



# **PROESA® TECHNOLOGY**

Break-through Technology for Producing  
Advanced Bio-Fuels and Renewable Chemicals  
from Cellulosic Biomass

September 2012



## PROESA: A Proven Technology .. Commercially Viable Today



Not a Science Project

# Topics

1. Overview of Chemtex and Beta Renewables
2. The PROESA™ Technology
3. CRESCENTINO – World's 1<sup>st</sup> Commercial Cellulosic Ethanol Plant

# Chemtex Overview

## Chemtex Italy



Tortona, Rivalta

## Chemtex USA



Wilmington, NC  
Sharon Center, OH

Founded in 1947

A wholly-owned  
subsidiary of the  
**M&G Group**



- Annual Turnover:  
USD 300 MM
- Employees: 1000

## Chemtex China



Shanghai, Beijing

## Chemtex India





Mumbai, Bangalore



GRUPPO MOSSI & GHISOLFI

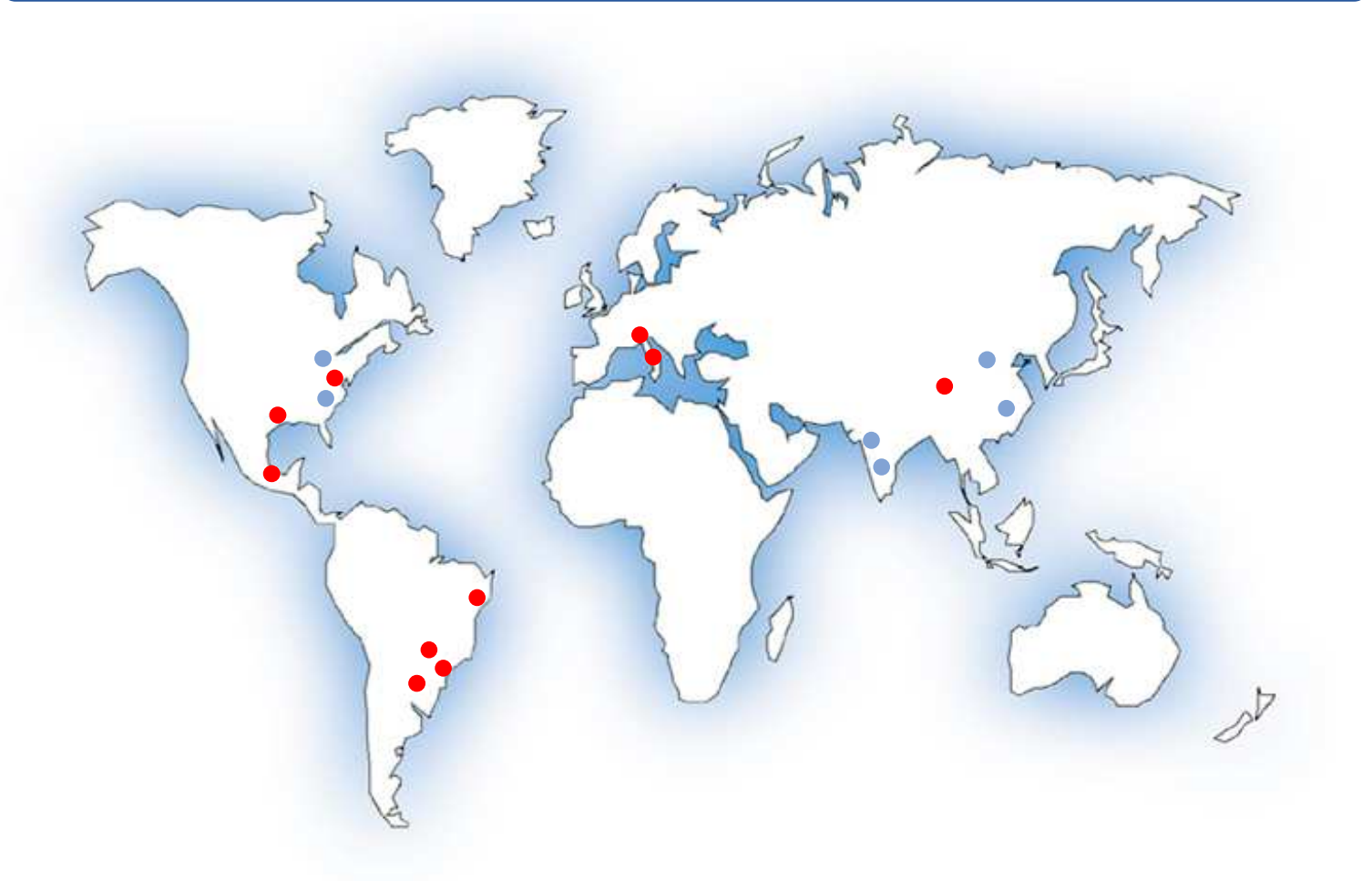
# Gruppo Mossi & Ghisolfi

★ 1950 - 1979	1979-2000	2000-2007	2007 & Beyond
<b>Packaging Manufacturing Phase</b> <p>M&amp;G was founded in 1953 by Vittorio Ghisolfi in Tortona, Italy</p> <p>M&amp;G offered customers packaging from HDPE and PVC</p>	<b>Chemical Specialty Manufacturing Phase</b> <p>Group activities were integrated upstream in the development and production of special resin (PET) for food packaging applications</p>	<b>PET Expansion Phase</b> <p>2000 Acquisition of Shell's PET business</p>  <p>2002 Acquisition of Brazilian controlled Rhodia-ster from Rhone Poulenc</p> <p>2003 Start up of world's largest PET production unit at Altamira (Mexico)</p> <p>2004 Acquisition of the world class engineering group Chemtex from Mitsubishi Corporation</p> <p>2007 Start-up of highest capacity single line PET plant in Suape, Brazil <i>A Chemtex EPC Project</i></p>	<b>Renewables</b> <p>2007 Testing and development of technology on lab scale for cellulosic ethanol</p> <p>2008 Agronomic testing of energy crops</p> <p>2009 Construction and operation of a continuous pilot plant for cellulosic ethanol</p> <p>2011-2012 Construction of a 40ktpa Cellulosic Ethanol Demonstration Plant</p> <p>Collaboration with Gevo, Genomatica and Codexis for 2G Sustainable Chemicals</p> <p>Launch of </p>



- Privately held company with deep roots in manufacturing (PET and Acetates)
- 2600 Employees worldwide
- A commitment to R&D (3 Centers) and Process
- USD 3 billion annual revenue
- Operations in the USA, Italy, Mexico and Brazil

## M&G Group – Worldwide Locations



- M&G locations
- Chemtex Locations

# Providing Project Solutions

Chemtex markets:



Renewables

Fibers & Petrochemicals

Energy & Environmental

Chemtex offers:

- State-of-the-Art Technologies
- **In-house R&D** facilities
- Extensive Technology Transfer Expertise
- Conceptual and **Feasibility Studies**
- **Process optimization** and de-bottlenecking
- Basic Engineering and in-house cost-effective Detailed Engineering
- Global Strategic Sourcing
- **EPC capability and experience**



# Center for Renewable Resources

**Rivalta, Italy**

3000 m<sup>2</sup> dedicated to  
renewable resources  
biochemistry and  
technology

100+ dedicated staff





## Center for Renewable Chemistries



**Sharon Center, Ohio**

Fundamental and applied  
cellulosic sugar chemistry  
and engineering research:

- Catalytic Conversion of Sugar
- Lignin conversion
- Intermediate and final product separation technologies
- US based agronomic studies
- 49,000 ft sq. of space

# BETA RENEWABLES



- A €250 million joint venture between M&G and TPG Capital (\$48bn of assets) and TPG Biotech announced on October 13, 2011.
- BETA RENEWABLES will:
  - Exclusively license PROESA™ Technology worldwide.
  - Will develop new bio-chemical processes.
  - Will own the Crescentino Demonstration/Industrial Cellulosic Ethanol Facility in Italy.
- Chemtex will be the exclusive engineering partner for basic engineering design, supply of key equipment and field services (installation support, training, commissioning and start-up).



## Latest News



### GraalBio Licenses Beta Renewables' PROESA Process to Build Brazil's First Commercial Cellulosic Ethanol Plant



Rivalta Scrivia, Italy, May 23, 2012

[GraalBio](#) Investimentos S.A. and [Beta Renewables](#) announced that GraalBio will build Brazil's first commercial cellulosic ethanol plant, with a planned start of operations by the end of 2013. The plant, with a production capacity of 65,000 metric tons per year (22 million gallons) will use Beta's [PROESA](#)® technology to deliver cost-competitive ethanol while using non-food cellulosic biomass as its feedstock.

[<< Back](#)

### Codexis and Chemtex to Collaborate on Sustainable Detergent Alcohols for the Household Products Market

REDWOOD CITY, Calif. and TORTONA, Italy, July 28, 2011 /PRNewswire via COMTEX/ --

Codexis, Inc. (Nasdaq: CDXS) and Chemtex, a global technology and engineering Company wholly-owned by Italy's Gruppo Mossi & Ghisolfi ("M&G Group"), today announced a broad collaboration to develop and produce sustainable detergent alcohols for use in the household products market. The collaboration includes development of second generation detergent alcohols from cellulosic (non-food) biomass.

Detergent alcohols - a \$6 billion worldwide market - are surfactants which stabilize mixtures of oil and water. They are widely used in laundry detergents, shampoos and other consumer products. Detergent alcohols today are made from non-sustainable palm kernel and petroleum sources.

The collaboration with Chemtex includes the following:

- [Development of a world-class process for the conversion of cellulosic biomass to sustainable detergent alcohols](#)

The process will utilize Chemtex's break-through PROESA(TM) Pretreatment and Viscosity Reduction Technology with Codexis' proprietary CodeEvolver(TM) directed evolution technology to enable more cost-effective production of detergent alcohols from cellulosic feedstocks. Both elements—an efficient pretreatment and high performance enzymes—are required to enable commercial use of cellulosic feedstocks such as straw, sugar cane bagasse and energy crops to produce industrial products. The collaboration will focus on development of a technology package suitable for use with a wide variety of feedstocks. Under the terms of the agreement, Codexis will have exclusive rights to PROESA(TM) technology for the production of detergent alcohols.



## Latest News



### **Gevo and Beta Renewables (Chemtex/TPG) Sign Agreement to Develop Integrated Process for Cellulosic Isobutanol**

*Potential for bio-based isobutanol and derivatives,  
including jet fuel, from cellulosic biomass*

ENGLEWOOD, Colo. and Rivalta Scrivia, Italy  
– July 10, 2012 – Gevo, Inc. (NASDAQ:  
GEVO), a leading renewable chemicals and  
next-generation biofuels company, signed a  
Joint Development Agreement (JDA) with  
Beta Renewables, a joint venture between  
Chemtex and TPG, to develop an integrated  
process for the production of bio-based  
isobutanol from cellulosic, non-food biomass.

C E R T I F I C A T E

# Innovation-Award

at ACHEMA 2012

for the most innovative product  
in the category

Biotechnology

will be awarded to

**Beta Renewables S.p.A.,  
Tortona (AL)**

Product:

**PROESA® Technology**

Frankfurt, June 19, 2012

  
Gerd Kollmann, Group Publisher

**PROCESS**  
Chemtech International

**PROCESS**  
WORLDWIDE

**PharmaTEC**  
Pharmaceutical Technology

**LABOR**  
PRAXIS

Vogel Business Media [www.vogel.de](http://www.vogel.de)

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## PROESA™ - A Snapshot

- ✓ More than **USD \$200M investment** into R&D since 2006.
- ✓ Extensive agronomic studies and supply chain logistics investigation.
- ✓ A continuous 1t/d biomass pilot facility operational since 2009. →
- ✓ **Intellectual Property** – 14 patent family applications filed, 4 are public.
- ✓ Collaboration with *Codexis*, *Genomatica*, *Gevo* and others for the joint development of drop-in fuels and bio-based chemicals using PROESA™ Pre-Treatment & Viscosity Reduction Technology.
- ✓ Commitment of M&G / Chemtex and its partners to **continuous development** and improvement.





## The Development of PROESA™



2006-2008

- Scouting of Technologies
- Generation of key inventions
- Proof of UNIT OPERATION in the labs



2009-2010

- Pilot plant construction & start up (June 2009)
- Pilot Plant operation and data gathering
- Test of Plant flexibility using multiple biomasses

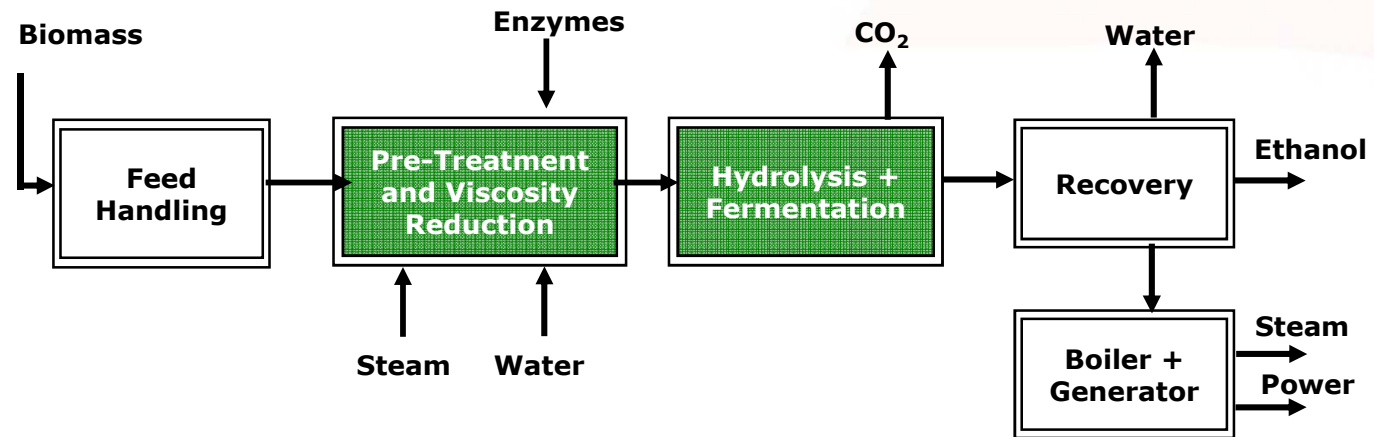


2011-2012

- Crescentino Plant
- Collaboration Agreements with leading synthetic biology companies
- License Agreements
- Formation of Beta Renewables



# PROESA™ - A Total Project Solution



## A Total Project Solution based on:

1. **Agronomy:** Field experimentation and best energy crops identified and characterized.
2. **Biomass Pre-Treatment and Viscosity Reduction:** Continuous process developed and piloted to produce cost-effective and clean fermentable sugars, without using chemicals: only steam and hot water!
3. **Hydrolysis and Fermentation:** Unique hybrid SSCF process scheme yielding high ethanol concentrations.



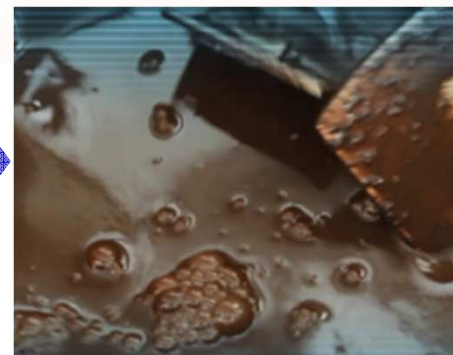
## Locally Sourced Supply

- Thanks to **great flexibility** of the PROESA® Pretreatment, it is possible to locally source **agricultural waste, or energy crops**, for each production site.
- Supply chain will be flexible, and based on **most suitable** or most available feedstock **for each geographical area**.
- **Different sources** of biomass can be fed to each plant, in periodic campaigns
- This approach guarantees **security of supply**, all year round





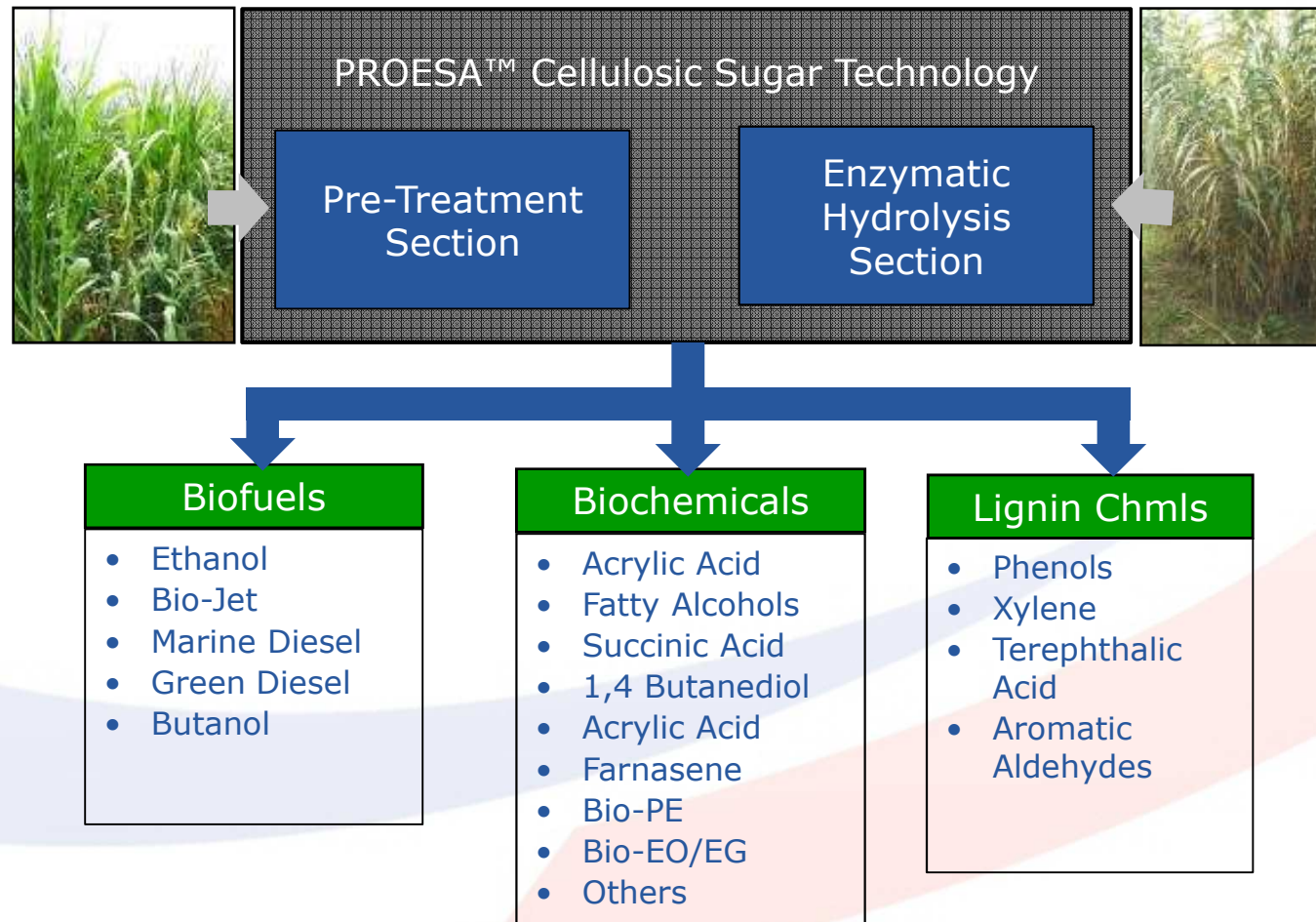
## From Biomass ... To Sugars ...



- Best in class technology with lowest capex and opex
  - Use of continuous equipment enables large scale plants
- Without the use of chemicals (acid or alkali) for hydrolysis
  - Minimal formation of by-products and inhibitors
  - Pure lignin by-product
- Feedstock flexibility – optimal C5 and C6 sugar extraction from a broad array of biomass including energy crops, residuals (straw, stover, bagasse) and hardwood
- Strong IP positions
- Cash cost of fermentable sugars at ~10¢/lb.
- Cash cost of ethanol of <\$1.5/USG (\$0.4/L).
- Performance guarantees



## ... to biofuels and bio-based chemicals



# PROESA™ for Renewable Chemicals



**Codexis and Chemtex will work together to develop a novel process to produce C12-C14 fatty alcohols from cellulosic biomass.**



**Biomass**



C5-6 sugars

**PROESA™**

**Fermentation**

**Separation**

**2G-FOH TECHNOLOGY**

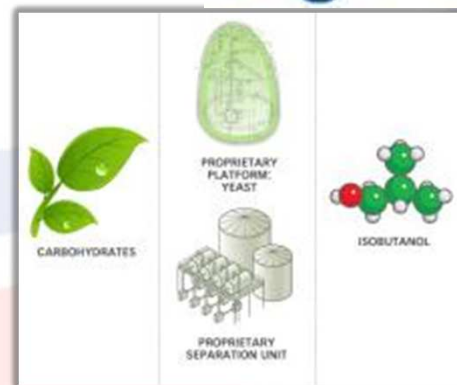
**FOH**



20



Genomatica and Chemtex together for production of 2G bio-BDO from PROESA® sugars



Gevo and Chemtex together for production of 2G isobutanol from PROESA® sugars

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## Crescentino 40 ktpa Plant



- In April 2011, M&G and Chemtex broke ground for a 40 ktpa (60ktpa design) cellulosic ethanol plant based on Arundo Donax & wheat straw.
- Plant will generate 13MW of “green” power from lignin to the grid and will sell ethanol to a major oil company.
- Design incorporates state-of-the-art wastewater treatment facility for maximum recycle of water.
- **Start-up: October, 2012 (target).**



## Crescentino Commercial Plant

Photo taken May 2012:



<http://www.betarenewables.com/Crescentino.html>

In April 2011 Chemtex broke ground for a 60 ktpa (20 MMgpy) cellulosic ethanol plant based on Arundo Donax & wheat straw.



# Crescentino JULY 2012



## Topics

**In conclusion .....**



## Why PROESA™ & Chemtex?

- ✓ The best-in-class technology offering:
  - **A Total Project Solution** - from field to product
  - **Cost competitiveness** – low capex (simplified flow schemes and no special materials of construction) and opex (no chemicals required in pre-treatment and energy integration).
  - **Process and Performance Guarantees** for capacity, conversion yield and key consumptions.
  - **Feedstock flexibility** – energy crops, agricultural wastes and woody biomass to mitigate risk and maximize asset utilization.
  - **Uniqueness** – IP protection through multiple patent filings.
  - **Experience** – Continuous pilot facility in operation since June 2009 and a Commercial Plant operational in 2012.
  - **Commitment** – by Chemtex, M&G and its partners to continuous development/improvement.



## PROESA™ - We Are Ready!

- ✓ Commercial-scale  
20MMgpy cellulosic ethanol  
plant in Crescentino, Italy  
operational in 2012
- ✓ Competitive without  
subsidies  
Benchmark: Oil @ \$70/bbl
- ✓ Cellulosic Costs Less  
Estimated cash costs:  
Ethanol: <\$1.50/USG  
Sugars: 10¢/lb



[www.chemtex.com](http://www.chemtex.com)  
[www.betarenewables.com](http://www.betarenewables.com)



**PROESA™ – We Are Ready!**

**Second Generation Technology  
Up and Running Now!**



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