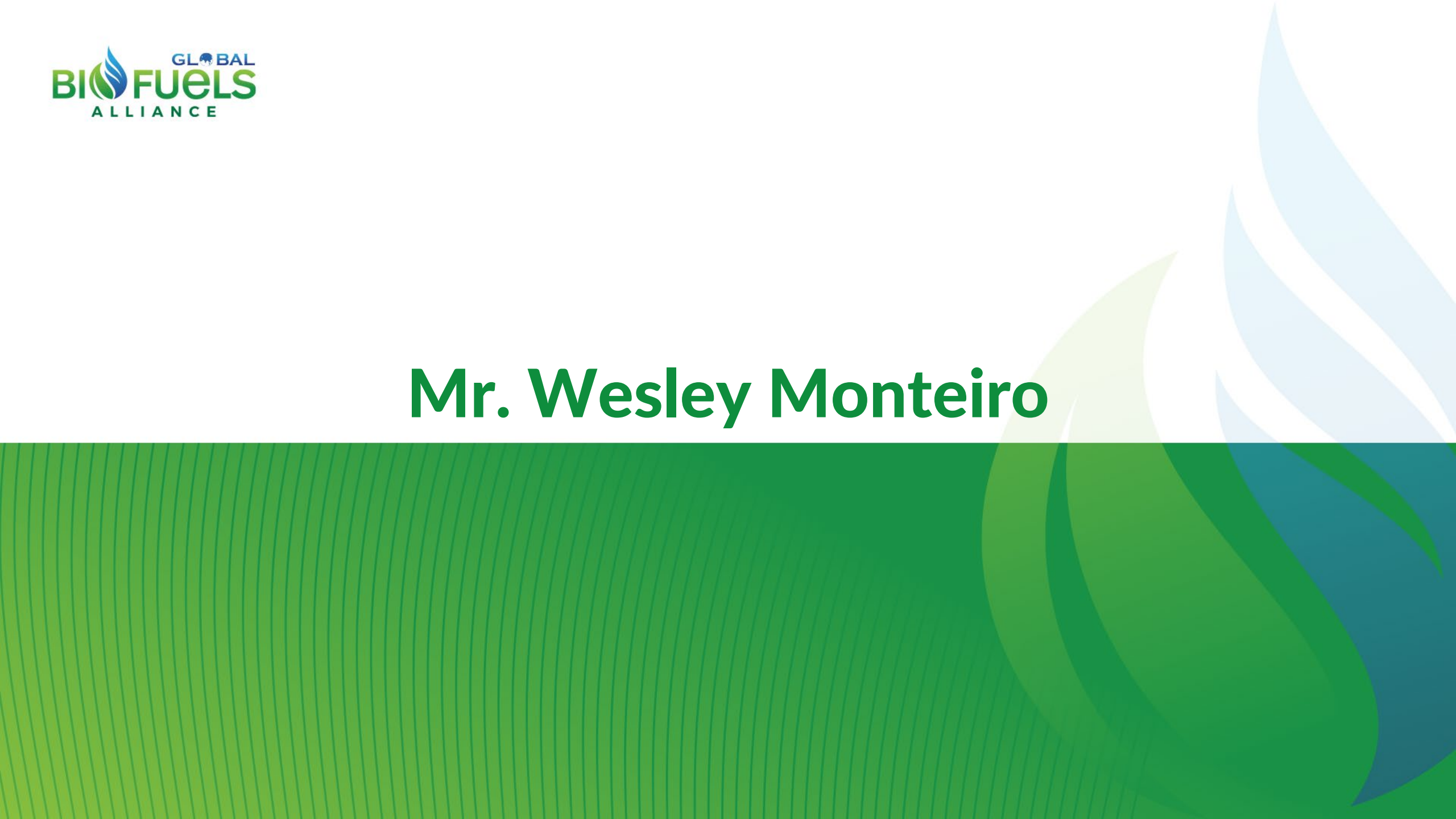


GBA SAF Webinar

25th July 2025

Mr. Wesley Monteiro

The background of the slide is white. On the right side, there are several large, stylized, overlapping leaf or flame shapes in shades of light blue and green. The bottom half of the slide is covered by a solid green band with a pattern of fine, vertical, wavy lines.

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SAF & Feedstock Market Development and Pricing Mechanisms

Wesley Monteiro

Global Market Engagement Lead

Market Reporting and Trading Solutions –
SP Global Commodity Insights



FLIGHT PLAN



Introduction

- S&P Global
- S&P Global Commodity Insights (Platts / MRTS)
- Price Methodology



How Is SAF Made Today And What Could Transform It Tomorrow?

- Main Technological Routes Today
- Present Demand Landscape
- Forecast for Emerging or Scalable Pathways



From Field to Flight: Which Feedstocks Will Take Off?

- Current Main SAF Feedstocks
- Is There Enough Feedstock?



What Drives the Flow? Market and Policy Forces Shaping Feedstock Dynamics

- Feedstock Flows and Global Trade (UCO Ex.)
- Regional Market Dynamics (UCO Ex.)



Can SAF Compete on Price? And Should It?

- Biofuel and Feedstock Prices
- SAF Production Costs / Market-Based Prices
- Pricing & Benchmarks

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INTRODUCTION



MRTS sits within S&P Global Commodity Insights, combining an unparalleled coverage platform with world-class news, price assessments and benchmarks

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S&P Global Commodity Insights

We are the leading independent provider of benchmark prices and information to the global commodities and energy markets.

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Agriculture & Food



Coal



Electric Power



Metals



Natural gas



Nuclear



Oil



Chemicals



Shipping



Energy Transition

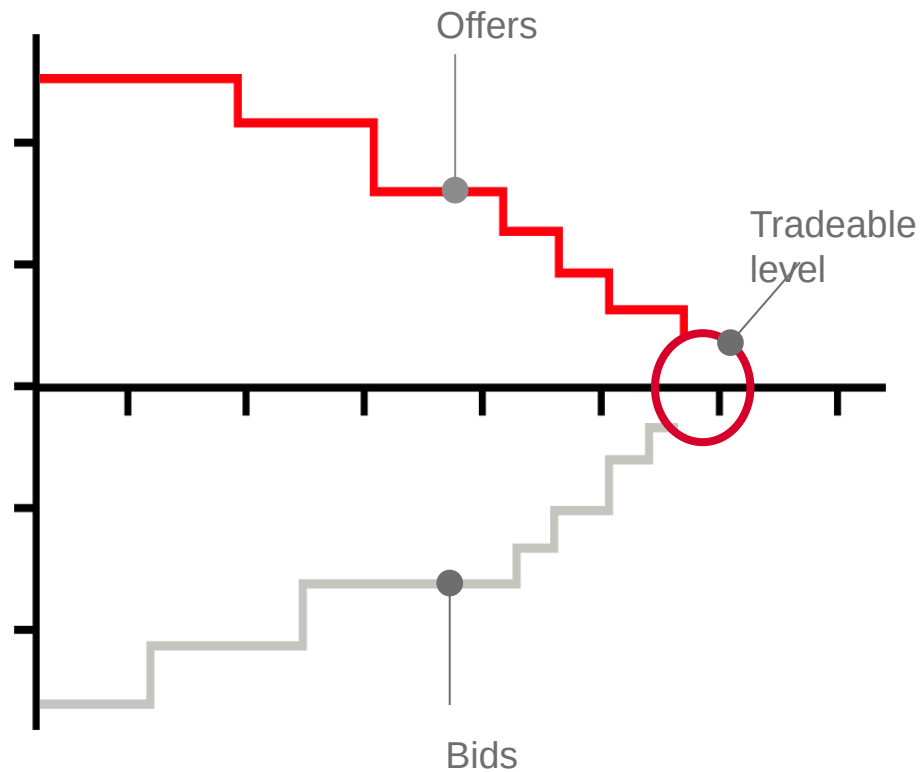


Biofuels



LNG

Platts uses well-defined, transparent, and established methodologies to provide accurate assessments that reflect the true market value



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Commodity +

Jan 28, 2025
Correction
 A Jan. 28 article about Chevron, Engine No. 1 and GE Vernova planning to develop natural gas-fired generation to power data centers incorrectly

Jan 28, 2025
Platts republishes Jan. 20-24, 2025, weekly averages for LME settlement prices
 Platts, part of S&P Global Commodity Insights, wishes to inform subscribers that it has republished the weekly averages for London Metal Exchange

Jan 28, 2025
Platts corrects US Middle Distillate Intradays historical data
 Platts, part of S&P Global Commodity Insights, has corrected the following historical intraday assessments: 9 am Houston intradays Name Symbol

Jan 28, 2025
Platts to rename ERCOT SREC CRS Current YTD Abatement Value
 Platts, part of S&P Global Commodity Insights, will change the description of its ERCOT SREC CRS Current YTD Abatement Value assessment, effective

Jan 28, 2025
Platts proposes European advanced recycling mixed plastic waste feedstock assessment
 Platts, part of S&P Global Commodity Insights, is proposing to launch a European daily spot assessment for mixed plastic waste bales, suitable as

Jan 28, 2025
Platts corrects USD/EUR Spot Forex and Latin America I-REC conversions to Euros for Jan 27

Transparency & consistency Repeatability & incrementability Price verification Robust and consistent methodology

Platts Methodology Principles - Platts applied a very specific hierarchy to evaluate the information received from the market and if the price accurately reflects the market value



Source: S&P Global Commodity Insights

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How Is SAF Made Today And What Could Transform It Tomorrow?



The variety of pathways and feedstocks suggests both availability and a competitive market in the medium term. Each option offers its own value proposition, and the balance of cost, availability, and GHG emissions reduction makes it challenging to determine a clear winner

1 st Gen – Crop	Edible oil crops	Palm oil, Soybean oil, Sunflower oil, Rapeseed/Canola oil	HEFA-SPK	20-45% CI reduction
	Edible sugars	Sugarcane, maize/corn, sugar beet	ATJ-SPK	
2 nd Gen – Advanced / waste	Waste lipids	Tall oil, Palm Oil Mill Effluent (POME), Palm Fatty Acid Distillate (PFAD), Used Cooking Oil (UCO), Animal Fat (Tallow)	HEFA-SPK	45-90% CI reduction
	Energy crops	<u>Oil trees</u> : Jatropha, Pongamia, <u>Oil cover crops</u> : Camelina, Carinata, Pennycress. <u>Cellulosic cover crops</u> : Switchgrass, Miscanthus, Reed	Oil: HEFA Cellulosic: ATJ	
	Ag residues	Straw, sugarcane bagasse, corn stover, cereal residues	ATJ-SPK	
	Forestry residues	Roundwood, sawdust, woodchip, sawmill slabs, logging leftovers, stemwood residues	FT-SPK	
	Biogenic compounds	Municipal waste streams (biogenic portion), algae, sewage sludge	HEFA-SPK	
3 rd Gen – RFNBO / eFuels	Non-biomass	CO ₂ from DAC, Green H ₂	PTL-SPK	90-99% CI reduction
	Recycled carbon fuels	Fossil share of reusable plastic waste Industrial waste gas :CO ₂ from CCS, Other (such as flue gas from steel production)	FT-SPK	

HEFA: Hydroprocessed Ester Fatty Acids, ATJ: Alcohol-to-Jet, FT: Fischer Tropsch, PTL: Power-to-liquid, SPK: Synthetic Paraffinic Kerosene, RFNBO: Renewable Fuels of Non-Biological Origin

Source: S&P Global Commodity Insights.

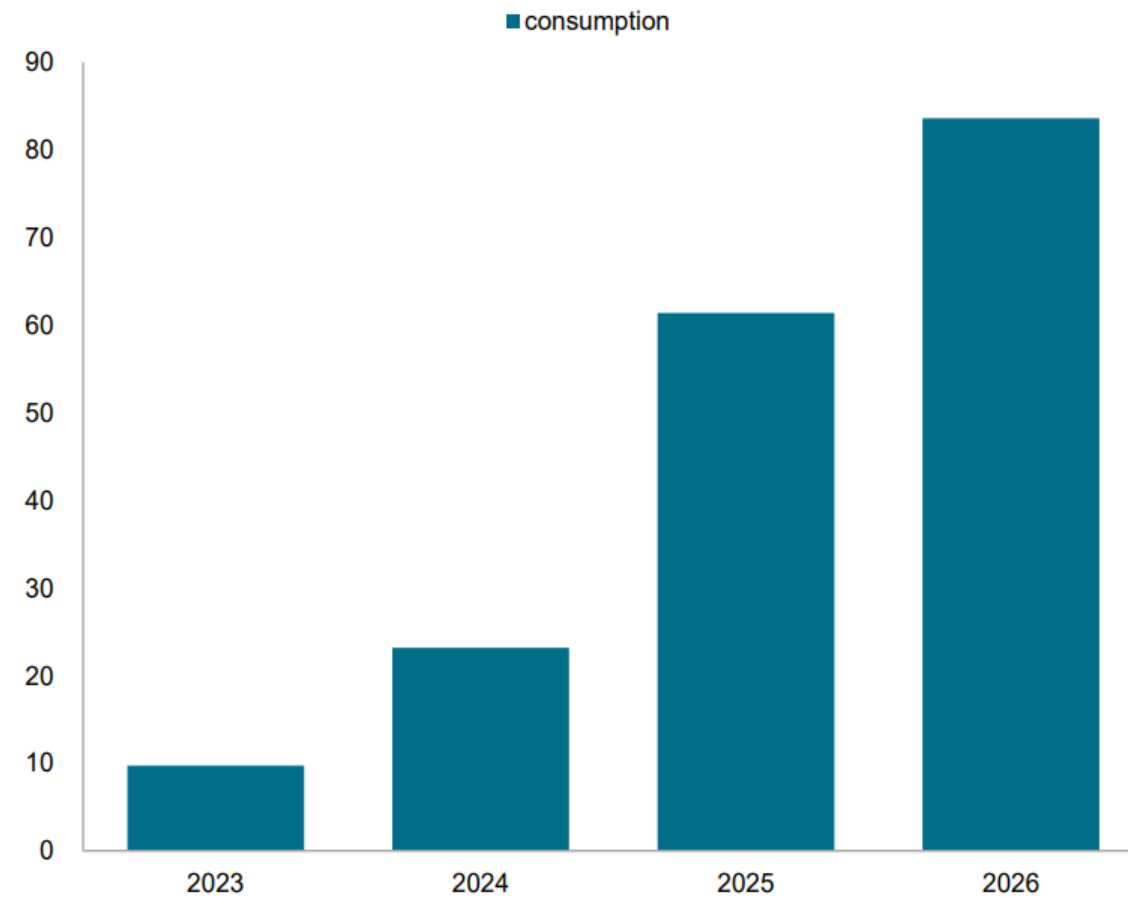
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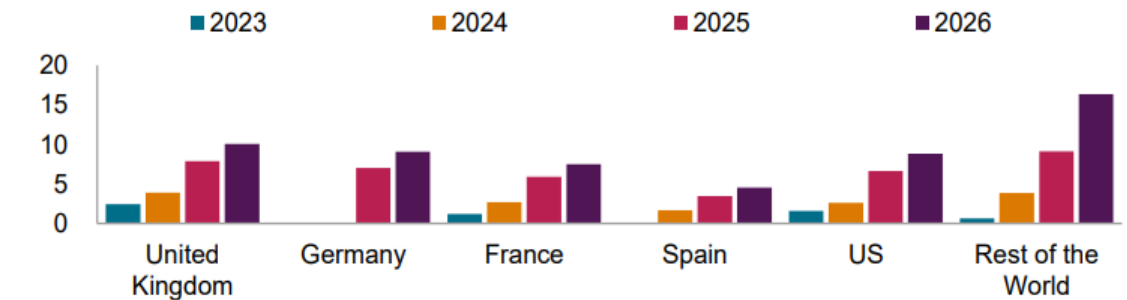
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Global SAF demand is projected to exceed 80,000 b/d by 2026, with Europe accounting for nearly two-thirds of total consumption

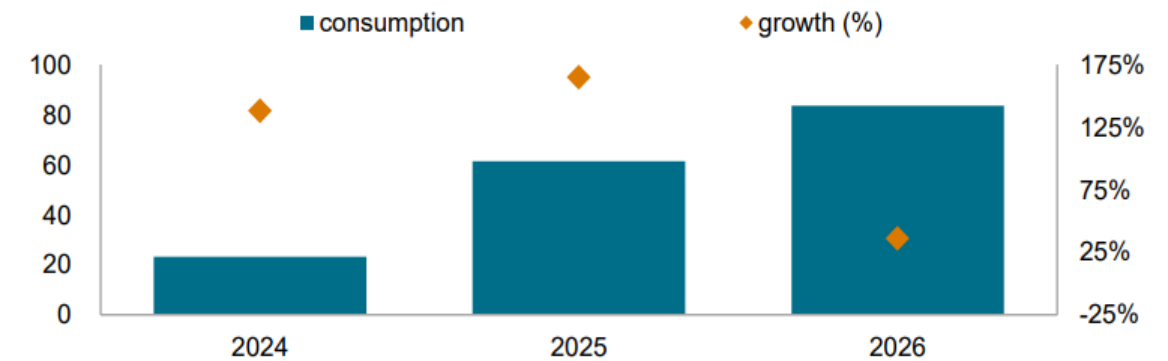
Global sustainable aviation fuel (thousand barrels/day)



Global sustainable aviation fuel demand in main countries (thousand barrels/day)



Global SAF demand (thousand barrels/day)



Source: S&P Global Commodity Insights

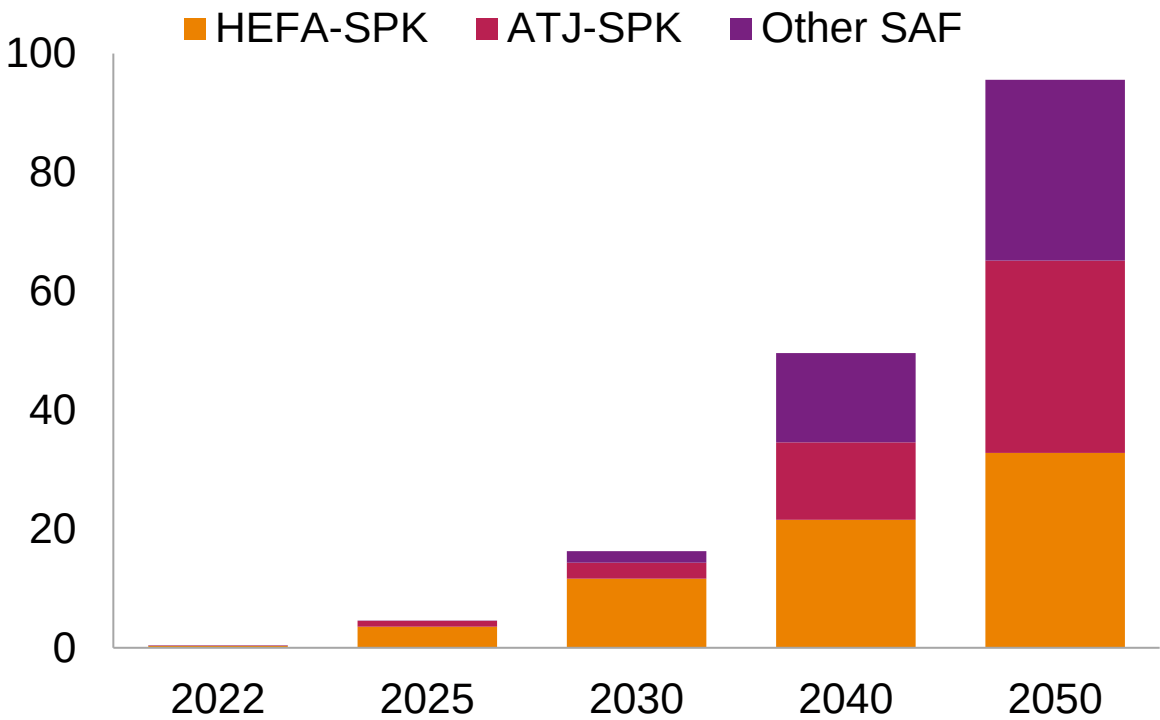
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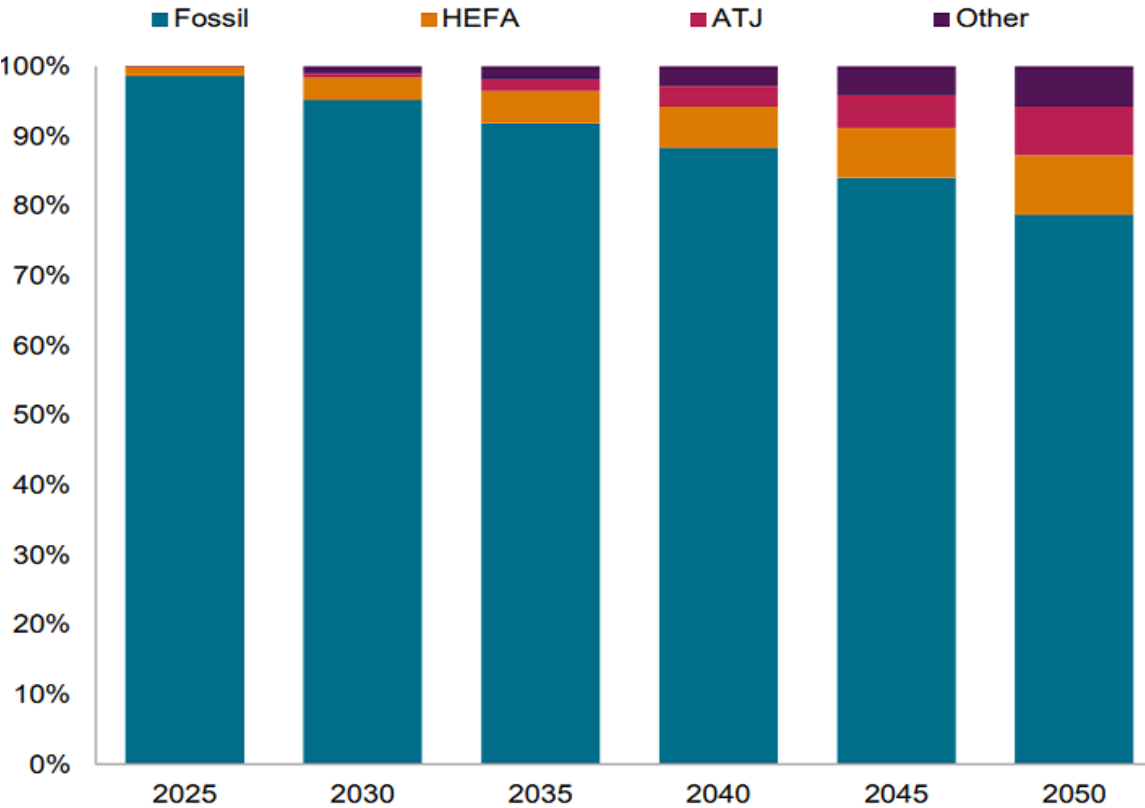
In the short to medium term, HEFA will remain dominant due to lower costs and proven technology, with ATJ growing quickly. In the long term, the three main pathways are expected to share market share equally

World SAF Supply Outlook by Pathway

(Million metric tons)



Volumetric Share of Fuel by Pathway x Jet Fuel



Source: S&P Global Commodity Insights

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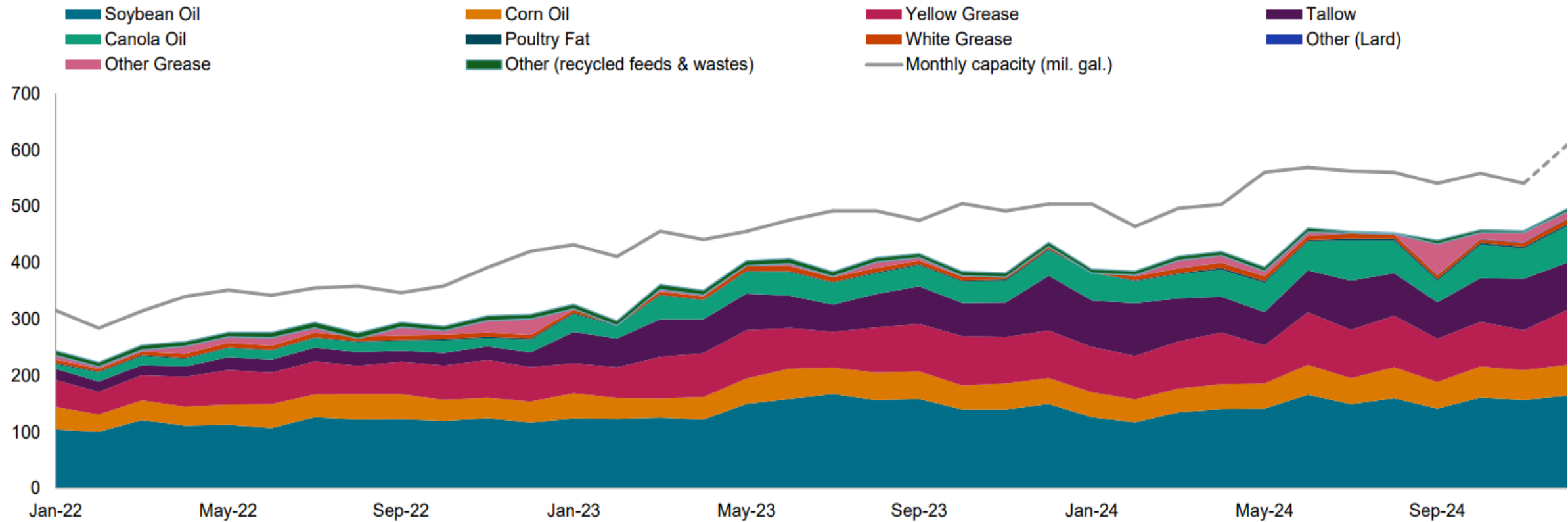
Commodity Insights

From Field to Flight: Which Feedstocks Will Take Off?



US feedstock supply expected to tighten in 2025 amid strong soybean oil exports and restrictions on imported UCO

Monthly US feedstock use (million gallons) and capacity



Data compiled February 27, 2025.

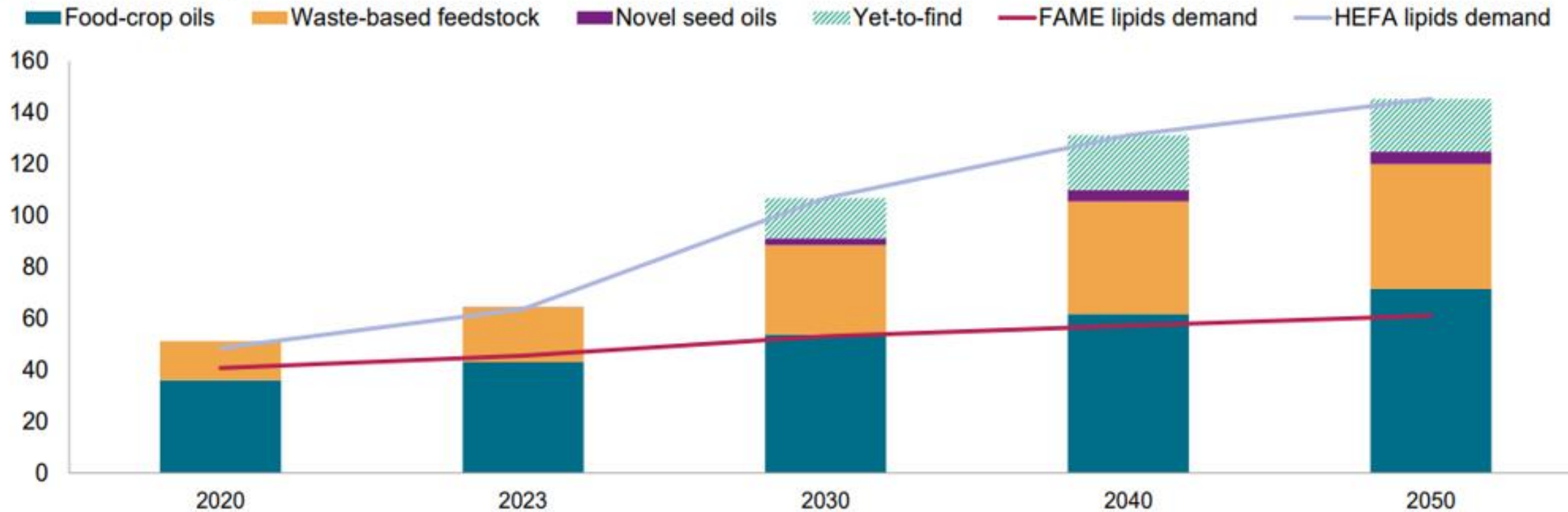
Source: S&P Global Commodity Insights.

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In the long term, limited feedstock availability constrains biofuels production, as demand grows faster than supply

Global fuel sector lipids demand (Million metric tons)



Data compiled Sep. 23, 2023.
Source: S&P Global Commodity Insights.
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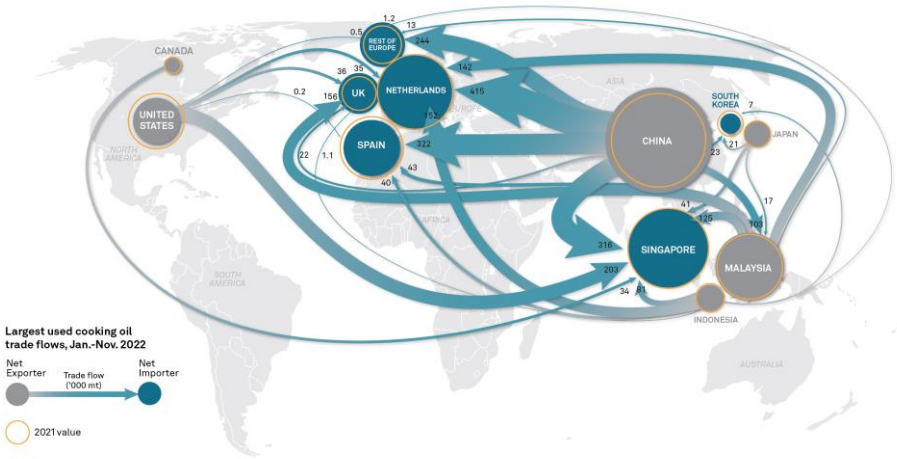
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What Drives the Flow? Market and Policy Forces Shaping Feedstock Dynamics (UCO Ex.)

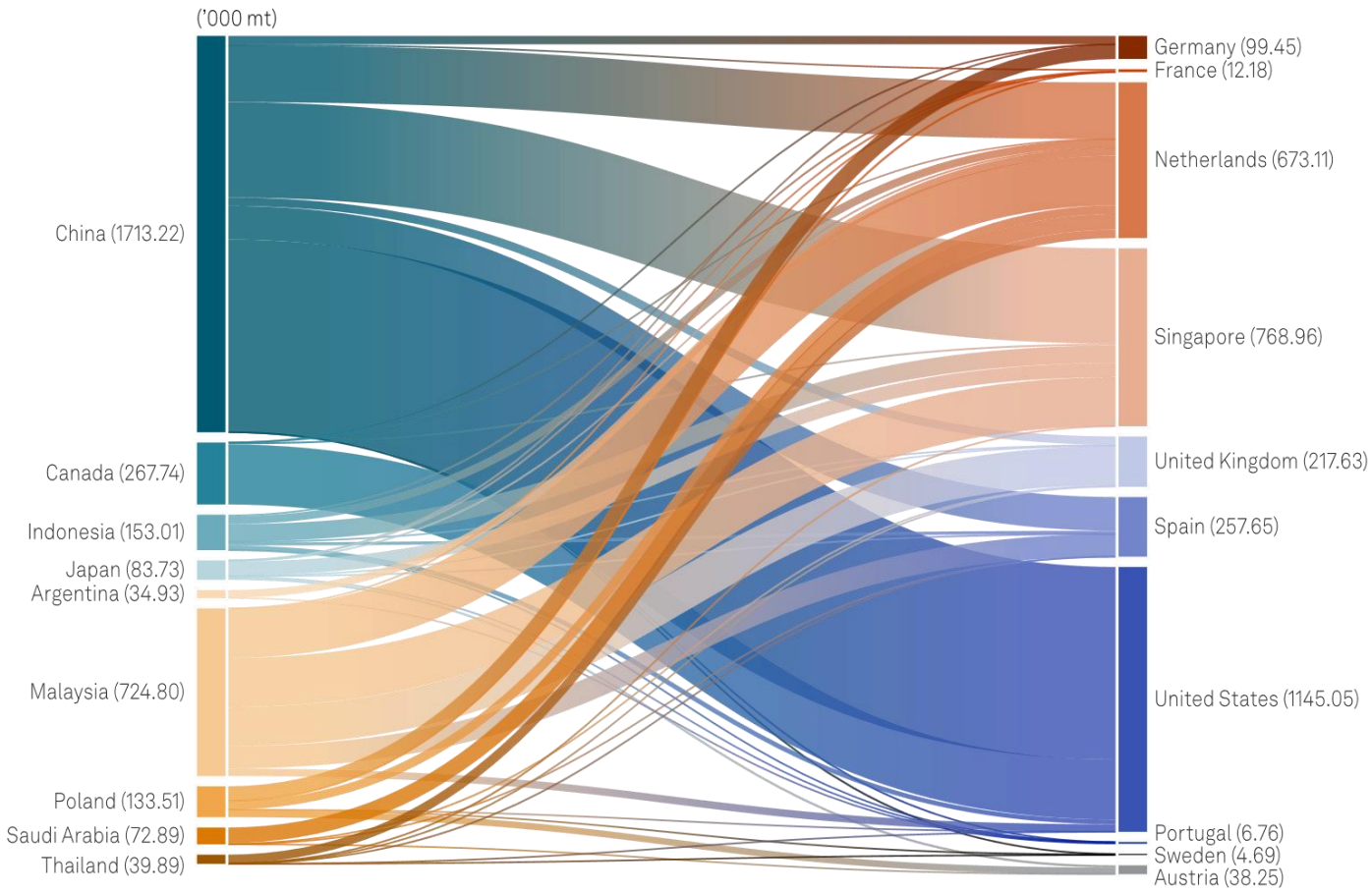


China has been the leading supplier of UCO globally, but policymakers have signaled an intention to retain more of it domestically for biofuel production, including SAF

Asian, US origin used cooking oil finding homes in largest demand and refining centers worldwide in 2021

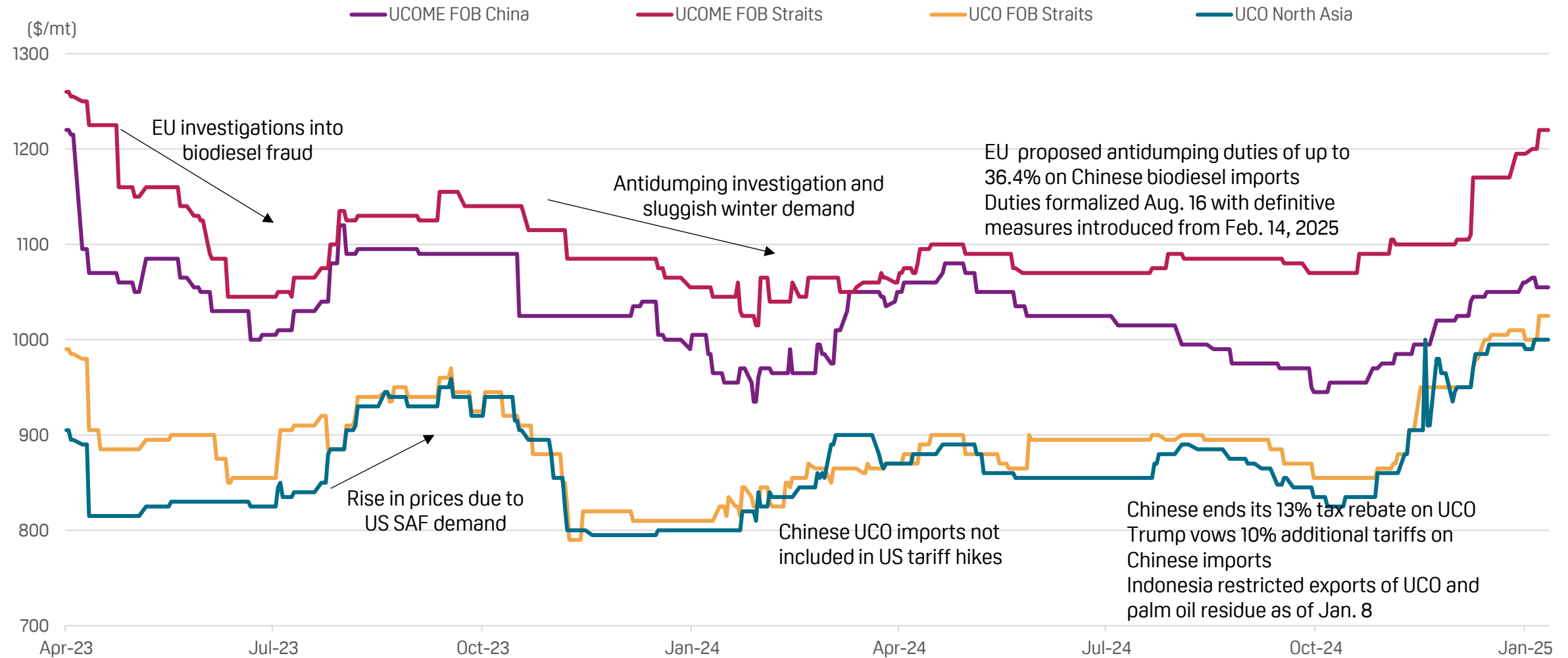


2023 UCO Global Trade Flows



Source: S&P Global Commodity Insights

UCO/UCOME prices largely impacted by policies and demand



Source: S&P Global Commodity Insights.

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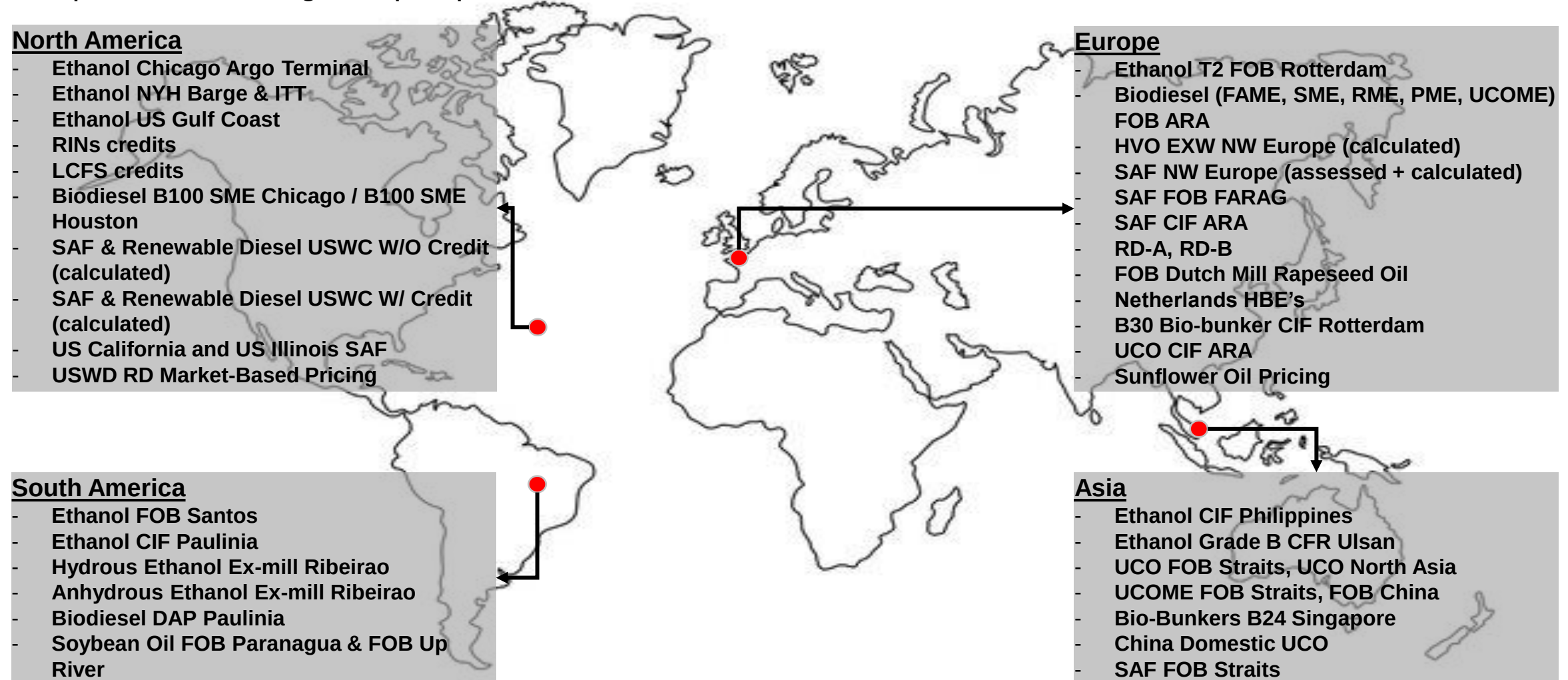
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Can SAF Compete on Price? And Should It?



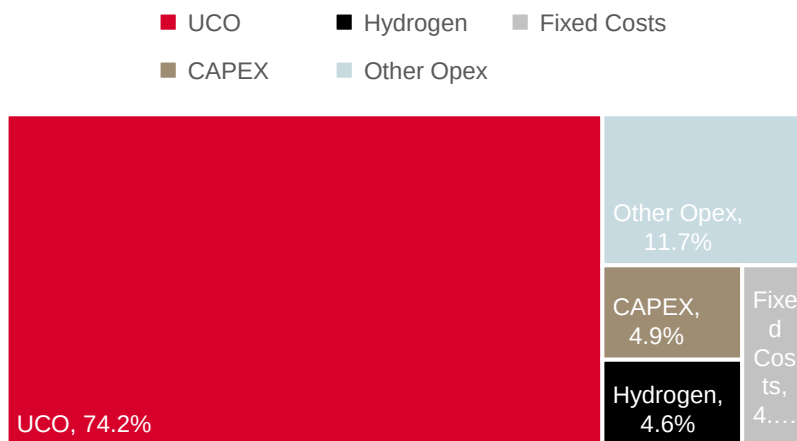
As a biofuel, SAF prices are somewhat linked to feedstock prices, making it essential to have a comprehensive and global perspective on the market



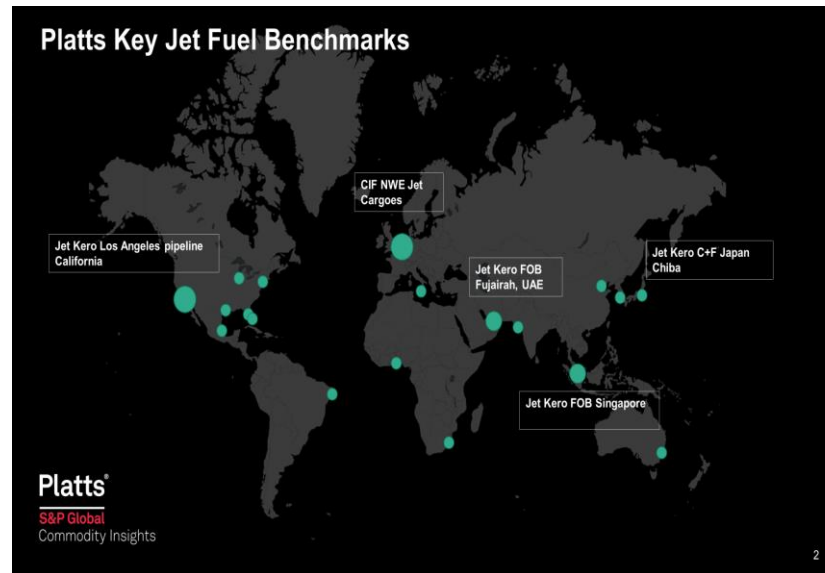
Market players have used different pricing structures as part of their negotiations to enter commercial agreements. These strategies aim to reduce risk or hedge it according to their business models

Cost+ Model

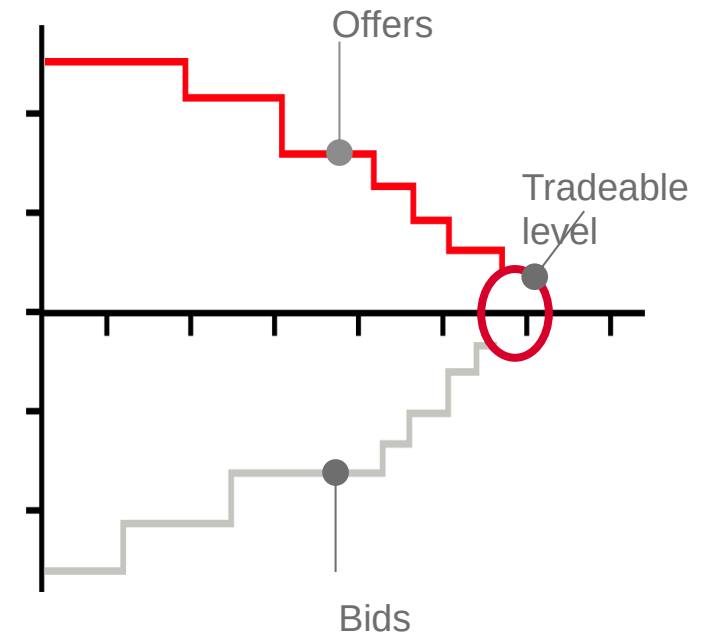
EMEA SAF Cost of Production Breakdown
(Apr 16)



Differential Marked to a Jet Index

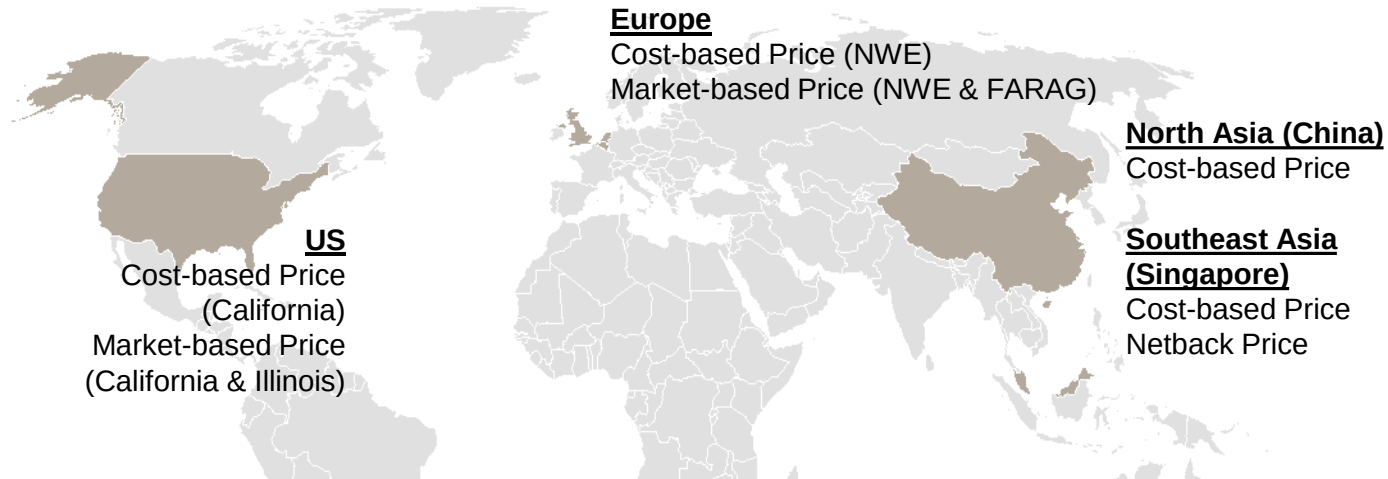


SAF Prices (Platts MOC)



Platts has released Sustainable Aviation Fuel (SAF) prices for three key regions

SAF price assessments



Northwest Europe sustainable aviation fuel price assessments (\$/mt) (PBF page 1013)

SAF (H-S) CIF NWE	AJNWD00	2079.250	-18.750
SAF (H-S) CIF NWE Premium	AJNWF00	1309.250	0.000
SAF (H-S) FOB FARAG	SUAFA00	2052.75	-19.75
SAF (H-S) FOB FARAG Premium	SUAFB00	1284.25	0.00

Americas sustainable aviation fuel price assessments (\$/gal) (PBF page 0012)

SAF CA	SAFCA00	703.730	-1.940
SAF CA vs Jet LA	SAFCB00	455.300	+3.550
Aviation Turbine Fuel 30/70 blend basis CA	SAFCF00	530.690	-5.490
SAF IL	SAFCD00	827.170	-1.940
SAF IL vs Jet Chicago	SAFCE00	613.990	+2.800
Aviation Turbine Fuel 30/70 blend basis IL	SAFCG00	543.220	-4.740

Source: S&P Global Commodity Insights.

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Market-based SAF prices

US Assessments

- Neat SAF and Blended SAF
- Locations: California & Illinois
- Characteristics: HEFA pathway, Reference CI of 42 gCO₂e/MJ

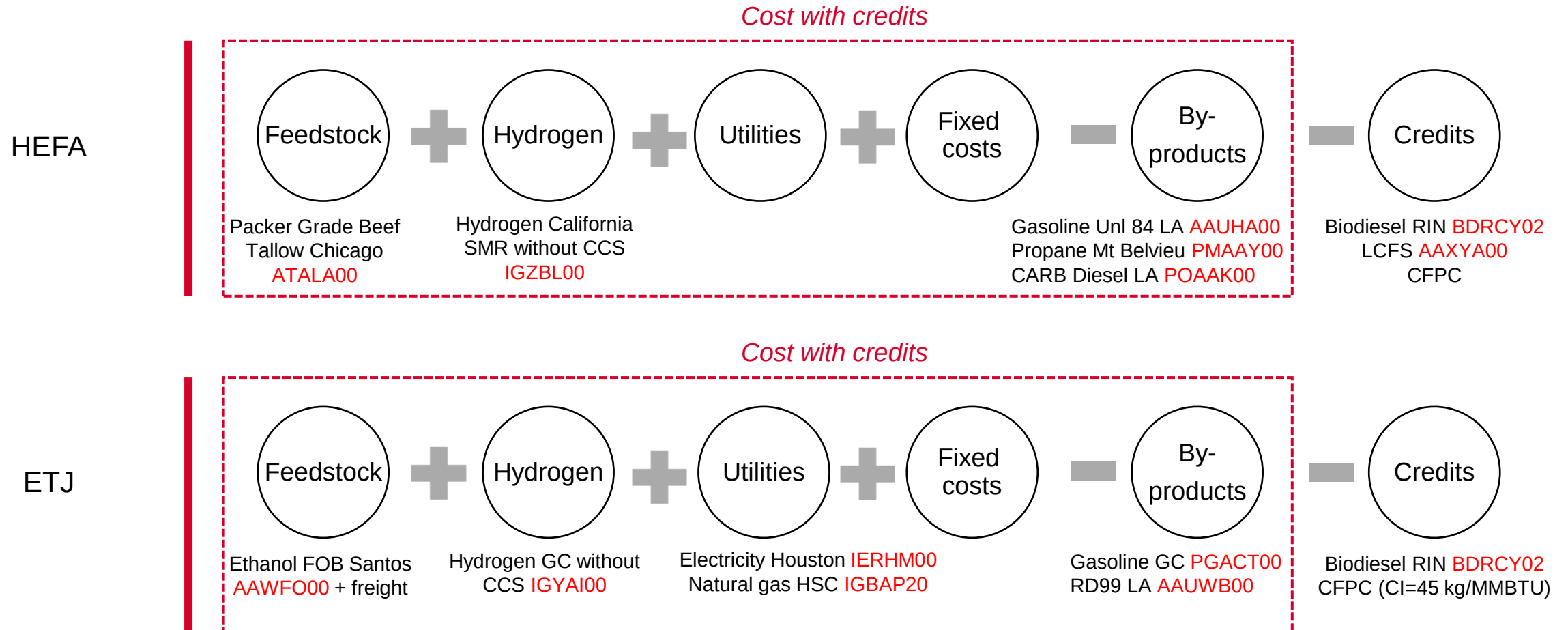
European Assessments

- Ewindow
- Location: NWE & FARAG
- Characteristics: raise minimum GHG savings to 85%. HEFA pathway

Asian Assessments

- Netback price assessment
- Location: Singapore
- Characteristics: based on the market-based NWE SAF assessment

Platts has released Sustainable Aviation Fuel (SAF) Cost-Based Prices for HEFA and ATJ Pathways



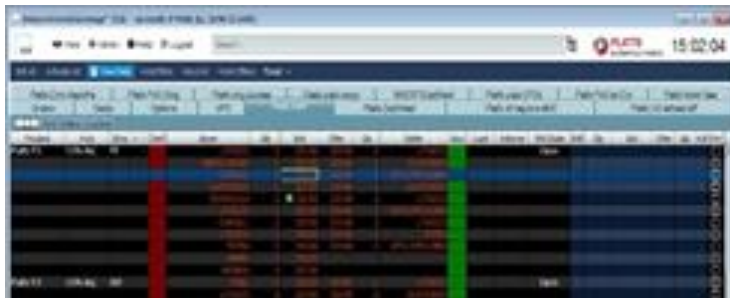
Source: S&P Global Commodity Insights.

With the evolving SAF market, participants have requested a market-based SAF price assessment, built on a robust process to provide the transparency and reliability that meet market needs



European Market-Based SAF Prices

- CIF basis Amsterdam Rotterdam Antwerp. Other locations within Northwest Europe will be considered for the assessment but may be normalized to reflect basis ARA
- Delivery period of 10-25 days forward
- Volume 500-5,000 mt, HEFA pathway
- Minimum GHG savings of 80%



September - 2023



US Market-Based SAF Prices

- US California assessments
 - Neat SAF, basis Los Angeles
 - Aviation Fuel (70% Jet / 30% SAF), basis LA
- US Illinois assessments
 - Neat SAF, basis Chicago
 - Aviation Fuel (70% Jet / 30% SAF), basis Chicago
- HEFA pathway, Reference CI of 42 gCO₂e/MJ
- Inclusive of credits, Published as outright price and premium to Jet

August - 2024



Market-Based SAF Prices (New Ones / Updates)

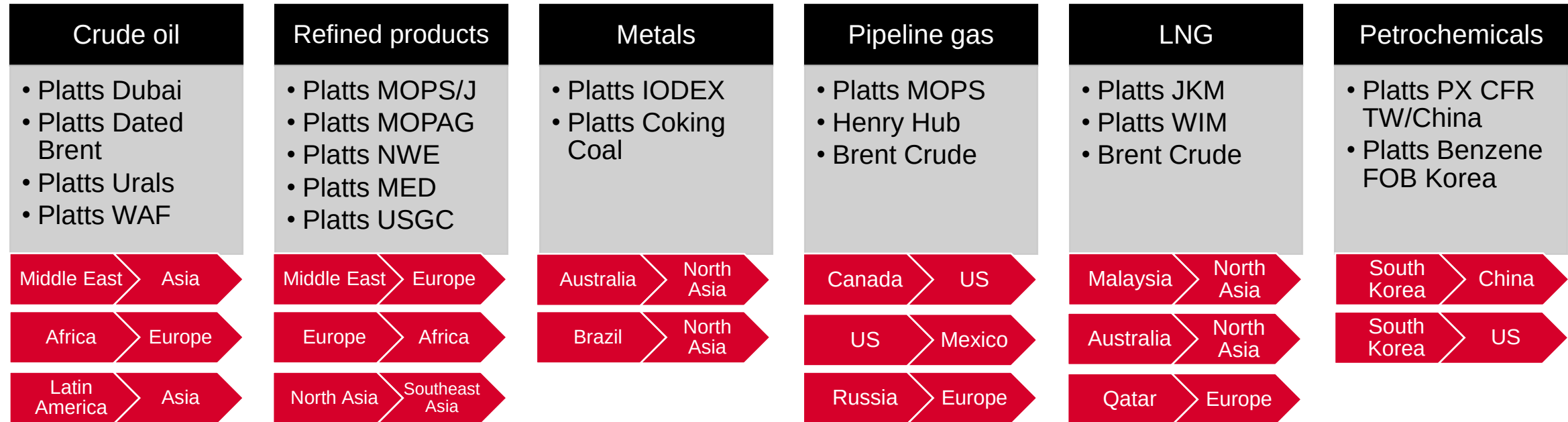
- Change the basis for SAF CIF ARA to SAF NWE
 - Include UK as a delivery option
 - Cargo size to change from 500-5000mt to 5,000-10,000mt
 - Raise minimum GHG savings to 85%
- SAF FOB FARAG barge assessment:
 - Assessment reflecting SAF flow throughout Europe via barge
 - Amsterdam-Rotterdam-Antwerp-Ghent and reflect volumes of 1,000-3,000 mt
 - HEFA, minimum GHG savings of 85%
 - Published as an outright in \$/mt and a premium to the Platts Jet barge FOB FARAG assessment

September - 2024

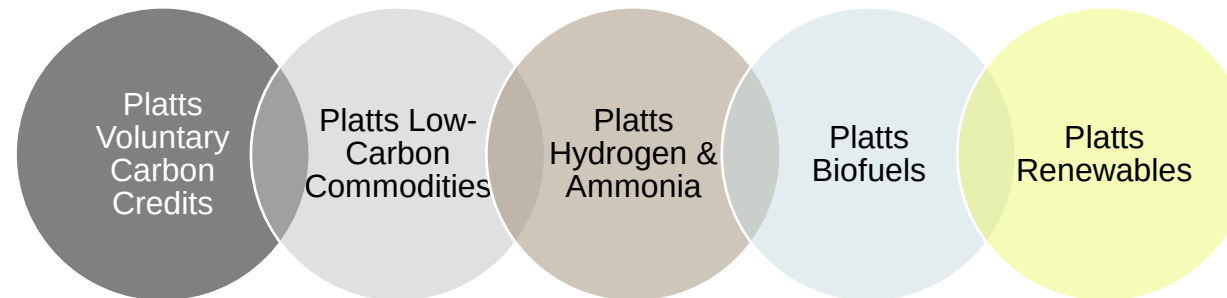
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Indexation to Platts benchmarks is the standard in commodity trading, refined products, petrochemicals, and metals supplied through term contracts referencing spot prices, while most spot trading in the energy market also relies on benchmark prices



Energy Transition sectors will need to commoditize to become efficient and contribute to decarbonization



Indexation is happening

We're taking off on WhatsApp!

Say hello to **Sustainable Aviation with Platts**. Scan the QR code to receive daily updates on low-carbon aviation fuels & more!



Join the Conversation: Will You Board This Plane?

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Q&A and Closing Remarks

Thank You!

Join the conversation and help shape the future of sustainable aviation fuel.

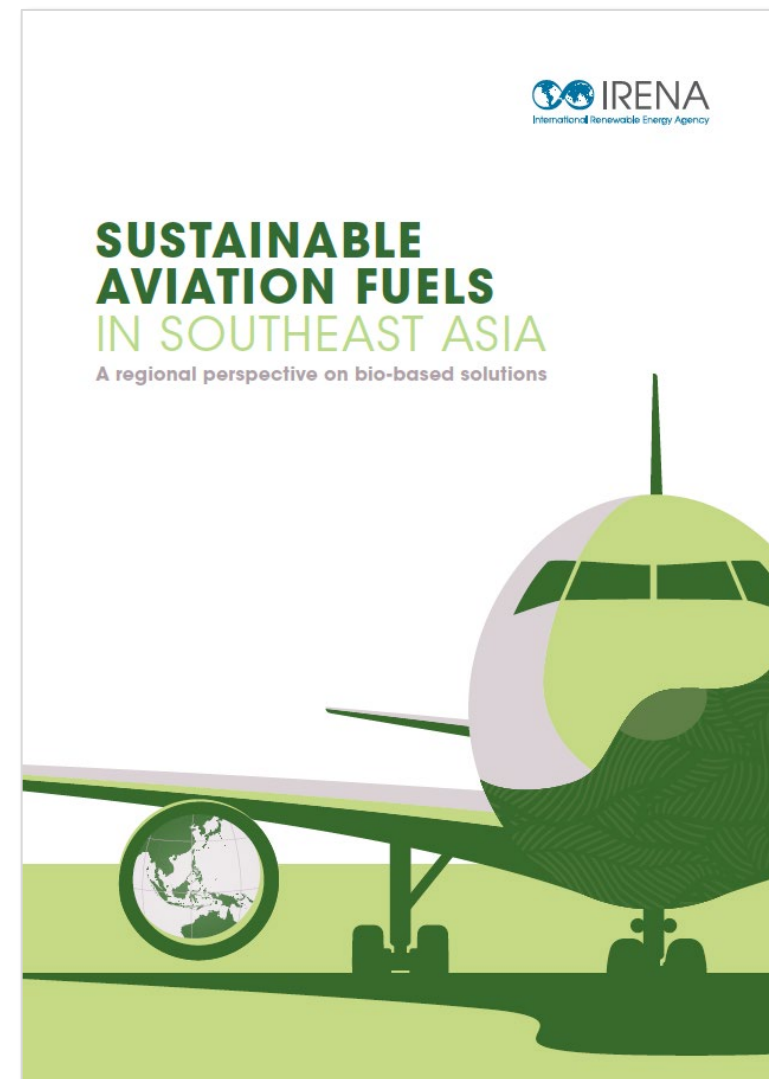
7/25/2025

Dr. Chun Sheng Goh

SUSTAINABLE AVIATION FUELS (SAF) IN SOUTHEAST ASIA

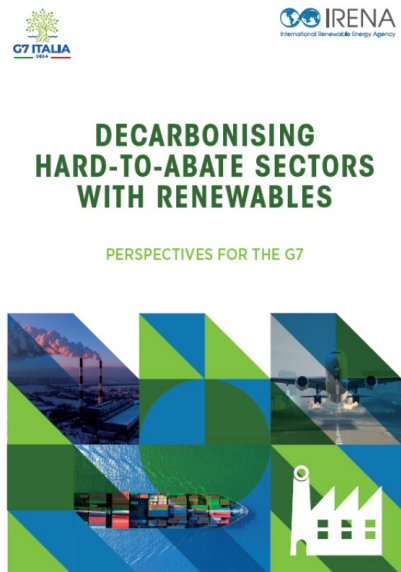
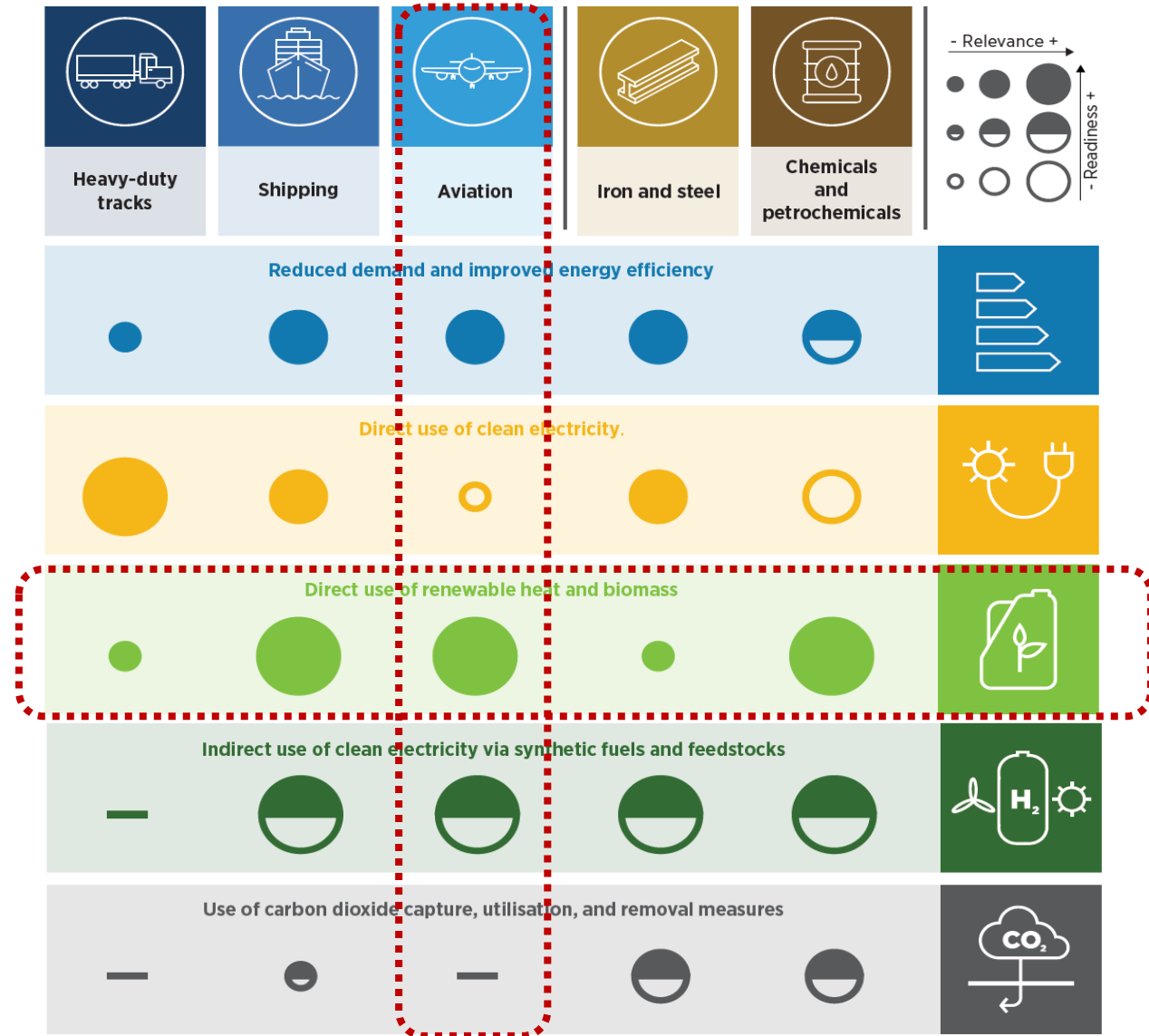
A regional perspective on bio-based
solutions

Goh, Chun Sheng, Ph.D.
Programme Officer, IRENA



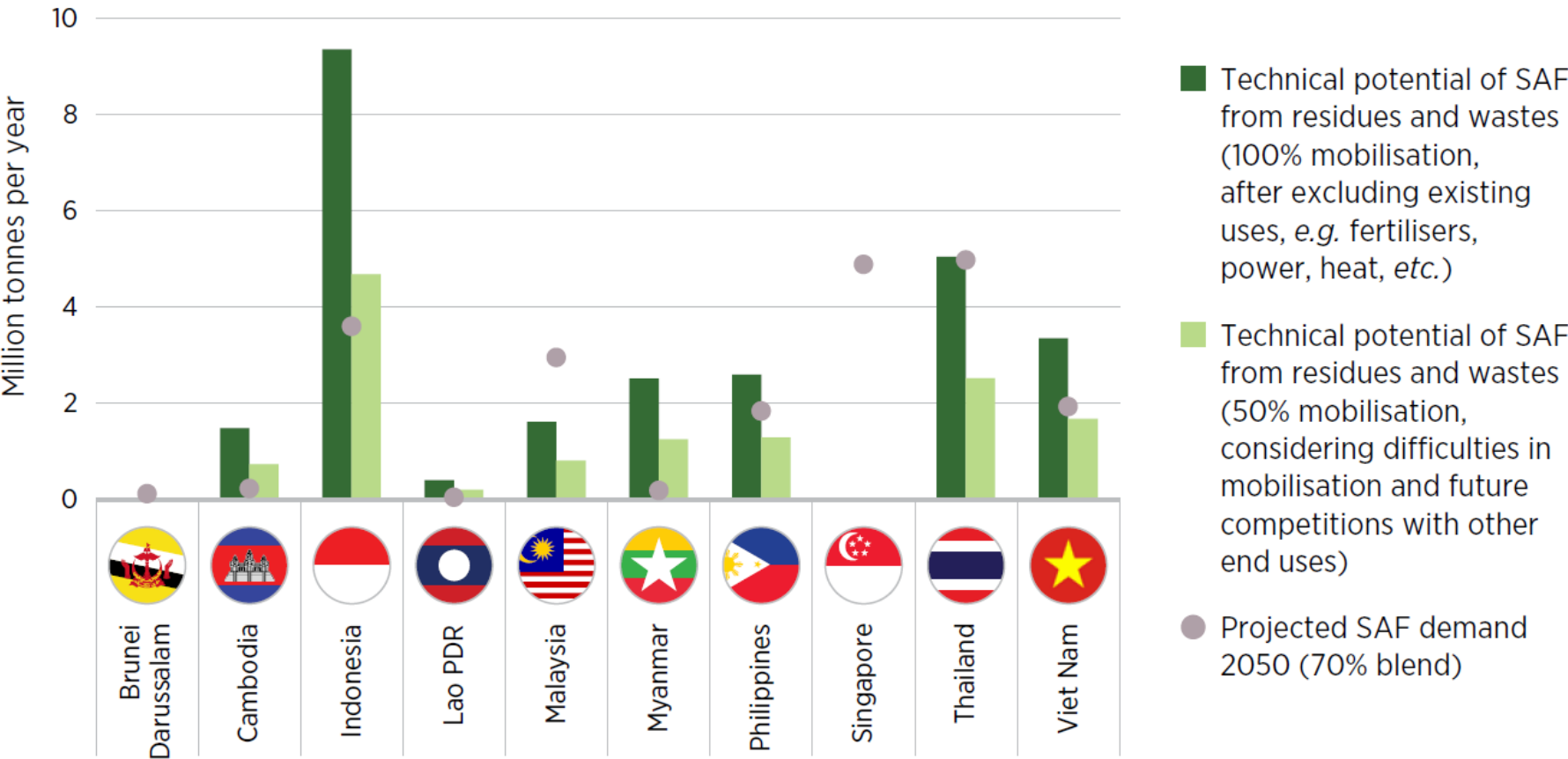
Hard-to-abate sectors

Bioenergy is deemed the **most technologically ready & relevant** option for **aviation**, shipping, and chemicals.



Potential volume of SAF from residues and wastes

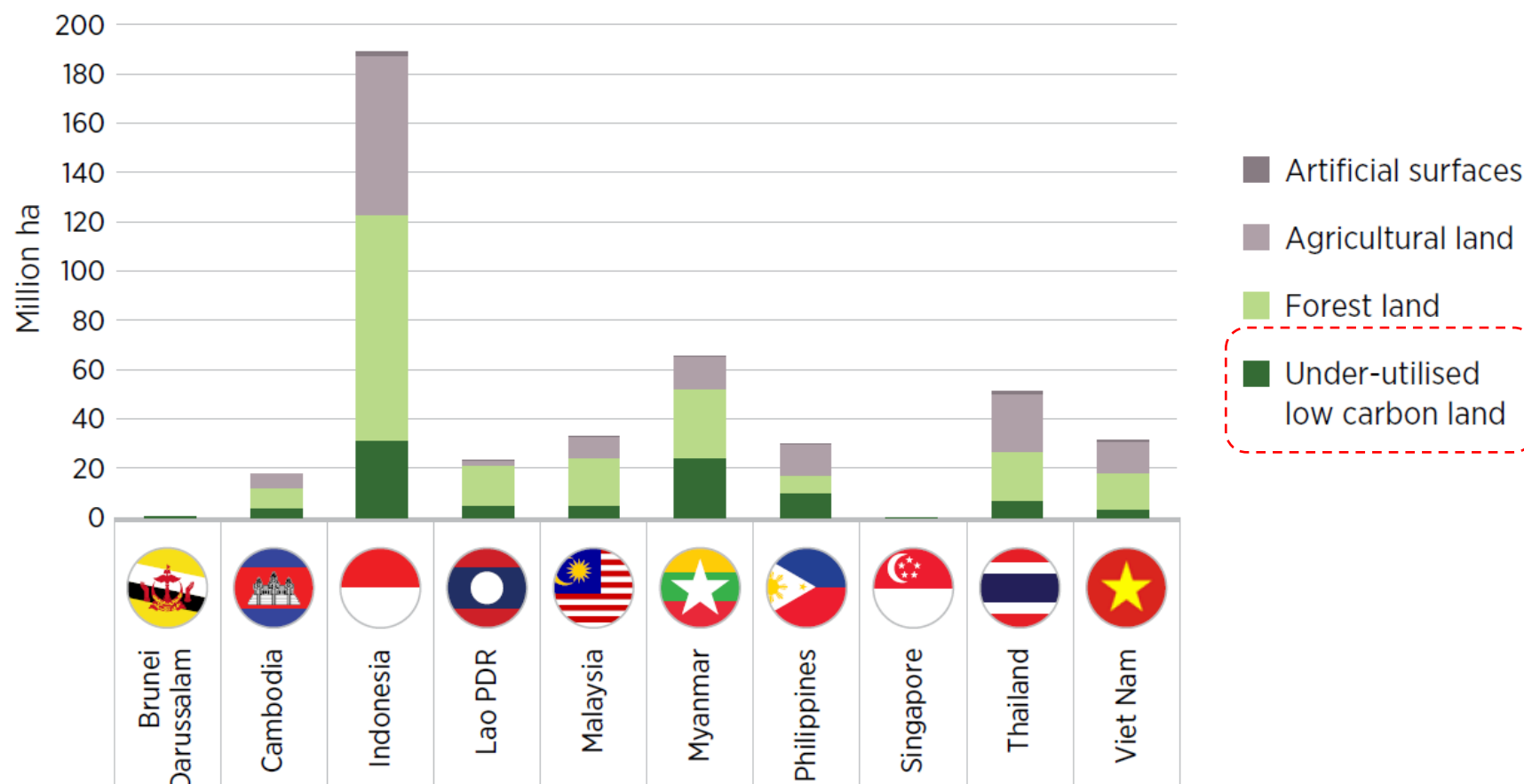
Figure 1 Potential volume of SAF from residues and wastes compared to projected demand in 2050



Notes: Technical potential = The technical volume of biomass feedstock is calculated by subtracting the theoretical volume with the recovery rate and the utilisation rate of the feedstock in existing competing uses, but does not consider future competition from, e.g. shipping or biochar applications. Lao PDR = Lao People's Democratic Republic.

Potential under-utilised low carbon land?

Figure 2 Rough estimates of under-utilised low-carbon land area* in Southeast Asia



Note: *i.e. land remaining after excluding forest land, agricultural land and artificial surfaces.

Based on: FAOSTAT (FAO, 2023b)

Three aspects to consider

- International trade and investment - resources are not evenly distributed among countries
- Feedstock allocation between sectors - a longer-term strategy for hard-to-abate sectors (aviation, shipping), incentivise alternatives in other sectors
- Local conditions and labour availability for energy crops production - farmers, landowners, and local communities

Professor Mohamed Pourkashanian OBE

Next-Generation Sustainable Aviation Fuel Production Pathways

A technical analysis of emerging SAF production technologies, their process advantages, challenges and market readiness.

*M. Pourkashanian, OBE
Professor of Energy Engineering,
Head of Energy Innovation Centre
University of Sheffield, UK*



Technical Assessment of Novel SAF Pathways

1

Current State of SAF

Brief overview of conventional HEFA and Fischer-Tropsch pathways dominating current production

2

Alcohol-to-Jet (AtJ)

Technical analysis of catalytic alcohol oligomerization and conversion processes

3

Power-to-Liquid (PtL)

Assessment of electrolytic hydrogen and carbon capture technologies for e-fuel synthesis

4

Advanced Biological Pathways

Exploration of microbial conversion and advanced feedstock engineering innovations

5

Techno-Economic Analysis

Comparative assessment of production costs, carbon intensity, and scale-up potential

Current SAF Production: Limitations Driving Innovation

Today's commercial SAF production relies primarily on Hydroprocessed Esters and Fatty Acids (HEFA) from vegetable oils, animal fats and waste oils, plus some Fischer-Tropsch synthesis from gasified biomass.

These pathways face critical limitations:

- Feedstock availability constraints (~2.5% of jet fuel demand)
- High production costs (2-4× conventional jet fuel)
- Competition with food production
- Scaling challenges for carbon intensity goals

Current ASTM-approved pathways: HEFA-SPK, FT-SPK, SIP, ATJ-SPK, CHJ, HC-HEFA-SPK, HH-SPK, and catalytic hydrothermolysis jet (CHJ)



Alcohol-to-Jet (AtJ) Pathway: Technical Assessment

Process Fundamentals

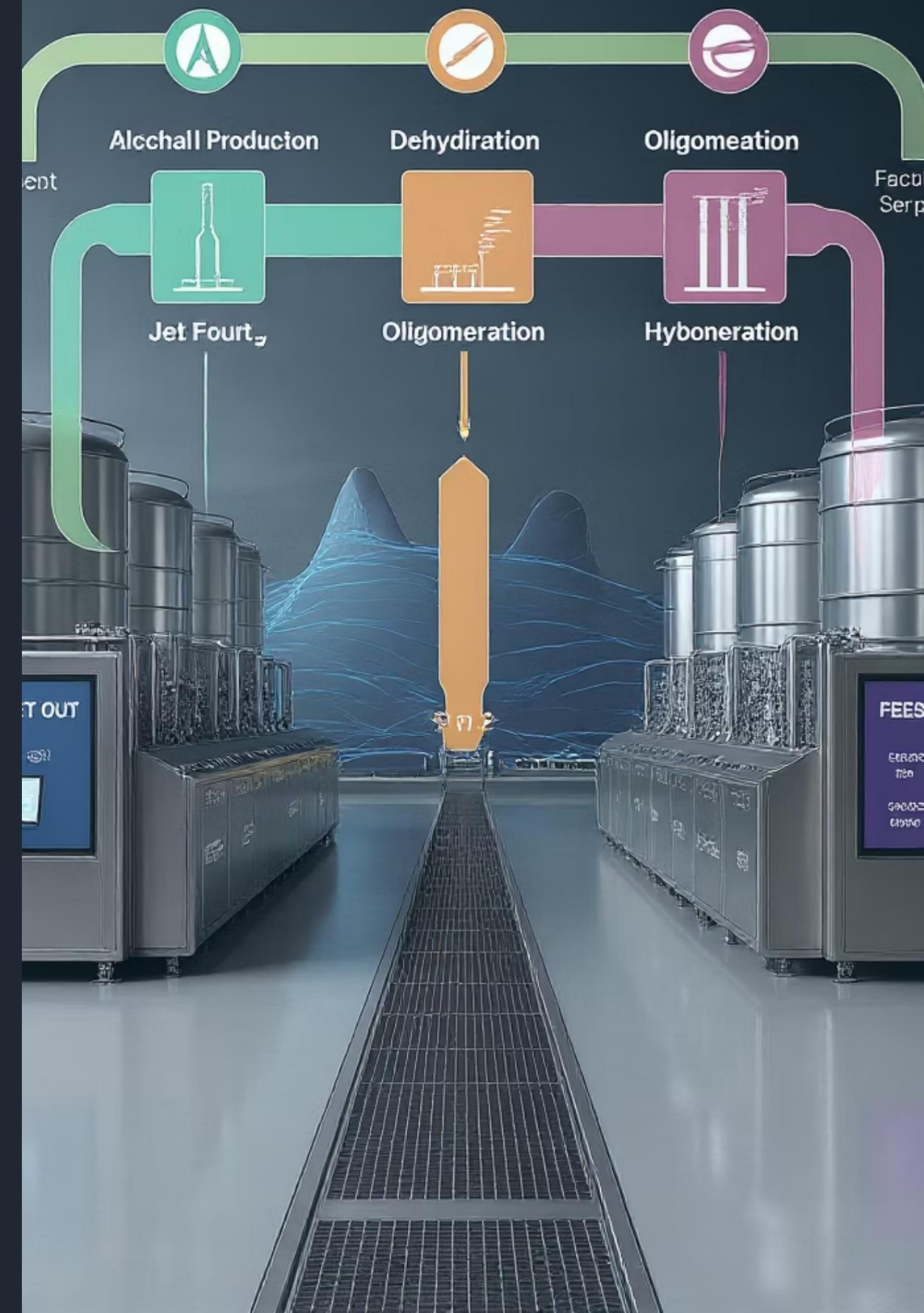
Conversion of alcohols (ethanol, butanol, isobutanol) to jet fuel through dehydration, oligomerization, hydrogenation and fractionation. Targeting C8-C16 hydrocarbons.

Technical Advantages

- Versatile feedstock compatibility (corn, sugarcane, cellulosic)
- Utilisation of existing ethanol infrastructure
- Superior cold-flow properties vs HEFA
- Lower aromatic content (reduced particulate emissions)

Key Challenges

- Multiple catalytic steps increase capital intensity
- Higher hydrogen requirements than conventional refining
- Energy-intensive distillation steps
- Catalyst deactivation issues in oligomerization



Power-to-Liquid (PtL) SAF: Technical Foundation



Renewable Electricity

Solar, wind or other renewable power sources provide zero-carbon electricity input



Water Electrolysis

PEM or alkaline electrolyzers split water into hydrogen and oxygen (30-50 kWh/kg H₂)



Carbon Capture

CO₂ sourced from industrial emissions, direct air capture, or biogenic sources



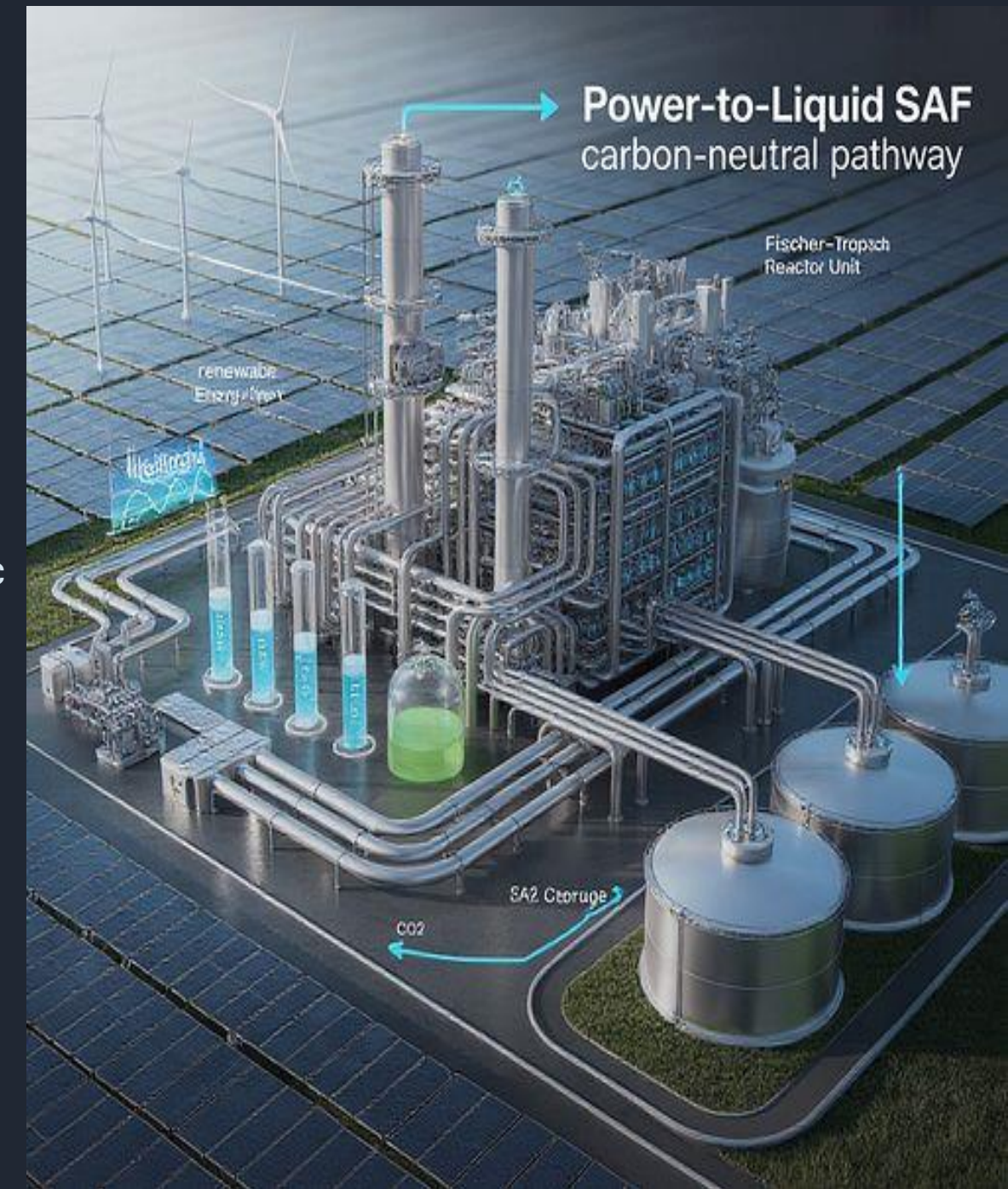
Syngas Production

Reverse water-gas shift reaction converts H₂ and CO₂ to CO and water



Fischer-Tropsch Synthesis

Catalytic conversion of syngas to hydrocarbon chains with iron or cobalt catalysts



PtL Technical Challenges and Recent Innovations

Critical Technical Challenges

- Extremely high electricity requirements (~55 kWh per litre of jet fuel)
- Low overall energy efficiency (~45% well-to-wake)
- High capital costs for electrolyser and Fischer-Tropsch units
- CO₂ capture energy penalty and cost, especially for direct air capture
- Scale-up challenges for catalyst manufacturing and reactor design

Breakthrough Technologies

Several promising innovations show potential to overcome key limitations:

High-Temperature Co-Electrolysis

Solid oxide electrolyzers simultaneously converting H₂O and CO₂ to syngas, reducing process steps and improving efficiency by ~20%

Structured Microchannel Reactors

Novel Fischer-Tropsch reactor designs enabling 30% higher throughput and improved heat management

Microbial Production Systems

Engineered microorganisms are creating entirely new production routes:

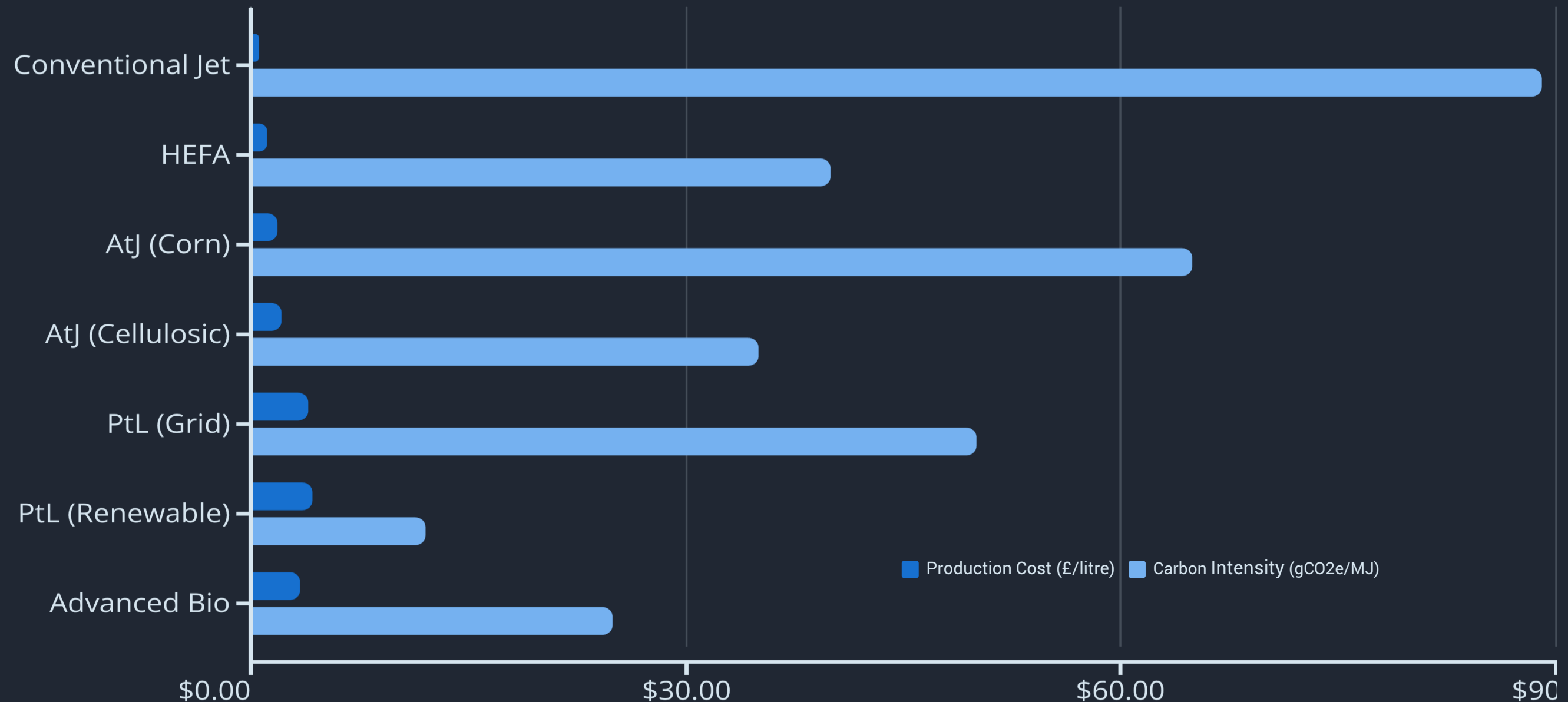
- Genetically modified *E. coli* strains producing medium-chain fatty acids directly from glucose
- Cyanobacteria engineered for direct photosynthetic production of hydrocarbons
- Oleaginous yeasts with lipid accumulation >70% of dry cell weight
- Cell-free enzymatic synthesis systems for targeted molecule production



Molecular Engineering for Jet Fuel: Synthetic biology platforms are being developed to engineer microbes that produce specific hydrocarbon structures not found in nature, enhancing energy density and cold-flow properties

Novel photobioreactor designs enable continuous cultivation of engineered cyanobacteria for direct hydrocarbon production with theoretical solar energy conversion efficiency of up to 5%.

Techno-Economic Comparison of Next-Gen SAF Pathways



Production costs reflect 2023 technology readiness levels and are expected to decrease with scale. Carbon intensity values represent full lifecycle analysis from feedstock to combustion, including land-use change impacts where applicable.

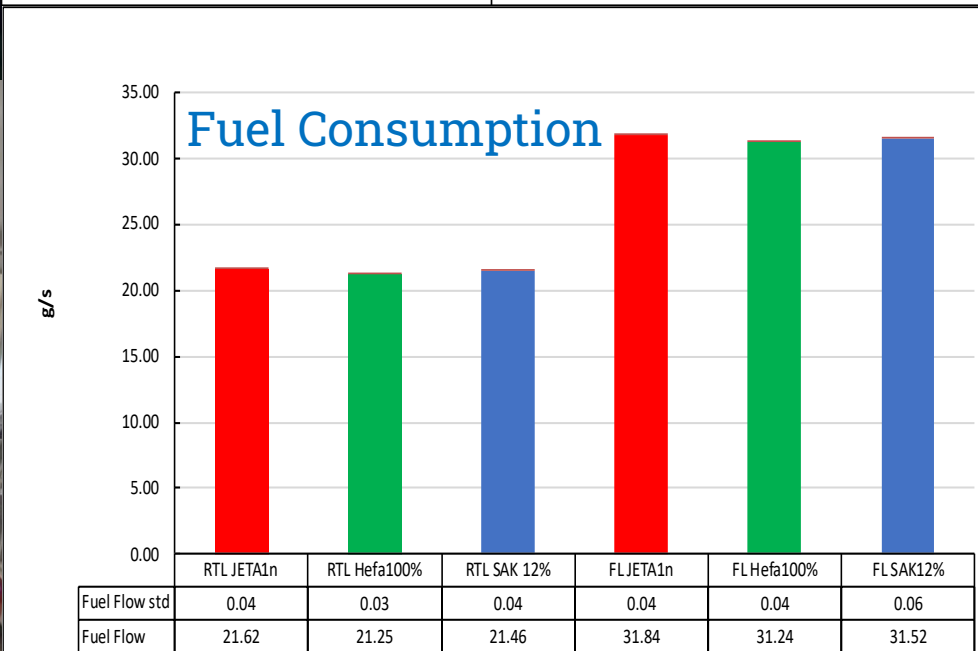
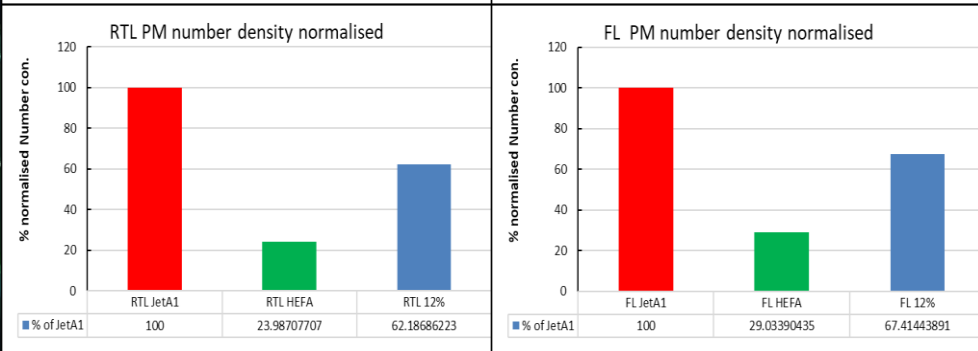
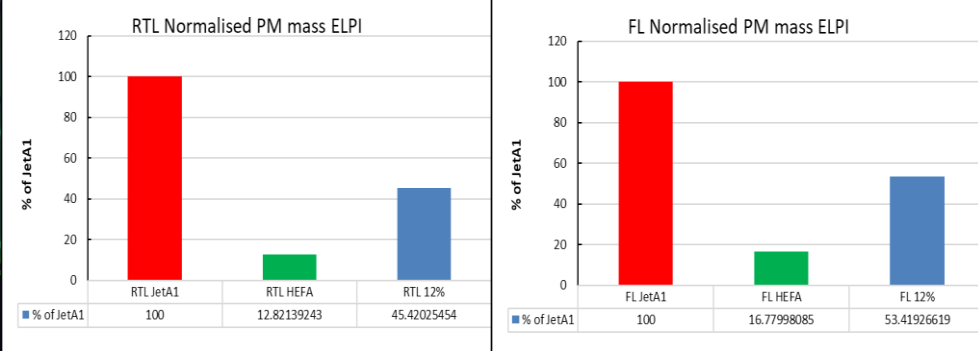
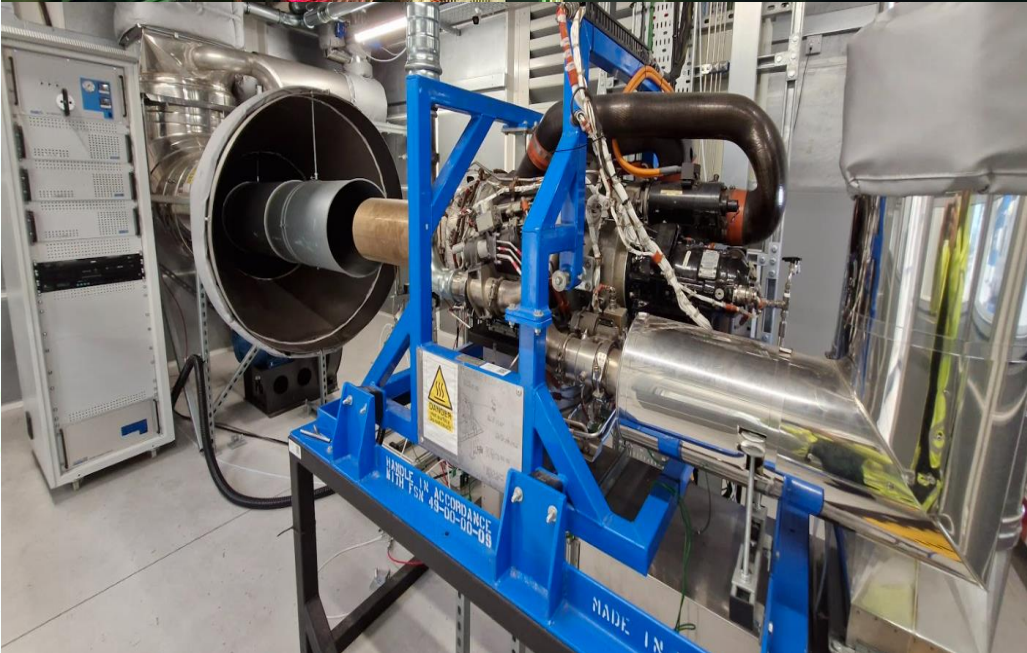
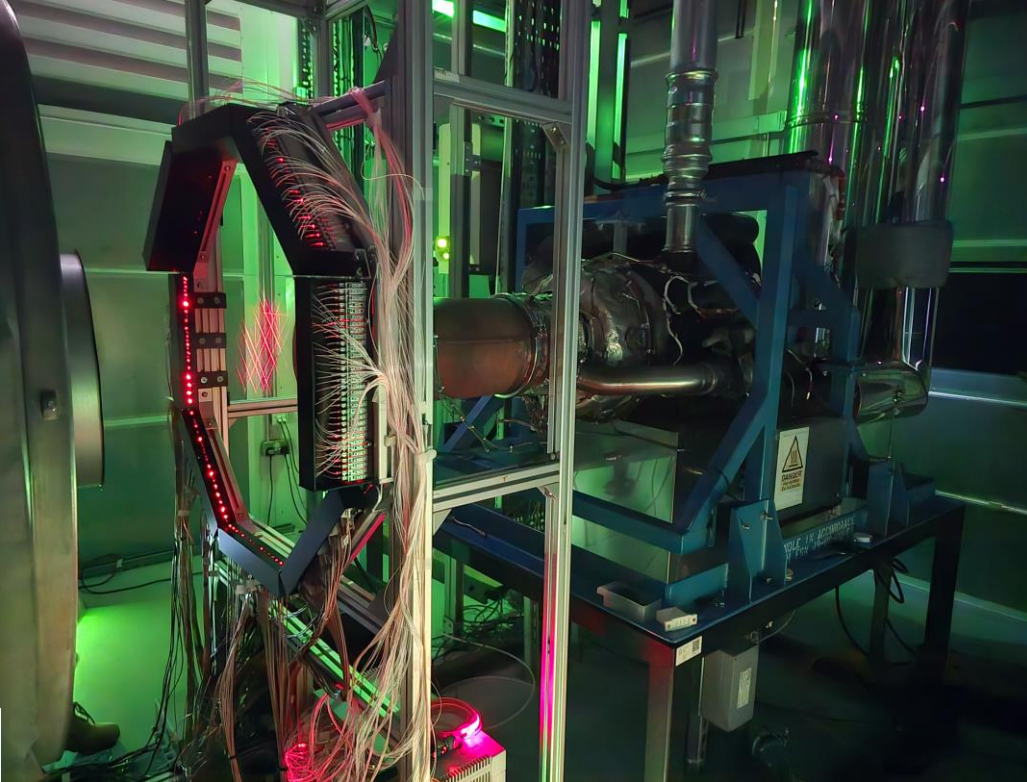
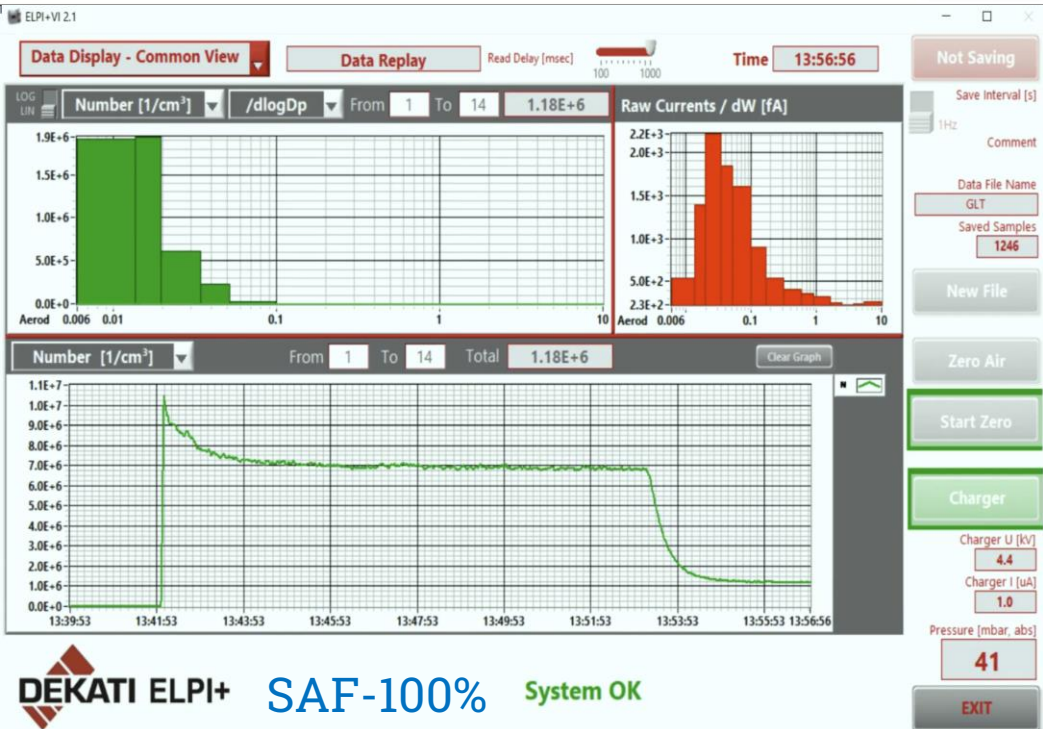
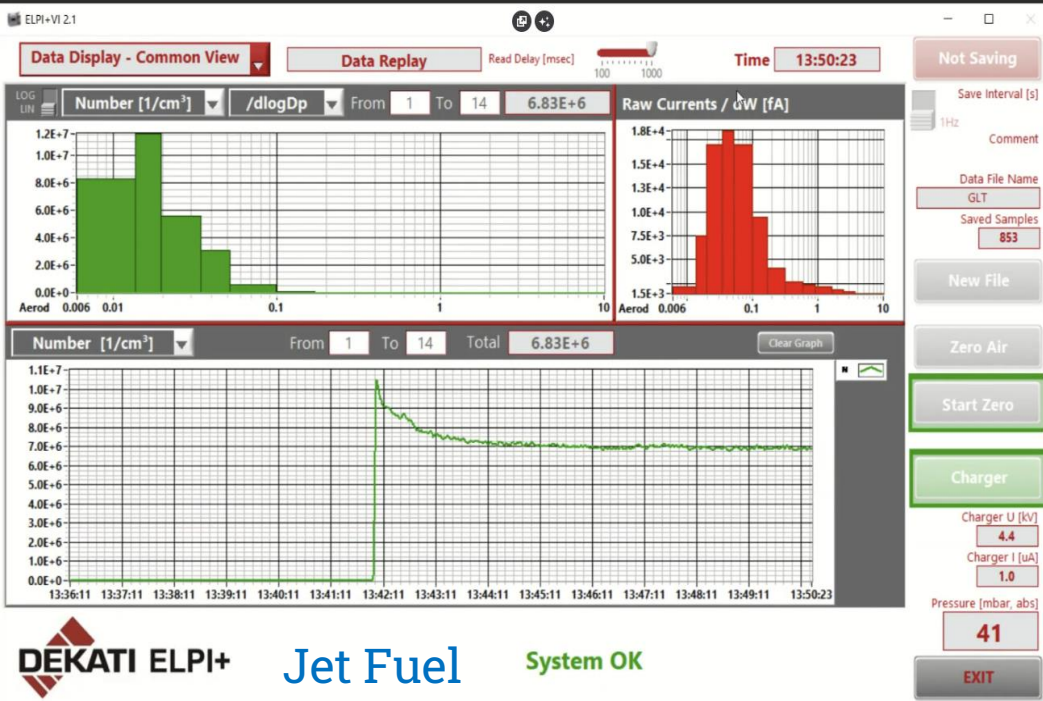


'Sustainable flight is too difficult'
Challenge accepted

100% SUSTAINABLE AVIATION FUEL
FLIGHT 100 28.11.23

virgin atlantic

Impact of SAF on Particulate Emission: Flight-100 APU Test



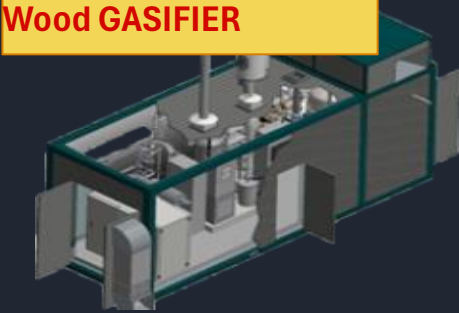
Research and Innovation Infrastructure At EIC

BIO/ENERGY



WTE/BIOMASS

Wood GASIFIER



BioGas Turbine



Bio/Diesel

Marine Engine



Combustion Test Furnace

CARBON CAPTURE

MCFC



ACP



RPB



DAC



HYDROGEN



CO₂

H₂

CO

CO₂

CO₂

CO₂

H₂

SUSTAINABLE FUELS PLANT

REWG

FT

UPGRADING



GAS

GASOLINE

NAPHTHA

SAF

DIESEL

FUEL OIL

HEAVIES



FUEL ANALYSIS

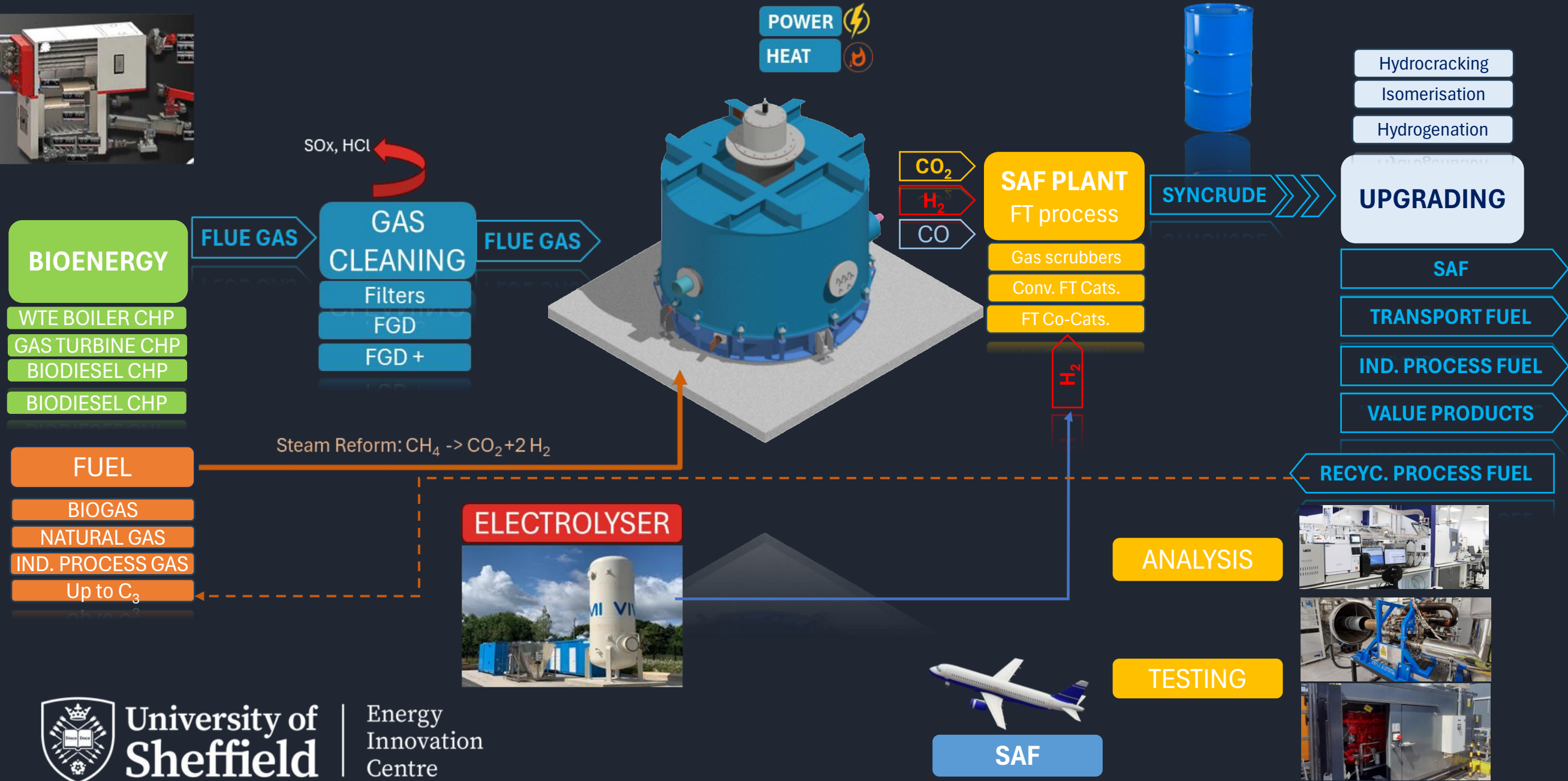


SAF TESTING



Sustainable transport fuel

Next Generation SAF production Pathway: NEXTGEN-SAF



Strategic Recommendations and Next Steps



Research Priorities

- Focus catalyst development on improved selectivity and lifetime
- Advance electrolyser efficiency and durability for PtL pathways
- Develop low-cost, scalable CO₂ capture technologies



Demonstration Projects

- Scale up integrated AtJ production to 10-50 million litres/year
- Establish 1-5 MW PtL demonstration facilities at industrial CO₂ sources
- Pilot advanced biological pathways at 1,000-10,000 litre scale



Policy and Industry Action

- Establish long-term carbon pricing mechanisms to improve economics
- Develop technology-specific support schemes for emerging pathways
- Create strategic partnerships across aviation, energy and biotech sectors
- Implement coordinated UK-EU research programmes to accelerate development

With focused research investment and supportive policy frameworks, next-generation SAF technologies could reach commercial viability by 2030-2035, potentially meeting 30% of UK aviation fuel demand by 2050.

Thank You

Any Question

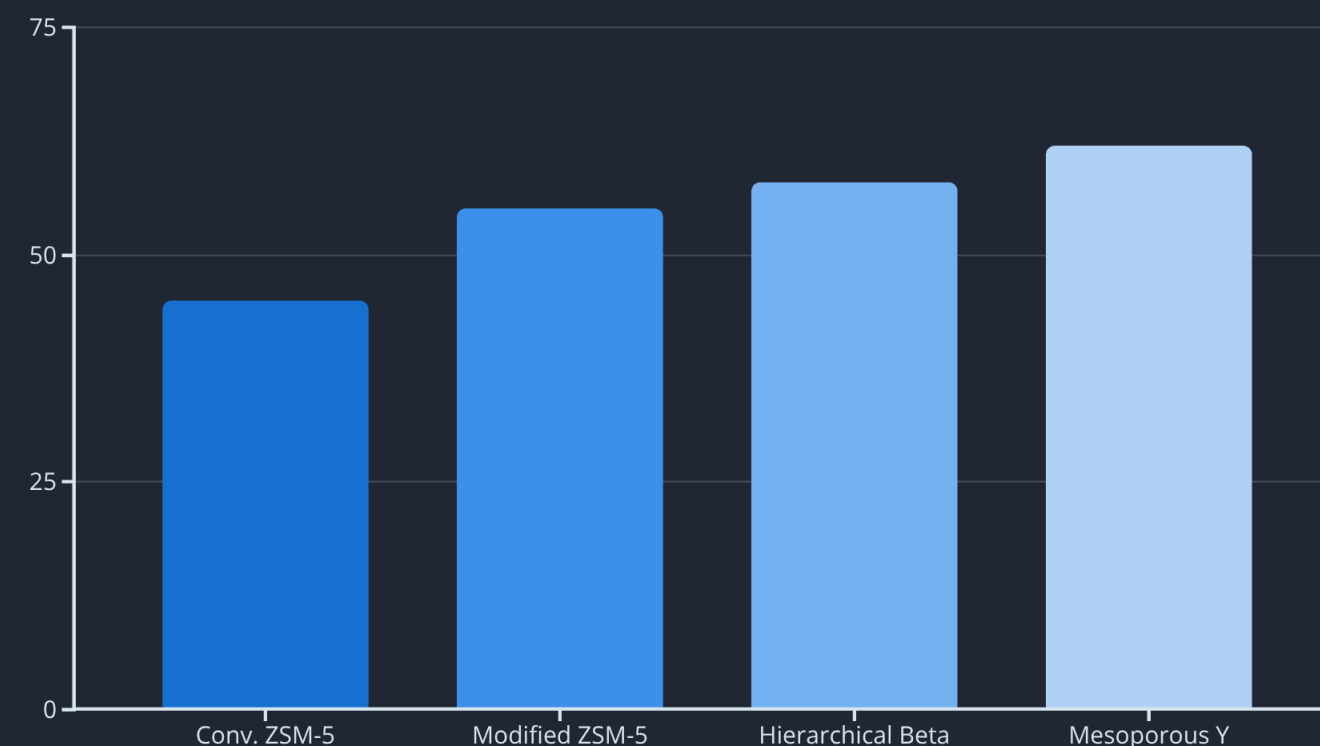
Contact: m.pourkashanian@sheffield.ac.uk

AtJ Catalyst Development: Recent Breakthroughs

Heterogeneous Catalysis Innovations

Recent advances in bifunctional zeolite catalysts have demonstrated significant improvements in selectivity and conversion efficiency:

- Modified ZSM-5 catalysts with tuned acidity profiles show 22% higher jet-range selectivity
- Novel Ru/Pt bimetallic catalysts reduce hydrogen consumption by up to 15%
- Hierarchical zeolites with mesoporous structures exhibit 3× longer catalyst lifetimes



Jet fraction yield comparison for various catalyst formulations in the dehydration-oligomerization step (based on 2023 laboratory data)

Ms. Amparo Arellano

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SAF Sustainability Certification

The Roundtable on Sustainable Biomaterials (RSB)



Global Biofuels Alliance, 25 July 2025 (*Online webinar*)
Amparo Arellano, RSB Standards & Certification Director



Agenda

- 1** Who we are
- 2** RSB certification system
- 3** How RSB supports economic operators
- 4** SAF in emerging markets: SEA, India & Brazil
- 5** Key take aways
- 6** Q & A





RSB®

RSB: Who we are

- **Mission:** to promote the transition to a biobased economy (sustainable biofuels and beyond)
- **Recognized by the European Commission** for certifying compliance EU RED III
- **Governmental recognition for ICAO CORSIA**, Japan FIT (+ RSB scheme)
- **Variety of sectors:** Sustainable aviation fuels, maritime, biomass sector, chemical industry.
- Strong presence in the US, Canada, LA and SEA markets.



Our global membership is highly diverse





Our global membership is highly diverse
A wide range of organisations across supply chains, regions and industries



Holistic approach to driving a positive impact



RSB certification globally

RSB is an international certification scheme with a global application, with strong presence in Sustainable Aviation Fuels supply chains. RSB has a diverse scope of implementation also covering, bioenergy, maritime, chemical and other sectors.



- US
- Canada
- EU
- South East Asia
- Latin America
- Other



RSB Certification System



Certification schemes

	RSB Global Fuels & Advanced Products 	RSB EU RED 	RSB CORSIA 	Japan FIT 
Sustainability requirements	RSB Principles and Criteria 			
Type of claim	Voluntary	Regulatory; linked to EU RED targets	Regulatory; linked to ICAO CORSIA targets	Regulatory; linked to METI targets
Scope	Fuels and materials produced from biocircular feedstock	Renewable fuels and energy produced with bio-based feedstock and RCF/RFNBOs	SAF from bio-based feedstock and waste gases	Bio-based wastes and residues from agri industry for energy production
Renewable input allocation	Across all outputs, based on energy or economic value. Flexible attribution options.	Across all outputs, based on energy value (LHV).	Across all outputs, based on energy value (LHV).	Across all outputs, based on energy value (LHV).
GHG reduction threshold	Fuel: 50% (60% after 2015) Products: 10%	60% (65% after 2021) RCF/RFNBO: 70%	50% core LCA (10% LCA+ILUC)	50% (70% after 2030)
Fossil baseline	Fuel: 90g CO ₂ e/MJ Products: fossil comparator	94g CO ₂ e/MJ RCF/RFNBO:	89g CO ₂ e/MJ	180 g CO ₂ /MJ electricity
Book and claim allowed?	Yes	No	No	No



Pillars of sustainability certification

Management system

- **Clear responsibilities of staff pertaining to all relevant RSB requirements** (e.g. record keeping, GHG calculation, forwarding of sustainability documents)
- **Yearly internal audit** conducted and results kept for check by auditor
- **Written commitment by Management** to comply with relevant rules

Sustainability

- **Meet the RSB 12 Principles and Criteria – Industrial and Agricultural sites**
- Meet social, legal & rights-based, environmental and management practices for sustainable production in a bio-based supply chain

GHG emissions calculation

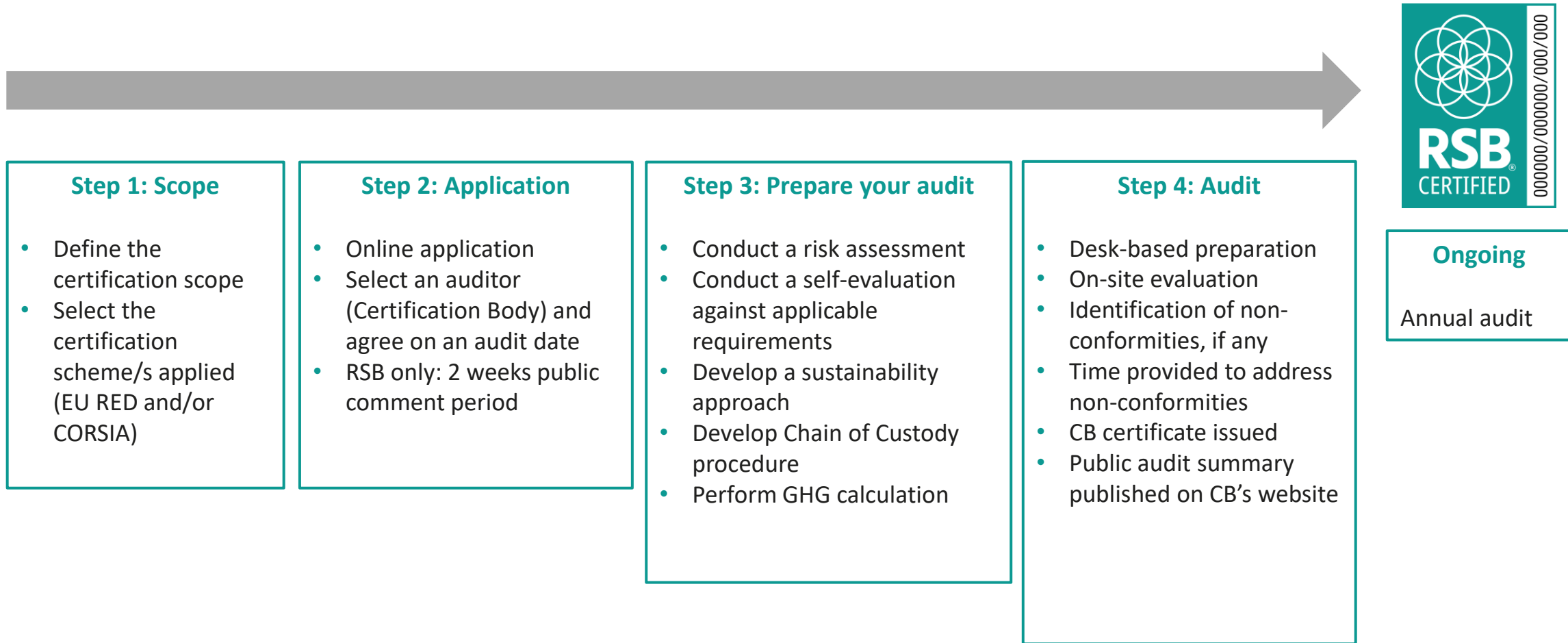
- **Availability, completeness and correctness of GHG calculation**
- Appropriate use of **emission factors**
- **Correct indication of GHG emission value on sustainability documents** (e.g., on Proof of Sustainability)

Traceability and chain of custody system

- **Record of documentation** (e.g. Proofs of Sustainability documents, delivery documents, contracts, weighbridge tickets, etc.)
- Fit-for-purpose **traceability and mass balance system**



RSB certification process



Risk based approach: due diligence prior to the audit



① **Self-Risk Assessment**

Self-risk assessment using RSB's **Risk Assessment Tool**: **identify your risk class and audit frequency**



② **Screening Exercise**

Risk Screening Tool to identify social and environmental risks (P&C), **inform the measures in MP.**



③ **GHG calculation**

Calculate GHG emissions (RSB GHG Calculator Tool available). **Minimum 50% reduction from fossil fuels (P3)**



④ **ESMP**

Environmental & Social Management Plan (ESMP) describing how you will adhere to RSB P&C

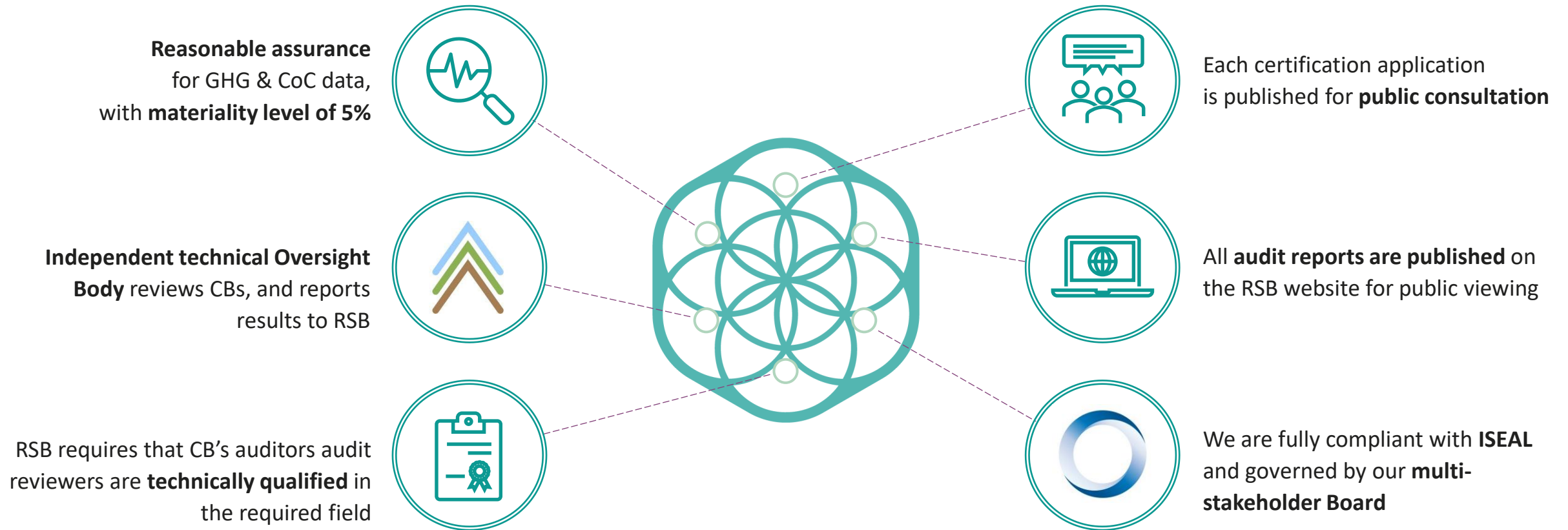


⑤ **Ensure traceability**

Need for **traceability systems** and procedures in place to trace material across supply chain.



RSB Certification: Investing in System Integrity



How can RSB support operators in overcoming these challenges?



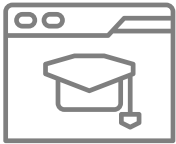
Clear set of rules and requirements

- EC recognized Standards
- Comprehensive language translating complex EU Directives into more a user-oriented understandable package of rules



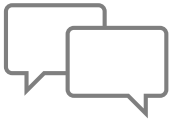
Hand-holding in the certification process

- Client oriented support in the certification process
- Advisory services



Tools & Training

- RSB Academy
- GHG Calculator tool
- Feedstock assessments



Stakeholder dialogue platforms and international events

Promote communication and exchange among industry partners and interested stakeholders (SAF and beyond)



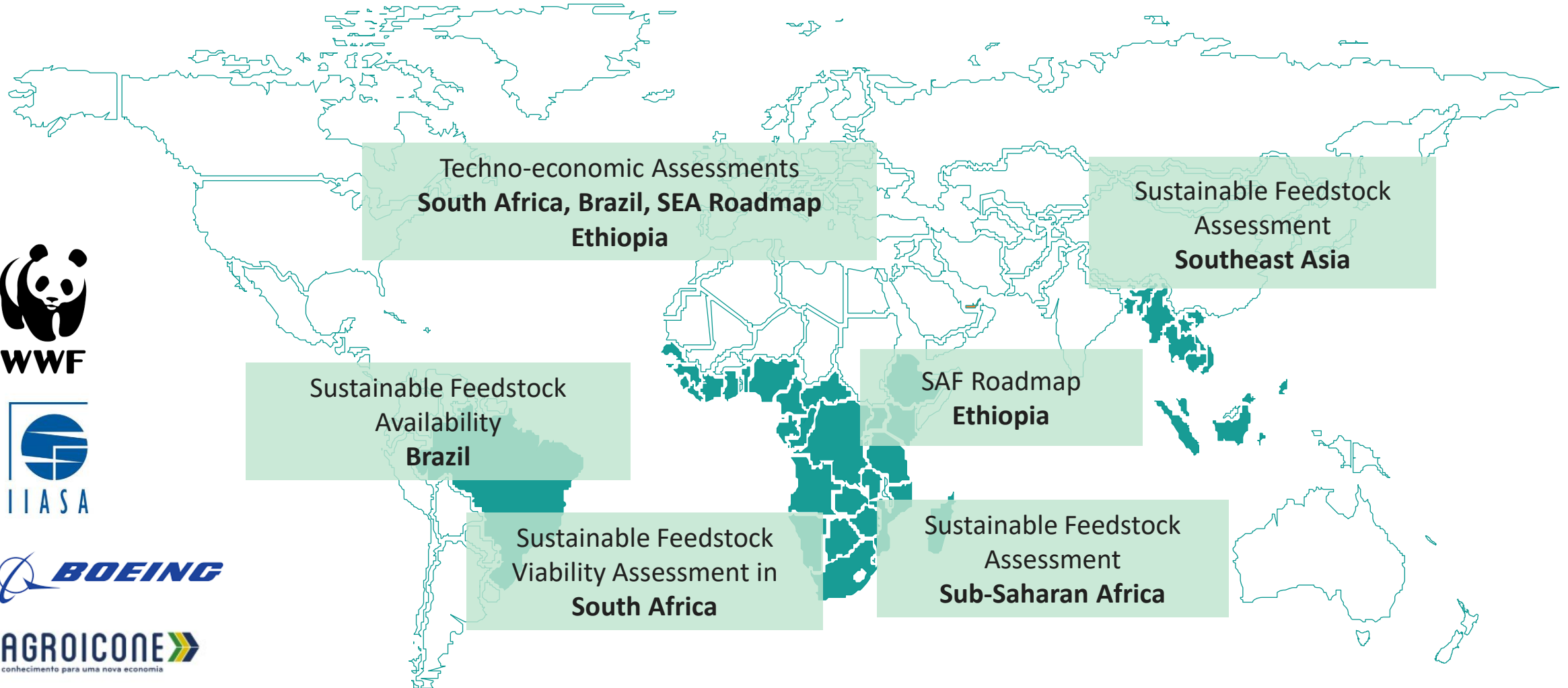


SAF emerging markets

Feedstock assessments & capacity



RSB research on feedstock availability



Brazil & LATAM region: Feedstock assessment



- By 2050, **36 - 43% of the total jet fuel** could be met by **RSB-compliant** biofuel produced in **South America**
- **Brazil's SAF potential:** 61% of South America's total SAF potential is concentrated in Brazil.
- **Energy cane** is the largest contributor for biofuel production (high yield)
- **Intercropping:** **macauba palm with Brachiaria** grass
- **Sustainability challenges:** deforestation, biodiversity loss, and land degradation.



Southeast Asia: Feedstock Assessment

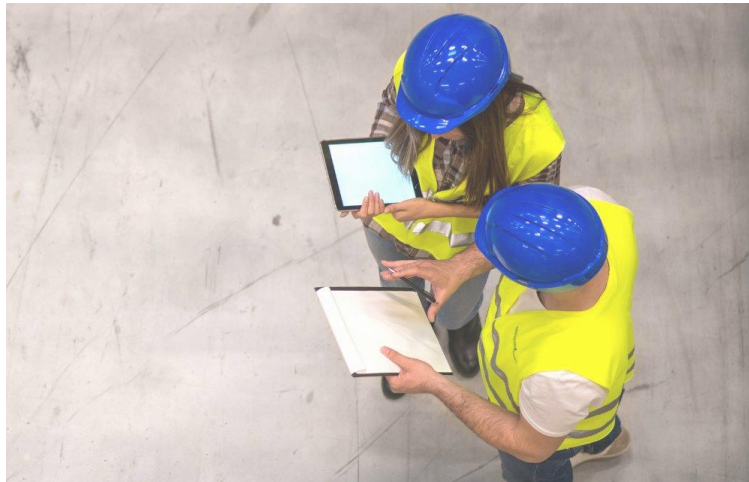
		Indonesia	Thailand	Vietnam	Malaysia	Philippines	Feedstock (%)
Crops for energy use	Palm oil (CPO)	9.5	1.2	-	1.0	-	3.1
	Sugarcane (for ethanol)	-	5.7	-	-	0.1	1.5
	Corn (for ethanol)	-	3.7	2.6	-	-	1.7
	Coconut oil	-	-	-	-	0.2	0.1
	Cassava roots and starch	20.5	9.5	5.0	-	-	9.3
Agricultural residues	Palm oil residues (PKS, EFB, etc)	27.6	6.5	-	10.1	-	11.8
	Palm oil mill effluent (POME)	2.8	-	-	-	-	0.7
	Rice husks, rice straw	46.0	23.0	34.5	2.1	10.8	36.9
	Sugarcane bagasse, tops & leaves	2.8	14.9	3.0	0.1	2.1	6.4
	Sugarcane molasses	1.2	4.0	0.6	-	1.0	1.9
	Cassava residues (pulp, stem)	5.3	4.5	2.2	-	-	3.2
	Maize cob/husk/stover/straw	-	3.5	10.6	-	0.8	4.0
	Coconut shell, front, husk, bunches	-	-	0.7	0.9	5.4	1.9
	Coffee husk	-	-	0.9	-	-	0.2
	Peanut (groundnut) shell, husk	-	-	0.6	-	-	0.2
Forest and wood industry residues		13.1	3.7	5.3	8.2	-	8.4
Post-consumer waste	UCO	0.2	-	-	0.1	-	0.1
	MSW	13.5	5.6	6.5	2.2	2.9	8.6
Country contribution (%)		38.0	22.9	19.3	6.6	6.2	

- **SEA feedstock potential:**
12% SAF demand by 2050
- **Indonesia, Thailand, and Vietnam:** leading feedstock producers
- **Rice husks & rice straw** most available feedstock
- **Palm oil residues, cassava roots and starch (2nd)**
- Sustainability risks: deforestation and water availability.

*Available feedstock per country and feedstock type (Mt/year dry mass)



India: SAF Mandate in emerging market



- India's Ministry of Civil Aviation is *discussing* a SAF (Sustainable Aviation Fuel) blending target for aviation of:
 - **1% SAF** blend with jet fuel for international flights by **2027**
 - **2% SAF** blend by **2028**
 - **5% SAF** blend by **2030**
- An ambitious target, this will apply initially only to international routes
- **Potential pathways:** Alcohol to Jet and HEFA (UCO among other feedstocks)



Challenges: Scaling SAF industry in India

- ④ **Limited availability:** Currently* no commercial-scale production in India yet.
- ④ **Infrastructure:** Need for more refueling and production infrastructure.
- ④ **Cost of Production:** SAF currently costs 3–4 times more than traditional jet fuel.
- ④ **Mandate not finalised:** SAF Mandate still in planning phase.

*Facilities in process of being built, coprocessing using already existing production facilities in the meantime



Overcoming
Road
Blocks



BENEFITS OF SUSTAINABILITY CERTIFICATION FOR THE INDUSTRY

Meets consumer demands

Combines the sustainable sourcing and GHG calculations



Drives improvement in industry performance:

traceability systems, advanced technology, local sourcing, awareness raising, higher soc. & env. STDs



Tool to build a strong reputation: Recognition from official institutions (ICAO, EC & Japan FIT) and impartiality in auditing



Promotes innovation: increasing investments and interest in renewable energies and biofuels globally

Key Takeaways

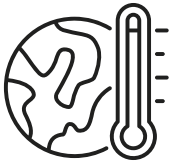


Biofuels key to reach global Climate targets

Scaling the SAF industry is a fundamental element in the global energy transition.



RSB develops feedstock assessments & capacity building projects To identify key emerging markets in the SAF industry and implements projects **promoting the transition to a biobased economy** (SEA, Brazil, India).



Sustainability standards strengthen reputation

By obtaining third party RSB certification, organisations build **credibility** and contribute towards a **climate positive biobased economy**.



Questions?



Amparo Arellano
RSB Standards & Certification Director
amparo.arellano@rsb.org



Dr. Andreas Mundel

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A DHL cargo aircraft is parked on a tarmac. A yellow DHL fuel truck is positioned next to the aircraft. The aircraft has a yellow body with red stripes and a rainbow-colored tail. The DHL logo is visible on the side of the fuselage. The background shows a cloudy sky and airport infrastructure.

SUSTAINABILITY CERTIFICATIONS AND THE SAF CREDITS PROCESS

DHL GROUP CASE STUDY

Dr. Andreas Muendel, SVP Strategy & Operations Programs

Global Biofuels Alliance SAF Webinar, 25 July 2025

FACTS & FIGURES

DHL GROUP

DHL Group is the **largest logistics company** globally

~600,000 employees worldwide

179 nationalities of employees in Germany



2 strong brands
DHL
Deutsche Post



Business in **>220 countries** and territories

>42.000 electric vehicles worldwide

Nr.1 share of sustainable aviation fuel (SAF) among all airlines

Target by 2030**:
Reducing GHG emissions to **<29m** metric tons p.a.



Group Revenue around EUR **84.2** billion*

Group EBIT around EUR **5.9** billion*

Free Cashflow around EUR **3.0** billion*

* FY 2024

** subject to potential restatement due to methodology updates or change in business scope, e.g., due to M&A

GOVERNANCE STRUCTURE

MANAGEMENT ORGANIZATION



Central Functions

Corporate Center

Group management functions are centralized in the Corporate Center, incl. Finance and Human Resources

Global Business Services (GBS)

Internal services that support the entire Group

Customer Solutions & Innovations (CSI)

Cross-divisional account management and innovation unit

Five Operating Divisions



Express

International time-definite shipments with **~300 dedicated aircraft**



Global Forwarding, Freight

Forwarding air, ocean and road freight, **3.1m tonnes air freight, 3.3m ocean TEUs** in 2024



Supply Chain

Tailor-made logistics services and supply chain solutions, **operating ~3,000 warehouses**



eCommerce

Domestic parcel transport; deferred cross-border services, **>145,000 service points**

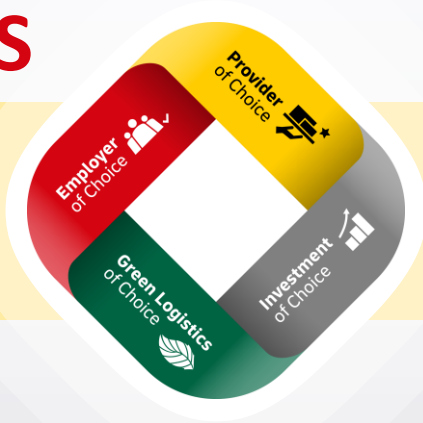


Post & Parcel Germany

Mail & parcel services in Germany, **~6.7m parcels per business day**



OUR BOTTOM LINES



EMPLOYER OF CHOICE

As **Employer of Choice**, we strive to create a **safe and healthy workplace**: We promote a Safety First culture, our employees' health and well-being, and our values of "Respect & Results"

PROVIDER OF CHOICE

As **Provider of Choice**, we aim to deliver a **best-in-class customer experience** by emphasizing customer-centricity, digital innovation, and quality

INVESTMENT OF CHOICE

As **Investment of Choice**, we plan to **accelerate our growth** - in a profitable and sustainable way. This will be underpinned by reliable and resilient execution, strong compliance, and robust cybersecurity measures

GREEN LOGISTICS OF CHOICE

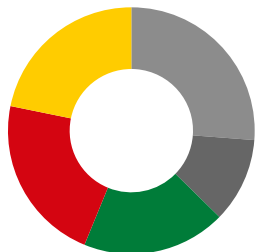
As **Green Logistics of Choice**, sustainability is becoming an increasingly differentiating feature in logistics. Assisting our customers to decarbonize is crucial, and we aim to achieve this by remaining the frontrunner in **low-carbon logistics operations**

Focus today

DHL EXPRESS REMAINS A LEADER IN SAF

**73 KT VOLUNTARY¹ SAF
USE IN OWN FLEET**

3.5 % SAF SHARE



**Key DHL Express
suppliers in 2024:**

AirBP, Neste, Shell,
World Energy & IAG
(scope 3)

~7.3 % of global SAF²

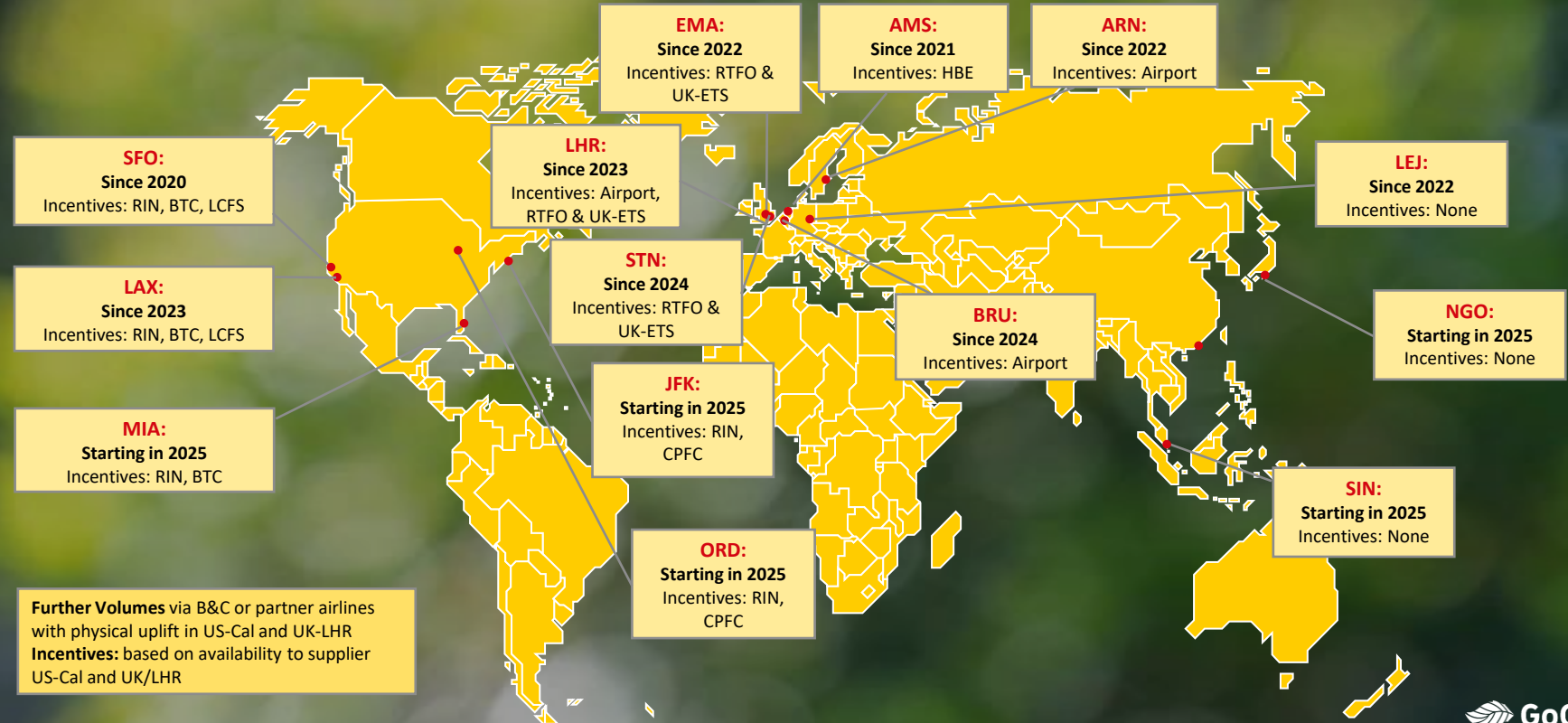
was used by DHL Express own operations in 2024. Including joint investments with partner airlines – also at DHL Global Forwarding – DHL has used 9.8 % of global SAF.

DHL Express continues to focus on SAF use in its **own fleet** (Scope 1) but since 2024 also uses **SAF via partner airlines** (Scope 3).

Majority of DHL Express SAF use took place in **EU, US and UK** – new SAF uplift locations in **Asia added in 2025**.

SAF use remains focused on sustainable waste & residue feedstocks with **avg. GHG-reduction > 80 %**.

COVERING 14 AIRPORTS ON THREE CONTINENTS



ALLOCATING SAF REDUCTIONS TO CUSTOMERS

Procurement of sustainable fuels



Enabling cost- and resource-efficient purchase of sustainable fuels via Book & Claim:

- Without unnecessary logistics costs
- Without necessity to establish separate green infrastructure
- Without market barriers for SF supplier



DHL Group

Pool of emission reductions



Insetting customer products



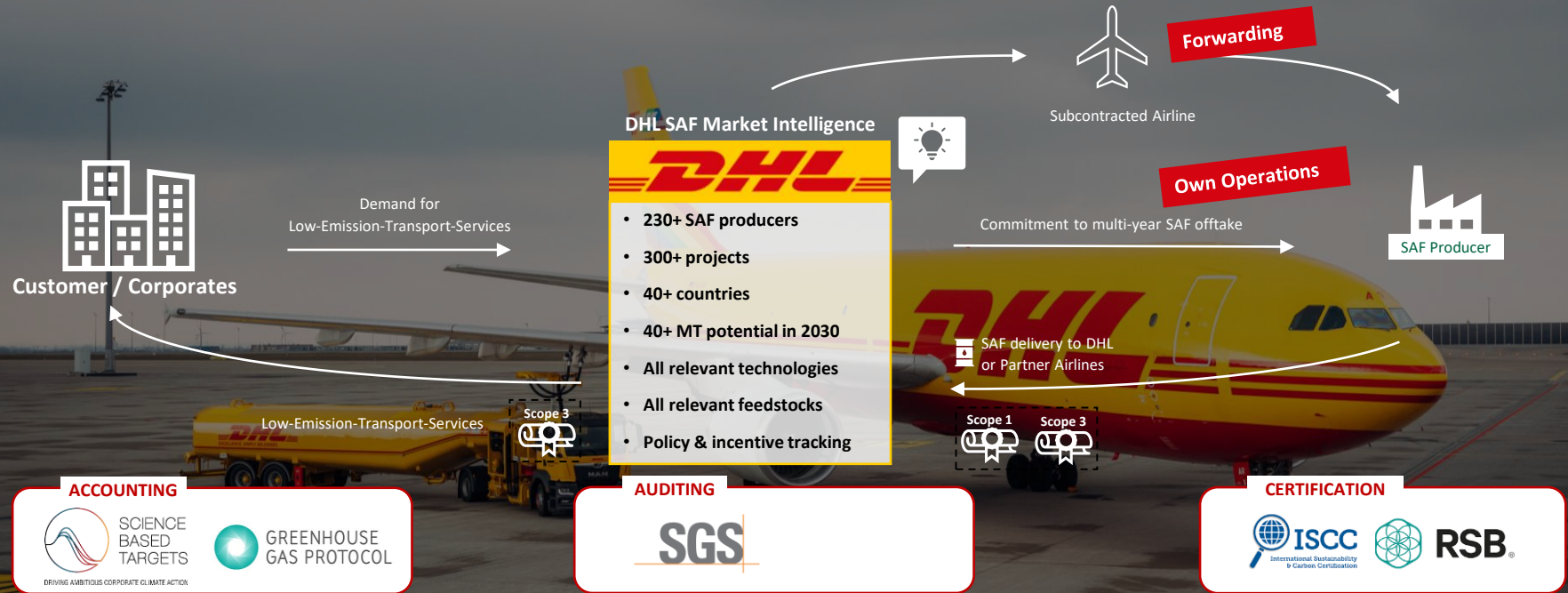
Enabling customers to actively contribute to emission reductions:

- Targeted allocation of reductions to customers, i.e. opportunity to reduce footprint already now
- Customer contributes to decarbonization cost
- Without necessity to establish a separate green infrastructure

Prerequisite: Clear standard and system for a robust and fraud-resistant Book & Claim mechanism

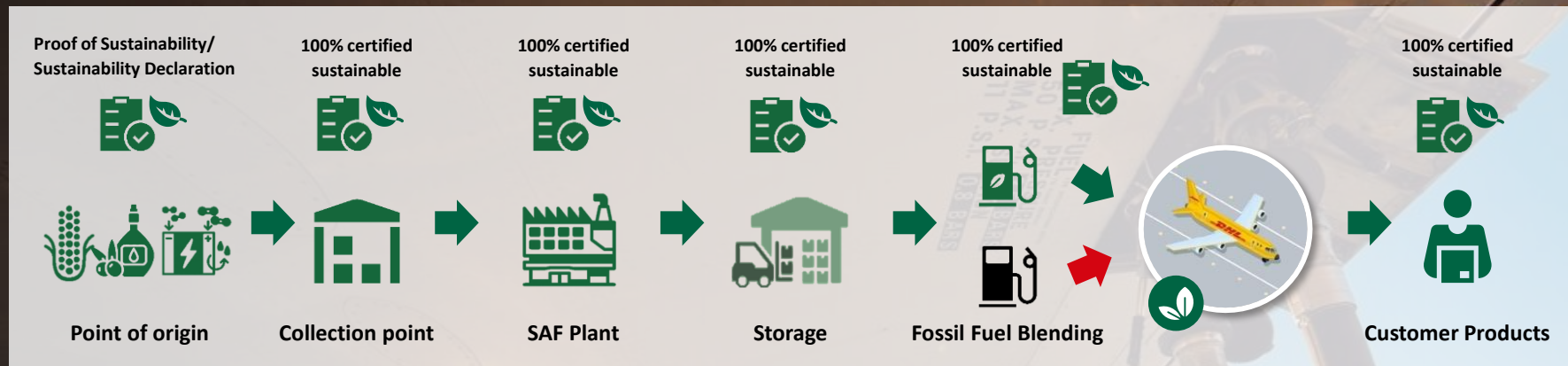
CREATING PRODUCTS WITH CUSTOMER VALUE

TRUST IN STANDARDS UNLOCKS COMMITMENT



New SAF projects need firm long-term offtake to be bankable and reach Final Investment Decision. DHL can offer this only if our customers create demand for decarbonized transport. **Customer's GoGreen+ purchase today will enable the SAF production of tomorrow.**

TRACING SUPPLY CHAIN SUSTAINABILITY



DHL is committed to purchase all SAF in line with our Sustainable Fuels Policy, which is updated regularly under stakeholder consultation:

- Current focus on waste & residue feedstocks such as used cooking oil, manure and tallow; no fuels from feedstocks with a high risk of unsustainable production – e.g. ban on palm oil
- Fuels' production does not contribute to deforestation or undesired land-use-change; no other negative impact on local communities by feedstock sourcing or processing (e. g. water depletion)
- Certified life-cycle GHG emission reduction of >60% according to relevant frameworks (e.g. EU RED) for individual contracts, targeting average reduction >75% across the Group
- Third party verification required – for liquid fuels from ISCC or RSB or equivalent



RECAP: PREREQUISITES FOR TRUST IN SAF SUSTAINABILITY

CORNERSTONES FOR SUCCESSFUL SAF USE



SUPPLY CHAIN DUE DILIGENCE

Certification bodies need to adhere to **stringent assessment criteria** and sound **due diligence**



CONSTRUCTIVE DIALOG

Continuous dialog is important, e.g. on **sustainability criteria** and **feedstock eligibility**



BOOK & CLAIM ACCEPTANCE

Standards incl. necessary safeguards to be developed, **broad acceptance crucial** for scale-up



FRAUD-PROOF REGISTRIES

Independent registries as a cornerstone for **credible, fraud-proof transfer** of SAF sustainability attributes

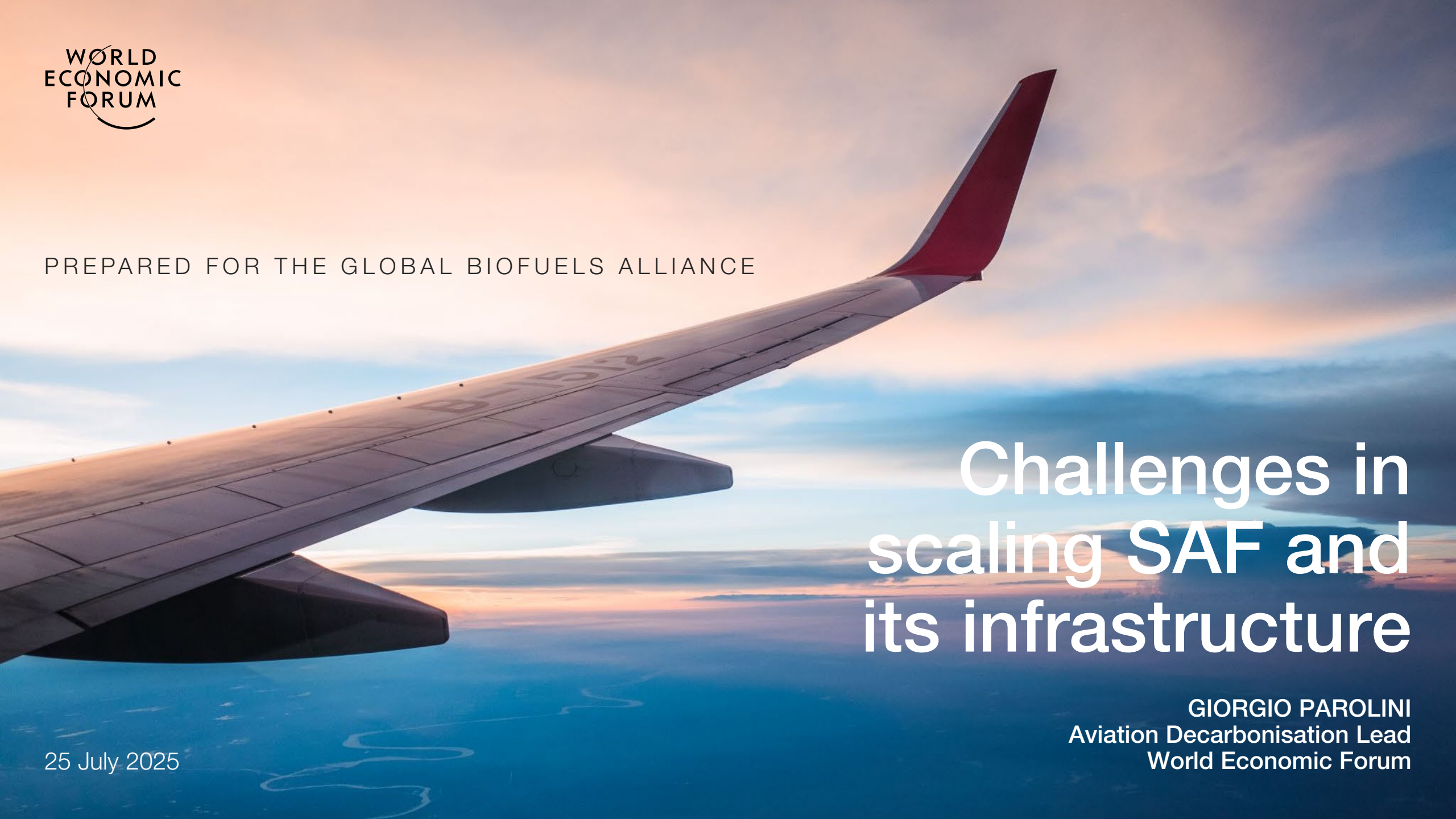


THANK YOU

Mr. Giorgio Parolini

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PREPARED FOR THE GLOBAL BIOFUELS ALLIANCE



Challenges in scaling SAF and its infrastructure

25 July 2025

GIORGIO PAROLINI
Aviation Decarbonisation Lead
World Economic Forum

Contents

1. The global context

2. Latest SAF market developments

3. Levers to scale SAF

4. Infrastructure challenges

5. Upcoming opportunities for engagement



01

The global context



The Global Aviation Sustainability Outlook 2025 identified ten key risks affecting aviation decarbonisation progress

Aviation-specific risks

- 1 Availability/cost of SAF 
- 2 Alignment of SAF policy across regions and longevity of subsidies 
- 3 Implementation of CORSIA 
- 4 Traceability of sustainability criteria for SAF feedstocks 
- 5 Effectiveness of carbon pricing and emissions trading schemes 

Wider risks

- 1 Geopolitics 
- 2 Bankability and attractiveness of the aviation sector for investors 
- 3 Economic downturn and inflation 
- 4 Change in governments 
- 5 Competing priorities (e.g. climate resilience, growth, revenue) 

● Technology ● Policy and geopolitics ● Economic ● Sustainability

<https://www.weforum.org/publications/global-aviation-sustainability-outlook-2025/>



02

Latest SAF market developments

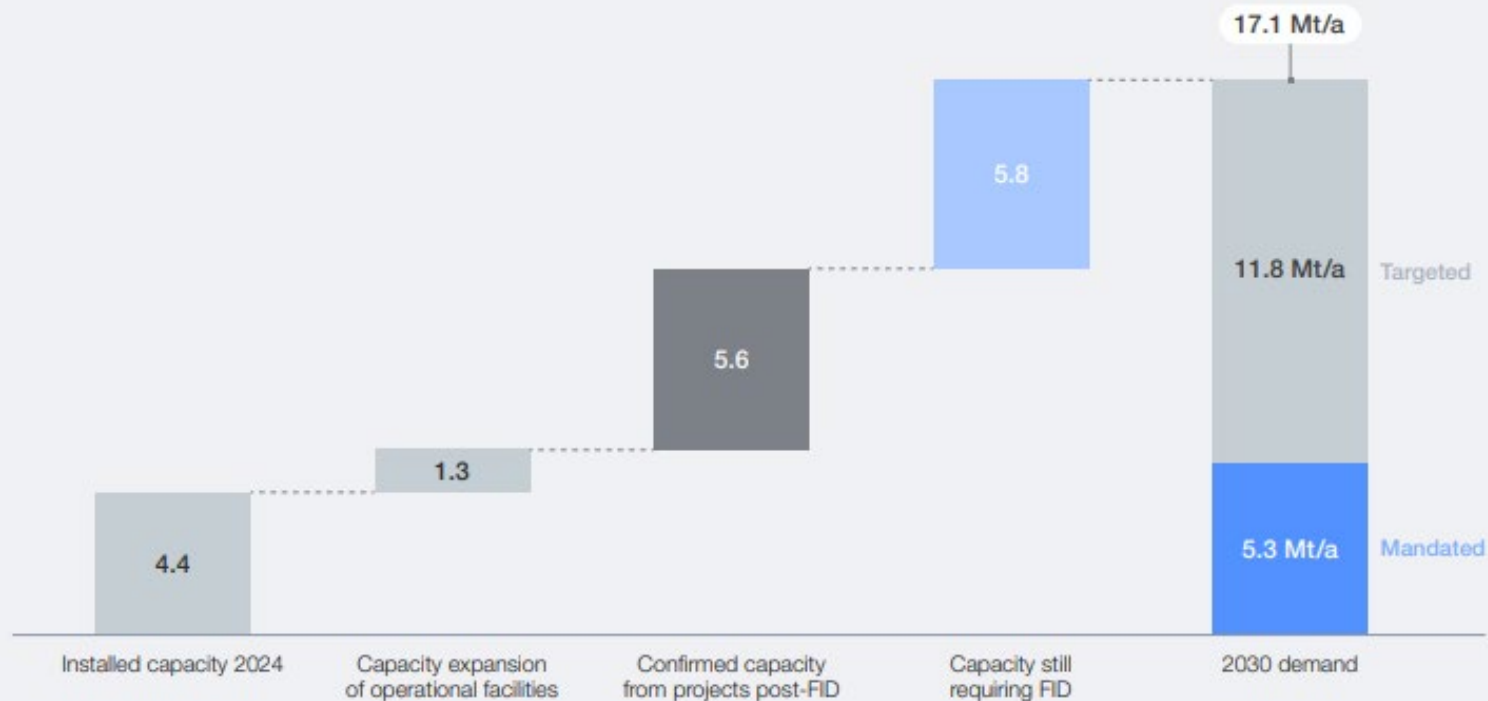


SAF capacity doubled in 2024 compared to 2023, with positive upward trajectory but potential supply gaps

Overview of SAF capacity ramp-up needed between 2024 and 2030

Global SAF production capacity at 4.4 Mt/a in 2024, with additional pipeline of ~7Mt/a confirmed by 2030.

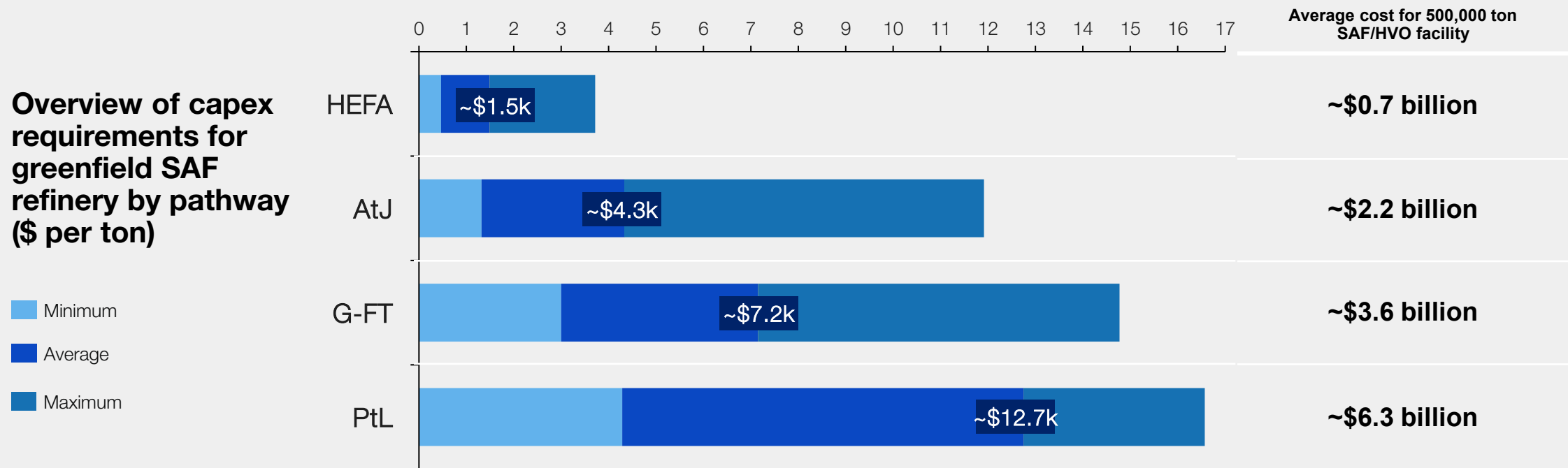
Reaching FID is a big challenge with a supply gap looming if more financing is not deployed, assuming targeted demand is firm.



Note: Mt/a = million tonnes per annum. FID = final investment decision.

Sources: Kearney analysis, S&P Platts, International Energy Agency (IEA), airline announcements. Capacity figures include co-processing.

Most of the upcoming plants use HEFA, currently the cheapest and most commercial SAF production pathway



Key infrastructure needs or steps

HEFA

1. Feedstock pre-treatment
2. Hydro-processing units
3. Hydrogen production

AtJ

1. Ethanol production
2. Alcohol dehydration and oligomerization
3. Feedstock handling

GFT

1. Feedstock pre-treatment and handling
2. Gasification
3. Syngas cleaning and conditioning
4. Fischer-Tropsch reaction
5. Carbon capture and storage

Power-to-Liquid

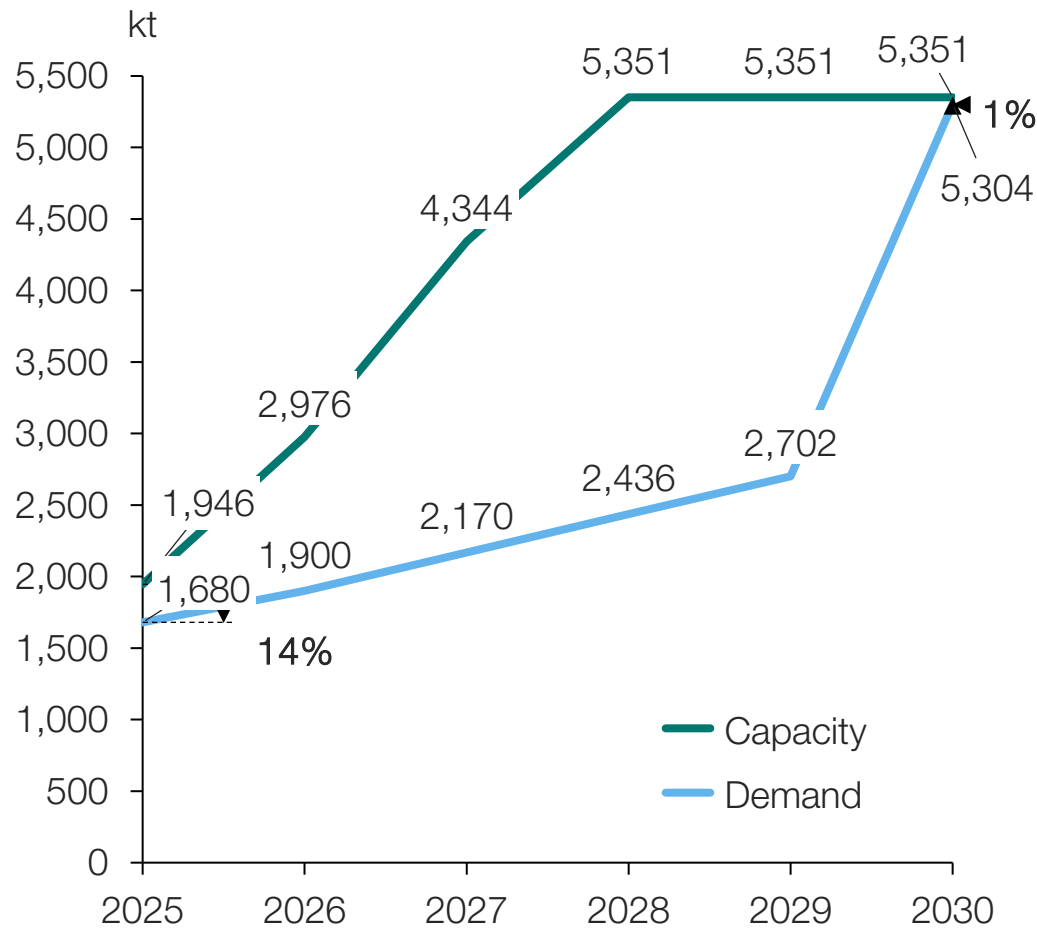
1. Electrolyzers for hydrogen production from water electrolysis
2. Renewable energy infrastructure
3. CO2 capture and conditioning
4. Reverse water gas shift and Fischer-Tropsch (FT) synthesis

Notes: HEFA is hydro-processed esters and fatty acids; AtJ is alcohol-to-jet; G-FT is gasification Fischer-Tropsch; PtL is power-to-liquid; HVO is hydro-treated vegetable oil. Pricing for PtL is approximate, given the lack of reliable datapoints.
Sources: disclosure from ~50 SAF bio-refineries with minimum capacity of 80 kt; Kearney analysis

Source: Kearney analysis for Airports of Tomorrow

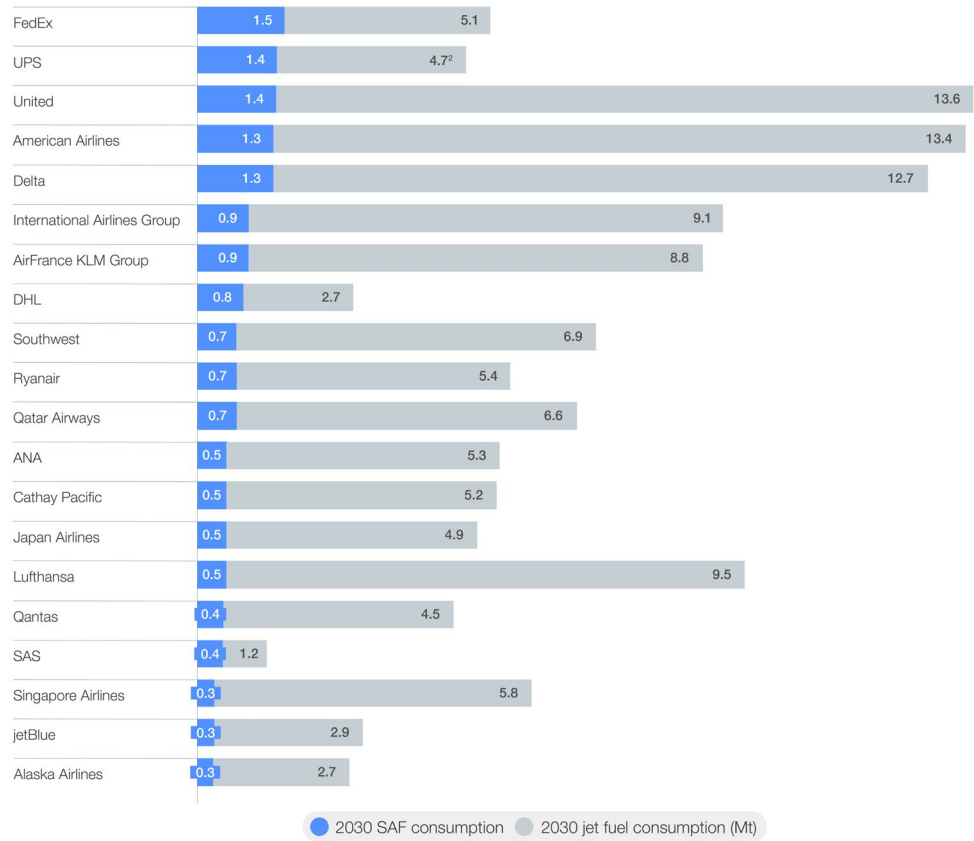
The likelihood of supply gaps can be impacted by the strength of the SAF demand signal

Latest SAF demand vs capacity forecasts in Europe



Source: Argus

Estimated SAF and jet fuel consumption by 2030 by top 20 SAF consumers (Mt)¹



Note: 1. Estimates based on forecast 2030 fuel consumption and voluntary commitments.
2. UPS has a goal of 30% SAF by 2035, which is used here for 2030.

Source: US Energy Information Administration (EIA), airline annual reports and press releases; excludes airline-specific fuel efficiency programmes.

Incentives can help, with positive momentum in the US for SAF and major implications on feedstock

Previous measures enacted under IRA

Clean Fuels Production Tax Credit provides between \$0.35 - \$1.75 per USG of SAF until 2027

Clean hydrogen production tax credit for facilities starting construction before 2033

One Big Beautiful Act provisions

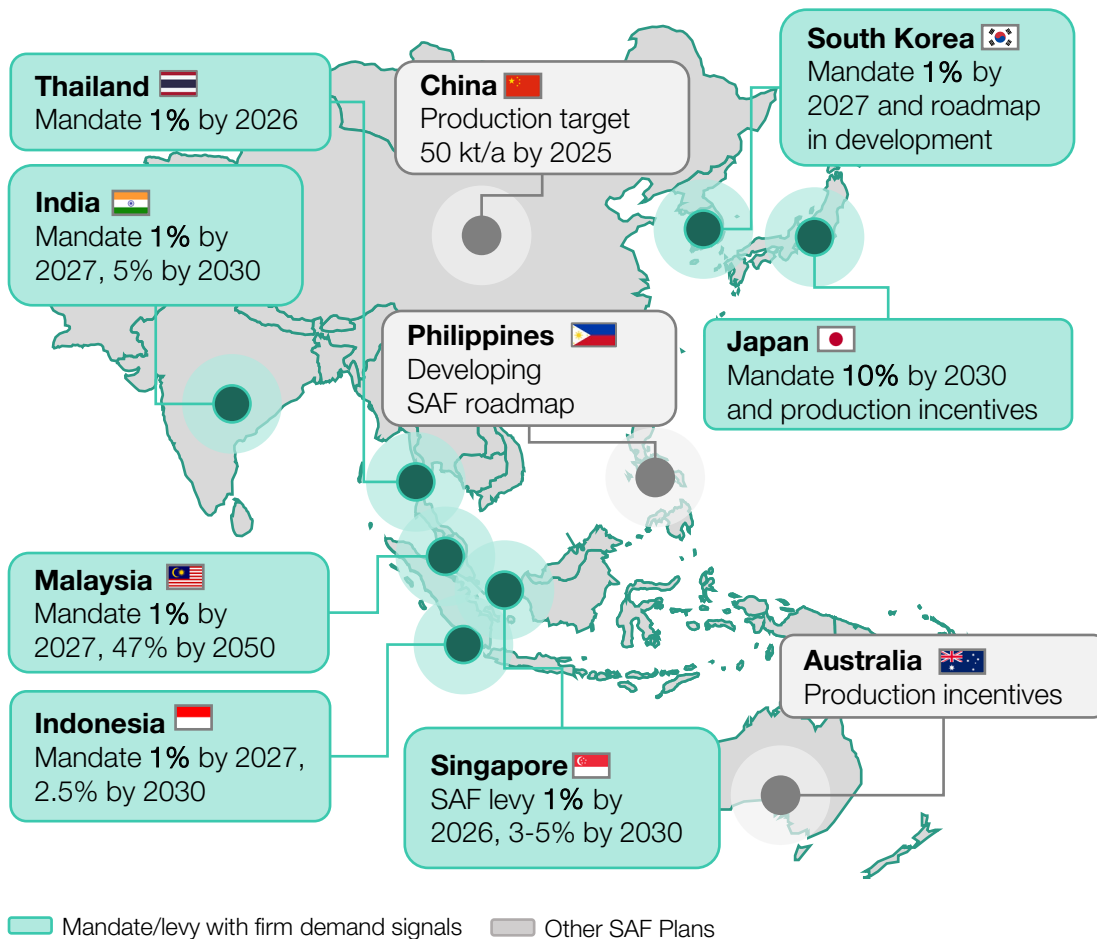
- Credit extension until end of 2029, but with new eligibility criteria from 2026 and enhanced rates for SAF phased out (up to \$1 per gallon)
- Restriction of feedstocks to US, Mexico and Canada, with limited credit for those coming from other regions
- LCA criteria exclude indirect land use changes in the GHG calculation

45V clean hydrogen production tax credits now remains available for production facilities that begin construction before 1 January 2028

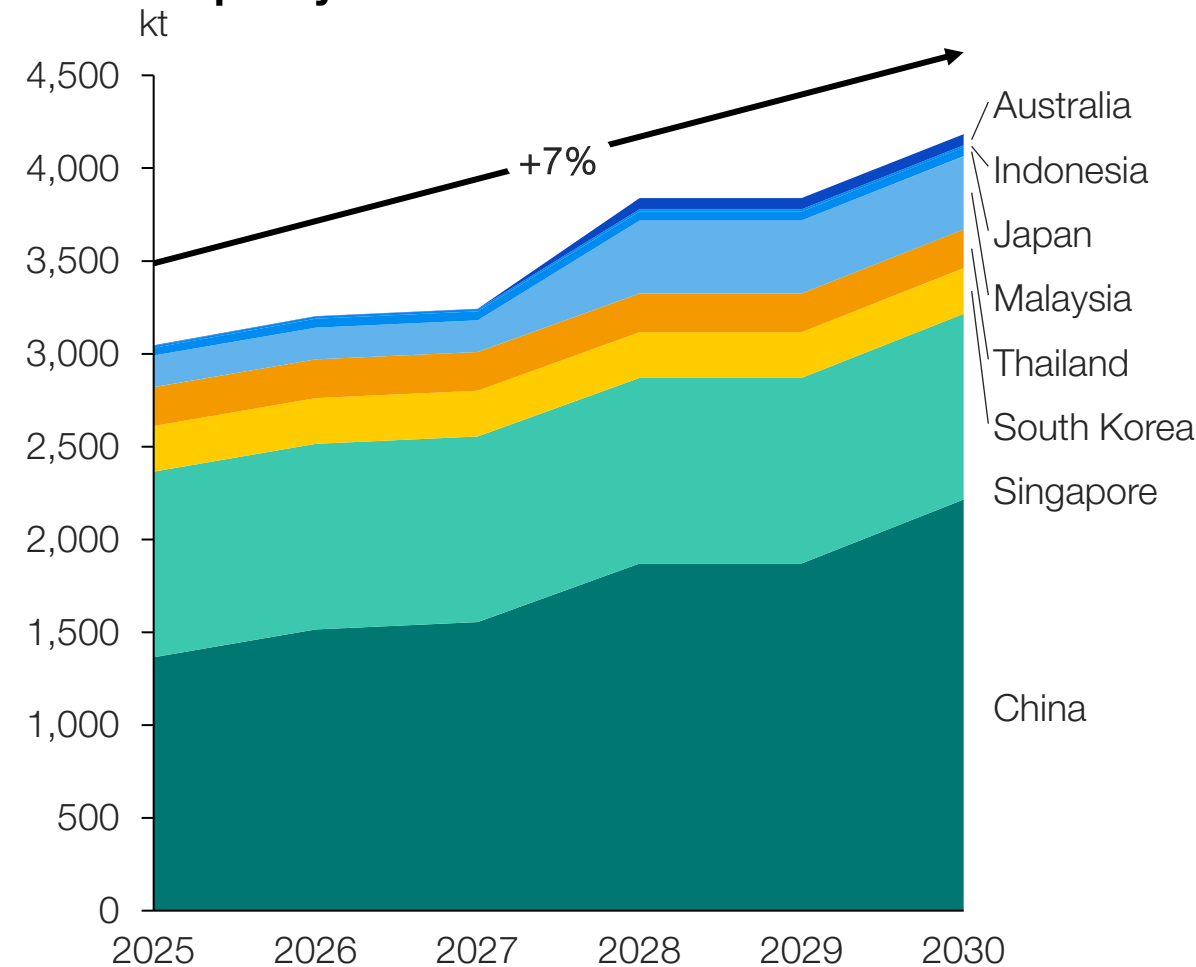
+ more recent developments from EPA on the RFS biofuels blending requirements

Asia Pacific is also increasingly looking into SAF policy, aiming to leverage its industry potential

Nascent SAF regulatory environment in Asia-Pacific



SAF capacity forecasts in Asia Pacific



Source: Argus

Green Fuel Forward aims to raise awareness of SAFc to boost demand and scale supply in APAC

Driving greater SAF demand

Encouraging members to **undertake test* purchase** of SAF/SAFc with a view to use SAF/SAFc as part of their decarbonisation toolkit

2025

2026

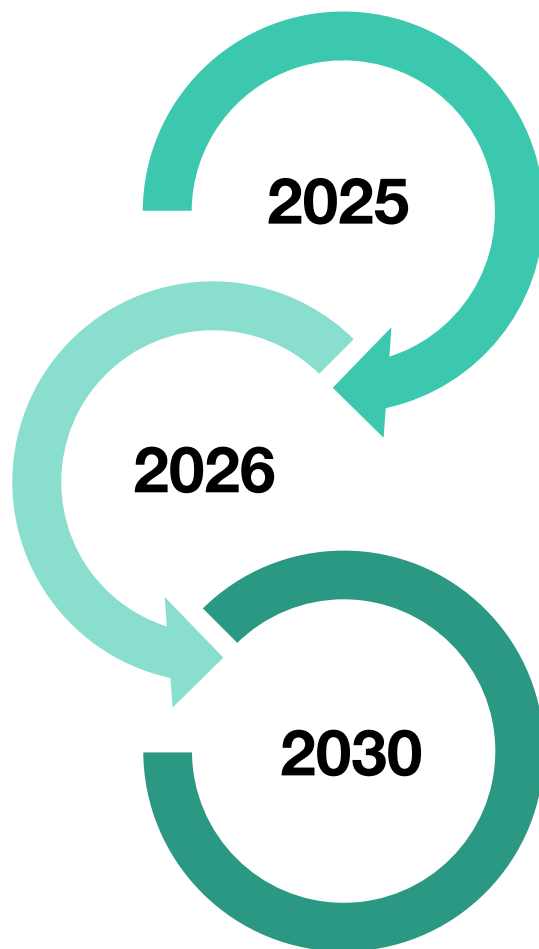
2030

Building SAF capability

Improving knowledge of SAF, SAF certificates (SAFc), book-and-claim mechanisms, procurement options and sustainability standards

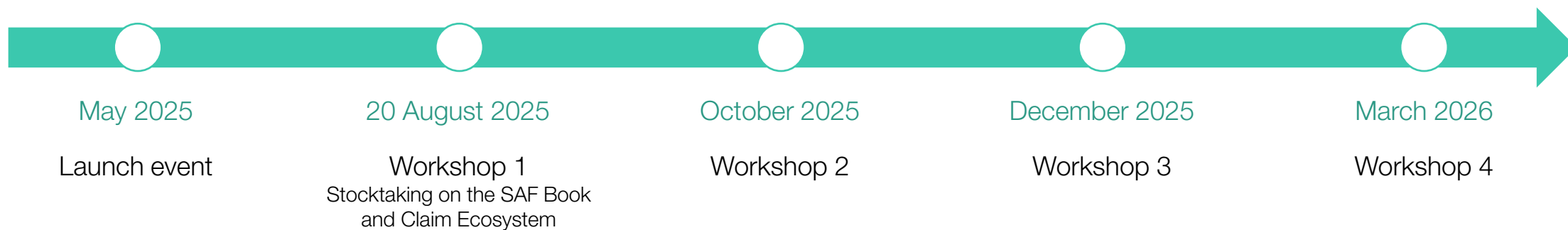
Strengthening APAC market

With greater number of local airlines and corporates exploring and using SAF and SAFc, we can **unlock greater SAF production**. This will also contribute to global targets, such as ICAO's goal to **reduce international aviation emissions by 5% by 2030**



In the next year, Green Fuel Forward will focus on capability building activities and workshops

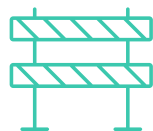
Indicative timeline



Potential workshop topics



SAF certificates,
benefits and
business models



Hurdles and
challenges in
SAFc scaling



SAFc schemes,
registries and
interactions



Feedstocks,
innovation and
sustainability



SAF and SAFc
procurement and
best practice



SAFc
accounting and
reporting

03

Levers to scale SAF



Ten levers can help SAF projects scale

Methods for attracting more funding into a SAF production facility

- Public funding
- Industry funding
- Institutional funding

Relevance of guideline by pathway

Low Medium High
(nice to have) (must have)

Relevance of guideline by life-cycle phase

Low Medium High
(rarely applicable) (very common)

Financial levers	Pathways				Life-cycle phases				
	HEFA	AtJ	G-FT	PtL	Pre-feasibility	Feasibility + FEED	FID	Construction	Commissioning
1 Research and innovation grants	Low	Medium	High	High	Medium	High	High	Low	Low
2 Multilateral development bank support	High	High	High	High	Medium	High	High	Low	Low
3 Guarantees and insurance	Medium	High	High	High	Low	High	High	High	Low
4 Strategic investments	Medium	High	Medium	Medium	Low	Medium	High	Medium	Low
5 Long-term offtake agreements	High	High	High	High	Low	Low	High	Low	Low
6 Book-and-claim mechanisms	High	High	High	High	Low	Low	High	Medium	Medium
7 Private equity investment	High	High	High	Medium	Low	Low	High	High	High
8 Infrastructure investors	Medium	High	High	High	Low	Low	High	High	High
9 Tolling model	High	High	High	High	Low	Low	High	High	High
10 Green bonds	Medium	High	High	High	Low	Low	Low	High	High

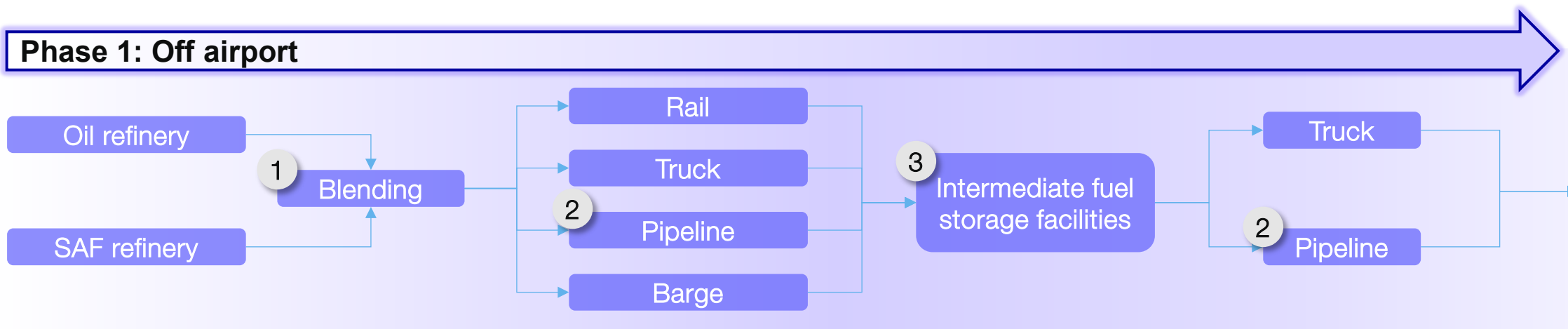
Notes: HEFA is hydro-processed esters and fatty acids; AtJ is alcohol-to-jet, G-FT is gasification Fischer-Tropsch; PtL is power-to-liquid.
Sources: World Economic Forum Airports of Tomorrow; Kearney analysis

04

Infrastructure challenges

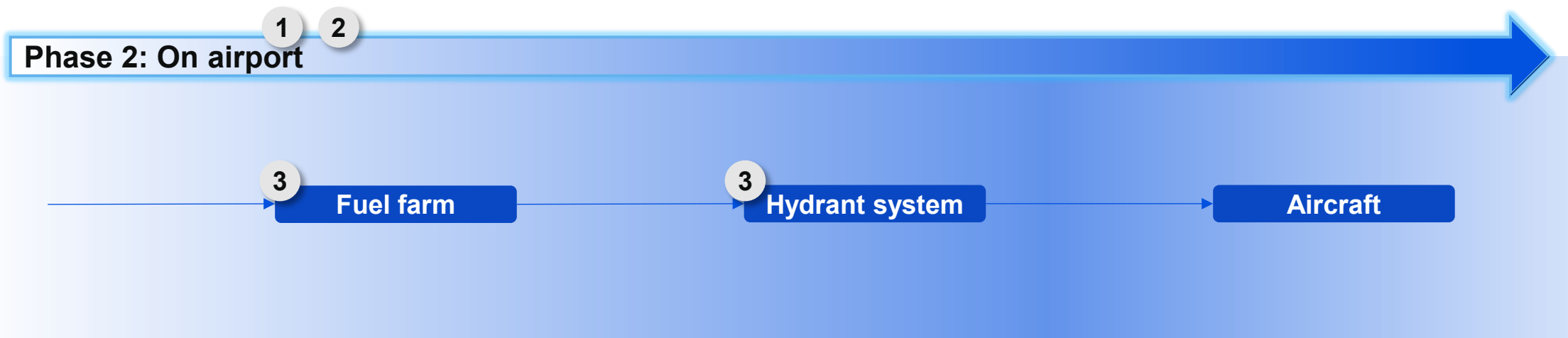


New SAF developers can face infrastructure challenges to move the fuel along the value chain



#	Challenge	Description
1	Blending	Segregation requirements: Different SAF pathways require separate blending processes, complicating logistics and duplicating infrastructure. Only blended SAF (now compliant with jet fuel specs) can then be blended. Fuel specifications: Even though SAF could be blended up to 50% in volumes, the need to add aromatics and the quality of the fuel currently produced limit actual blending to 30-40%.
2	Pipeline access	Dominance of incumbent players: Existing fuel infrastructure is owned by private companies that can restrict access for new SAF producers. Direct access to airport fuel systems is often not possible without going through incumbents. Without pipelines or access to infrastructure, reliance on truck and rail transportation increases costs, with challenging optimisation due to low SAF volumes.
3	Intermediate storage	Storage size mismatch: Competition with fossil fuel refiners for tankage, who often have long-term agreements, limits available blending and storage capacity and increases cost. Availability/access: Particularly in emerging markets, availability of storage is limited, and, across regions, where storage is available to SAF it is catered to HEFA and not e-SAF.

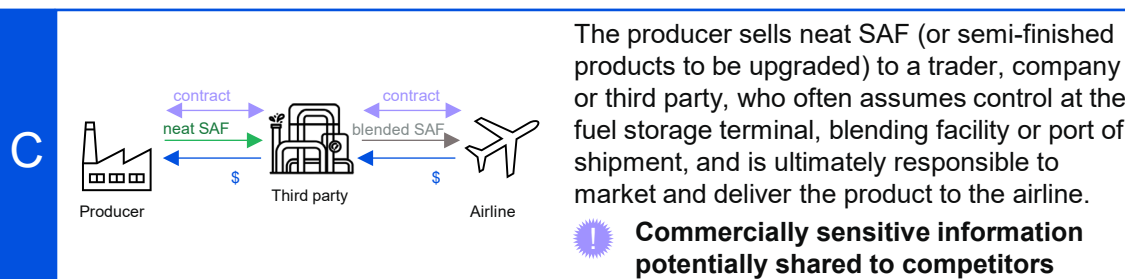
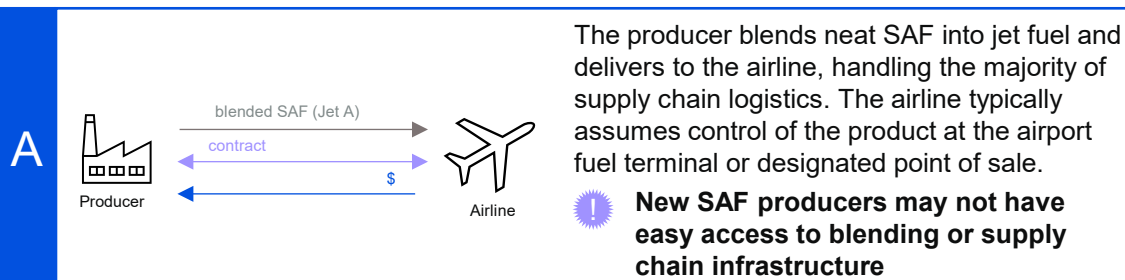
Some of these challenges include access to airport infrastructure and ability to deliver SAF there



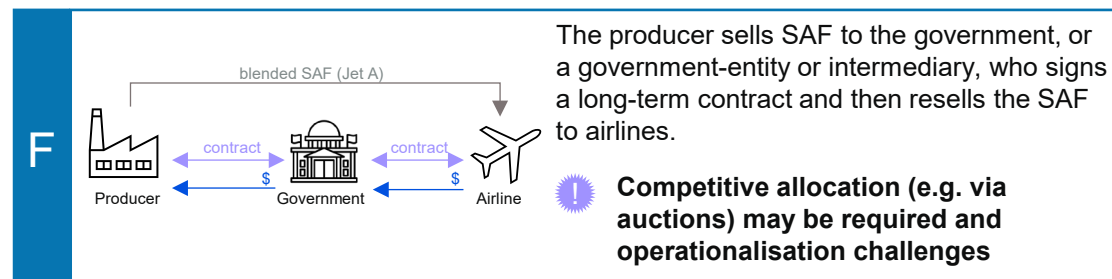
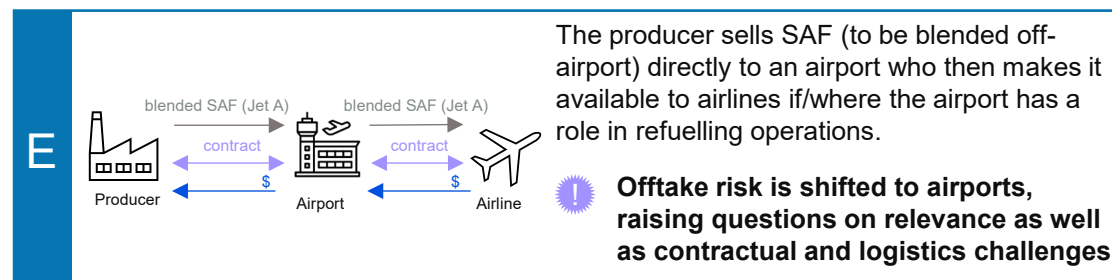
#	Challenge	Description
1	General infrastructure access and control	Ownership of fuel infrastructure: Airports' fueling infrastructure (storage, pipelines, hydrant systems) can be controlled by a small group of fuel producers (e.g. in Europe), or by airlines and their consortia (e.g. in the US). Access to airport fuel infrastructure may thus not be possible or, where allowed, can incur additional costs set by controlling entities.
2	Regulatory and policy gaps	Lack of mandates or incentives for SAF integration: the provision of enabling infrastructure or incentives at airports are not, per se, sufficient to offer physical SAF delivery in the absence of a wider regulatory framework that make SAF supply attractive in that location. Not all airports are thus expecting to see SAF in the short term, even if there is willingness to offer SAF from their side or to facilitate its logistics.
3	Operational rigidity	Lack of flexibility for new fuels: Airport systems are optimized for conventional jet fuel, not for handling small, segregated, or variable SAF volumes, that thus get blended off airport.

Multiple SAF business models and supply chain options have emerged, with different challenges

More established business models raised by stakeholders



Emerging or potential business models raised by stakeholders



There are many potential supply chain combinations and regional variations, and this overview does not aim to be comprehensive

05

Upcoming opportunities for engagement



The World Economic Forum is planning several aviation decarbonisation discussions, incl. on SAF



Book-and-claim schemes and business models

To review existing book-and-claim schemes, registries, business models and partnerships to assess similarities and differences

Summer and Autumn 2025
GFF workshop 20 August 8-10am CET



Fuel resource allocation and best use

To align on overarching principles across sectors in the allocation of biomass, renewable electricity, hydrogen as well as CO2 to produce fuels

Autumn 2025
Workshop 7 October 15.00-16.30 CET



Innovation driving aviation decarbonisation

To identify potential applications of innovation, digitisation and artificial intelligence across the aviation value chain to drive decarbonisation further

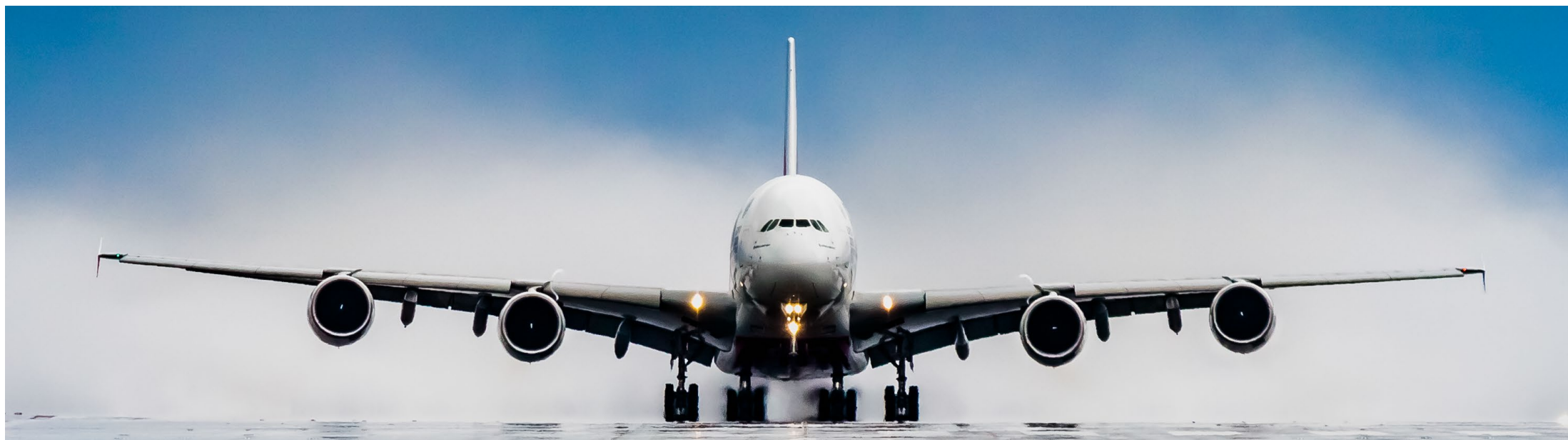
Autumn 2026 and Winter 2026



The Future of Aviation at the Dubai Airshow

To discuss the future of aviation on the ground and in the air, with special focus on the topic of SAF financing and investment

17-21 November 2025



WORLD ECONOMIC FORUM

A blue circular arc, resembling a stylized 'C' or a partial circle, is positioned behind the text 'WORLD ECONOMIC FORUM'. The arc starts to the left of the word 'WORLD', curves around the middle of the text, and ends to the right of the word 'FORUM'.

Mr. Eric van den Heuvel

The background of the slide is white. On the right side, there are several large, overlapping, curved shapes in shades of light blue and green, resembling stylized flames or leaves. The bottom half of the slide is a solid dark green band with a pattern of fine, vertical, wavy lines in a slightly lighter shade of green.



IEA Bioenergy
Technology Collaboration Programme



Decarbonising EU Aviation with SAF - current challenges and perspectives

Eric van den Heuvel, Technical Coordinator
IEA Bioenergy TCP

Global Biofuel Alliance - SAF Webinar, 25 July 2025

The IEA Bioenergy Technology Collaboration Programme (TCP) is organised under the auspices of the International Energy Agency (IEA) but is functionally and legally autonomous. Views, findings and publications of the IEA Bioenergy TCP do not necessarily represent the views or policies of the IEA Secretariat or its individual member countries.

IEA Bioenergy TCP

Technology Collaboration Programme (TCP), functioning within a framework created by the International Energy Agency (IEA)

Goal:

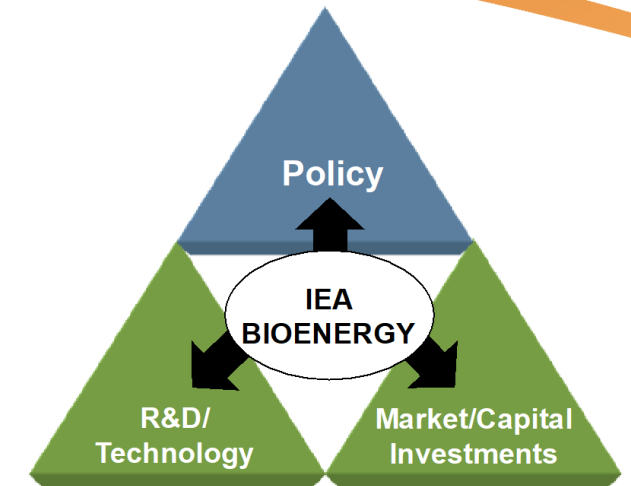
- International **collaboration** and **info exchange** on bioenergy research, technology development, demonstration, markets, and policy analysis
- Facilitate the commercialization and market deployment of sustainable bioenergy systems = **climate positive, environmentally sound, socially acceptable** and **cost-competitive** (incl. external costs)

Members:

13 European countries + EC, USA, Canada, Brazil, India, China, Japan, Korea, Australia, New Zealand, South Africa

Work programme:

Carried out through **Tasks** and **Special Projects**, covering the full value chain from feedstock to final energy product (~200 experts worldwide involved)



IEA Bioenergy TCP - overview of all activities

Industrial
Energy-Related
Technologies
and Systems

TCP Coordination Group on
Thermal Networks

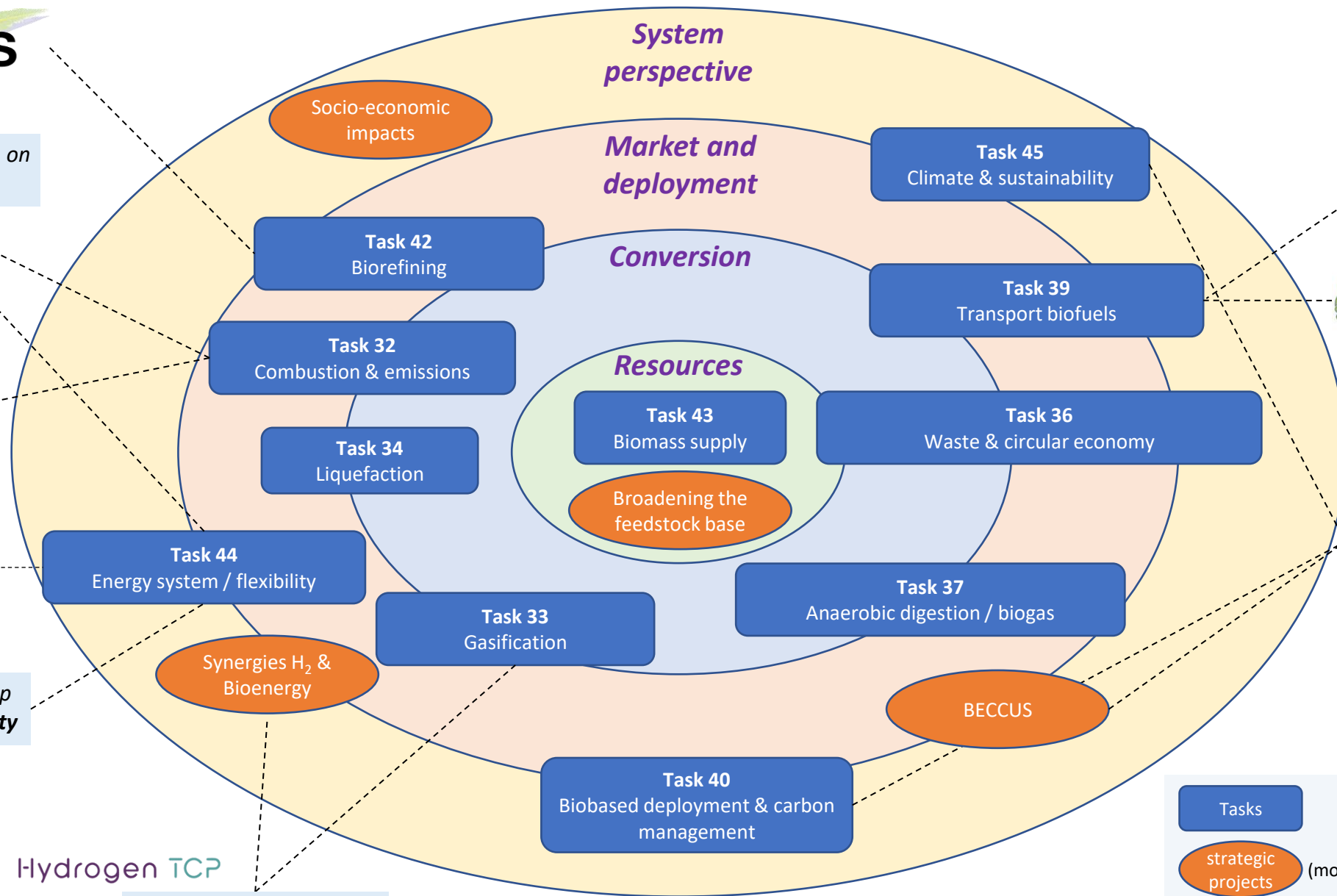


TCP Coordination Group
Energy System Flexibility

Hydrogen TCP



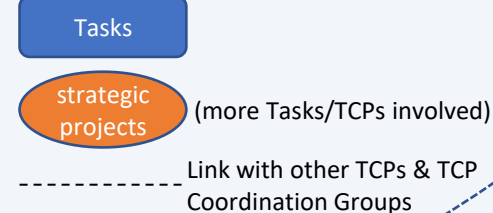
TCP Coordination Group
on **Hydrogen**



TCP **Transport**
Coordination Group



TCP Coordination Group
on **Carbon Management**





IEA Bioenergy
Technology Collaboration Programme



Task 39 Biofuels to Decarbonize Transport

Key projects for 2025-2027

- Implementation Agenda including Emerging Markets
- Advanced Biofuels Demonstration Database
- Renewable Hydrocarbons for Diesel and Jet Sectors
- E-Fuels and synergies with biofuel production
- Marine Biofuels
- BECCUS - BioEnergy Carbon Capture Utilization & Storage



IEA Bioenergy
Technology Collaboration Programme

Task 39
Biofuels to Decarbonize Transport

Renewable Hydrocarbons for Heavy Duty and Jet Fuel Sectors

- Feedstocks and Biofuel Process Conversion Routes (led by USA and Brazil)
- Assessing GHG LCA in Coprocessing of Renewable Diesel and Jet Fuels (led by EC)
- 11 participating countries

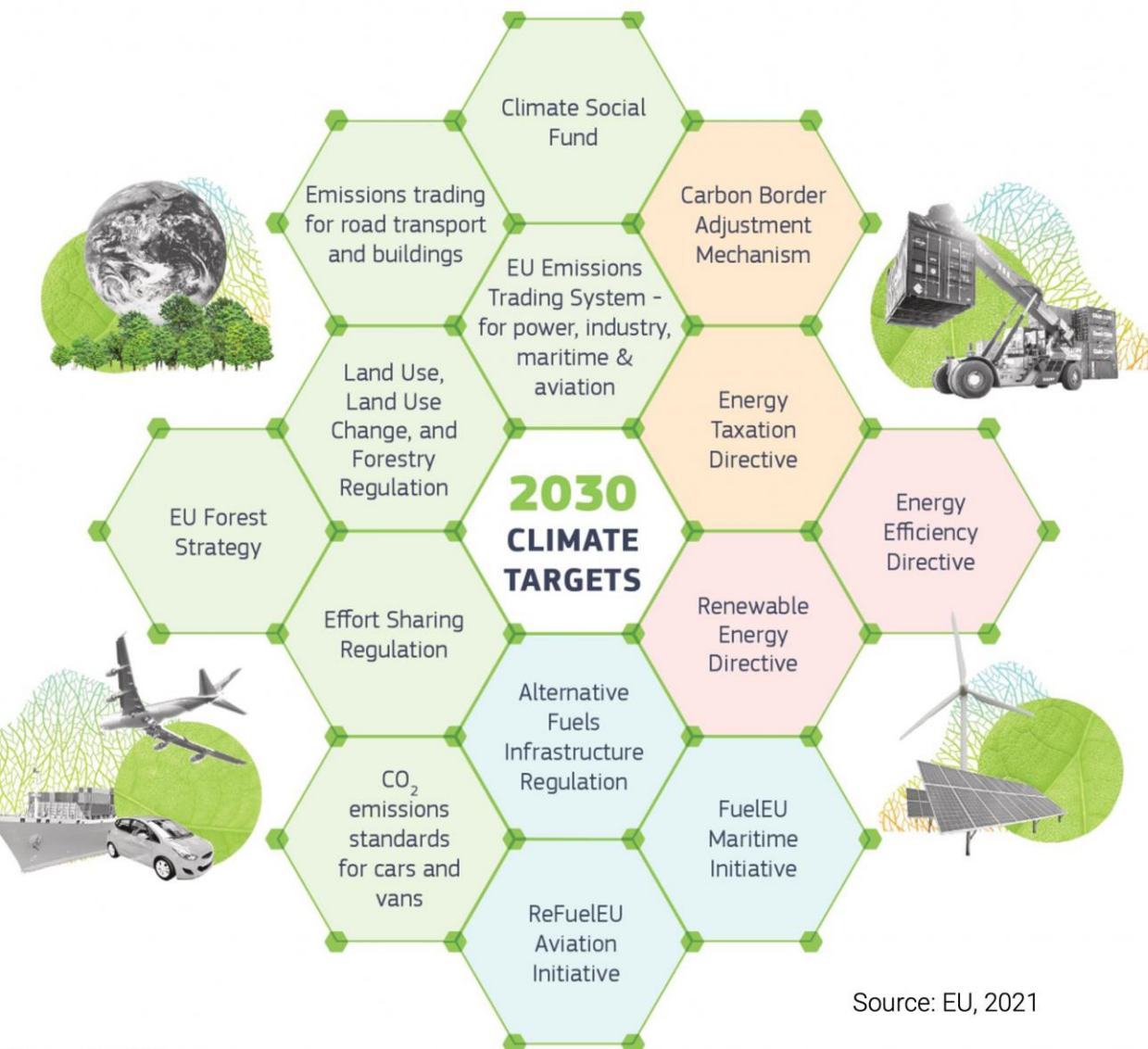
Country:	Representative:
Belgium	Robert Malina Sumit Maharjan
Brazil	Glaucia Mendes Souza Rubens Maciel Filho Luiz Augusto Horta Nogueira Jean Felipe Leal Silv
China	Fuli Li
EU	Nicolae Scarlet Marco Buffi
Germany	Franziska Müller-Langer Nicolaus Dahmen
Japan	Tomoaki Hara
The Netherlands	Jose Muisers Stephan Janbroers
Norway	Duncan Akporiaye
South Korea	Kyungsu Na
Sweden	Tomas Ekbom
United States	Ling Tao

Biofuels Implementation Agenda (including Emerging Markets)

Provision of country-specific insights on:

- Policies related to biofuels and sustainability
- Research efforts and strategies
- Market development and main drivers for biofuel production and use
- Feedstock input for biofuels and land use
- Share of individual transport modes in total transport
- Contribution of transport to greenhouse gas (GHG) emissions
- Upcoming policies and developments
- Updates in relevant certification schemes

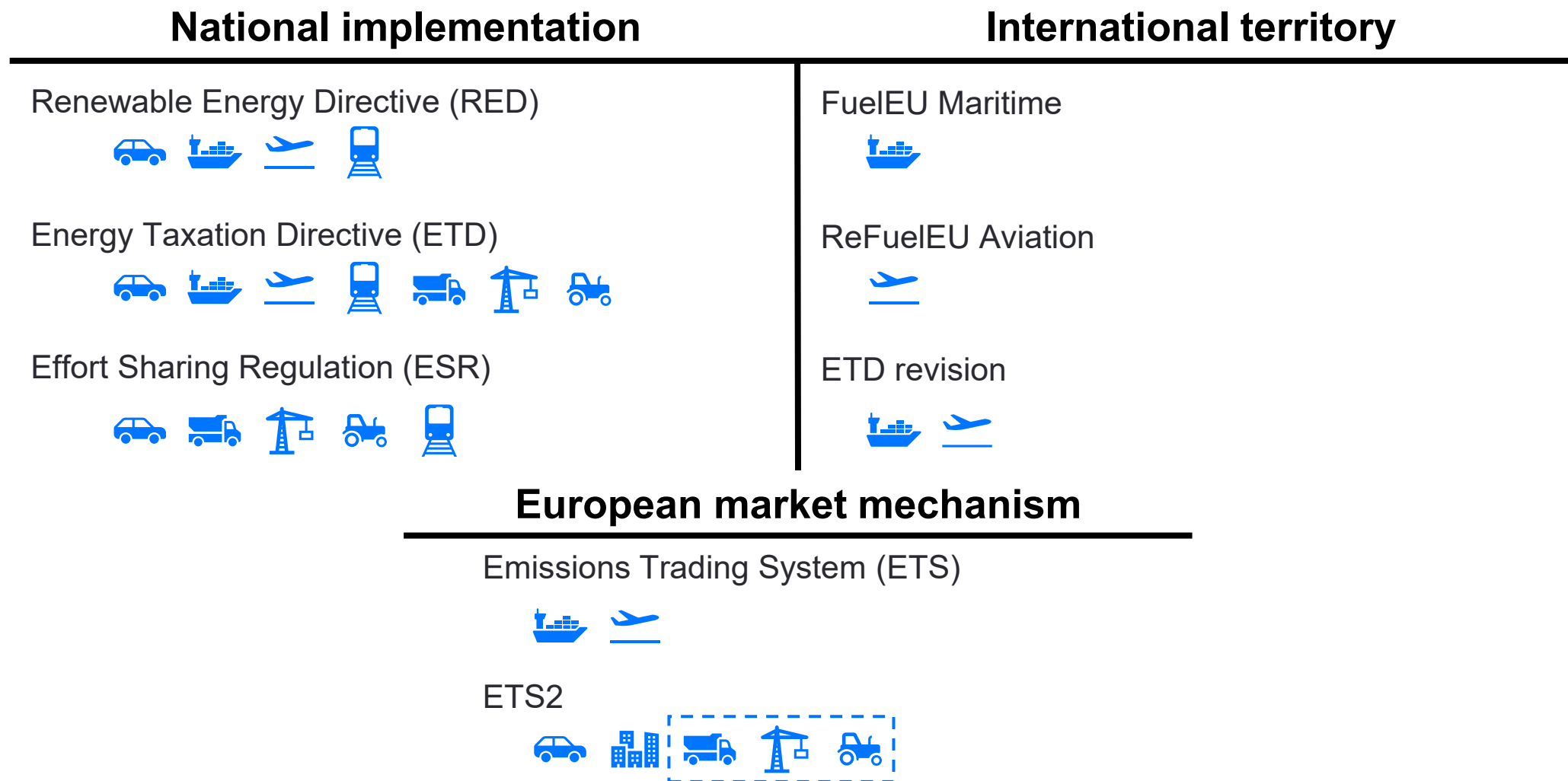
Market and Policy context for SAF in European Union



© damianobuffo/Adobe Stock



EU Policy on energy in transport



Types of steering instruments

Mandated share of renewables	GHG emission intensity
RED II - e.g. minimum 14% renewable energy in fuel mix by 2030 ReFuelEU Aviation - e.g. minimum 6% of SAF in fuel mix by 2030	RED III - By 2030, -14.5% GHG emission intensity of energy in transport FuelEU Maritime - By 2030, -6% GHG emission intensity of energy used in ships
Effective GHG emission reduction	
ETS By 2030, -61% overall GHG emissions in these sectors compared to 2005	
ETS2 By 2030, -43% overall GHG emissions in these sectors compared to 2005	
Effort Sharing Regulation (ESR) By 2030, -48% GHG emissions in these sectors in the Netherlands compared to 2005	
Energy Taxation Directive (ETD) e.g. minimum tax tariff categories dependent aimed at reducing emissions from fuel usage	

Types of steering mechanisms

Mandated share of renewables

RED II

- e.g. minimum 14% renewable energy in fuel mix by 2030

ReFuelEU Aviation

- e.g. minimum 6% of SAF in fuel mix by 2030

GHG emission intensity

RED III

- By 2030, -14.5% GHG emission intensity of energy in transport

FuelEU Maritime

- By 2030, -6% GHG emission intensity of energy used in ships

Effective GHG emission reduction

ETS

- By 2030, -61% overall GHG emissions in these sectors compared to 2005

ETS2

- By 2030, -43% overall GHG emissions in these sectors compared to 2005

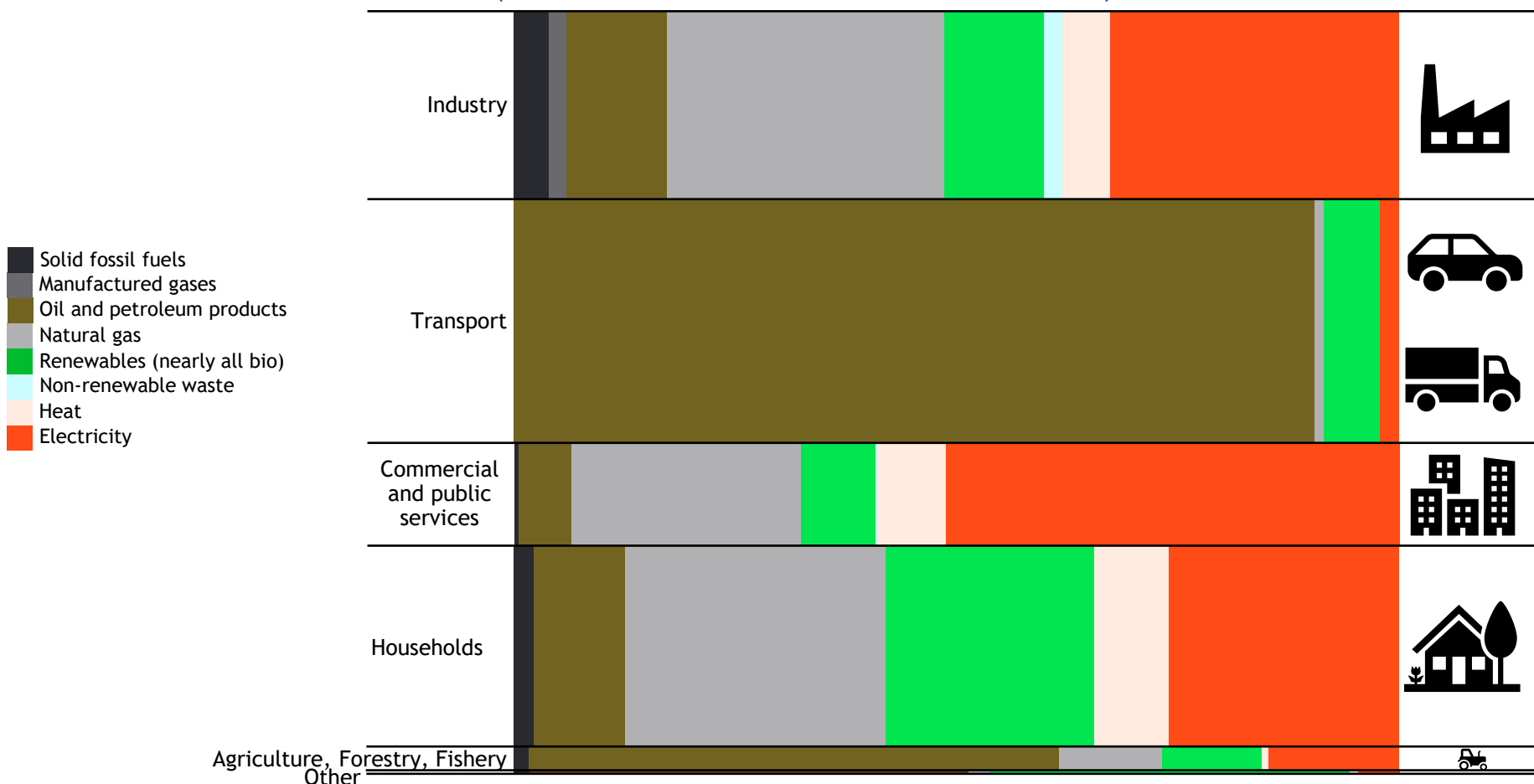
Effort Sharing Regulation (ESR)

- By 2030, -48% GHG emissions in these sectors in the Netherlands compared to 2005

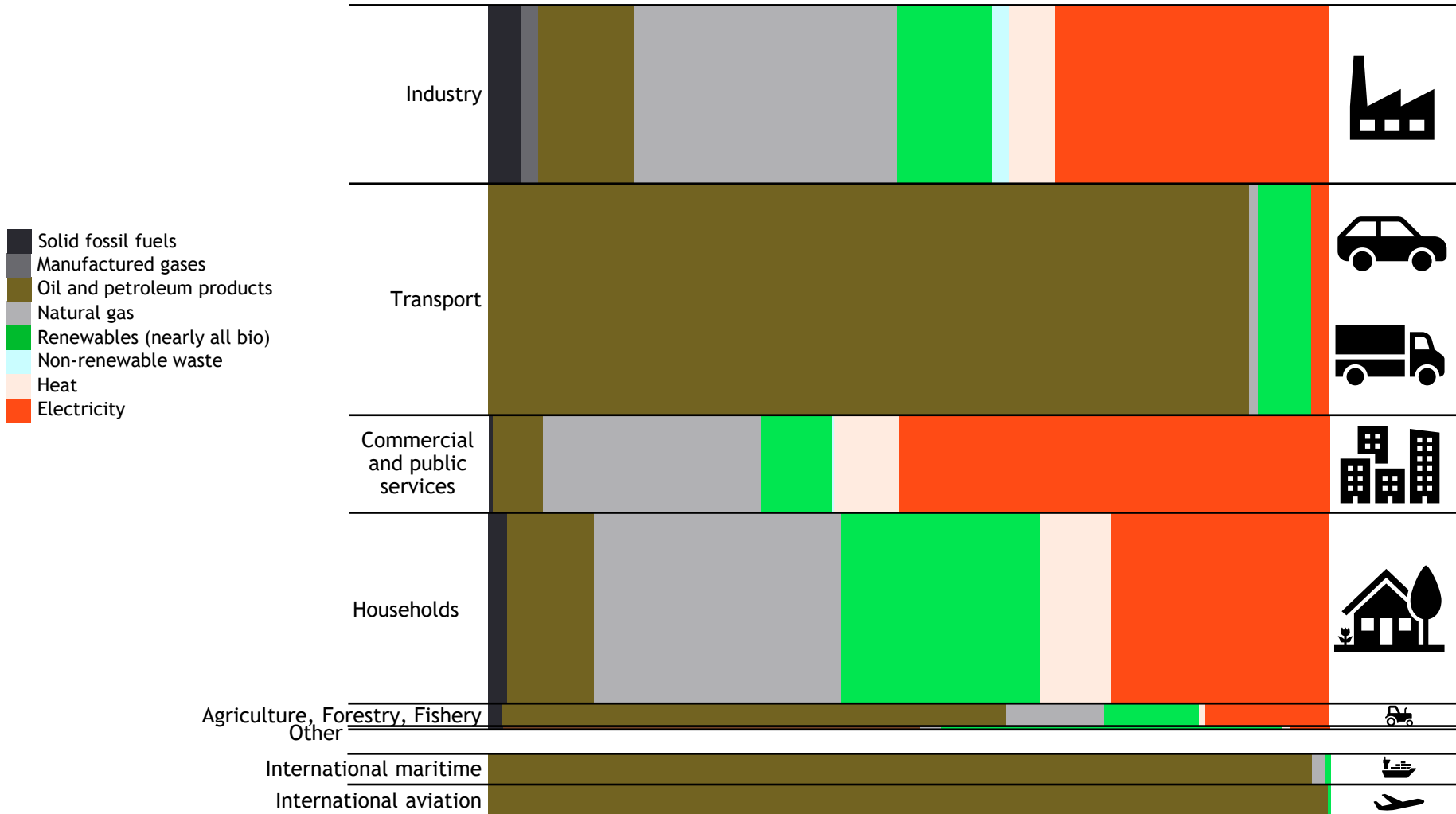
Energy Taxation Directive (ETD)

- e.g. minimum tax tariff categories dependent aimed at reducing emissions from fuel usage

Per sector, final energy consumption in the EU27 in the year 2023: 873 Mtoe (excl. int. aviation and maritime)



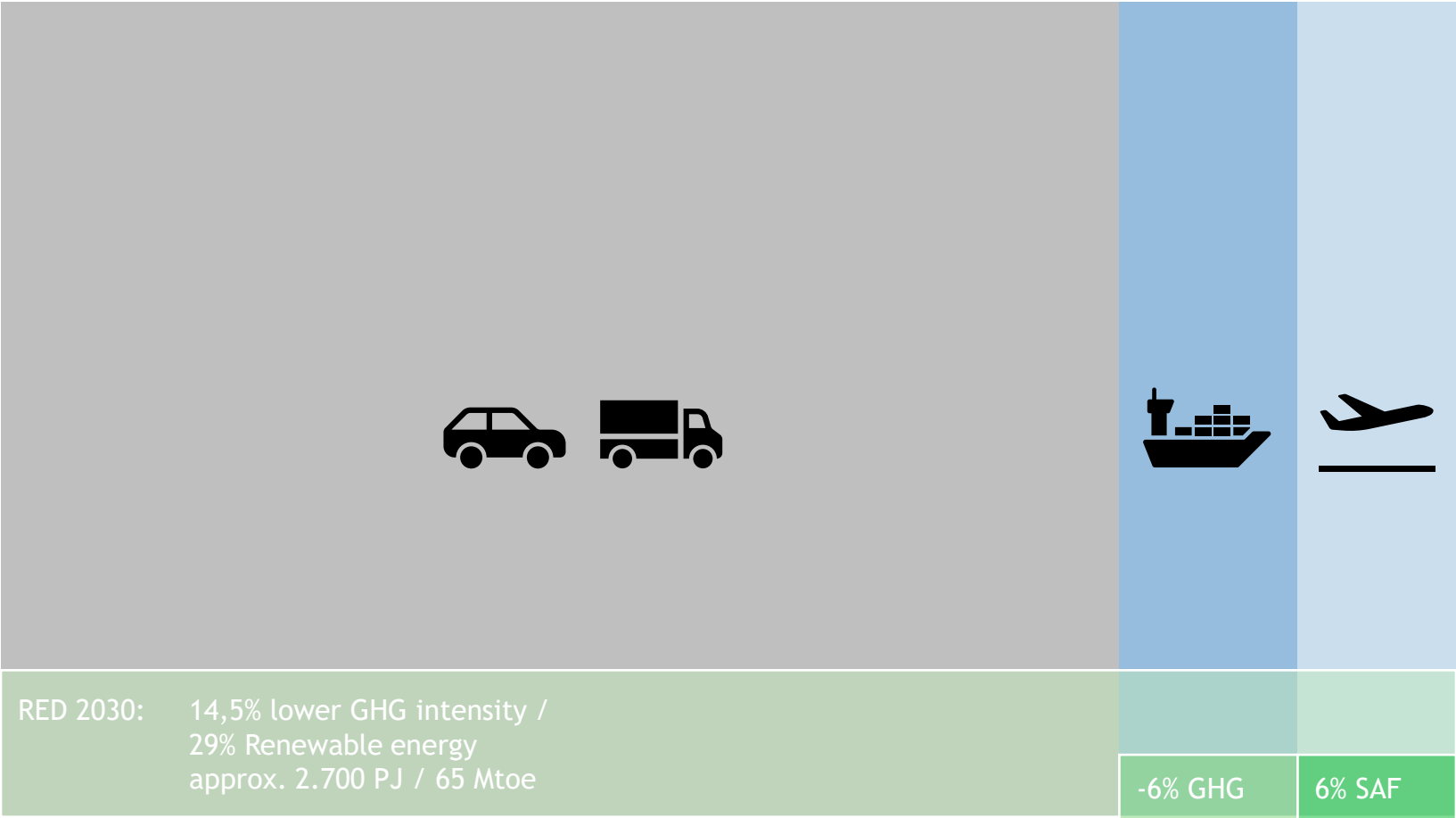
Per sector: final energy consumption in the EU27 in the year 2023: 950 Mtoe (incl. int. aviation and maritime)



Source: Eurostat, Energy Balance, 2023 data. Data are excluding international aviation and maritime bunkering, graph created by studio Gear Up

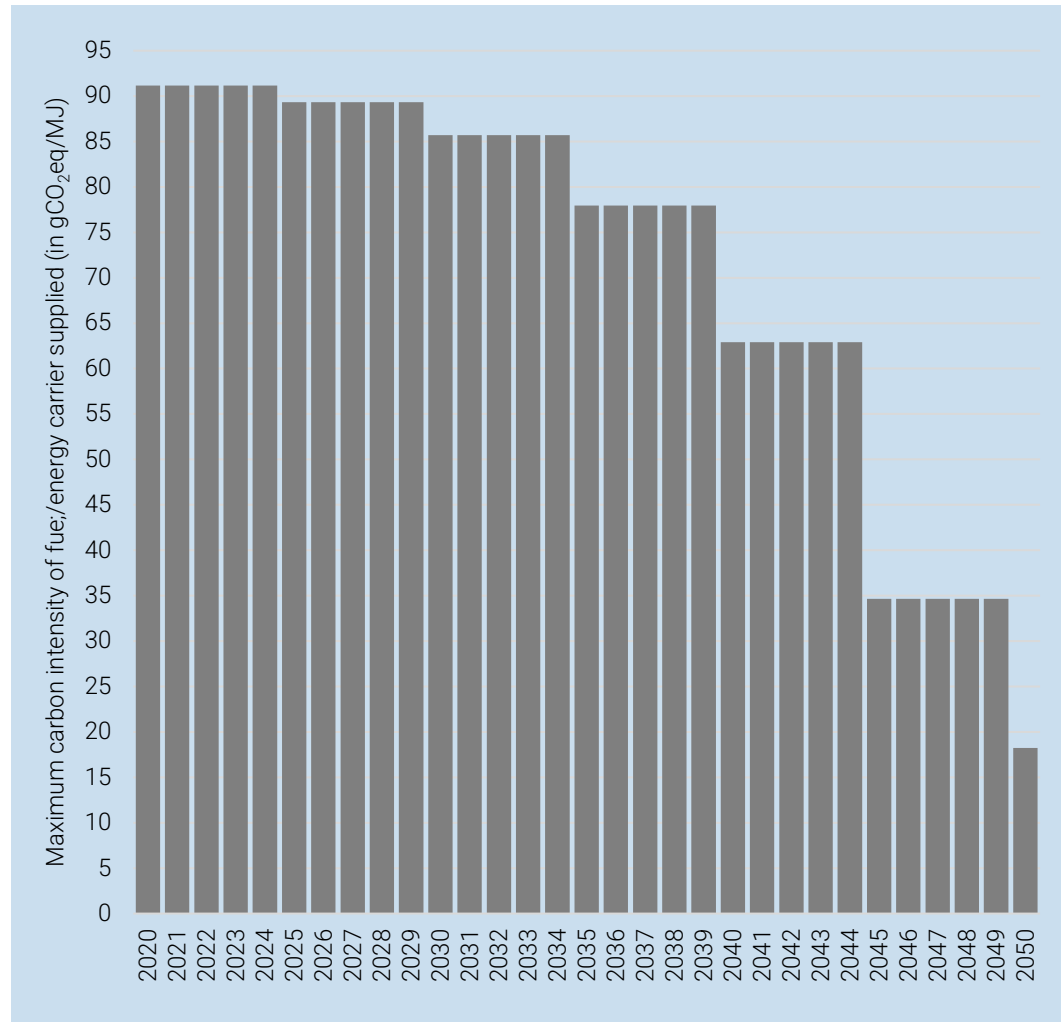
The need for renewable fuels over time in the various transport sectors in EU

The upcoming 2030 targets for the EU Renewable energy directive in comparison to the FuelEU Maritime and ReFuelEU Aviation mandates



Fuel EU Maritime

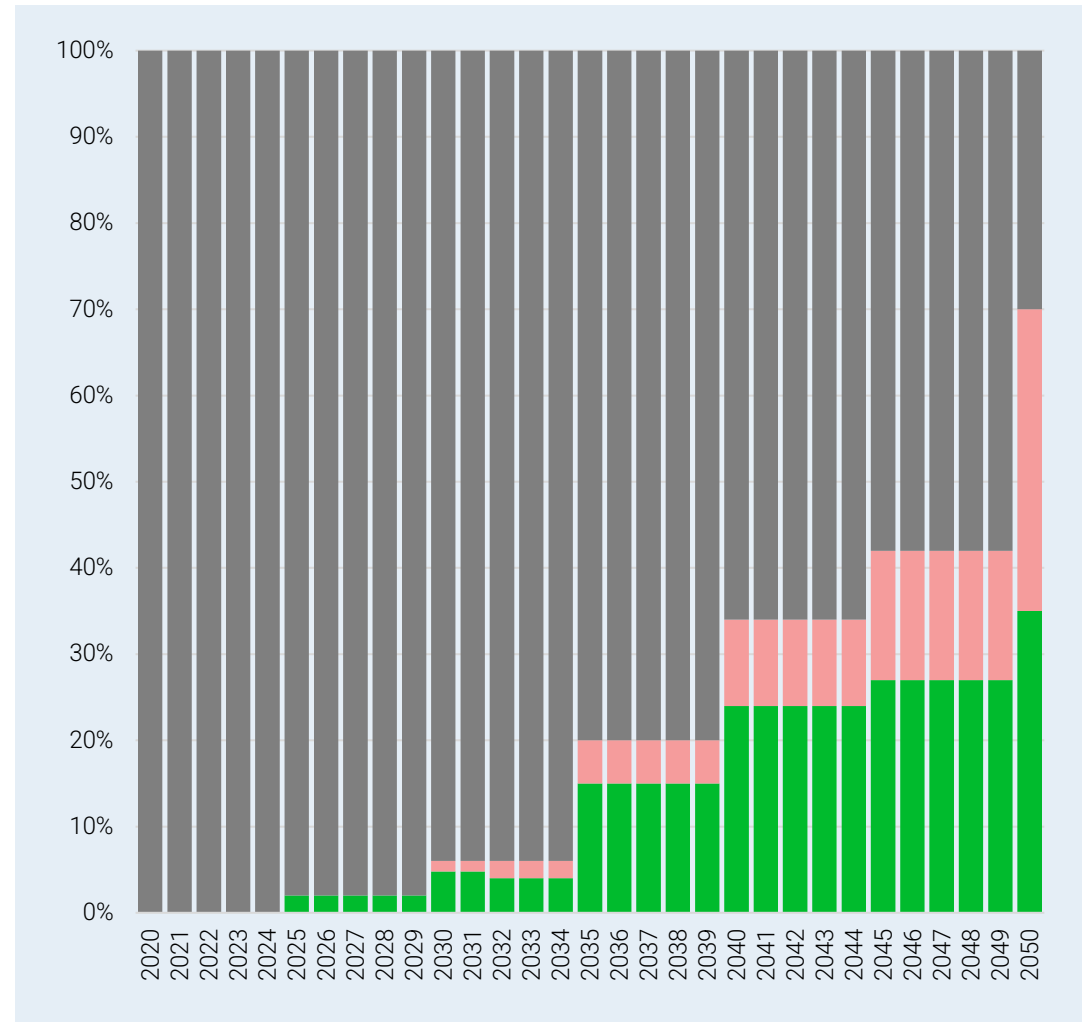
Focus on lowering GHG intensity



Source: EC, 2023, Fuel EU Maritime agreed percentages for carbon intensity reduction.
Reference value of 91,16 gCO₂eq/MJ

ReFuelEU Aviation

Focus on increasing share of SAF

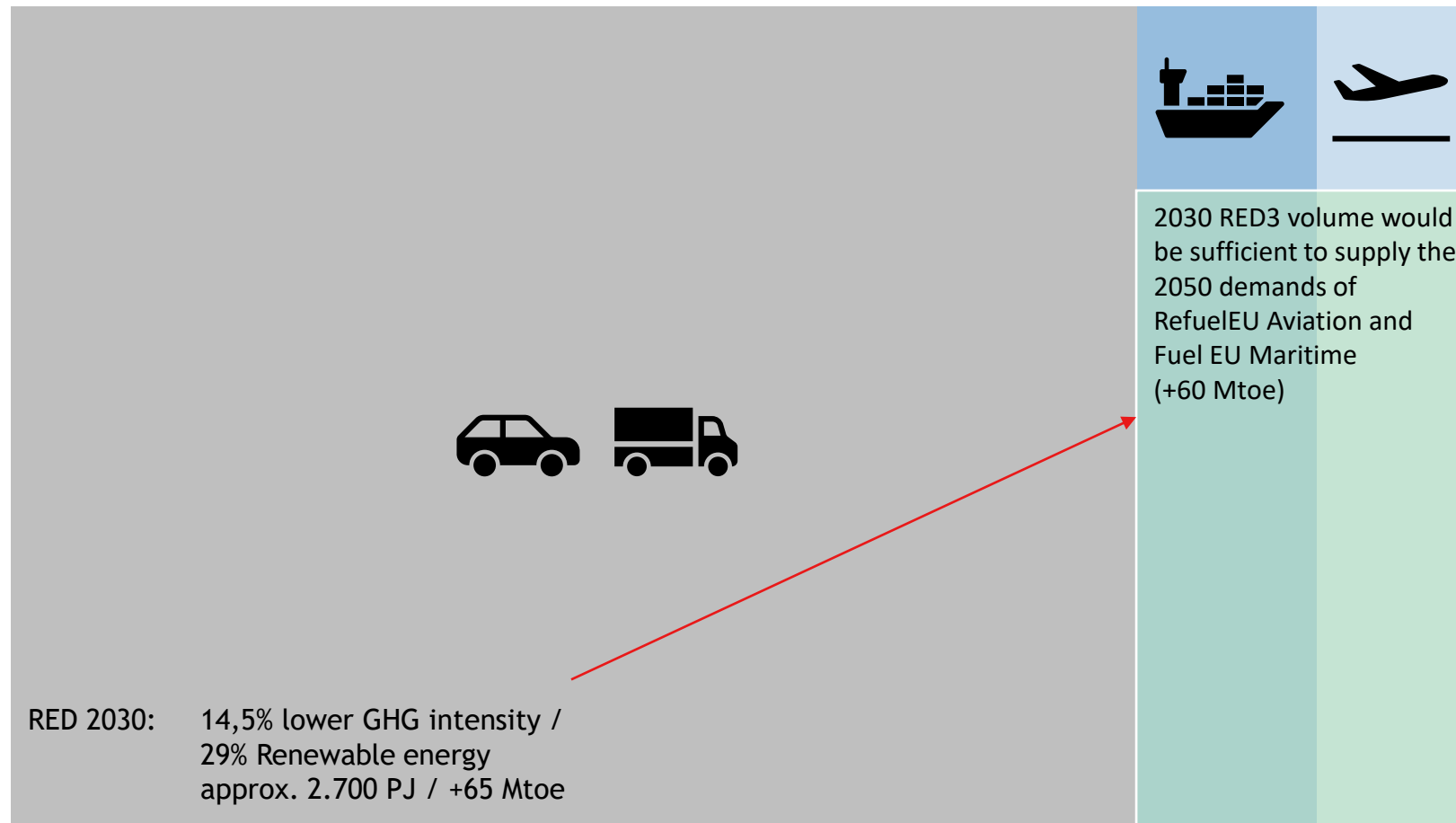


Source: EC, 2023, ReFuelEU Aviation agreed percentages for mandates of SAF to be used in aviation fuel

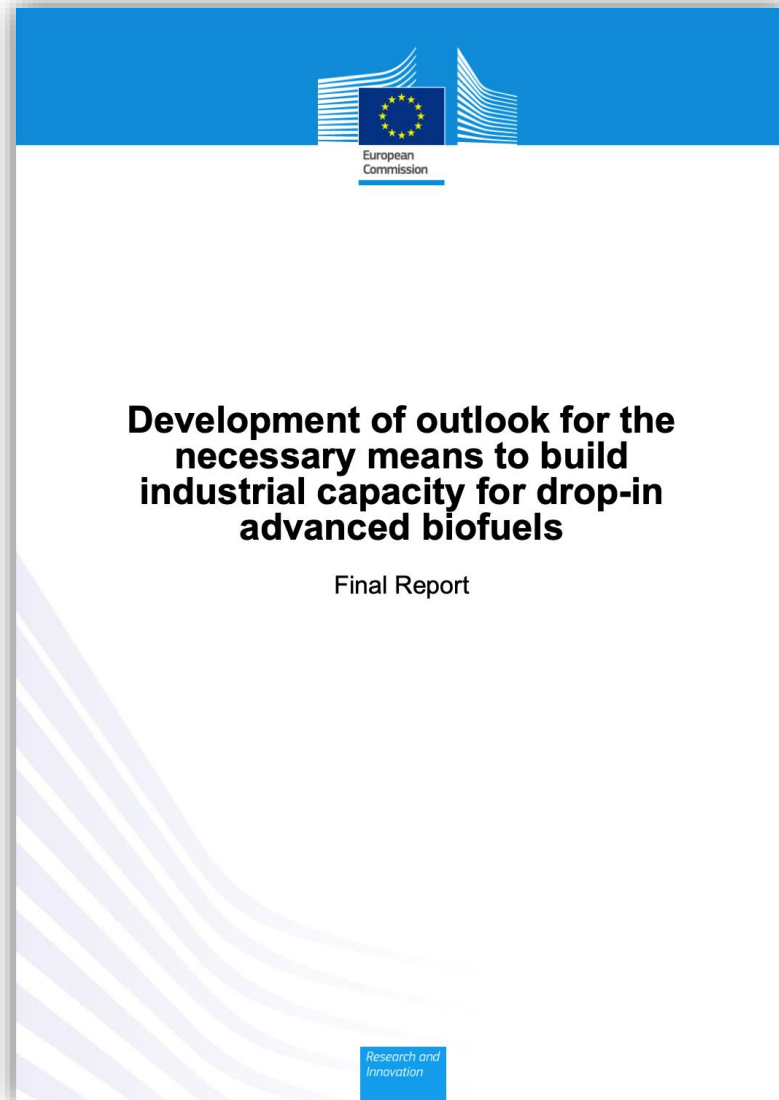
The upcoming 2030 targets for the EU Renewable energy directive in comparison to the FuelEU Maritime and ReFuelEU Aviation mandates



The upcoming 2030 targets for the EU Renewable energy directive in comparison to the FuelEU Maritime and ReFuelEU Aviation mandates



2024 study on outlook advanced biofuel capacity published by EC sheds some light on the required pathways for expanding production capacity



Development of outlook for the necessary means to build industrial capacity for drop-in advanced biofuels

European Commission
Directorate-General for Research and Innovation
Directorate C – Clean Planet
Unit C.2 – Clean Energy Transitions
Contact: Dr. Maria Georgiadou
Email: Maria.Georgiadou@ec.europa.eu
RTD-PUBLICATIONS@ec.europa.eu
European Commission
B-1049 Brussels

Manuscript completed in December 2023
First edition

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PDF	ISBN 978-92-68-09662-8	doi:10.2777/679307	KI-09-23-571-EN-N
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Luxembourg: Publications Office of the European Union, 2024

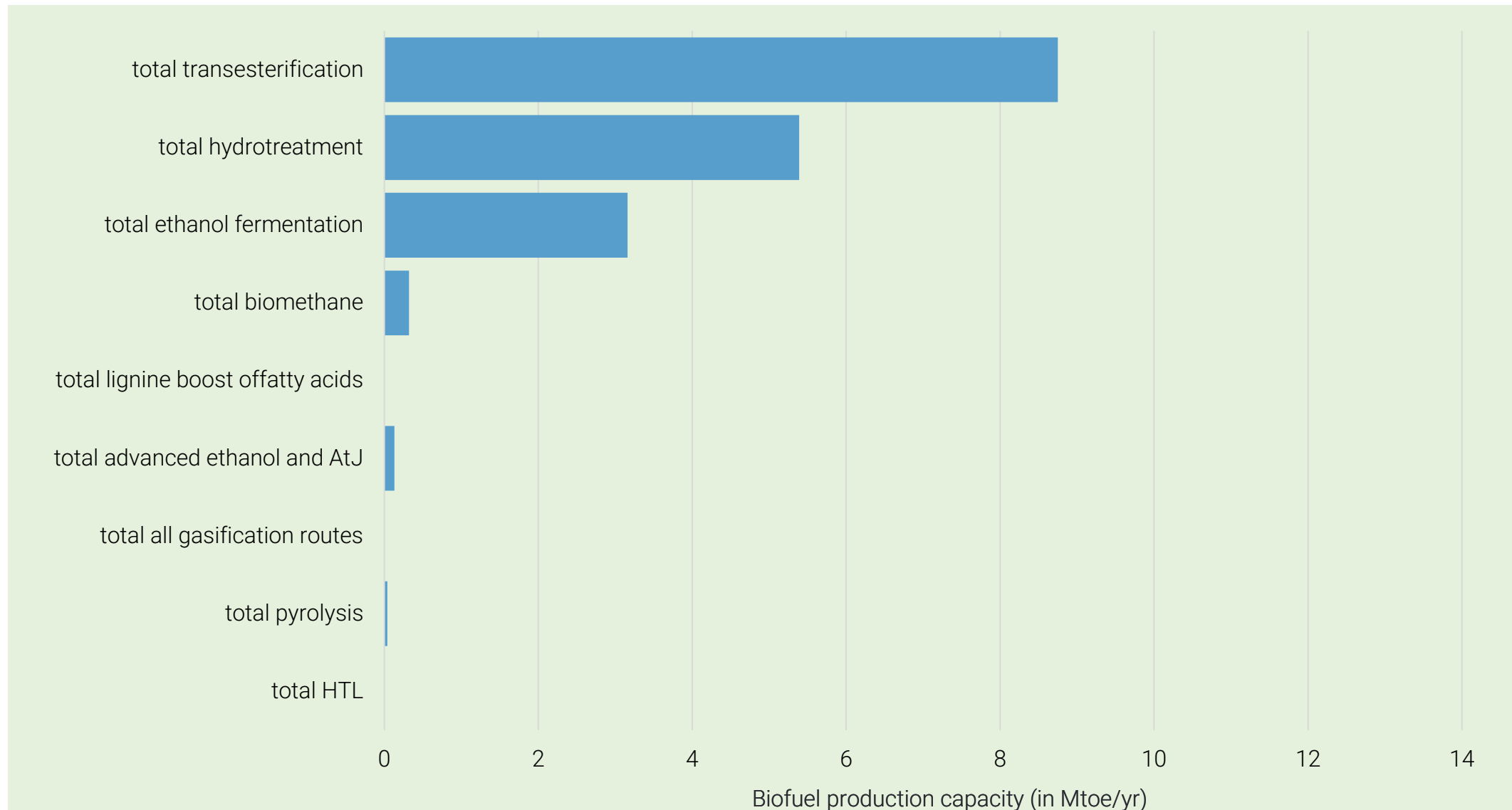
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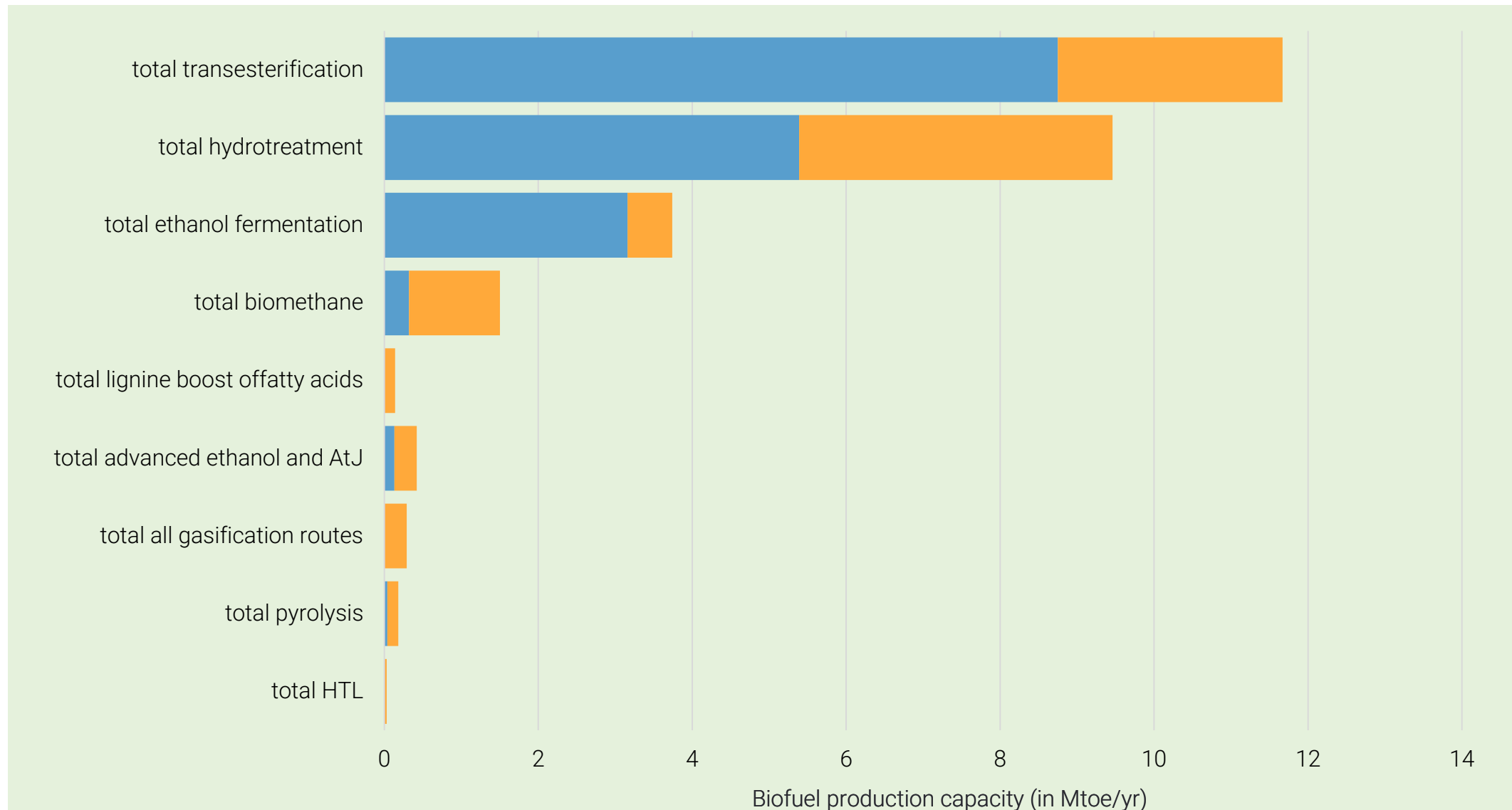
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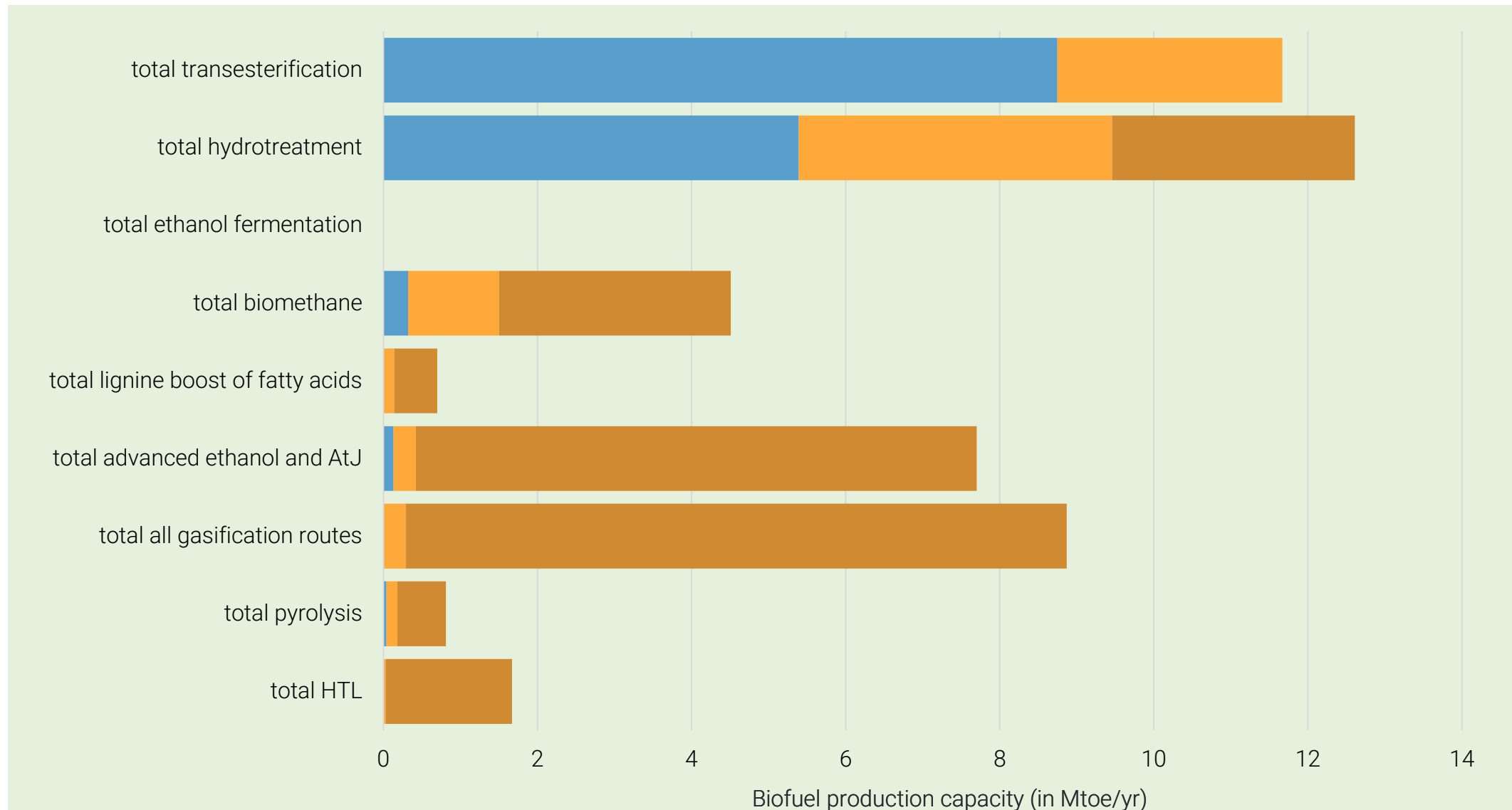
Production capacity for biofuels used in 2023 in EU27



Production capacity for biofuels used in 2023 in EU27



Production capacity for biofuels used in 2023 in EU27 and further development to 2050 (dark orange)



Production capacity for biofuels used in 2023 in EU27 and further development to 2050 (dark orange)

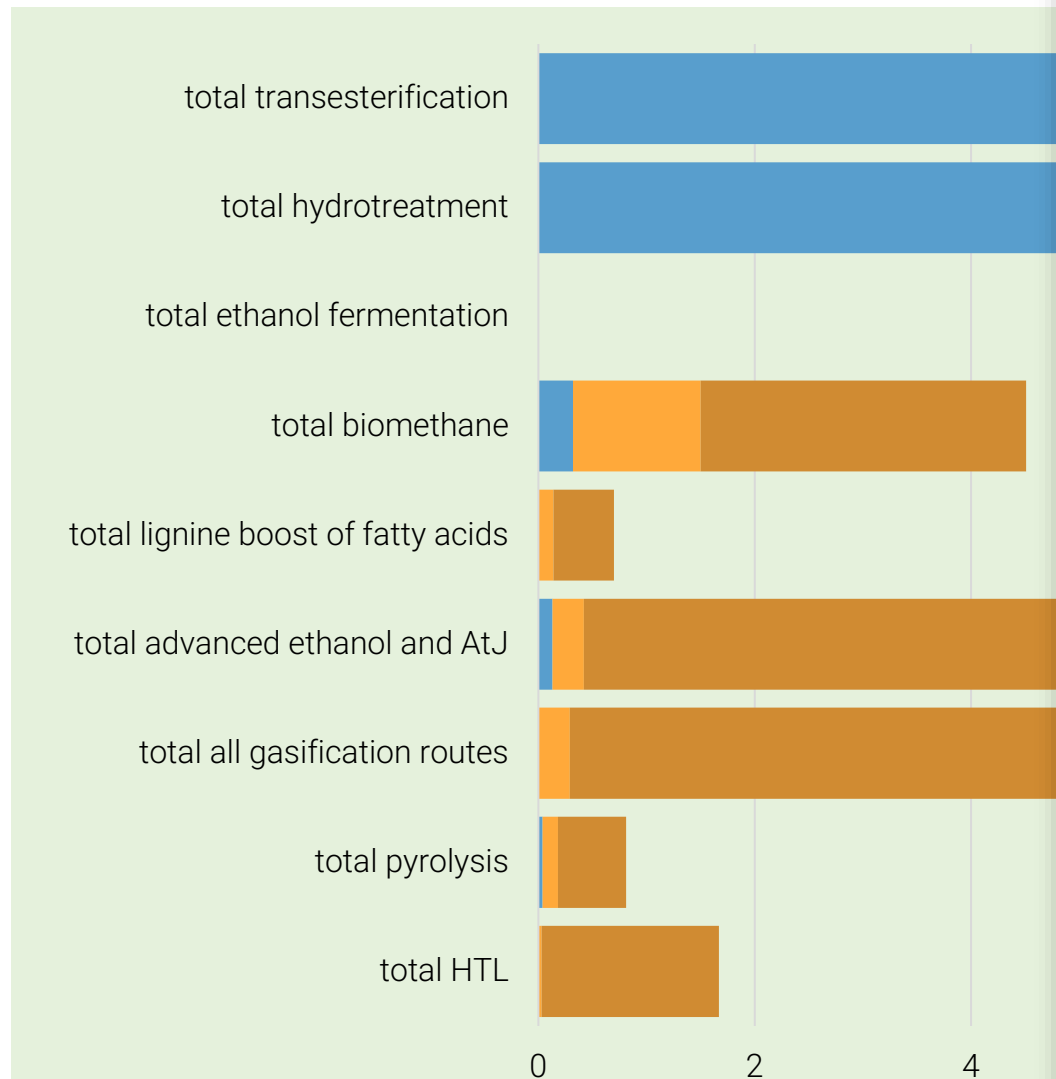
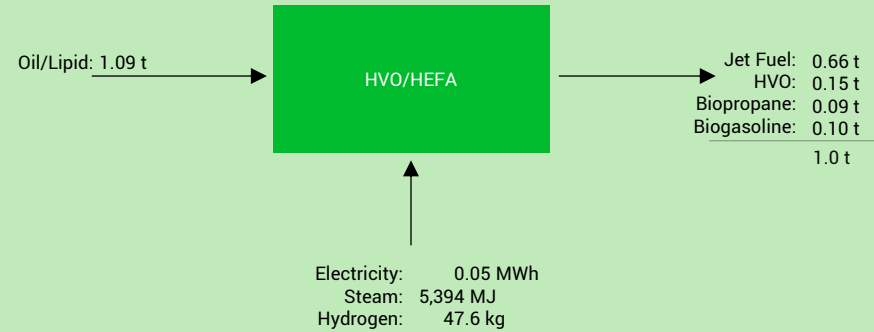


Figure 3-13 Technically possible capacity evolution from Annex IX Part A feedstocks in Mtoe/yr by technology (no allocation to specific sectors)

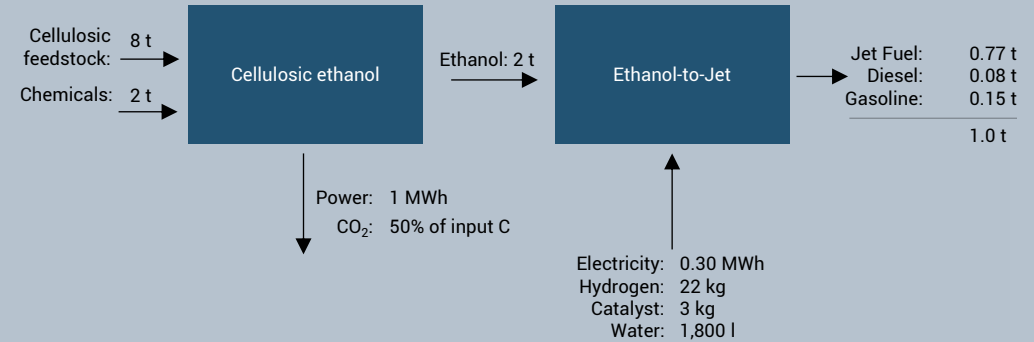
	Capacity 2023	Capacity 2030	Capacity 2050
Current market conditions (cmc)			
Total volume	17.8	27.4	48.5
Conventional	13.0	14.1	10.4
Annex IX Part A	1.7	4.3	26.2
<i>Advanced biofuels</i>	<i>1.4</i>	<i>2.8</i>	<i>21.7</i>
<i>Biomethane</i>	<i>0.3</i>	<i>1.5</i>	<i>4.5</i>
Annex IX Part B	3.1	9.0	12.0
Technically possible capacities (tpc)			
Total volume	17.8	61.1	207.0
Conventional	13.1	21.0	16.9
Annex IX Part A	1.7	30.0	174.3
<i>Advanced biofuels</i>	<i>1.4</i>	<i>28.5</i>	<i>169.7</i>
<i>Biomethane</i>	<i>0.3</i>	<i>1.5</i>	<i>4.5</i>
Annex IX Part B	3.1	10.1	15.9
Capped by feedstock (cbf)			
Total volume	17.8	57.4	129.2
Conventional	13.1	21.1	16.9
Annex IX Part A	1.7	30.3	101.3

Examples of pathway synergies in aviation

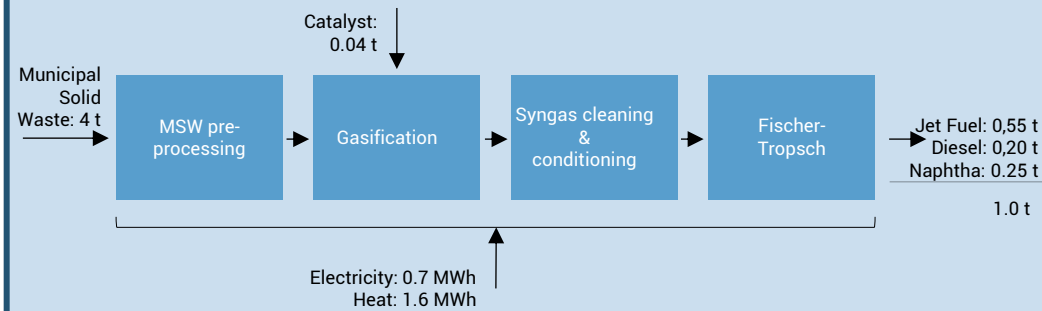
HEFA pathway



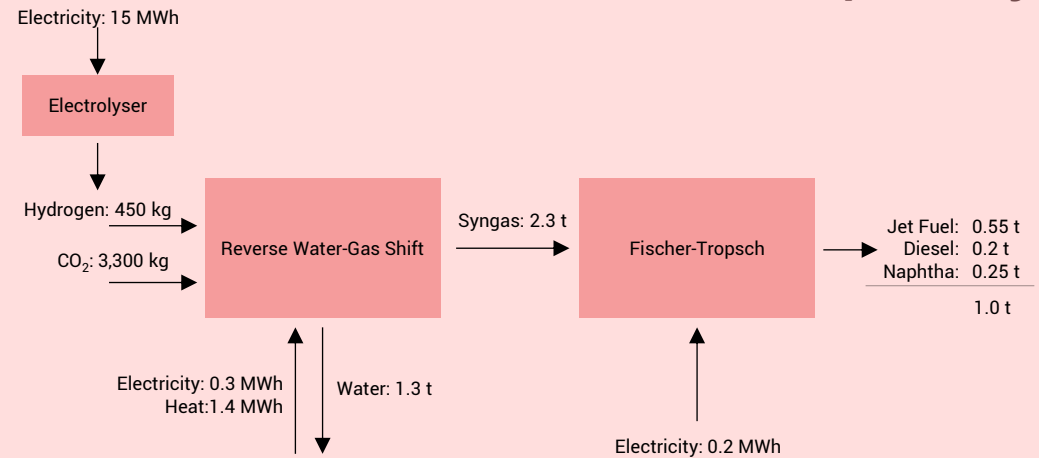
Alcohol to Jet pathway



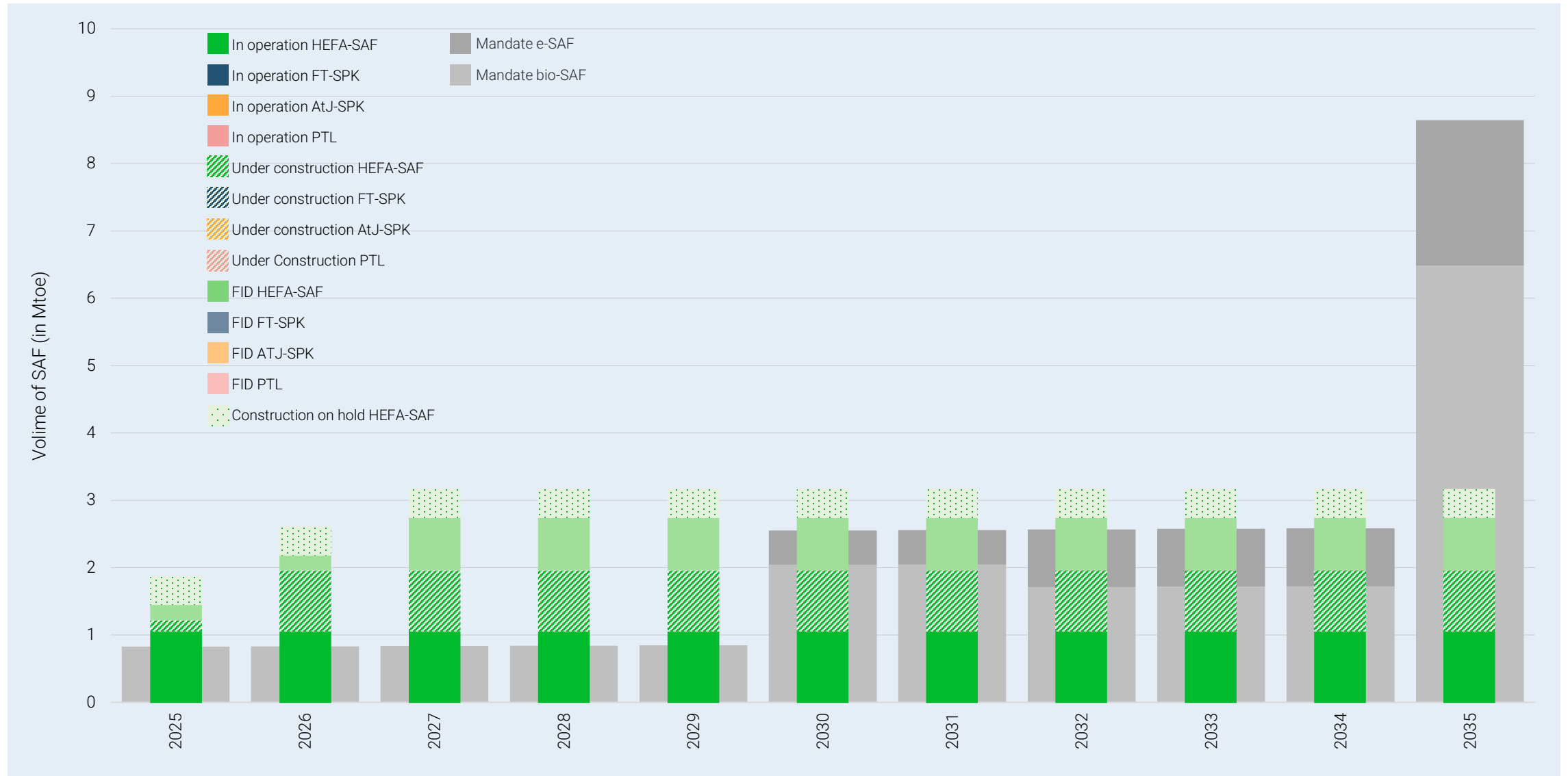
Syngas-FT pathway



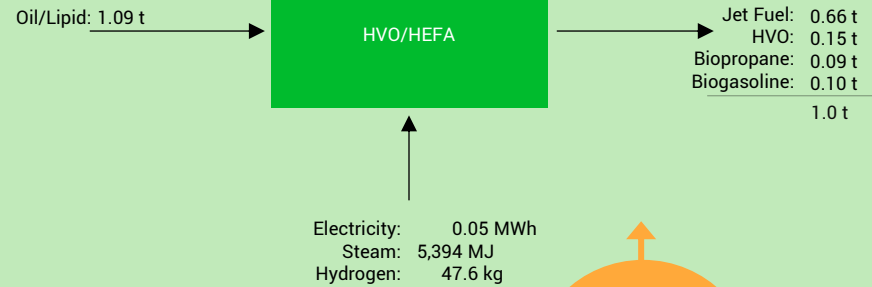
Power to Jet pathway



Production capacity for biofuels used in 2023 in EU27

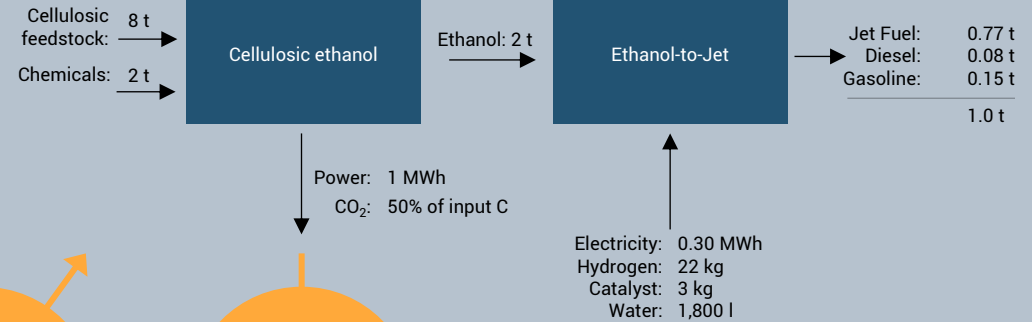


HEFA pathway



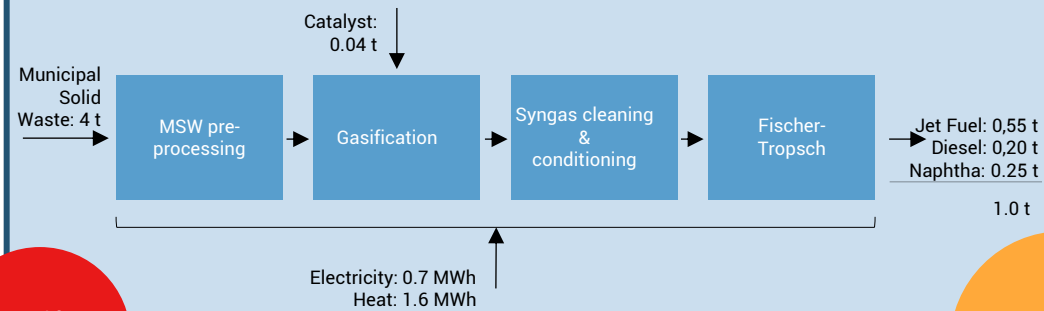
Synergy with HVO in road sector

Alcohol to Jet pathway



Built up capacity ethanol in gasoline

Syngas-FT pathway



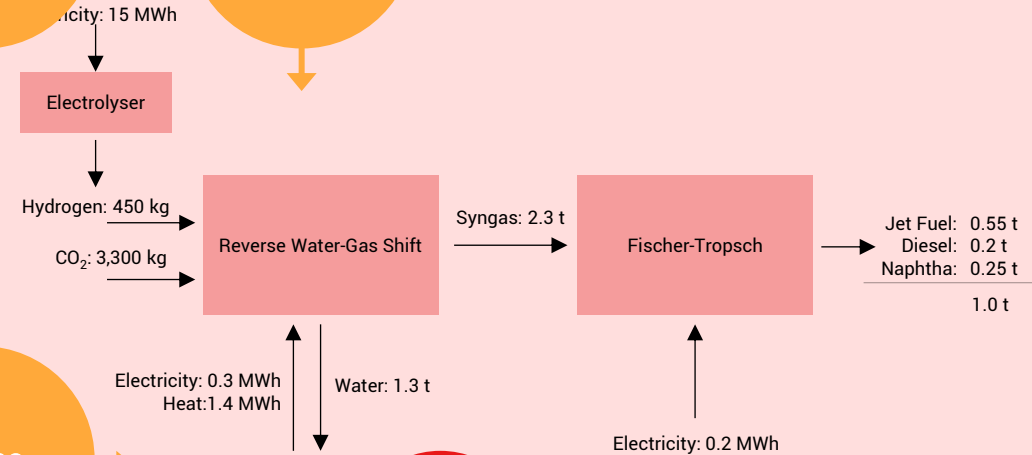
Need for drop-in in road diesel

hydrogen

Feed-stock

Synergy of CO₂

Power to Jet pathway



FT technology

RFNBO use in road

Key take aways

- **Transport sector is 'Achilles heel'** in reaching EU climate goals - and it is behind
- **2030 RED3 renewable energy volumes are much larger** than the 2030 volumes equivalence in FuelEU Maritime and ReFuelEU Aviation
- **2030 RED3** renewable energy volumes are **±4 times larger** than the volumes deployed in **2020**. A rapid scale-up is needed to comply to targets
- Expanded deployment needs to come from electricity, **Advanced Biofuels and RFNBO**
- The advanced production pathways rely on **Annex IX-A (mainly lignocellulosic) wastes**
- The **road sector provides the 'volume'** to establish **scale-up, learning curve and economies-of-scale** for later **deployment in aviation sector** (and maritime)
- Among pathways potential **synergies exist**
- The renewable fuels industry could **benefit** from the **collaborative development** of an **integral, multi-sectors, multi-pathways, investment and innovation agenda** for synergetic production capacity built up, that built up over time and serves these demand sectors, finetuned, in time.

Available for further questions and discussions

Eric van den Heuvel
Technical Coordinator
eric.tc.ieabioenergy@studiogearup.com
+31-683223098



www.ieabioenergy.com