

Navigating Complexities of **Renewables** Processing

“Feedstocks, Legislations, Challenges & Solutions”

Marc Nicolas, VP Markets & Business Development

Agenda

- Who is Ketjen?
- Renewables processing
 - HVO
 - FCC Co-processing
 - Waste Plastics
- Feedstocks
- Legislations
- Key takeaways





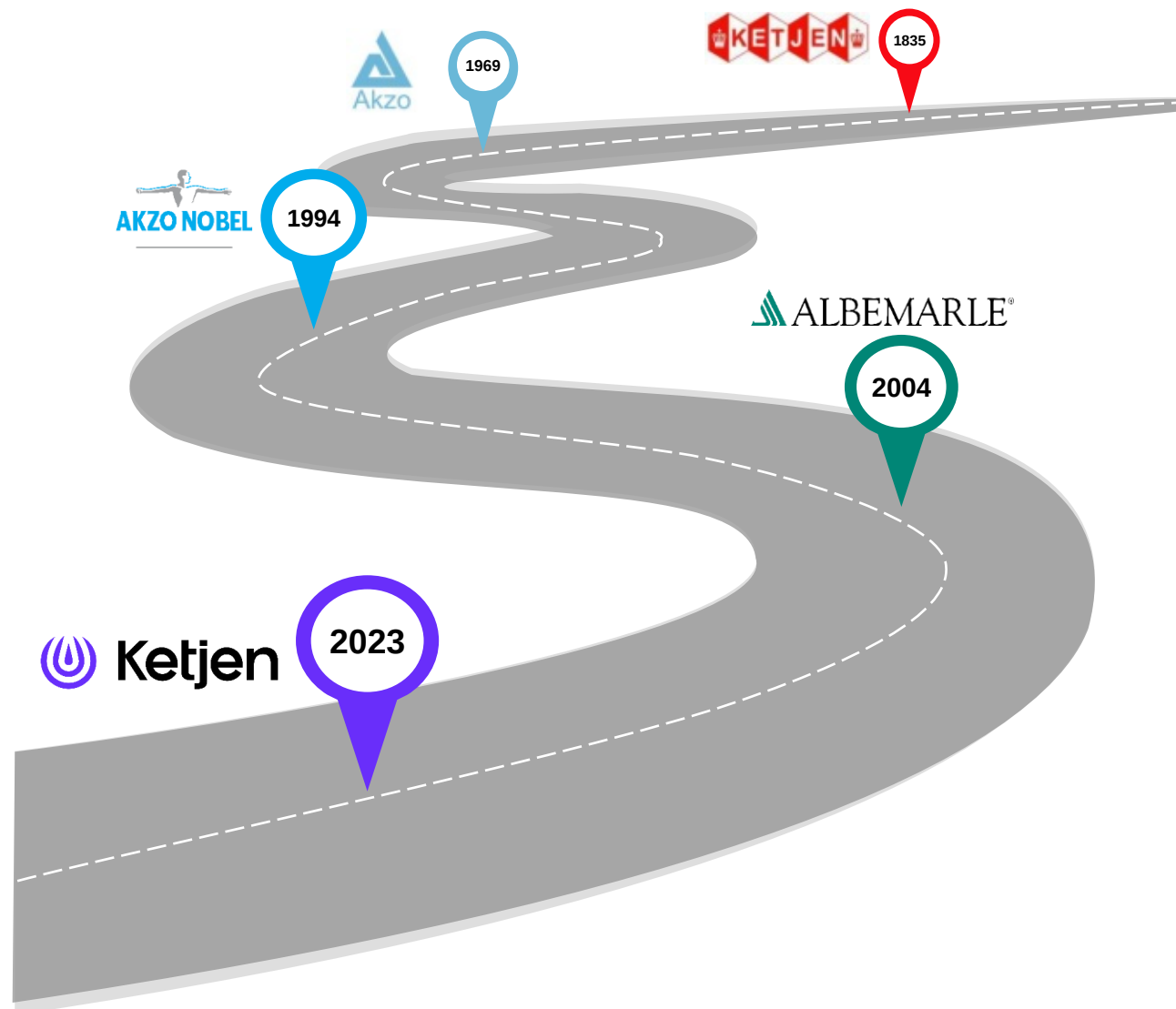
Who is Ketjen?

Independent catalyst supplier with decades of expertise



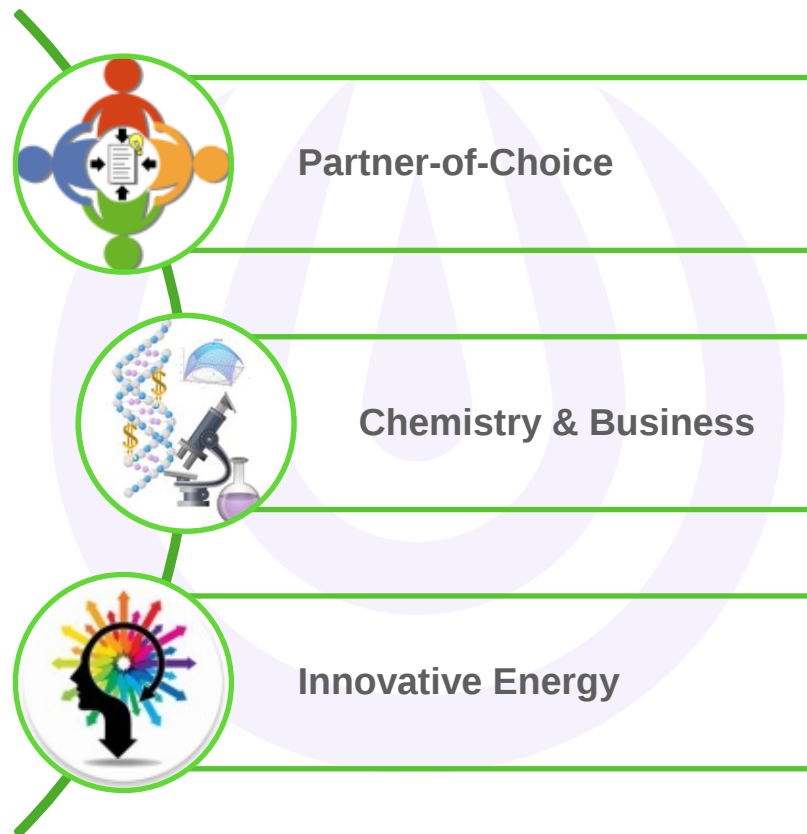
Spark success, unleashing the potential of advanced chemistry for industries that power the world of today and tomorrow

- 1835 Creating value since 1835
- 1947 Ketjen starts refinery catalyst business
- 2023 Reaffirm commitment to Refining & Petrochemical industries



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- # The Future of Catalysts Is Here
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-

Resilient partner, offering custom catalyst solutions for unique energy transition journeys to meet sustainability goals



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- ## Advanced solutions to deliver ever increasing performance
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- Enable leading producers in refining & petrochemicals industries to maximize the potential of their assets



Maximize performance
of assets



Expertise in advanced
chemistry



Custom catalyst
solutions



Renewables Processing

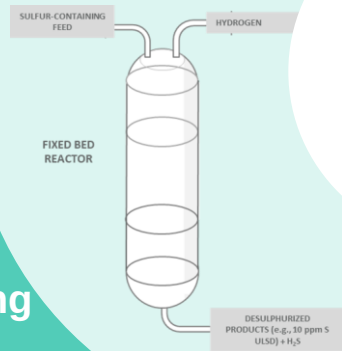
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- **Ketjen offers a comprehensive portfolio**
- **for renewables processing**



100% HVO

ReNewFine

Hydroprocessing

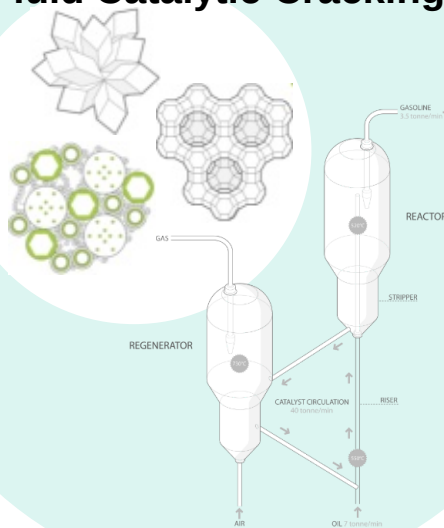


HVO
coprocessing

ReNewFine



Fluid Catalytic Cracking



FCC
coprocessing

ReNewFCC

Waste
Plastics

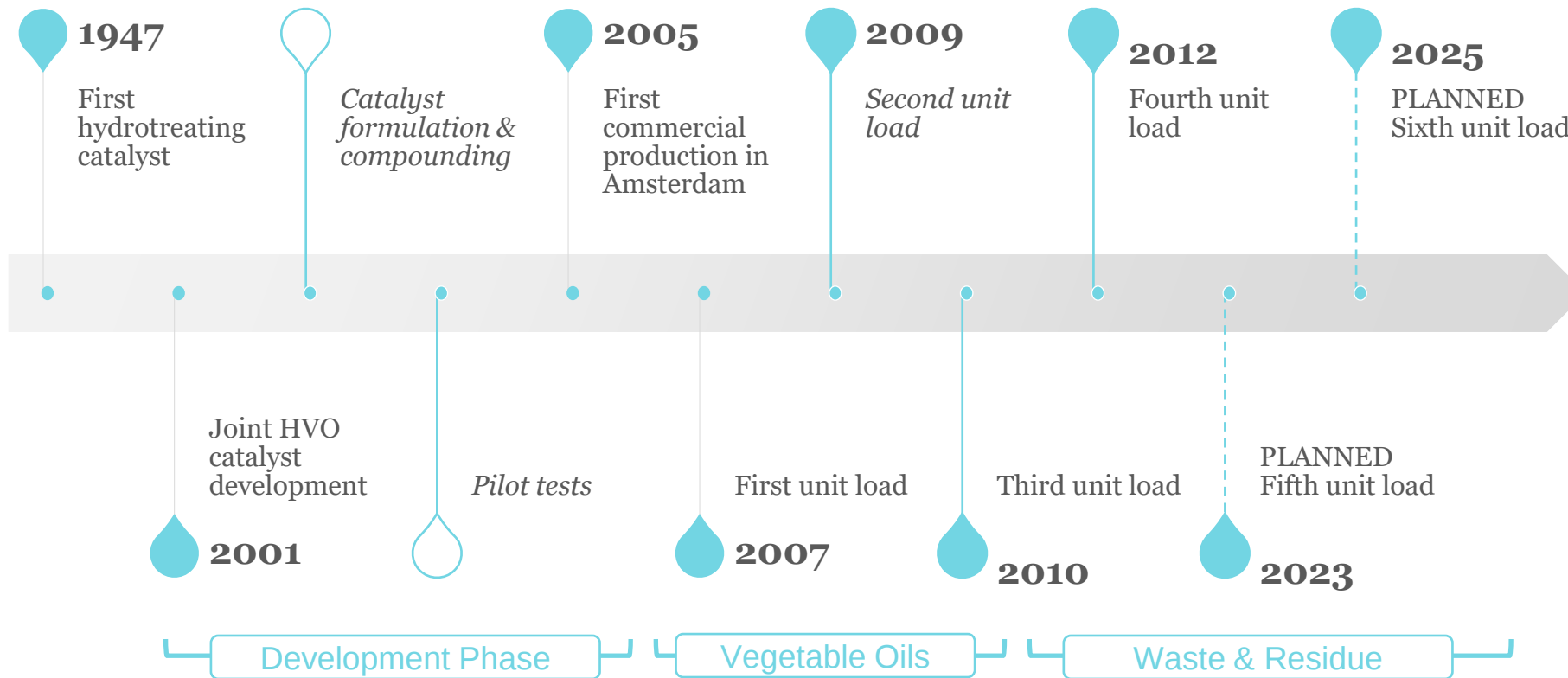
ReNewFine



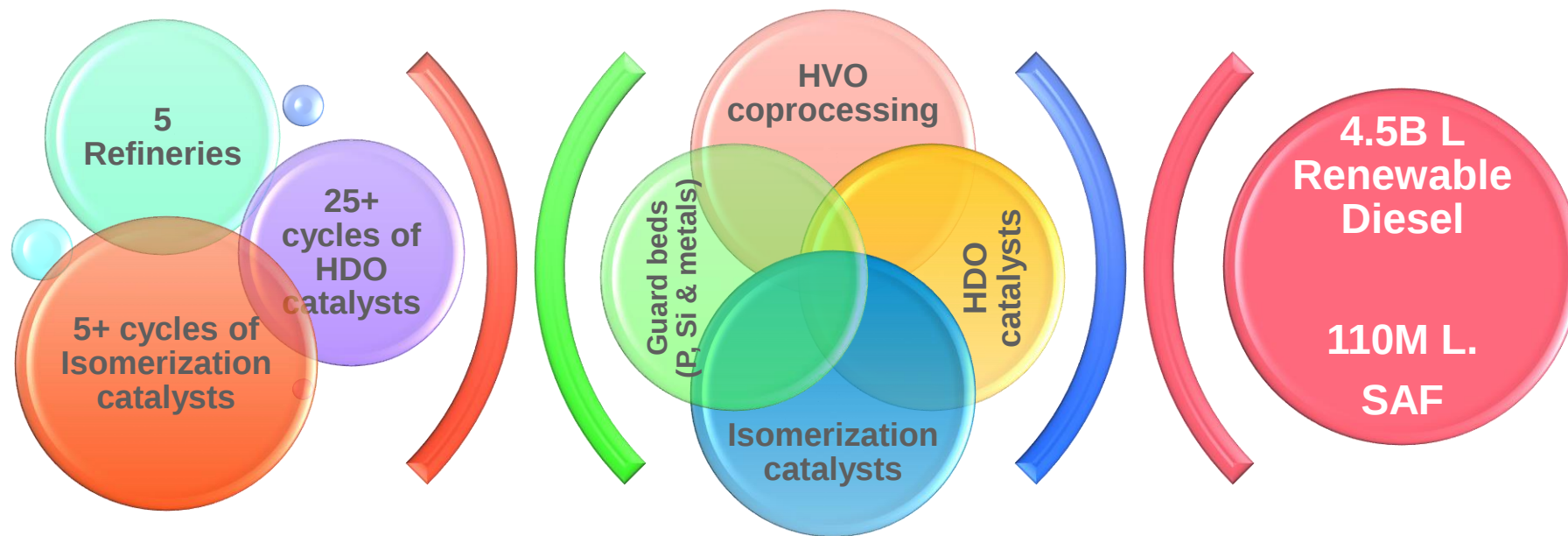


HVO

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- **20+ years of partnership with leaders in**
- **100% HVO processing**



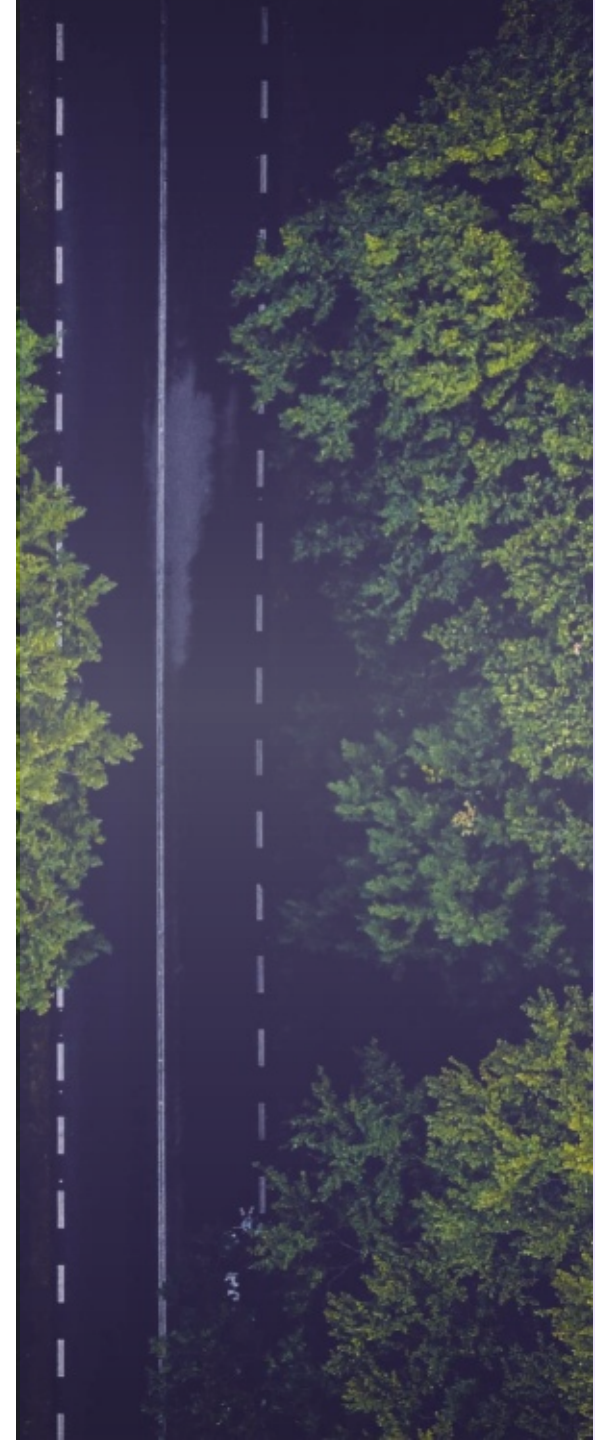
- Subject matter expertise & extensive experience  Ketjen
- in renewables processing



Commercial Applications

ReNewFine™ Portfolio

Total Production





FCC Co-Processing

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•
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Processing renewable & circular feedstocks in FCC requires catalysts for advanced chemistry



FOG Oils

Sources

- Edible/non-edible oil
- Used cooking oil
- Animal fat (tallow)

Main HC Types

- Natural oils & fats
- Triglycerides & fatty acids

Characteristics

- Known & predictable composition
- Some Impurities: **Na, K, Si, P**



Plas-Oils

Sources

- Waste plastics
- Used tires/rubber
- Electronic wastes

Main HC Types

- Products from pyrolysis or HTL
- (di)Olefins / Aromatics

Characteristics

- Highly variable
- High concentration of impurities: **halides, alkalis, P, Si, metals**



Bio-Oils

Sources

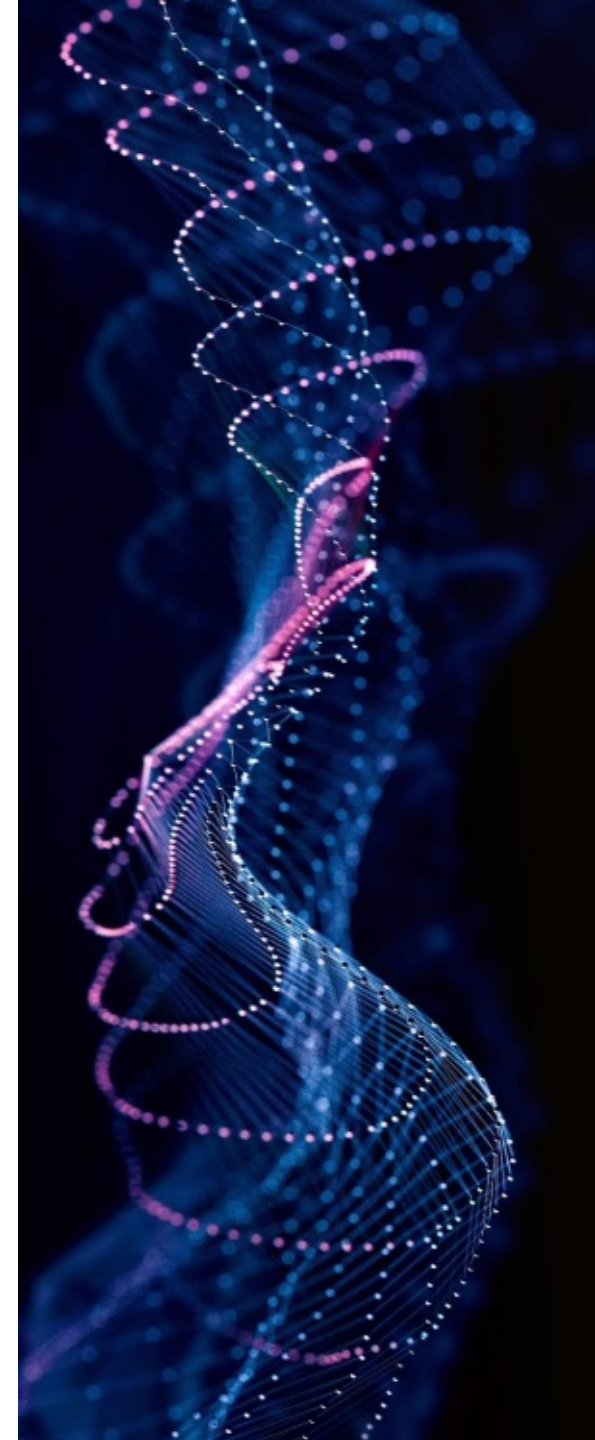
- Agricultural wastes
- Forestry wastes
- Municipal wastes
- Lignocellulosic mtrls.

Main HC Types

- Products from pyrolysis or HTL
- Unsaturated compounds

Characteristics

- Not compatible with fossil fuels
- Stability concerns
- High concentration of impurities: **O, alkalis, Ca, Fe, Mg, P, Cl**



• Ketjen catalyst solutions customized to address challenges to maximize yields and profitability



- Corrosion in OVHD due to HCN and NH_4Cl formation – nitrogen & halides

Collaborations with corrosion specialists and customers

- Feed impact on product slate
- Catalyst performance
 - Deoxygenation pathways
 - Metals tolerance
 - Customized catalysts

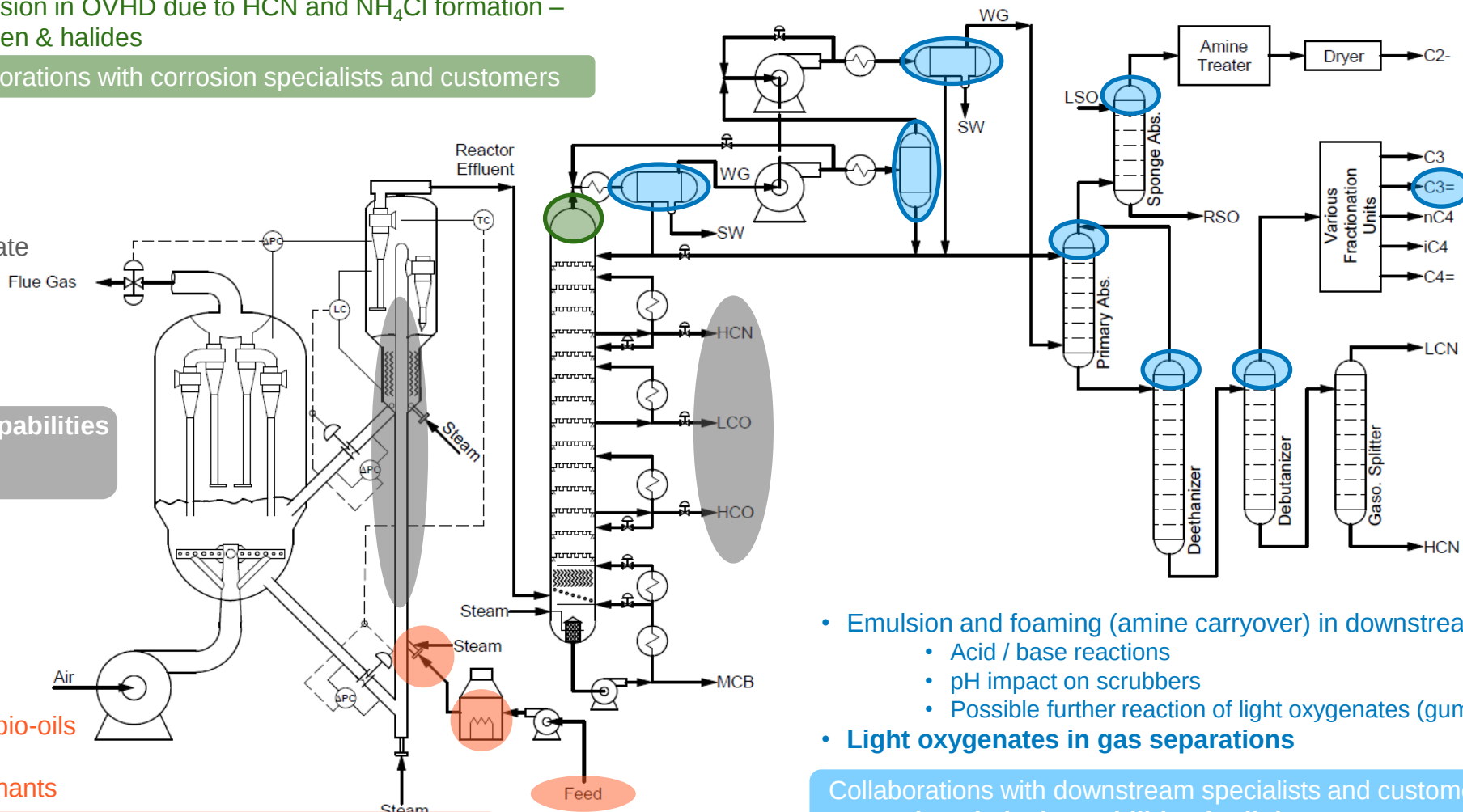
Testing & analytical capabilities

- Wide range of feeds
- Deactivation methods

- Storage
- Corrosion issues
- Injection & stability of bio-oils
- Free-water expansion
- Metals/halide contaminants

Collaborations with technology providers, feed producers, and corrosion specialists

Internal capabilities for feed characterization



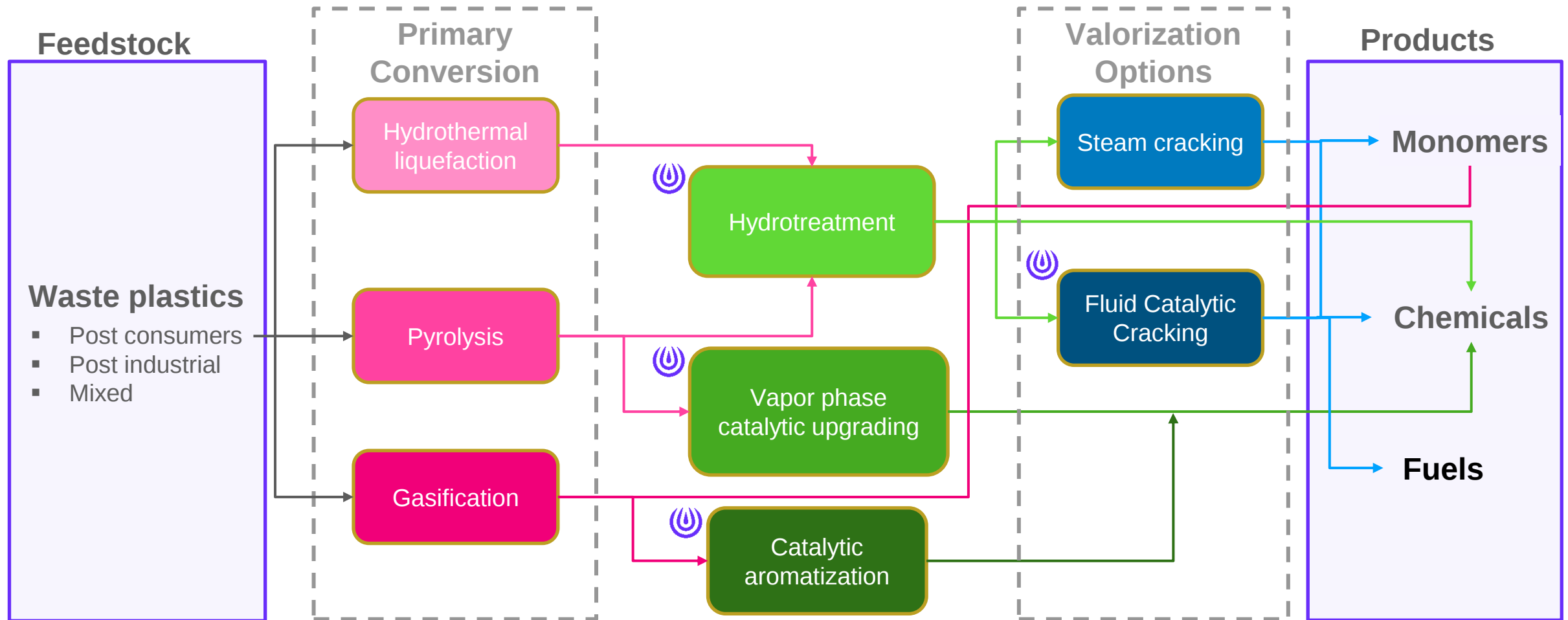
- Emulsion and foaming (amine carryover) in downstream gas treatment
 - Acid / base reactions
 - pH impact on scrubbers
 - Possible further reaction of light oxygenates (gums & acids)
- Light oxygenates in gas separations

Collaborations with downstream specialists and customers
Internal analytical capabilities for light oxygenates



Waste Plastics

- Ketjen catalysts are essential for chemical recycling of waste plastics

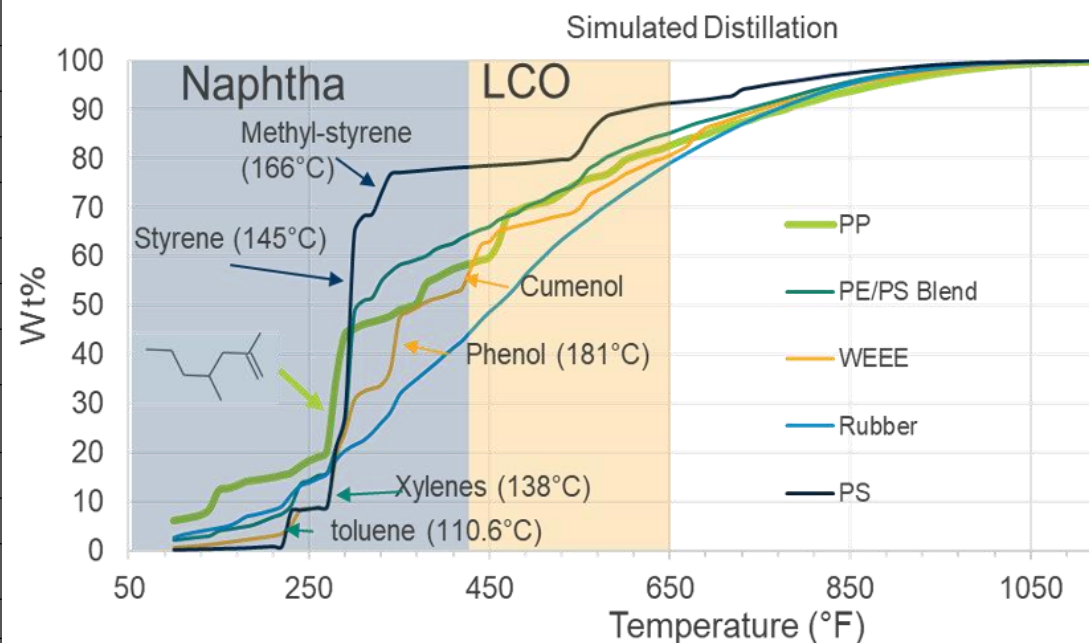


- **Composition & contaminants in waste plastic pyrolysis oils vary with different source of plastic**



Advanced catalyst technologies are required to handle the diverse composition & contaminant levels to maximize performance and value

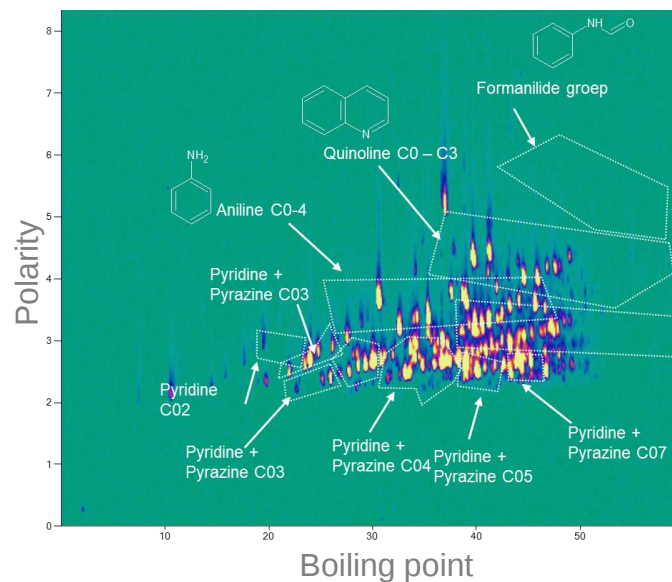
Contaminant		PP	PE/PS Mix	WEEE	Rubber Shred
Al ₂ O ₃	ppm	100	110	490	110
Br	ppm	0	0	6870	100
CaO	ppm	130	120	120	140
Cl	ppm	tr	70	2640	110
Fe ₂ O ₃	ppm	10	30	10	0
MgO	ppm	230	680	200	150
NiO	ppm	0	0	10	0
P ₂ O ₅	ppm	40	40	190	20
Sb ₂ O ₃	ppm	0	0	240	0
SiO ₂	ppm	190	220	7320	380
SO ₃	ppm	50	30	640	20660
Oxygen	ppm	<1500	<1500	62244	4086
ConCarbon, wt%		0.06	0.02	1.77	0.73
API		49.5	32.4	13.7	21



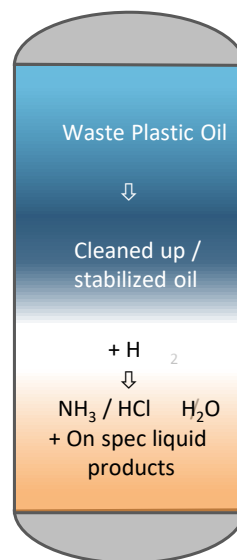
- Ketjen provides innovative, customized and reliable catalyst solutions



Hydrocarbon Characterization



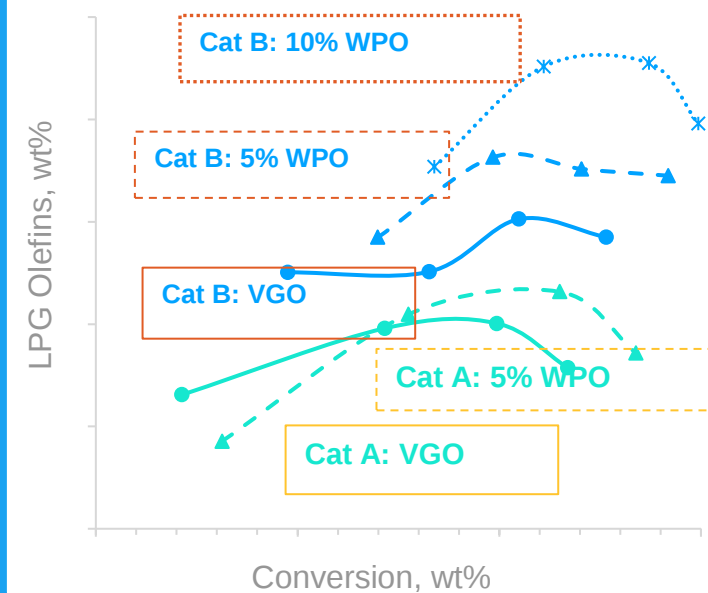
Catalyst Expertise & Modeling



Guard Bed Development and Design

Catalyst Selection Experience, STAX™ Technology, and Kinetic Modeling

Customized Catalyst Development

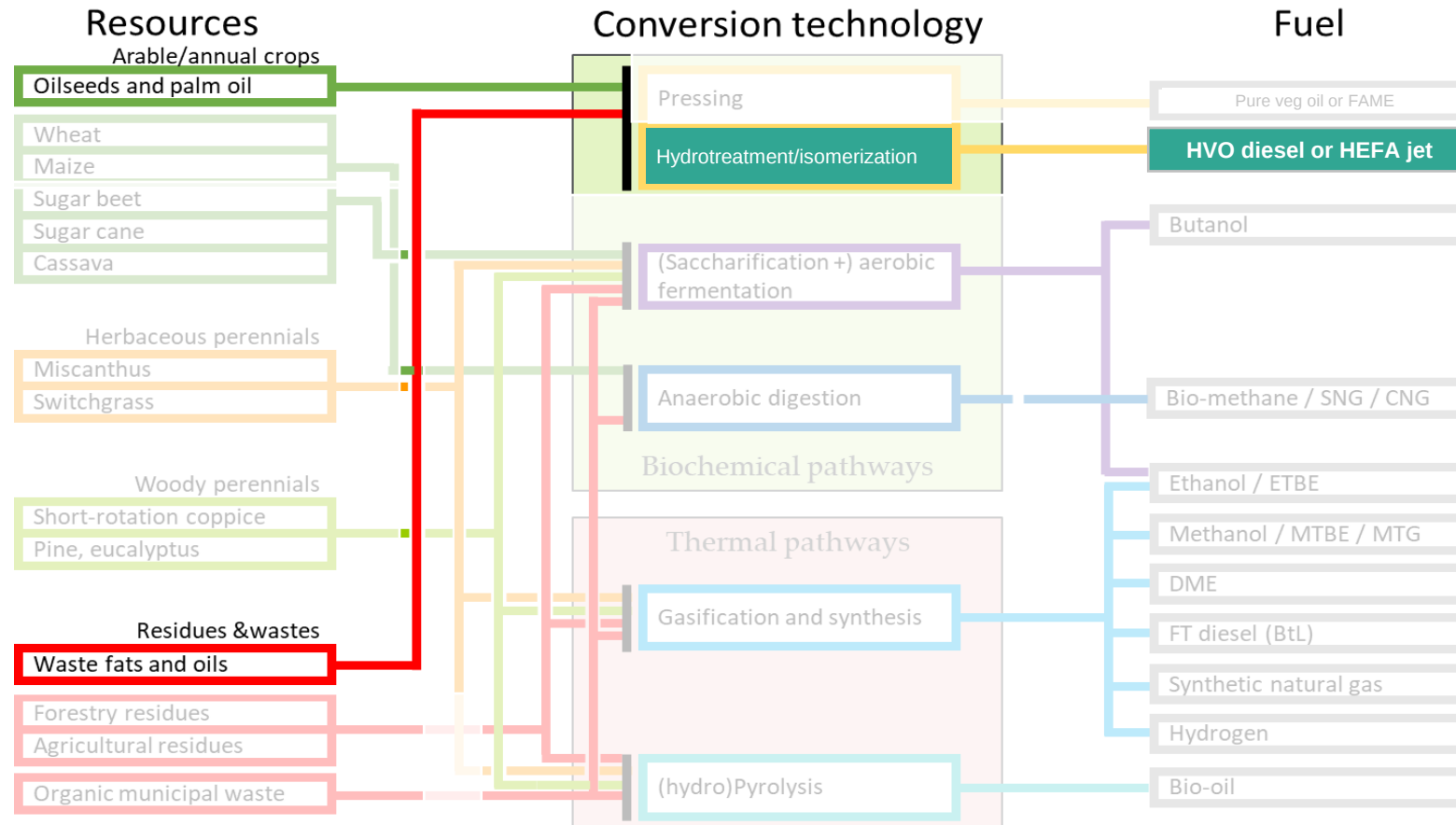




Feedstocks

Many technology pathways lead to renewable fuels

HVO (Hydrotreated Vegetable Oils) currently the only commercial technology to produce drop-in diesel & jet fuels



**HVO
pathway**

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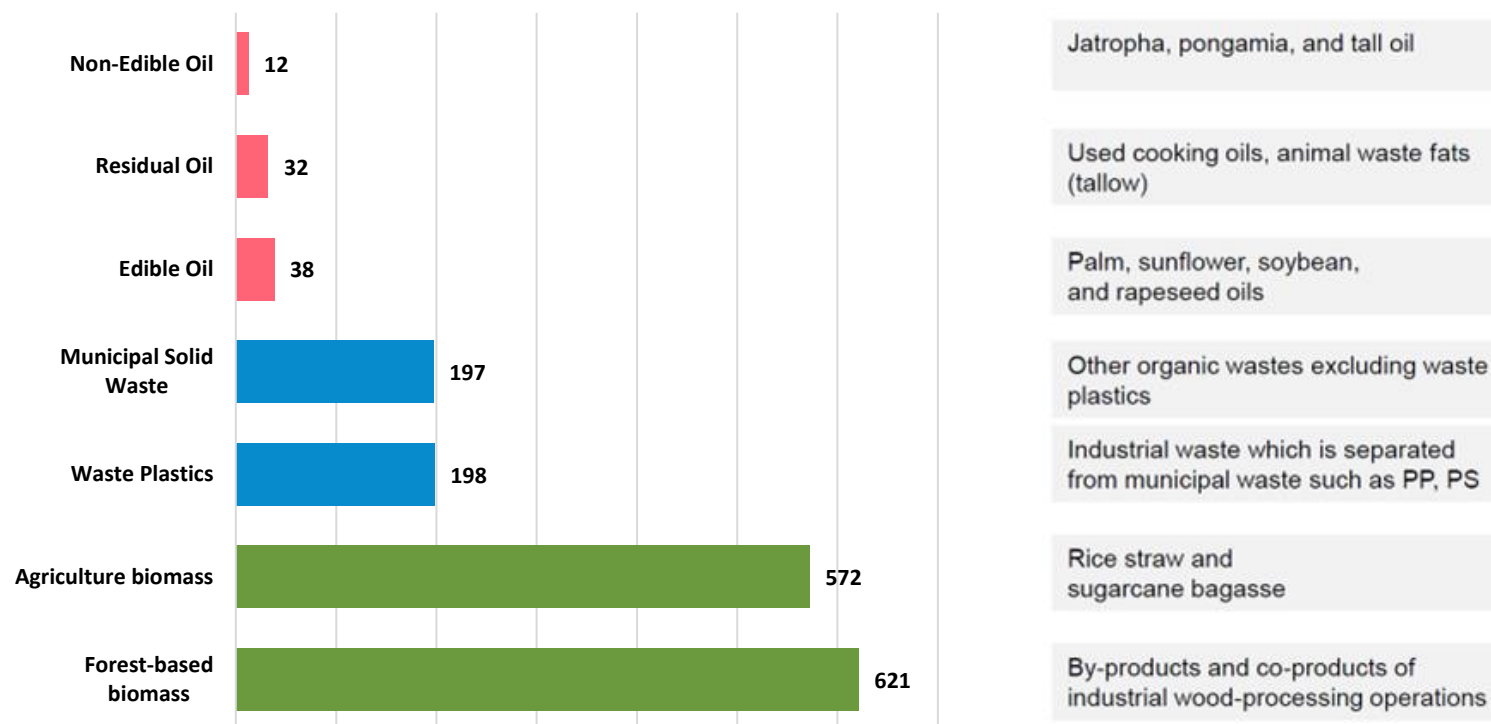
Biofuels supply limited by feedstock



Feedstock resources define future of biofuels

- Limited potential of oils as feedstocks
- Regulations to use more waste/residue
- Significant potential in waste materials, agricultural and forest residue

Total Alternative Feedstocks Supply in 2030 – High Case
(Million tons / year)



Source: ADI Analytics, validated by Ketjen



- **Ready for successful HVO commercialization**
- Technology readiness challenges timing of new biofuels pathways



**Technology
Readiness Level (TRL)**

Technology concept and pilot test proofs					Pre-commercialization		Commercial deployment	
1	2	3	4	5	6	7	8	9

Hydrotreatment of vegetable oils to diesel / jet

Biomass gasification + Fischer-Tropsch to diesel / jet

Alcohol to jet

Biomass pyrolysis + hydrotreatment to diesel / jet

Power-to-X to diesel / jet

**Years until impactful
commercialization**

0

5-10

5-10

10+

10+





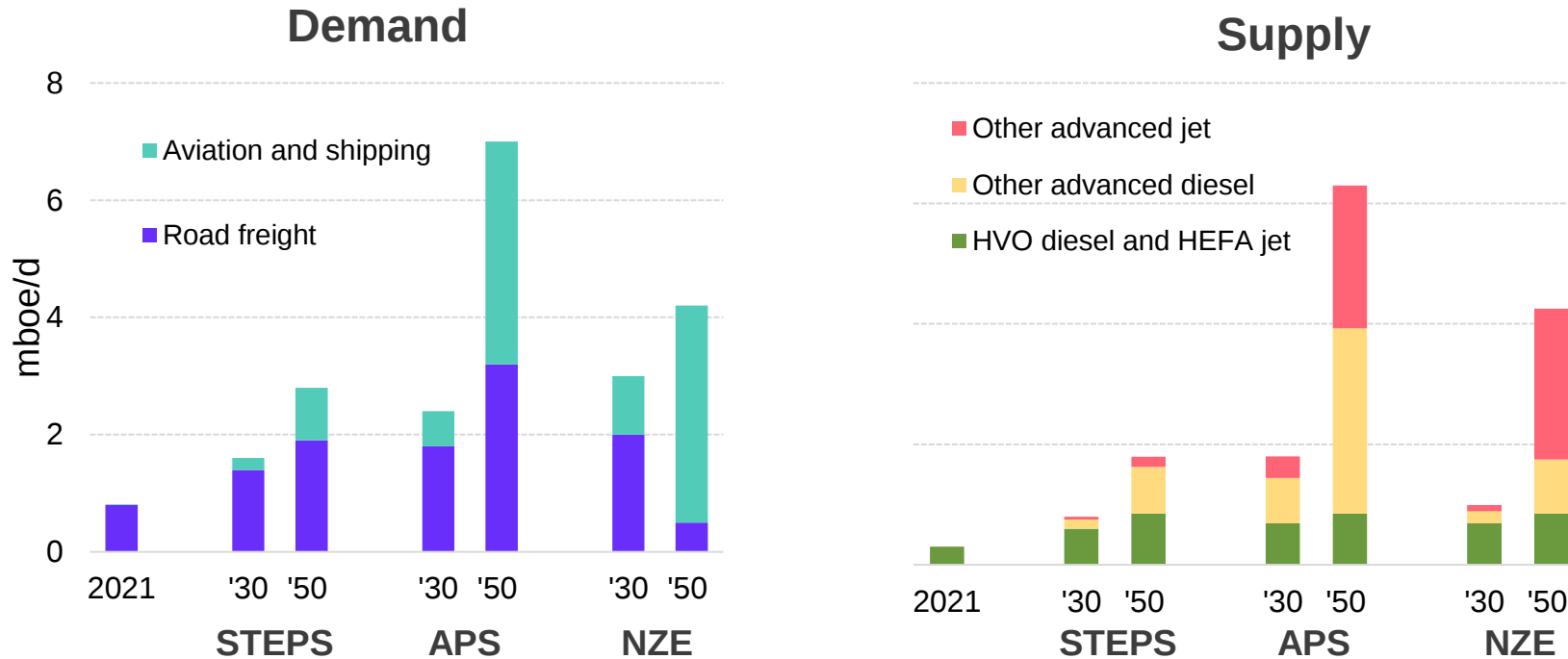
Legislations

Biofuels supply will be challenged for 2030



Scenarios illustrate the longer term investment uncertainty

- Supply growth is limited in STEPS
- Supply/demand gap is largest in 2030 in NZE
- Road freight sizable uncertainty depending on electrification



STEPS = Stated Policies Scenario, APS = Announced Pledges Scenario, NZE = Net Zero Emissions scenario

Source: IEA Energy Outlook 2022 and Ketjen estimates

Key Takeaways



- Renewable Diesel and SAF from **HVO/HEFA** at **scale** and **de-risked**
- Feedstock availability and regulatory frameworks necessitate new **technology pathways** and scaling depends on scenario implementation
- Timeline to develop new pathways may result in **precarious investment decisions** and pose challenges to Net Zero commitments
- **Ketjen** offers a comprehensive catalyst portfolio for renewables processing and forges **deep and long-lasting partnerships** with our customers to support their energy and material transitions





Join us!

at our seminar on processing
renewable feedstocks

Experts from Neste, Concawe,
Hellenic Petroleum, Motor Oil (Hellas)
and Ketjen will share more



SCAN TO REGISTER



PROCESSING RENEWABLE FEEDSTOCKS SEMINAR

 12th June, 2023

 Athens, Greece

 09:00 - 17:00

 Seating is limited.
Register today!