

Lignocellulosic ethanol production at industrial scale (BIOLYFE)



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Tortona (AL), ITALY

Summary

- Status of Italian biofuel production capacity and use
- PROESA™ and the Biolyfe project
- Preliminary results
- Construction of the Demonstration plant

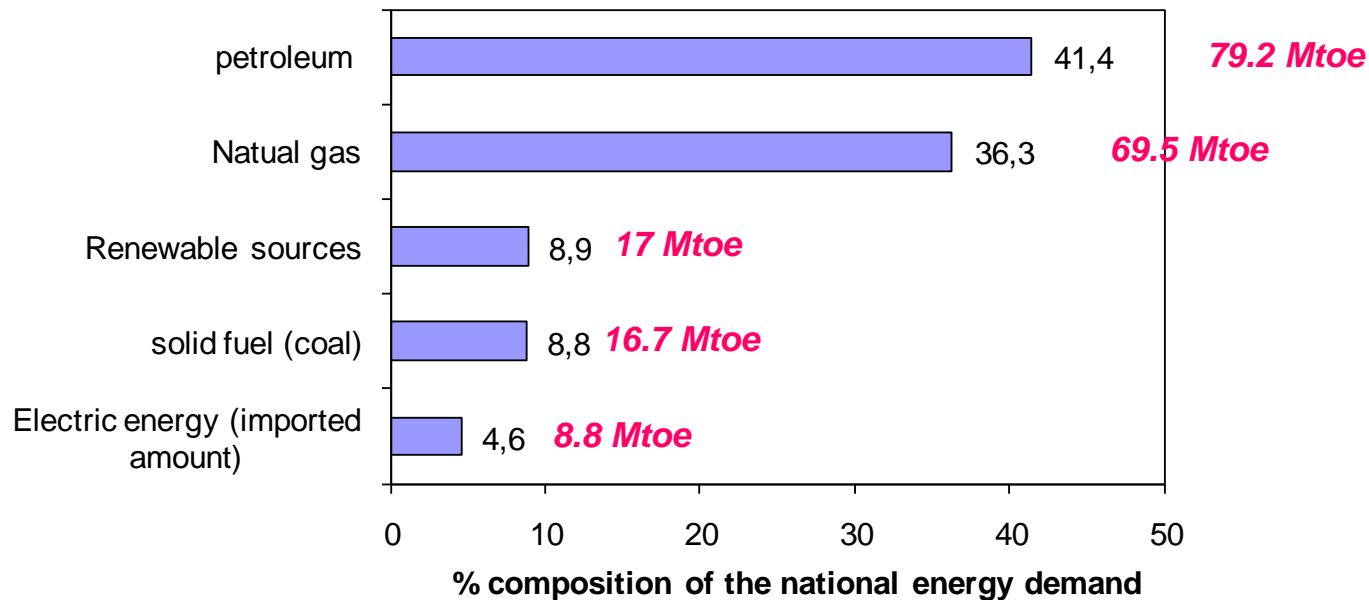
STATUS OF ITALIAN BIOFUEL PRODUCTION CAPACITY AND USE

ITALY – NATIONAL ENERGY DEMAND

Population ~ 60 ML = 0.9 % of world

Total energy demand: 180-190 Mtoe ~ 1.6 % of world

CO₂ emissions : 482Mt/a = 2% of the world emission and 14% of the European emissions



Source: Ministry for economic development - 2008

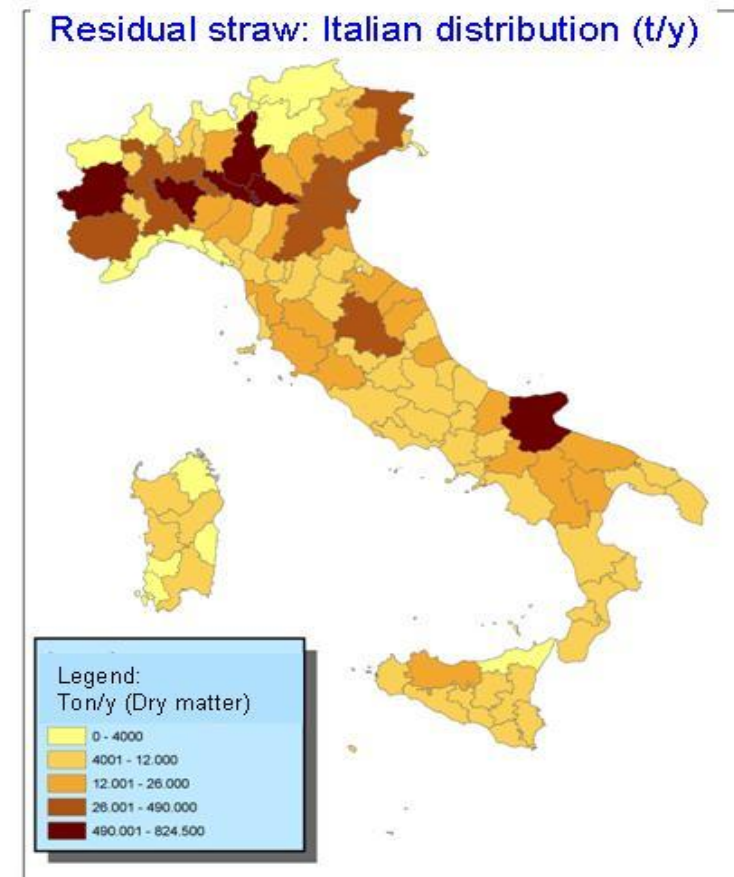
- Energy supply still based on fossil fuels and foreign imports
- Still limited contribution from Renewables if compared to total energy consumption

Source: I. De Bari, ENEA, 2011

Italian bioenergy potential

ENEA's *national atlas* of biomass is a GIS tool which support the evaluation of local biomass potential

Biomass	Mtoe
Residual straw	6
Pruning	2
Forests	0.9
MSW (organic fraction)	0.6
bovine and swine manure	0.9
animal slaughter wastes	0.03
dedicated crops	4
Firewood	2
TOTAL	15



Source: I. De Bari, ENEA, 2011

http://www.enea.it/attivita_ricerca/energia/sistema_elettrico/Censimento_biomasse/SchedaCB.html

Italian National Action Plan on Renewables

Consumi finali lordi di energia e obiettivi per le energie rinnovabili

	2005			2008			2020		
	Consumi da FER	Consumi finali lordi (CFL)	FER / Consumi	Consumi da FER	Consumi finali lordi (CFL)	FER / Consumi	Consumi da FER	Consumi finali lordi (CFL)	FER / Consumi
	[Mtep]	[Mtep]	[%]	[Mtep]	[Mtep]	[%]	[Mtep]	[Mtep]	[%]
Electricità	4,846	29,749	16,29%	5,040	30,399	16,58%	9,112	31,448	28,97%
Calore	1,916	68,501	2,80%	3,238	58,534	5,53%	9,520	60,135	15,83%
Trasporti	0,179	42,976	0,42%	0,723	42,619	1,70%	2,530	39,630	6,38%
Trasferimenti da altri Stati	-	-	-	-	-	-	1,144	-	-
Totale	6,941	141,226	4,91%	9,001	131,553	6,84%	22,306	131,214	17,00%
Trasporti ai fini dell'ob.10%	0,338	39,000	0,87%	0,918	37,670	2,44%	3,419	33,975	10,06%

➤ BIOENERGY (2005 → 2020):

✓ Power.....	0.40	MTOE → 1.8 MTOE
✓ Thermal Energy.....	1.65	MTOE → 5.5 MTOE
✓ Transports.....	0.20	MTOE → 2.5 MTOE
TOT	2.25	MTOE → 9.8 MTOE
TOT RES	6.94	MTOE → 22.3 MTOE - 17 % Gross Final Energy Consumption

Biodiesel Production Capacity - Italy

<u>COMPANY</u>	<u>PLANT LOCATION</u>	<u>PRODUCT.CAPACITY (t/y)</u>
ALCHEMIA ITALIA SRL	Rovigo	15.000 (o)
BIO-VE-OIL OLIMPO SRL	 Corato (BA)	100.000
CEREAL DOCKS SRL	Vicenza (VI)	150.000
COMLUBE SRL	Castenedolo – Brescia	120.000 (o)
DP LUBRIFICANTI SRL	Aprilia (LT)	155.520
ECOIL SRL	 Priolo (SR)	200.000
F.A.R. – Divisione Polioli	Cologno Monzese (MI)	100.000 (o)
ECO FOX SRL	Vasto (CH)	199.416
ITAL BI OIL SRL	Monopoli (BA)	190.304
ITAL GREEN OIL	San Pietro di Morubio (VR)	365.000 (o)
GDR BIOCARBURANTI	Cernusco sul Naviglio (MI)	50.000 (o)
MYTHEN SPA	Ferrandina (MT)	200.000
NOVAOL SRL	Livorno (LI)	250.000
NOVAOL SRL	Ravenna (RA)	200.000
OIL.B SRL	Solbiate Olona (VA)	200.000
OXEM	Mezzana Bigli (PV)	200.000

 Under realization

(o) Unused capacity

TOTALE:

2.395.240



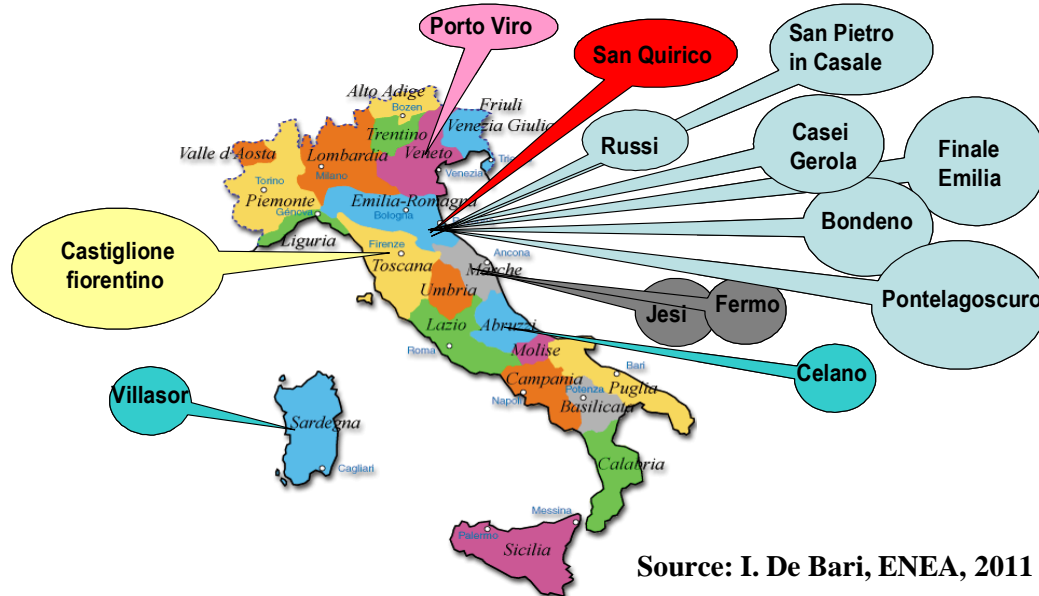
ASSOCOSTIERI *Unione Produttori Biocarburanti*

Bioethanol Production Capacity - Italy

AZIENDE ASSOCIATE	LOCALITA'	CAPACITA' PRODUTTIVA (tonn.)
<u>Caviro Distillerie S.r.l.</u>	Faenza (RA)	43.000
I.M.A. S.r.l.	Partinico (PA)	172.000

Source: Assocostieri, 2011

TOTAL 215.000



Source: I. De Bari, ENEA, 2011

Conversion of Sugar Factories



Common Organisation of the sugar market



16 plants out of 21 have been shut down or converted to other production

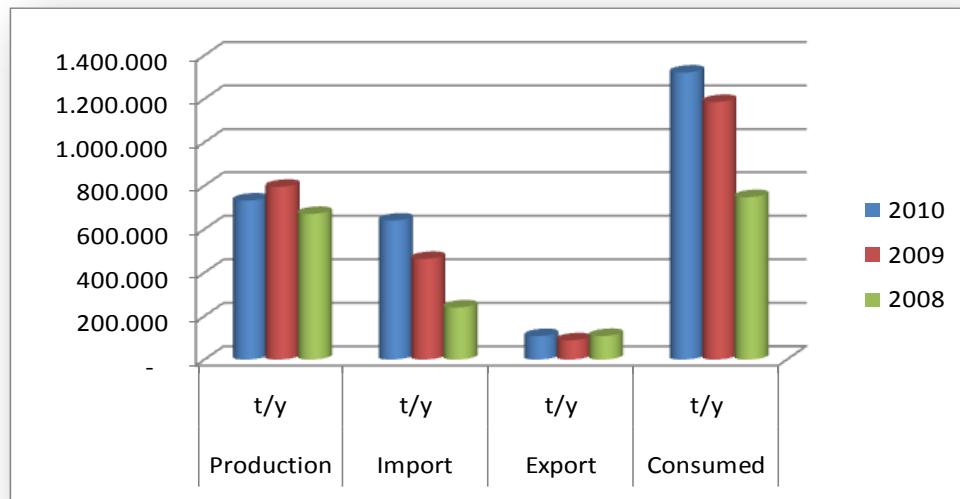


Most of these formerly-sugar plants should be converted to bioenergy

A biomass plant will be built close to the sugar production plant

BIODIESEL - NATIONAL STATISTICS

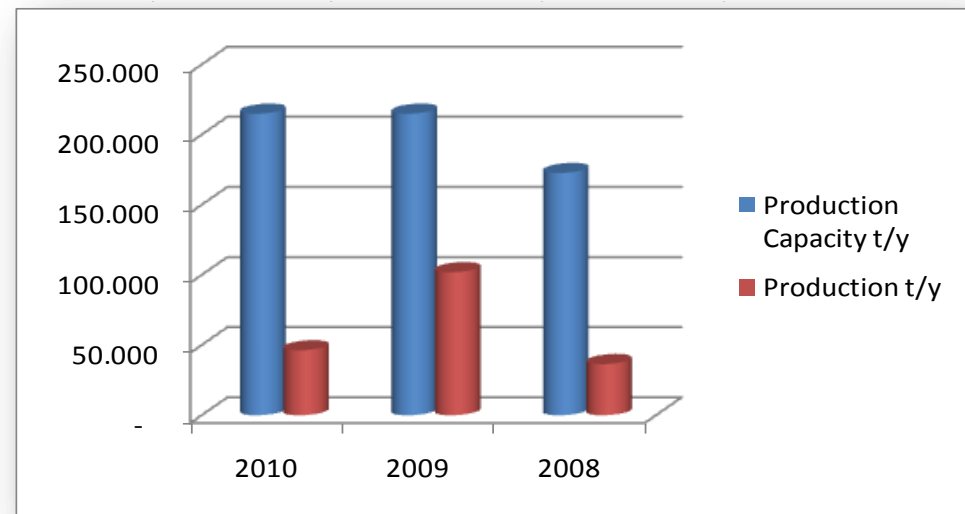
	Production t/y	Import t/y	Export t/y	Consumed t/y	Employees	Turnover €
2010	731.844	639.684	107.956	1.321.139	356	1.272.912.796
2009	795.118	463.390	88.670	1.185.573	364	1.205.473.761
2008	670.449	239.887	108.426	747.725	480	1.273.201.761



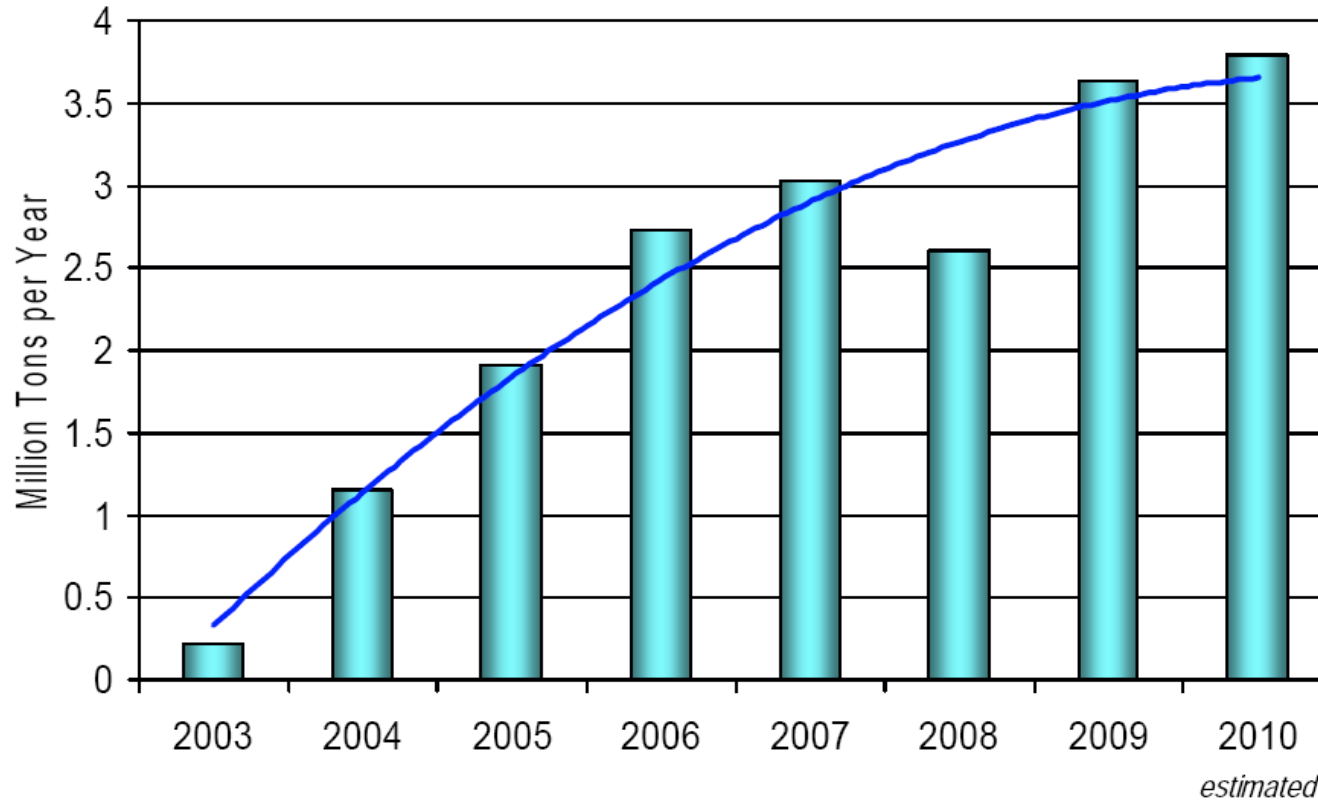
Source: Assocostieri, 2011

BIOETHANOL - NATIONAL STATISTICS

	Production Capacity t/y	Production t/y	Employees	Turnover €
2010	215.000	46.295	19	46.709.640
2009	215.000	102.000	19	37.380.120
2008	172.700	36.510	15	26.071.796



ETBE Consumption EU 2003 - 2010



Source: EFOA

2006 EU₂₅ ^[1] Average Percentage of Ethers in Gasoline = 4.7 % v/v
Italy: slightly above 5 % v/v



Source: DG Env: "EU Fuel Quality Monitoring – 2006 Report" and W.Mirabella, 2011

PROESA™ AND THE BIOLYFE PROJECT

- ❖ Global presence : 11 plants in the world (5 in Brazil, 4 in Italy, 1 in Mexico and 1 in USA)
- ❖ Turnover : about 2.1 billion \$ in 2009
- ❖ 3 Business Units: PET Polymer, Acetates , Engineering
- ❖ Staff: 2600 persons on 6 location (Italy, Brazil, India, China, USA, Mexico)
- ❖ 3 R&D Centers: Italy, USA and Brazil

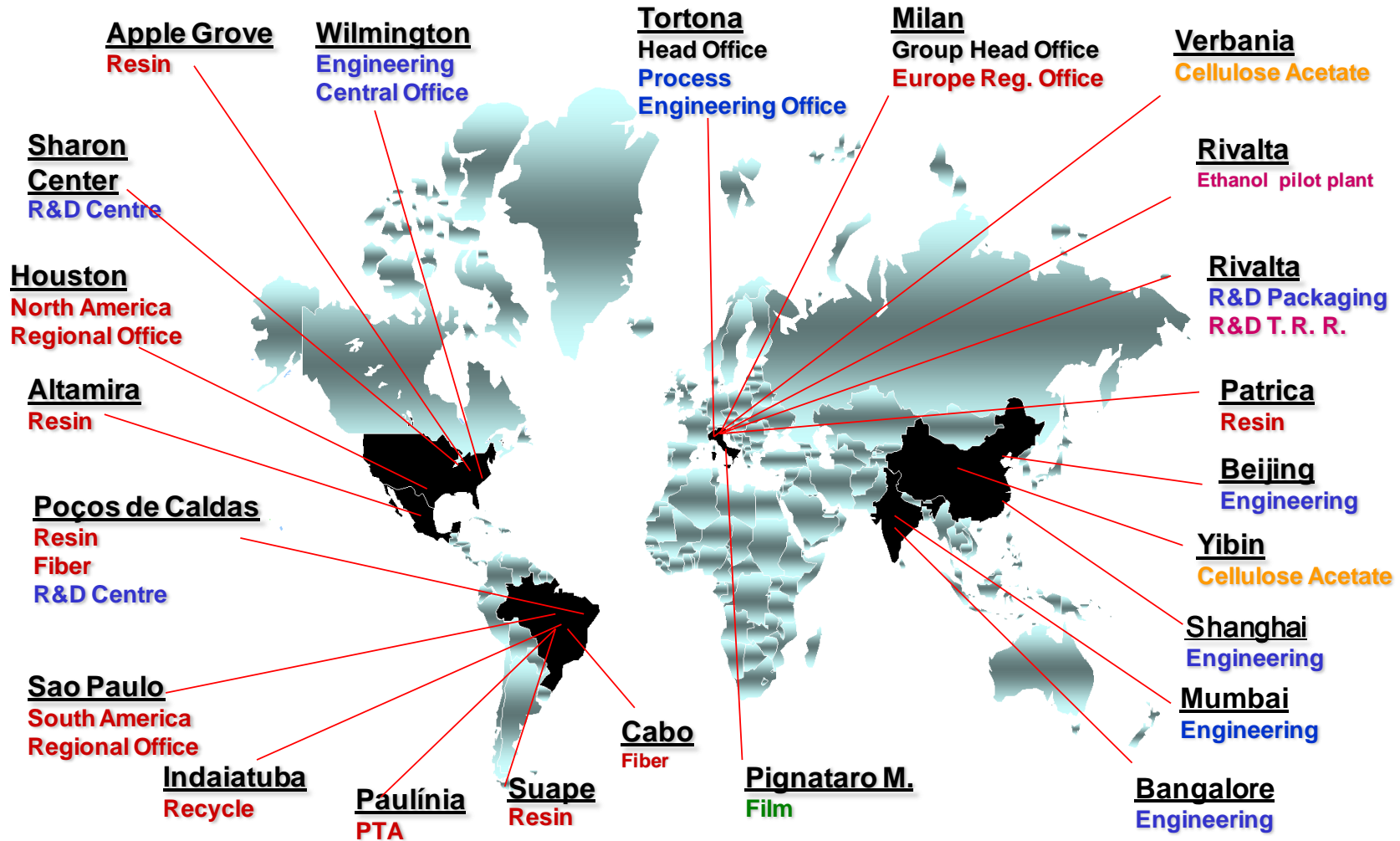


Mossi & Ghisolfi Group

1950	1960	1970	1980	1990	2000	2002	2003	2004	2005	2006	2007		
<p>1950  M&G was founded in 1953 by Vittorio Ghisolfi in Tortona, Italy</p>													
<p>Packaging Manufacturing Phase</p> <p>M&G offered customers packaging from HDPE and PVC</p>				<p>Chemical Specialty Manufacturing Phase</p> <p>Group activities were integrated upstream in the development and production of special resin (PET) for food packaging applications</p>				<p>PET Expansion Phase</p>					
				<p>Acquisition of Shell's PET business</p>				<p>Acquisition of Brazilian controlled Rhodia-ster from Rhone Poulenc</p>		<p>Start up of world's largest PET production unit at Altamira (Mexico)</p>		<p>Acquisition of the world class engineering group Chemtex from Mitsubishi Corporation</p>	



M&G Overview: Sites




Chemtex Operations

Chemtex Italy



Tortona, Rivalta

Chemtex China



Shanghai, Beijing

Chemtex USA



Wilmington (NC)



- Annual Turnover: USD 300 MM
- Employees: 1000

Chemtex India

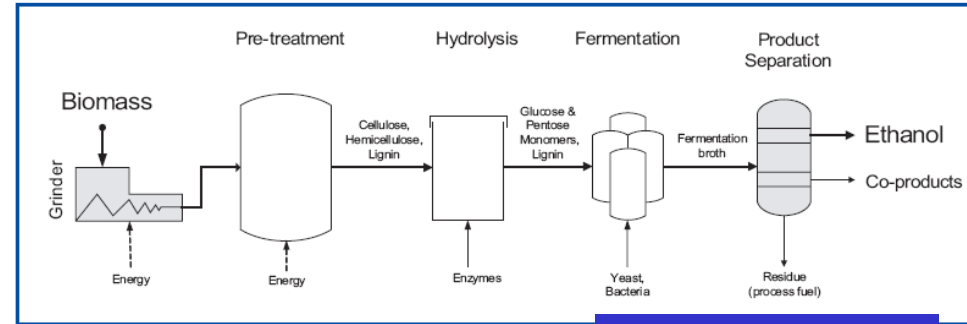


Mumbai, Bangalore

The lignocell.BioEtOH Chain

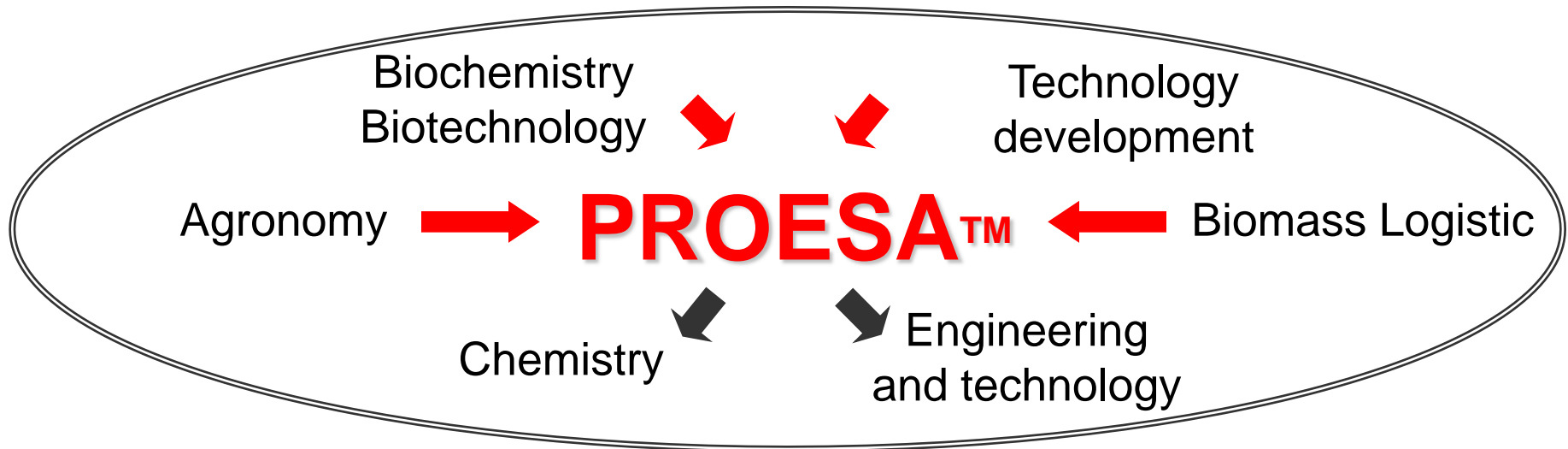
➤ Main steps of the process:

- ⇒ BIOMASS PRETREATMENT
- ⇒ HYDROLYSIS & FERMENTATION
- ⇒ DISTILLATION AND EtOH RECOVERY
- ⇒ VALORIZATION OF COPRODUCTS



Source: IEA-Bioenergy

A very multidisciplinary approach is needed



- ✓ **Scientific collaborations with ENEA, Turin Politechnic, CREAR-Univ.Florence, Univ.Genova, CRA.....**

PRO.E.SA™: Steps

Break-through technology for the production of Bio-fuels and Bio-Chemicals from Cellulosic Biomass

Chemtex Italia R&D Center



3000m² labs dedicated to Renewable Resources, >45 people dedicated to R&D



2007 - 2008

Scouting, testing and development of technology on lab scale



2009 - 2010

Construction and tests on a continuous pilot plant



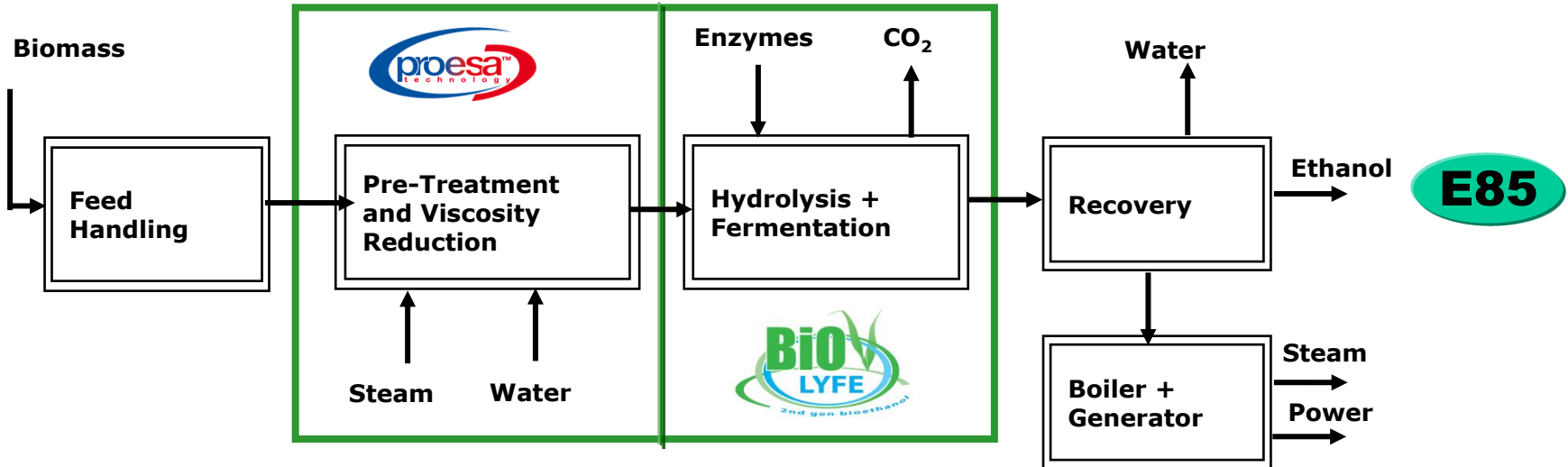
2011

Construction of a Demonstration Plant 40 ktpa (15 MGY)



Technology for the production of Drop-in Fuels, Bio-chemicals and Ethanol

2012+



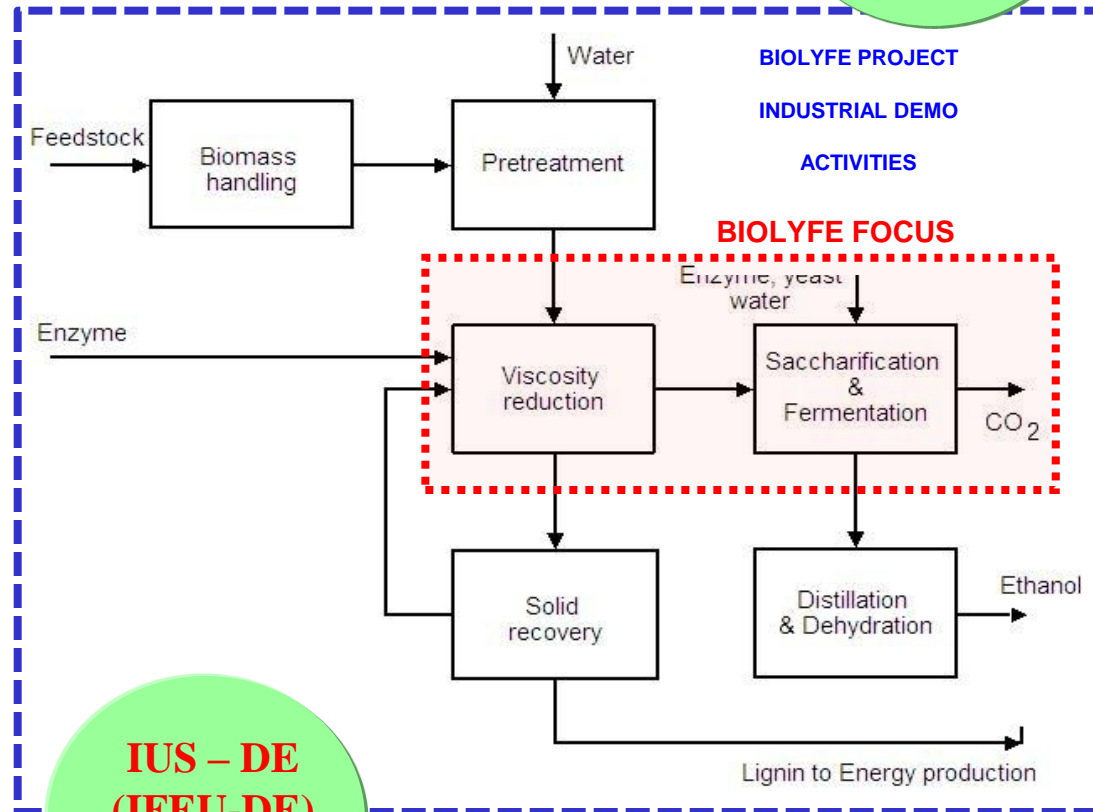
The main sections developed in R&D are:

- 1. Agronomy:** Field experimentation. Best energy crops identification and characterization.
- 2. Biomass Pre-Treatment and Viscosity Reduction:** Continuous process developed and piloted to produce cost-effective and clean fermentable sugars.
- 3. Hydrolysis and Fermentation:** Unique hybrid SSCF process scheme yielding high ethanol concentrations.



Second generation BIOethanol process: demonstration for the step of Lignocellulosic hYdrolysis and FERmentation

**Univ. Lund-SE
(TAURUS-SE)**
(Microorganism
Fermentation);



ENEA - IT
(Pretreatment);

**WIP - DE
(ETA-IT)**
(Dissemination);

Chemtex - IT
(Coordinator,
Second generation
Bioethanol demo
unit);

**IUS - DE
(IFEU-DE)**
(Integrated
assessment);

**Agriconsulting
IT**
(biomass production);

**Novozymes
DK**
(Enzymes);

EC-FP7

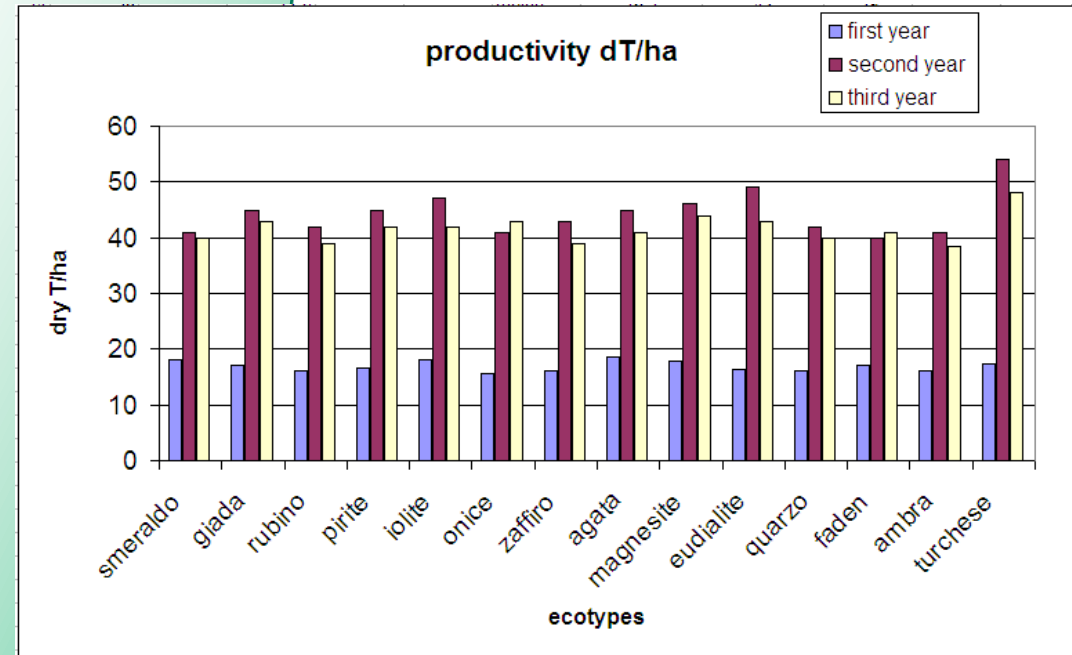


PRELIMINARY RESULTS

Cassana Experimental Farm (60 ha)

Arundo Donax – Results 2009

3rd year dry_ton/ha/y

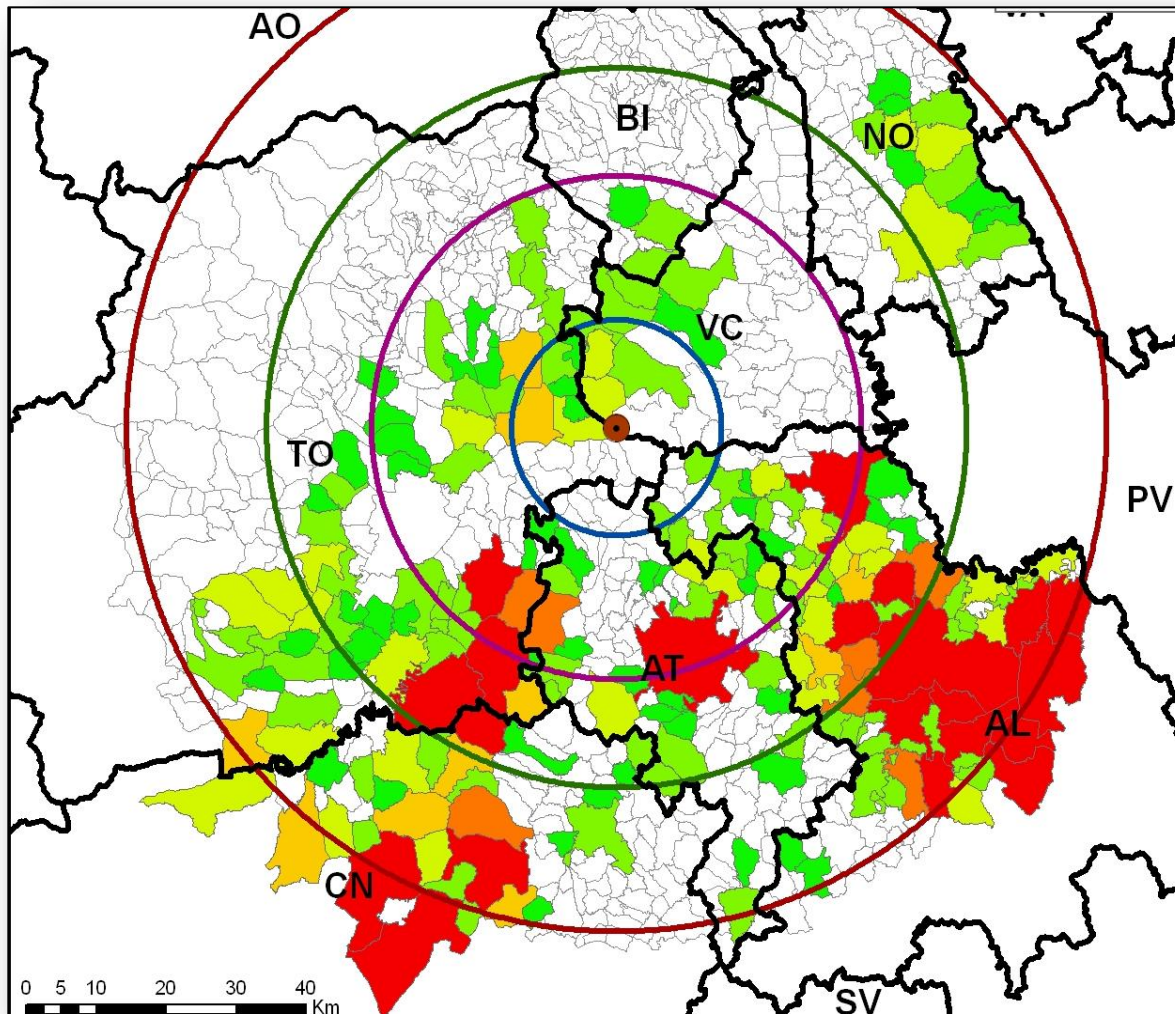


US Project



Arundo donax nursery (~10 years old) in Columbus Ohio

Productivity: 43.1 dry T/ha



- Both residues and dedicated crops under investigation. Most interesting:
 - ✓ *Straw*
 - ✓ *Arundo Donax*
- GIS Analysis of land availability, potential production, etc
- Contract development

SOURCE: AGRICONSULTING S.P.A. BASED ON REGIONE PIEMONTE DATA

Collaborations on Biomass Pretreatment (SE)

ENEA: steam explosion unit
(300 kg/h biomass in)

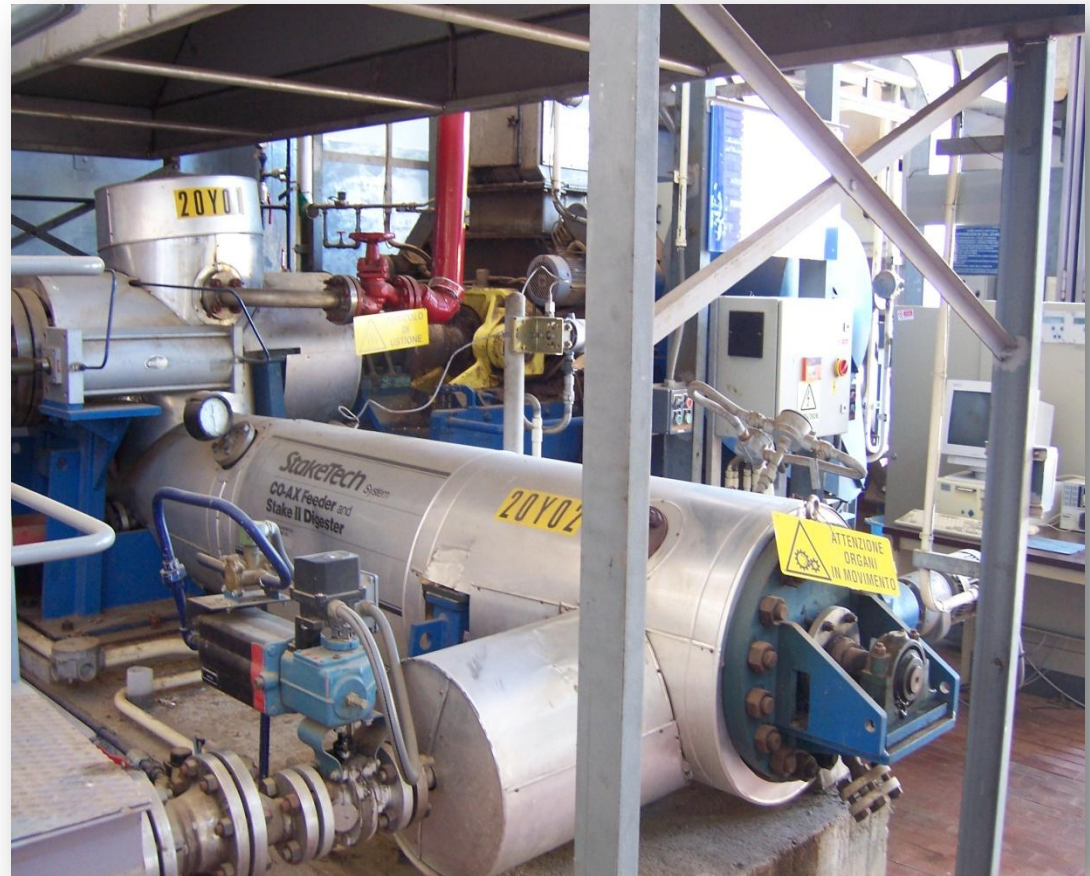
✓ Since 1992 ENEA owns and operates this pilot unit at the premises of the Trisaia R&D Center.

✓ ENEA has developed specific skills and expertise on this technology, investigating the main operational parameters needed to control this biomass pre-treatment steps.

PRIT (Industria 2015) project:

✓ Min.for Econ.Development

✓ **CREAR** (Univ.of Florence): energy valorization of lignin residue



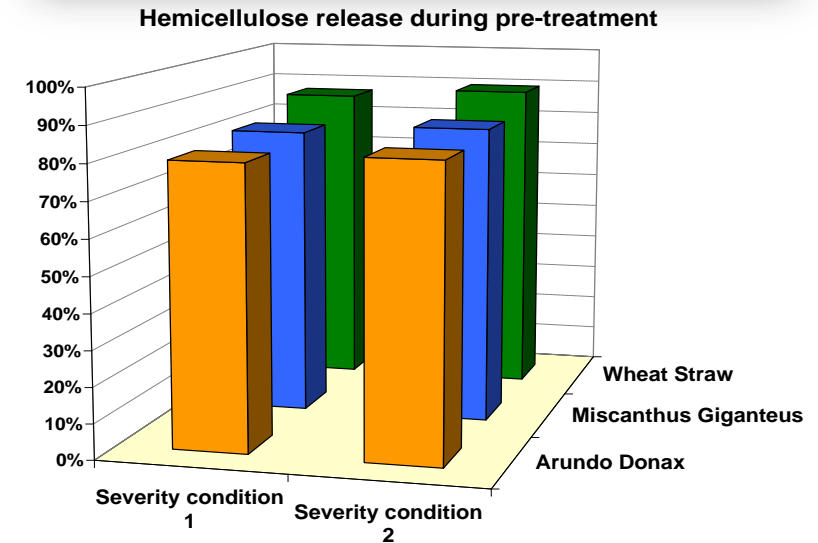
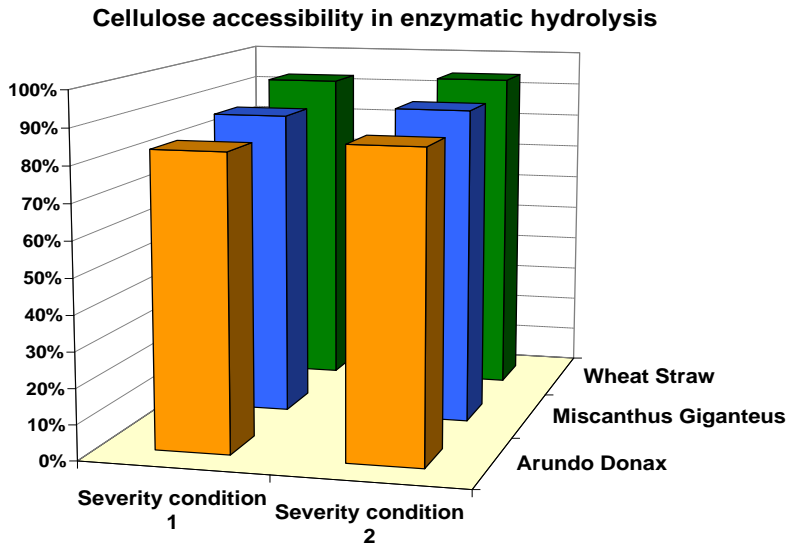
PROESA™ Technology

Key Features

CAPABILITY TO USE A LARGE VARIETY OF BIOMASS AS COLLECTED
 (same hardware, changed process conditions only)

RUNNING ON A CONTINUOUS PILOT SCALE IN RIVALTA LAB SINCE JUNE 2009

Pre-treatment pilot plant can be fed with several material with a size up to 5 cm.

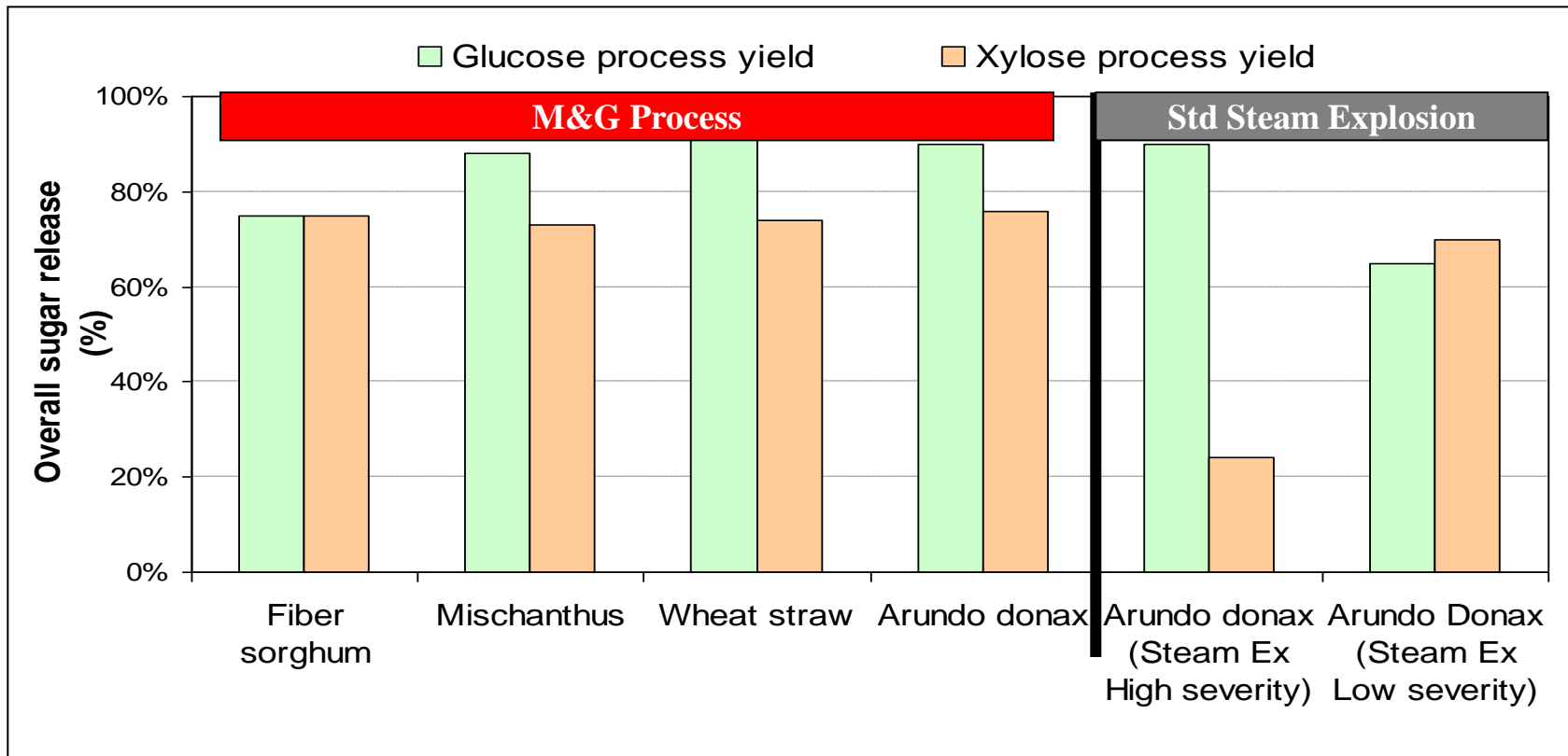


Different feedstocks show a similar behaviour in pretreatment

PROESA™ Technology

Key Features

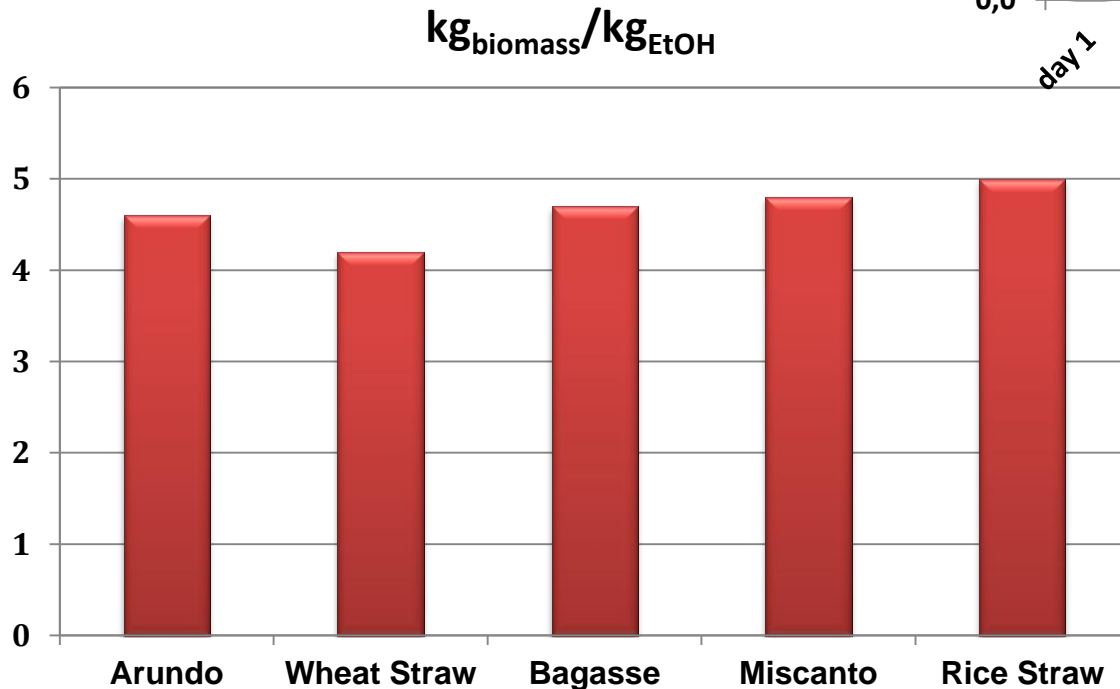
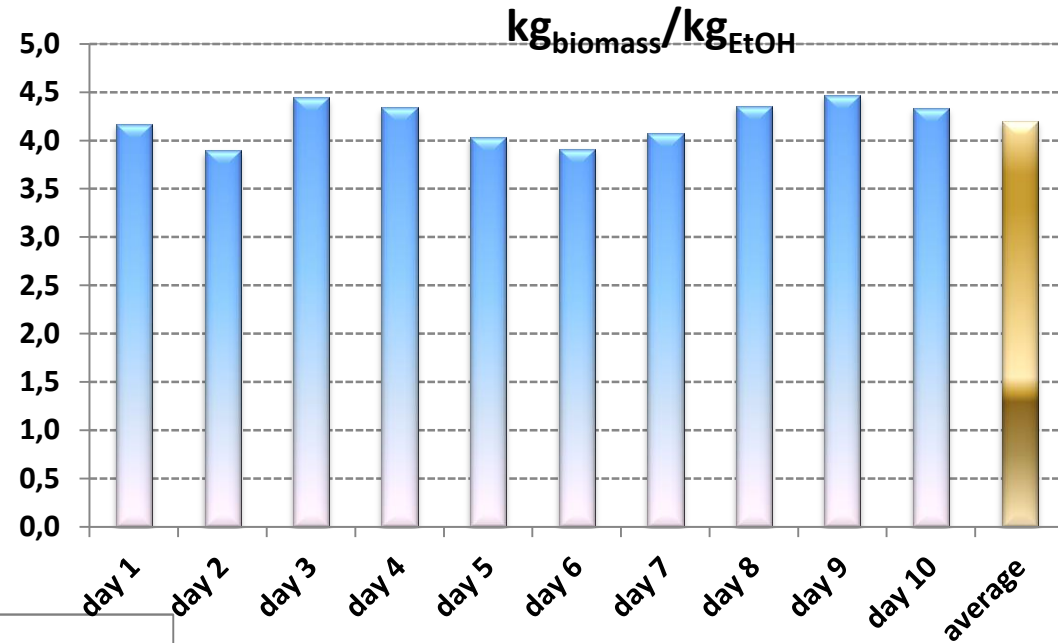
UNIQUE PRETREATMENT PRODUCING HIGH QUALITY LOW COST SUGAR FROM CELLULOSIC BIOMASS



PROESA™ Technology

Ethanol yields

GOOD yields also with different biomasses



GOOD process stability on long run

PROESA™ Technology

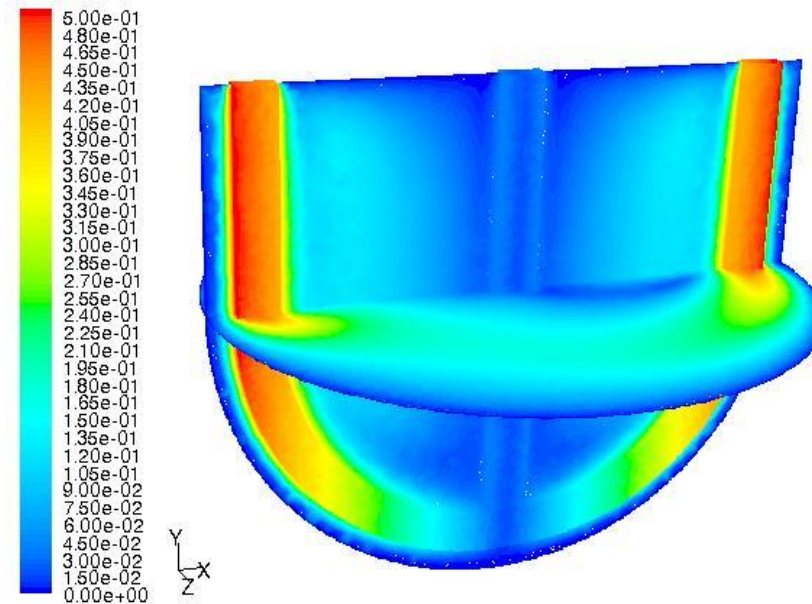
Key Features

Lab. High Solid Viscosity Reduction



Viscosity reduction

Velocity Field – Stationary Model



Contours of Velocity Magnitude (m/s)

Mar 18, 2009
FLUENT 6.2 (3d, dp, segregated, lam)

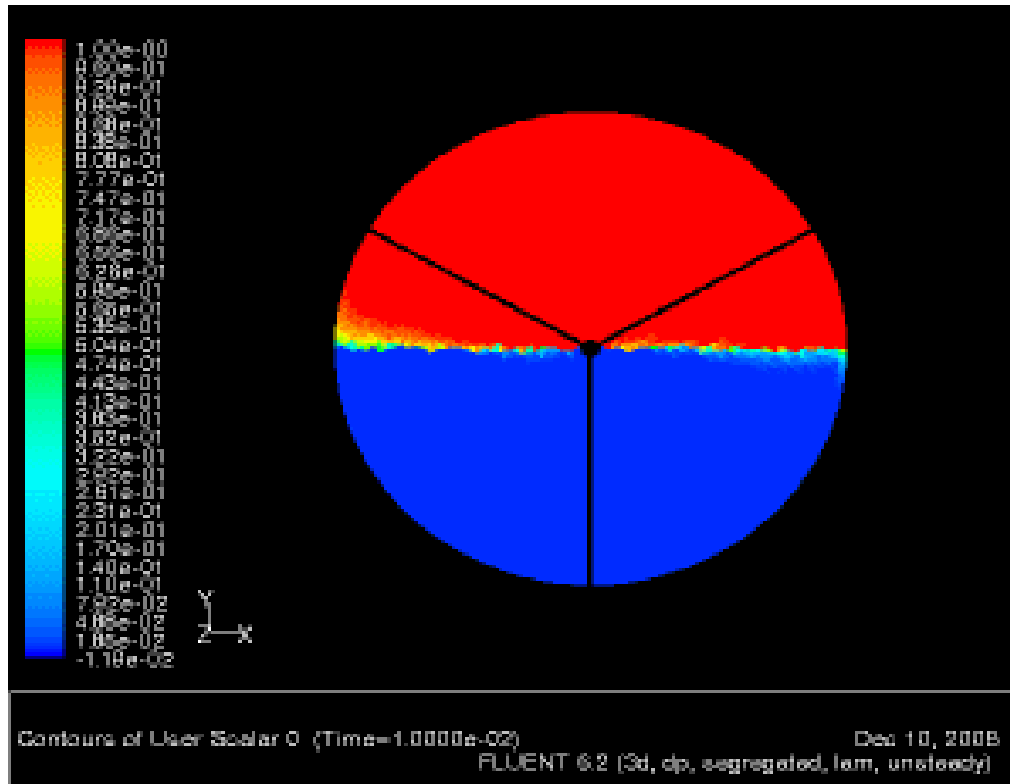
Viscosity determination of pretreated material during hydrolysis by CFD Modelling.

70 RPM, Moving Reference Frame 735.846 cells – unstructured.

PROESA™ Technology

Key Features

Mixing modelling

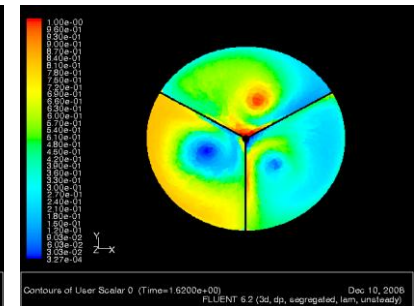
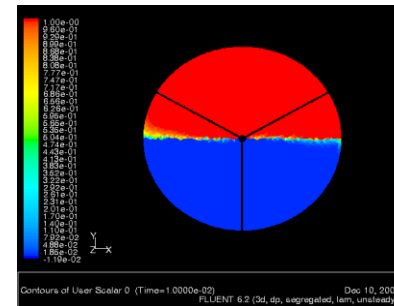


50 RPM

Viscosity reduction

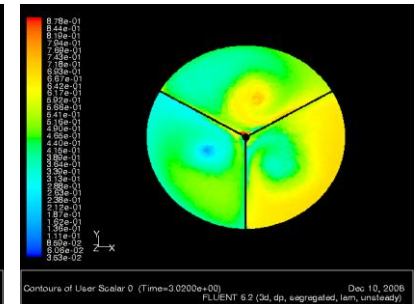
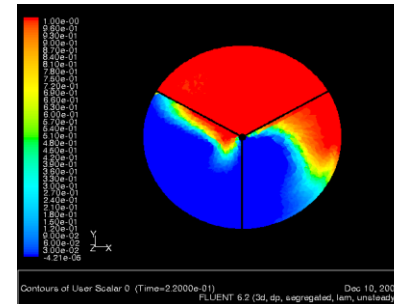
t = 0

t = 0.26



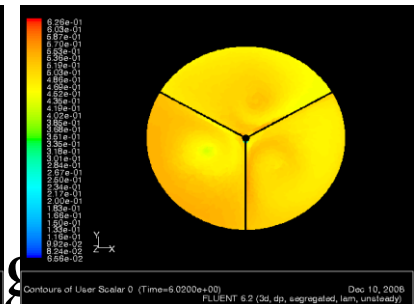
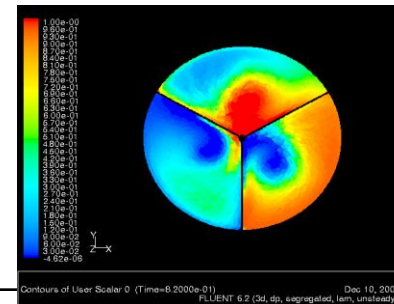
t = 0.03

t = 0.5



t = 0.13

t = 1



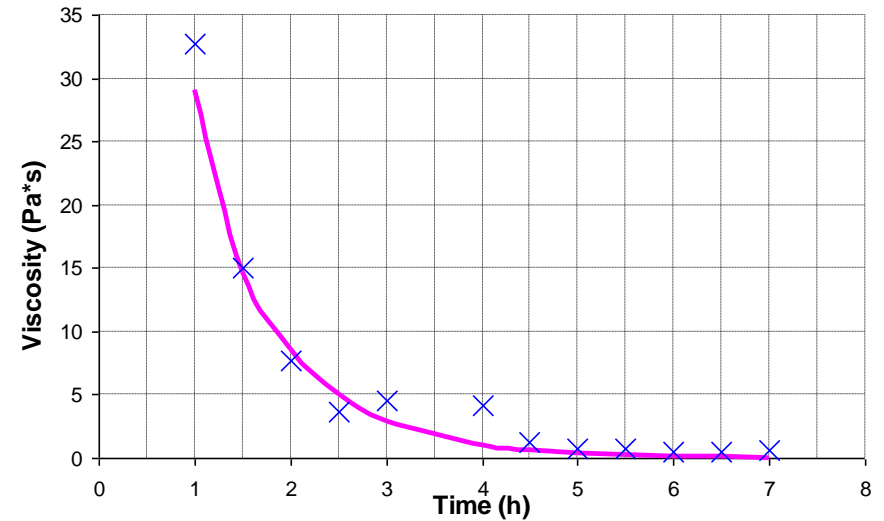
PROESA™ Technology

Viscosity reduction

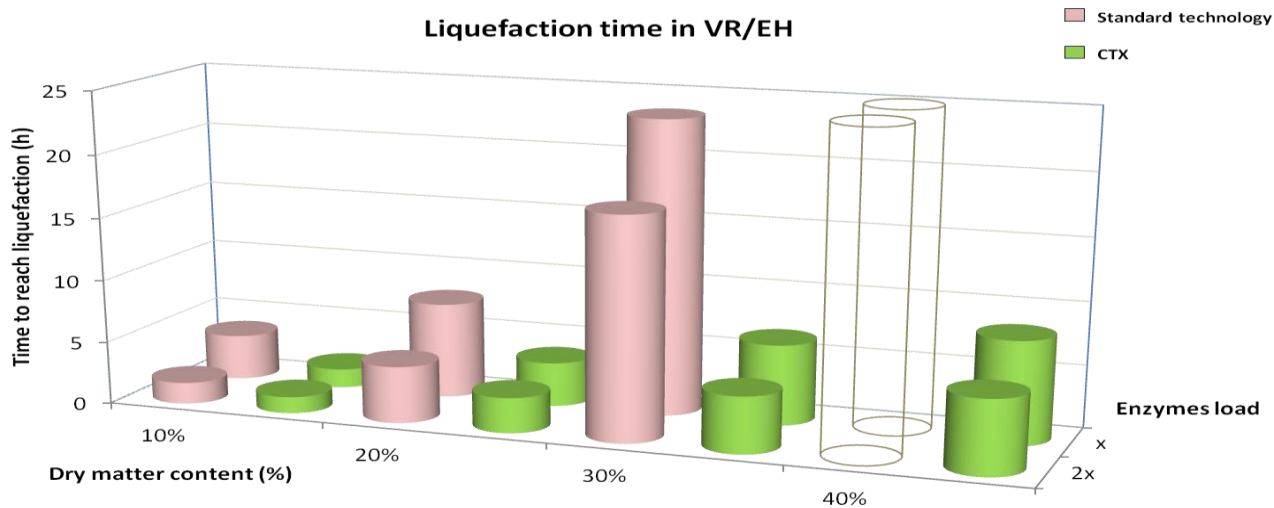
Advantages of new continuous

high solid Viscosity Reduction concept:

- Possibility to work at dry matter contents up to 40%
- Very low energy consumption for agitation
- Material is liquefied in less than 8 h even at low enzyme load
- Easy pH and temperature control

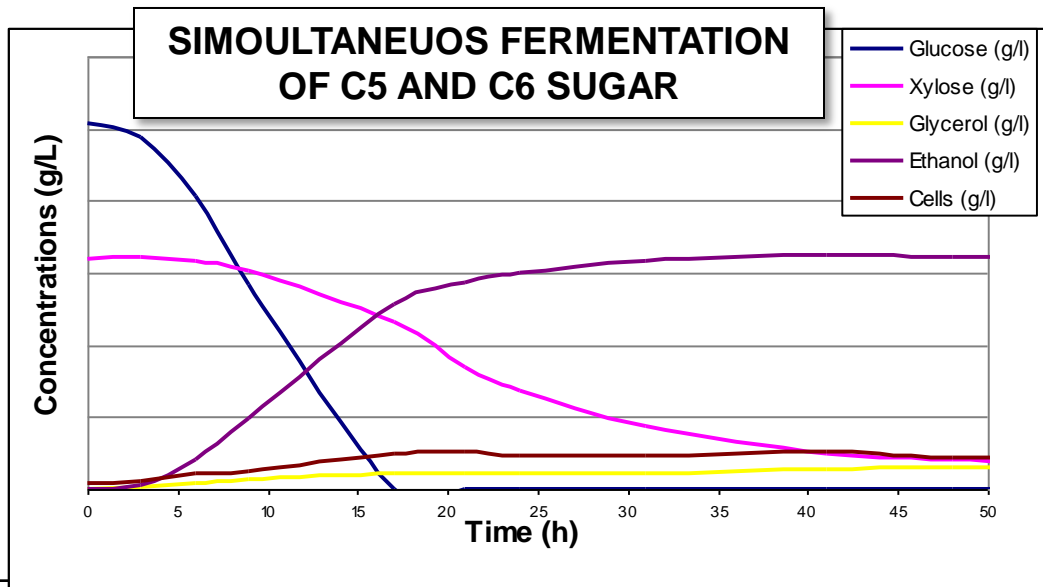
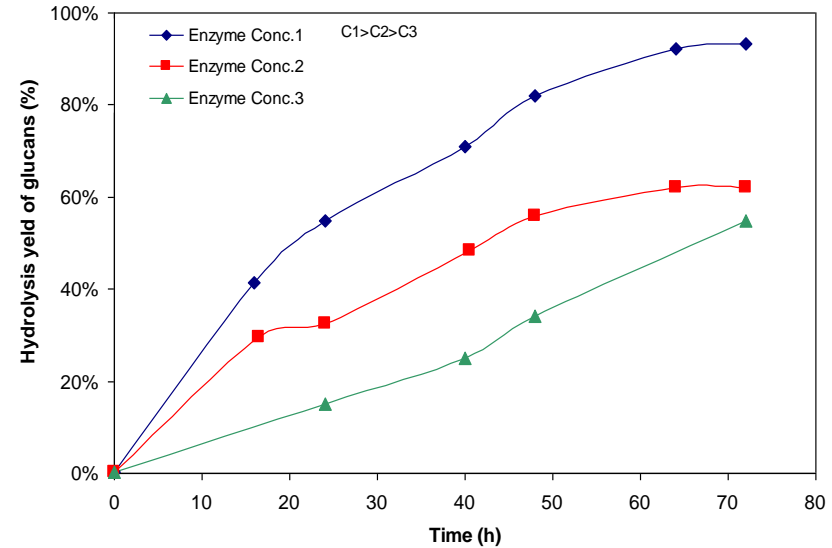


Liquefaction time in VR/EH



R&D on enzymatic hydrolysis and C5-C6 fermentation

PROESA™ Technology Key Features



Available MO's will assure fermentation of C5 and C6 sugars.

The fermentation time will be comparable to fermentation time of first generation plants

The beer will contain more than 6% of EtOH, assuring an efficient conversion and low cost during the separation steps compared to other 2 gen EtOH technologies

PROESA™ Technology Key Features

- ✓ ENERGY INTEGRATION THANKS TO HIGH EFFICIENCY LIGNIN BURNING
- ✓ PURE LIGNIN FOR CHEMICALS



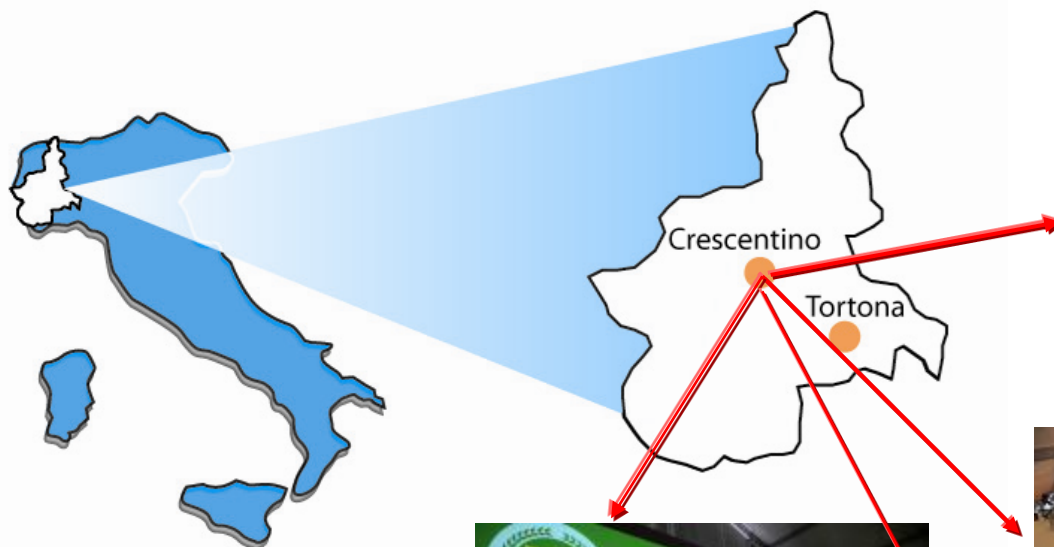
Lignin from the process has enough energy content to meet all plant energy demand.

Design of each plant will include a power generation unit.

Lignin from the PROESA™ technology is free from Sulfur, Chlorine and Ammonia and can constitute an unique base for producing chemical from biomass.

CONSTRUCTION OF THE DEMONSTRATION PLANT

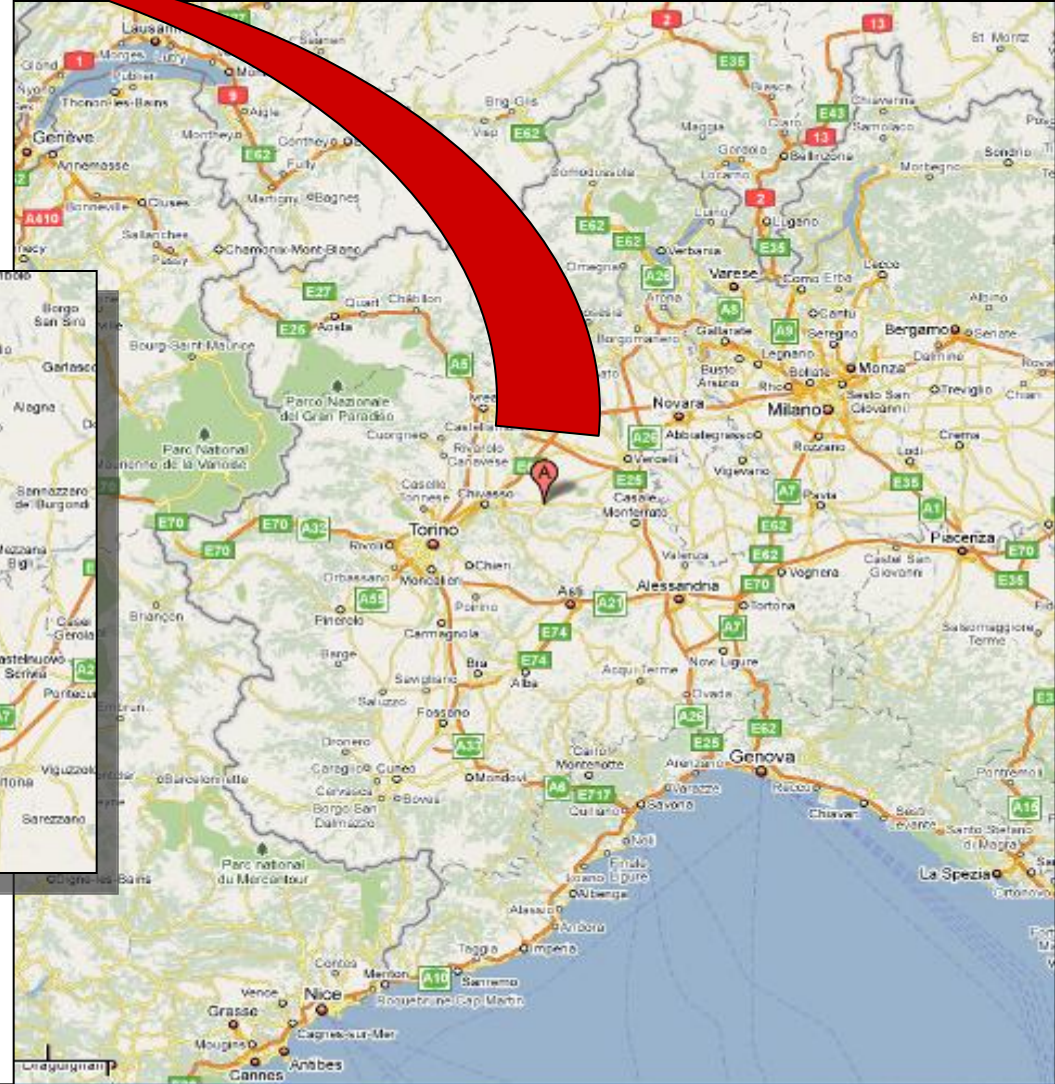
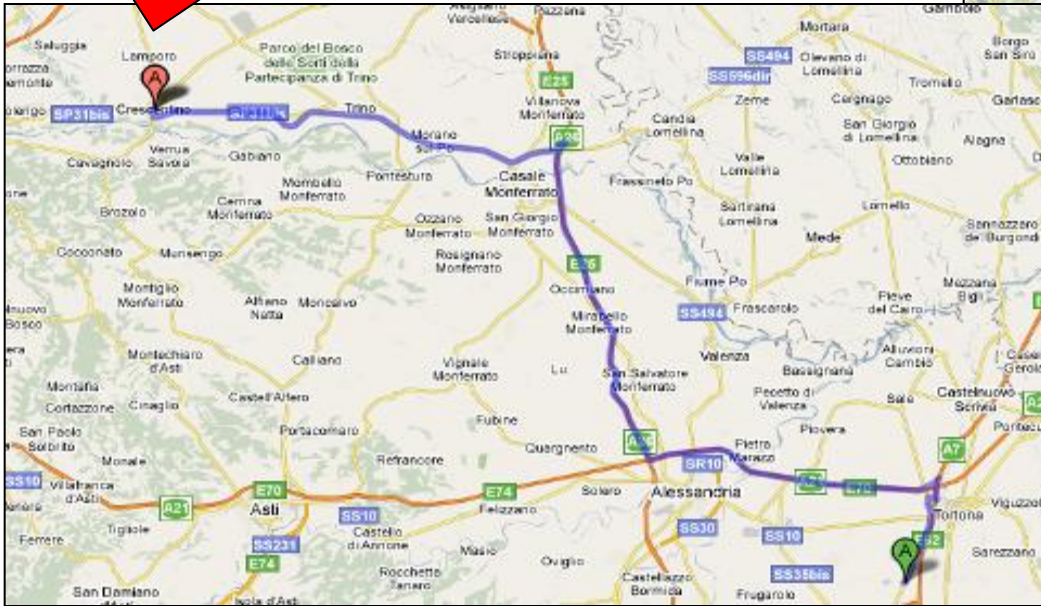
April 12, 2011: Ground-Breaking of the first 40.000 ton/y plant




BIOLYFE Demo Plant Location



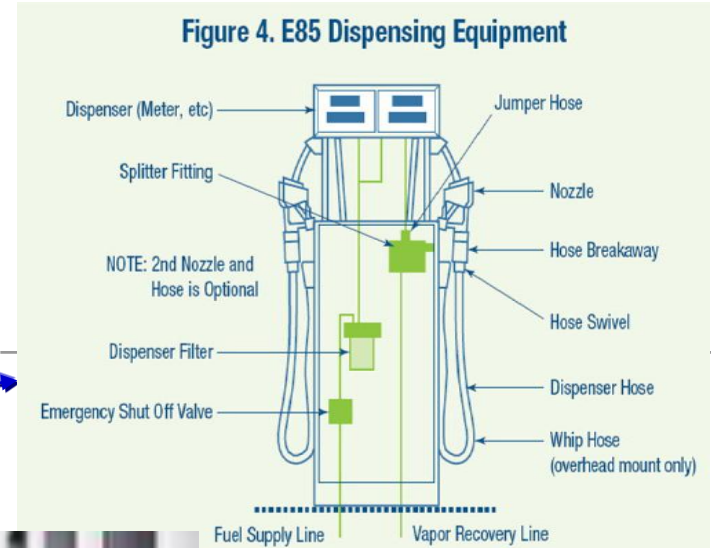
Crescentino, Piemonte



40.000 t/y First Plant- Key Features

- **Production based on Arundo Donax (~5000 ha) and Wheat Straw (300.000 t/y) locally available.**
 - **Plant located 70 km from nearest refinery.**
 - **Plant will incorporate all technology features developed during the R&D project phases.**
 - **Plant will demonstrate at commercial scale the new pretreatment technology (PRIT).**
 - **Plant will incorporate innovative Hydrolysis and Fermentation step as part of the BIOLYFE FP7 Project.**
 - **Plant will sell Dry Ethanol to major oil company/ies.**
 - **51.000 ton of CO₂ emission saved per year. 40,000 t/y Ethanol = 6.800 car without CO₂ emission.**
- 

Vehicle fleet Installation of E85 Pump



6 SAAB 9.3 2.0 BIOPOWERGRIFFIN



**Biolyfe partners:
WIP - Eta Florence**

XIX ISAF

International Symposium on Alcohol Fuels



PREVIOUS EVENTS		
NAME	HOST	YEAR
ISAF I	Stockholm - Sweden	1976
ISAF II	Wolfsburg - Germany	1977
ISAF III	Asilomar - USA	1979
ISAF IV	Guaruja - Brazil	1980
ISAF V	Auckland - Newzealand	1982
ISAF VI	Ottawa - Canada	1984
ISAF VII	Paris - France	1986
ISAF VIII	Tokyo - Japan	1988
ISAF IX	Florence - Italy	1991
ISAF X	Colorado Soprings - USA	1993
ISAF XI	Sun City - South Africa	1996
ISAF XII	Beijing - China	1998
ISAF XIII	Stockholm - Sweden	2000
ISAF XIV	Phuket - Thailand	2002
ISAF XV	San Diego - USA	2005
ISAF XVI	Rio de Janeiro	2006
ISAF XVII	Taiyuan - China	2008
ISAF XVIII	New - Delhi	2010





2nd Lignocellulosic Bioethanol Conference

VERONA Italy, 11-13 October 2011

Organised by: European Commission & Brazil

Facilitated by: Mossi & Ghisolfi/Chemtex

Chairs: Dario Giordano & Kyriakos Maniatis

Organising Committee:

Mrs Soares Pinto, Hart Energy

Mr David Chiaramonti, University of Florence

Mr Marco Aurelio Lima, LNCTB

Mr Kyriakos Maniatis, DG ENER

Logistics: Verona Fiere & Media Consulta

Co-located with: International Symposium on Alcohol Fuels



ISAF XIX





Thanks for your attention
www.biolyfe.eu

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