Eni contribution to Energy Transition

New fuels for transportation and sustainable mobility

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Eni's strategy to Energy Transition in transportation

green 15% eni diesel+

biofuels

- **green** conversion of Venice and Gela refineries
- **low emission fuel** production
- initiatives for the **recovery of exhausted vegetable oils**
- research on **bio-advanced feedstock**

LNG BLUE CORRIDORS

natural gas

- **CNG** retail network development
- **LNG** in heavy transport (truck on main routes and maritime)

smart mobility

- **car sharing** development
- **5 cities** (Milano, Roma, Torino, Firenze, Catania)
- 500.000 users
- 12.000 rents per day

R&D

- A "memorandum of understanding" has been signed between Eni and FCA for joint activities on Sustainable Mobility
- Several activities have been kicked of:
  - Development of an alternative fuel with high alcohol content,
  - CCS-CCU project, for Carbon Capture and Storage
  - ANG, Adsorbed Natural Gas project

Eni vision on Biofuels

EU Refinery Industry Crisis

Bio Quality Improvement

EU biofuels needs

ECOFINING™ Eni-Uop Technology

Re-Design a traditional Refinery!

Biorefinery

Patent Eni n° MI2012A001465 – Sept. 2012

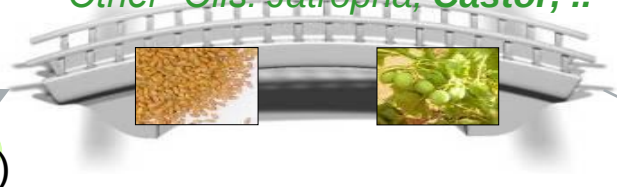
- Produce real "drop-in" fuels instead of fuel additives.
- Leverage existing refining/ transportation infrastructure:
  - Lowers capital costs, minimizes value chain disruptions, and reduces investment risk.
- Focus on path toward advanced generation feedstocks.

~~*Oxygenated Biofuels*~~
~~Ethanol~~ ~~Biodiesel~~

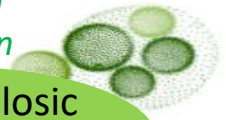
Hydrocarbon Biofuels
Diesel Jet Gasoline

First Generation
Natural oils (vegetables, greases)

*"Other" Oils: Jatropha, **Castor**, ..*

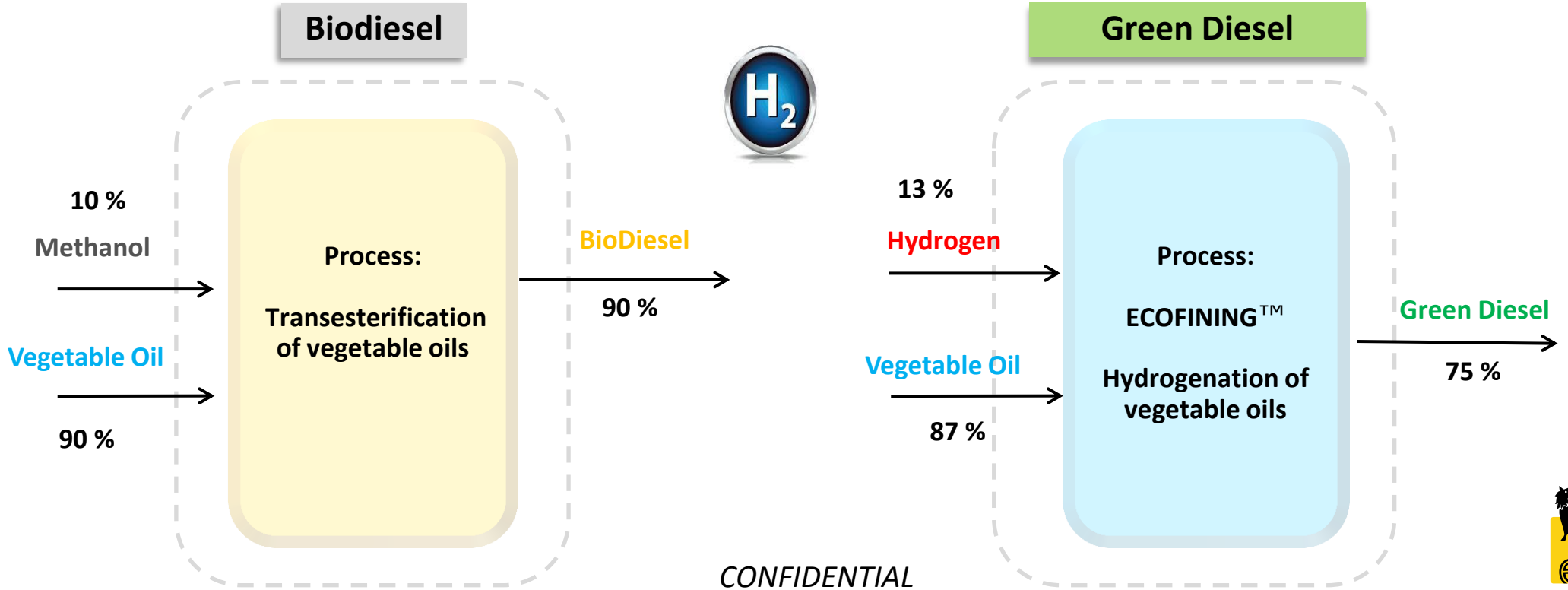


Advanced Generation
Lignocellulosic biomass, algal oils



Biodiesel vs Green Diesel

- Eni, in partnership Honeywell-UOP, has developed a proprietary technology, EcofiningTM, to overcome qualitative issues related to traditional biodiesel through an innovative hydrogenation process.
- The convertion of vegetable oils for the production of traditional biodiesel is realized using methanol as feedstock.
- Ecofining™ process instead, thanks to the use of pure hydrogen, is able to completely remove oxygen from the organic feedstock, obtaining a final product, called Green Diesel, which has a totally hydrocarburic composition. This chemical structure determines a full compatibility with fossil diesel and allows the blending of high percentages without any qualitative issue. Moreover, Green Diesel quality does not depend on feedstock type.



Renewable Component Characteristics

Biodiesel

Triglyceride + Methanol → Biodiesel + Glycerol

- **Low chemical stability**
- **Quality variability**
- **Microbiological contamination and filter blocking issues**
- **Low energy content**
- **Tendency to dilute engine lubricant**
- **Additivation limit at 7%**

Green Diesel

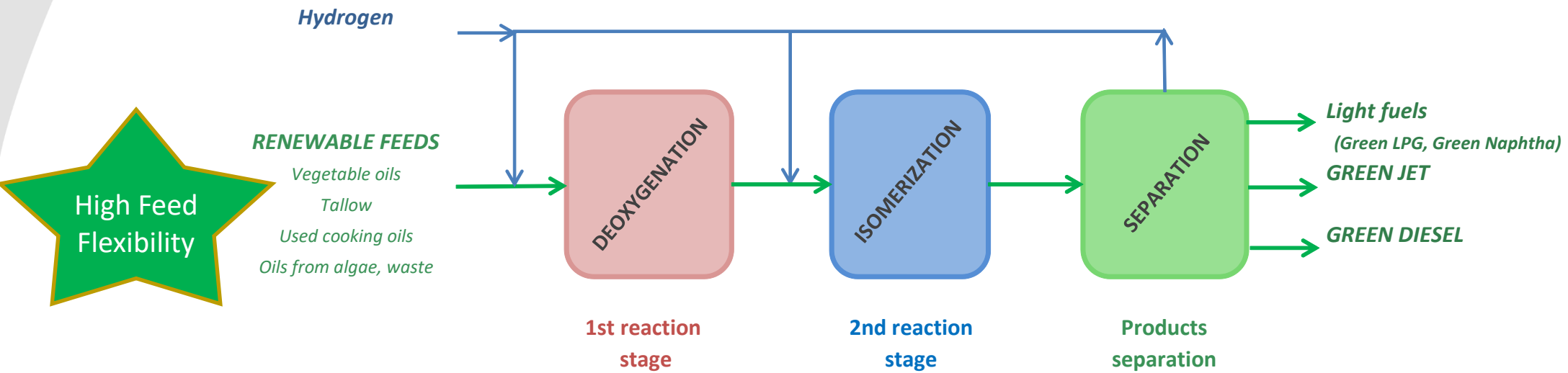
Triglyceride + Hydrogen → Green Diesel + Water

- **Higher chemical stability and full compatibility with fossil diesel**
  - Obtained through a hydrogenation process that completely eliminates oxygen
- **Very low water solubility**
  - Prevent microbiological contamination and filter blocking phenomena
- **Very high Cetane number**
  - Improve vehicle driveability and cold startability
- **High hydrogen content and heating value**
  - Beneficial impact on fuel consumption
- **Possible additivation up to 100%**
  - No compatibility issues

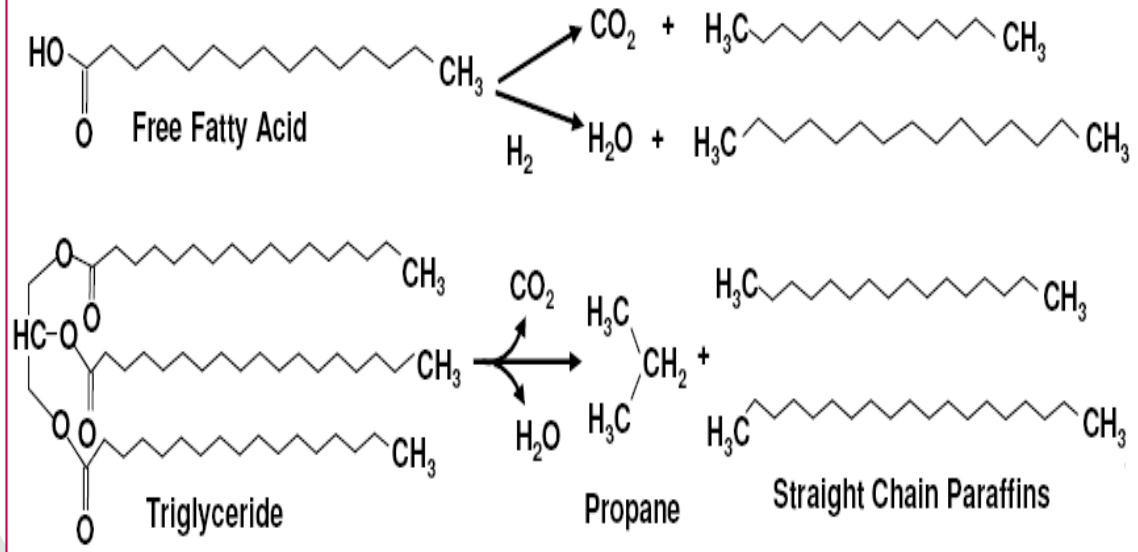
Potentials risks associated to Biodiesel

- The presence of oxygen in the chemical structure of Biodiesel facilitates microbiological contamination which should lead, in some case, to filter blocking phenomena.
- In the pictures below some examples of filter blocking are represented : all these examples are referred to fuels containing biodiesel as renewable component.

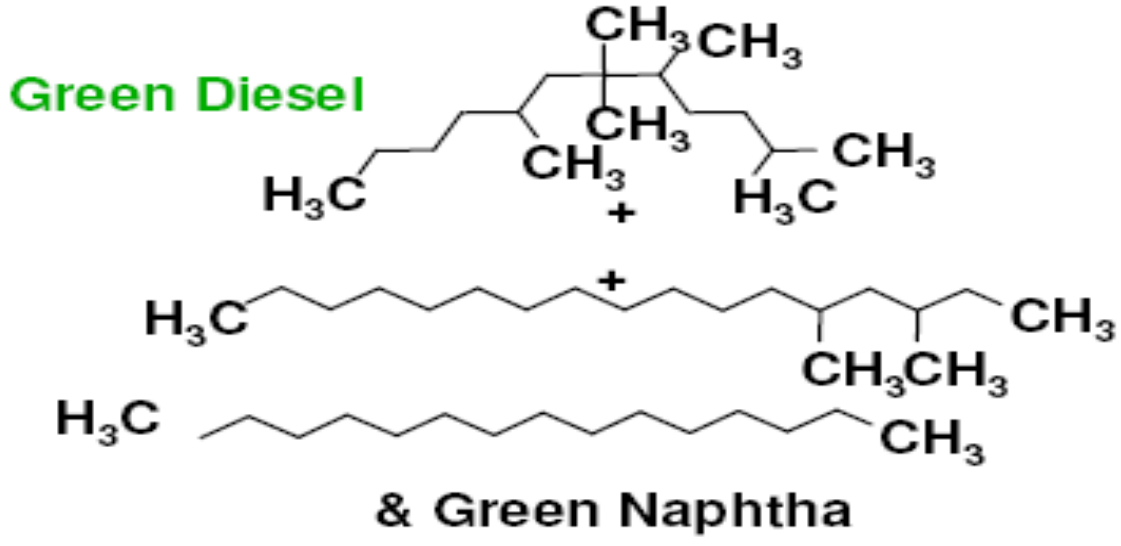
ECOFINING™ process



1st stage of reaction: Hydrodeoxygenation



2nd stage of reaction: Hydroisomerization



Green Diesel quality

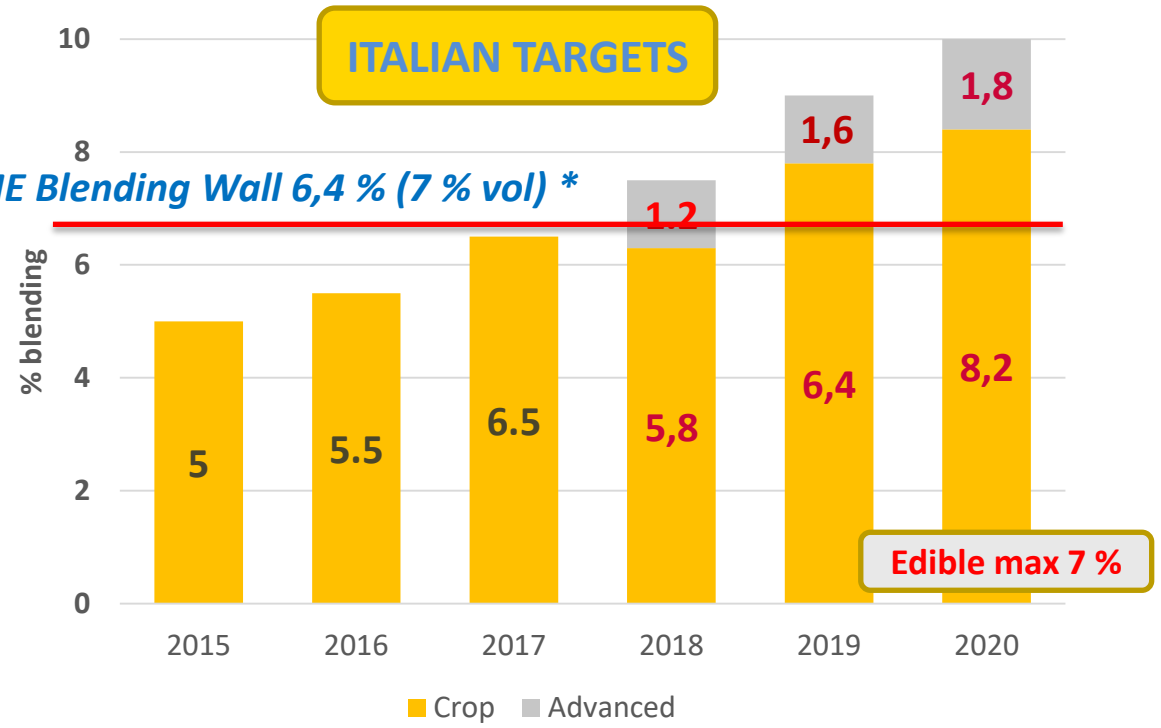
- Green Diesel is composed almost completely by paraffinic molecules and represents a perfect component for the blending with fossil diesel: it can be added at very high percentages, also at 30-35%, depending on density of fossil fuels.

Proprietà	Fossil Diesel ULSD	FAME	Green Diesel
BIO	**0**	**100**	**100**
Oxygen, %	**0**	**11**	**0**
Density	0.840	0.880	0.780
Sulphur, ppm	<10	<1	<1
Heating Value, MJ/kg	**43**	**38**	**44**
Cloud Point, °C	**-5**	**From -5 to +15**	**Down to -20**
Polyaromatics, %w	**8**	**0**	**0**
Cetane Number	**51**	**50-65**	**70-90**
Oxydation Stability	Standard	Poor	Excellent

European Directives for Biofuels

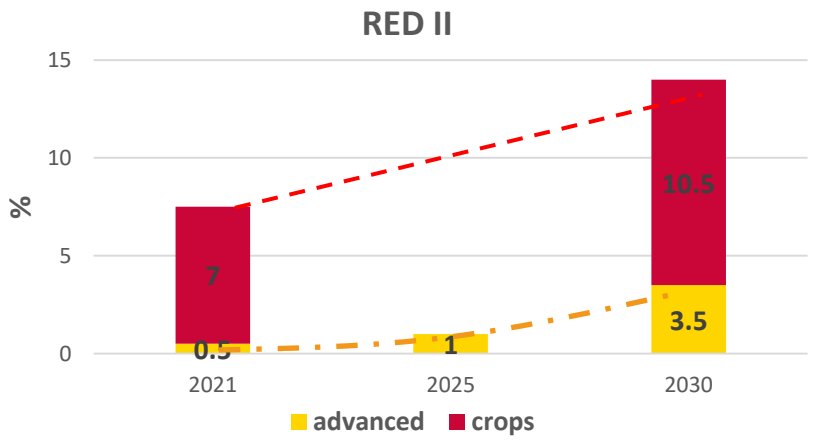
European environmental directives introduce biofuels blending obligation:

- **RED 20/20/20 (current decade)**
- **ILUC Directive** (1513/2015)



** due to very low FAME quality (stability) and engine related problems*

- **RED II – next decade 2021-'30**
- Min. 32% renewable energy at 2030 in EU, with **min. 14% in transport energy**
- **Advanced biofuels** produced from feedstocks listed in part A annex IX **at least 3,5% in 2030** (double counted)
- Feed-crop based biofuels limited to 7%, can be further limited by EU Members (this would reduce the limit 14% accordingly)
- High ILUC Risk crops (as Palm Oil) phase out from 2024 to 2030
- Multiplication factor 4 for electrical transport (1,5 railway) and 1,2 for aviation
- GHG emission savings of at least 70% vs fossil fuel for biofuels produced in installations starting operation after 1 January 2021.



Green Refineries and Premium Fuels evolution

2007
Ecofining™ patent

2012
Venice Permitting

2013
Project start

May 2014
Green fuels production

Dec. 2015
Eni R&D completes the experimentation on New EniDiesel+ with 15% of Greendiesel. Results validated by Cnr.

Jan 2016
EniDiesel+ is lauched on the market and available in 3500 Eni station

Gela Refinery conversion 720 kt/y

Hydrogen Plant

Advanced

Low ILUC

Used Cooking Oil

PFAD

Others

Crude Palm Oil

PRE-TREATMENT

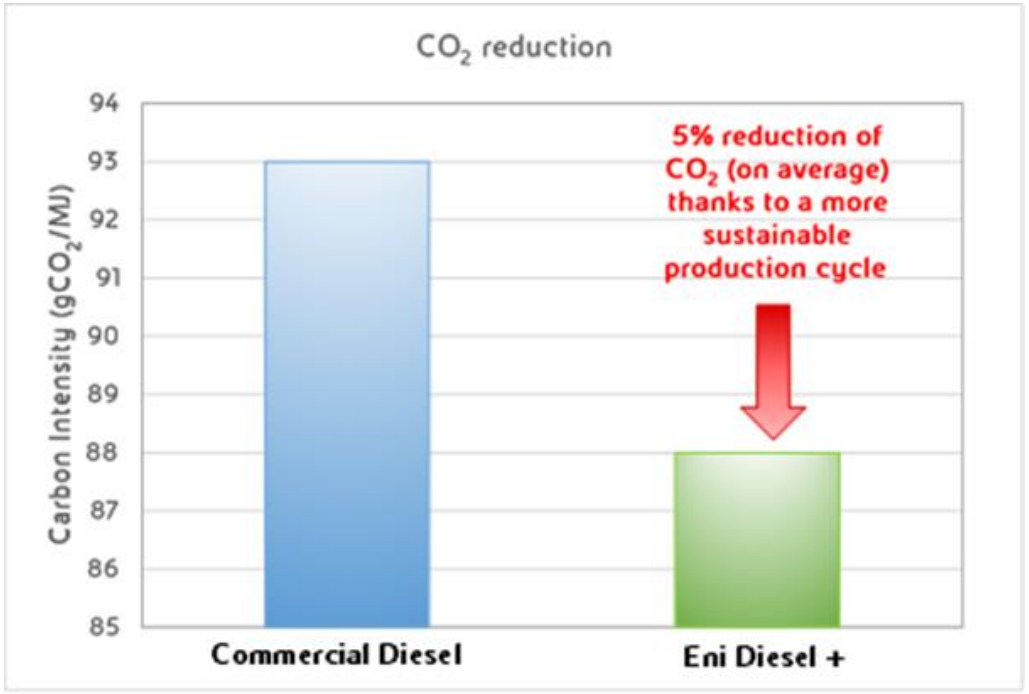
600 kt/y

ECOFINING™

CONFIDENTIAL

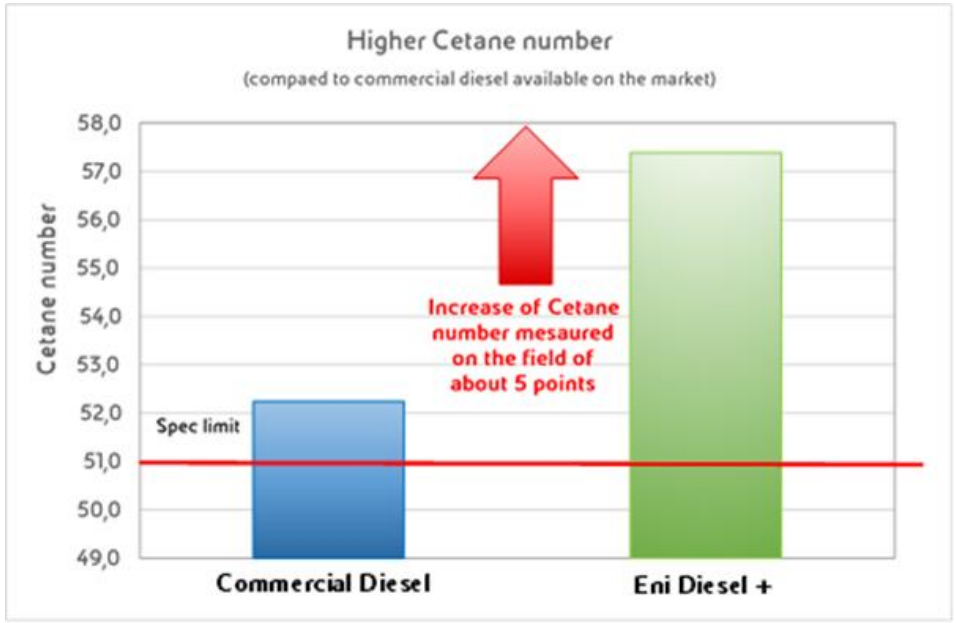
…to the new product Eni Diesel +

- **Eni Diesel +** is the new Eni premium diesel formulated with 15% of **Green Diesel,** the innovative renewable component produced by **Eni Biorefinery of Venice** using the **proprietary technology Ecofining™**.
- **Eni Diesel+** complies with the European specification for automotive diesel **EN 590.**
- Thanks to the presence of the renewable component **Green Diesel,** produced through a more sustainable production cycle, Eni Diesel + shows a "Carbon Intensity ” lower than other commercial diesel formulated with biodiesel and **contributes to reduce CO_2 emissions of 5% on average.**



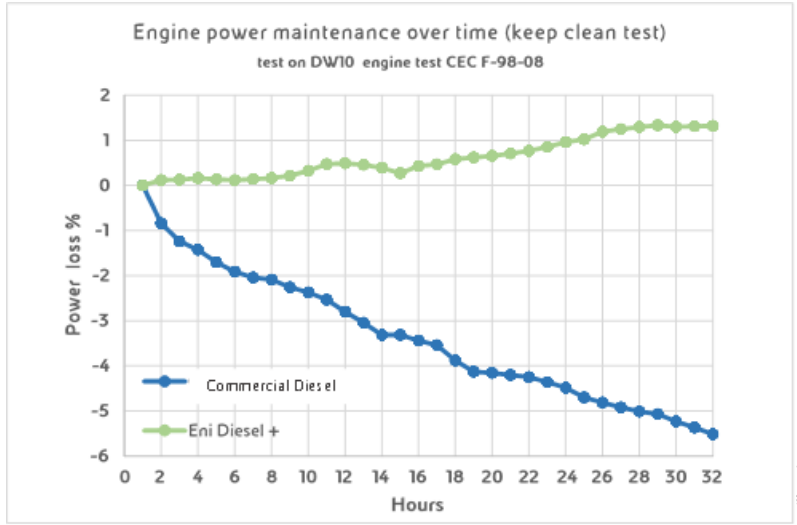
Higher Cetane number

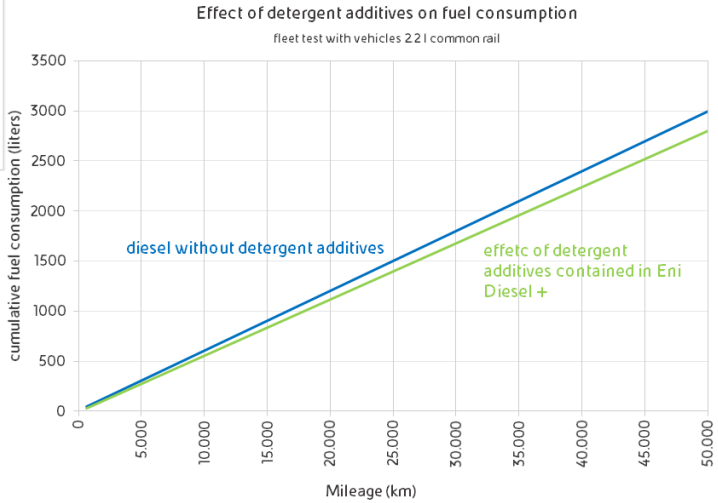
- **Eni Diesel +** has a minimum Cetane number of 55 while the EN 590 specification set a minimum value of 51.
- Thanks to higher Cetane number, **Eni Diesel +** improves cold startup, reduces engine noise and vibrations, and results in a better driving experience.
- The Cetane number increase, contributes to both combustion efficiency and acoustic comfort (-1/2 db).

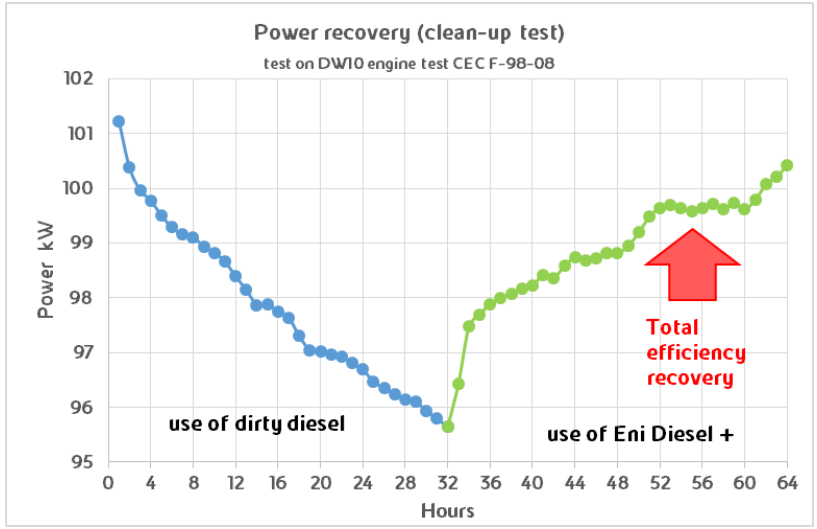


Detergency and fuel economy benefits

- **Eni Diesel +** thanks to the presence in its formulation of special detergent additives, is able to guarantee a high detergency of the injection system.
- With conventional diesel, due to the high temperatures in the combustion chamber, some deposits could form into injector holes, reducing the engine efficiency and, therefore, increasing fuel consumption and emissions.







Biofuels in maritime transportation

Eni and the Italian Navy defined an agreement, within the frame of the Navy Green Fleet Project, to formulate and produce a new military ship bio-fuel by means of the Ecofining™ Technology.

Green Diesel application tested with high level of additivation (about 50%).

EU and U.S. promote the transition to the Low ILUC risk and advanced

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

	FEEDSTOCKS	OPPORTUNITIES	RISKS
1st gen.	*Agrifood Feedstocks*	• Large & liquid markets • support from the EU and U.S. regulatory targets	• strong social and environmental impacts (Food vs fuel) • climate risk • possible phase-out legislation
Double counted	*Agricultural non-food, Agro/Urban waste Feedstocks*	• environmental impact favorable • valorization waste materials • strong regulatory support	• high production costs and complex logistics • climate risk for some productions
Advanced	*Non-agricultural High Innovation Feedstocks*	• Not in competition 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

Eni initiatives: real examples of circular economy

- Agreement with Waste recovery Associations
- Agreement with Restaurants Associations
- Agreement with Municipalities

Restaurants & Catering chains

UCO

Collection

Domestic collection

Local Public Administrations

Local Public Transport

Collection & Regenaration Consortium

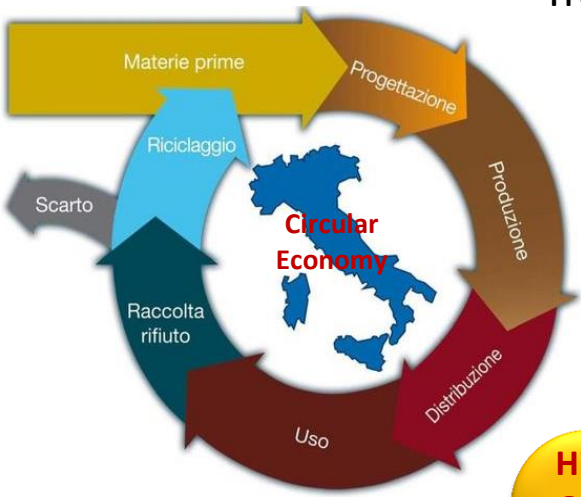
Collection & Regeneration companies

Framework agreement

Contracts

Eni

Biorefineries



High quality Greendiesel (HVO)

green[15] eni diesel+

UCO collection at Eni's Sites

Demo Project for Sustainable Castor Oil Production for Eni Biorefineries

A demo Castor Oil Project has started some month ago, with differents irrigation systems (salt content) in North Africa

Demo Project Targets:

- Verify espected production 2,5 T/ha*y of Castor Oil
- Indication on production Costs €/T

Advantages:

- It is not edible.
- Use of Marginal pre-desertic fields (Maghreb).
- Counteract desertification.
- Low water need and not clean water possible use.
- Compatible as Ecofining feedstock (Gela Biorefinery is not far from production sites).
- First crop in next november, with first indications on yields and other agricultural data

Waste/Byproduct Oils (not food competition) for Eni Biorefineries

A possible medium term feedstock scheme for Eni's Birefineries coul be:

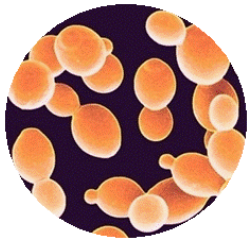
- **Used Cooking Oil (UCO)** discarded from restaurants (under investigation also UCO by Isotanks from Far-East): current situation @ Eni for Biorefinery Feedstock: 40 kt/y of UCO (out of the 70 kt/y currently recovered in Italy of a production of 250 kt/y). Medium Term 200 kt/y with imports.
- **Animal fats** (Tallow, lard, yellow grease, chicken fat, and the by-products of the production of Omega-3 fatty acids from fish oil): start-up state as biorefinery feedstock, expected in medium term 200 kt/y (mainly imported)
- **Palm Fatty Acids Distillate-PFAD** (palm oil by-product after removal of free fatty acid fraction). Expected in m.t. up to 200 kt/y according to favorable economics
- Marginal quantity for**:**
  - **Palm Stearin** (palm oil by-product after removal of saturated high melting point fraction)
  - **POME** (Palm Oil Methil Ester): byproduct from first processing of Palm fruits.
  - **Matrilox**: byproduct of BioPlastic Eni production @ Porto Torres Plant
- **The balance should be Feedstock LOW-ILUC (i.e. from marginal culture)**

All the above are classified as double counting (with current RED) and sustainable but not advanced feedstock

Feedstock for Advanced Greendiesel

Some possible alternative sources for **advanced** oil feedstock are:

Tall-oil (by-product of the pulping industry)



Microbial oil from fermentation of cellulosic sugar

Algal oil from photosynthetic microalgae

Eni is involved in R&D projects for the second and third one.


Thank -you