



Stand-alone vs- co-processing

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Agenda

**Why
hydroprocessing?**

**Overview
commercial units
processing
renewables**

**New technical
challenges for
refineries**

**Stand alone vs.
co-processing –
how to choose?**

**Conclusion
Trends
Questions**



Why hydroprocessing?

How can biofuels be produced?

Feedstocks

Vegetable oils

e.g. Carinata

Animal fat

e.g. Tallow, Lard

Waste

e.g. Used Cooking oil

Technology

Esterification

Hydroprocessing

Biofuel

Biodiesel/FAME

Renewable jet fuel

Renewable diesel

How can biofuels be produced?

Advanced Feedstocks

Ligno-cellulosic biomass

Algae

Municipal waste

Technologies

Pyrolysis +
Hydroprocessing

Hydrothermal
liquefaction +
Hydroprocessing

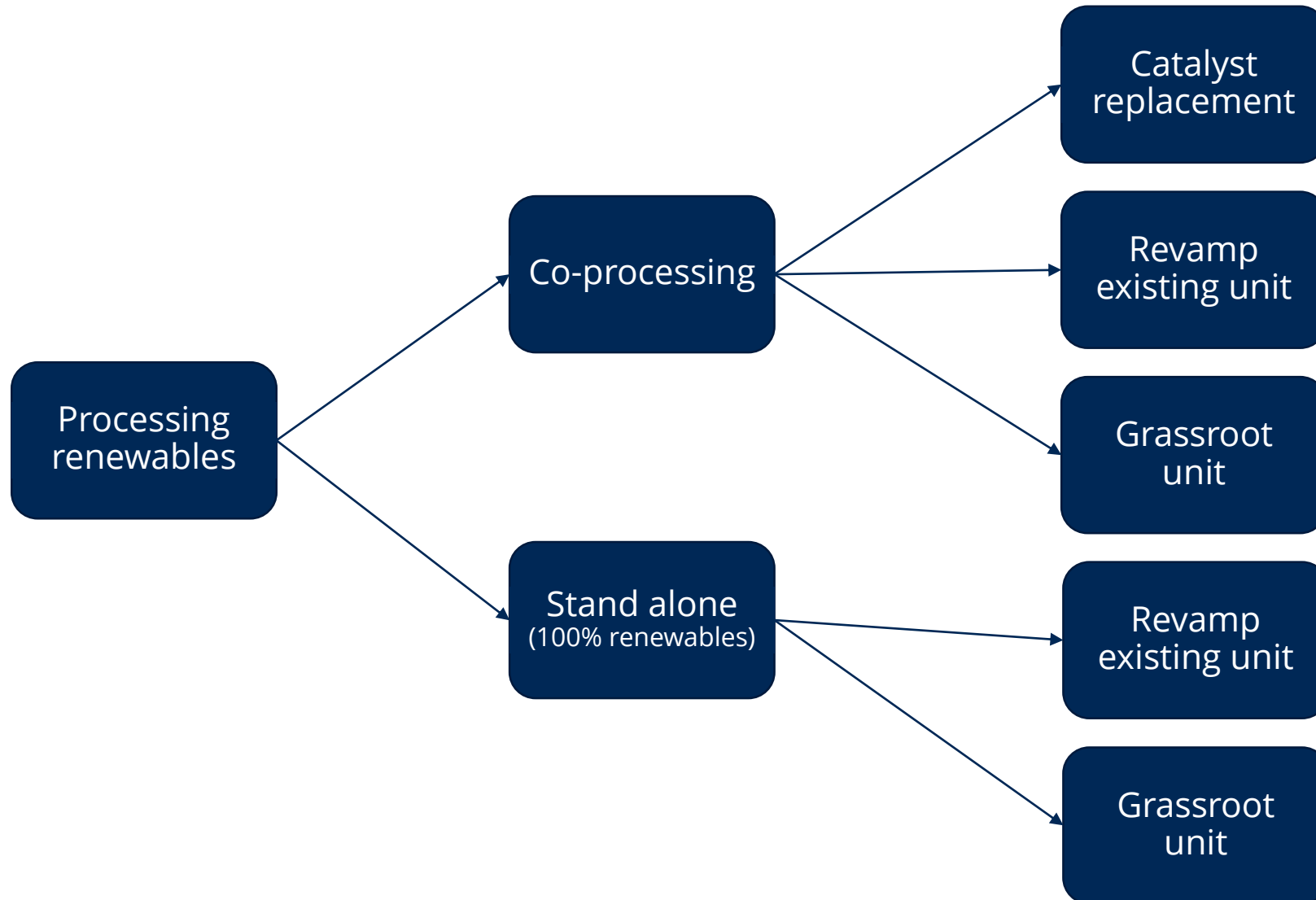
Gasification + Fischer
Tropsch +
Hydroprocessing

Biofuel

Renewable jet fuel

Renewable diesel

How to upgrade renewable feedstocks into renewable transport fuels?





Overview of commercial units processing renewables

Topsoe's experience with renewable feedstocks

<i>Feed</i>	Plant triglyceride	Animal triglyceride	Tall oil	Sulfate turpentine	Hydro-thermal bio crude	Pyrolysis oil	Algae-derived pyrolysis oil
<i>Derived from</i>	Various vegetable oils	Animal fat	Wood	Wood	Biomass or coal	Biomass	Algae
<i>Main product</i>	Diesel and jet	Diesel	Diesel	Gasoline	Jet fuel	Gasoline+ diesel	Gasoline+ diesel
<i>Topsoe's R&D test carried out</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Industrial operation (Topsoe's catalyst)</i>	Yes	Yes	Yes	No	No	Yes	No



New technical challenges for refineries

Comparison of various feedstocks

Straight run diesel	Vegetable oil	Crude tall diesel
Alkanes and naphthenes (70-80%)	Fatty acids (80-100%)	Tall oil free fatty acids (70-90%)
Aromatics (20-30%)	Free fatty acids (0-20%)	Rosin acids (10-20%)
Sulfur compounds (0.5-1.5%)	Unsaponifiables (0-2%)	Unsaponifiables (e.g. sterols) (0-8%)
Nitrogen compounds (100 ppm)	Contaminants (P, Na, etc) (ppm level)	Contaminants (P, Na, etc) (ppm level)
No oxygen	High O content	High O content

Technical challenges

Pressure drop

Contaminants and coke

Deactivation

Contaminants and coke

Corrosion

FFA, resin acids, carbonic acid, Cl

Hydrogen consumption

Exotherms

Composition of recycle gas

C₁, C₃, CO, CO₂

Product properties

Cold flow properties, end point reduction, aromatics, etc.



Stand alone vs. co-processing – how to choose?

Stand-alone vs. co-processing?

Company's objectives

Refinery? New player? EU? USA? Other?

Which product?

Renewable diesel?
HVO-100? MK-1?
Renewable jet fuel?
Specs? Credit?

Investment

Existing infrastructure?
Material? Storage?
Pre-treatment? H2?
Reactors?

Feed

Supply? Pricing?
Availability? Stability?
Sustainability?
Quality? Analyses?



Conclusion, Trends, Questions

How to upgrade renewable feedstocks into renewable transport fuels?

