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MOSSI GHISOLFI GROUP

Cellulosic ethanol, status, prospects and Biochemtex experience

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MOSSI GHISOLFI GROUP

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Mossi Ghisolfi is a multinational, family-run business established in 1953 by Vittorio Ghisolfi and Domenico Mossi

Polymers

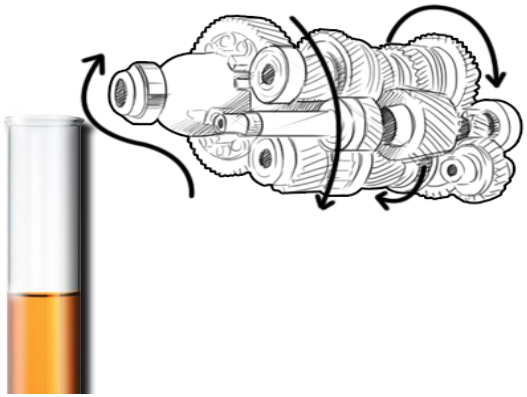
One of the top 3 producers worldwide

Engineering and R&D

60 years of excellence in process development and commercialization of plants

Sustainable Chemistry

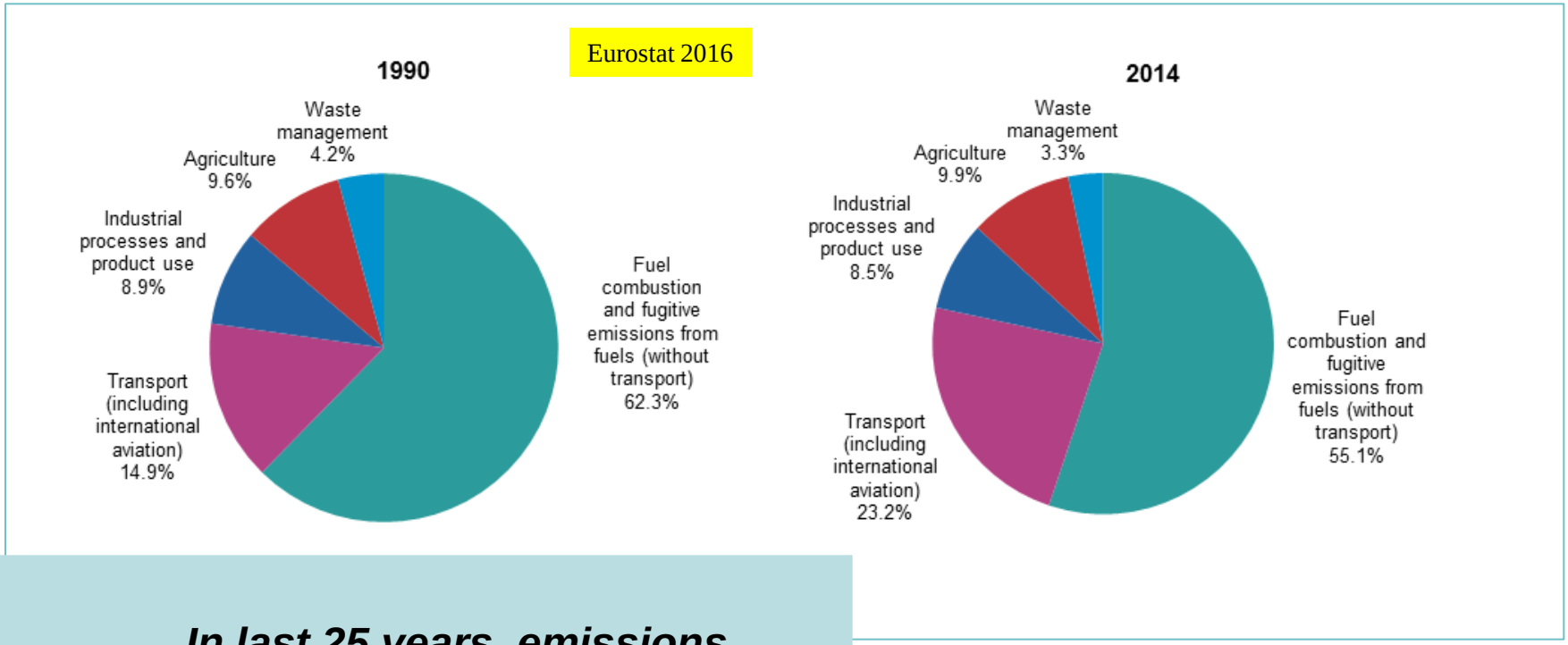
PROESA®: technology leader in biofuels and chemical intermediates from non-food biomass



Mossi Ghisolfi Group: a global presence

1953 - 1979	1979 - 2000	2000 - 2006	2006- ….
Packaging Manufacturing	Chemical Specialty	PET expansion phase	*Renewables*

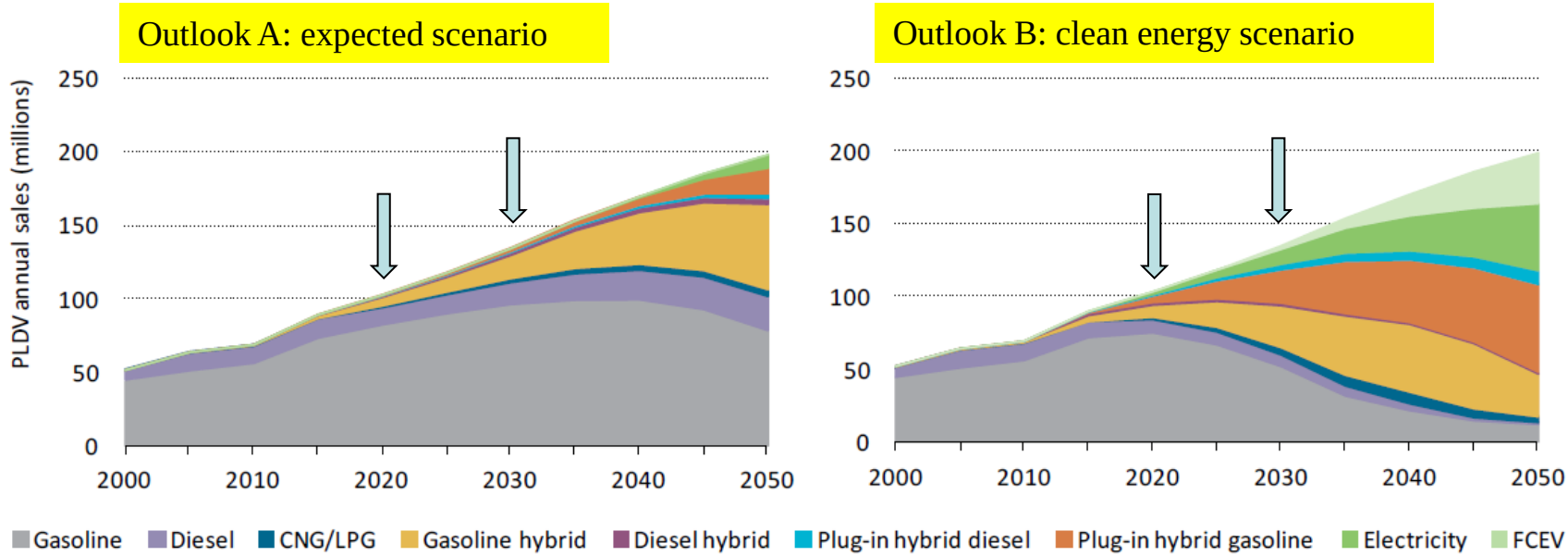
Emissions by sector: transport, second largest emitter



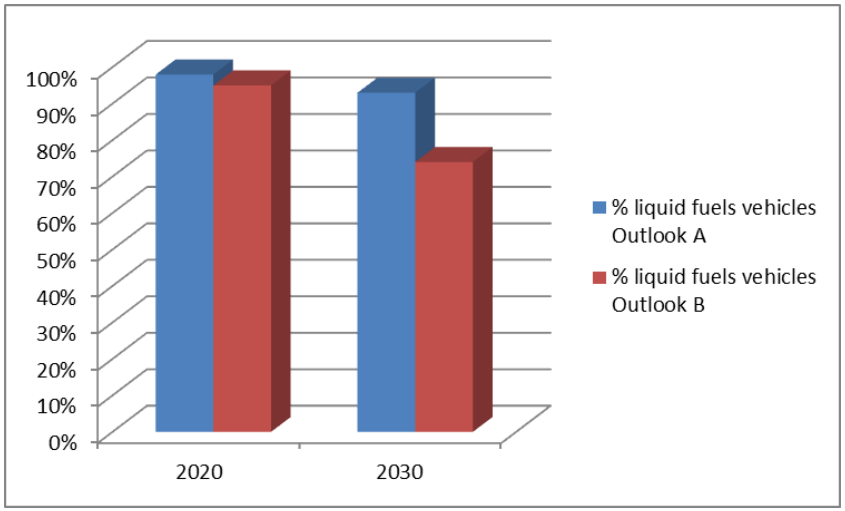
In last 25 years, emissions decreased across all source sectors, except transport (33% increase from 1990 to 2007 Source EU Comm)

It is key to cut emissions of the transport sector to mitigate global warming

In the medium-term, global transportation dominated by liquid fuels



Source: IEA



IT IS ESSENTIAL TO INCREASE THE SHARE OF TRULY SUSTAINABLE LIQUID BIOFUELS WITHIN 2030 !

Bio-Ethanol and Bio-Diesel: the biofuel most commonly utilised worldwide

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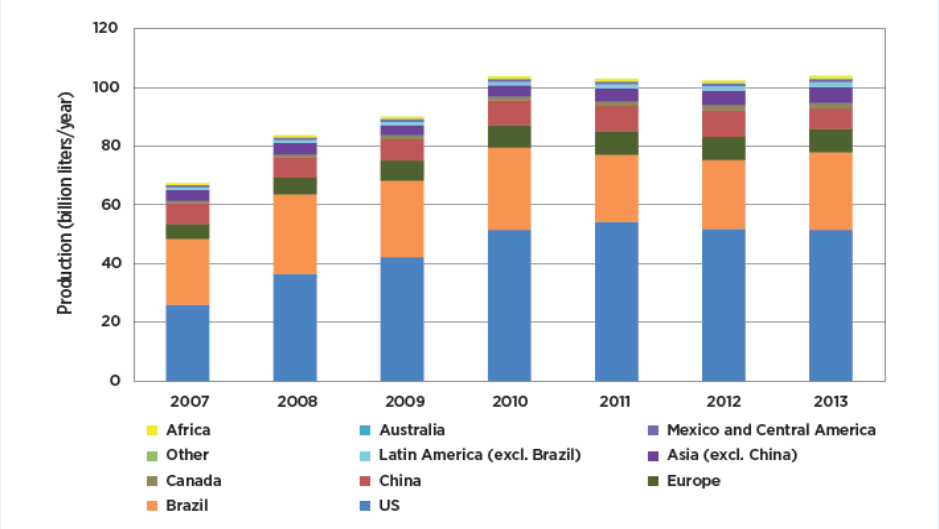
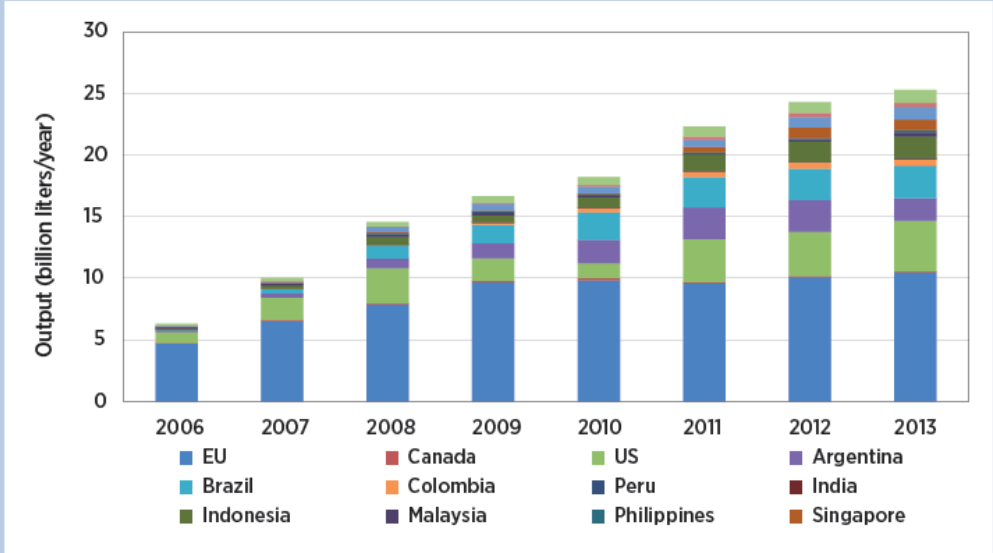
Figure 7: Global ethanol production by country and region, 2007-2013



Source: F.O. Lichts (2013a)

Note: Data for 2012 for Africa, Australia, Mexico and Central America, and "Other" are not available and includes both fuel and non-fuel ethanol.

Figure 8: Global biodiesel production by country and region, 2006-2013.



Source: F.O. Lichts (2013b)

Bioethanol, the most common biofuel in the world

Why are advanced biofuels preferred to decarbonize the transport sector ?

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Biofuels are not all equal

Advanced Biofuels* may be defined as those (1) produced from lignocellulosic feedstocks (i.e. agricultural and forestry residues), non-food crops, or industrial waste and residue streams, (2) having low CO2 emission or high GHG reduction, and (3) reaching zero or low ILUC impact (*unintended consequence of releasing more carbon emissions due to land-use changes around the world induced by the expansion of croplands*)

Advanced biofuels do not compete with food

- *Advanced biofuels start from residues, waste materials, non-food crops, etc*

Advanced biofuels provide very high emission saving vs fossil fuels

- Up to 90% or more and much more than 1G biofuels

Advanced biofuels have zero or minimum impact on «land use change»

- As biomasses don't come from agricultural land

Advanced biofuels may help rural economy

- As some kind of biomass (e.g. energy crops) may grow on marginal land not used for common agricultural practice, thus generating additional income for farmers

Advanced biofuels helps creating green jobs

- Advanced biofuels are based on innovative technologies and continuous research and optimization

** Source European Biofuels Technology Platform*

Advanced Biofuels : cellulosic ethanol shows the best in class emission performance

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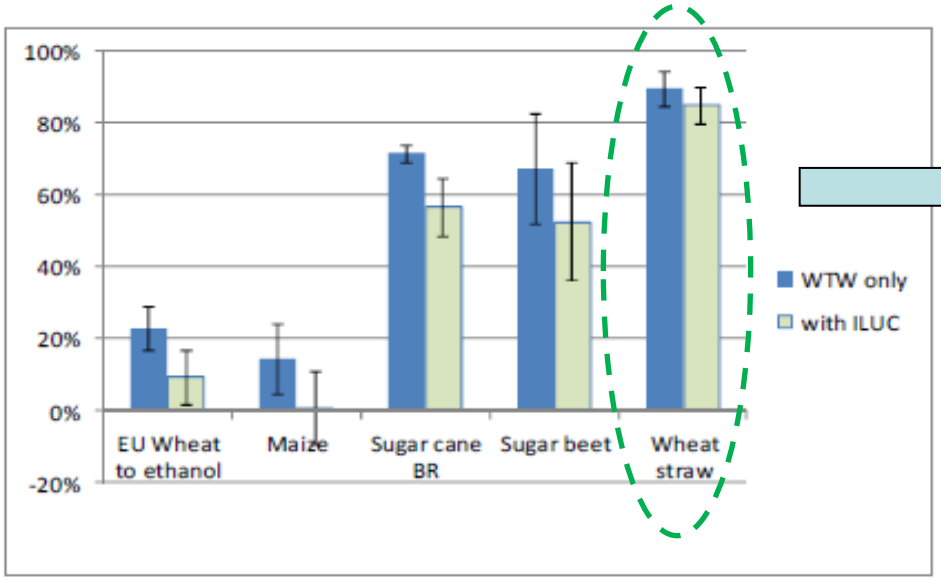
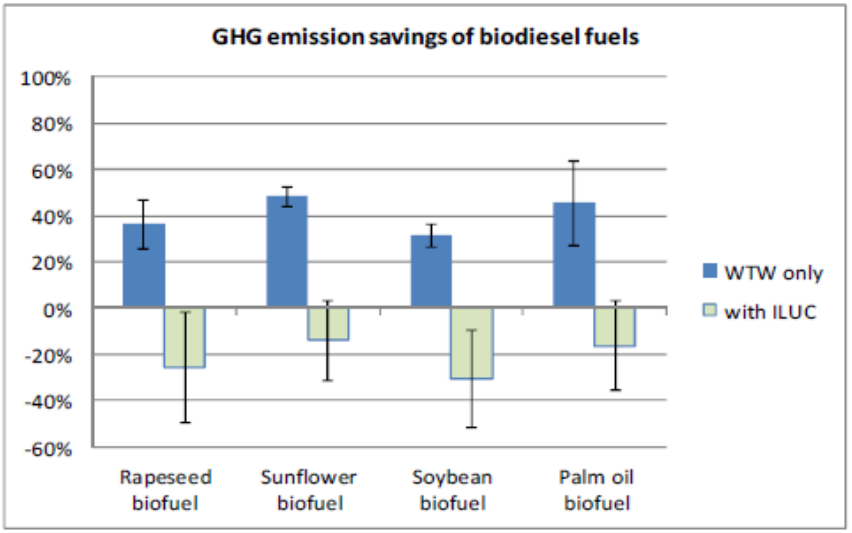
Emission savings from different bioethanol fuels



Cellulosic ethanol, best choice

Emissions savings from different biodiesel fuels



Source: Scientific department of the EP , june 2015

…but how much advanced biofuels are actually needed by 2030 to decarbonize EU transport ????

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Advanced biofuels are just one of the dimensions policy makers are considering to decarbonize the transport sector by 2030: efficiency, other low carbon fuels, electrification are other important pillars of the 2030 policies on transportation.

Renewable Energy Directive (RED), established in 2009, paved the way to the decarbonization of the transport sector by 2020, with a 10% renewable energy (dominated by biofuels) blending mandate.

The RED is now under revision to set the target post 2020 to 2030. In dec 2016 EC proposed new targets for transportation:

- Phasing out of Conventional-1stGen- biofuels: maximum share is reduced over time from 7% in 2021 to 3,8% in 2030;
- Minimum share of «low emission and renewable fuels» gradually increasing from 1,5% in 2021 up to 6,8% in 2030
  - **Binding subtarget of Advanced -2ndGen- biofuels gradually increasing from 0,5% in 2021 to reach at least 3,6% in 2030**
  - Maximum contribution of UCO, animal fats and molasses limited to 1,7%

Equates to approx 12-14 Mtoe/yr of advanced biofuels by 2030

Biofuels share evolution to 2030 according to the RED2 proposal

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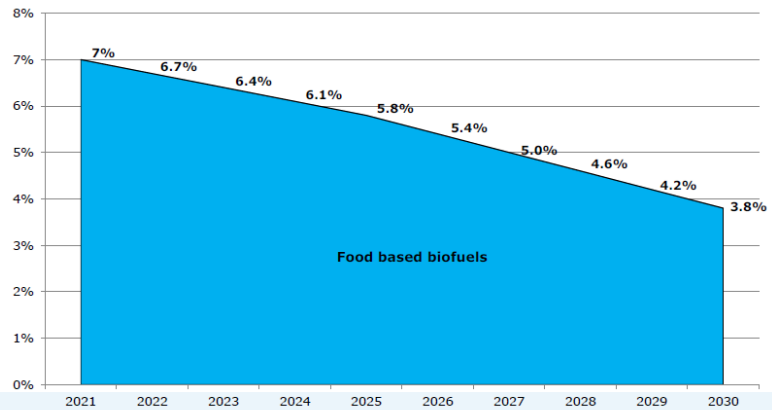
Gradual phase out of conventional crop based biofuels

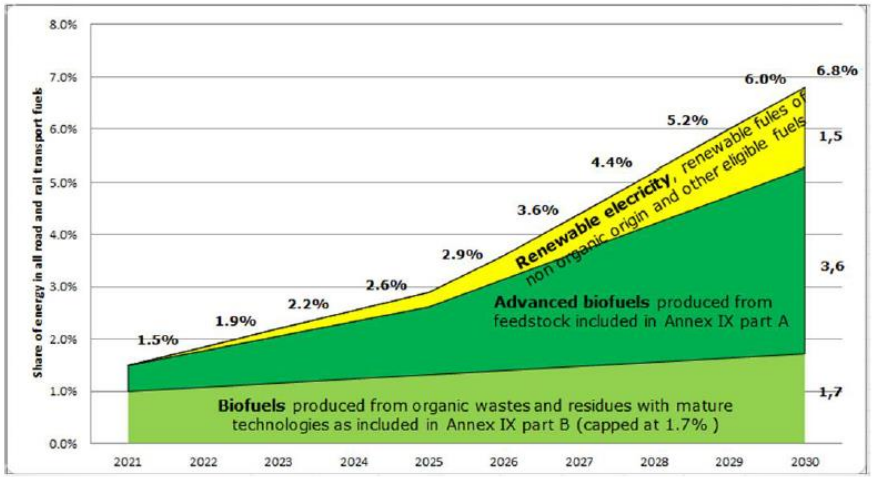


- **Gradual phase out of crop-based biofuels from 7% in 2020 to 3.8% in 2030, effectively bringing the conventional biofuel use to pre-2008 levels.**
- **Member States may set a lower limit and may distinguish between different types of biofuels for instance by setting a lower limit for the contribution from food or feed crop based biofuels produced from oil crops, taking into account indirect land use change.**

Europe targetting a decrease in 1G biofuels….

…and a <u>simultaneous increase in highly sustainable biofuels</u>

Promoting renewables in transport



Increasing the share of low carbon and renewable fuels in transport through an EU blending mandate

European potential “wasted” biomass supply for advanced biofuels production

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Europeans generate around 900 million tonnes of waste paper, food, wood and plant material each year

If all the wastes and residues that are sustainably available in the European Union were converted only to biofuels, this could supply 16 per cent of road transport fuel in 2030. (Technical potential).

….creating additional jobs:

High-end estimates of additional employment from fully utilizing wastes and residues for conversion to advanced biofuels

Source: Wasted ! Report - ECF, 2015

Residual biomass actually available in Italy

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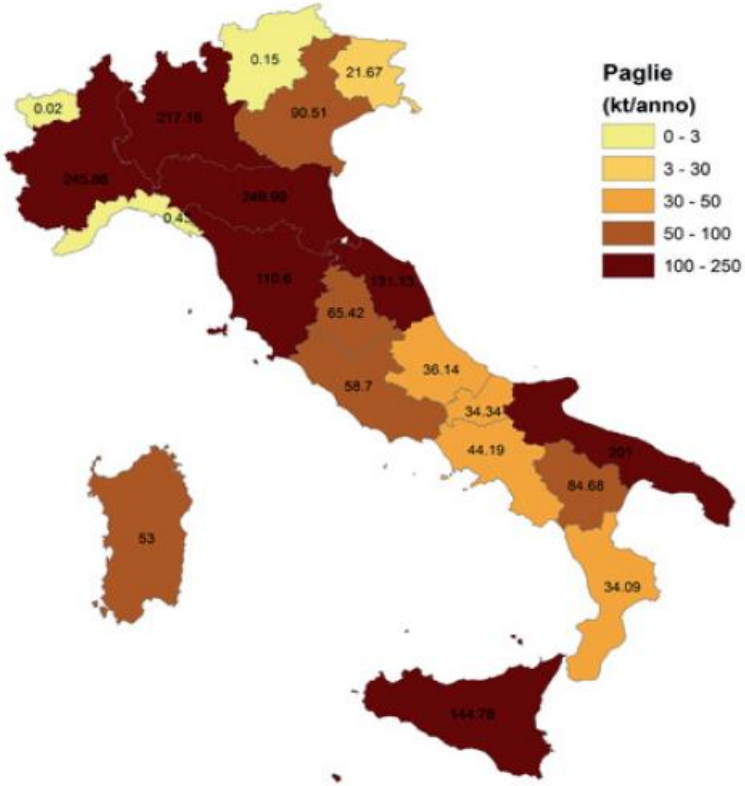
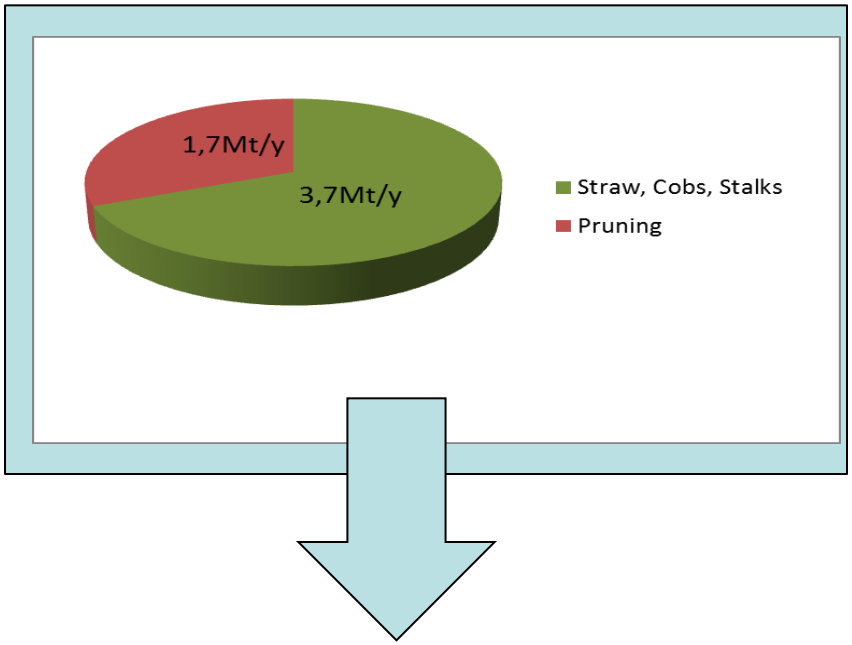
Biomass availability (Mt/y)		
	Global	Actually available for bioenergy production
Agricultural	12,8	5,4
Forestry	3	0,8





Advanced biofuel (from agri/forestry residues only) potential
0,6-1 Mtoe/y (2-3,5% transport consumption)

Source: ENAMA

Advanced biofuels need and biomass availability in Europe: perfect fit ?

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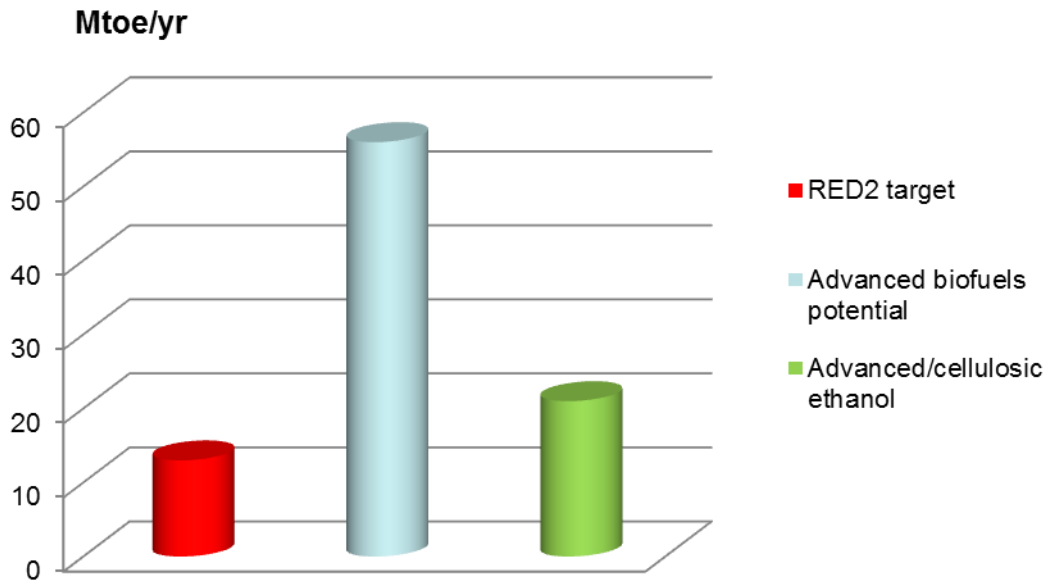
According to the «new» RED (RED2), at least 3,6% (or 12-14 Mtoe/yr) advanced biofuels should be made available by 2030.

Advanced biofuels comprise cellulosic ethanol, biomethane and other fuels from waste, algae based fuels, other residues based fuels, etc.

Biomass eligible to produce advanced biofuels and sustainably available in Europe is enough to cover up to 16% the transport demand in 2030 (Wasted! Report) that is more than 4 times the RED2 target.

Based on available biomass volume, cellulosic ethanol potential (just one of the advanced biofuels) by 2030, able to cover up to 5-7% the transport demand in 2030.



Biochemtex pioneered cellulosic bioethanol with PROESA® technology: Crescentino plant

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Capacity: up to 40kt/y ethanol plant,

Feedstock: NON FOOD biomass (residues and energy crops)

GHG saving: -85% or more

Innovative technology – «first of its kind» plant in the world

Technology platform for green chemistry development

The cellulosic biorefinery today : …. PROESA™ Technology

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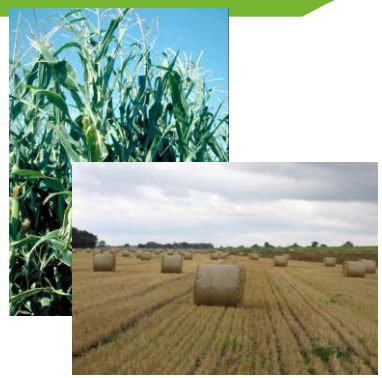


Lignocellulosic Biomass

Pre-Treatment

Enzymatic Hydrolysis

Fermentation

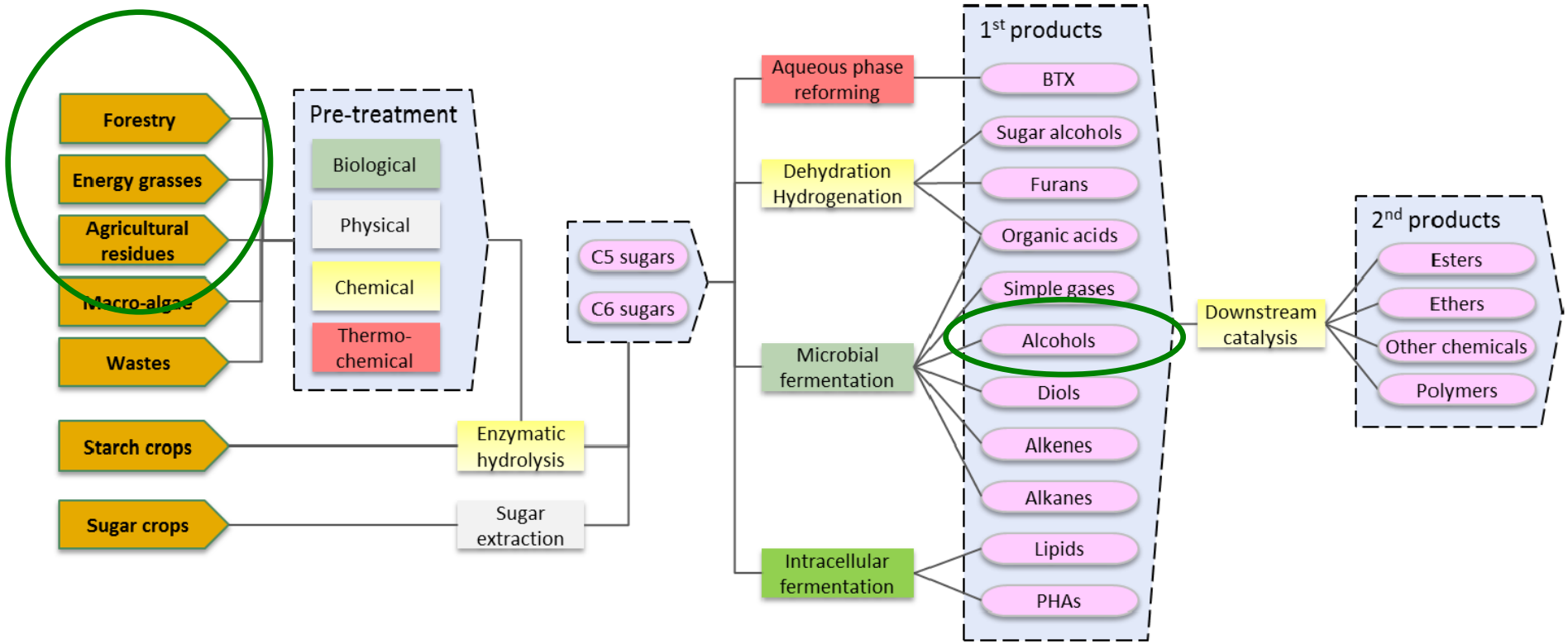
Distillation and separation

Bio Ethanol

Lignin residue

Steam and power generation

Advanced biorefinery to unlock the incredible biomass potential



High-level representation of pathways via the sugar platform

Source: EC, From the Sugar platform to biofuels and biochemicals, 2015

Advanced biorefinery deployment in the EU: a slow process

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Off-take risk

- Though EU is promoting advanced biofuels and biorfineries, regulatory framework is unstable and uncertain in the long term, no obligations are in place for advanced biofuels and bioproducts yet
- Unbalanced taxation among various fuels
- Bio-based fuels and products are deemed not «cost competitive» vs fossils

High capex

- Capex associated to advanced biorefineries are typically well above 100M€ and projects hardly bankable, while public financial support is limited (typically below 10% from grants)

Technology immaturity

- Many advanced processes are still at lab or pilot scale and need further financial support to materialise

Complex, costly and time consuming permitting and certification processes

- EU and national rules are often complex and hard to comply with

Some analyses attempted at fuel cost comparison focusing on mere production costs

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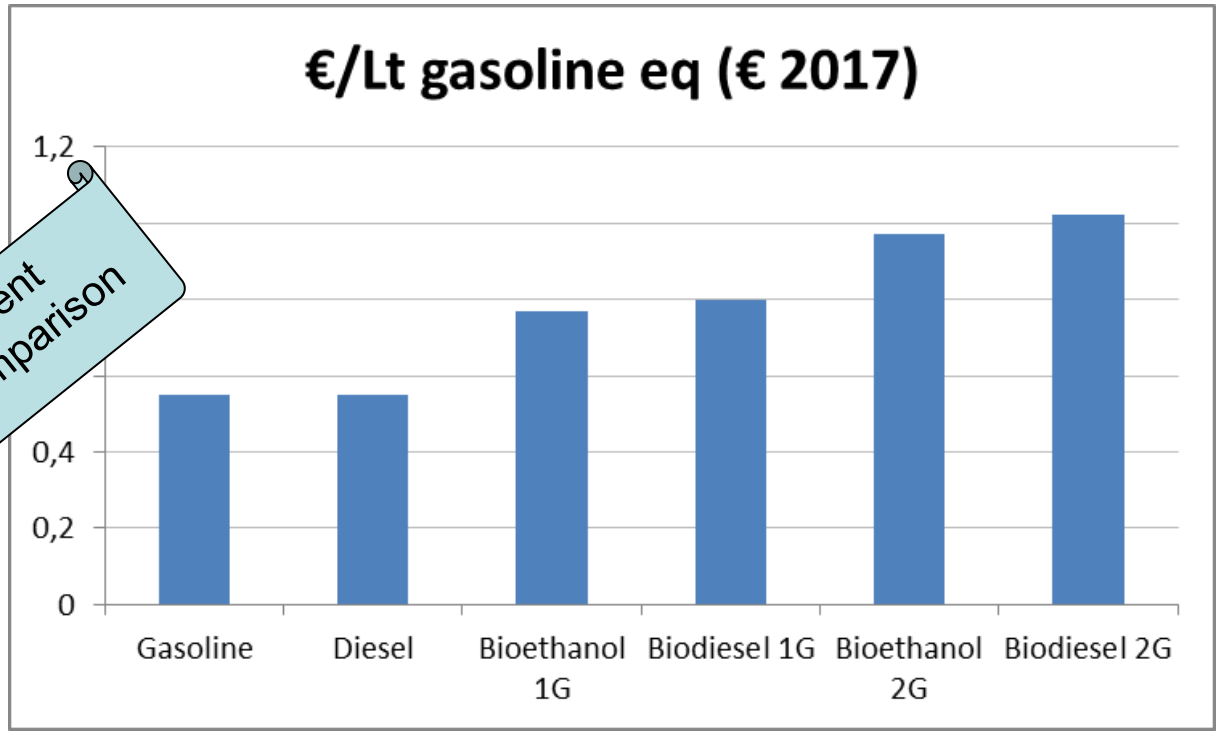
2030 Fuel prices in € per litre gasoline equivalent (at the gate of the refinery/production facility)

Example from a recent report on cost comparison



At a glance, fossils are far cheaper than biofuels.

However, are they really considering all the variables ?

Source Energy Analysis, 2017

Energy markets generally do not account for externalities related to climate change and air pollution

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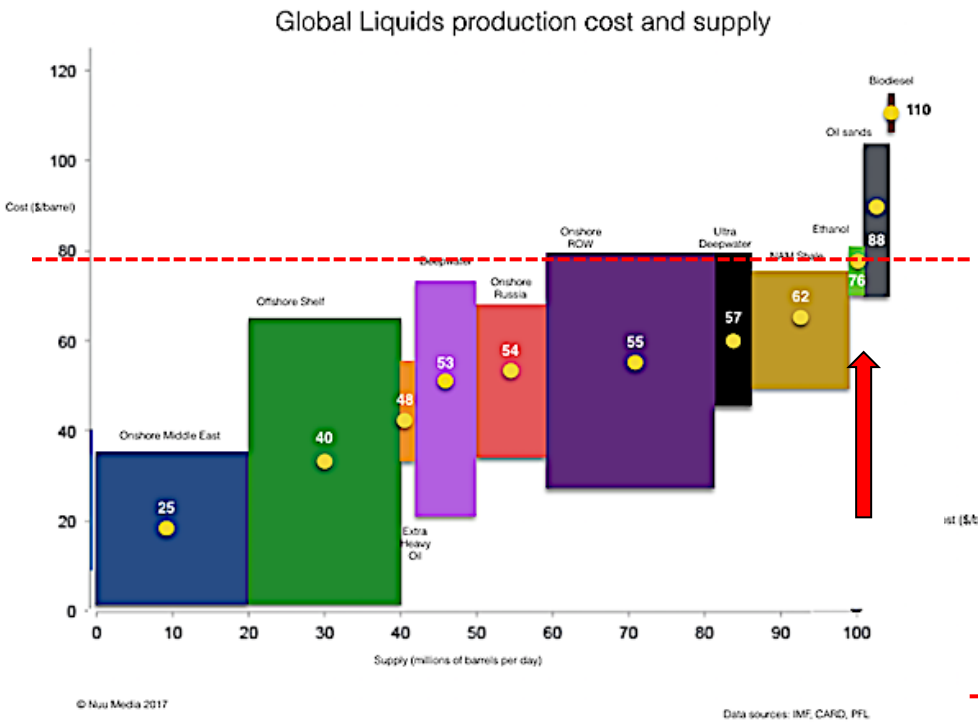
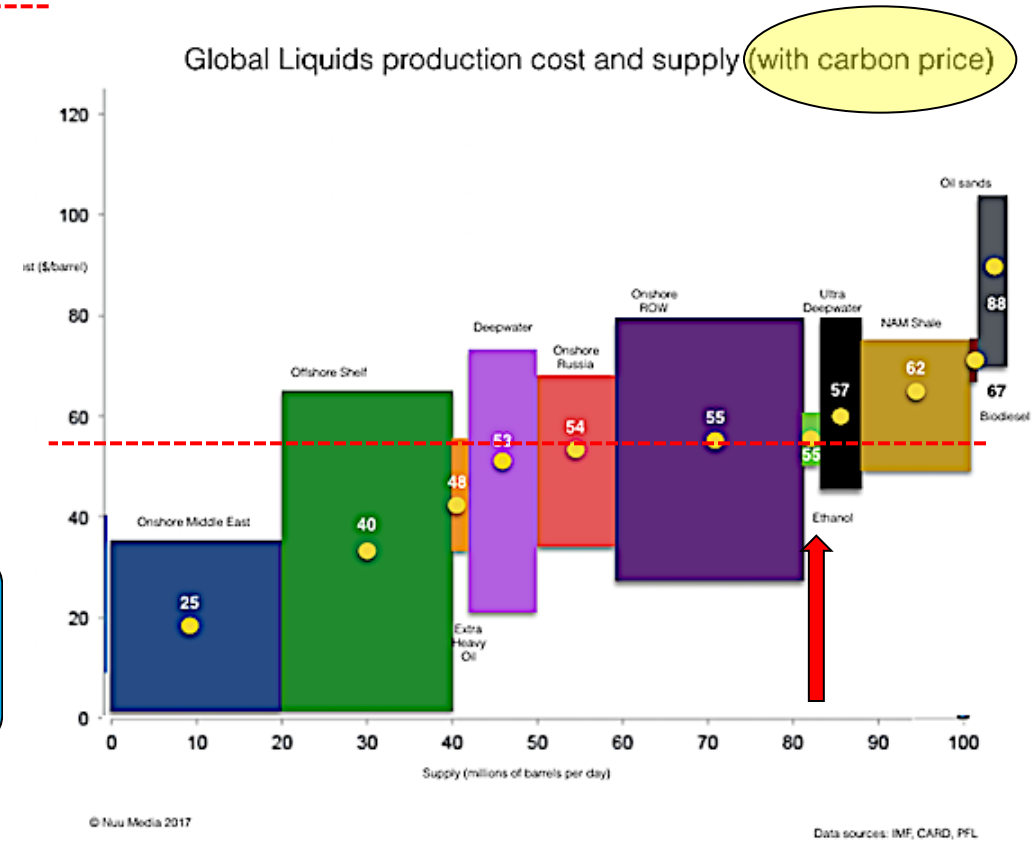
There are external costs related to the use of fossil fuels (e.g. pollution and environmental degradation resulting from the extraction of resources; indoor and outdoor air pollution due directly to fuel combustion; the negative impact of extreme weather events caused by global warming; etc).

"Currently, the external effects of energy supply and use related to climate change and air pollution are in the order of USD 2.2 trillion – USD 5.9 trillion per year. ***According to European Commission estimates, the external costs of air pollution in the European Union (EU) alone ranged between USD 330 billion and USD 940 billion in 2010. "***

THE TRUE COST OF FOSSIL FUELS, International Renewable Energy Agency, 2016

Recent analysis from US points at actual fuel cost comparison





Just one (positive) externality (CO2) brings the ethanol cost down 25% and aligned with oil

Source Biofuels Digest 2017

Policy should fully recognize the environmental value of advanced biofuels

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Blending mandate and due carbon (and pollution) cost accounting are the pillars to boost the advanced biorefinery deployment

Investing in renewables is money-saving

"With renewables doubled in the energy mix, the resulting reduction of air pollution, both indoors and outdoors, would offer large financial savings estimated to be between USD 1 trillion and USD 3.2 trillion per year in 2030, compared to the Reference Case (i.e. business as usual). Annual savings related to climate change could amount to between USD 200 billion and USD 1 trillion depending on how carbon emissions are priced. In total, ***these savings are at least 4 times—and as much as 15 times—higher than the costs associated with doubling the share of renewables in the global energy mix by 2030****.*

<u>These tremendous savings, however, will not occur without policy change</u>"

THE TRUE COST OF FOSSIL FUELS International Renewable Energy Agency, 2016

Take-aways

- ✓ **Decarbonization of the transport sector by 2030 needs the contribution of advanced biofuels (up to 90% emission saving)**
- ✓ **Advanced biofuels are industrial reality at scale**
- ✓ **Help energy security while adding value to local resources and rural economy, revitilizing marginal land**
- ✓ **Mobilize huge investments in innovation and «green jobs»**
- ✓ **Help the deployment of truly advanced biorefineries able to produce multiple output**
- ✓ **Investing in advanced biorefineries is money-saving, thanks to reduced pollution and low emission, mitigating climate change phenomena**
- ✓ **Italy is leader in the advanced bio-technologies and pioneering first-of-its-kind advanced biorefineries**

- ✓ **However, clear, long-term policy strategy is needed to kick-start large deployment of advanced biorefineries in EU**