Eni contribution to Energy Transition

New fuels for transportation and sustainable mobility

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Summary

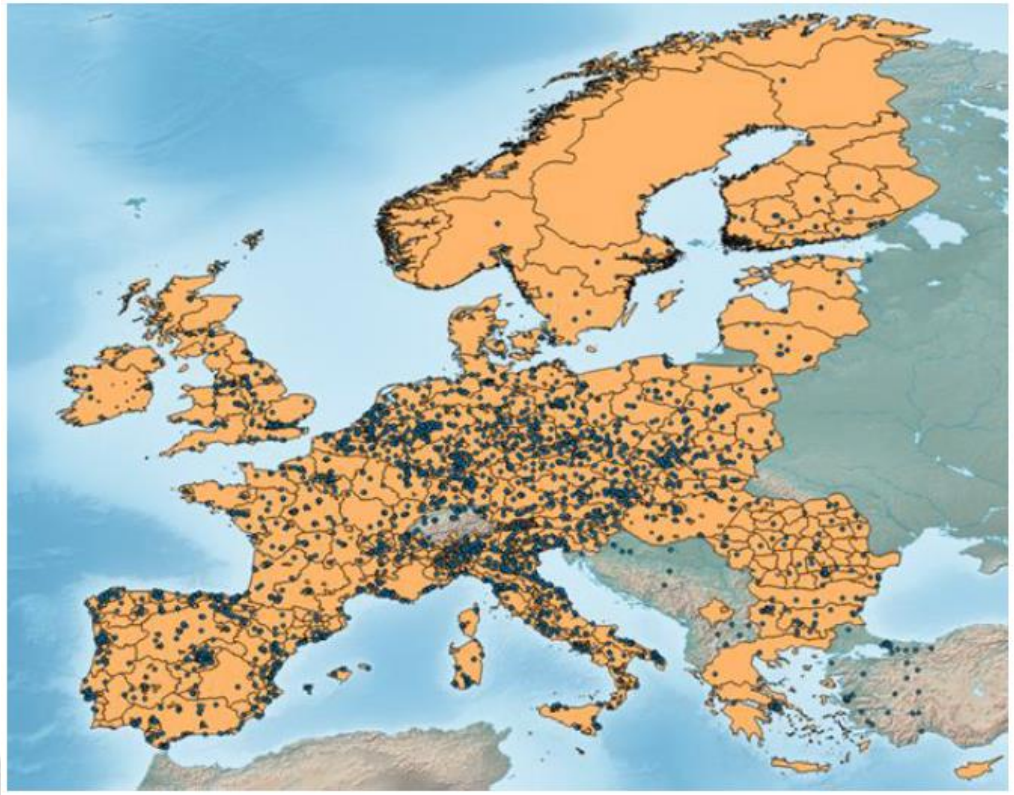
- *Effect of vehicles exhaust emissions on urban air quality*
  - *Urban air quality*
  - *Regulated exhaust emissions and exhaust gas post treatment systems*
  - *New cycles for emissions assessment*

- *Decarbonization of transports*
  - *Evaluation of CO_2 emissions with “well to wheel” approach (production-transportation-combustion)*
  - *Development of "low-carbon fuels" to lower GHG emissions from road transportation:*
    - *High quality biofuels produced by green refineries;*
    - *The natural gas as a bridge for the decarbonization of transports;*
    - *Methanol as energy carrier and the methanol circular economy;*

Urban Air Quality EU countries (CONCAWE Study)

- European cities are facing increased pressure to take action to ensure compliance with nitrogen dioxide (NO_2) and particulate matter (PM) air quality standards.
- Despite considerable improvements in European air quality resulting from the progressive implementation of emission reduction measures over the past decade, non-compliance area persists.
- For both atmospheric particulates and nitrogen oxides (NO_x), the primary focus for emission reductions at both national and local levels is road transport.

European AQMZ and measuring stations



- Air quality management zones are designated under the ambient air quality directive (2008/50/EC) and oblige Member States to divide their entire territory into zones.
- The compliance of individual stations within each zone is used to determine overall zone compliance, specifically the single least compliant station is chosen for PM2.5 and NO_2. This means that zone compliance is reflective of the "worst" compliance situation within that zone.
  - The position of monitoring stations should have a huge influence on the measured value because of the different conformation of land and also weather conditions.
  - Within short distances, the measured concentration should vary widely mainly because of the complex path of air flows that drag exhausted particles.

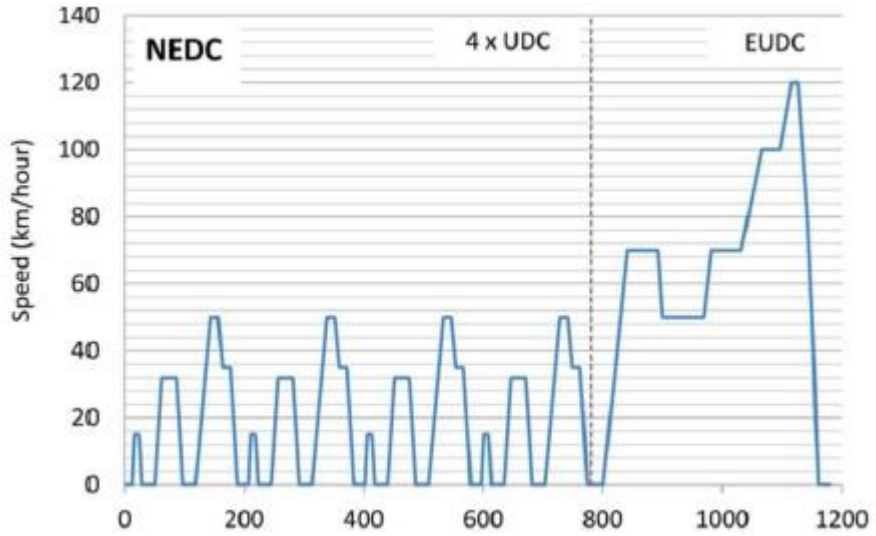
Likely compliant (the modelled concentrations are less than the AQLV by at least 5µg/m^3)

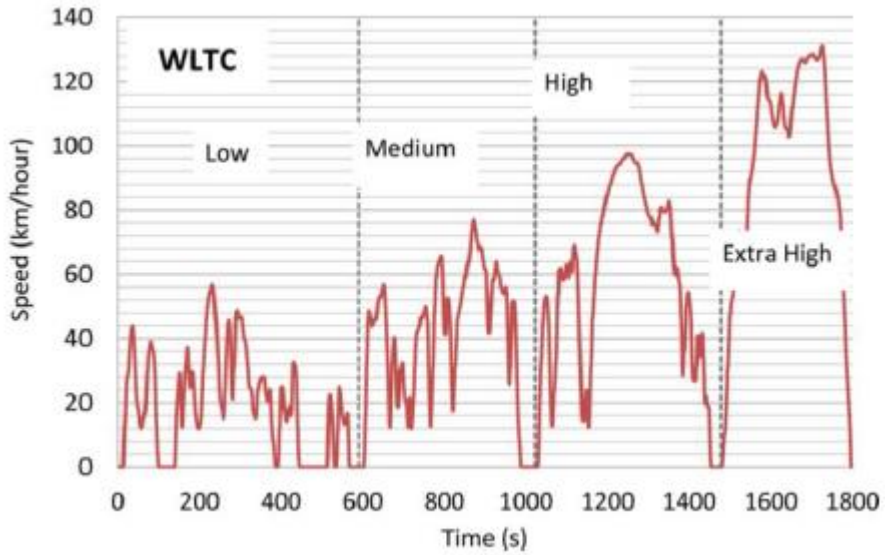
Uncertain compliance (the modelled concentrations are within 5µg/m^3 of the AQLV)

Likely non-compliant (the modelled concentrations are greater than the AQLV by at least 5µg/m^3)

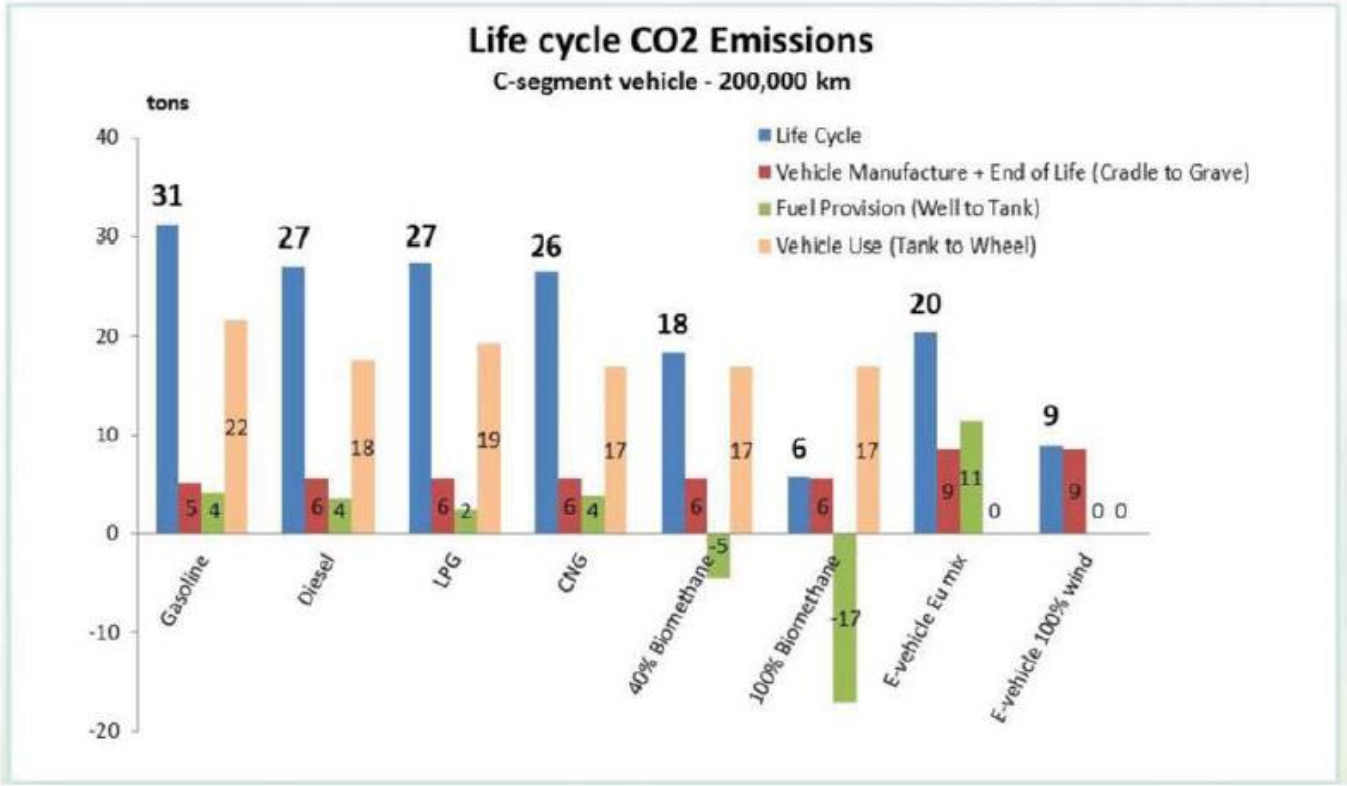
CO_2 Emissions Regulation for New Vehicles Homologation

- The emissions regulation of vehicles in the road transportation, gives a key contribution to the strategy for the reduction of CO_2 emissions.
- From 2020 new rules on emissions level for vehicles homologation will come into force: the new vehicles shall not emit more than 95 gCO_2/km while, before 2020, this limit was set at 130 gCO_2/km.
- Currently CO_2 emissions from new vehicles are measured with the "New European Driving Cycle" – NEDC which, starting from 2017, will be replaced by the "Worldwide Harmonized Light Vehicles Test Procedure" – WLTP that gives a better representation of real driving cycle. The two methodologies WLTP and NEDC need to be mathematically related to fix the same emission level as homologation limit.





Post 2020 light vehicle CO_2



Source: ArtFuels study financed by European Commission

- The energy transition in the short-mid-term should be based on:
  - a continuation of the growing trend for vehicle efficiency, with realistic and achievable targets by different technologies.
  - the recognition of the fact that blending sustainable biofuels/renewable fuels results in a substantial reduction of CO_2 emissions.
- Regarding electro mobility:
  - advantages of electric vehicles (“EVs") rely on their high efficiency, simplicity, low maintenance, zero tailpipe emissions.
  - however, from a GHG perspective, EVs are not always more sustainable than ICE vehicles, as it is shown in Figure 1 below. In this case the improvement of the CO_2 emission must strictly be of competence of the electric energy producers.

The Eni Strategy for Sustainable Mobility

- Promotion of renewable component produced by Eni green refineries (Green Diesel).
- New fuels with CO_2 reduction benefit for the existent vehicle fleet.

- Smart Mobility: reducing CO_2 emissions in urban driving.
- Promoting the share economy

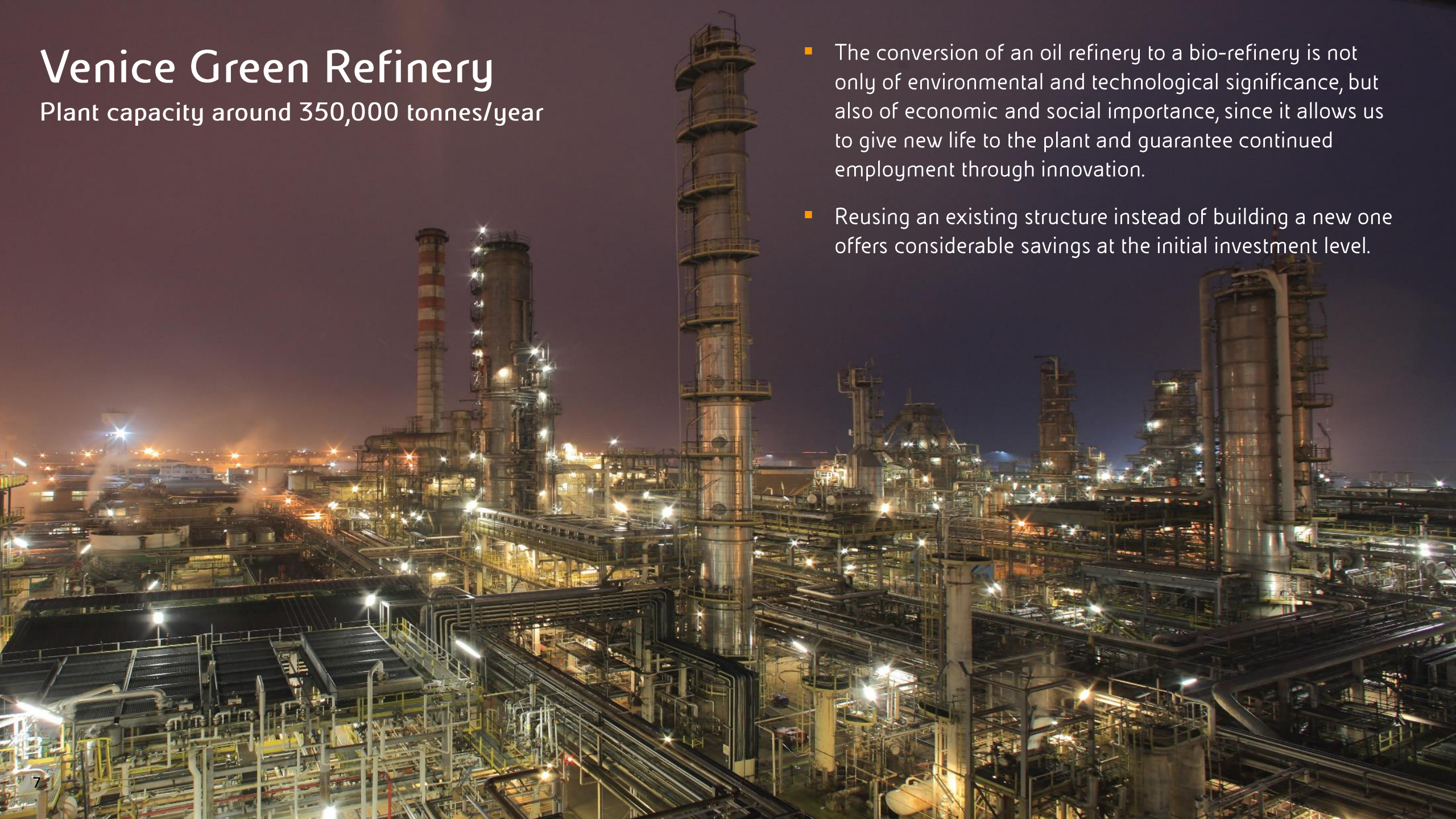
- Promotion of CNG, Compressed Natural Gas.
- Promotion of LNG, Liquefied Natural Gas.

R&D ACTIVITIES

- 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
  - Pure HVO, benefit evaluation

Venice Green Refinery

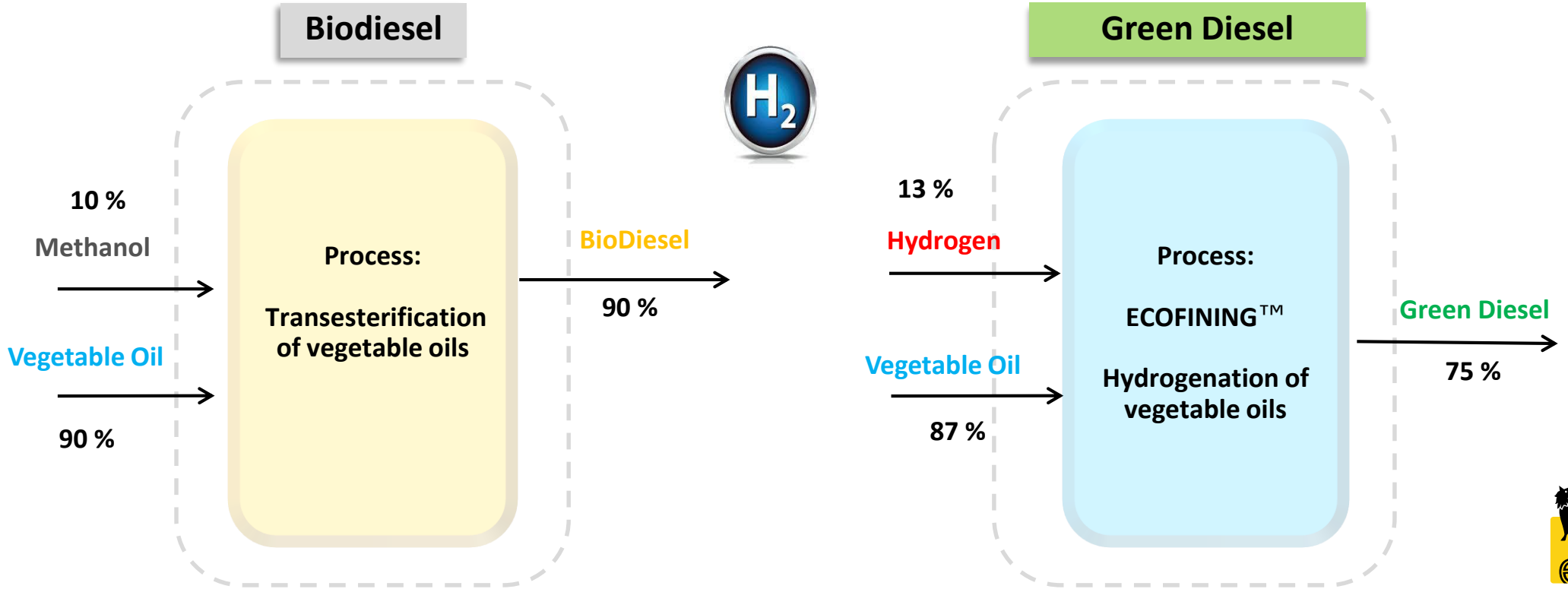
Plant capacity around 350,000 tonnes/year



- The conversion of an oil refinery to a bio-refinery is not only of environmental and technological significance, but also of economic and social importance, since it allows us to give new life to the plant and guarantee continued employment through innovation.
- Reusing an existing structure instead of building a new one offers considerable savings at the initial investment level.

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%**

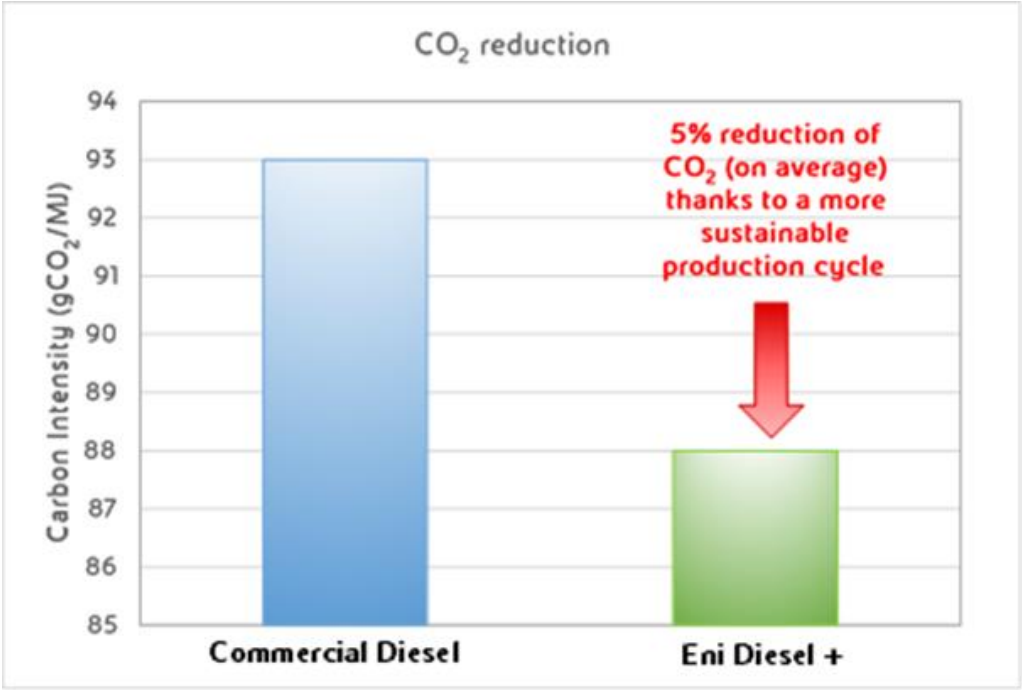
Green Diesel

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

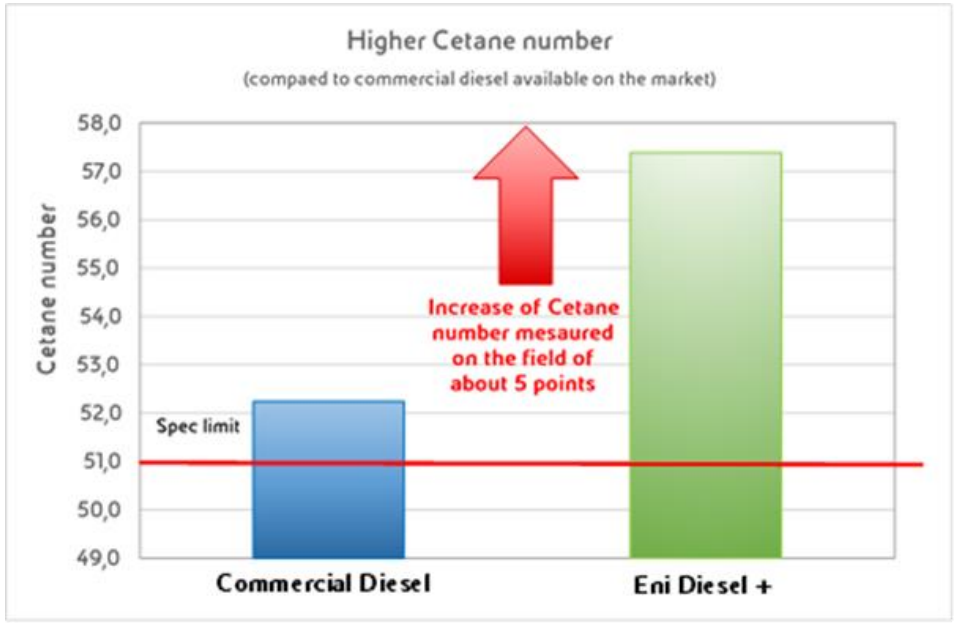
The new product Eni Diesel +

- **Eni Diesel +** is the new Eni premium diesel formulated with 15% of **Green Diesel,** the innovative renewable component produced by **Eni Green refinery 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.**
  - Emissions tests performed during the experimental phase, showed a significant reduction of exhausted gas emissions (CO and HC) up to 40%.



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 startability, 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).



Alcohol-Based High Octane Gasoline as new alternative fuel (A20)

Property	Units	Limits MIN – MAX		Test Method
Research octane number, RON		100		EN ISO 5164
Motor octane number, MON		86		EN ISO 5163
Lead content	mg/l		5.0	EN 237
Density (at 15 °C)	Kg/m^3	720.0	775.0	EN ISO 3675 EN ISO 12185
Sulfur content	mg/kg		10.0	EN ISO 13032 EN ISO 20846 EN ISO 20884
Manganese content	mg/l		2.0	EN 16135 EN 16136
Nitrogen content	ppm		100	ASTM D4629
Oxidation stability	minutes	360		EN ISO 7536
Existent gum content (solvent washed)	mg/100 ml		5	EN ISO 6242
Water content	% (m/m)		0,2	EN ISO 12937
Oxygen content	%(m/m)		10.0	EN 1601 EN 13132 EN ISO 22854
Methanol	%(V/V)	12.0	16.0	
Ethanol + other Alcohols (C3-C4)	%(V/V)	4.0	6.0	
ethers (5 or more C atoms) other oxygenates	Volume blending of these components is restricted to 10.0 % (m/m) maximum oxygen content including methanol oxygen.			EN ISO 22854

High octane number

Protection against aniline octane booster

Parameters in disagreement with FQD

16-22 % alcohol content

A20 shall be considered as **alternative fuel** due to higher Alcohol, higher Octane, lower carbon content

Enjoy fleet test with A20 fuel

- The fleet test with A20 fuel on Enjoy vehicles (Fiat 500), started in November, will last about 4-5 months.
- The vehicles will have a road journey of about 30000 km with an estimated fuel consumption of about 2000-3000 liters of A20 fuel.
- The fleet test is realized with 5 Enjoy vehicles, free to move in the Milan area.
- During the fleet test, the vehicle operational parameters are constantly monitored using the traditional detection system equipped on enjoy vehicles.
- The vehicle refuelling is managed by the Enjoy fleet team on a Eni retail station with a dedicated fuel dispenser not accessible to normal customers.

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