gallon jet fuel) |
|---|---|---|---|
| **1. Hydroprocessing Esters & Fatty acids (HEFA)**<br>Refining of vegetable/waste oils into SAF via hydrogen & cracking | • Algae<br>• Cooking oil<br>Plant oil | Mature | Low (3.4-4.9) |
| **2. Alcohol-to-jet (ATJ)**<br>Conversion of alcohols into SAF by removal of oxygen | • Agricultural/ forestry residues<br>• Municipal waste | Commercial pilot | High (7.4-11) |
| **3. Fischer-Tropsch(FT)**<br>Refining of hydrocarbon products into SAF | • Sugarcane<br>• Molasses<br>• Corn | Commercial pilot | Medium (6.1-8.3) |
| **4. Power to liquid(PtL)**<br>Conversion of renewable electricity into SAF via synthetically produced hydrocarbons | • $CO_2$ from Direct Air Capture(DAC) + hydrogen | Early stage | High (6.1-11) |

**4 official pathways certified by American Society for Testing and Materials(ASTM) International*




**Family of biofuel feedstocks to produce SAF:**

**1st Generation Produced from edible sources**
E.g. Corn, sugar, vegetable oils

**2nd Generation Produced from non-food residues/ lignocellulosic biomass**
E.g. Agricultural biomass, forestry refuse, energy crops

**3rd Generation**
**Produced from algae, sewage sludge, municipal solid waste**

*Source: MUFG compiled from IATA, Nikkei Asia and various public sources*

# Introduction to Sustainable Aviation Fuel I Coping with the challenges

**Targeted measurements are deployed to scale-up future SAF production and adoption**

## Challenges

1. **Limited availability of feedstocks**
2. **Technological maturity yet to be developed in some conversion pathways**
3. **Pending regulatory approvals**

SAF producers e.g. Neste, Shell

**High adoption cost for air transport could result in lower profitability for airlines**

SAF buyers e.g. airlines, airports

## Mitigating measures

**New & advanced feedstocks for SAF**

Research & development focused on sourcing feedstocks derived from solid biomass waste, rotational crops, or recycled carbon

- Oct 2023: Petronas & Idemitsu signed an agreement to focus on building supplies of non-edible oil SAF feedstocks like rare plant species, pongamia & jatropha
- **Benefit**: Much more abundant resource than 1st & 2nd generation & projected to reach approximately 3.4 billion tonnes by 2050

**Airport subsidies for SAF**

Assist airlines financially to bridge the price gap between SAF & traditional jet fuel

- 2022: Heathrow was the 1st airport globally to launch a **SAF Incentive Program** covering up to **50% extra cost of SAF**
- Schiphol Airport offers subsidies for airlines that refuel with SAF - €500/metric tonne for biofuel SAF & €1,000/metric tonne for e-fuels SAF

*Source: MUFG compiled from IATA, Nikkei Asia and various public sources*

# APAC Landscape for Sustainable Aviation Fuel I Playing catch-up in the race towards SAF

**Despite high cost & limited feedstock supply, a growing interest in the region to secure SAF is observed**

| Market | Policy Developments | Market Activity |
|---|---|---|
| **Australia** | Jun 2023: SAF Funding Initiative launched by ARENA builds on government's 2021 $30m funding support to develop advanced biofuels sector | • Qantas & Airbus jointly invested A$2m in biofuel refinery set up in Queensland to convert agricultural by-products into SAF |
| **China** | 2022: 14th Five-Year Plan for Green Civil Aviation Development targets to raise SAF consumption to >20kt in 2025 | • Dec 2022: Air China Cargo successfully completed 1st commercial cargo flight using SAF in Chinese mainland<br>• Nov 2022: Airbus signed agreements with Xiamen, Zhejiang Loong & Colorful Guizhou Airlines to promote use of SAF |
| **Hong Kong** | - | • Cathay Pacific will acquire 38m gallons of blended SAF & set own target for sustainable jet fuel (10% of its fuel consumption by 2030) |
| **India** | India to mandate 1% SAF for domestic airlines by 2025 | • Jun 2023: Vistara was 1st Indian airline to operate a commercial domestic flight on a wide-body aircraft using SAF |
| **Indonesia** | - | • Oct 2023: Garuda Indonesia completed a test SAF flight using palm oil-blended jet fuel |
| **Malaysia** | Target to produce 100,000 barrels of SAF per day by 2030 from Sarawak state | • Sarawak to begin commercial production of SAF from microalgae by 2024 |
| **New Zealand** | NZ Government & Air New Zealand partner to invest >NZ$2.2m for feasibility studies in SAF production | |
| **Philippines** | Sep 2023: Department of Energy planning to issue guidelines & regulations for use of SAF to accelerate decarbonization of commercial aviation | • Oct 2023: Cebu Pacific looking towards long-term deal for SAF to establish supply agreements with partners like Neste, Itochu & Shell |
| **Singapore** | Mar 2023: Committed $50m to CAAS to become SAF hub | • Neste launching 1st production facility on Singapore in 2023, producing 1m tonnes/year<br>• SQ & Scoot recently conducted 20-month trial for SAF |
| **South Korea** | - | • Sep 2023: GX Caltex secured 1st foreign-sourced SAF from Neste for Korean Air cargo flight |
| **Taiwan** | - | • May 2023: China Airlines launched 1st SAF passenger flight which was from Taipei to Singapore |
| **Thailand** | - | • Bangchak Corporation building Thailand's 1st SAF production plant adjacent to its oil refinery in Bangkok's Phra Khanong district to be completed before end 2024<br>• Thai Airways announced gradual increase in SAF use, target 2% by 2025 & 60% by 2050 |
| **Vietnam** | - | - |

*Source: MUFG compiled from ARENA, S&P, Taipei Times, The Star and various public sources*

# SAF in Reality I A flight in progress towards sustainability

**Spectrum of decarbonization efforts across airlines to include SAF as a key decarbonization lever**

| Airline | Decarbonization target | SAF target | SAF milestones | Other SAF highlights |
|---|---|---|---|---|
| **Cathay Pacific** | Net Zero by 2050 | 10% use by 2030 | • Jun 2023: completed 1st refuel of overseas cargo flight with SAF | **Customer engagement**<br>• 2022: Launched Corporate SAF Programme, a 1st in Asia, with 8 initial corporate customers as opportunity to reduce carbon footprint from business travel/airfreight via SAF flights |
| **Etihad Airways** | | - | • Oct 2022: 1st SAF flight departed using SAF procured from Neste & Itochu | **Technological innovation**<br>• Part of Abu Dhabi Hydrogen Alliance & currently working on using green $H_2$ to produce synthetic kerosene (SK) for its SAF |
| **Lufthansa** | | - | • Nov 2020: launched 1st SAF-fuelled cargo flight | **Green Fare program to promote sustainable flying**<br>• Passengers could opt in to contribute towards reducing 20% flight-related $CO_2$ emissions via SAF & offset remaining 80% by equivalent contribution to high-quality climate protection projects<br><br>**Technological innovation**<br>• Accelerating next generation of SAF by involving in projects for next-generation technologies like Power-to-Liquid (PtL) & Sun-to-Liquid (StL) |
| **Singapore Airlines** | | 5% use by 2030 | • Jul 2022: operated 1st batch of flights with blended SAF | **Carbon credits**<br>• SIA Group Voluntary Carbon Offset Programme: from 4Q 2022, customers able to purchase mix of SAF credits & carbon offsets<br>• Partnership with Climate Impact X (CIX), a global exchange, to introduce bundled portfolio consisting of SAF & carbon credits |
| **United Airlines** | | Triple use to 10 m gallons by 2023 | • 2021: 1st passenger flight using 100% SAF in one engine | **Corporate partnership**<br>• United's Eco-Skies Alliance is innovatively designed for participating companies to share "green premium"/cost associated with purchasing low-carbon fuels<br>• At end-2022, corporate passenger & cargo customers managed to fund 9m gallons of SAF |

*Source: MUFG compiled from ASEAN, SEADS and various public sources*

# Case Study of Japan I Positioning itself to be frontrunner for SAF in the region

**Cohesive efforts between public and private sectors drive SAF's technology development and adoption in Japan**

**Japan's national policy on SAF**

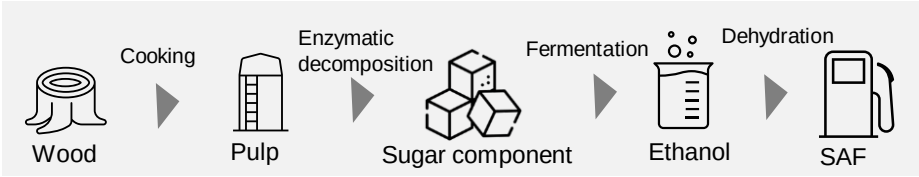
Ministry of Economy, Trade & Industry (METI)'s "Public-Private Consultative Meeting to Promote the Introduction of SAF"

**10%** of Japan's jet fuel consumption replaced by SAF by 2030

## Oji Holdings: SAF supplier perspective

- Oji HD is largest Japanese paper manufacturer

*Value chain of woody biomass as next-generation feedstock:*




- Use ethanol derived from woody biomass, a non-edible form existing in large quantities on earth
- **Challenge: H**igh production costs from decomposing raw material
- **Solution:** Oji exploring integration of pulping technology to fully utilize oil(lignin) in wood as bioenergy & reuse enzymes to break down pulp & yeast into ethanol
- May 2023: installed bioethanol pilot production facility from woody biomass & sugar at Oji Paper Yonago mill
- Target: Produce up to 820t/year by FY2024

See also *MUFG Transition Whitepaper 2.0*
(https://www.mufg.jp/dam/csr/report/transition/wp2023.pdf)

## Japan Airlines(JAL) : SAF buyer perspective

- Target: replace 1% total fuel consumption with SAF by FY2025, 10% by FY2030
- Secure 400-500k kl of SAF to achieve above target

*Stakeholder initiatives for SAF*

- Mar 2022: JAL & 15 other Japanese companies established voluntary organization ACT FOR SKY to commercialize domestically produced SAF for utilization
- Apr 2022: discussion with METI, other government agencies & aviation players on technical & economic issues of SAF based on GX Basic policy

*Investment in manufacturers to secure SAF*

- Jointly acquired shares of Fulcrum BioEnergy, Inc. which is developing process to manufacture SAF from general waste

*Source: MUFG compiled from MUFG Transition Whitepaper 2.0 and various public sources*

# SAF in Reality I Ongoing conversations toward the future of SAF

**A narrative surrounding standard-setting to properly fuel up momentum**

## Establishing consistency & standard-setting for SAF

- **Optimal blend (%) of SAF into jet fuel to unlock the endgame**
  - Aircrafts currently allowed to operate only up to 50% blend of SAF & conventional jet fuel
  - Large aircraft manufacturers like Airbus targets to enable 100% pure drop-in SAF capability by 2030

**Fact**

**SAF emission reduction pathway:**

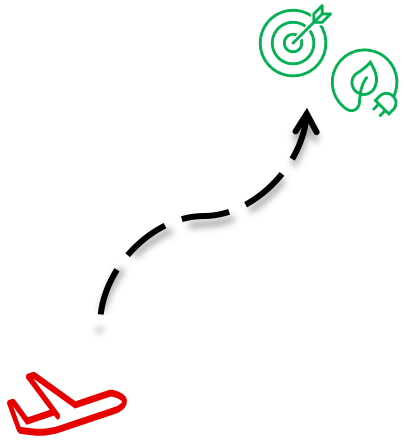
Current: **50%** blend of SAF -> up to **80%** reduction in GHG emissions

vs

Future: **100%** pure blend of SAF-> up to **94%** reduction in GHG emissions

*Source: US Department of Energy, Alternative Fuels Data Center (2023)*

- **International recognition of SAF use across flights where countries of arrival & departure could have different regulations**
  - EU prefers waste-based SAF over ethanol-based SAF while other regimes do not specify preference
- **High costs, administrative & reporting burdens due to lack of uniform certification system for SAF**
  - Key certification schemes for SAF approved by International Civil Aviation Organization(ICAO): International Sustainability & Carbon Certification, Roundtable on Sustainable Biomaterials & Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)
- GHG abatement costs for airlines via SAF($258/mt$CO_2$e) much higher than purchasing carbon offsets under CORSIA ($3.86/mt$CO_2$e)



## Restoring commercial tailwind

- Length of recovery period post-pandemic needed for airline companies to be able to rebound & redirect their priority towards SAF again

*Source: MUFG compiled from S&P and various public sources*

# Contact Us

## ESG Finance Department
## Asian Investment Banking Division


**Colin Chen**
Managing Director,
Head of ESG Finance,
APAC

colin_chen@sg.mufg.jp
+65 6918 4798

**Amanpreet Singh**
Director, Deputy Head of ESG Finance,
APAC

Amanpreet_Singh@sg.mufg.jp
+65 6918 3475

**Shareef Omar**
Head of ESG Finance,
Oceania

shareef_omar@au.mufg.jp
+61 403 682 738

**Angkana Meeploy**
Director, Head of Market Intelligence,
APAC

meeploy@sg.mufg.jp
+65 6918 4876

**Archana Khemka**
Director, ESG Finance,
APAC

archana@sg.mufg.jp
+65 6918 5113

**Serena Lum**
Analyst, Market Intelligence,
APAC

Serena_lum@sg.mufg.jp
+65 6918 4772

# Disclaimer

This report has been prepared by MUFG Bank, Ltd. (the “Bank”), for information only and is not intended for use by or distribution to any person or entity in any jurisdiction or country where such distribution or use would be contrary to law or regulations. The Bank and/or any person connected with it may make use of or may act upon the information contained in this report prior to the publication of this report to its customers.

Neither the information nor the opinion expressed herein constitute or are to be construed as an offer, solicitation, advice or recommendation to buy or sell deposits, securities, futures, options or any other financial or investment products.

This report has been prepared solely for informational purposes and does not attempt to address the specific needs, financial situation or investment objectives of any specific recipient.

This report is based on information from sources deemed to be reliable but is not guaranteed to be accurate and should not be regarded as a substitute for the exercise of the recipient’s own judgment. The recipient should obtain separate independent professional, legal, financial, tax, investment or other advice, as appropriate.

This report is based upon the analysts’ own views, therefore does not reflect the Bank’s official views. All views herein (including any statements and forecasts) are subject to change without notice, its accuracy is not guaranteed; it may be incomplete or condensed and it may not contain all material information concerning the entities referred to in this report. None of the Bank, its head office, branches, subsidiaries and affiliates is under any obligation to update this report.

Historical performance does not guarantee future performance. Any forecast of performance is not necessarily indicative of future or likely performance of the any product mentioned in this report.

The Bank and/or its directors, officers, and employees, from time to time, may have interest and/or underwriting commitment in the relevant securities mentioned herein or related instruments and/or may have a position or holding in such securities or related instruments as a result of engaging in such transactions. Furthermore, the Bank may have or have had a relationship with or may provide or have provided corporate finance or other services to any company mentioned herein.

The information contained herein has been obtained from sources the Bank believed to be reliable but the Bank does not make any representation or warranty nor accept any responsibility or liability as to its accuracy, timeliness, suitability, completeness or correctness.

Therefore, the inclusion of the valuations, opinions, estimates, forecasts, ratings or risk assessments described in this report is not to be relied upon as a representation and / or warranty by the Bank. The Bank, its head office, branches, subsidiaries and affiliates and the information providers accept no liability whatsoever for any direct, indirect and/or consequential loss or damage of any kind arising out of the use of all or any part of this report.

The Bank retains copyright to this report and no part of this report may be reproduced or redistributed without the written permission of the Bank and the Bank, its head office, branches, subsidiaries or affiliates accepts no liability whatsoever to any third parties resulting from such distribution or re-distribution.

MUFG Bank Ltd.
7 Straits View
#23-01 Marina One East Tower
Singapore 018936

www.mufg.jp/english