

BIOFUELS:
A Step Further to Sustain
Present & Future Challenges
of the Energy Transition

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Axens
SOLUTIONS

Axens in Brief

Company Profile

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

Business areas



ALTERNATIVES & RENEWABLES



PETROCHEMICALS



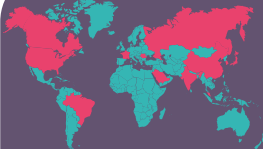
GASES



OIL REFINING



WATER



Offices in
15 countries



3,000+
industrial units
under license



3,500+
furnaces sold



500+
modular units
references



8 Million fuel
barrels produced
by units under
Axens license

70,000+ Tons catalysts
and adsorbents/year

Axens Offer

Integrated solution

Covers entire value chain

Axens
HORIZON

Axens
SOLUTIONS

Heurtey
Petrochem
SOLUTIONS





Climate Change / Energy Transition

Axens Pathways to Renewables

Axens offers today the largest portfolio to transition towards bioeconomy for transportation and chemical industries

All type of lipidic feedstocks

Syngas,
Lignocellulosic biomass

Green H2, Carbon Capture, Waste, low-Cl, inedible starches and sugars



Axens



Renewable Naphtha



Renewable Jet (SAF)

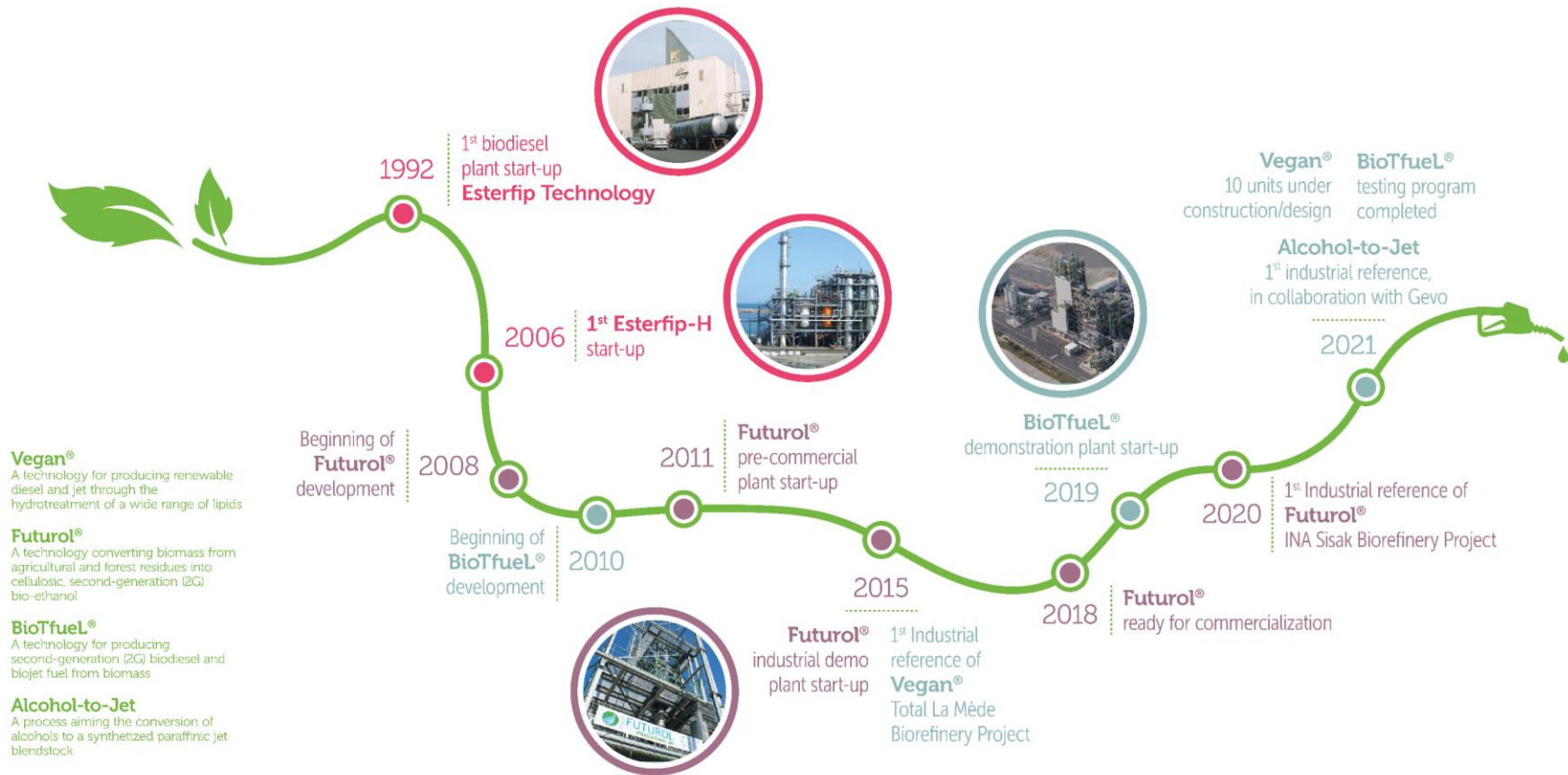


Renewable Diesel

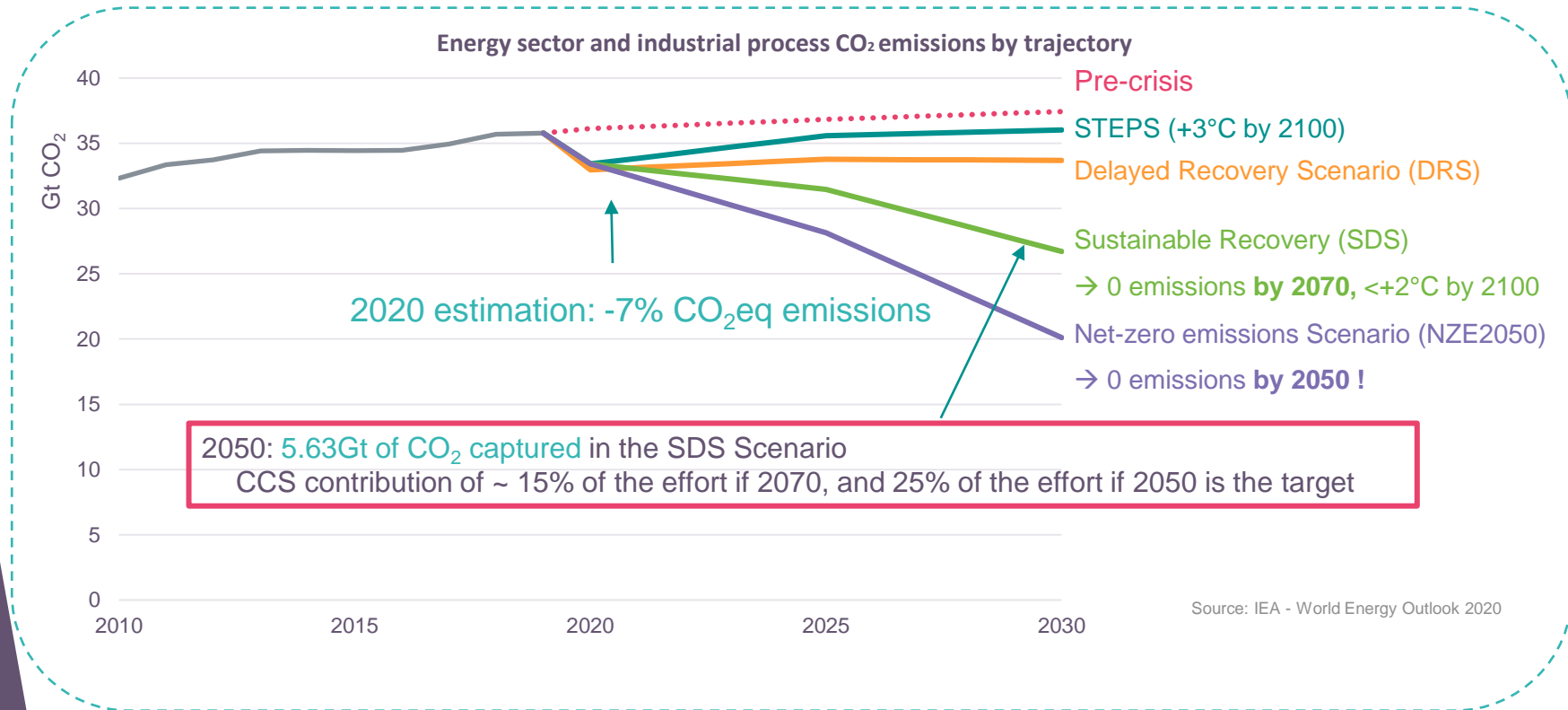


Fossil Fuels

Axens Group: A Long History with Bio processes

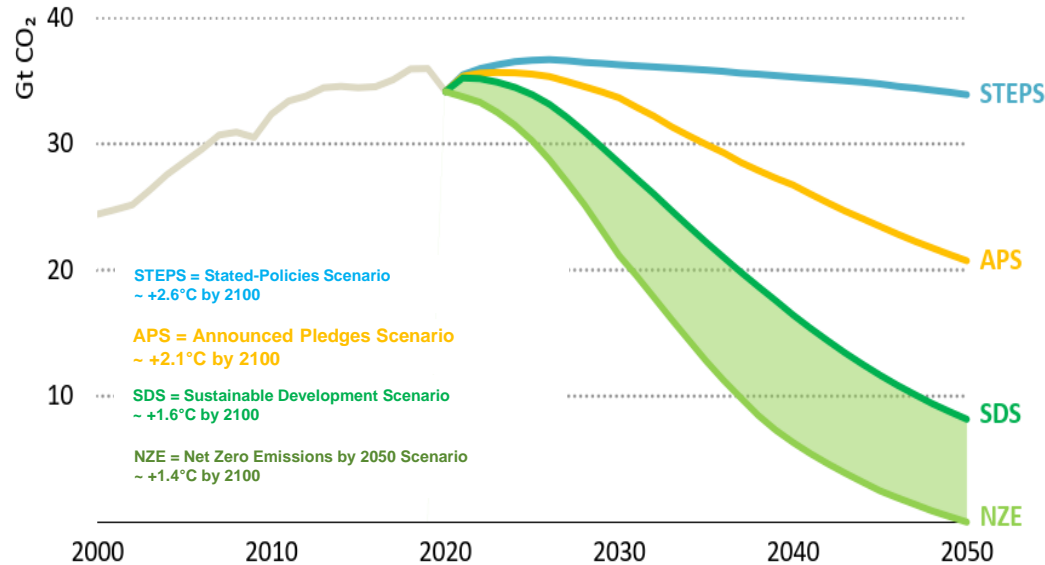


Evolution of Energy Sector Emissions – IEA Scenarios



Reaching NZE will not require a single technological solution

Global energy-related CO₂ emissions in the 2021 WEO scenarios (IEA)



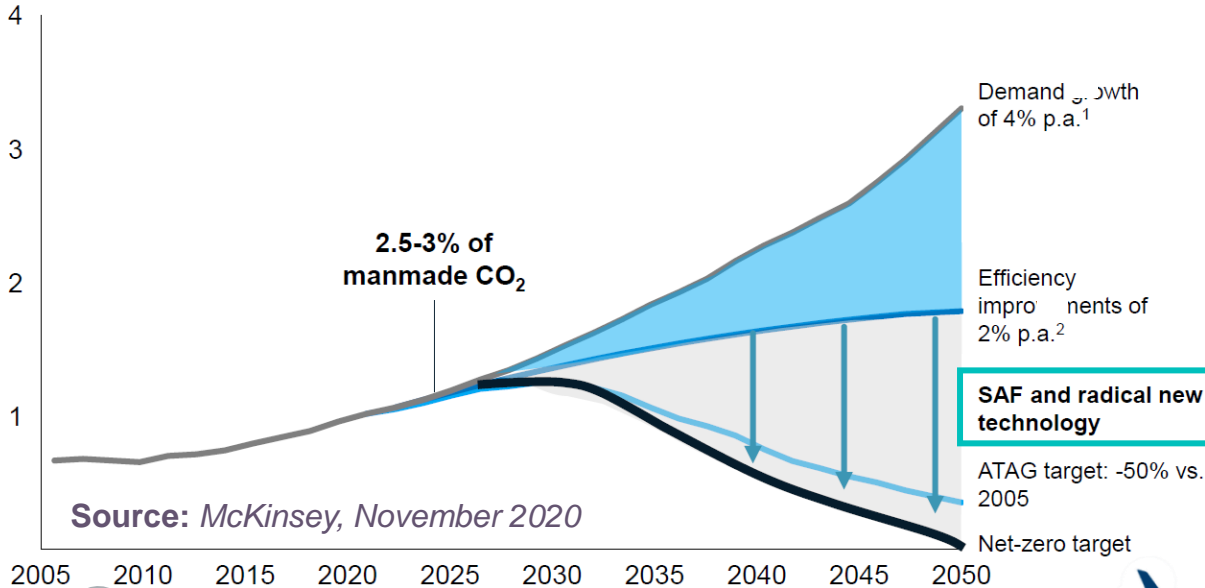
Switch from SDS to NZE scenario will not require a single technological solution but a **combination of solutions:**

- Efficiency >40%
- Renewables & Fuel Switching ~ 40%
- CCUS ~10%

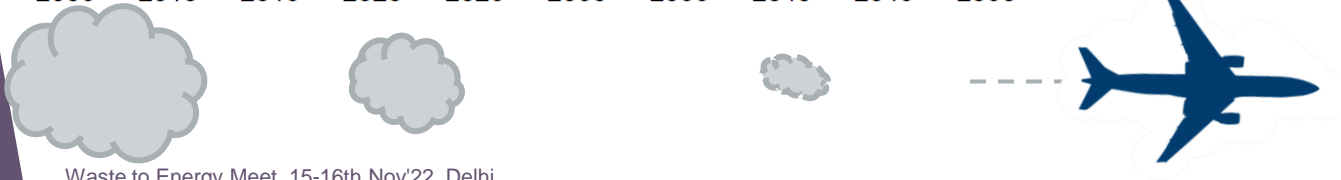


How to Achieve Net Zero Emissions?

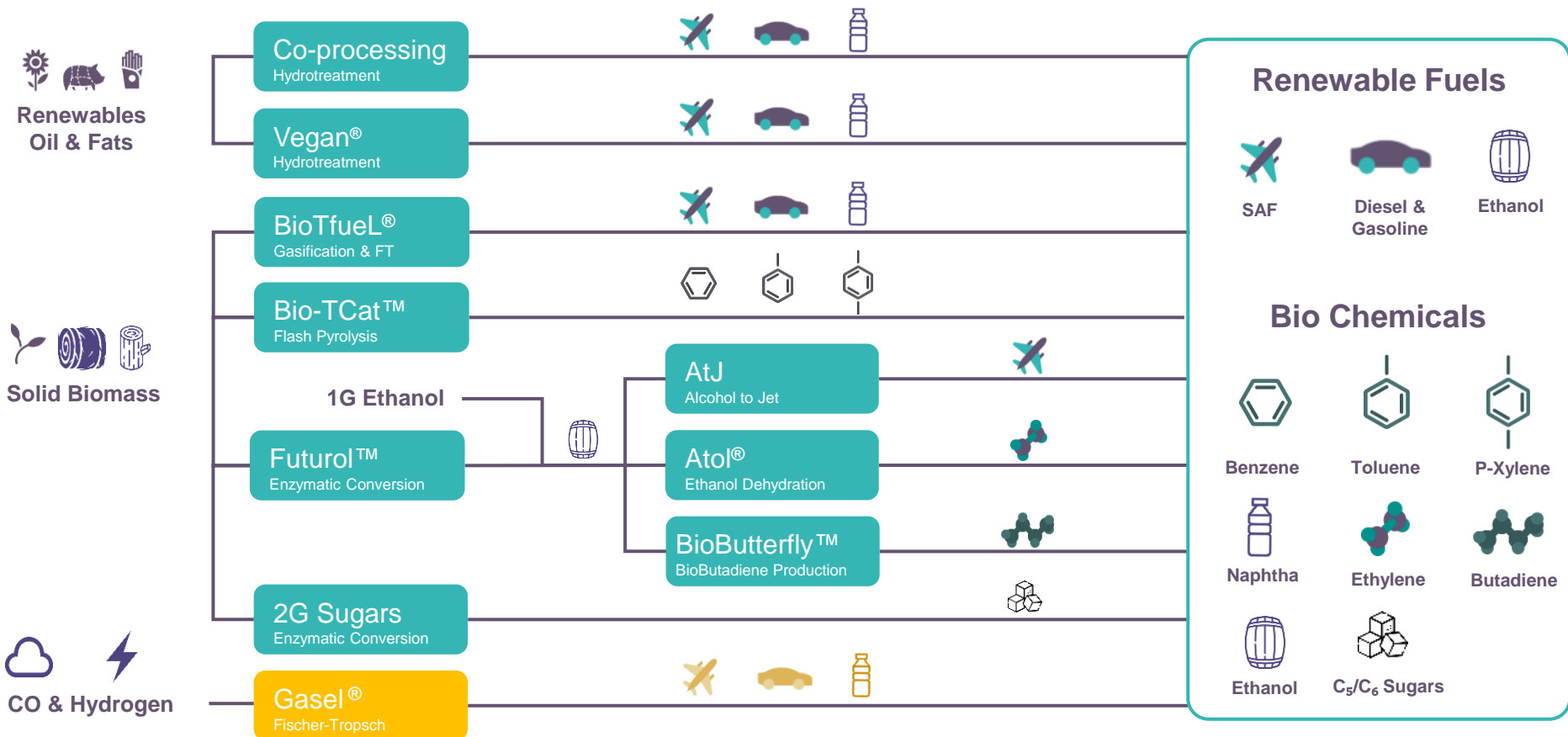
Gt CO₂ emissions from aviation



➔ SAF as one of the solutions



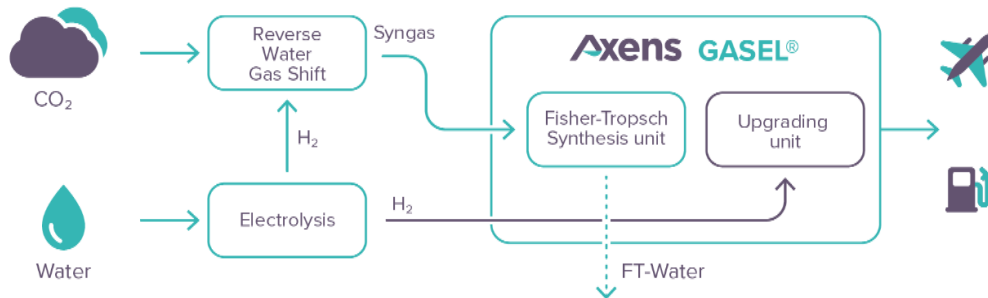
Axens Biofuels & Biochemical Solutions



POWER/BIOMASS TO LIQUID: Biofuels via Syngas

E-fuels: from CO₂ & H₂ to Biofuels

Axens DMX®



Technology key features

- ▶ End to end Guarantees
- ▶ Optimization between units to maximize projects economics
- ▶ Single point of contact

Products quality

- ▶ Advanced / 2G biofuels
- ▶ High quality, ultra-clean, O₂ free, drop-in fuels
- ▶ Compliance with ASTM D7566 for SAF
- ▶ 90 to 125% GHG emissions savings vs. fossil fuel baseline (source ICAO)

Technology development

- ▶ RWGS by 2023
- ▶ Gasel:
 - › 2 references
 - › 25 000 hours of operation of FT pre-commercial plant
- ▶ Upgrading > 70 references worldwide for upgrading section



Climate Change/ Energy Transition Involvement in Carbon Capture Project

AdvAmine™

for **Pre-Combustion Carbon Capture**

Natural Gas / Syngas

(High Pressure)

References

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



DMX™

for **Post-Combustion Carbon Capture**

Flue Gas

(Atm Pressure)

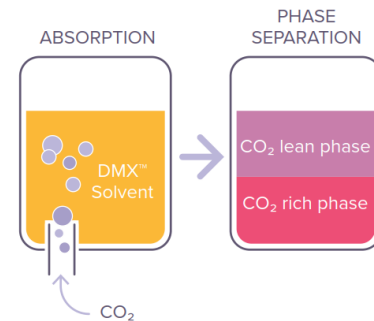
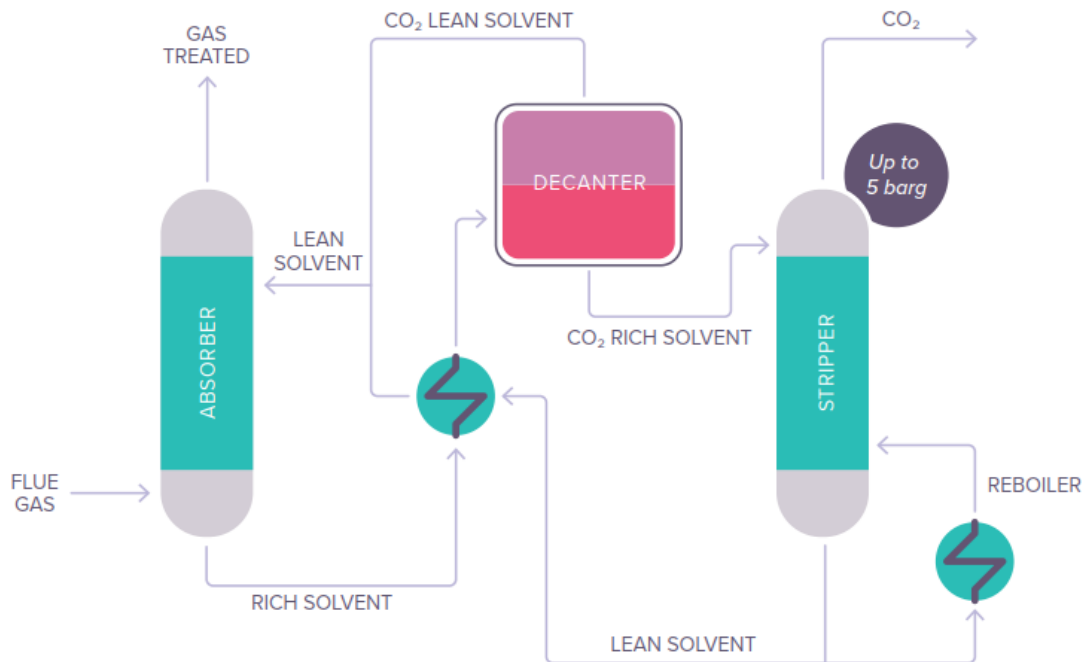
References

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





DMX™ Process - Capture of CO₂ on Flue Gas

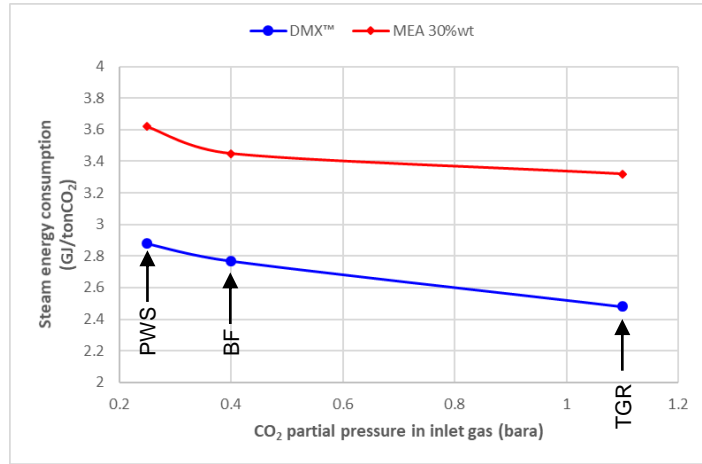


BENEFITS

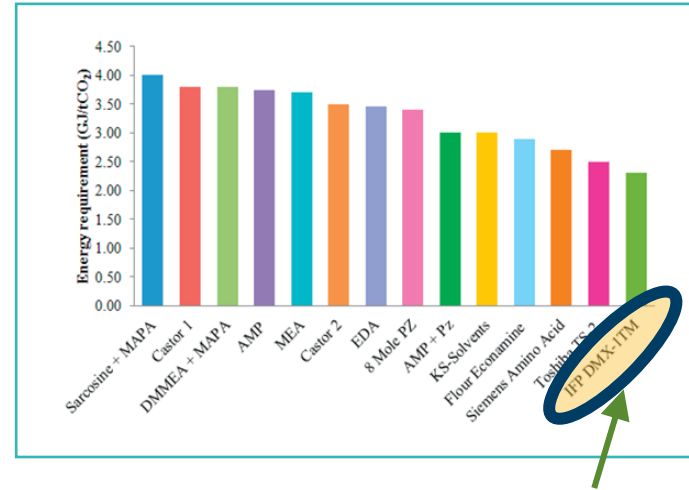
- Low steam energy consumption: from 2.3 to 2.9 GJ/tCO₂ depending on application and capture rate
- Thermally stable solvent with low degradation rate
- CO₂ produced readily under pressure up to 5 barg for significant compression cost savings
- High capture rate achievable (>90%) and high purity of produced CO₂ (>99%)

**High potential of energy saving:
up to 30% reduction on OPEX**

DMX™ Process – Performances



PWS: Power station
BF: Blast Furnace
TGR: Top of Gas Recycle



Source: Singh P. (IEAGHG), et al.,
 Energy Procedia 37 (2013) 2021-
 2046, Oral presentation , GHGT-11,
 Kyoto, 2012.

- 30% OPEX (vs MEA)

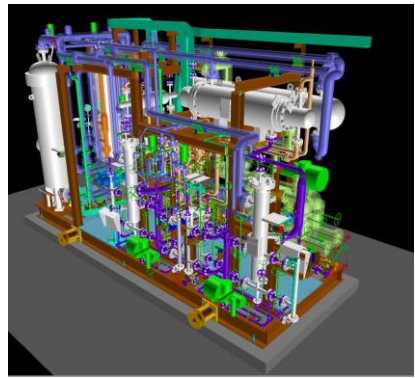


H₂ purification



Decades of experience in purification
Full package provider (catalyst/adsorbent + skid)
Several years of industrial experience in H₂ purification
Ready to use solution

Dryer skid (3D view)



Dryer skid in workshop



H₂ storage in Salt caverns - Native H₂ from underground



O₂ Removal

Axens
DO 125 catalyst

- Pd catalyst
- Very high activity and low cost to fill

Drying

Axens
AxSorb Alumina & Molecular Sieve

- Patented Multibed™ technology
- Reliable and high performance
- Lowest energy consumption for drying

H₂S removal

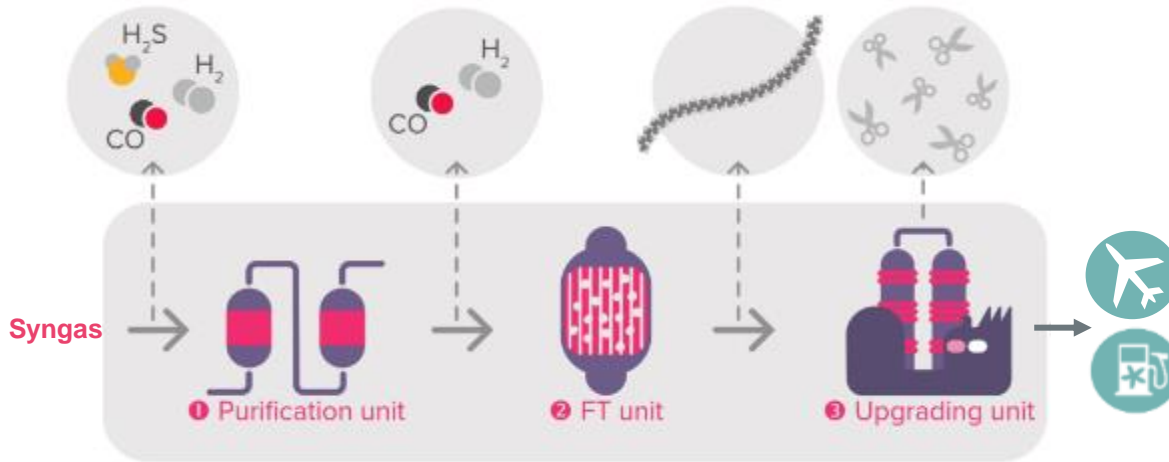
Axens
AxTrap 4000

- Scavengers
- High capacity in H₂S
- Safe disposal

Feed Purification Package

- H₂ /CO₂ purification (pollutants traces removal)
 - ▶ Very low sulfur compounds ≤ 10 ppb
 - ▶ Very low inorganic compounds
 - ▶ Very low metal compounds ≤ 10 ppb
 - ▶ Moisture removal

Gasel[®] from Synthetic Gas to Biofuels



Technology key features

- ▶ Flexible Feed Slate: **Power to Liquid**, Gas to Liquid, Biomass to Liquid
- ▶ Innovative reactor technology to maintain product quality and high availability
- ▶ Mild operation to maximize middle distillate, easier operation

Products quality

- ▶ Advanced / 2G biofuels
- ▶ High quality, ultra-clean, O₂ free, drop-in fuels
- ▶ Compliance with ASTM D7566 for SAF
- ▶ 90 to 125% GHG emissions savings vs. fossil fuel baseline (*source ICAO*)

Commercial technology

- ▶ 2 references
- ▶ 25 000 hours of operation of FT pre-commercial plant
- ▶ > 70 references worldwide for upgrading section

Pre-Commercial Plant



FT Demo Unit- Sanazzaro

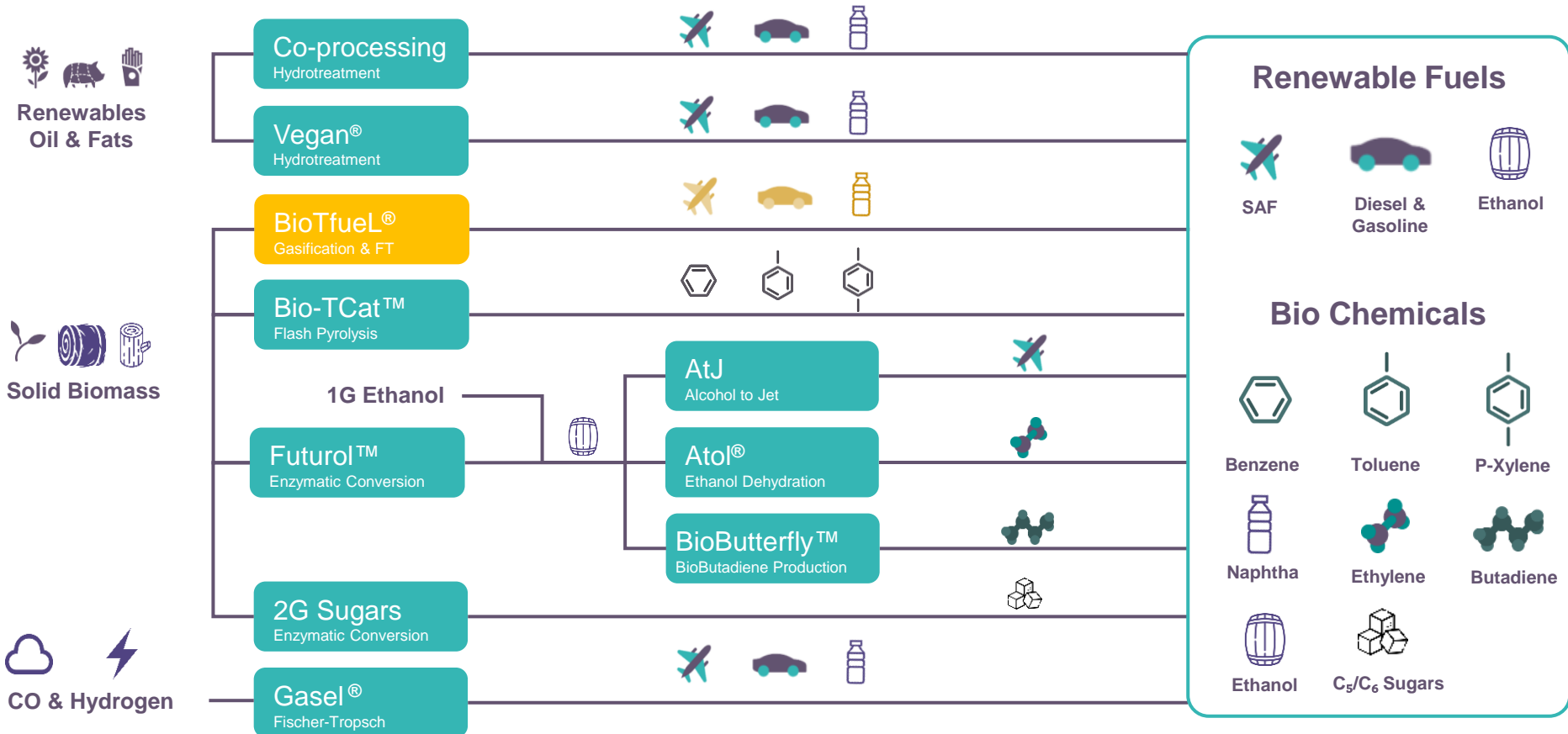


Upgrading Pilot Plant

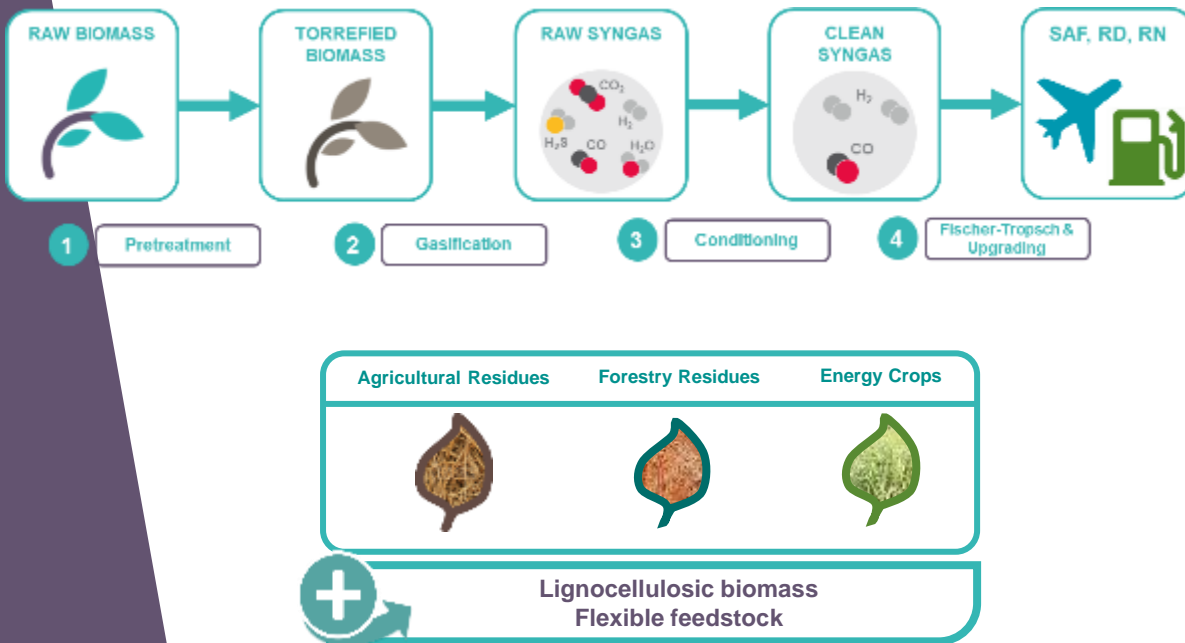


Gasel®

Axens Biofuels & Biochemical Solutions



BioTfuelL[®] from Biomass to Biofuels



■ Technology key features

- ▶ Adaptable to wide ranges of capacities
- ▶ Fully integrated, robust, demonstrated
- ▶ High quality syngas
- ▶ Green H₂ integration possible → e(bio)fuel compatible. Double the carbon yield
- ▶ Single point licensor from biomass to biofuels

■ Products quality

- ▶ Advanced / 2G biofuels
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■ Commercial technology

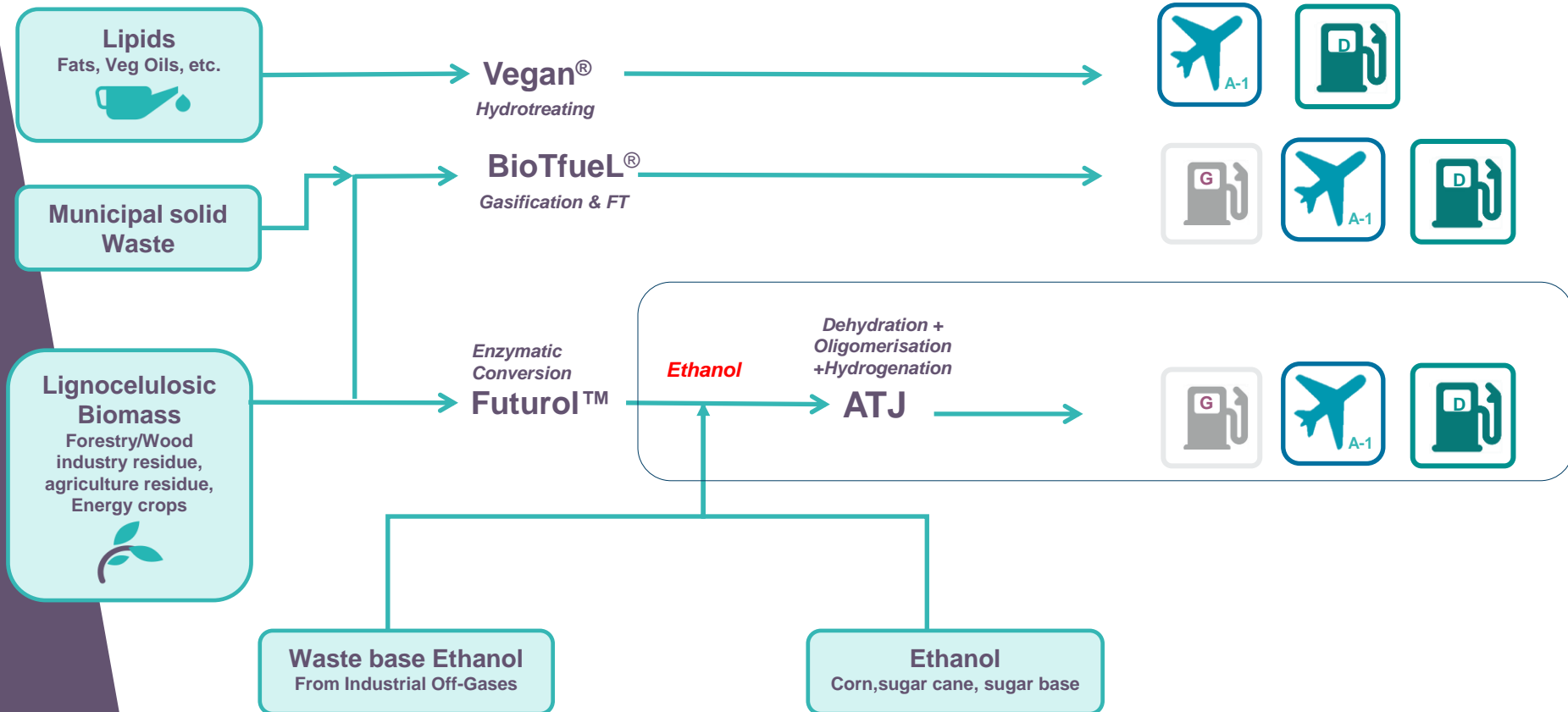
- ▶ 3 years operation of pre-commercial plant
→ References for main technology bricks

Full Chain Pre-Commercial Plant



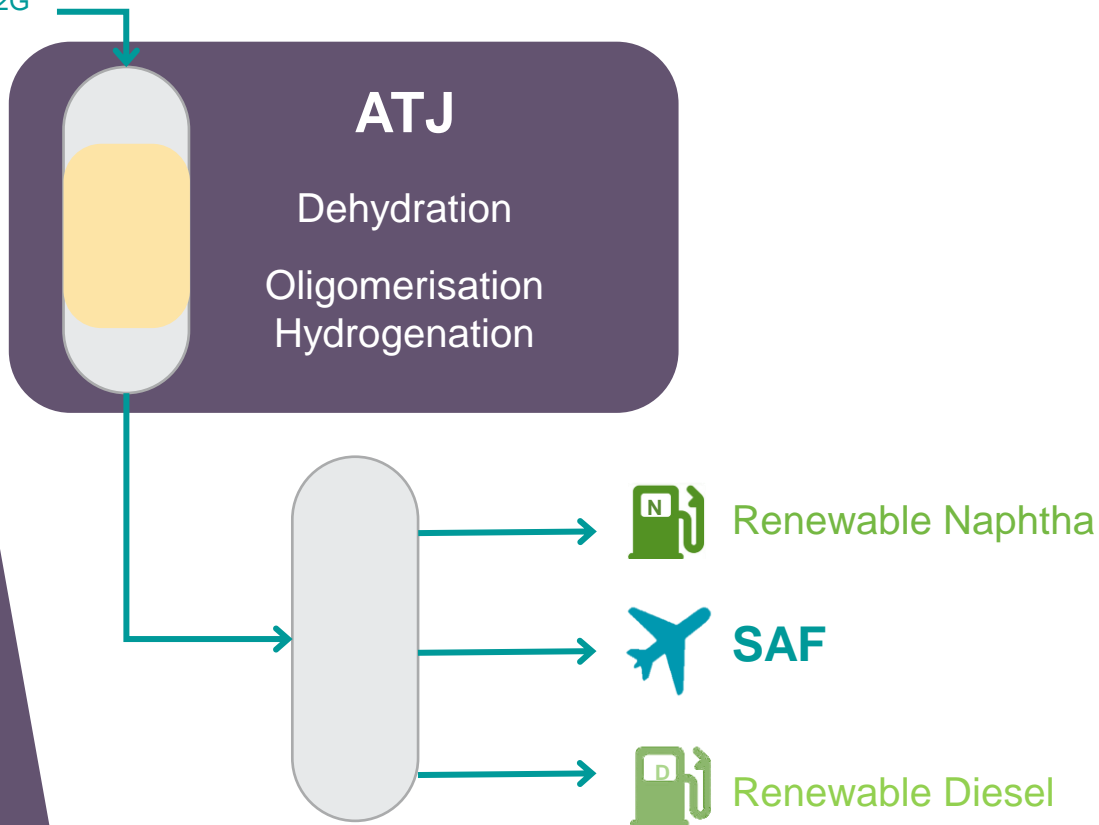
Biofuels Around Ethanol

Axens SAF Technology Portfolio & Pathways



SAF Production Through Alcohol to Jet

Alcohol
1G/2G



Waste to Energy Meet_15-16th Nov'22_Delhi



KEY FEATURES

- 99% yields on carbon
- Yields flexibility toward gasoline or middle distillates
- Combination of well-known industrially proven blocks
- Up to 110% GHG WTW emissions savings

(source ICAO)

ATJ from Ethanol to Biofuels



5 references



>100 references



>70 references

■ Technology key features

- ▶ For CProducts & feedstock flexibility
- ▶ Superior yields → Market leading catalyst
- ▶ High selectivity → easier separation/purification
- ▶ Near zero carbon conversion loss
- ▶ Single point licensor from biomass to biofuels
 - › Catalysts and Process Design Package execution
 - › End to end guarantees

■ Commercial technology

- ▶ Long track record of references
- ▶ Catalyst already used in the industry
- ▶ 2 references (1 Japan, 1 USA)

Atol®: Industrial Reference in Japan (Sumitomo Chemical)

Highlights

- First phase under construction
- Start-Up in 2022
- Second phase foreseen for production ramp-up



Axens SOLUTIONS

- Production of polyolefins, a key chemical compound.
- Creating value, reducing crude oil consumption.
- Using waste as feedstock.
- Creating a circular economy model.
- GHG emissions reductions.

Axens

Powering Integrated Solutions

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Rueil-Malmaison, France

Date 26/10/2021

Press Release

Axens and Sumitomo Chemical Achieve Historical Landmark with the First Waste-based Polyolefin Production

Sumitomo Chemical has successfully conducted the first waste-based polyolefin production at its laboratory in Japan earlier this year, by use of the ethylene produced by Axens ethanol-to-ethylene technology Atol®. This process value chain is complemented with the upfront "Waste to Ethanol" technology by Sekisui Chemical.

This project promotes circular economy making it possible to turn waste into polyolefin, a key product in the petrochemical industry. With this first trial production, the project has entered into a new phase to corroborate the quality of the product on the laboratory basis until mid-2022 toward the next step, which will be the start-up of a pilot plant, currently under construction in Japan.

At full roll-out, the project will enable the production of waste-based polyolefin at industrial scale, which will represent a leapfrog towards a sustainable economy based on renewable carbon.

Axens Renewables Business Group Director Frédéric Balligand said: "We are excited to work with Sumitomo Chemical in this project that tackles the problem of waste plastics in Japan. Since the beginning of the project back in 2020, we have been seamlessly working with Sumitomo Chemical and this amazing teamwork has made it possible to keep project on track. This project paves the way towards plastics sustainability, accelerates the deployment of circular economy in Japan and reduces substantially the GHG emissions of the value chain."

About Atol®

Atol® is a technology for the most profitable production of polymer grade ethylene by dehydration of any kind of renewable ethanol from biomass or waste. The ethylene produced can be integrated in partial and/or total replacement of fossil hydrocarbon based ethylene in various downstream polymerization installations without requiring modifications. Atol® ethylene can therefore be fed into existing or new units of, for instance, polyethylene (PE), ethylene oxide/ethylene glycol [polyethylene-terephthalate - PET], polyolefins, alpha-olefins production for linear alkybenzene (LAB) and polyphosphazenes (PPAZ), benzene alkylation for polystyrene (PS), acrylonitrile-butadienestyrene (ABS), polyvinylchloride (PVC), etc. Atol® is the result of a partnership between Axens, Total and IFP Energies nouvelles (IFPEN).

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Thank you

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a new digital
journey