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MOSSI GHISOLFI GROUP

Biofuels driven cellulosic biorefinery

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Mossi Ghisolfi background

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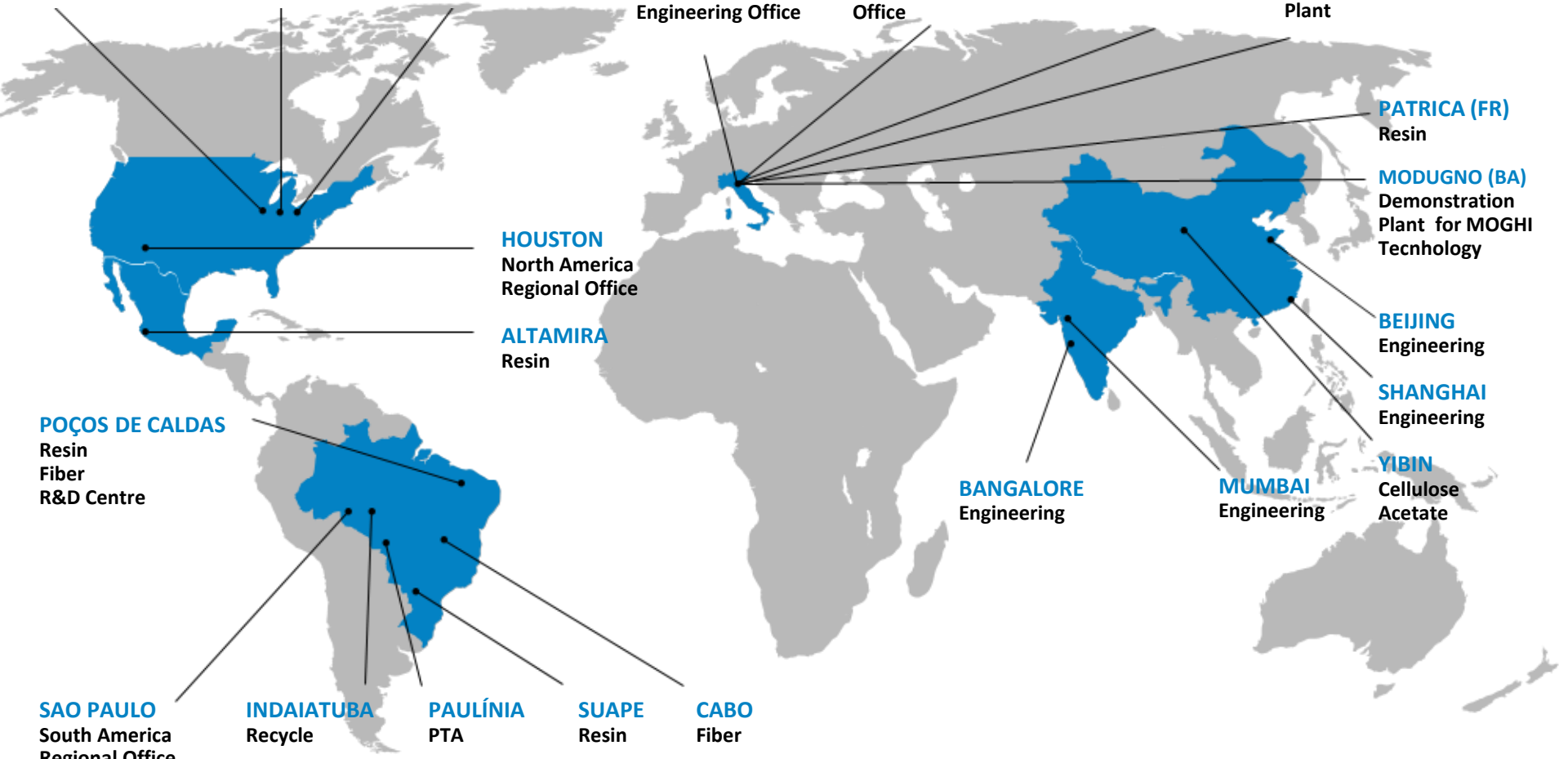
1953 - 1979	1979 - 2000	2000 - TODAY	
Packaging Manufacturing Phase	**Chemical Specialty Manufacturing Phase**	**PET expansion phase**	***Renewables***
HDPE and PVC packaging production	Development and production of PET resins for food packaging	Acquisition of PET Shell activities and Rhodia from Rhone Poulenc Acquisition of Chemtex from Mitsubishi Corporation Construction of the world's largest plants for PET production in Altamira (Mexico) and Suape (Brasil) Plans announced for a new plant in Corpus Christi (Texas, USA)	**2006 -2008 -** Lab scale technology development for 2nd gen ethanol **2009 - Pilot plant** for cellulosic ethanol **2011 - Beta Renewables** is founded, dedicated to sustainable chemistry. **2012 -** Beta Renewables and Novozymes partnership. **Oct 2013 - World's 1st commercial-scale biofuel plant** from non-food biomass (40.000 ton/year)

Where we are located

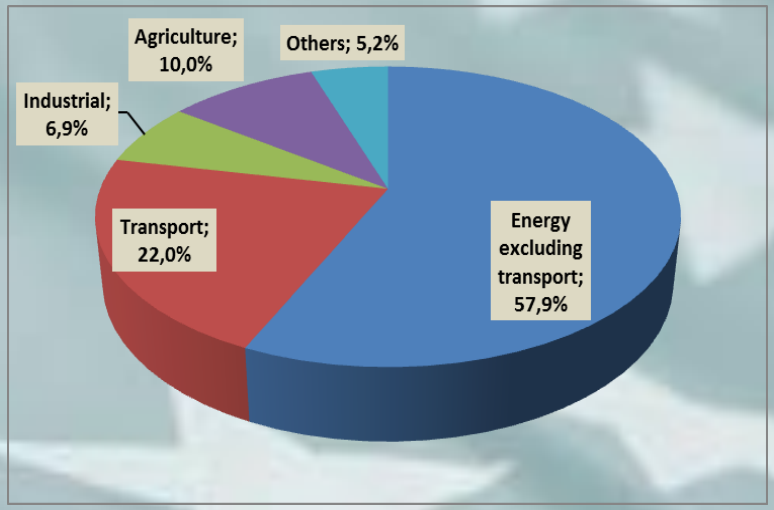


EU vision is a sustainable, low carbon and climate friendly economy

- In feb 2015 EC launched the Energy Union Package: low carbon technology, efficiency and job creation are the pillars and EU target -40% GHG emissions by 2030.

- BUT….
  - "Latest data shows that the EU imported 53% of its energy at a cost of around EUR 400 billion"
  - "94% of transport relies on oil products, of which 90% is imported"
  - 22% of GHG emissions relate to transport

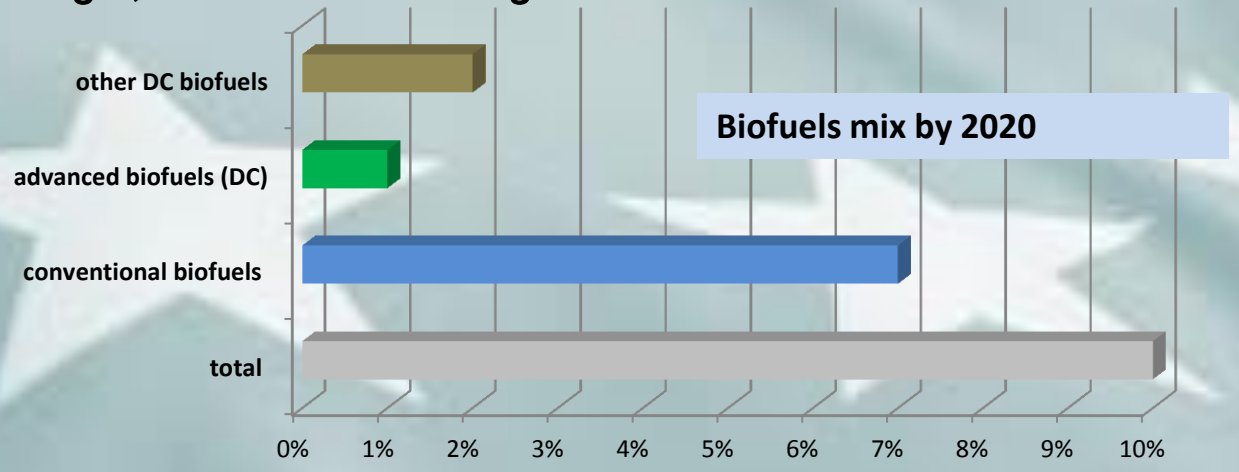
In last 20 yrs transport emissions increased by 20% while all other sectors'emissions decreased by around 15-20%



INVESTING IN SUSTAINABLE AND RENEWABLE ENERGY FOR TRANSPORT IS KEY TO MEET THE EU DECARBONIZATION TARGETS !

What is EU doing to address the trasport issue

- 2009: Renewable Energy Directive sets 10% renewable energy in the transport sector by 2020. Only sustainable biofuels can be used to meet the target.
- 2012: ILUC Proposal. The Commission published a proposal to limit global land conversion for biofuel production, and raise the climate benefits of biofuels used in the EU. The use of food-based biofuels to meet the 10% renewable energy target of the RED should be limited.
- Apr 2015: Energy Council and ENVI Committee reached a political agreement on ILUC proposal:
  - ✓ 7% cap on conventional biofuels (no support post 2020)
  - ✓ Non binding 0,5% min national targets for advanced biofuels



Any biofuel capable to address all the policy obligations and long term expectations?

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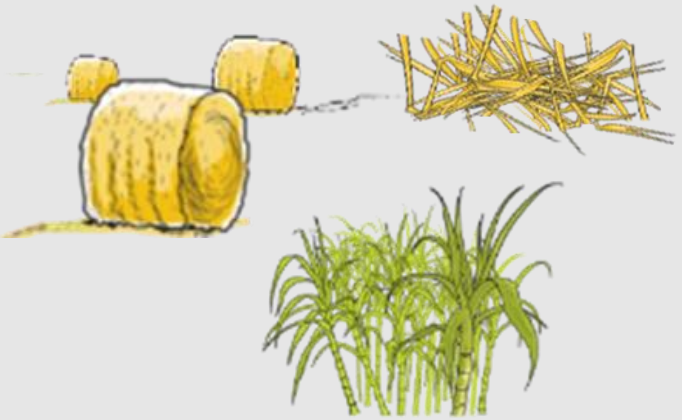
According to the current policy framework and expectations, post-2020 allowed biofuels shall feature at least:

- ✓ No competition vs food
- ✓ High GHG saving vs fossil
- ✓ Minimal use of land
- ✓ Price competition
- ✓ Technology innovation
- ✓ Benefits for rural areas



THIS IS WHAT WE CALL **ADVANCED BIOFUELS** !

Italy's approach to advanced biofuels

January 2013: IT Governement signed an agreement (Protocollo d'Intesa) with Gruppo Mossi Ghisolfi to foster the deployment of second and third generation biorefineries in Italy

May 2014: IT Government signed an agreement with MG to build up 3 cellulosic ethanol plants in the South of Italy

October 2014: DM set minimum quota of adv biofuels from 2018 on (from 0,6% in 2018 to 1% in 2022). This translates into around 180ktoe/y in 2018 and 300ktoe/y in 2022.

Biochemtex pioneered cellulosic bioethanol with PROESA® technology

The cellulosic biorefinery today ….

Non food Biomass → PROESA® Technology → Fermentable Sugars → Fermentation → Separation → Ethanol (up to -85% GHG saving)

Separation → Lignin → Energy Production → Steam & Power generation

2nd Gen Ethanol Plant (Crescentino – Italy) – Awarded FP7 support

…using a variety of sustainable (non-food) biomasses…

Non-food cellulosic crops

- ✓ Arundo donax (Giant reed)
- ✓ Miscanthus giganteus
- ✓ Panicum virgatum (Switchgrass)

Agricultural residues

- ✓ Wheat straw
- ✓ Rice straw
- ✓ Corn stover
- ✓ Sugarcane bagasse

Lignocellulosic crops

- ✓ Eucalyptus
- ✓ Poplar

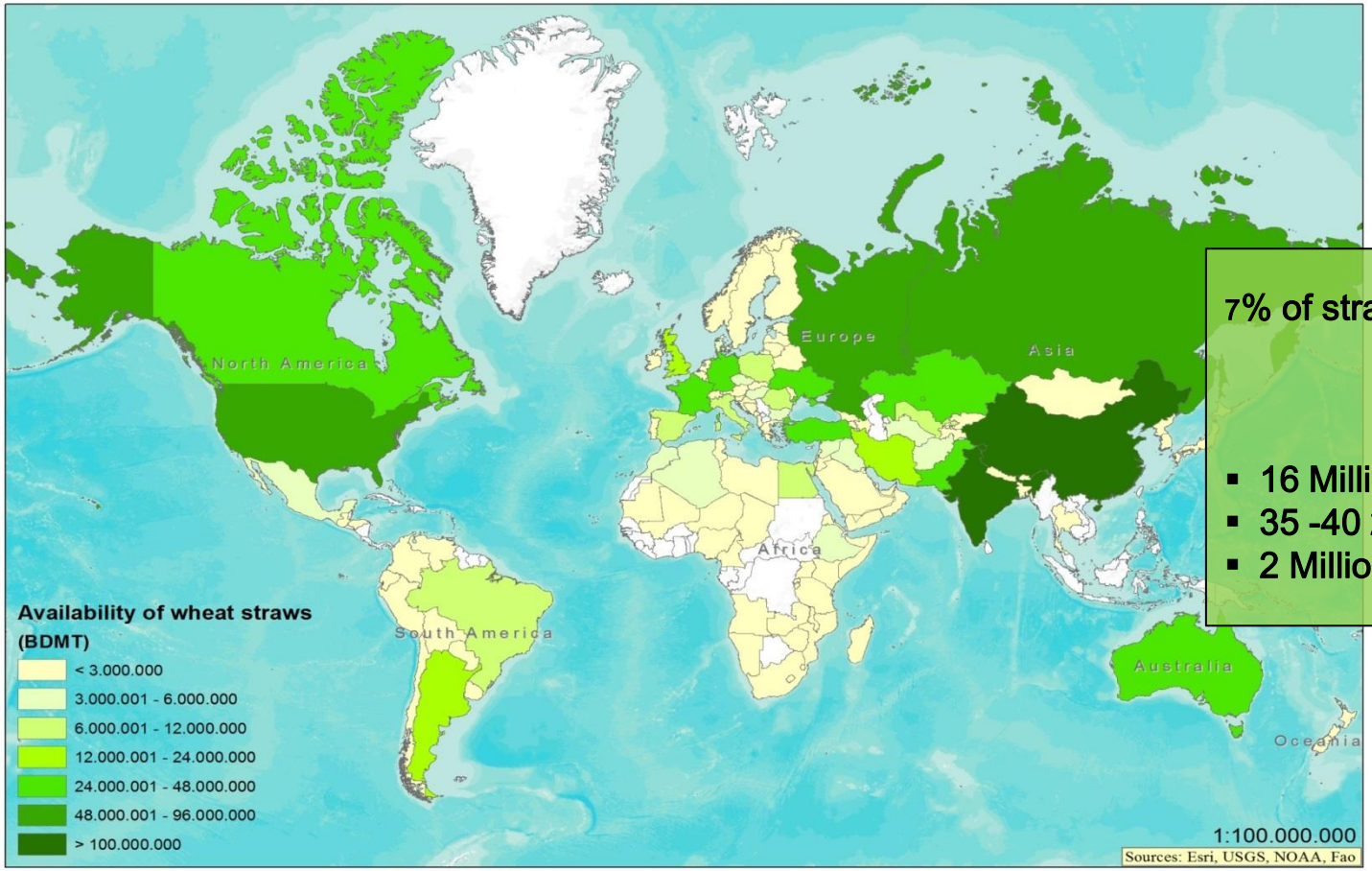






Might grow on marginal/abandoned land, creating additional income for farmers

Biomasses widely available worldwide: the wheat straw scenario



7% of straw produced in EU :

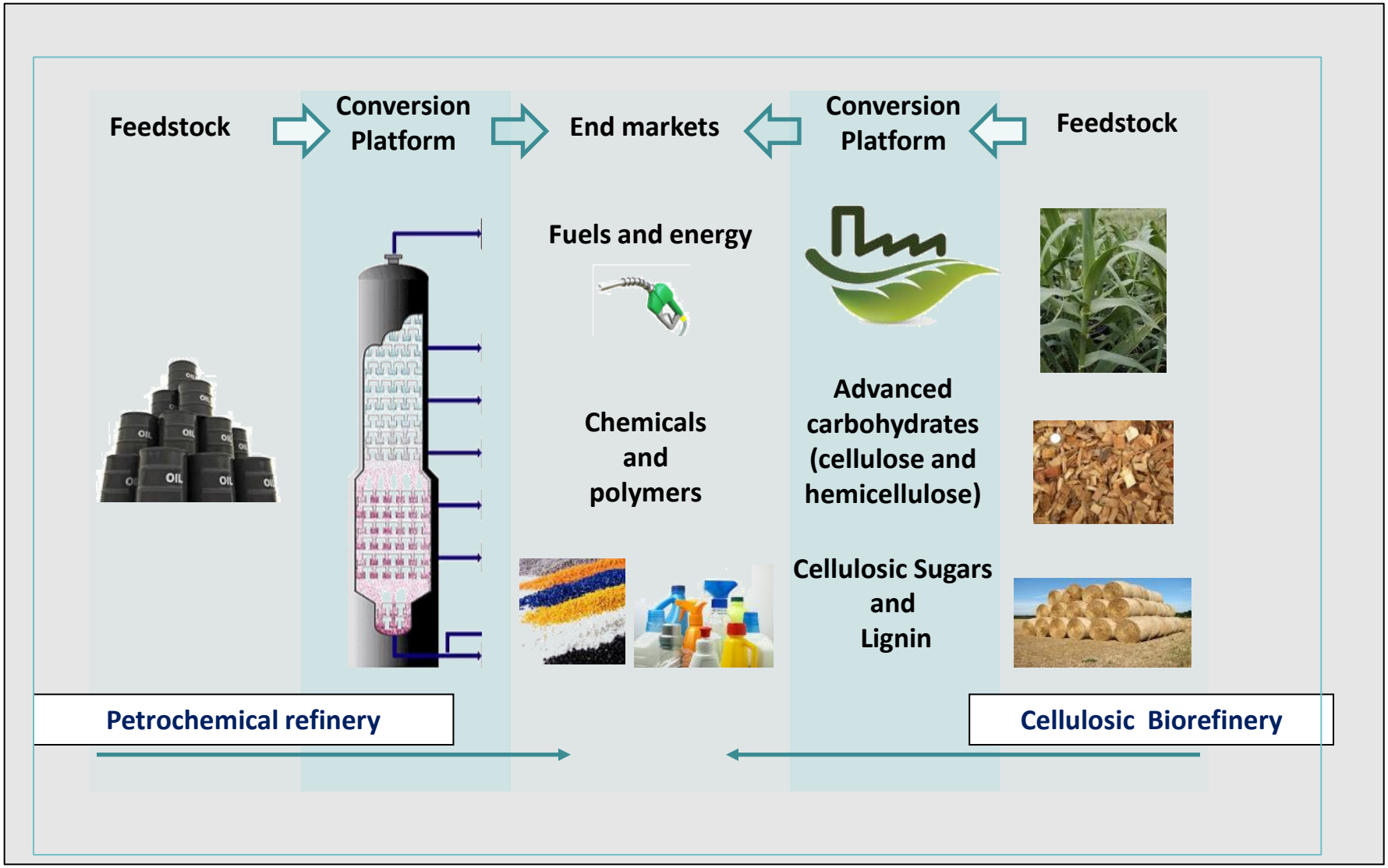
- 16 Million tons of biomass
- 35 -40 2G plants
- 2 Million toe Etoh

Recent studies calculate around 18000 PJ the potential of waste+residues available in the EU

Around 150% total fuel consumption in the EU

We want to develop the Cellulosic Biorefinery Concept

The biorefinery concept is similar to today's oil refinery, which produces multiple fuels and chemicals from crude oil.



The Biorefinery opportunity - One step ahead with PROESA® Technology

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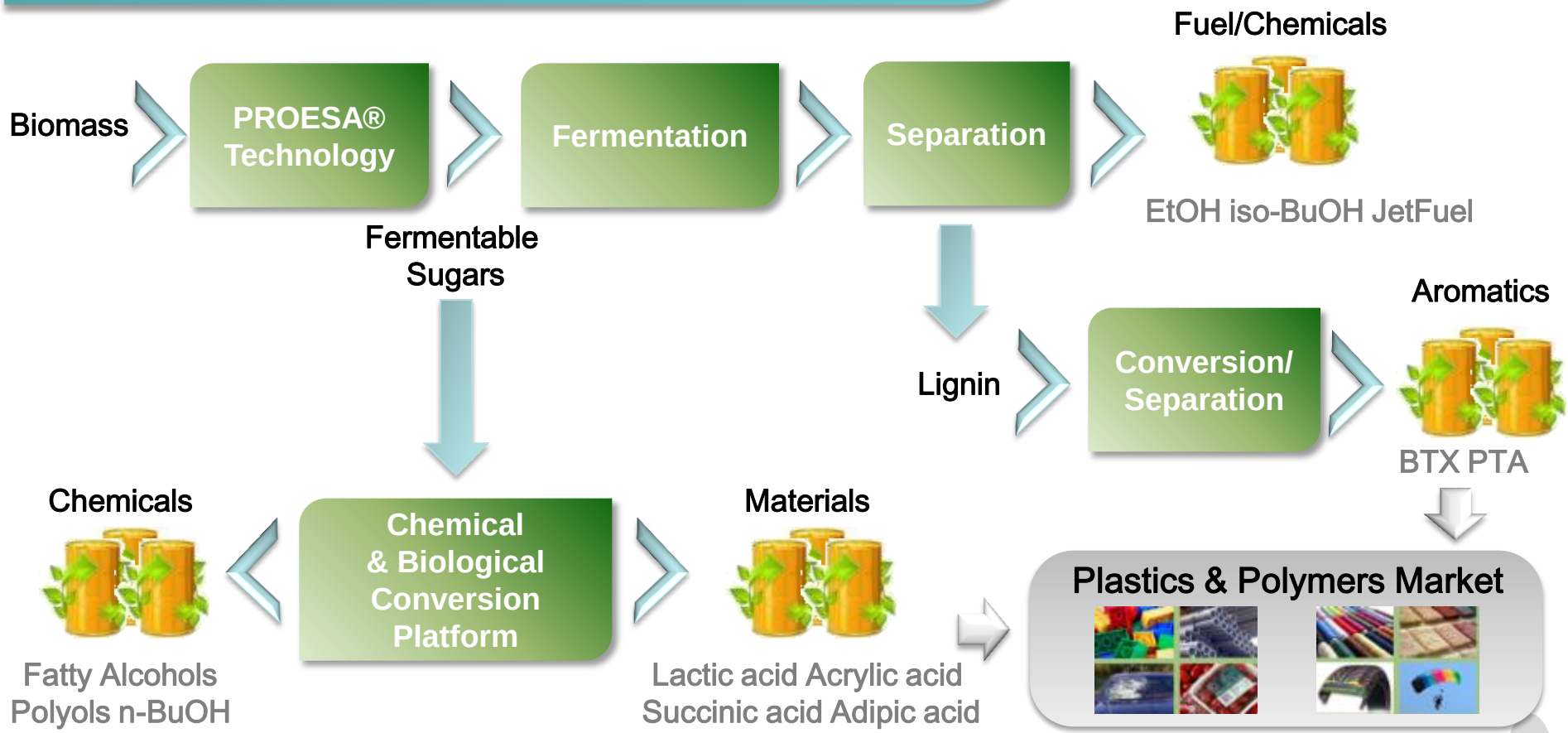
The cellulosic biorefinery tomorrow



Current Proesa technology deployment

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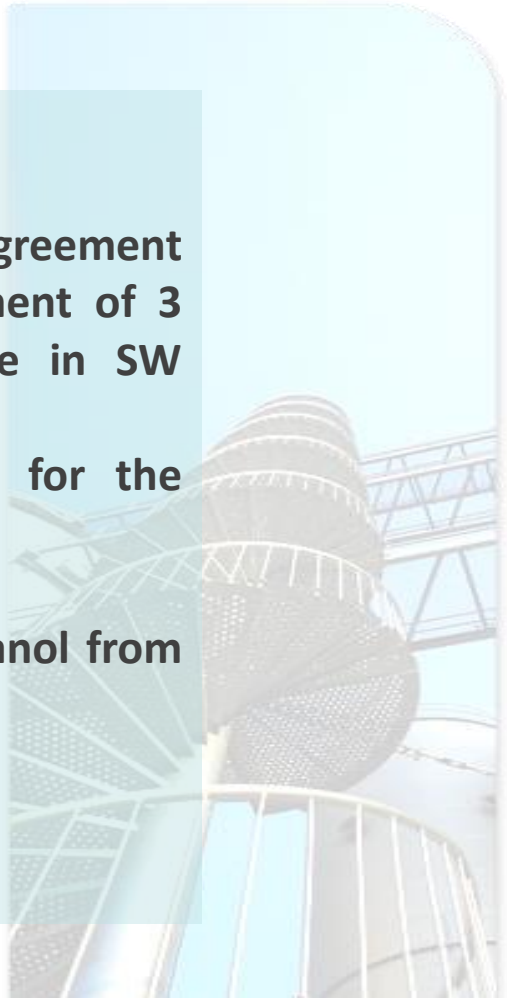
New Cellulosic Ethanol Plants

- In 2014 the italian government signed an agreement with Mossi Ghisolfi Group for the development of 3 new second generation ethanol plants (one in SW Sardinia)
- New “Cometha” project supported by FP7 for the construction of precommercial scale plant

- The Sardinia plant will produce cellulosic ethanol from agricultural residues and selected energy crops
- Feedstock primarily sourced locally
- Permitting process under preparation



Green chemistry with PROESA, not just fuel: MOGHI - lignin based technology

Lignin sourced from PROESA process

Phase I → Phenol Oil

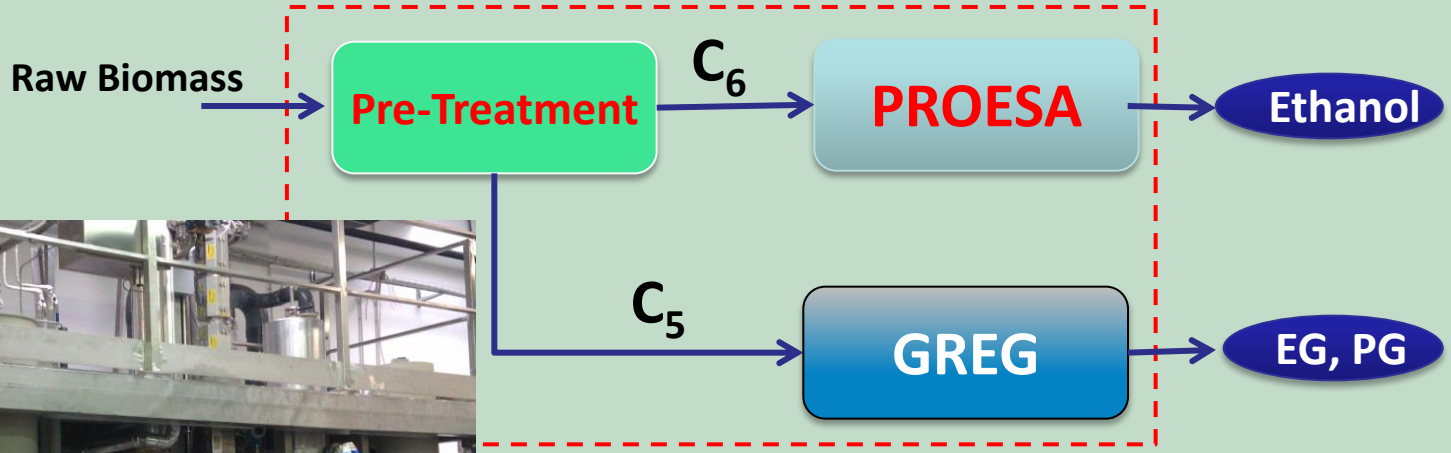
Phenol Oil → Phenols for Phenolic Resins
Guaiacols for food industry
Cresols
…

Phase I → Phase II

Phase II → Bio-reformate

Bio-reformate → BTX (for polymer production)
Bio Jet Fuel (BIOREFLY project supported by FP7)
Marinediesel
…

Greg Project – Green Glycols



GREG process products

Ethylene Glycol (EG) to PET production

1,2-Propylene Glycol (PG) to cosmetic, pharmaceutical and resin industries

Conclusions

- Cellulosic ethanol technology is ready
- Use of sustainable biomasses widely available in EU (multiple feedstock)
- No competition with food
- Environmental friendly (drastic emission reduction)
- Profitable for farmers
- Able to create high-tech green-jobs
- First step to green chemistry deployment

Thank you !