

refining & marketing



Green Refinery

eni

EU and USA promote the transition to 2nd generation biofuels

Depending on the feedstock and the time-to-market expected, ethanol and biodiesel can be traced back to different 'generations':

OPPORTUNITIES

RISKS

First generation

agrifood feedstocks

- large & liquid markets
- support from EU and USA regulatory targets

- strong social and environmental impacts (food vs fuel)
- climate risk
- phase-out legislation ?

Second generation

agricultural non-food & agro/urban waste feedstocks

- favorable environmental impact
- valorization of waste materials
- strong regulatory support

- high production costs and complex logistics
- climate risk for some productions

Third generation

non-agricultural high innovation feedstocks

- does not compete for use of the land resource
- high technological added value
- potentially large yields

- immature technologies
- strong investment in R&D required
- high production costs



Diesel



Biodiesel FAME



Ethanol



Gasoline refining & marketing



eni

The 5 biofuels industry challenges to overcome



FEEDSTOCK AVAILABILITY

Greater supply security

Selection of high productivity feedstocks

The cultivation of rapeseed in all European arable land (100 million ha) would satisfy only 40% of the European consumption of diesel



PRODUCTION COSTS

Costs convergence with petrol /diesel in the long term

Exploit opportunities for cogeneration (heat / electricity) if any



SOCIO ENVIRONMENTAL SUSTAINABILITY

Neutrality vs. food commodity prices (food vs. fuel)

Ensure reduction of CO2 emissions in the life cycle (2° and 3° generation)



LOGISTICS

OPTIMIZING TRANSPORTATION AND STORAGE TO DEAL WITH:

Low energy density biomass

Perishability of feedstock and products

A small biorefinery 2G 3 mb / d requires 700 kton of cellulose, which are transferred by 50,000 lorries a year, (one every 10 minutes)



BIOFUEL QUALITY

CHEMICAL CHARACTERISTICS SIMILAR TO PETROL / DIESEL TO ACHIEVE:

overcoming blend wall

consumer acceptance common network distribution / sales

Prospects for long-term market car / truck



First Generation bio-components

Early

Bio ETBE

(Ethyl tert-butyl ether)

→ High cost

Hygroscopic

Bio Ethanol

→ Low Calorific Value

→ Hygroscopic

FAME

(Fatty acid methyl esters)

→ Bio-fouling

→ Low Calorific Value

→ Hygroscopic

New

HVO

(Hydrogenated vegetable oil)

→ High Caloric Value

→ Hydrocaboric

→ High Cetanic

Others

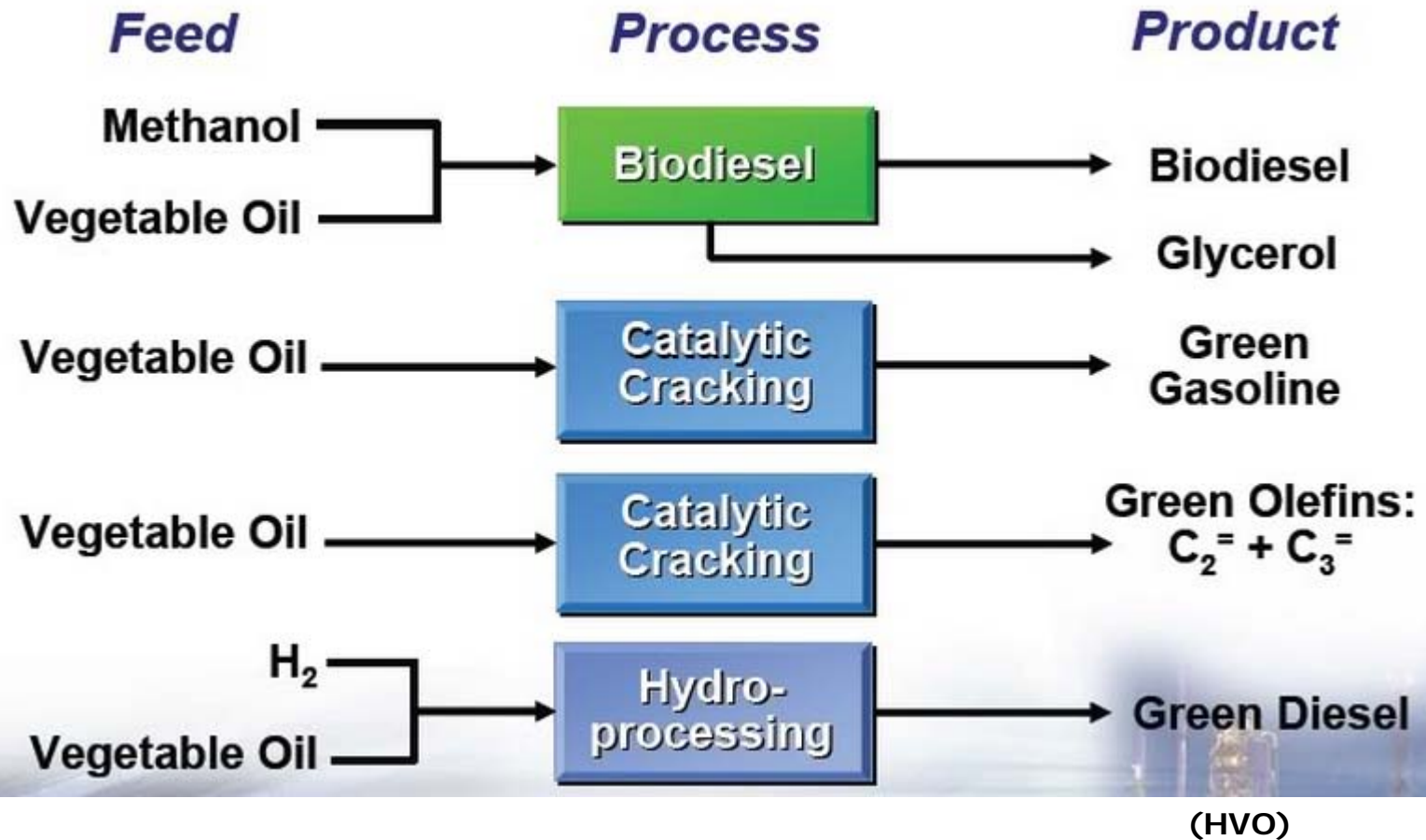
.....



eni

refining & marketing

Vegetable oil processing routes



eni

refining & marketing

eni's answers to environmental requirements & regulations

Industry need

- Environmental sustainability and compliance with legal requirements on renewable sources in transport by:
 - Increased use of sustainable renewable sources

eni's answer

- ➔ New production patterns for biofuels and renewable components of high quality at competitive prices
- ➔ Development of second and third-generation biofuels
 - ➔ **7** Green Refinery
 - ➔ **8** Green Refinery 2.0

Green Refinery: eni's main technological response to biofuel transport obligations

challenges and eni's response

- European 2020 regulatory biofuels obligations are difficult to reach through traditional biofuels:
 - **Technical limitations of conventional biodiesel (FAME)** to diesel blending up to a maximum of 7%
- Advanced hydrogenation technology (Ecofining) developed and patented by Honeywell UOP and eni
- **First industrial application** in Venice by the refinery conversion into bio-refinery (patent pending)
- **Minimization of CAPEX** (~ € 100 Mln for 560 kton)

advantages of eni's solution

- **High quality product of that:**
 - **improves the eni diesel pool** making it distinctive compared to other operators without an increase in cost
 - **helps to overcome the limits of existing technology (blending ~ 30%)**
 - **is better in terms of environmental sustainability** (reduction of particulate matter) **and engine efficiency**
- **Flexible technology** capable of processing **even II and III generation feedstocks**



Green Refinery Project leverages the innovation of processes and products resulting from eni's research



- eni's commitment to **technological innovation** and have distinctive technologies compatible with the environment
- Development of processes for the production of **sustainable biofuels** in line with European directives



- Flexible process for hydrotreating of renewable component:

- Patents eni / Uop
- "2010 Sustainable Energy Award"

I generation



II+III generation



- Innovative product of superior quality** compared to conventional biodiesel (FAME)
- Green Diesel vs. FAME**
 - Higher calorific value** (10.5 Mcal/kg vs. 9.1 Mcal/kg)
 - Blending in diesel fuel** (30% vs 7%)
 - Density** (780 kg/m³ vs. 883 kg/m³)
 - Performance at low temperature** (down to -20 ° C vs. -5 To +15)
 - Cetane number** (70-90 vs. 50-65)

refining & marketing



eni

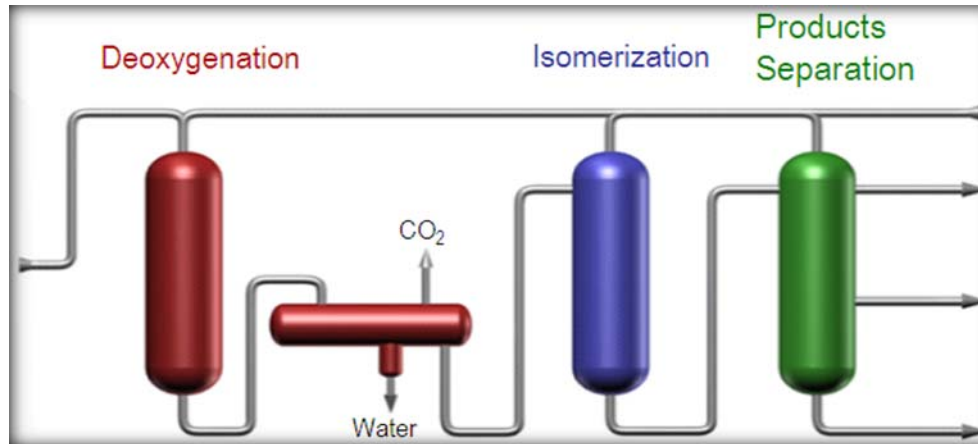
the "heart" of the project, minor amendments to 2 existing refinery units using Ecofining technology



*Palm oil
(base
case)*



*1st and 2nd
generation
feedstocks*



Project in progress
**Operation start up
2014**



- *Green GPL*
- *Green Nafta*
- *Green Diesel*
- *Green Jet*

eni filed a patent for conversion of conventional mineral oil refineries in biorefineries

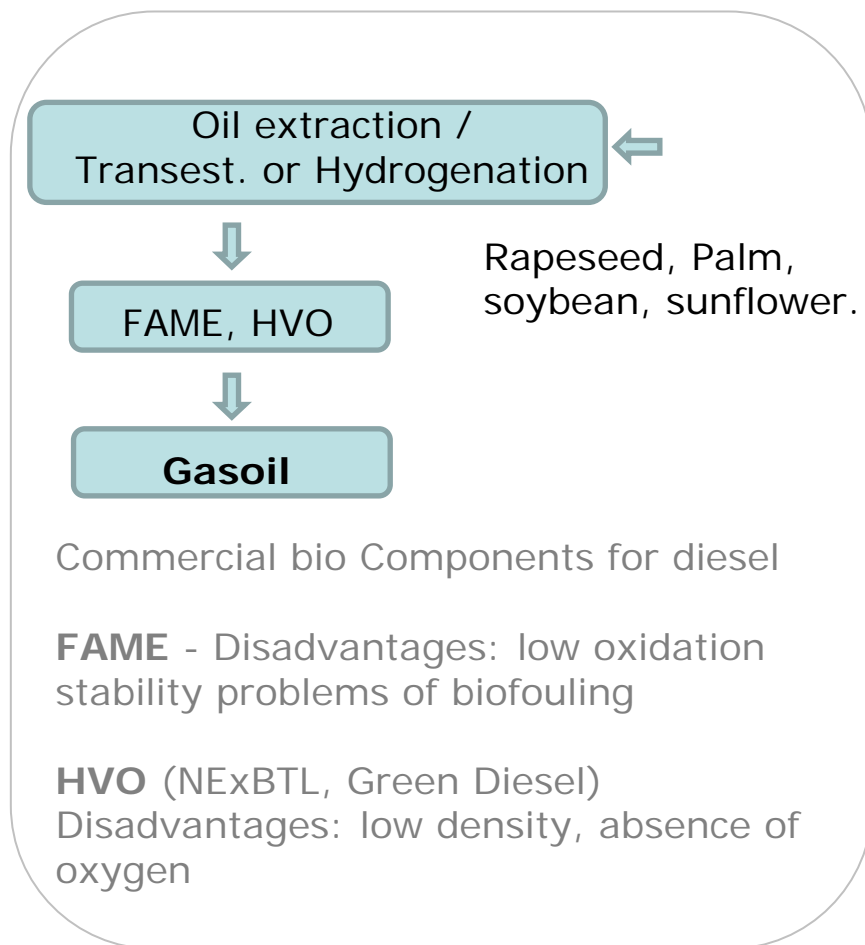
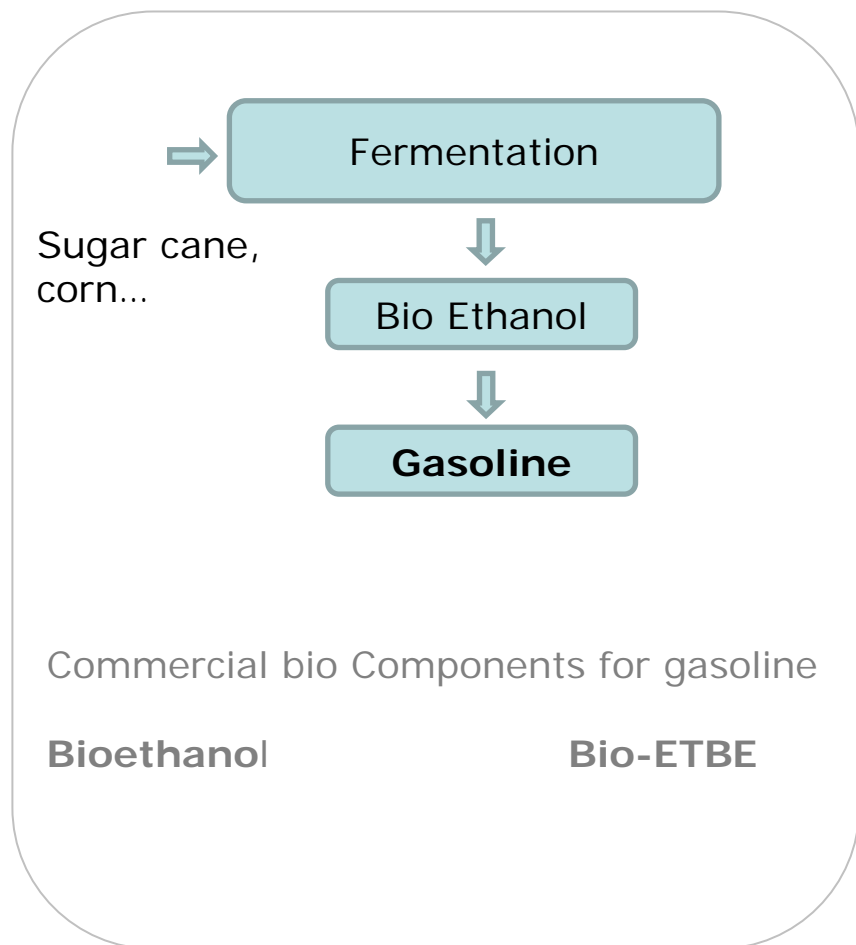
refining & marketing



eni

Commercial biofuel components

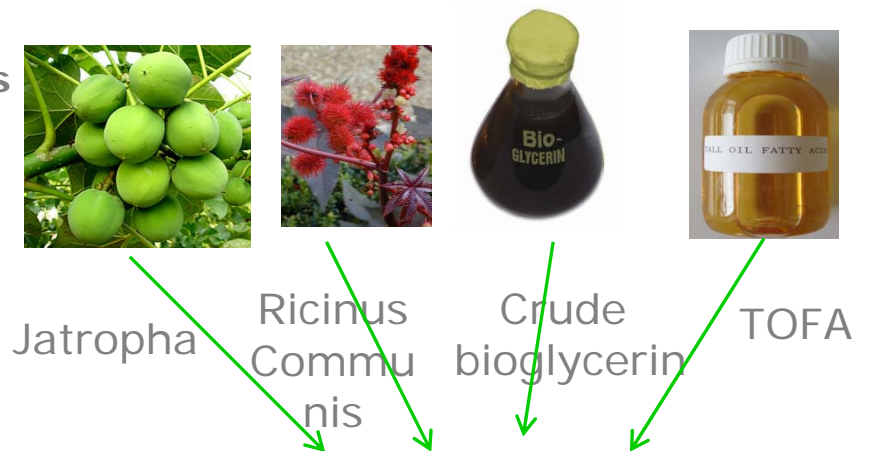
The bio-fuel components currently in production derive both from the "fermentation" & vegetable oils supply chains



Second & third generation bio-components

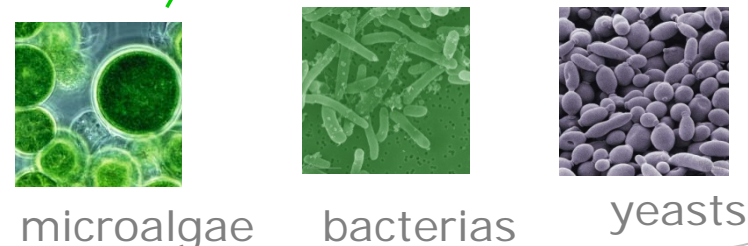
A proposed cap of 5% for the contribution of food based biofuels towards the Renewable Energy Directive target that 10% of energy for transport should be renewable by 2020

Second generation feedstocks such as corn stover, forest residues, primary mill residues, municipal solid waste, tall oil, TOFA, jatropha oil, castor oil, crude bioglycerin,...



HVO & NEW PRODUCTS

Third generation feedstocks such as algae, microalgae, bacteria, yeasts ..



refining & marketing



eni