



Biofuels

Letizia Bua

eni.com

Biofuels

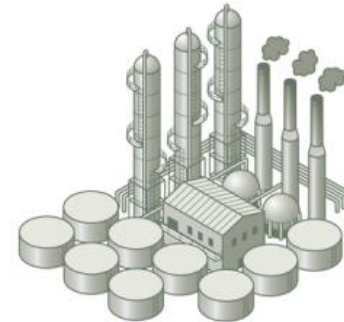
- What is a biofuel?



- What the European Community says about it?



- How we can produce it? (Technology options)



- eni and renewable energy



What is a biofuel?



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Biofuel

From Wikipedia, the free encyclopedia

A **biofuel** is a **fuel** that is derived from biological materials, such as plants and animals. Also biofuel can still be seen as fuel derived from organic matter (obtained directly from plants, or indirectly from agricultural, commercial, domestic, and/or industrial wastes).^[1] Examples of this **carbon fixation** occur in **plants** and **microalgae** through the process of **photosynthesis**. These fuels are made by a **biomass** conversion (biomass refers to recently living organisms, most often referring to **plants** or plant-derived materials). This biomass can be converted to convenient energy containing substances in three different ways: thermal conversion, chemical conversion, and biochemical conversion. This biomass conversion can result in fuel in **solid**, **liquid**, or **gas** form. This new biomass can be used for biofuels. Biofuels have increased in popularity because of rising **oil prices** and the need for **energy security**.

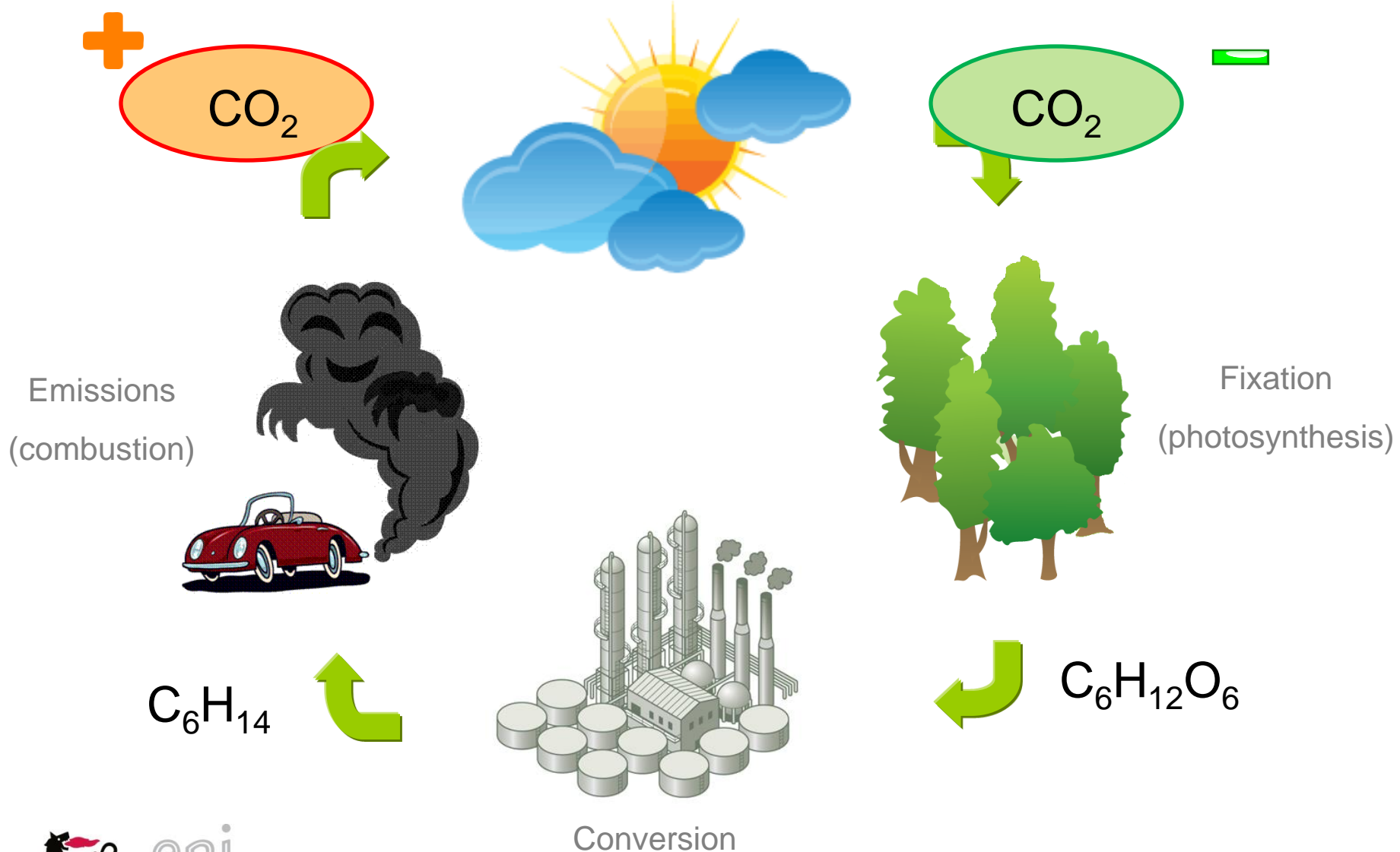


...interesting!



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Life cycle of biomass



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What the European Community says about it?



Renewable Energy Directive (RED)

In order to reduce CO₂ emissions, the European Community indicates a quantity of biofuels to use.



► The RED fixes that 10% of energy in transport sector at 2020 must be from biofuels, electricity and hydrogen produced from renewable.

► The suggested pathway is:

- 2015 5%
- 2016 5,5%
- 2017 6,5%
- 2018 7,5% of which 1,2% advanced biofuel
- 2019 9,0% of which 1,2% advanced
- 2020 10% of which 1,6% advanced
- 2022 10% of which 2,0% advanced

What does “advanced” means?



Biofuels: are all the same?



1st generation
Competition with food (e.g. corn)



2nd generation
Lignocellulosic waste: from forest, agricultur, organic fraction of municipal waste (not in competition with food)

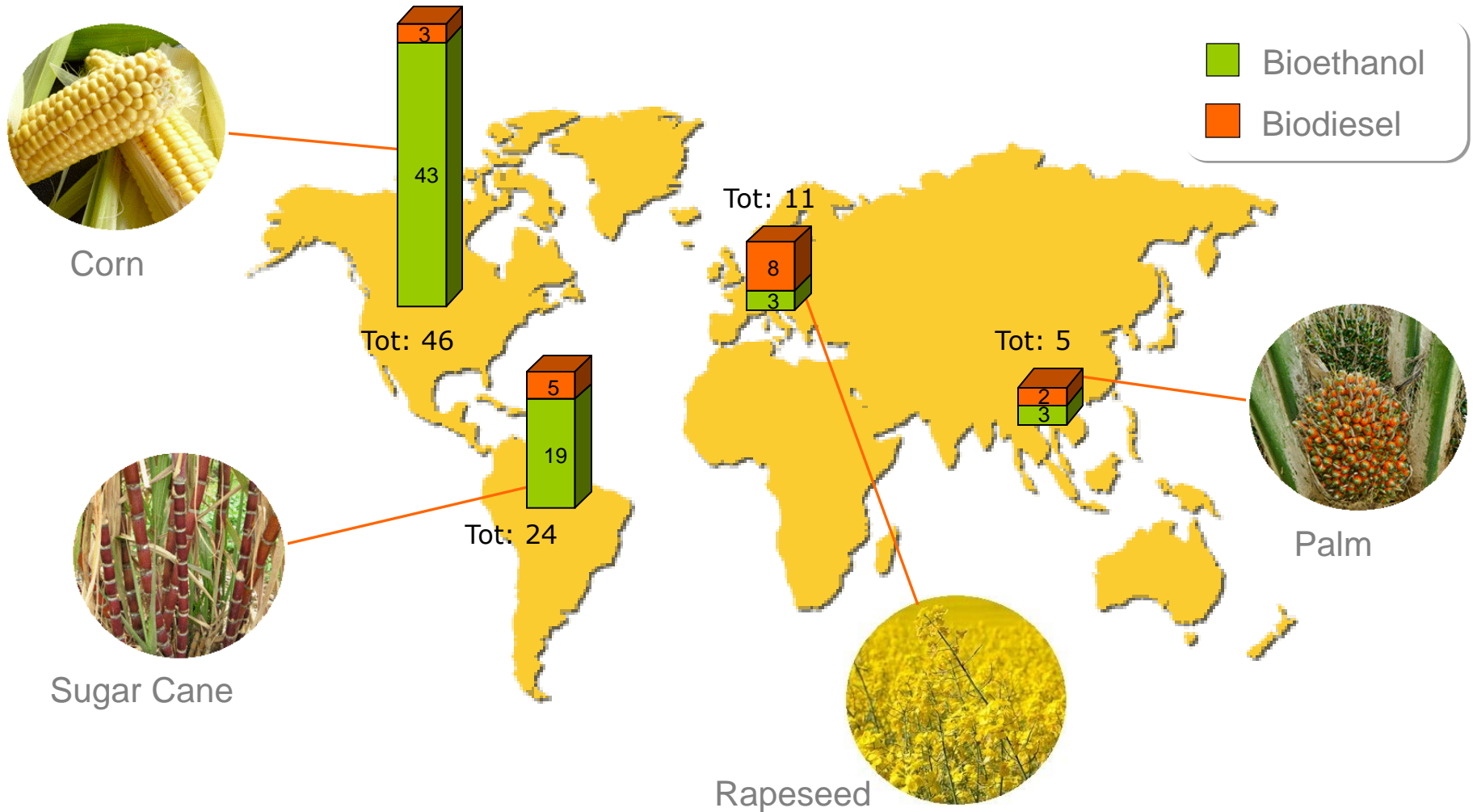


3rd generation
Not in competition with food, nor with land use (e.g. algae)

advanced



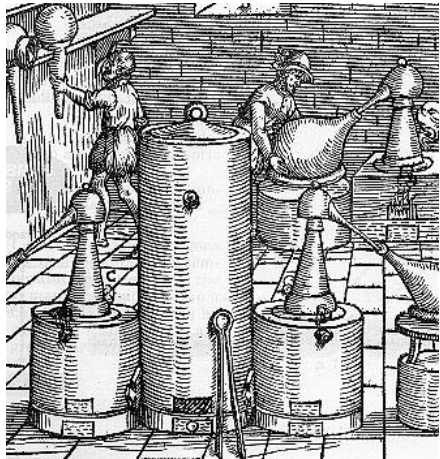
Biofuels production(Mt): now



Now the biofuels are most of 1st generation

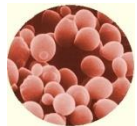


How we can produce it? (Technology options)



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Biochemical Conversion



➤ Saccharification
/Fermentation



➤ Anaerobic Digestion



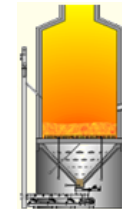
➤ Photosynthetic Processes

Thermochemical Conversion

➤ Pyrolysis



➤ Liquefaction









➤ Gasification

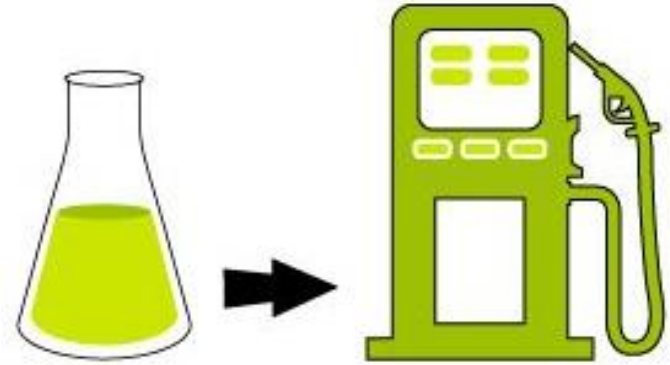
➤ Hydrotreating



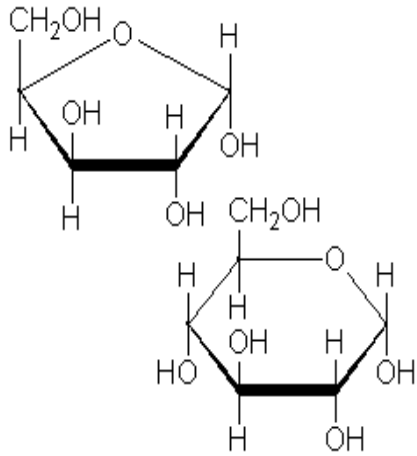
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Biofuels' s spectrum

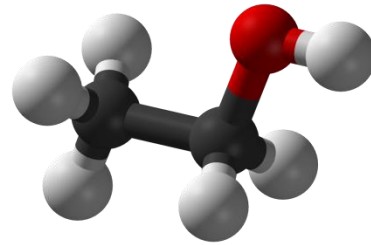
-  *Bioethanol*
-  *Biodiesel (FAME)*
-  *Hydrotreated Vegetable Oil (HVO)*
-  *Biomethane*
-  *Pyrolysis Bio-oil*
-  *Biomass to Liquid (BtL)*



Bioethanol



Sugars



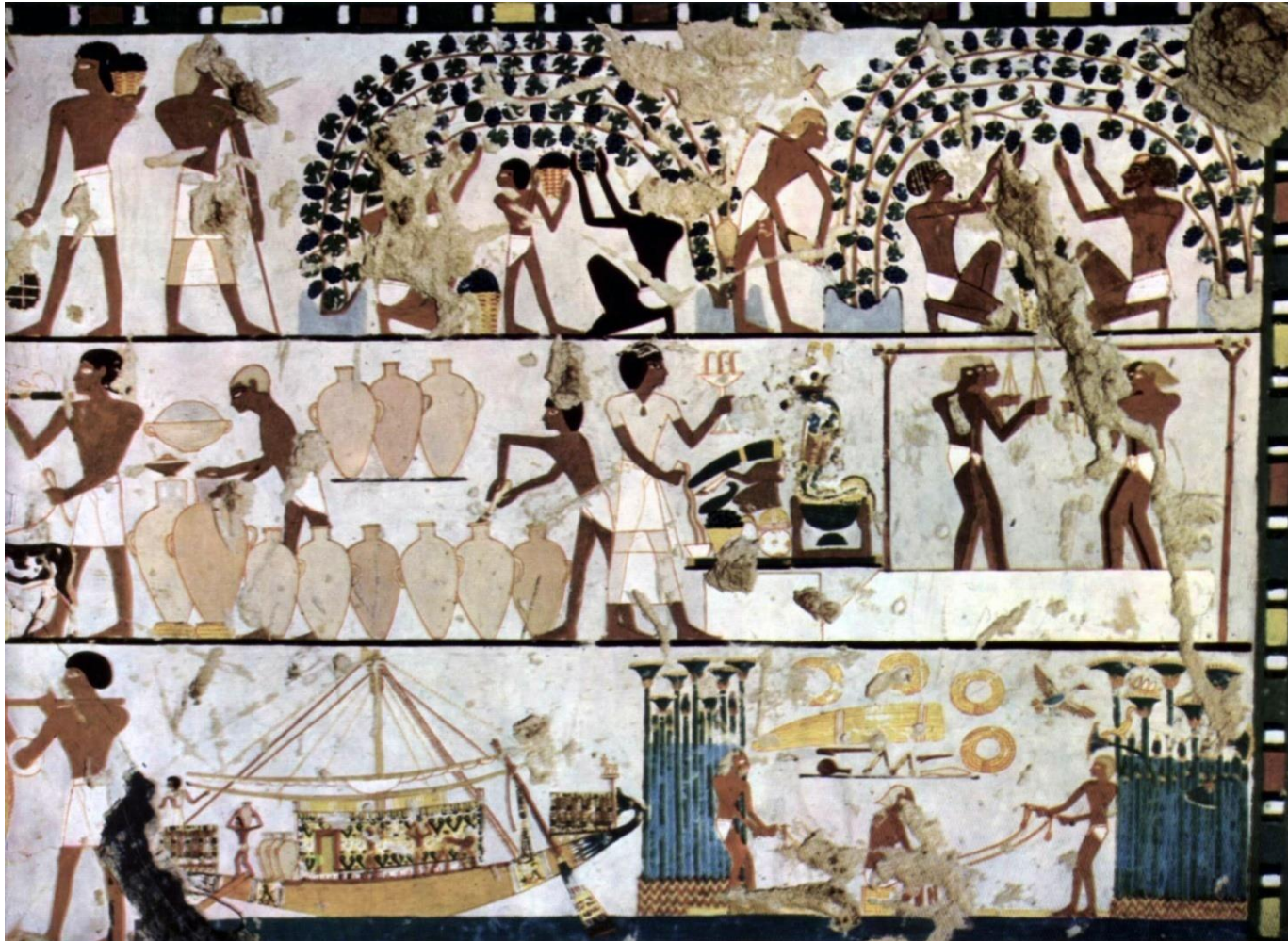
Ethanol



Carbon Dioxide



Bioethanol: the most ancient!



Biomass

Fermentation

Distribution

Grape cultivation, winemaking, and commerce in ancient Egypt ca. 1500 BC

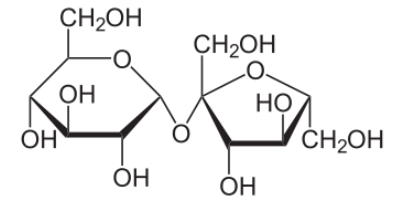
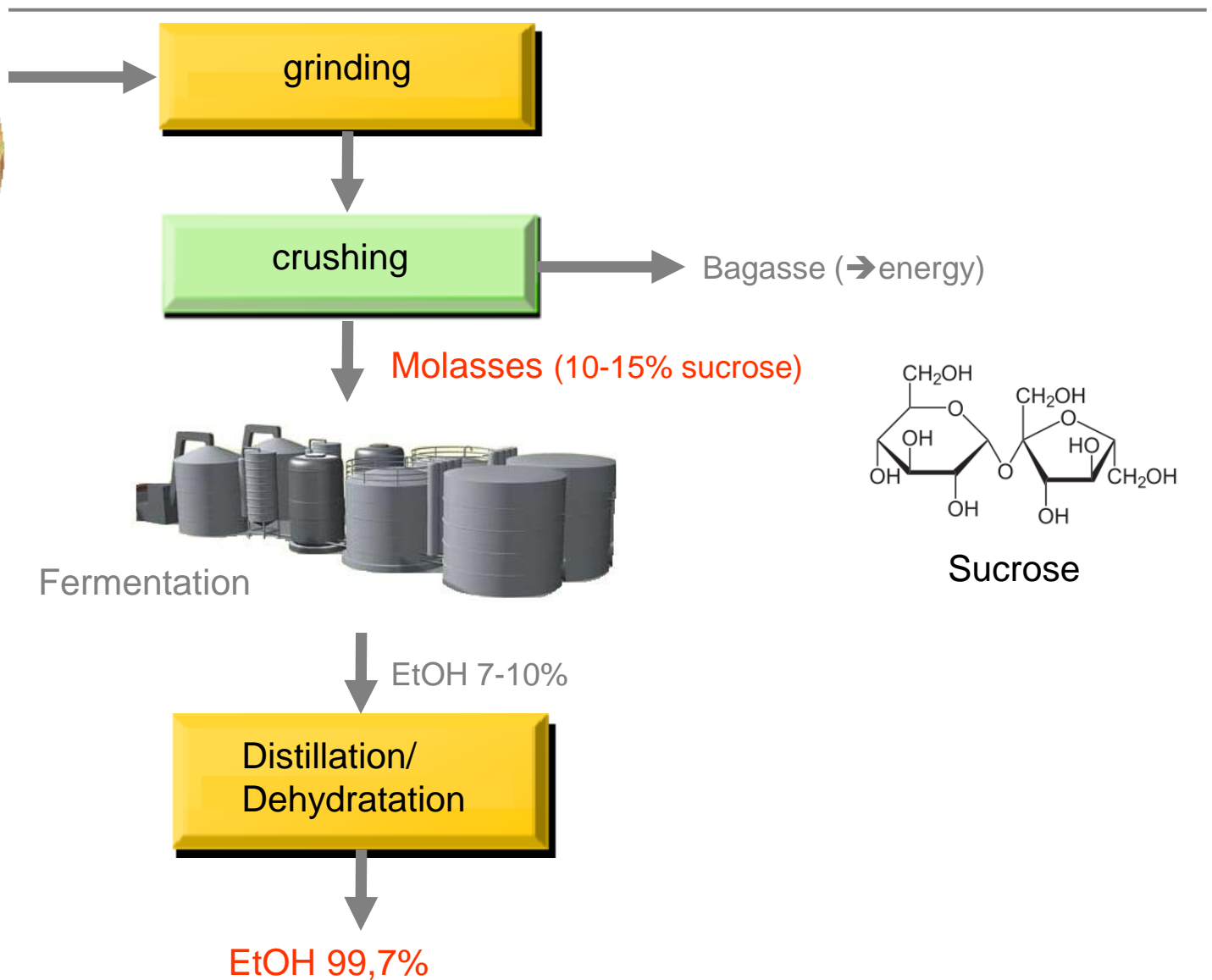


Fonte: http://en.wikipedia.org/wiki/History_of_wine

Ethanol (1st generation)



Sugarcane



Sucrose

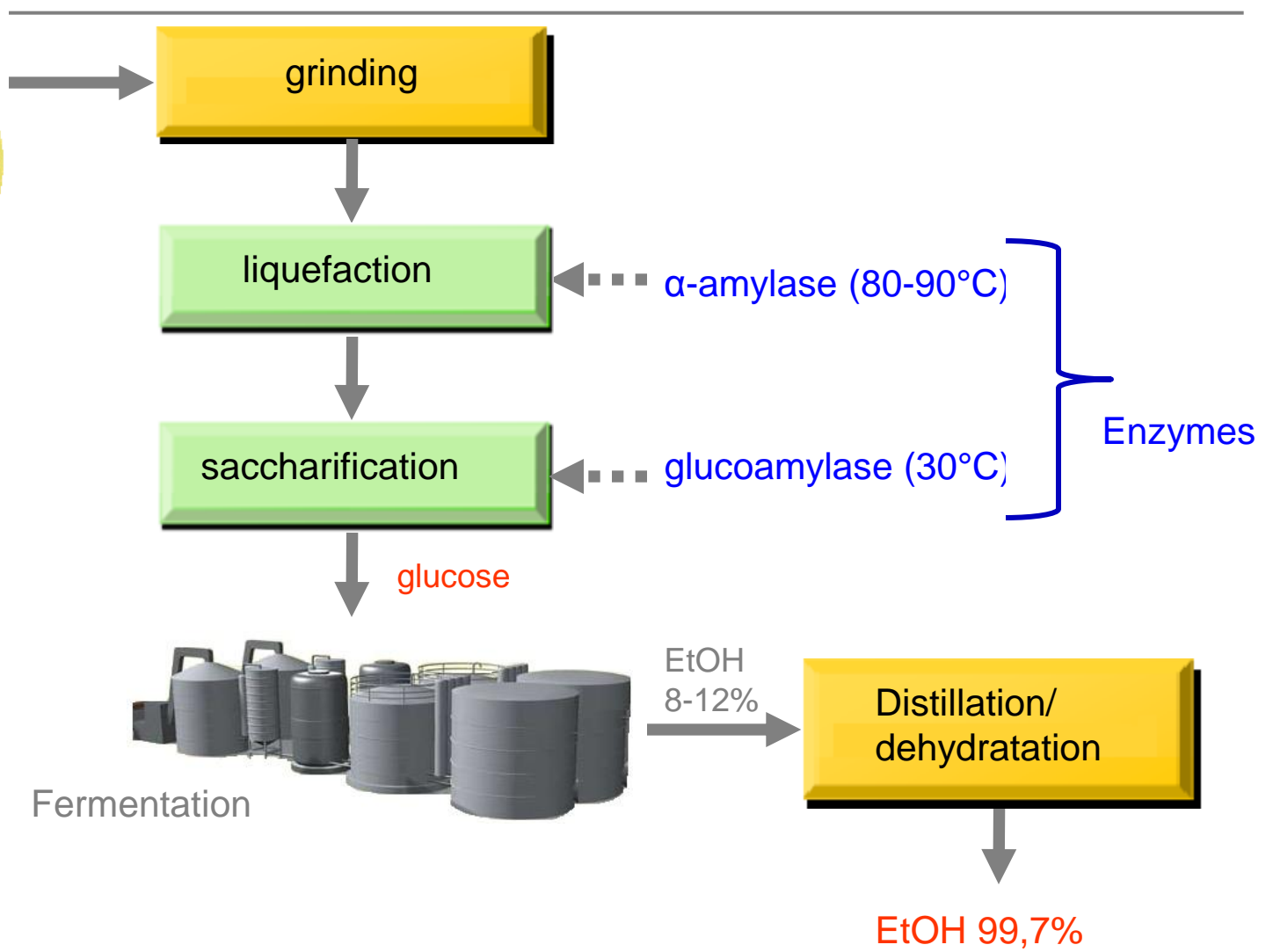


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Ethanol (1st generation)



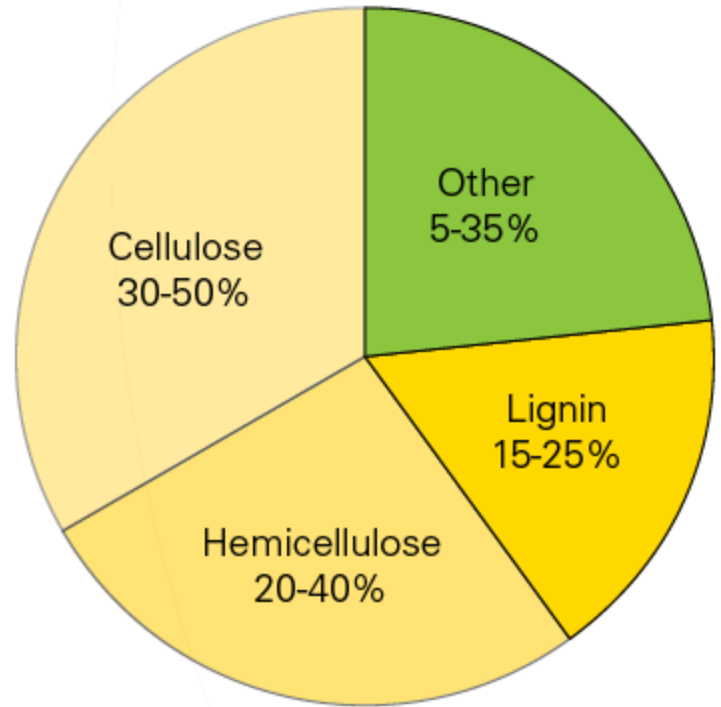
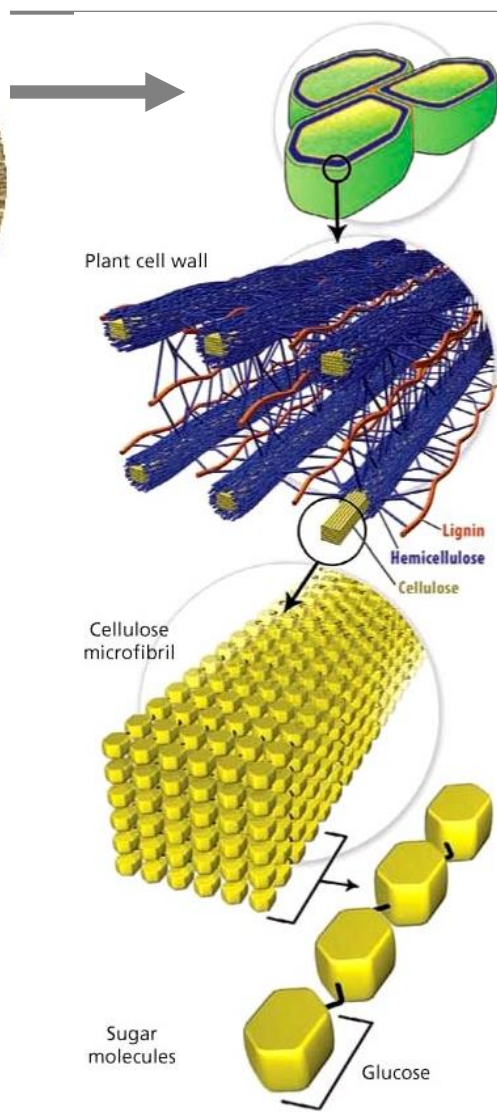
Corn



Ethanol (2nd generation)

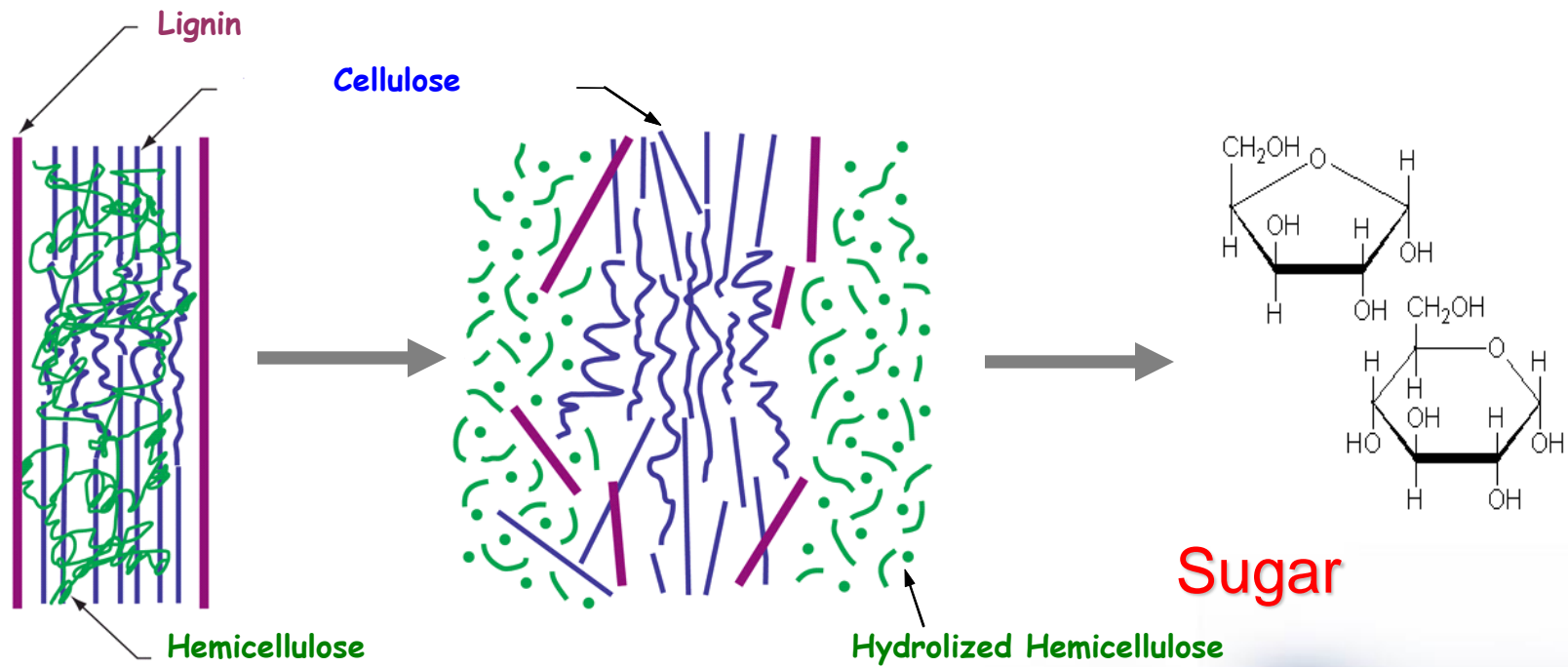


Lignocellulosic Biomass

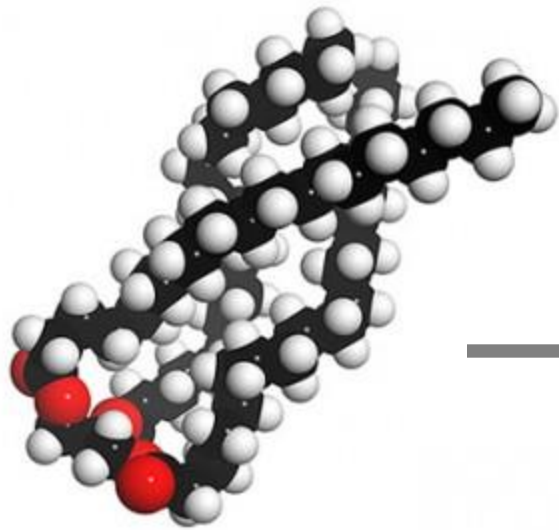


General composition of lignocellulosic biomass feedstocks

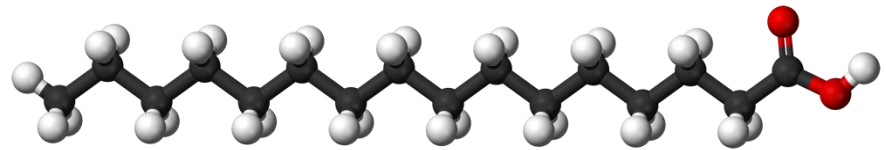
Saccharification process of lignocellulosic biomass



Biodiesel: FAME (Fatty Acid Methyl Ester)



Triglycerides



Fatty Acid Methyl Ester
(FAME)



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Biodiesel (1st generation)



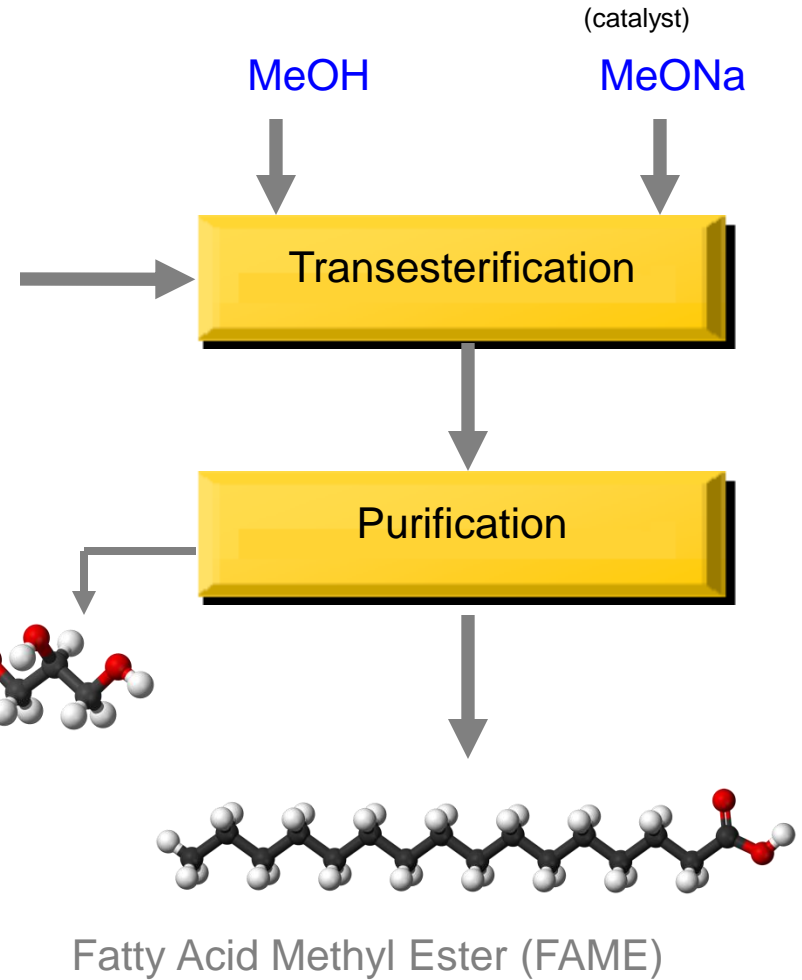
Oil Extraction



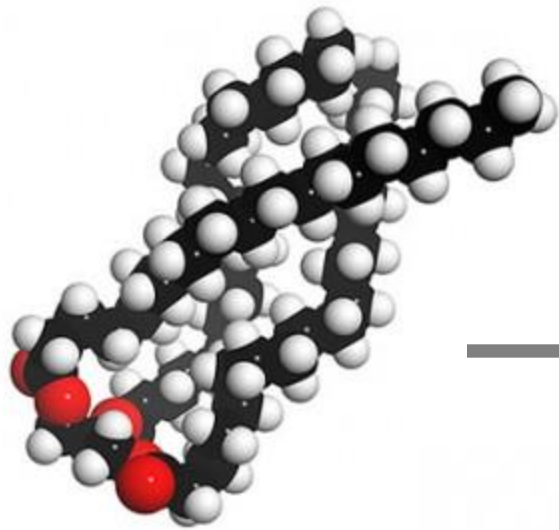
Oleaginous Plant



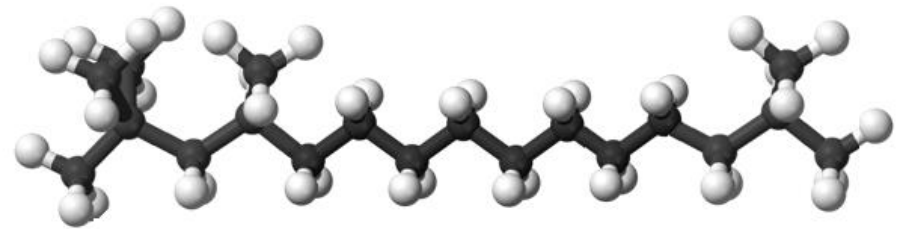
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Hydrotreated Vegetable Oil (HVO)



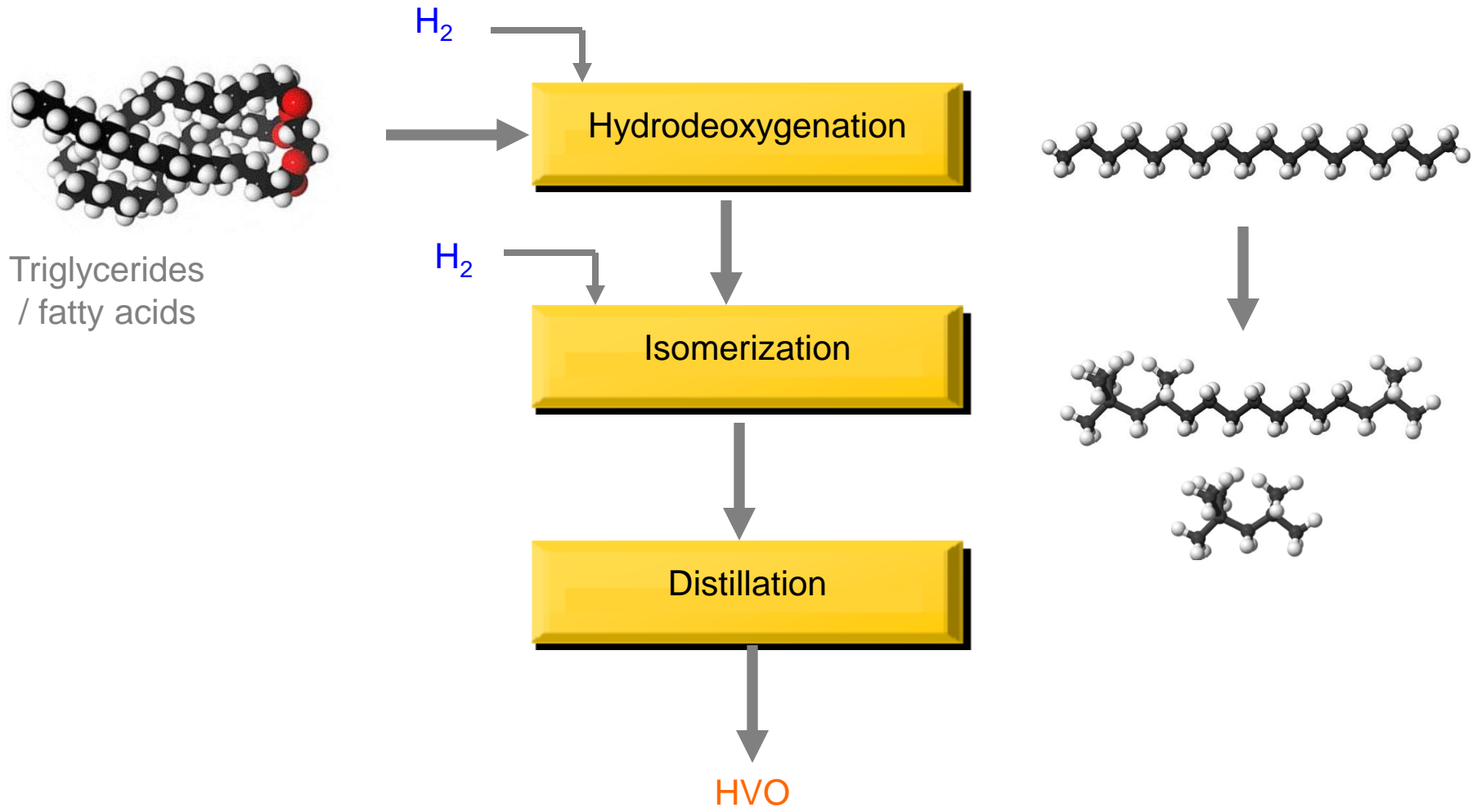
Triglycerides



HVO



Hydrotreated Vegetable Oil (HVO)



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Green Refinery Projects – Venice and Gela (I)

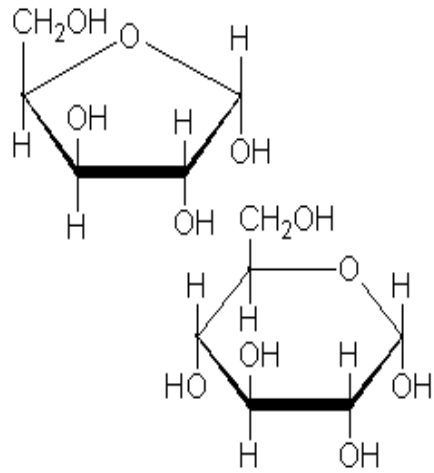


- Venice refinery has been converted into a biorefinery. eni with some partners (UOP) has developed a technology (Ecofining) to produce HVO (Greendiesel).
- An Ecofining plant started to work in January 2014, producing about 360.000 ton/year of biofuels.
- The maximum capacity of the biorefinery is 500.000 ton/year of biofuels.

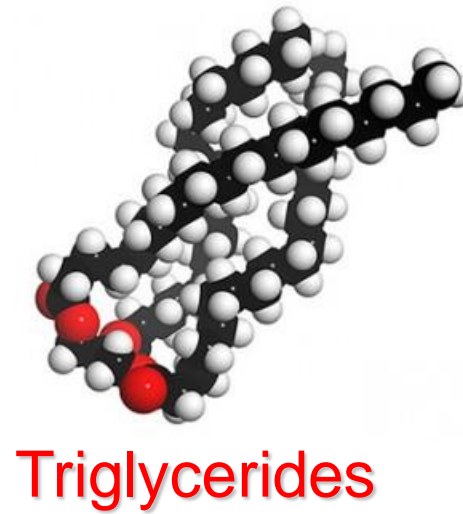
- A conversion in biorefinery is announced for Gela refinery too.
- An other Ecofining plant is planned for 2017.



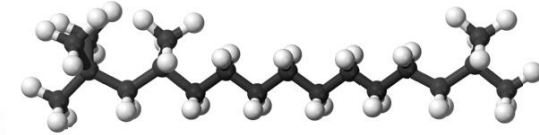
Diesel from microbial oil



Sugar



HVO



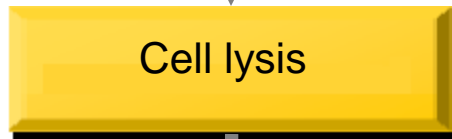
Microbial oil (2nd generation)



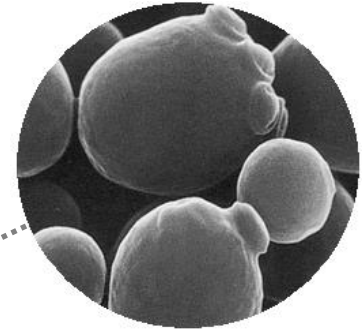
Lignocellulosic Biomass



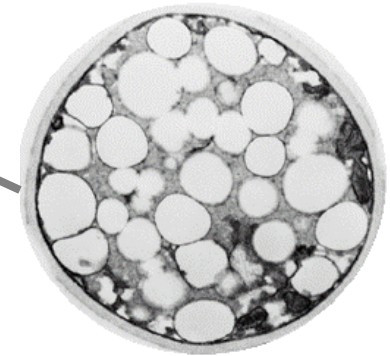
Fermentation



Saccharomyces (→ EtOH)



lignin



Oleaginous micro-organisms

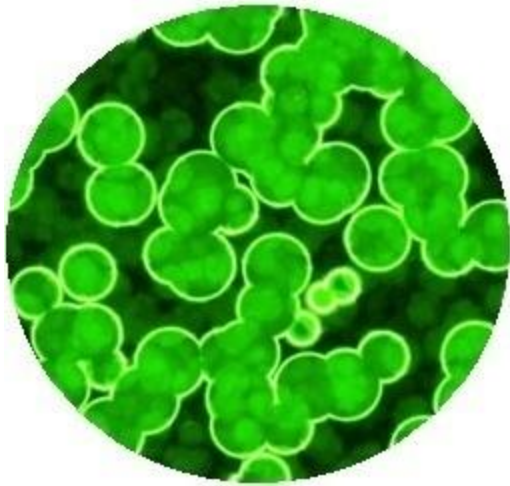
The microbial oil is equivalent to the vegetable oil.

microbial oil

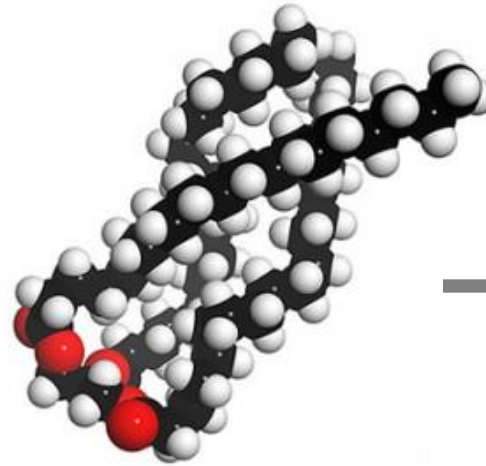
Greendiesel (HVO)



Diesel from Algae



Microalgae



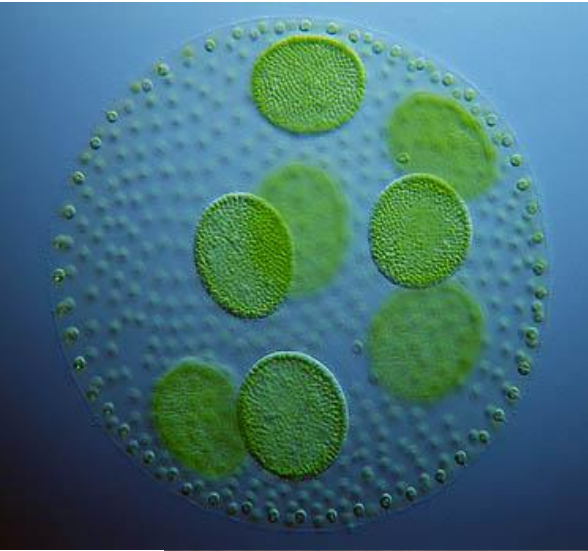
Lipids



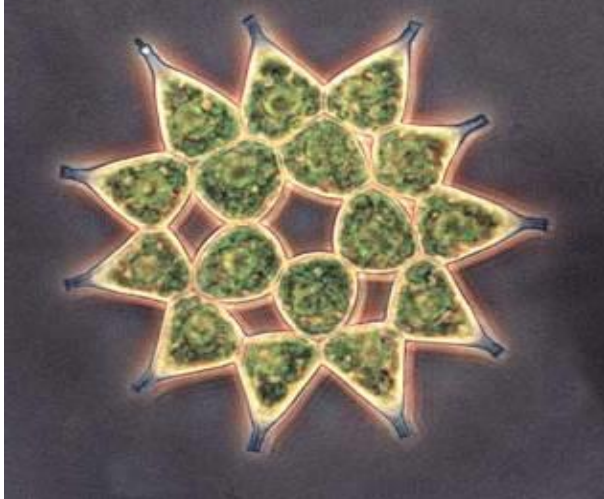
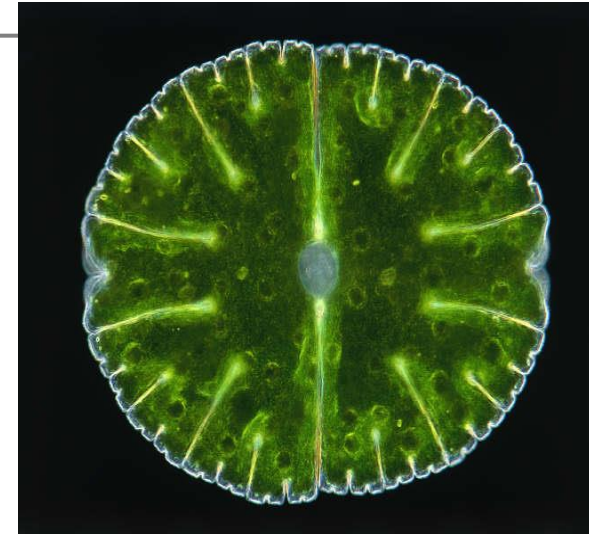
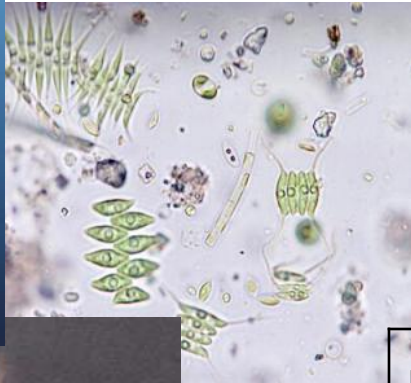
Diesel
Fuel



3rd Generation Biodiesel



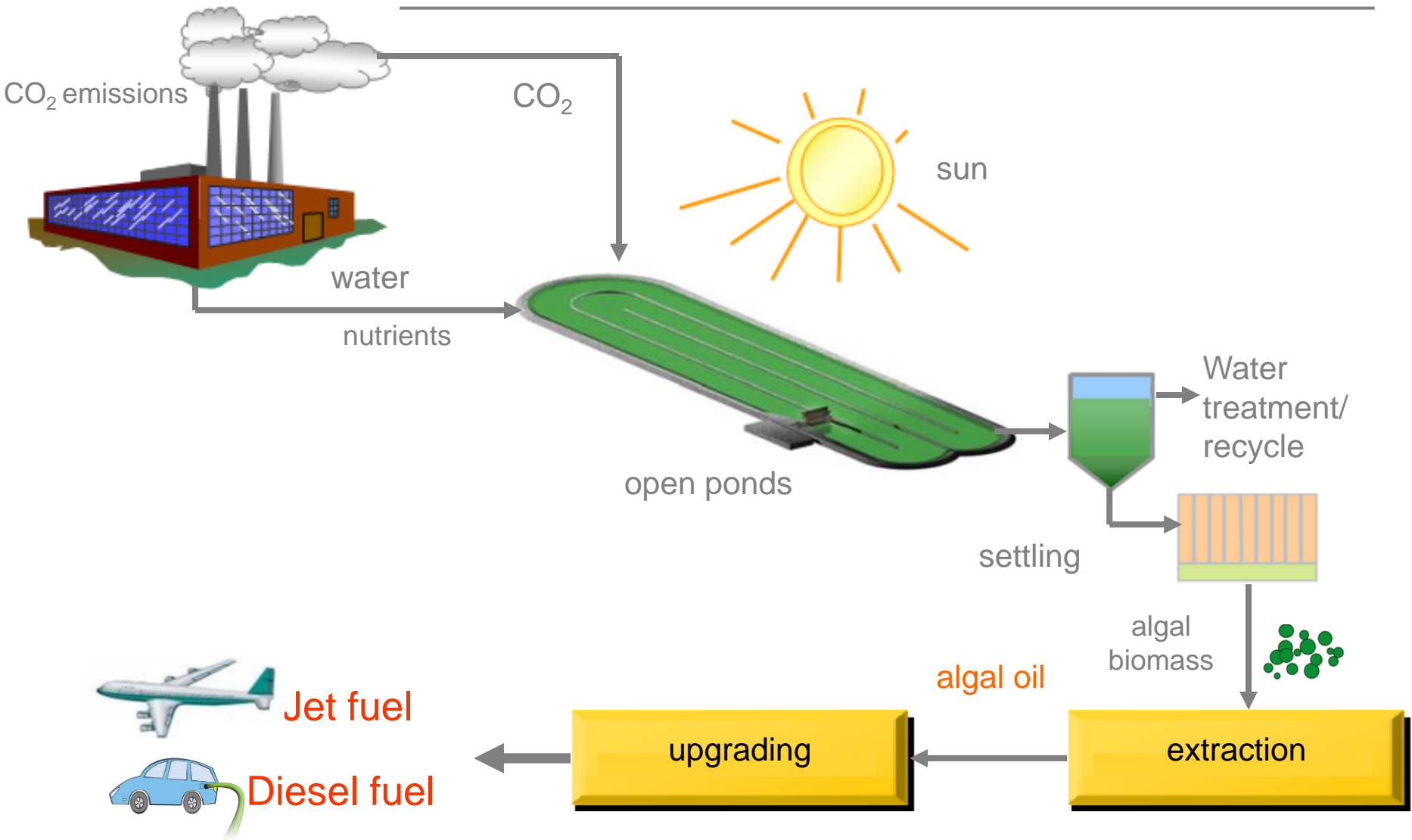
Microalgae are able to store up to 70% weight of oil inside the cell.



Microalgae	Oil content (% dry weight)
<i>Botryococcus braunii</i>	25–75
<i>Chlorella</i> sp.	28–32
<i>Cryptocodinium cohnii</i>	20
<i>Cylindrotheca</i> sp.	16–37
<i>Nitzschia</i> sp.	45–47
<i>Phaeodactylum tricornutum</i>	20–30
<i>Schizochytrium</i> sp.	50–77
<i>Tetraselmis suecia</i>	15–23



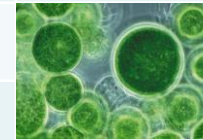
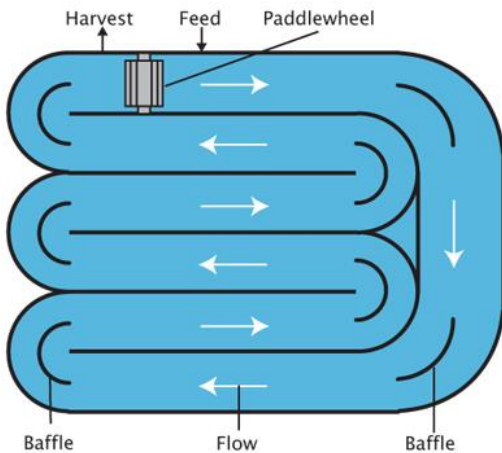
Diesel from Algae: production process



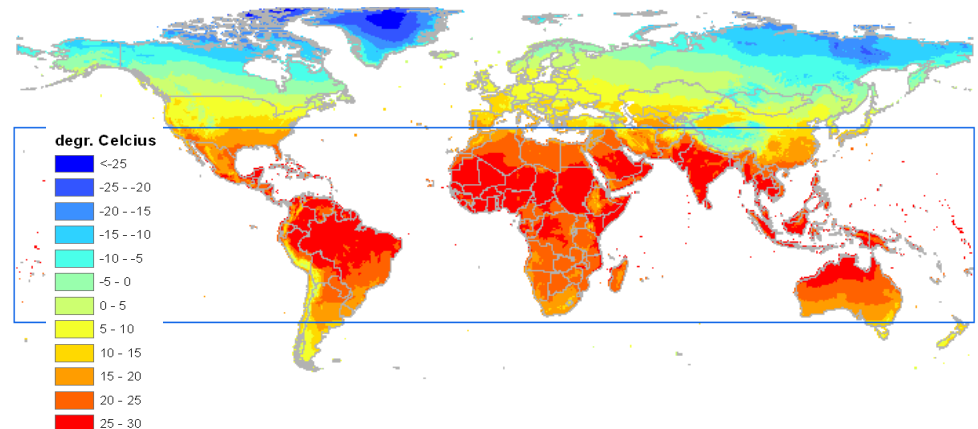
Diesel from Algae: oil productivity



	Productivity (oil, t/ha/y)
Corn	0.15-0.30
Soybean	0.5-0.7
Rapeseed	1.1-1.3
Sunflower	1.5-1.8
Palm	4.5-5.5
Microalgae (30%w oil)	50*
Microalgae (70%w oil)	120*



Optimal cultivation zone



(*) Fonte: Y. Chisti / Biotechnology Advances 25 (2007) 294–306

Microalgae cultivation: pilot plant at eni refinery (Gela, Sicily, I)

Since 2011 ~ 1 ha



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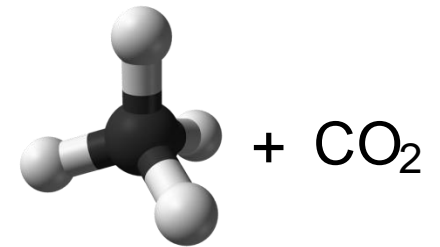
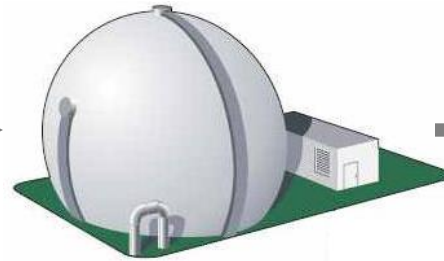
Productivity: up to 100 t/ha/y of algal biomass

Biomethane

Organic waste
(solid and liquid)



Biomass

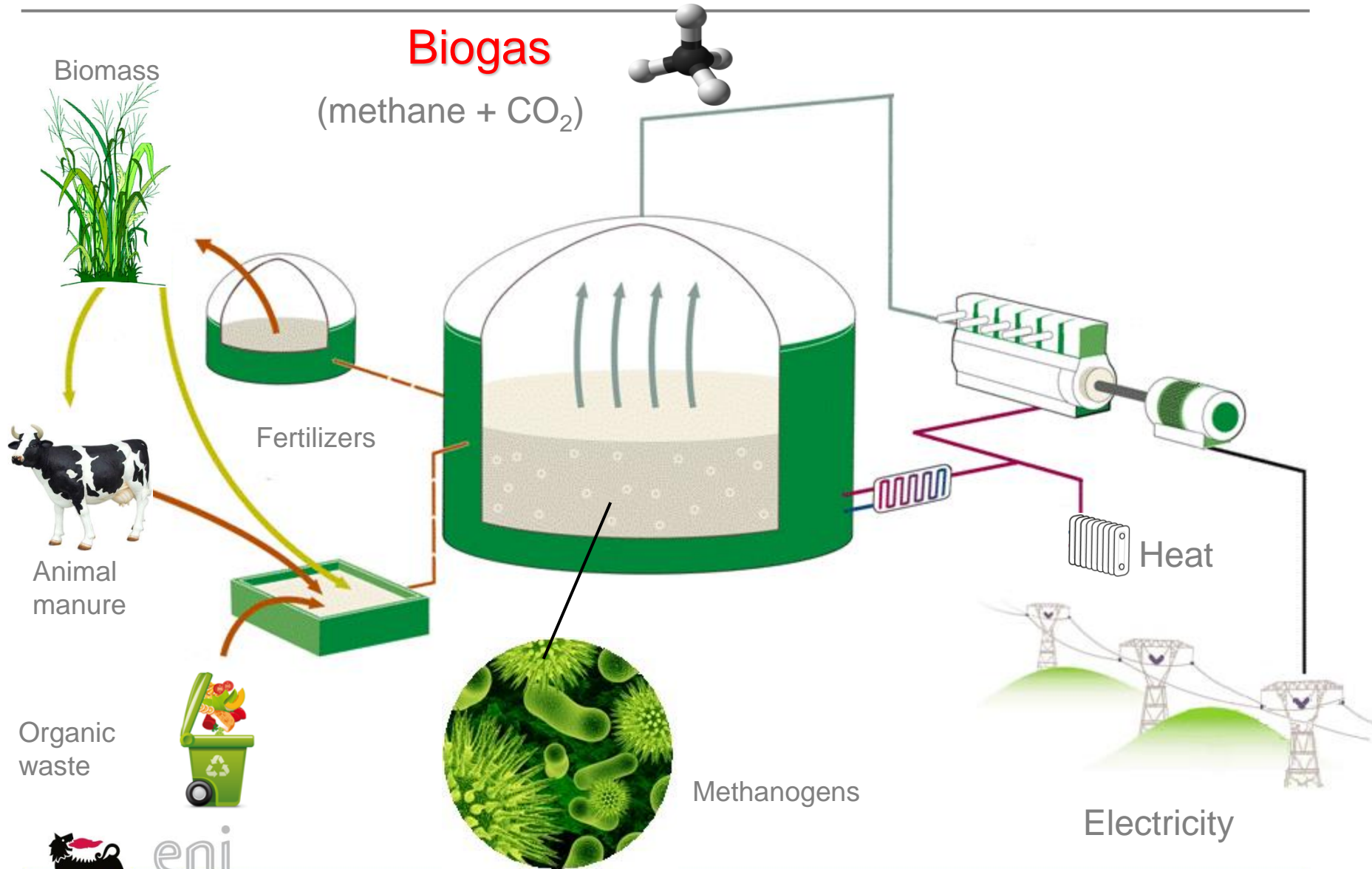


Methane



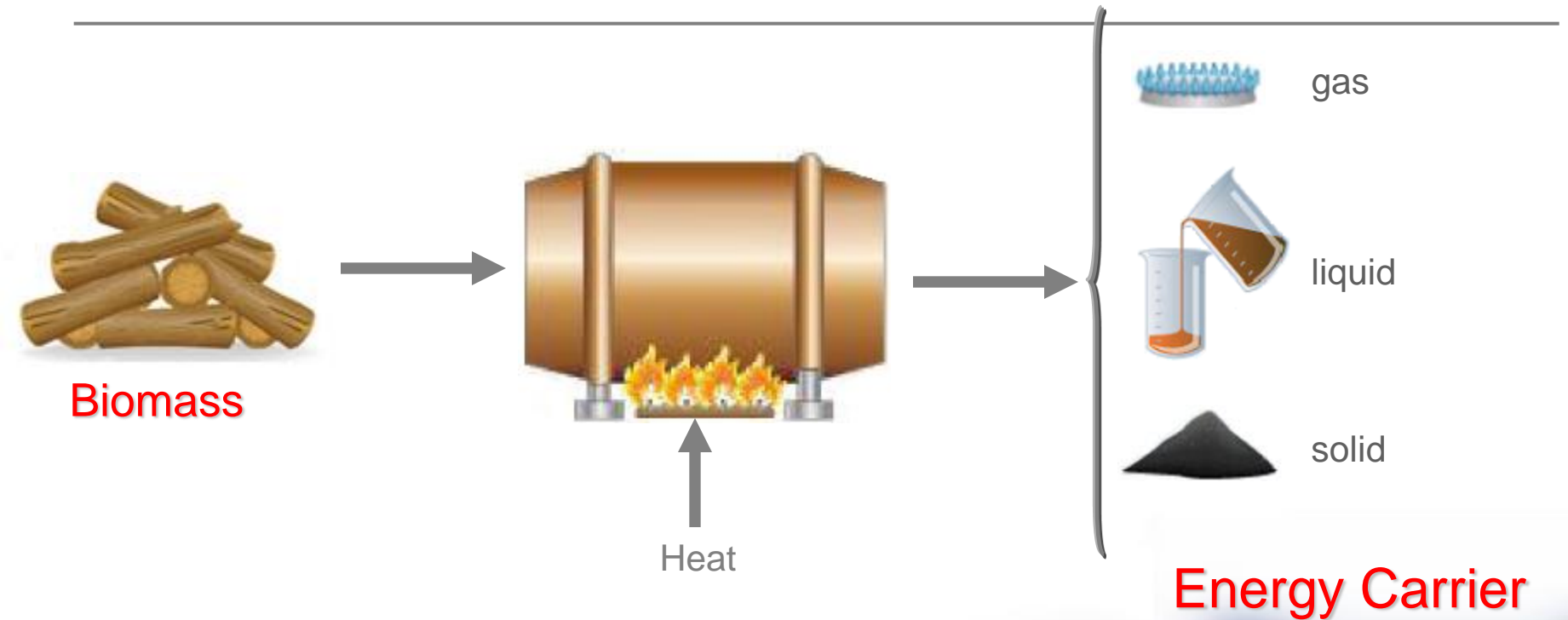
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Biochemical Conversion: BIOGAS



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Thermochemical conversion

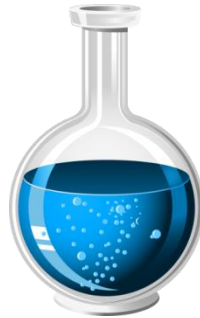


Thermochemical conversion: Pyrolysis and Liquefaction (hydrothermal)

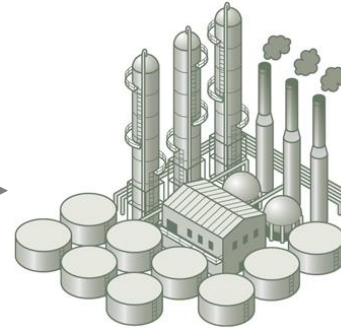
Pyrolysis



Biomass
DRY



Bio-oil



Refinery



Liquid
fuels

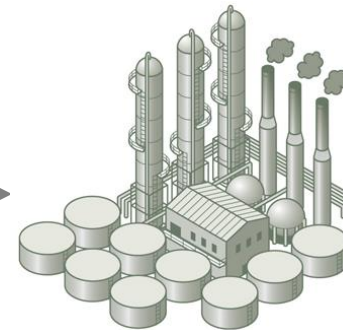
Liquefaction



Biomass
WET



Bio-oil



Refinery



Liquid
fuels



eni

Waste to Fuel



Biomass
(wet ~65% H₂O)



wet organic fraction
of municipal solid
waste



waste from food
processing



sewage sludge from
urban wastewater
treatment plants

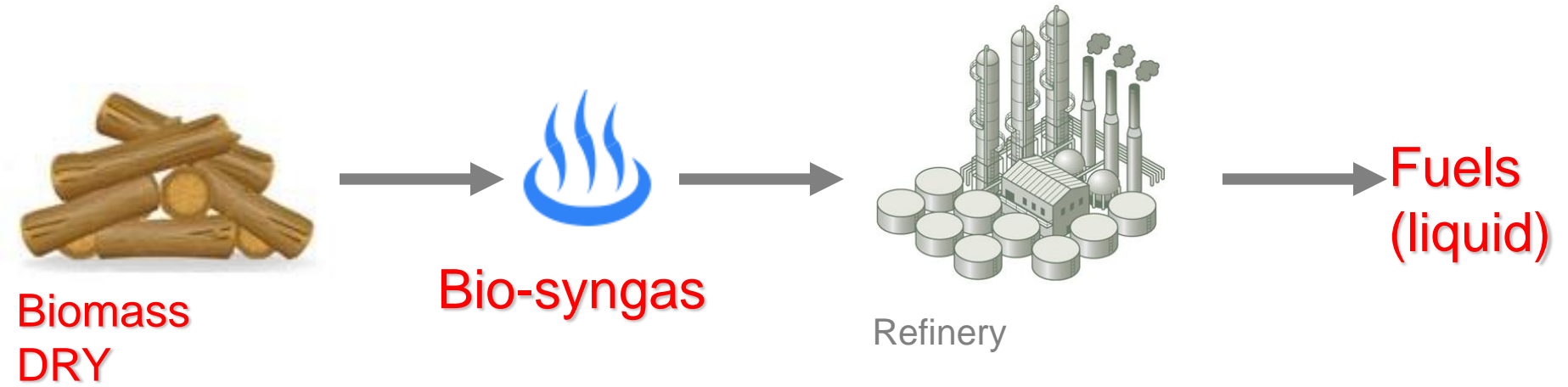


Waste to Fuel pilot plant at eni - Renewable Energy and Environmental R&D Center (Novara, I)



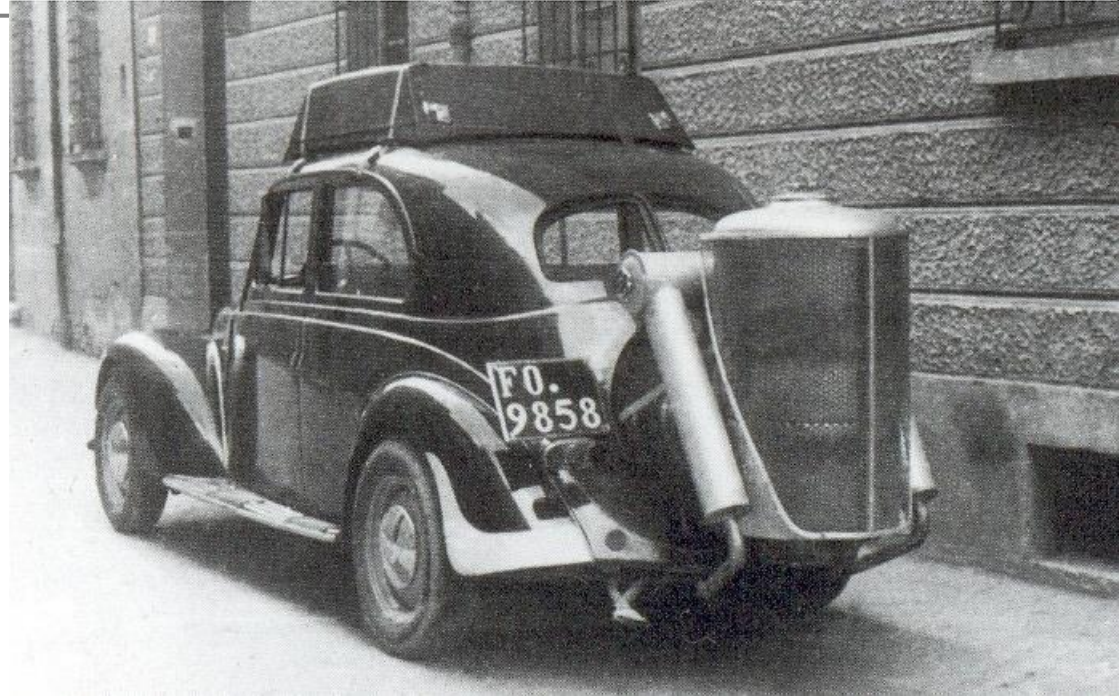
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Biomass to liquid(BtL)



Biomass to Liquid (BtL): ancient origins

A car built in the 1940s with a wood gas generator device*.



Wood gas generator ([gasogen](#)): is a bulky and heavy device that transforms burning wood in a mix of molecular [hydrogen](#) (H_2), [carbon monoxide](#) (CO), [carbon dioxide](#) (CO_2), [molecular nitrogen](#) (N_2) and [water vapor](#) (H_2O). This gas mixture, known as "wood gas", "poor gas" or "[syngas](#)" can fuel an internal combustion engine.



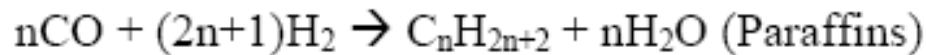
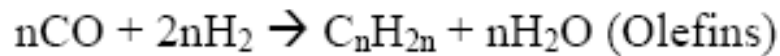
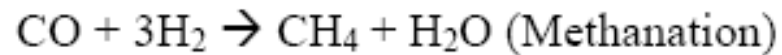
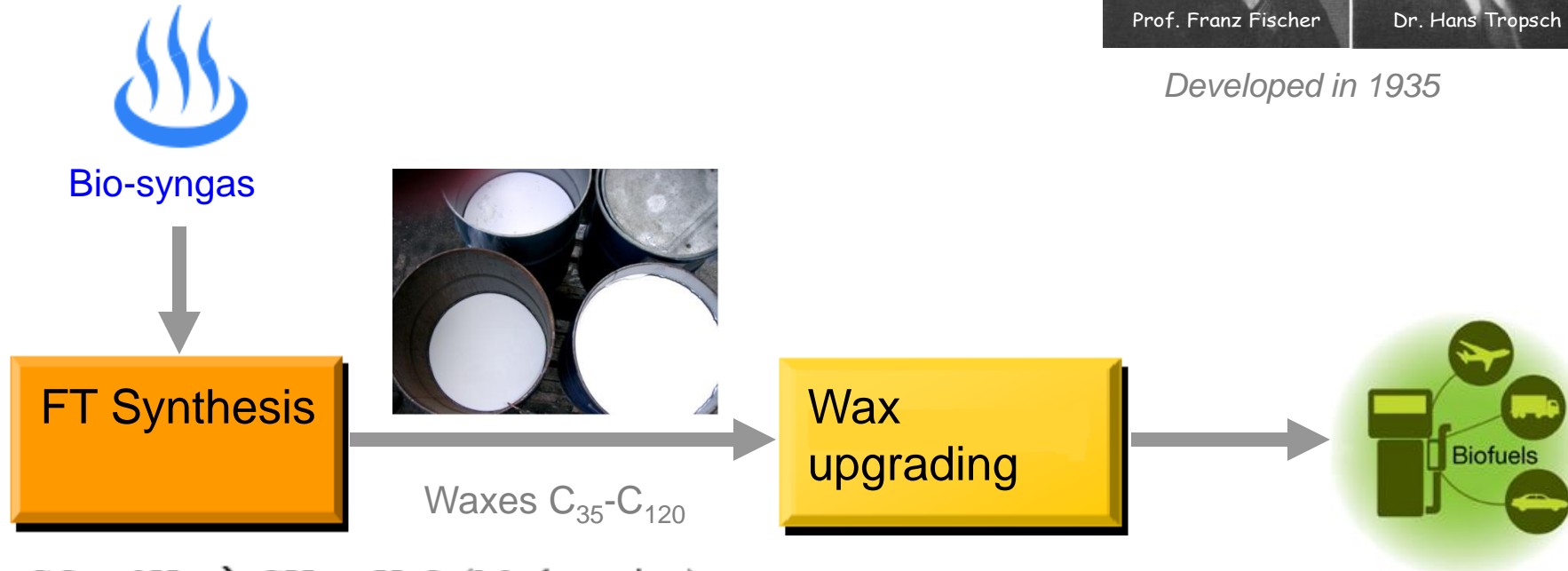
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*http://en.wikipedia.org/wiki/Wood_economy

From syngas to liquids: Fischer Tropsch synthesis



Developed in 1935

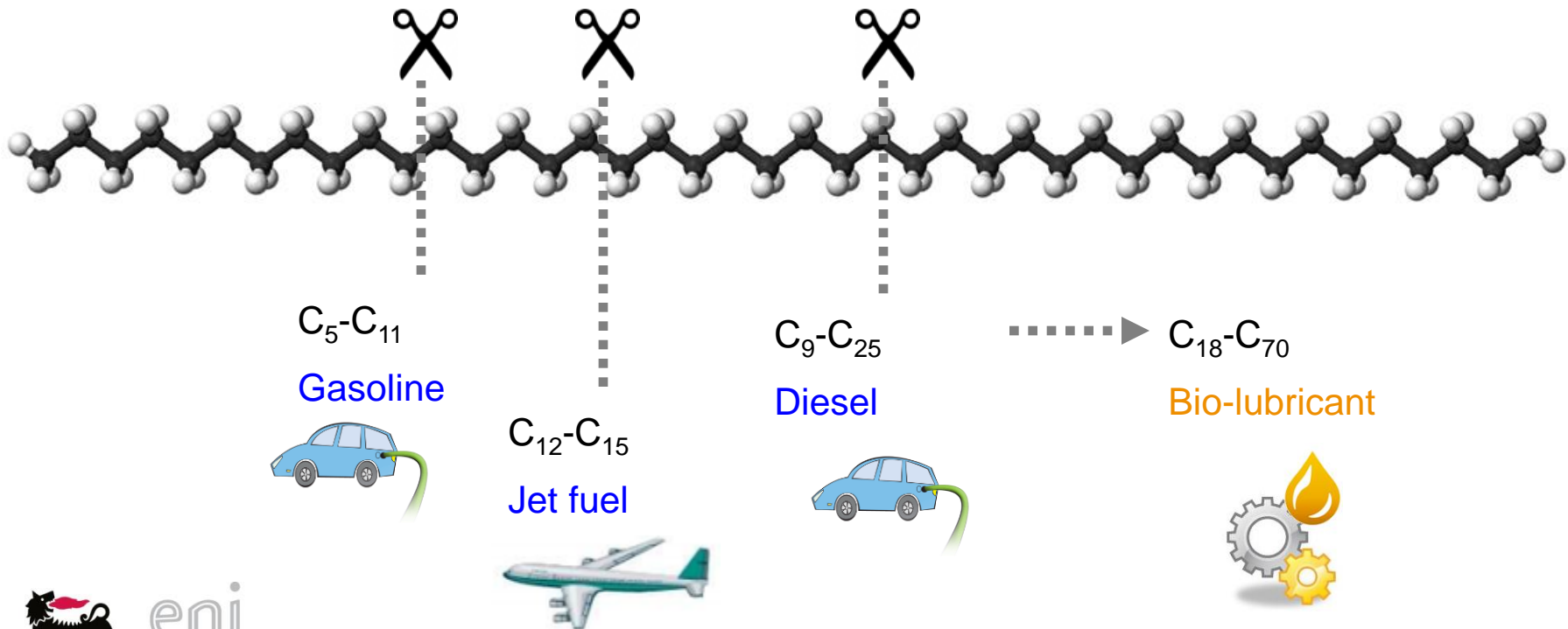


Fischer Tropsch waxes: upgrading



Waxes $C_{35}-C_{120}$

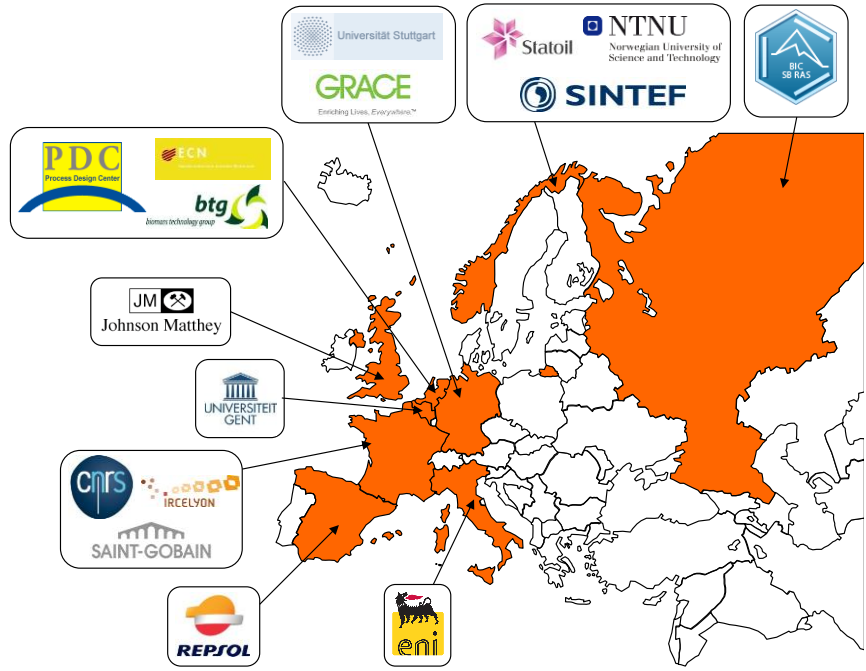
Hydrotreating



European Projects on biofuels

► BtL

FASTCARD, 2014-2017.



► Fast-pyrolysis/upgrading

CASCATBEL, 2014-2017.



Lignocellulose



Bio-oil



Advanced Biofuel

Thank you for your attention

