2024 ICAO REGIONAL SEMINAR ON ENVIRONMENT

In collaboration with CAAT
สำนักงานการบินพลเรือนแห่งประเทศไทย
The Civil Aviation Authority of Thailand

APAC Region

7 to 8 , August 2024

Bangkok, Thailand

ICAO ENVIRONMENT

ACT SAF

CORSIA

Colin Choong

Key Account Manager (Topsoe)

SAF Capacity Build-up in APAC

What do we see as a SAF technology provider?

1 How can SAF be produced?

2 Which trends do we observe in APAC when it comes to SAF?

3 What types of SAF activities do we have in APAC?

4 Take-home message

1

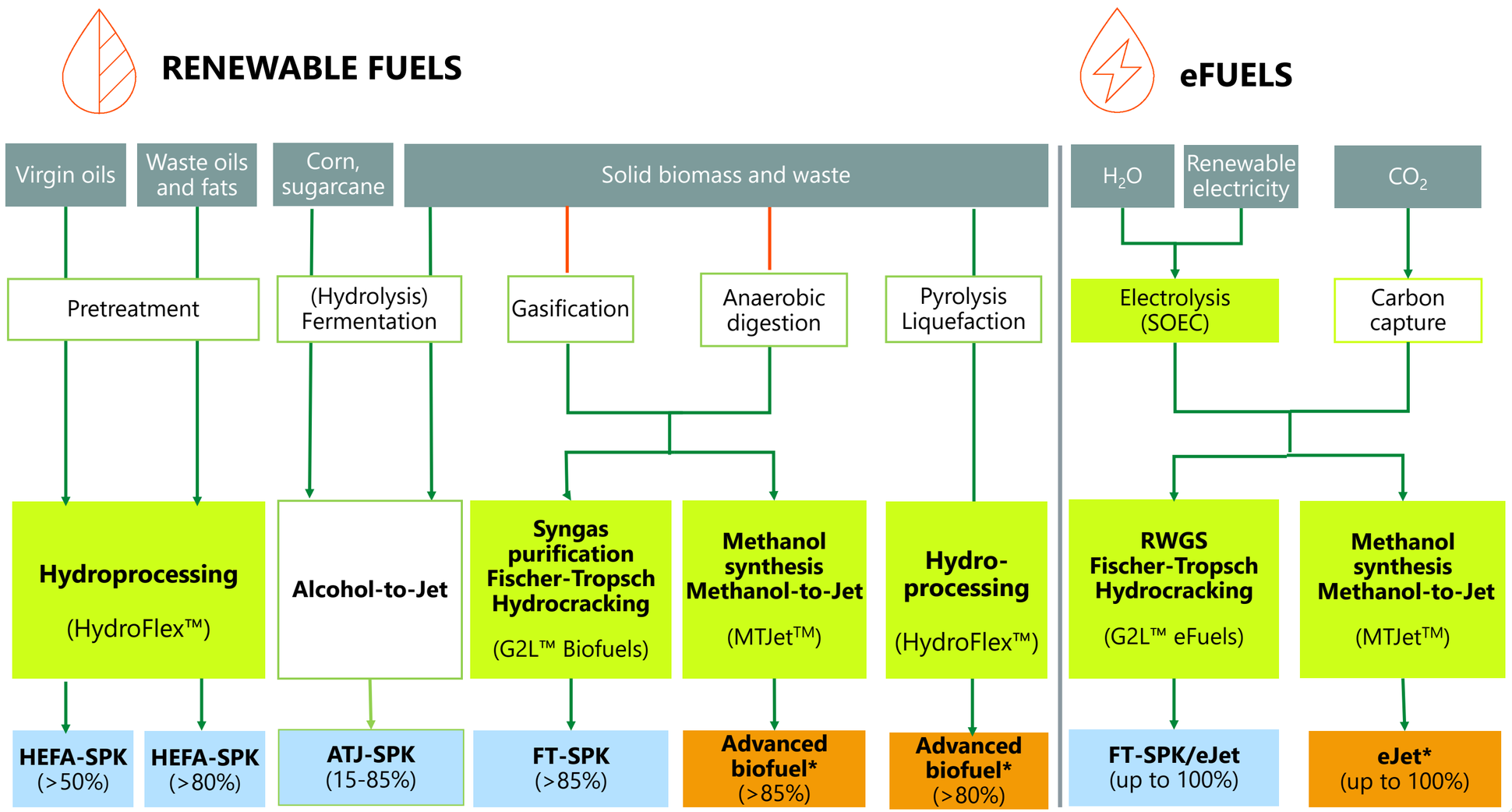
How can SAF be produced?

APPROVED CO-PROCESSING STRATEGIES TO PRODUCE AVIATION FUEL

Pathway	ASTM	Annex	Year	Feedstock options	Current blending limit
Fischer-Tropsch Synthetic Paraffinic Kerosene (FT-SPK)	D7566	A1	2009	Coal, natural gas, biomass (syngas)	50%
Hydroprocessed Esters and Fatty Acids Synthetic Paraffinic Kerosene (HEFA-SPK)		A2	2011	Vegetable oils and fats, animal fat, recycled oils	50%
Hydroprocessed Fermented Sugars to Synthetic Isoparaffins (HFS-SIP)		A3	2014	Biomass used for sugar production	10%
Fischer-Tropsch Synthetic Paraffinic Kerosene with Aromatics (FT-SPK/A)		A4	2015	Coal, natural gas, biomass	50%
Alcohol to Jet Synthetic Paraffinic Kerosene (ATJ-SPK)		A5	2016	Ethanol or isobutanol	50%
Catalytic Hydrothermolysis Synthesized Kerosene (CH-SK, or CHJ)		A6	2020	Triglyceride-based feedstocks	50%
Hydroprocessed Hydrocarbons, Esters and Fatty Acids Synthetic Paraffinic Kerosene (HHC-SPK or HC-HEFA-SPK)		A7	2020	Triterpenes produced by the Botryococcus braunii species of algae	10%
Alcohol-to-jet synthetic paraffinic kerosene with aromatics (ATJ-SKA)		A8	2023	C2 to C5 Alcohol	50%
Co-processing of mono-, di-, and triglycerides, free fatty acids, and fatty acid esters	**D1655**	A1.2.2.1	2018	Mono-, di-, and triglycerides, free fatty acids, and fatty acid esters	5vol% (feed & product)
Co-processing of hydrocarbons derived from synthesis gas via the Fischer-Tropsch process using iron or cobalt catalyst		A1.2.2.2	2020	Fischer-Tropsch hydrocarbons	
Co-processing of hydrocarbons derived from HYDROPROCESSED mono-,di-tryglycerides.	**D1655/23**	A1.2.2.3	2023	Hydroprocessed mono-, di-, and triglycerides, free fatty acids, and fatty acid esters	24vol% feed & 10vol% product

SELECTED CURRENT AND FUTURE SAF PATHWAYS

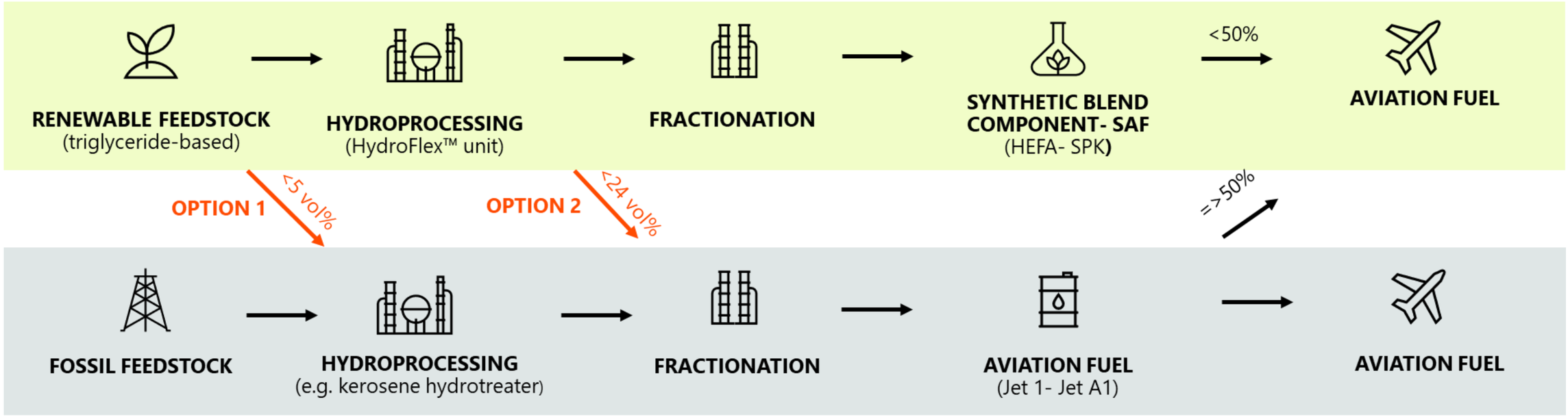
- Feed
- Process
- Process (Topsoe & Partners)
- Product (GHG emissions savings)



Source: CORSIA, ICCT paper 2021-11, WEF+McKinsey 2020-11

*Not approved ASTM pathways yet

STRATEGIES FOR CO-PROCESSING APPROVED BY ASTM



OPTION 1- ASTM 1655/23 A1.2.2.1 Co-processing as co-hydroprocessing

OPTION 2- ASTM 1655/23 A1.2.2.3 Co-processing as co-fractionation

BUT WHAT ARE YOU CONSIDERING IF YOU WANT TO PRODUCE SAF?

Is the technology I am considering flexible with respect to feedstock and product slate?

Should I be concerned about regulation, certification, GHG savings, etc.?

Can I get a long-term agreement/PPA for my feedstock? Can I get a long-term off-take agreement at the right price for my SAF?

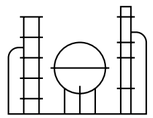
Is my SAF project bankable? Will the SAF market be undersupplied?

2

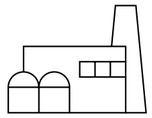
Which trends do we observe in APAC when it comes to SAF?

BUT WHAT ARE YOU CONSIDERING IF YOU WANT TO PRODUCE SAF?

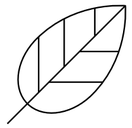
What types of stakeholders are we engaging with?



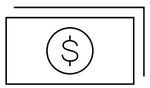
Refiners



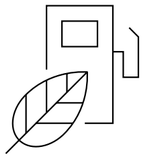
Project developers



Feedstock owners

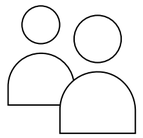


Investors

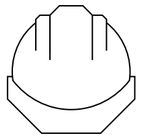


Biodiesel producers

Airlines



Consultants



EPC

Which feedstocks are mostly considered?

- UCO, POME (and other palm wastes), Tallow
- Sugarcane
- Agriculture residues such as Empty Fruit Bunch

Other trends

- HEFA and co-processing are getting most attention
- Most projects are considering export
- SAF premium could be a deterrance, call for cost transparency
- Lack of national mandates and incentives
- The need to create demand signal (long-term offtake agreement).
- Abundant feedstock - book and claim to unlock
- Innovators – retrofitting of biodiesel plants, toll manufacturing, apps for feedstock collection/traceability

3

What types of SAF activities do we have in APAC?

EXAMPLES OF LICENSED TOPSOE SAF PROJECTS IN APAC

PERTAMINA

Cilacap refinery (Indonesia)

6,000 BPSD HEFA-SPK

Completed BEDP stage

Guangxi Hongkun Biomass (China)

300,000 tons of feedstock will be processed into renewable fuels. Construction of the plant to begin in Q4 2024. SAF production expected to start in the beginning of 2026

UNDISCLOSED

Undisclosed reference (SE Asia)

6,000 BPSD HEFA-SPK

SELECTED EXAMPLES OF OTHER SAF PROJECTS AND ACTIVITIES IN THE REGION

As technology licensor and catalyst producer, we are engaging in many activities supporting deployment of SAF globally:

- Co-processing studies for refineries
- Proposals for grassroot HEFA units
- Discussions about other pathways (FT, MTJ, etc.)
- Involved in ASTM qualification groups for MTJ and high aromatics HEFA e.g.
- Knowledge sharing and training (SAF summit, seminars, courses, webinars, podcasts)
- R&D activities such as pilot plant tests or detailed analyses of feedstocks and products

CO-PROCESSING IS A LOW CAPEX FAST TRACK SOLUTION FOR SAF

- → Fastest way to add SAF to the market
- → Co-processing in hydrotreaters is a well-proven procedure
- → Existing assets are evaluated and reused while new components may be added
- → Up to 2 years construction time can be gained
- → Implementation possible both with hydrotreaters and hydrocrackers
- → CAPEX savings start at 30%

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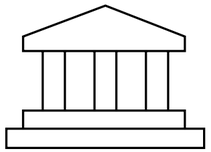
Take-home message

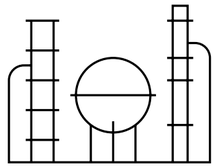
HAVING A BANKABLE SAF PROJECT REQUIRES THE ALIGNMENT OF MANY PLANETS



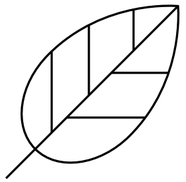
Mandates

Penalties

Incentives

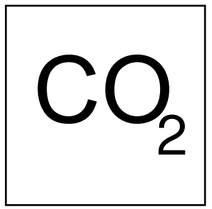


SAF technology



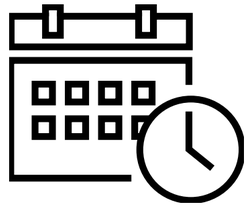
Feedstocks

Certification



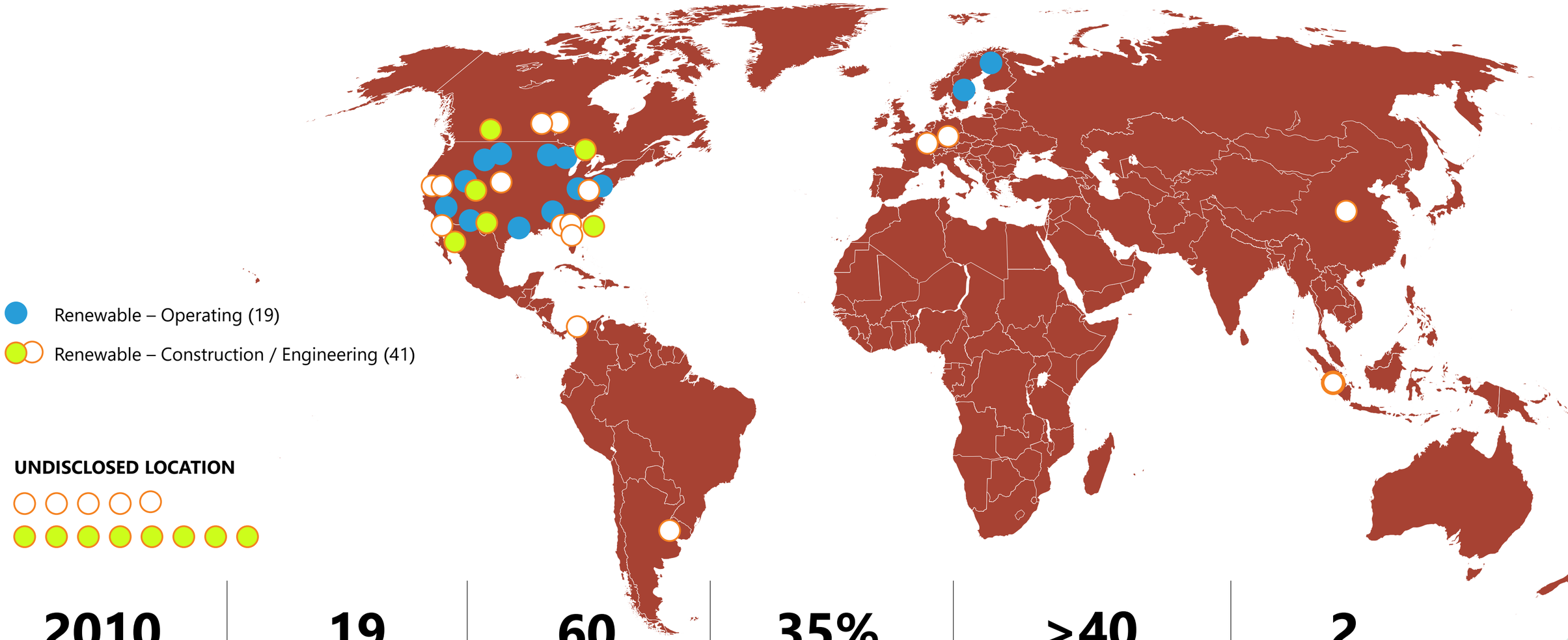
GHG saving and GHG calculation methodology

Offtake agreement



Right time to market

TOPSOE'S HYDROFLEX ™ TECHNOLOGY PRODUCING HVO AND HEFA-SPK



2010	19	60	35%	>40	2
Start-up of first reference	Running references	References	Of the renewable fuels operating capacity	Projects in the pipeline	SAF operating references

TOPSOE HAS A VAST CO-PROCESSING EXPERIENCE TO PRODUCE HVO AND THE FIRST UNITS PRODUCING SAF VIA CO-PROCESSING WILL START THIS YEAR

+90

Co-processing cycles

~20

Studies on co-processing for SAF

Up to 10%

SAF by coprocessing tested in pilot facilities

2

Catalyst charges ordered to produce SAF by co-processing (units starting Q3 2024)

Thank You

ICAO