



Ruta HEFA

HYDROFLEX™ & H2BRIDGE™

TOPSOE

II CONGRESO PANAMERICANO DE SAF

ROSARIO, ARGENTINA
AGOSTO 2025

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Technology Licensing Manager

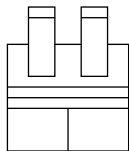
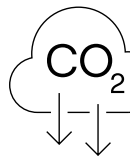


PRESENTATION AGENDA

1	ABOUT TOPSOE
2	HYDROFLEX™: TOPSOE'S HEFA TECHNOLOGY
3	HYDROFLEX™ REFERENCES
4	HYDROFLEX™ AND H2BRIDGE™ INTEGRATED SOLUTION
5	HYDROGEN REFERENCES
6	TAKE HOME MESSAGES

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TOPSOE AT A GLANCE: OVER 80 YEARS OF INNOVATION AND LEADERSHIP

Topsoe is a leading global provider of advanced technology and solutions for the energy transition. Built on decades of scientific research and innovation, we are working with customers and partners to drive energy resiliency and to achieve their sustainability goals. We offer world-leading solutions for transforming renewable resources into fuels and chemicals, and we provide technologies needed to produce low-carbon and conventional fuels and chemicals as well as ensuring clean air. We were founded in 1940 and are headquartered in Denmark, with over 2,800 employees serving customers all around the globe.	H-INDEX 178 Our H-index is 178 with more than 1,800 scientific publications since 1950	 Topsoe is headquartered in Denmark Locations: Edmonton, Los Angeles, Houston, Mexico City, Washington DC, Frederikssund, Heming, Copenhagen, Essen, Manama, Khobar, Beijing, Seoul, Shanghai, New Delhi, Chennai, Kuala Lumpur, Jakarta, Rio de Janeiro, Buenos Aires, Perth.			
	1/3 H_2 of hydrogen molecules are produced using Topsoe technology	 We started production in our industrial-scale Solid Oxide Electrolyzer Cell factory in Heming Denmark.	1/3 of the current renewable diesel and SAF operating capacity is based on Topsoe technology*	 Driven by innovation, we invested DKK 745 million in R&D in 2024.	 We aim to reach Net Zero across scope 1, 2 and 3 in 2040

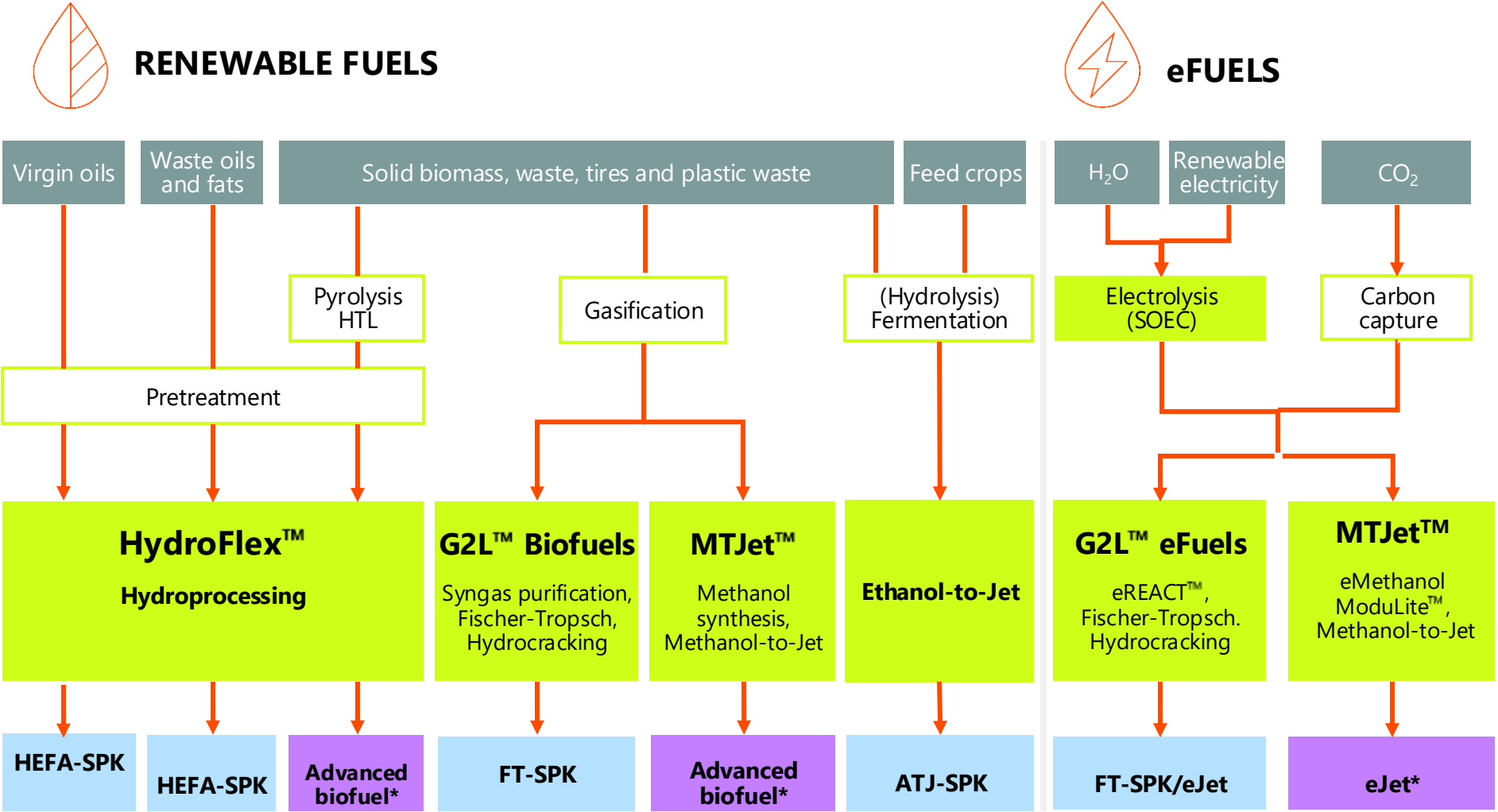
A HISTORY OF TAKING ON SOME OF THE WORLD’S TOUGHEST CHALLENGES

1940 Dr. Haldor Topsøe founds the company based on his passion for science and determination to make a positive difference in the world.		1980s Acid rain threatens environment and biodiversity Topsoe technology removes 18 million tons of sulfur oxides every year.		2000s Changing the fuels landscape through optimized solutions Topsoe's new diesel technology is the most yield-optimized solution on offer.	
1950s Growing populations put pressure on food supply Topsoe's ammonia technology produces fertilizer to help feed the growing world population.		1990s Air pollution threatens environmental stability and public health Topsoe solutions to ensure cleaner air remove hazardous particles, greenhouse gases, and smog from industrial emissions.		2020s Decarbonizing the energy-intensive industries and long-distance transportation Topsoe solutions support all phases of the energy transition.	

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SAF PATHWAYS -
TOPSOE PORTFOLIO

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

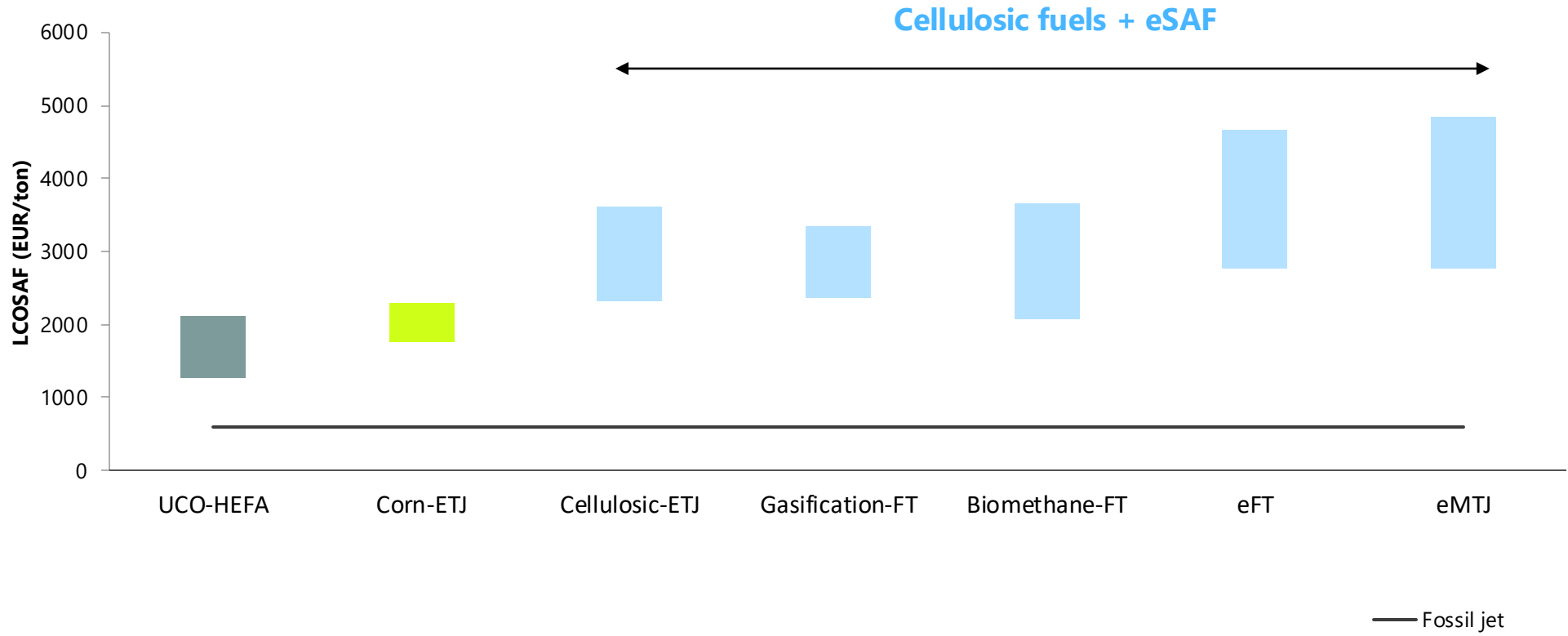


*Not approved ASTM pathways yet

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

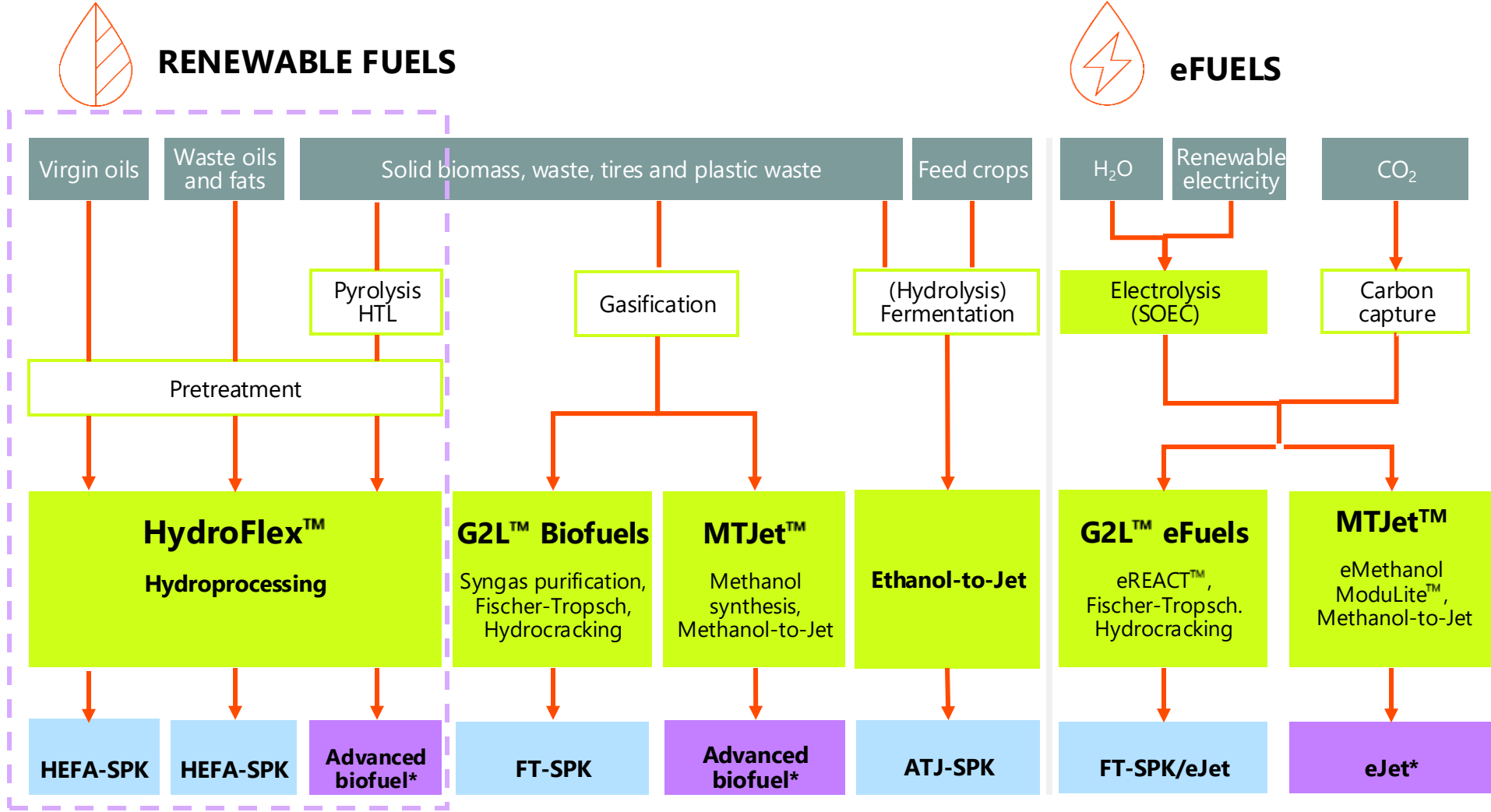
SAF IS AND WILL REMAIN MORE EXPENSIVE THAN FOSSIL JET FUEL AND **FEEDSTOCK** IS THE MAIN COST CONTRIBUTION

LEVELIZED COST OF SAF (LCOSAF)
EUR/TON SAF



SAF PATHWAYS -
TOPSOE PORTFOLIO

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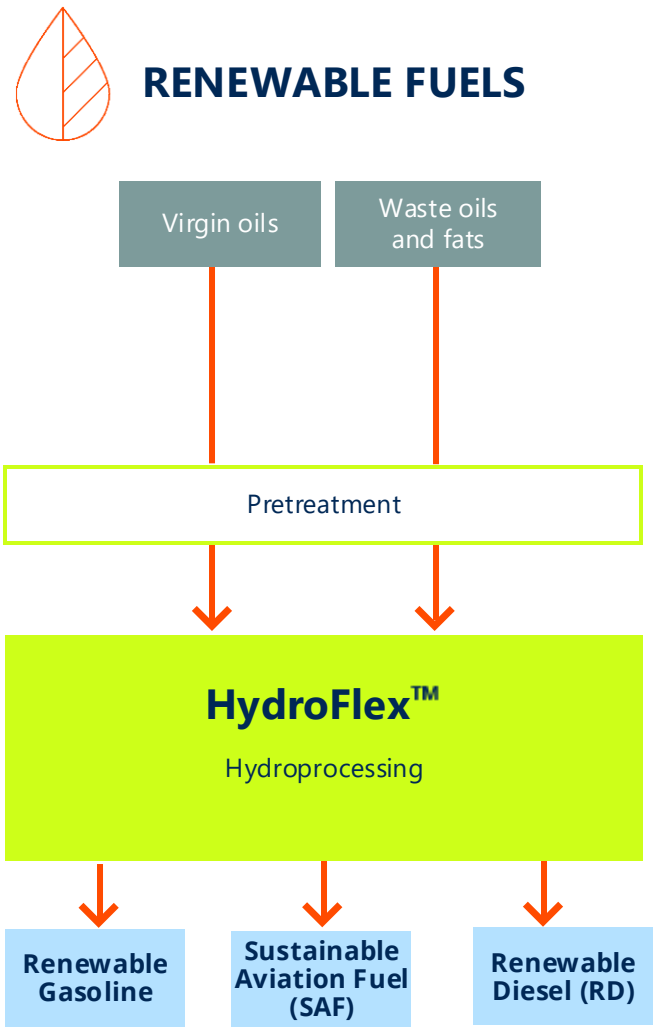


*Not approved ASTM pathways yet

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

TOPSOE HAS
DEVELOPED THE
BEST ROUTE
FOR RD/SAF

- Feed
- Process
- Process (Topsoe)
- Products





TOPSOE

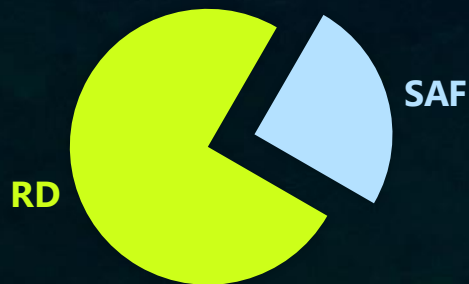
Topsoe designs flexible units for sustainable aviation fuel and/or renewable diesel

Continuously developing catalysts + technology



RD

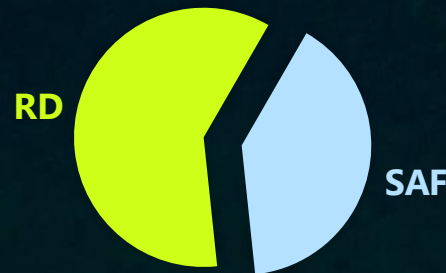
13 running references



RD

SAF

2 running references, incl.



RD

SAF

34 licensed units



RD

SAF



or SAF only

4 licensed units



HYDROFLEX™

THE NECESSARY PROCESS STEPS TO CONVERT TRIGLYCERIDES INTO RD/SAF



Feedstock



HDO

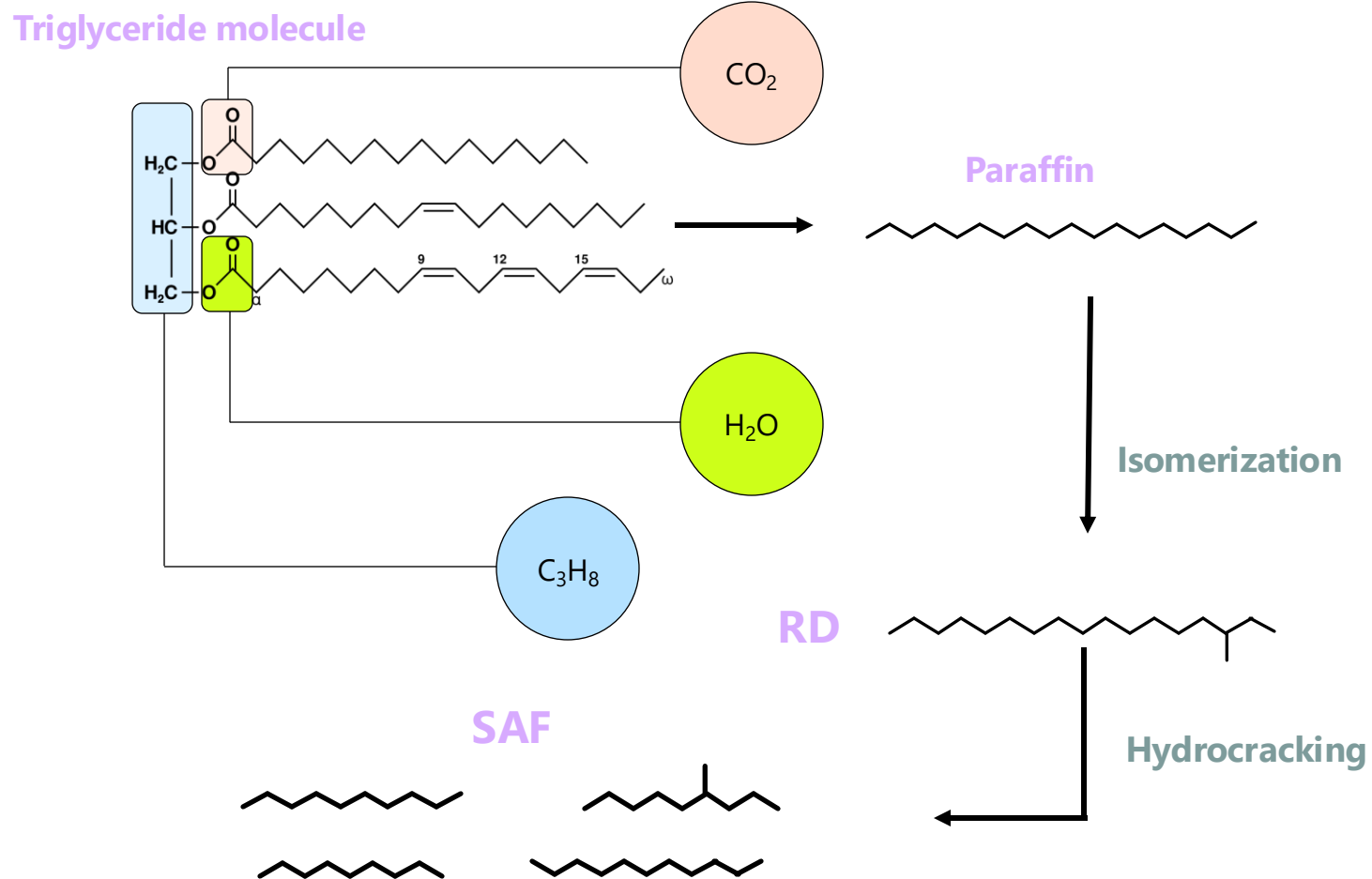
Removal of propane
back-bone and oxygen



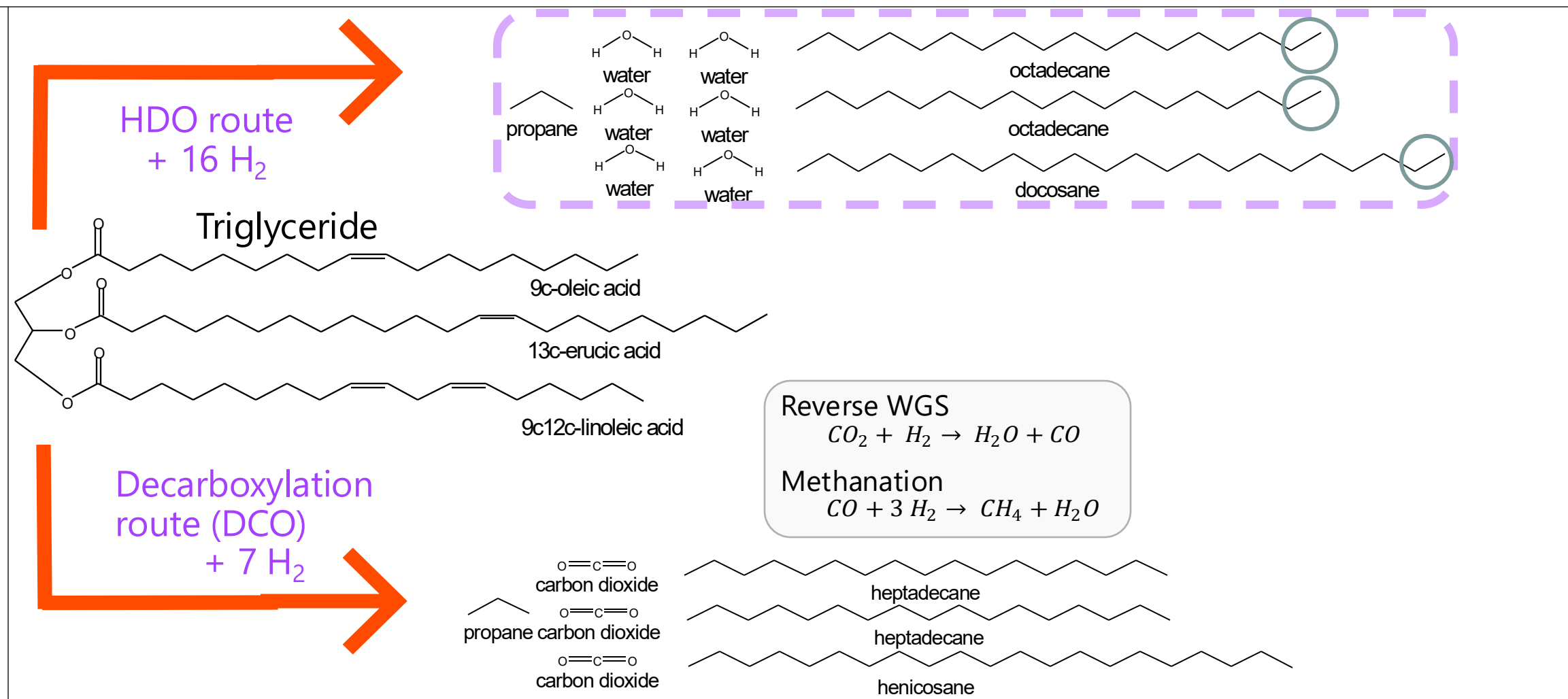
Dewaxing



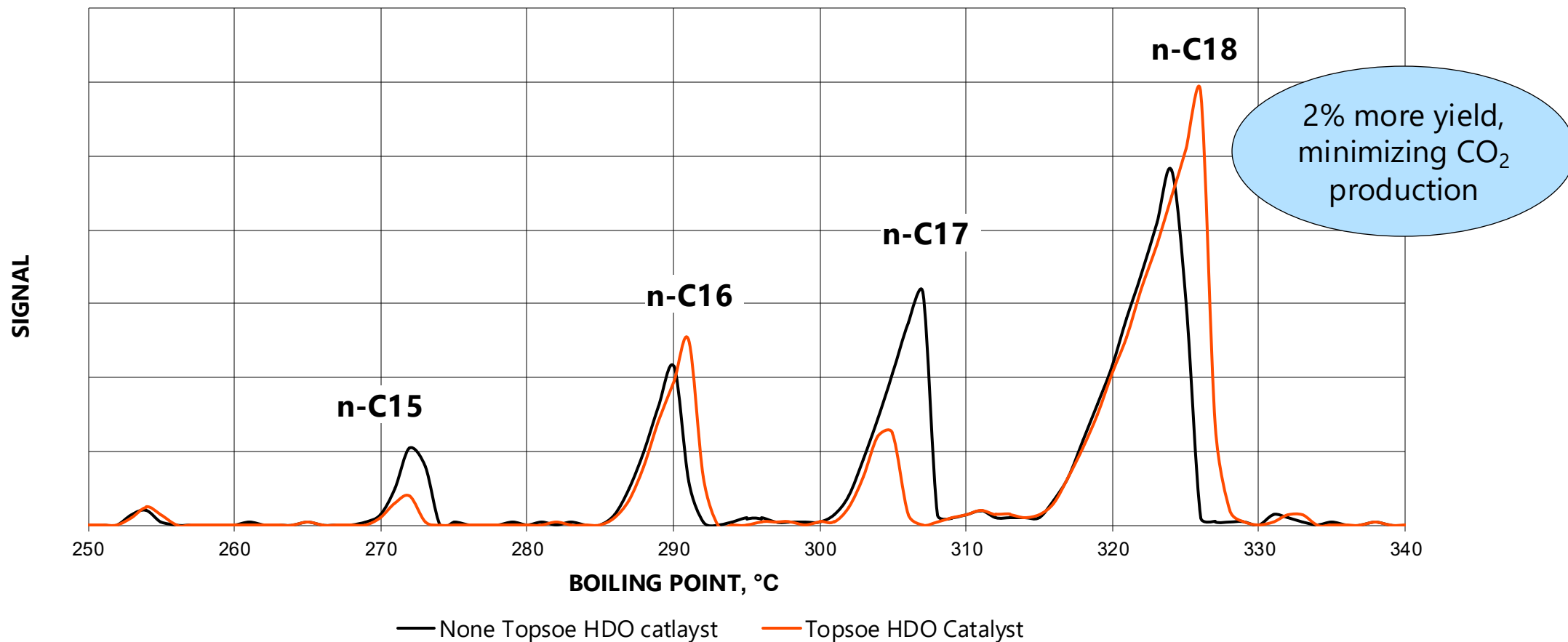
EP reduction



HDO SECTION – MAIN REACTION PATHWAYS

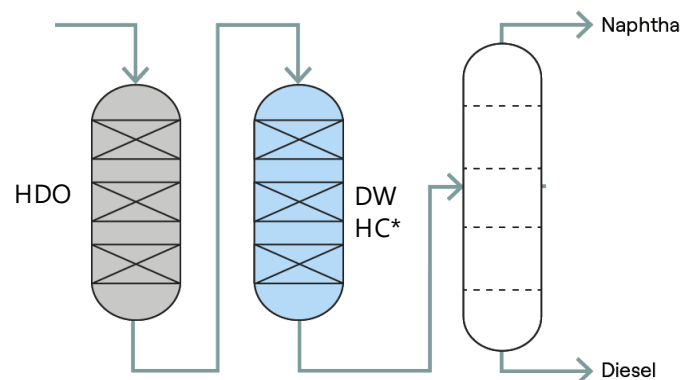


DIFFERENCE IN SELECTIVITY IS CONFIRMED INDUSTRIALLY

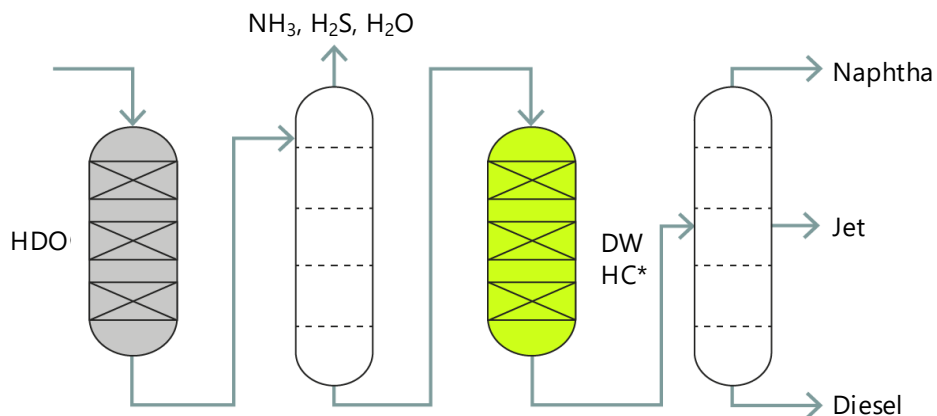


HYDROFLEX LAYOUTS

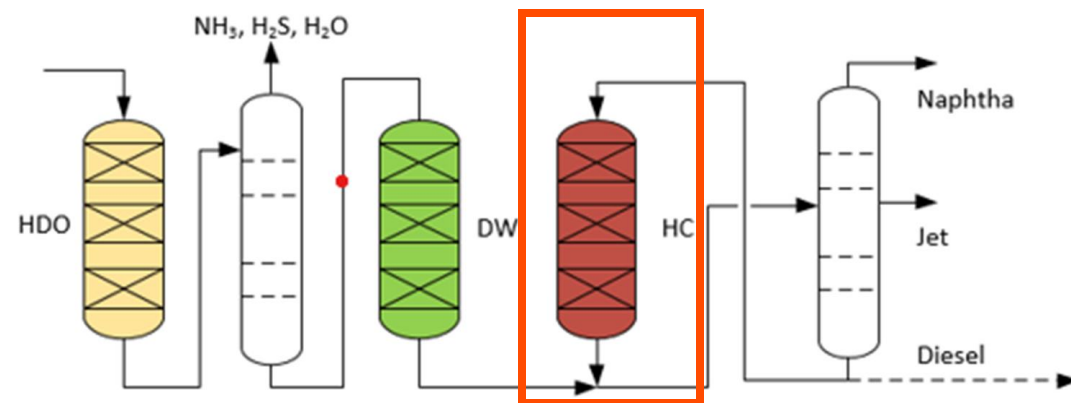
HydroFlex™ – sour mode



HydroFlex™ – sweet mode



Jet only, diesel only or coproduction



Specific feedstocks affect:

Pretreatment

Waste feeds require more pretreatment – **different strategies** practiced

- **Process design**

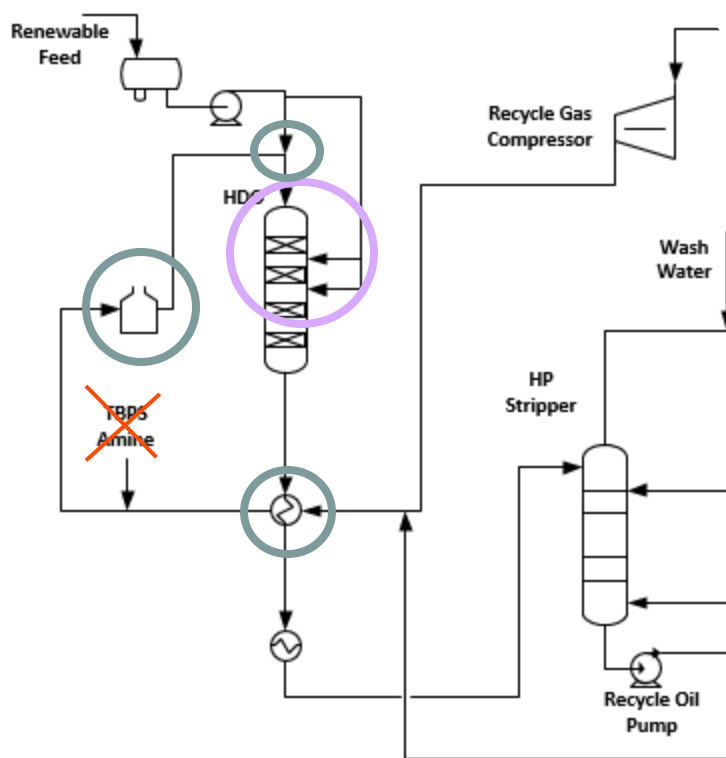
Guard catalysts affect OPEX+CAPEX

Specific feedstocks require more **hydrocracking**

- **Material selection**

Material selection to avoid different **corrosion** phenomena

SPLIT FEED TECHNOLOGY



- Lower Recycle to Feed ratio (1.5)
- Removal of Renewable feed in preheat exchangers
- **Reduces** Reactor Charge Heater and feed/effluent exchanger fouling
- **Avoids expensive alloys** in Exchangers
- **Smaller** equipment
- Better control of exotherm
- Avoids dP built up and prolongs cycle length
- No risk of raw feed leakage and damaging the noble metal catalyst downstream.

~ 11 MM € CAPEX savings
~ 3 MM € CAPEX savings
for a 6000 BPD Unit

Non-phenolic sour water containing NH₄HS eliminates the need of DMDS

~ 1 MM € /year OPEX savings
for a 6000 BPD Unit

NO NEED OF AMINE TREATMENT

- Robust HDO Catalyst + Less CO, CO2 formation → **No Amine Scrubbing required in Recycle Gas**
- Off-Gas H2S removed in iron oxide absorbent → **No Amine Treatment required in Off-Gas**

# of equipment in Amine System	# equipment for Iron Sponge Absorber
HP amine absorber and associated system: 8 LP amine absorber and associated system: 3 Amine Regeneration: 20 Total 31 pieces of equipment	2 absorbers (lead/lag configuration)
SRU required	No SRU required



~ 10 MM € CAPEX savings
~ 1.5 MM € /year OPEX savings
for a 6000 BPD Unit

AND REDUCTION OF CARBON INTENSITY!

TOPSOE
RENEWABLE
CATALYSTS



Specialized and selective catalysts for **maximizing yields**



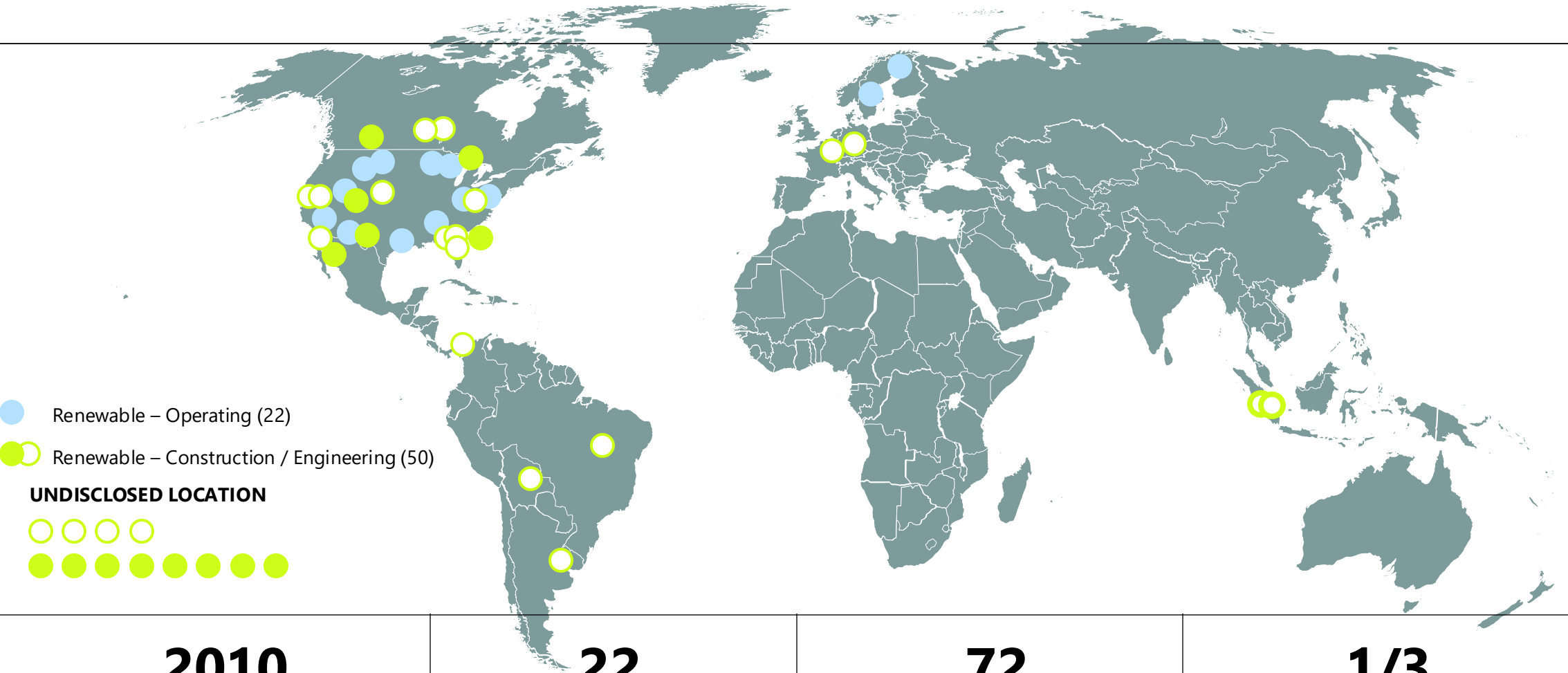
Robust catalysts with increasing activity and high contaminant pickup for **longer cycle length**



Tailor-made catalyst system for **optimal performance**

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HYDROFLEX™ REFERENCES



2010

Start-up of first reference

22

Running references

72

Projects in the pipeline

1/3

Of the renewable fuels operating capacity

SOME OF OUR REFERENCES

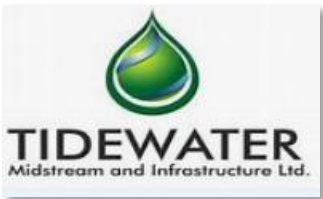


CALUMET IS NOW THE LARGEST PRODUCER OF SUSTAINABLE AVIATION FUEL IN NORTH AMERICA. TOPSOE DELIVERS TECHNOLOGY

By Arctic Business Journal - 27 July 2023

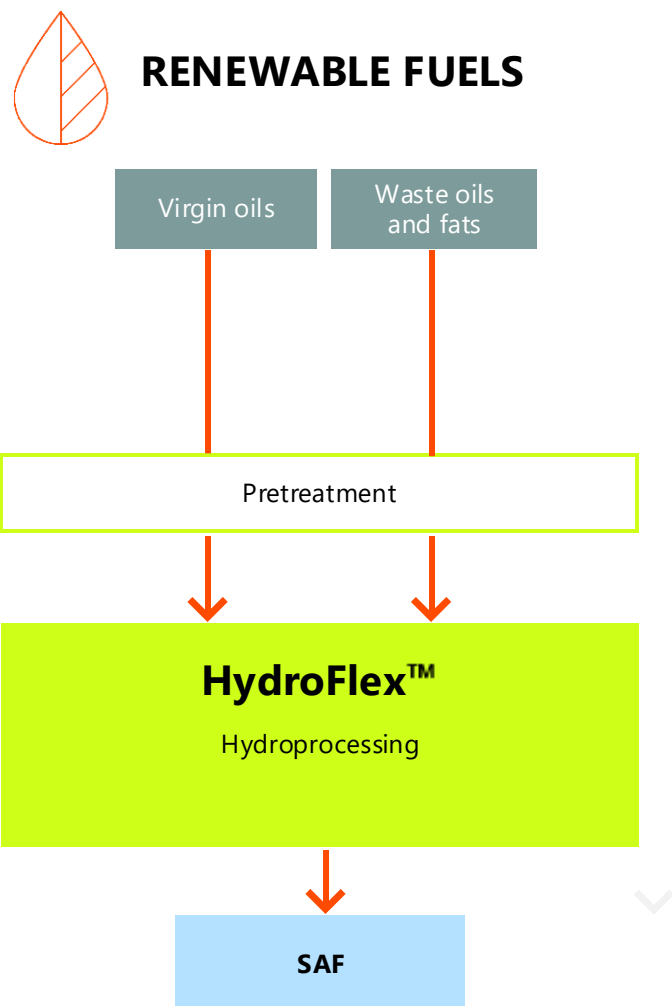
PT Pertamina chooses Topsoe SAF technology at Cilacap facility in Indonesia

September 18, 2023 | By Mary Bailey

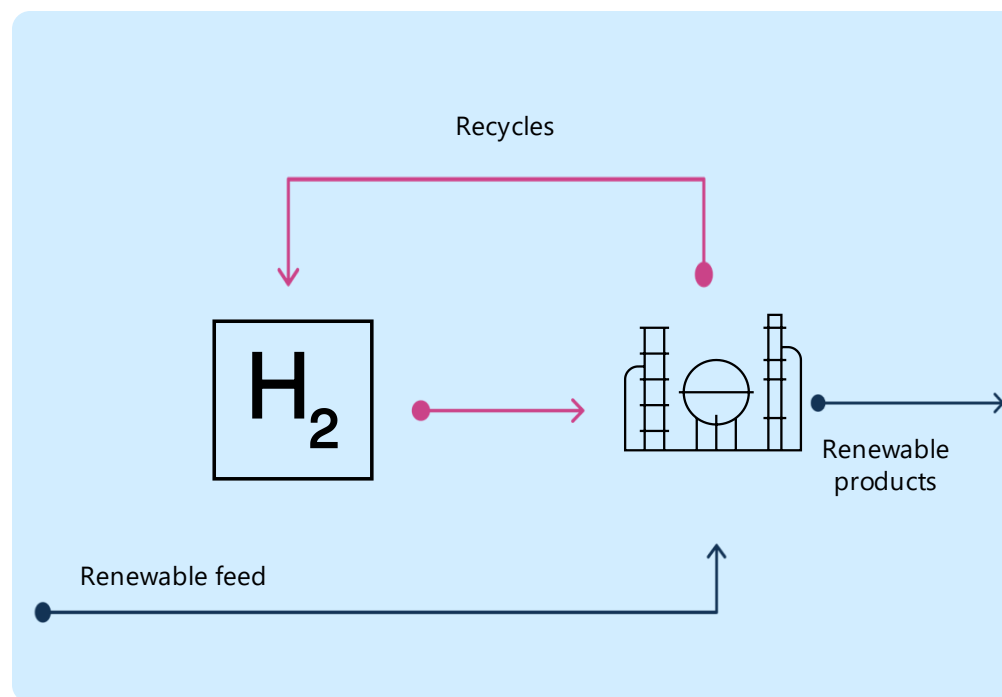


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HYDROFLEX™ AND H2BRIDGE™ INTEGRATED SOLUTION



H2BRIDGE™ UNPRECEDENTED GHG SAVINGS



A circular system integrating Hydrogen and Hydroprocessing

WIDEST PORTFOLIO OF REFORMING TECHNOLOGIES

SynCOR™

ADVANCED AUTOTHERMAL REFORMING
100,000 - 820,000 Nm³/h

- 99%+ Carbon recovery
- Lowest LCOH



SMR

RADIANT WALL TUBULAR REFORMER
20,000-200,000 Nm³/h

- Steam export flexibility
- Medium range capacity



SMR-B

SMR WITH BAYONET TUBES
20,000-200,000 Nm³/h

- SMR with Bayonet tubes
- Low / zero steam export



HTER™

HALDOR TOPSOE EXCHANGE REFORMER
50,000- 250,000 Nm³/h

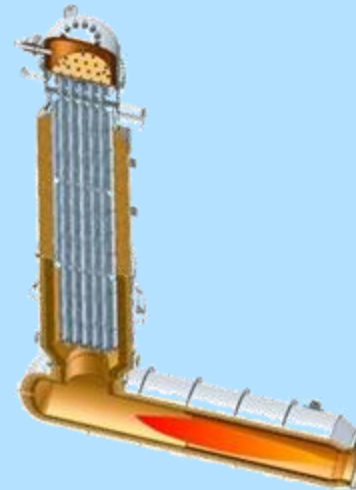
- Reduced steam export
- Option for plant revamp to increase capacity



HTCR™

CONVECTION REFORMER
1,000-50,000 Nm³/h

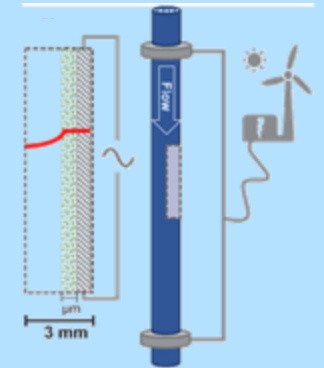
- Zero steam export
- Compact plot



eREACT™

ELECTRIFIED REFORMER
0 – 100,000+ Nm³/h

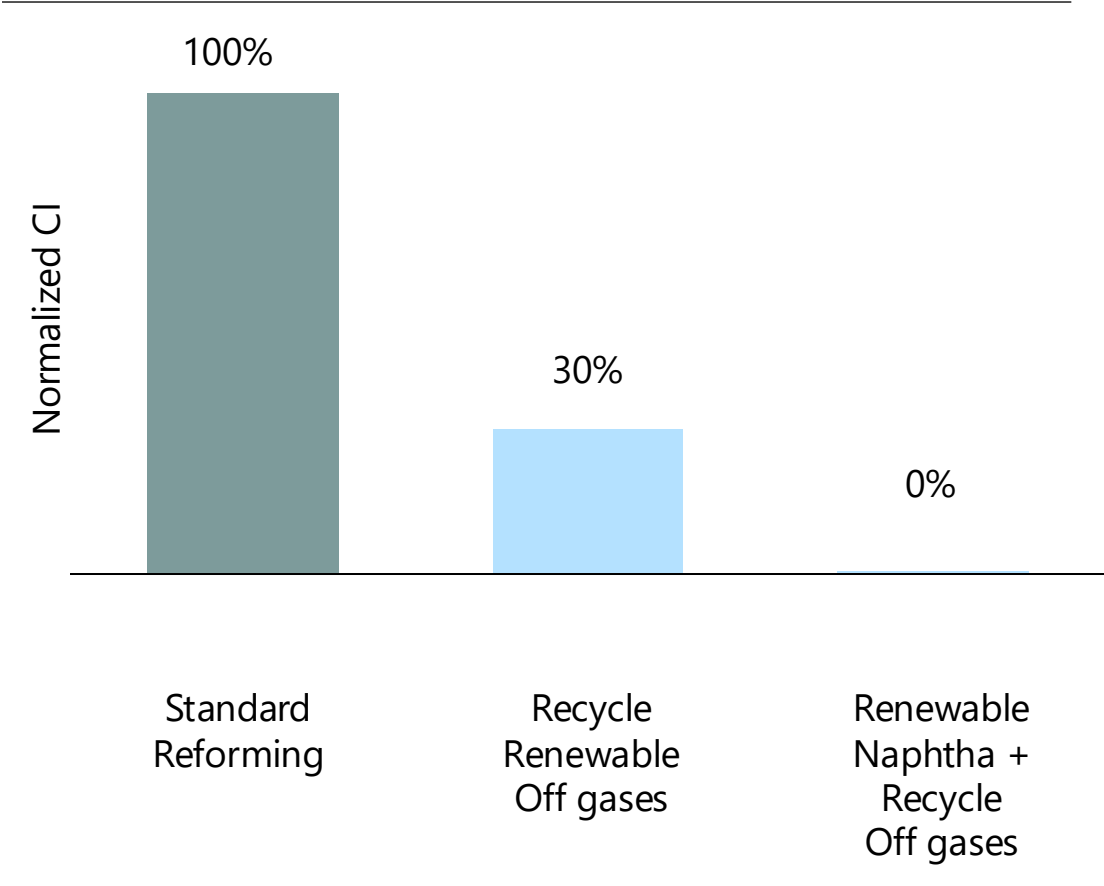
- Zero flue gas emissions
- Rapid start-up



PAVE THE WAY TO SUSTAINABLE BUSINESS

GAIN UNPRECEDENTED UP TO 100% GREENHOUSE GAS SAVINGS BY USING H2Bridge™

SIGNIFICANT CI REDUCTION WITH H2Bridge™



EMISSION FROM HYDROPROCESSING

Natural gas to produce hydrogen via steam reformer is the main source of GHG during hydroprocessing

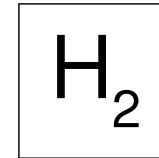
INTEGRATION OPTIONS

Recycle **off gases and LPG** to steam reformer
Up to 70% GHG reduction

Recycle off gases, LPG and **naphtha** to steam reformer
Up to 100% GHG reduction

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HYDROGEN REFERENCES GLOBAL & LATAM



**ONE OUT OF THREE HYDROGEN
MOLECULES ARE PRODUCED USING
TOPSOE SOLUTIONS**

+200

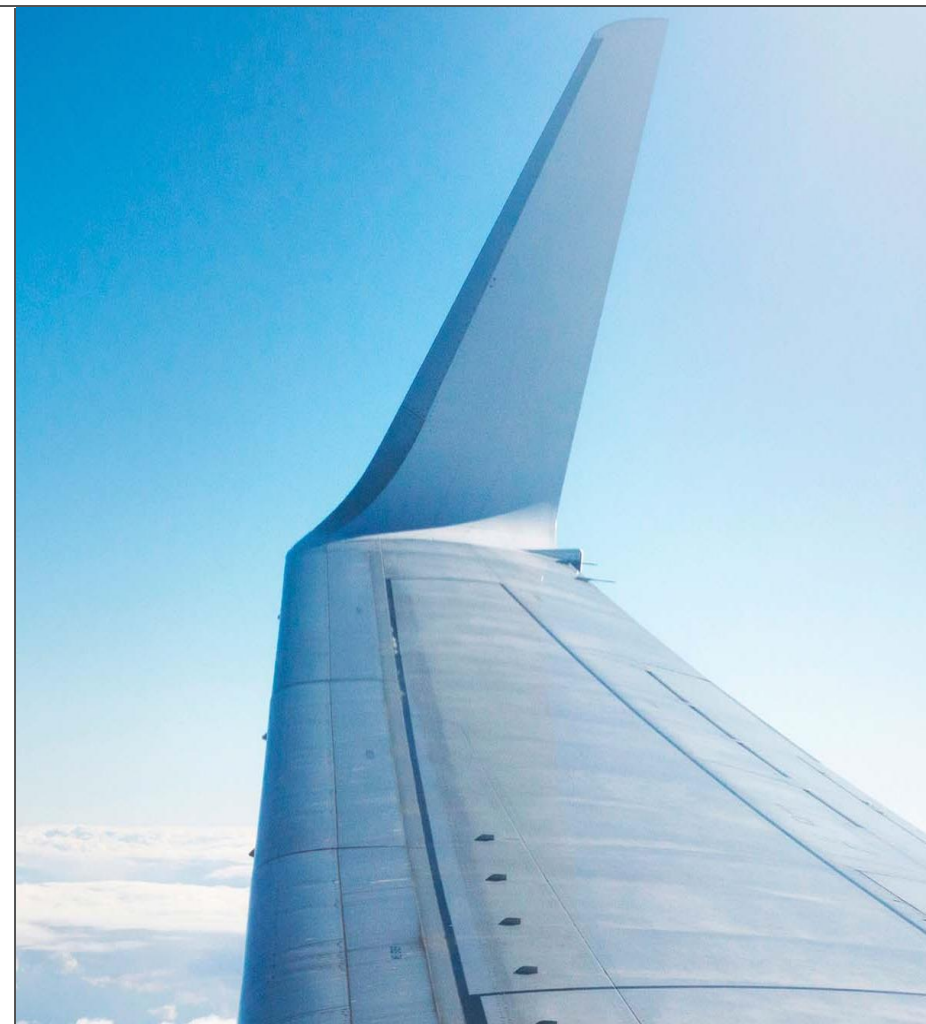
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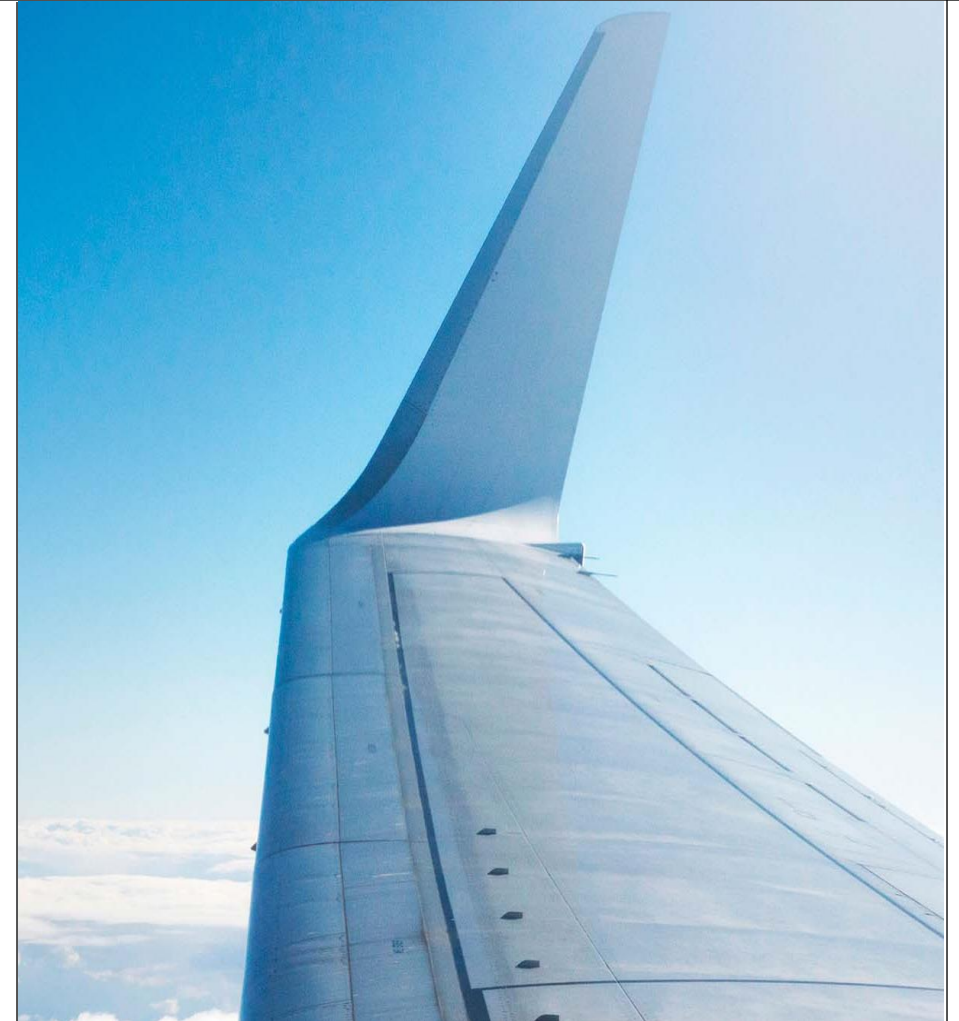
- **Feedstocks flexibility**- From Tallow to Tall Oil, HydroFlex™ technology suitable for all kinds of renewable feedstocks to produce RD, SAF and renewable naphtha.
- **High SAF/RD yields** by using high selectivity catalyst (HDO route), maximizing isomerization and minimizing hydrocracking
- **Lower CO₂ formation**, eliminate the need for amine unit resulting in **CAPEX and OPEX savings**.
- The **energy** used in the amine regeneration tower in competitors design is eliminated in our design, resulting in a **lower CI**.
- Industrially proven **split feed** technology ensuring **longer HDO cycle length**
- Topsoe unit product recycle ratio is substantially lower. This results in smaller equipment and piping resulting **lower CI** as well as a **lower CAPEX and OPEX**.



TAKE HOME MESSAGES



- **Catalyst robustness** to poisons such as CO, CO₂ and H₂S
- Use of sour water as Sulfur donor which will enable OPEX savings in DMDS purchases (this is a Topsoe patent)
- Carbon intensity can further be reduced with **H2Bridge™**
- Multiple **commercial references**



GRACIAS!!



TOPSOE



STOP. SCAN. LISTEN.

A TOPSOE PODCAST FOCUSING ON RENEWABLE FUELS.

THE FUEL FOR THOUGHT PODCAST SERIES

- Key industry players, experts, and influencers discuss industry challenges.
- What is driving our industry and where is it heading?
- Get new perspectives, inspiration, and knowledge.



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