Second generation ethanol. How to reach the goal.

The PRO.E.SA. project

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**PRO.E.SA Objective**

**Main objective:** Developing a complete crop-to-ethanol value chain through a conversion technology able to transform selected ligno-cellulosic material into bio-ethanol in a sustainable way.

**Timeframe:** 5 years (2008÷2012)
Project sub-objective

- Selection of the best energy crop for ethanol production through experimentation on field.

- Selection of the best technology route to covert ligno-cellulosic material into ethanol through laboratory experimentation on pilot plant.

- Construction, start-up and testing campaign of a demonstration unit.

- Design of an industrial plant based on data generated from the demo unit and conversion of 1st generation 200 kTY plant into a 2nd generation facility.
Energy crops

Cellulosic ethanol is competitive with fossil fuels if the raw material is:

- Relatively cheap (compared to corn or other cereals)
- High cellulose and hemicellulose content, low in lignin and ash
- Can be intensively grown with high yield per hectare
- Using less water and fertilizers then cereals
Key success factors of the entire process are:

- Pre-treatment needs to be optimized according to incoming biomass;
- Biomass-Pretreatment-Hydrolysis/Fermentation need to be perfectly aligned;
- Easy process-set up in order to achieve low conversion cost;
- High biomass-to-ethanol yield.
A key point for the success of the entire project will be the construction and running of a 20,000 tons/year ethanol demonstration unit.

Why a demonstration unit:

- To prove the technology tested on a pilot plant scale on larger scale
- To define the best operating condition
- To prove the entire crop-to-ethanol value chain on larger scale
- To generate all the data needed for the design of industrial plants
Project steps

Selection of the best energy crop for ethanol

Technology Scouting

Construction and test on labs and pilot plant of the most promising technologies

Construction and test on demo unit

Design of Industrial Plant

2005 2008 2012
M&G activities

Since 2005 M&G started different R&D activities in the bio-ethanol field:

- Technology scouting and analysis
- Support to engineering on 1st generation ethanol
- Construction of new R&D center fully dedicated to renewables
- Energy crop experimentation on field
M&G activities

New R&D centre dedicated to renewables:
M&G activities

Experimentation on field:

- 7 ha dedicated to R&D in 2007
- Testing on annual energy crops (Sorghum)
- 60 ha dedicated to R&D in 2008
- Annual and perennial energy crops will be tested
What needs to be done

- Selection of the best energy crops for each region.
- Reduction of environmental impact of new energy crops.
- Genetic optimization of new energy crops.
- Study of mechanization of biomass harvesting and logistics.
- Pre-treatment of the selected biomass.
- Simultaneous fermentation of C5 and C6.
- Development of enzymatic hydrolysis reactor.
- Development of new enzymes for 2nd generation ethanol.
- Development of fermentation biotechnology.
- Improvement of ethanol separation process.
- Lignin thermal and chemical valorization.
- Optimization of enzymatic hydrolysis.
- Demonstration plant.
Competence integration

In order to achieve the project goal there is the need of a complete integration of different sciences.

Know how needed for project success

- Biochemistry and Biotechnology
- Technology development and Process modeling
- Agronomy and Botanics
- Chemistry
- Engineering and Technology
- Biomass supply chain and Logistics
No 2\textsuperscript{nd} generation without the 1\textsuperscript{st}

In order to build specific knowledge needed for second generation ethanol, M&G decided to enter into first generation ethanol business:

- Today M&G has 1\textsuperscript{st} generation technologies available for bio-ethanol.
- Build and run a 200 kTY corn-to-ethanol (1st generation) then gradually convert to ligno-cellulosic (2nd gen.) implementing Proesa technology

Building a first generation ethanol plant will increment specific know-how on fuel-ethanol technology and management, thereby setting the grounds for success of the entire project. It is necessary to create industrial expertise (production, logistic, distribution) on a product not yet as well-known in Italy as it is in other countries like U.S. and Brazil.
# Milestones

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<thead>
<tr>
<th>Projects</th>
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<th>2nd Year</th>
<th>3rd Year</th>
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<th>5th Year</th>
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<tbody>
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<td>6 – Development of new enzymes for 2nd generation ethanol</td>
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<td>9 – Development of enzymatic hydrolysis reactor</td>
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<td>12 – Improvement of separation process</td>
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<td>14 – Demonstration plant</td>
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Conclusion

**Proeza:** (pronounced as Proesa): Portuguese word that means achievement, feat, accomplishments, exploit, performance, prowess.

**Proesa objective:** Develop a complete crop-to-ethanol value chain through a conversion technology able to transform selected ligno-cellulosic material into bio-ethanol in a sustainable way.

*The objective is a huge challenge, that requires great effort but will be feasible if competencies from private companies, University and research institutes are put together and cooperate with great commitment.*
Conclusion

Italian companies are used to dealing with huge challenges...

Next time with fuel ethanol?