

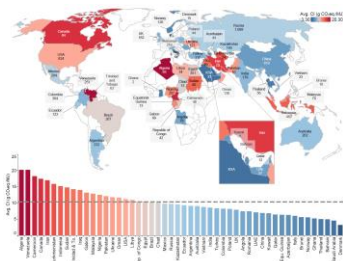


# LCAF and SAF through VO co-processing

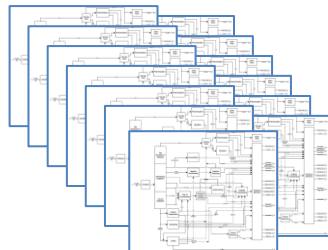
## Quick win options for aviation decarbonization

Dr. Stephane MORIN  
ADNOC Refining - UAE

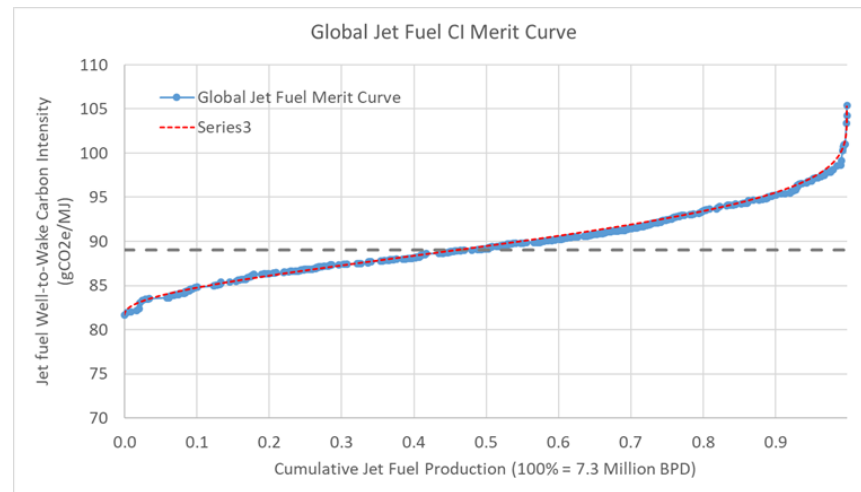
# Jet Fuel CI reference level



Actual refinery  
crude intake CI



409 Refinery LP models to  
estimate jet fuel production CI



*Jet-Fuel Average CI : 89gCO<sub>2</sub>e/MJ*

# LCAF “Definition

**14 CORSIA Sustainability criteria** validated by ICAO in Nov. 2022

“CORSIA SUSTAINABILITY CRITERIA APPLICABLE FOR BATCHES OF CORSIA LCAF PRODUCED BY A CERTIFIED FUEL PRODUCER ON OR AFTER 1 JANUARY 2024”

Theme	Principle	Criteria
<b>1. Greenhouse Gases (GHG)</b>	Principle: CORSIA LCAF should generate lower carbon emissions on a life cycle basis.	Criterion 1.1: CORSIA LCAF will achieve net greenhouse gas emissions reductions of at least 10% compared to the baseline life cycle emissions values for aviation fuel on a life cycle basis.

=> Eligibility criteria

Jet Fuel with a life cycle emission (Carbon intensity) CI < 80.1 gCO<sub>2</sub>e/MJ

=> 10% reduction on Jet Fuel worldwide Average CI (89 gCO<sub>2</sub>e/MJ)

# ... LCAF Sustainability criteria (#2-14)

THEME	PRINCIPLE: Production of CORSIA LCAF should...
2. Carbon Stock	...not be made from feedstock from land/aquatic systems with <b>high biogenic carbon stock</b>
3. Greenhouse gas Emissions Reduction Permanence	...result in <b>permanent emissions reductions</b>
4. Water	...maintain or enhance <b>water quality and availability</b>
5. Soil	...maintain or enhance <b>soil health</b>
6. Air	...minimize <b>negative effects on air quality</b>
7. Conservation	...maintain <b>biodiversity, conservation value, and ecosystem services</b>
8. Waste and Chemicals	...promote <b>responsible management</b> of waste and use of chemicals
9. Seismic and Vibrational Impacts	...minimize <b>seismic, acoustic, and vibrational impacts</b>
10. Human and labour rights	...respect <b>human and labour rights</b>
11. Land use rights and land use	...respect <b>land rights</b> including indigenous and/or customary rights
12. Water use rights	...respect prior formal or customary <b>water use rights</b>
13. Local and social development	...contribute to <b>social and economic development</b> in regions of poverty
14. Food security	...promote <b>food security</b> in food insecure regions

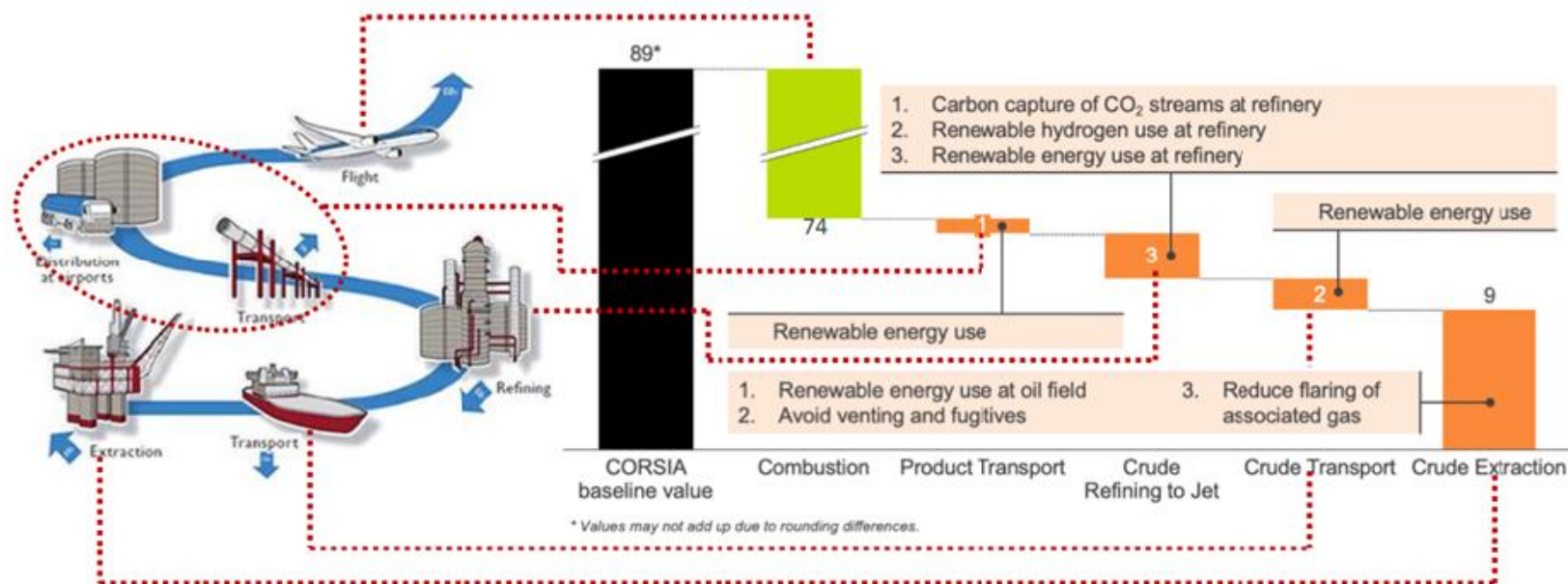
will be assessed by an ICAO approved Sustainability Certification Scheme (SCS)

demonstrated to the SCS by a national attestation from the State

demonstrated to the SCS by the economic operator

# Jet Fuel to LCAF - Mitigation strategies

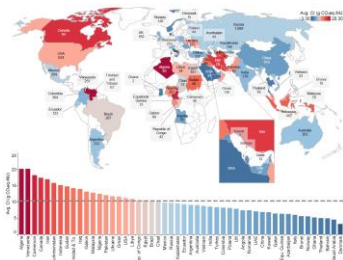
LCAF Carbon intensity is based on carbon management across jet fuel supply chain.



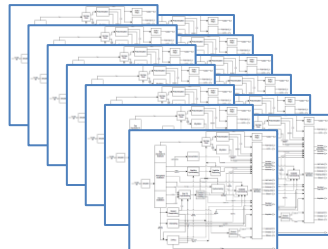
89 gCO<sub>2</sub>/MJ

< 80.1 gCO<sub>2</sub>/MJ

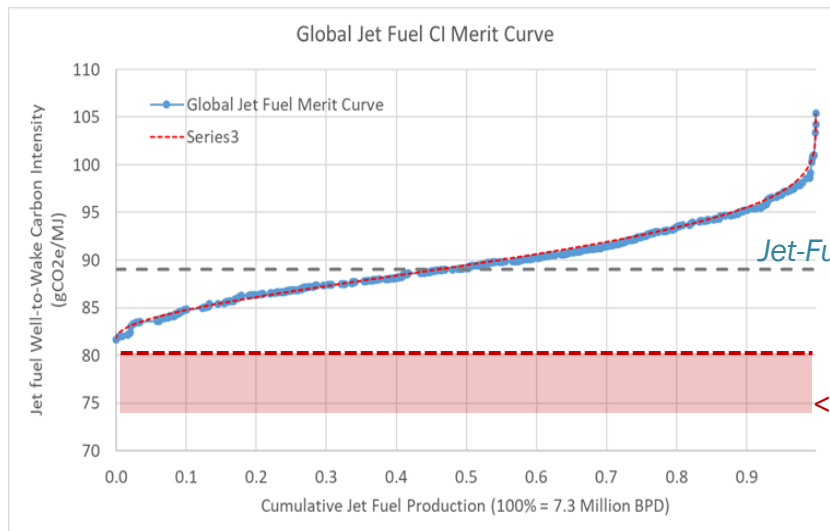
# Jet Fuel CI reference level



Actual refinery crude intake CI



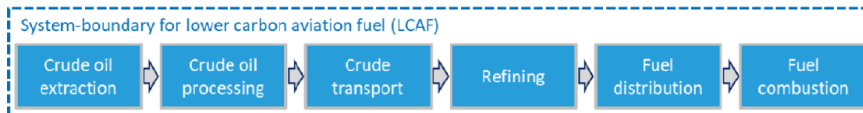
409 Refinery LP models to estimate jet fuel production CI



Jet-Fuel Average CI

LCAF CI  
<80.1 gCO<sub>2</sub>/MJ

# Life cycle emission – LCAF ELIGIBILITY



**CO<sub>2</sub>**  
Life cycle emissions **after**  
deploying measures  
For GHG reduction

**METHANE**  
VFF Emissions :  
CH<sub>4</sub> Venting, Fugitive leak,  
Flaring

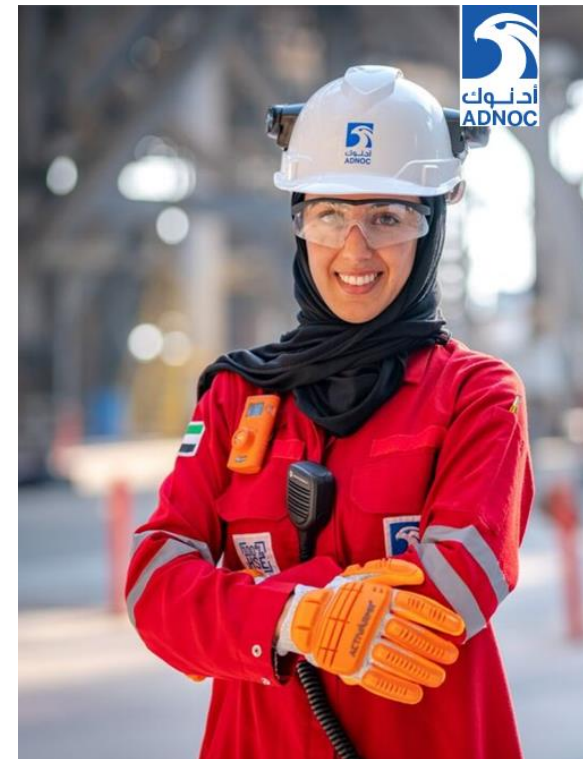
$$\text{LLCAF} = \text{CP} + \text{MP}$$

gCO<sub>2</sub>e/MJ

**LCAF ELIGIBLE if LLCAF =< 80.1 gCO<sub>2</sub>e/MJ**

# On the way to LCAF

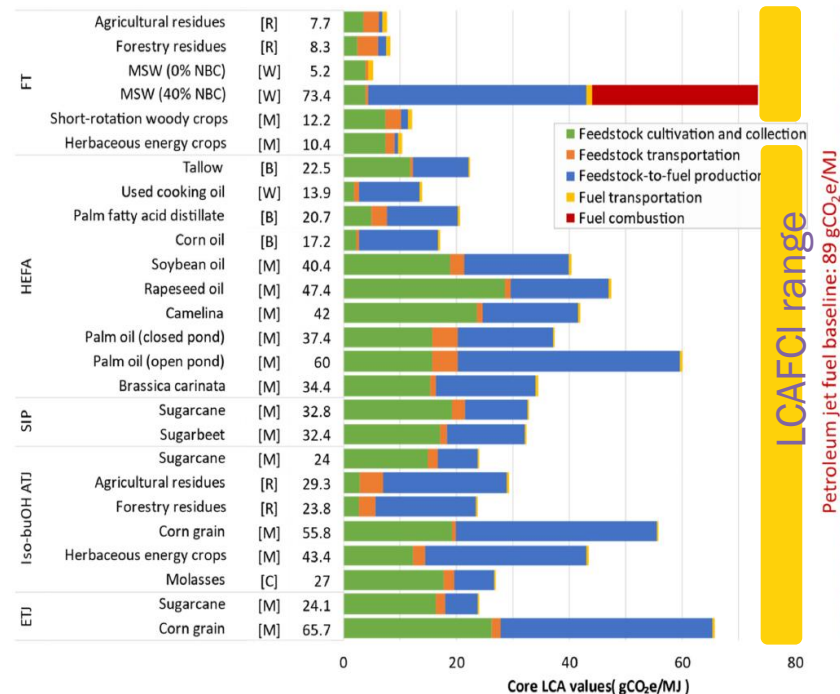
- UAE was the first country in the Middle East and North Africa region to announce a net zero strategic initiative by 2050 in line with requirements set out in the Paris Agreement
- ADNOC targets “Net zero” by 2045 and will decrease its GHG intensity by 25% by 2030.
  - ADNOC has allocated \$23 billion for landmark decarbonization projects, technologies, and lower-carbon solutions
  - Includes investments to grow domestic and international carbon management platforms, supporting the decarbonization journeys of both ADNOC and customers.
  - Already one of the least carbon-intensive energy producers in the world
- **Actions that benefit ADNOC Jet-Fuel Carbon intensity reduction**
  - Focus on Venting/Flaring/Fugitives minimization
  - 100% of ADNOC’s grid electricity from **Solar and Nuclear**
  - Ongoing project to decarbonize off-shore operations using decarbonized electricity instead of gas turbine generators
  - Ambition to strongly expand capacity of our Carbon Capture, Utilization and Storage (CCUS)





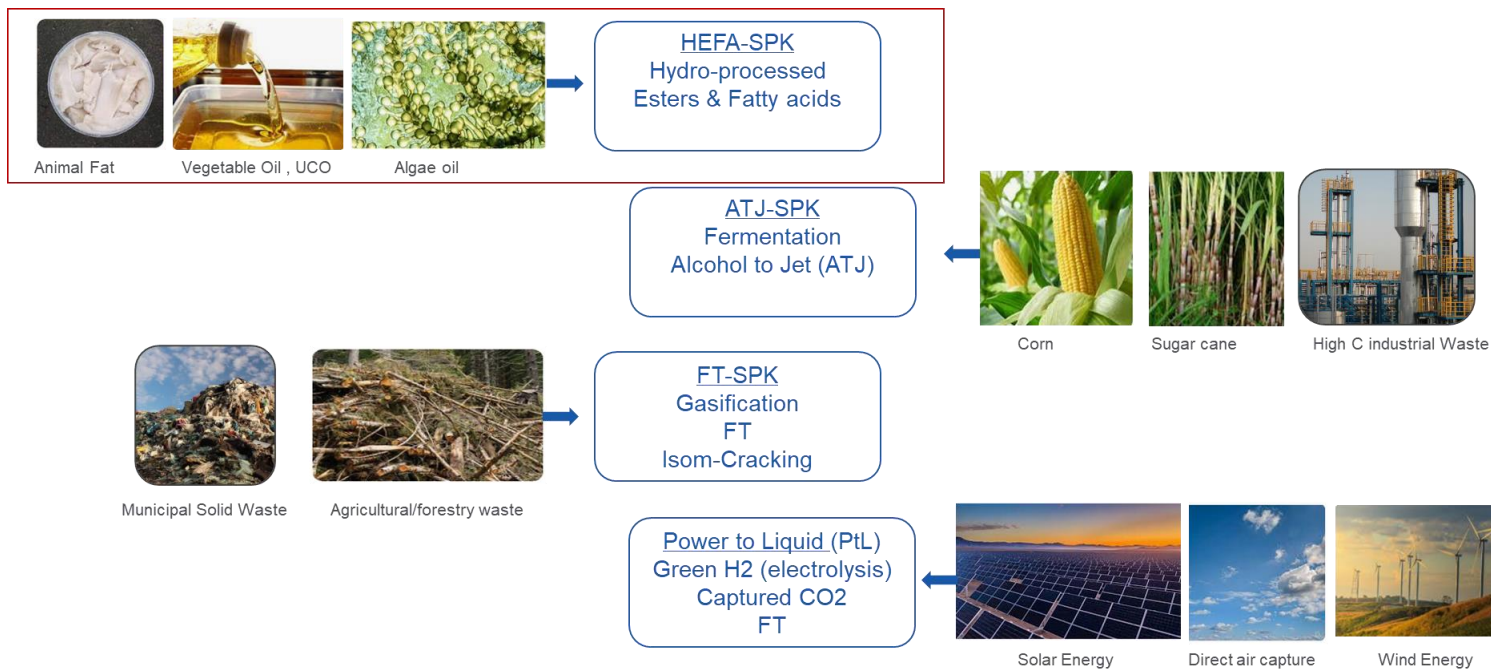
# On the way to LCAF

- Many oil producers/refiners are already engaged in Emission's reduction
- Technologies/practices are available
- Need : Certification scheme to be available Under preparation by ISCC
- Emission's reduction potential impact
  - Replacement of 50% of Jet-Fuel by LCAF is equivalent to having 9% of SAF at 30 gCO<sub>2</sub>e/MJ*
  - ≅ 50 Millions MT CO<sub>2</sub>e/y*



ILUC values not included

# SAF production PATHWAYS



# HEFA-SPK



SAF production unit  
from 100% VO feedstock

or



Kerosene Hydrotreater Unit

# VO co-processing

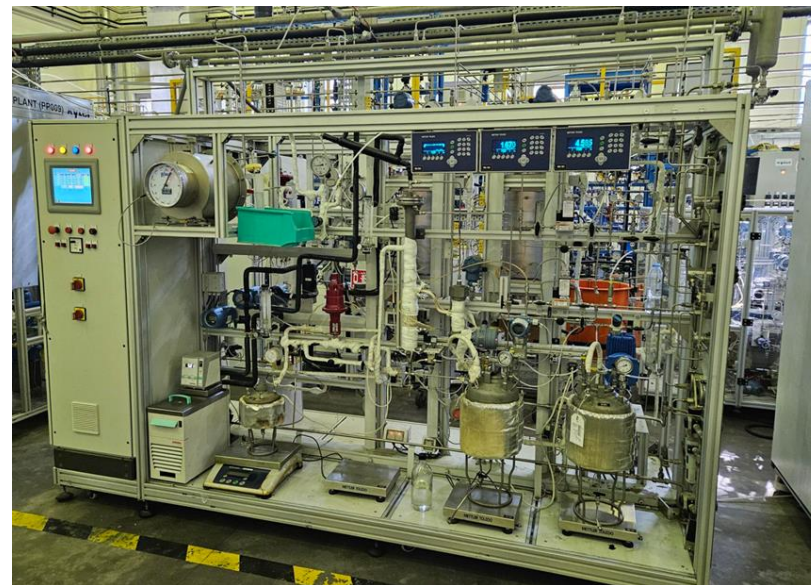
1. Access to bio-feedstock (vegetable oil, UCO, animal fat)
2. Feedstock quality evaluation (contaminants, ...)
3. VO conversion testing at pilot plant scale (process conditions evaluation)

Parameter	Test method	Unit	VEGETABLE OIL 1	VEGETABLE OIL 2
Density @ 15° C	ASTM D4052	kg/L	0.9178	0.9236
ASTM Colour	ASTM D6045		2.3	1.7
Total Sulphur	ASTM D2622	mg/kg	3	2.2
Total Nitrogen	ASTM D4629	mg/kg	12	3
Bromine Number	ASTM D1159	mg/100g	41	68
<b>Metals</b>				
Fe	ICP OES	ppm	2	1
Na			<1	171
K			<1	1
Ca			<2	<2
Mg			<1	<1
Al			<1	<1
Zn			<1	<1
Si			<1	2
P			6	85
Sn			3	22
Total Chloride	XRF		6	-
Pour Point	ASTM D 5949	° C	+21	-
Total Acid Number	ASTM D 664	mgKOH/g	0.45	0.75
Water content	ASTM D 2709	%vol	No Free water	No Free water
Free Fatty Acids as Oleic Acid	AOCS Ca 5a-40	%	0.34	0.28
Insoluble Impurities	AOCS Ca 3-46	%	0.05	0.21
Unsaponifiable matter	AOCS Ca 6a-40	%	0.25	0.43

# VO co-processing

1. Access to bio-feedstock (vegetable oil, UCO, animal fat)
2. Feedstock quality evaluation (contaminants, ...)
3. VO conversion testing at pilot plant scale (process conditions evaluation)

....



# VO co-processing

....

4. Product Quality Certification
5. Sustainability Certification
6. Transport of VO
7. Refinery processing
8. Marketing

## D1655 – 22a

TABLE A1.1 Extended Requirements of Aviation Turbine Fuels Containing Co-hydroprocessed Esters and Fatty Acids or Fischer-Tropsch Hydrocarbons<sup>A, B</sup>

Property	Jet A or Jet A-1		Test Methods <sup>C</sup>	
	Reference	Alternative	Jet A or Jet A-1	Reference
THERMAL STABILITY <sup>M</sup> <sup>E</sup> (2.5 h at control temperature of 280 °C min) Filter pressure drop, mm Hg	max	25	D3241/IP 323	
Tube rating: One of the following requirements shall be met <sup>F</sup>				
(1) Annex A1 VTR, VTR Color Code	Less than	3 No peacock or abnormal color deposits		
(2) Annex A2 ITR or Annex 3 ETR, nm average over area of 2.5 mm <sup>2</sup>	max	85		
Viscosity <sup>G</sup> -40 °C mm <sup>2</sup> /s <sup>G</sup>	max	12.0	D445/IP 71, Section 1 <sup>H</sup>	D7945
Freezing point °C		Table 1 freezing point limits apply	D5972/IP 435	D7153/IP 529 or D7154/IP 528
Unconverted esters and fatty acids, mg/kg <sup>I</sup>	max	15	D7797/IP 583 <sup>J</sup>	

**Certificate**  
according to the  
**Renewable Energy Directive (RED II)**

(Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources (recast))

**Certificate Number: EU-ISCC-Cert-IT206-2053**

RINA Services S.p.A.  
Via Corsica, 12 16128 Genova ITALY  
certifies that

**Abu Dhabi Oil Refining Company (TAKREER) - TA ADNOC REFINING**

Al Rubban Street, Al Ruwais Industrial City 971 Abu Dhabi UNITED ARAB EMIRATES

complies with the requirements of the certification system  
**ISCC-EU**  
(International Sustainability and Carbon Certification)  
and the requirements of the RED II.

Place of the audit  
(if different from the legal address of the system user as stated above, only applicable for traders and traders with storage):  
n.a.

**This certificate is valid from 08.08.2023 to 07.08.2024**

The site of the system user is certified as:  
Co-Processing plant

**Certificate**  
according to the  
**Carbon Offsetting and Reduction Scheme for International Aviation (CORSA)**  
As developed by the International Civil Aviation Organization (ICAO)

**Certificate Number: ISCC-CORSIA-PLUS-Cert-IT206-22**

RINA Services S.p.A.  
Via Corsica, 12 16128 Genova ITALY  
certifies that

**Abu Dhabi Oil Refining Company (TAKREER) - TA ADNOC REFINING**

Al Rubban Street, Al Ruwais Industrial City 971 Abu Dhabi UNITED ARAB EMIRATES

complies with the requirements of CORSA and the certification system  
**ISCC-CORSIA PLUS**  
(International Sustainability and Carbon Certification)  
which is approved by the ICAO Council.

**This certificate is valid from 08.08.2023 to 07.08.2024**

The site of the system user is certified as:  
Co-Processing plant

# Conclusion

- **The FUEL is a key player on the way to a more SUSTAINABLE Aviation industry**
- **Any Emission Reduction is welcome**
- **LCAF & SAF from VO co-processing are good options for supporting Aviation industry decarbonization with a short timing**



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**Thank you for your  
attention!**

