



HYDROCARBON PROCESSING®

IRPC

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Potential Emissions Reduction, Recycling, and Increased Energy Efficiency



Louis Courtaud
Technology Engineer



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OIL REFINING



PETROCHEMICALS



GASES



RENEWABLES
& ALTERNATIVES



WATER

Process Licensing

How to monetize CO₂: eFuels

Louis Courtaud – Technology Engineer

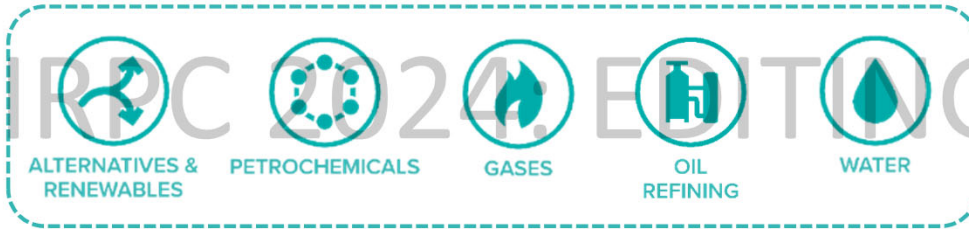
www.axens-solutions.net

Axens in Brief

Company Profile

- Technology and catalyst provider for biofuel, biochemical, oil & gas, and petrochemical industries
- 40+ yrs. experience in biofuel & biotech
- Ownership structure: 100% IFPEN

Business Areas

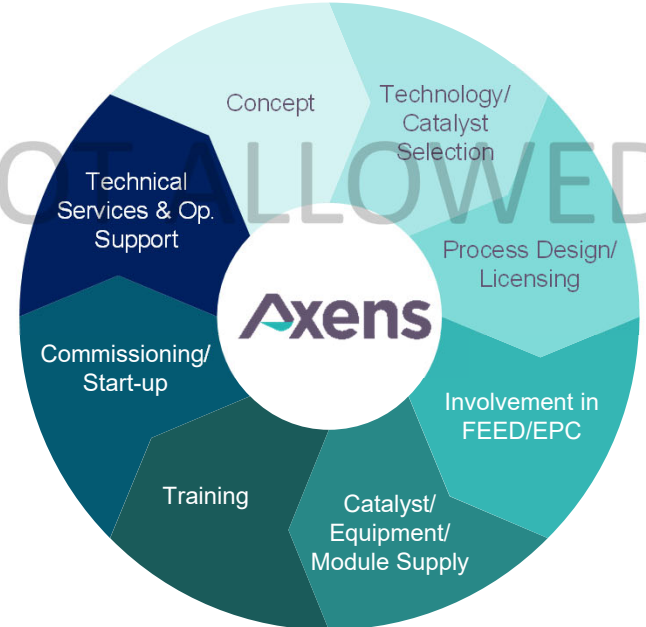


Offices in 15 countries

	3,000+ industrial units under license		3,500+ furnaces sold
	500+ modular units references		70,000+ tons catalysts & adsorbents sold each year

Axens Offer

- Integrated solutions
- Covers the entire value chain



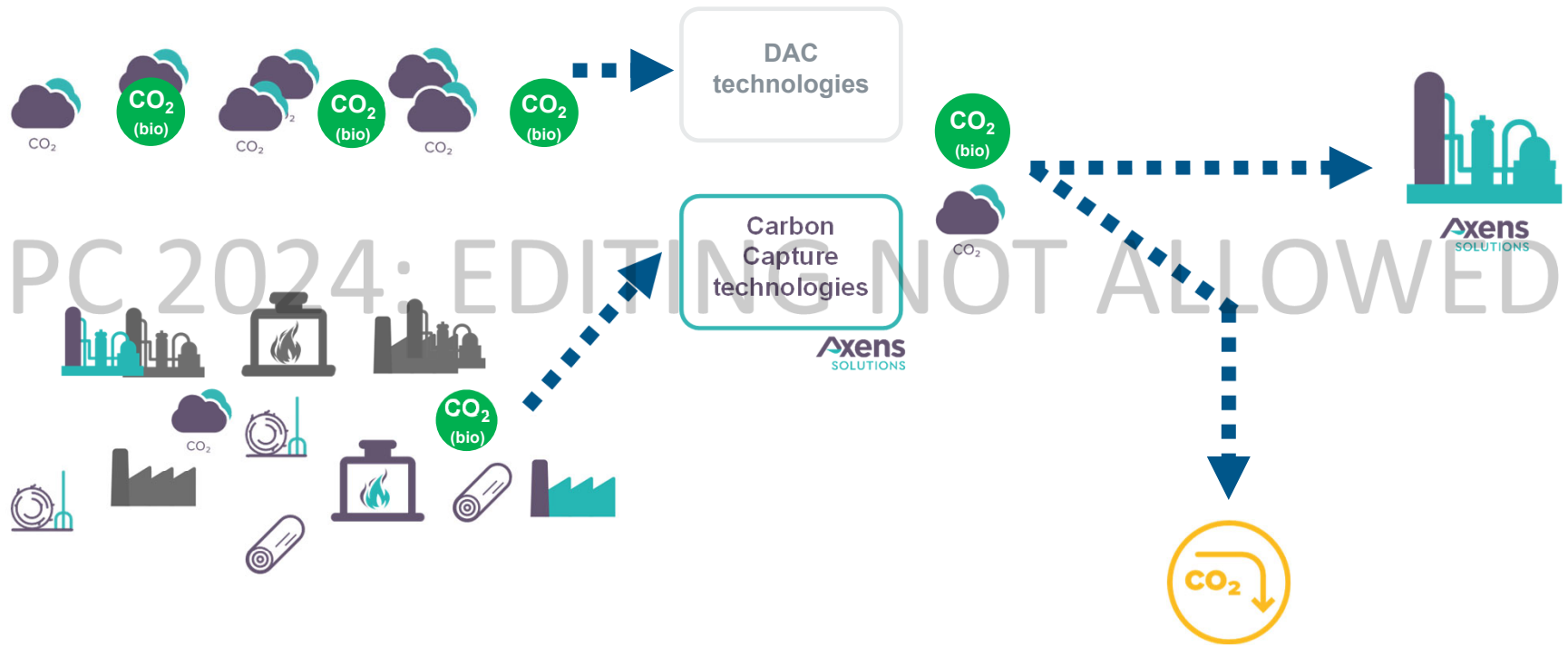


- 1,100 technical personnel
- \$300 MM Annual R&D Budget
- > 100 pilot plant units
- 11,000 active patents.
- Expertise includes:

Process Engineering, Modelling, Thermodynamics & Kinetics, Catalysis, Pilot plant scale-up and LCA



CO₂ : How to turn 21st century challenge into opportunities







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Regulations to drive and support CO2 conversion opportunities



- Inflation Reduction Act
- Production credits approach :
 - ▶ SAF credit 40B
 - ▶ Clean hydrogen production credit 45V
 - ▶ Renewable electricity production credit 45
 - ▶ Carbon oxide sequestration credit 45Q...
- Investments Funds and programs
- CI based
- Target 3B gallons SAF/year by 2030

- Fit for 55 legislation , ReFuelEU policies and RED III update, Mandates 
- Efuel mandates introduced in Aviation Fuel plan 
- Japan Efuel regulation under discussion for 2030-2040's implementation 
- Announcement in Brazil about "Fuel of the future program" for SAF, synthetic fuel, Carbon capture 

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CO₂ Utilization Solutions

Driven by regulations, CO₂ is developing as a resource of interest in many places. It can be utilized to produce different molecules addressing diverse markets such as transportation (aviation, maritime, heavy and light duty vehicle) and chemicals (bio plastics etc.).



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Axens - CO₂ Capture Technologies

AdvAmine™

Pressurised Gaseous streams (High Pressure)



References

- Equinor - Sleipner – CO₂ Sequestration
- Oxochimie / BioTfuel – France – Syngas
- 200 + references



DMX™

Flue gas streams (Atm Pressure)



References

- ArcelorMittal - 3D Project - Dunkirk
- IFPEN Pilot - Solaize



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RWGS: Joining the Best of Two Worlds



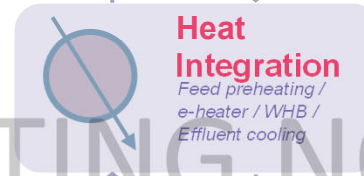
High Temperature Operations

- › Breakthrough e-heater technology
- › Expertise in high temperature services
- › Refractory design and assembly
- › Vessel internals for high temperature



Process Development & Extrapolation

- › Process development & Scale-up
- › Modeling & Hydrodynamics
- › Process plant design
- › Technology Licensing & Marketing
- › Start-up & Operations support



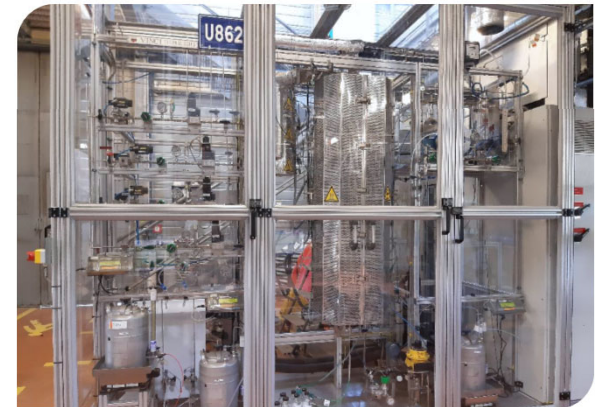
H₂+CO₂

Syngas & Water

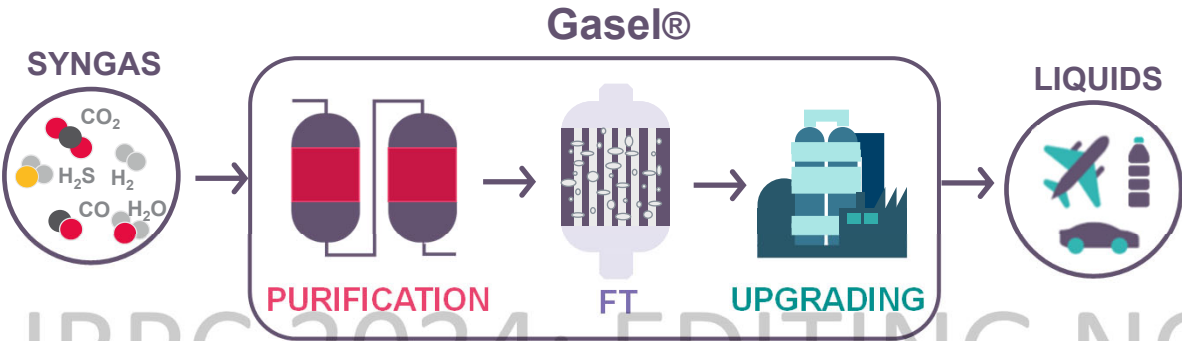


KEY FEATURES

- › Fast-track development
- › Simple Process scheme
- › Optimized conversion & CO selectivity
- › Fully electrified
- › Robust technology selection
- › Industrially available catalyst



FT & Upgrading – a Proven Technology



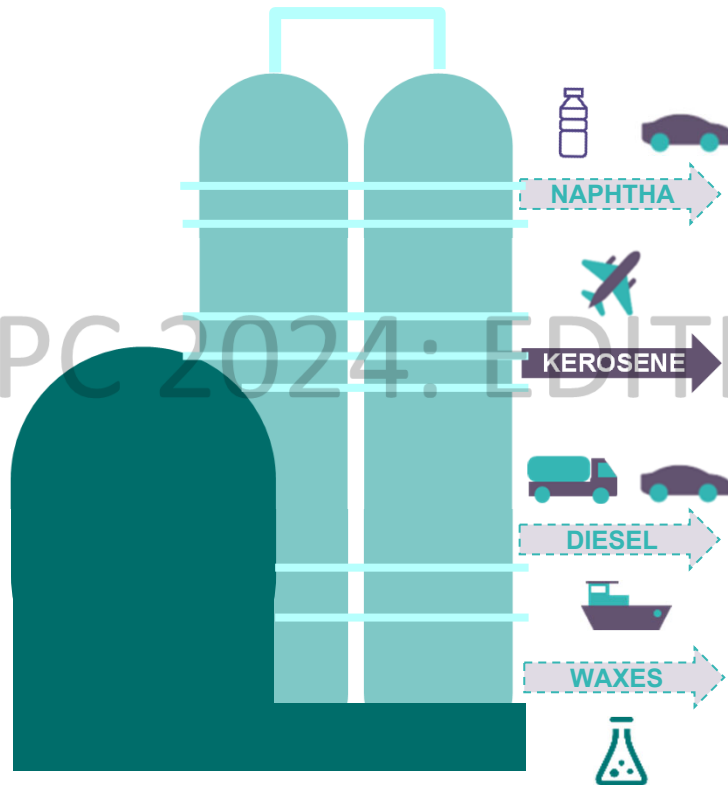
Key Features

- ▶ Flexible Feed Slate: PTL / BTL / WTL
- ▶ SBCR (Slurry Bubble Column Reactor) technology maintains product quality and high availability
- ▶ High performance Catalyst for Middle Distillate
- ▶ Flexible Upgrading scheme: Kerosene and more
- ▶ Certified ASTM D7566
- ▶ Upgrading Commercial References



05.07.20

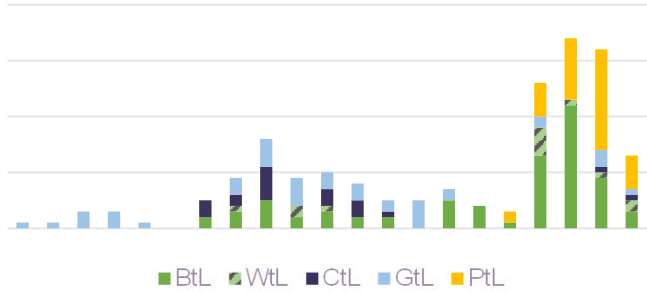
Products Flexibility through Syncrude upgrading



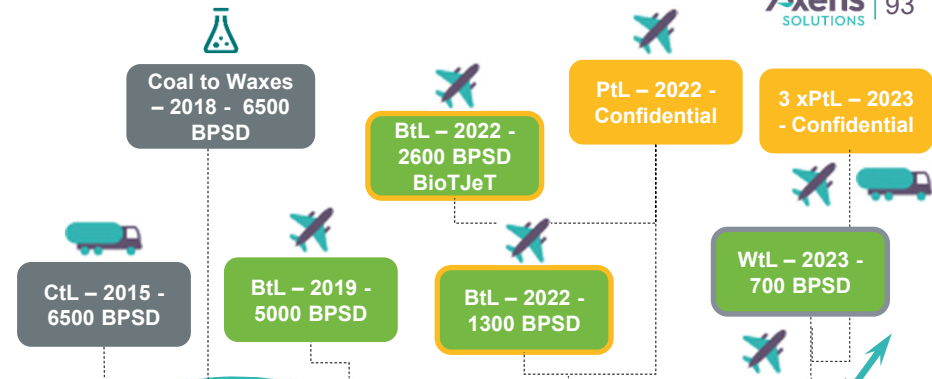
- Final products characteristics
 - ▶ High quality products
 - ▶ No sulfur, no oxygenates, paraffinic products
 - ▶ Ideal blending components to meet pools specifications
- Naphtha for Petrochemistry / Gasoline Pool
- Kerosene incorporable in Jet-A1 pool
 - ▶ ASTM D7566 (FT-SPK specification)
- Diesel
 - ▶ ASTM D975 and EN15940
- Waxes

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FT Pathway - References List



FEL 1



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25 000 hours on stream - 20 BPSD

Sannazarro Pilot Plant (IT)



FEL 2



2001

2010

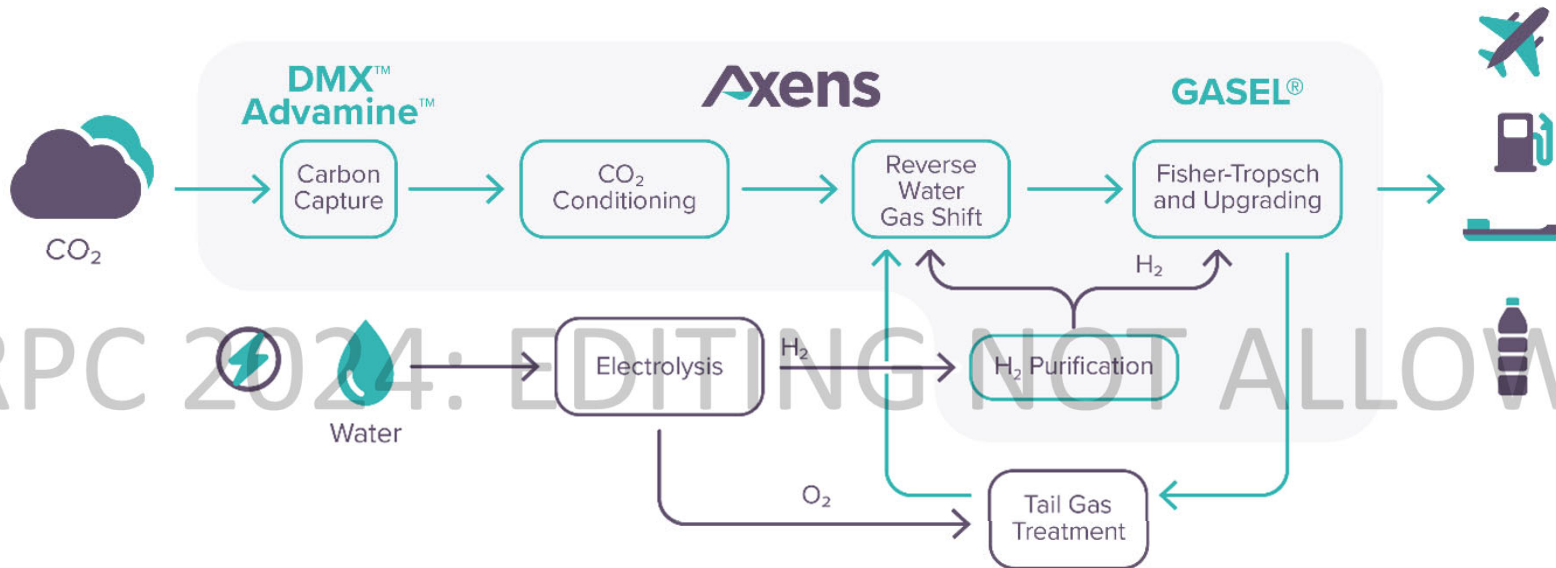
2014

2019

2022

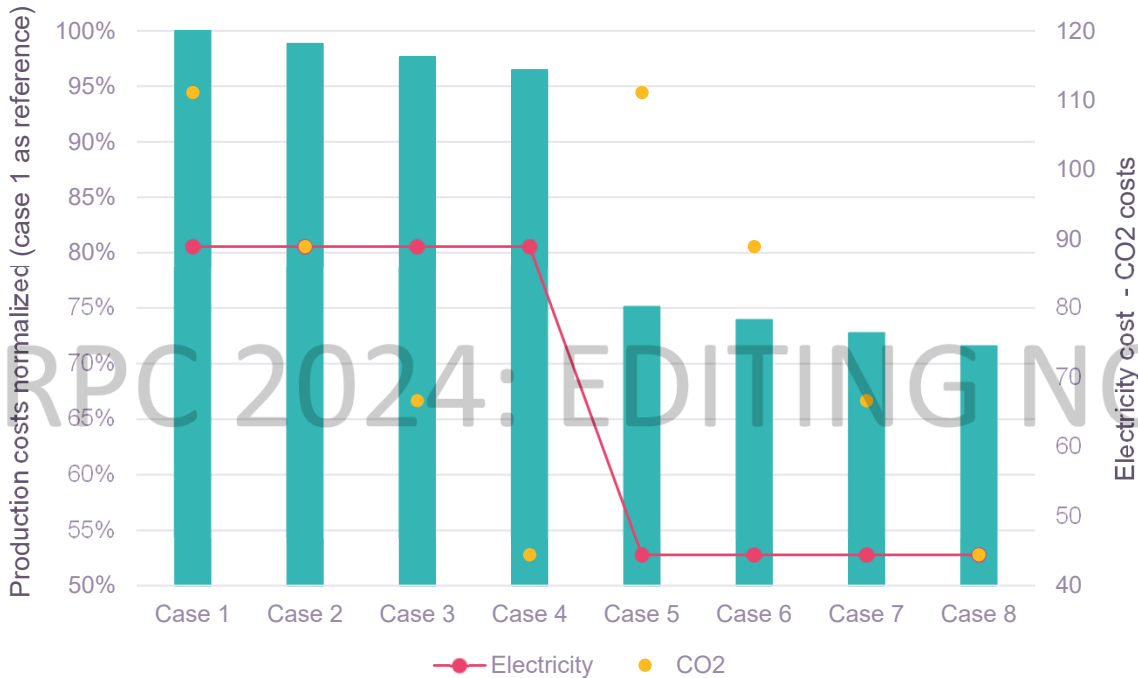
2023/2024

eFuels technical challenges



- Incremental development of commercial technologies
- Enhanced integration between ISBL and OSBL to limit energy use, freshwater make-up
- Electricity : fine selection of renewables electricity portfolio and energy storages design to reach high operating stream factor

Sensitivities on production costs



No subsidies / credit considered for the sensivity study

Electrolyzer electricity consumption : 52 kWh/kg H2

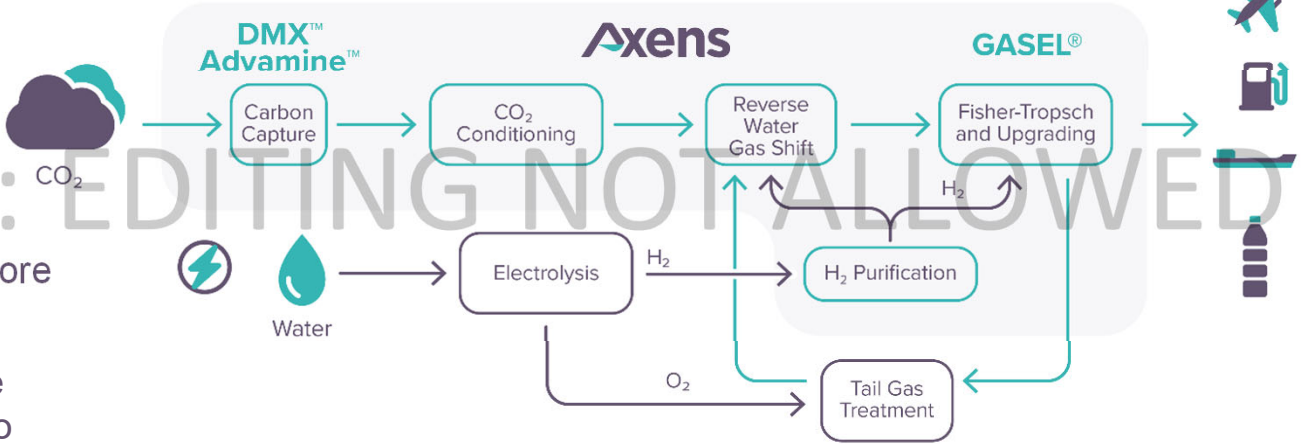
Electricity price in USD/MWh

CO₂ price in USD/ton

Location is key to match profitability : combination of available biogenic CO₂ and low costs + low CI electricity

E-fuels through FT pathway: Fully integrated and electrified solution

- › Carbon Recovery >96%
- › Single point of contact
- › End-to-end Guarantees
- › Integrated solution
- › Optimal H₂ consumption
- › Flexible : SAF/Diesel and more
- › Maximized SAF yield
- › Covering the entire life of the Project – from study phase to turnkey projects



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