



THE FUTUROL PROJECT

CELLULOSIC ETHANOL
INDUSTRIAL PROJECT



THE PARTNERS



- 1 company : PROCETHOL 2G
- 11 shareholders → Leaders in their activity

R&D PARTNERS



INDUSTRIAL PARTNERS



FINANCIAL PARTNERS



THE TARGETS



«IMPLEMENTATION AND VALIDATION OF AN ETHANOL PRODUCTION PROCESS, KNOWN AS SECOND GENERATION, USING LIGNOCELLULOSE»

The process and its biocatalysts (yeasts, enzymes) are to be licensed worldwide

The FUTUROL PROJECT is an R&D project with commercial targets in a tough context

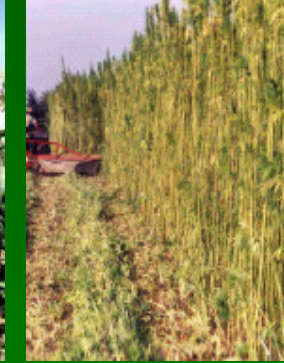
ALTERNATIVE RESSOURCES

ENERGETIC FOREST CROPS



Poplar short rotation coppices

ANNUAL CROPS



Wheat straw

Corn stover

Sorghum

ENERGETIC AGRICULTURAL CROPS



Switchgrass

Miscanthus

BY-PRODUCTS



Woodchips

Bagasses

THE BUDGET

- GLOBAL BUDGET : 76.4 M€

- FINANCING

- 46.5 M€

- Funding by project partners*

- 29.9 M€

- Public grants and loans*

bpifrance

AIMS:

1. Build crop systems adapted to energy use
2. Preparation of cellulose / hemicellulose / lignin
3. Adaptation / improvement of existing enzymes to raw materials and industrial conditions
4. Optimization of the conversion efficiency of hexoses and valorization of pentoses
5. Limitation of overall consumption of water, energy and emissions
6. Achieve thermal and process integration and upscaling

THE R&D WORK PACKAGES

THE TEAM

- +100 high-level researchers and engineers involved with 50 working full-time – 500.000 hours of R&D yet

12 R&D centres



THE R&D PARTNERS



- Specialized in plant fractionation, green chemistry and fermentation, with 70 researchers, leader on biosuccinate



- World's leader on baker's yeasts production and alcohol yeasts, with 100 researchers



- Developing innovative technologies on fuel and chemical processes, with 1,170 researchers and 180 patents/y

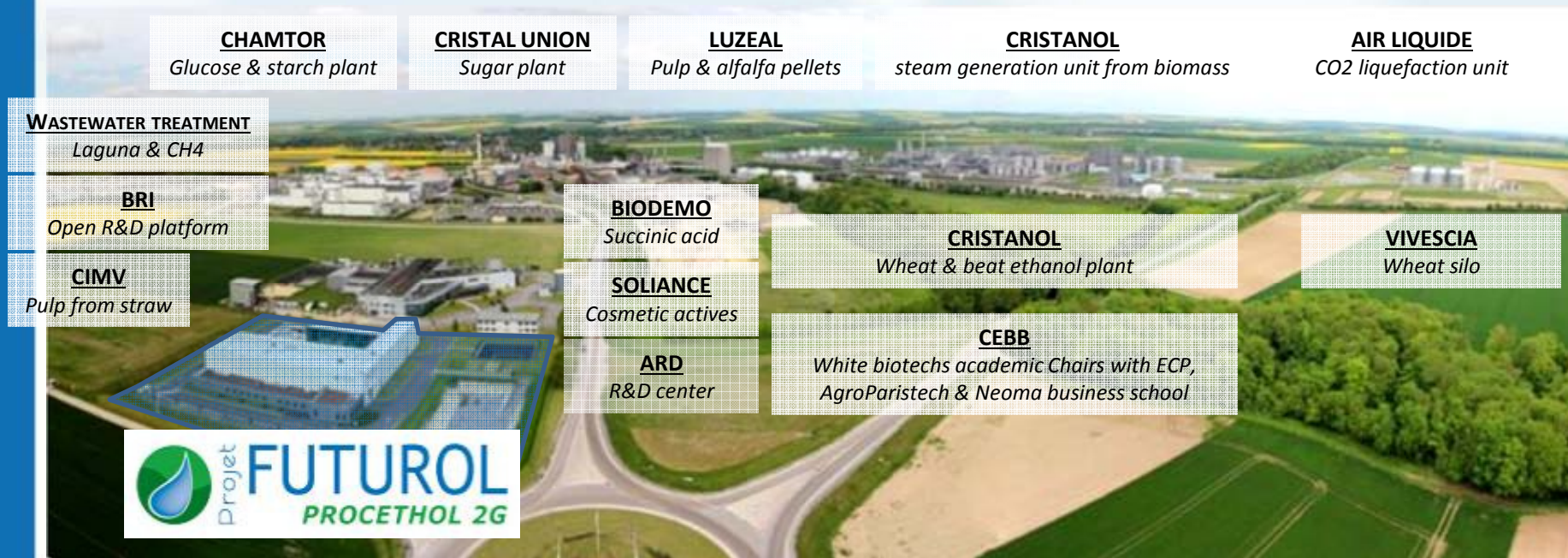


- 8,600 researchers working on plants, animals and microorganisms, leader of scientific publications in Europe

LOCATION OF FUTUROL PILOT PLANT : AN AGROINDUSTRIAL NEIGHBORHOOD



- 1 M tons of wheat, 2 M tons of sugarbeet, +100 kton of alfalfa & pulps and more annually
- 1,000 employees



- Several industrial cells using cereals, sugarbeet, alfalfa and lignocellulose, with water and energy integration... a biorefinery?

FUTUROL PILOT PLANT



FUTUROL PILOT PLANT



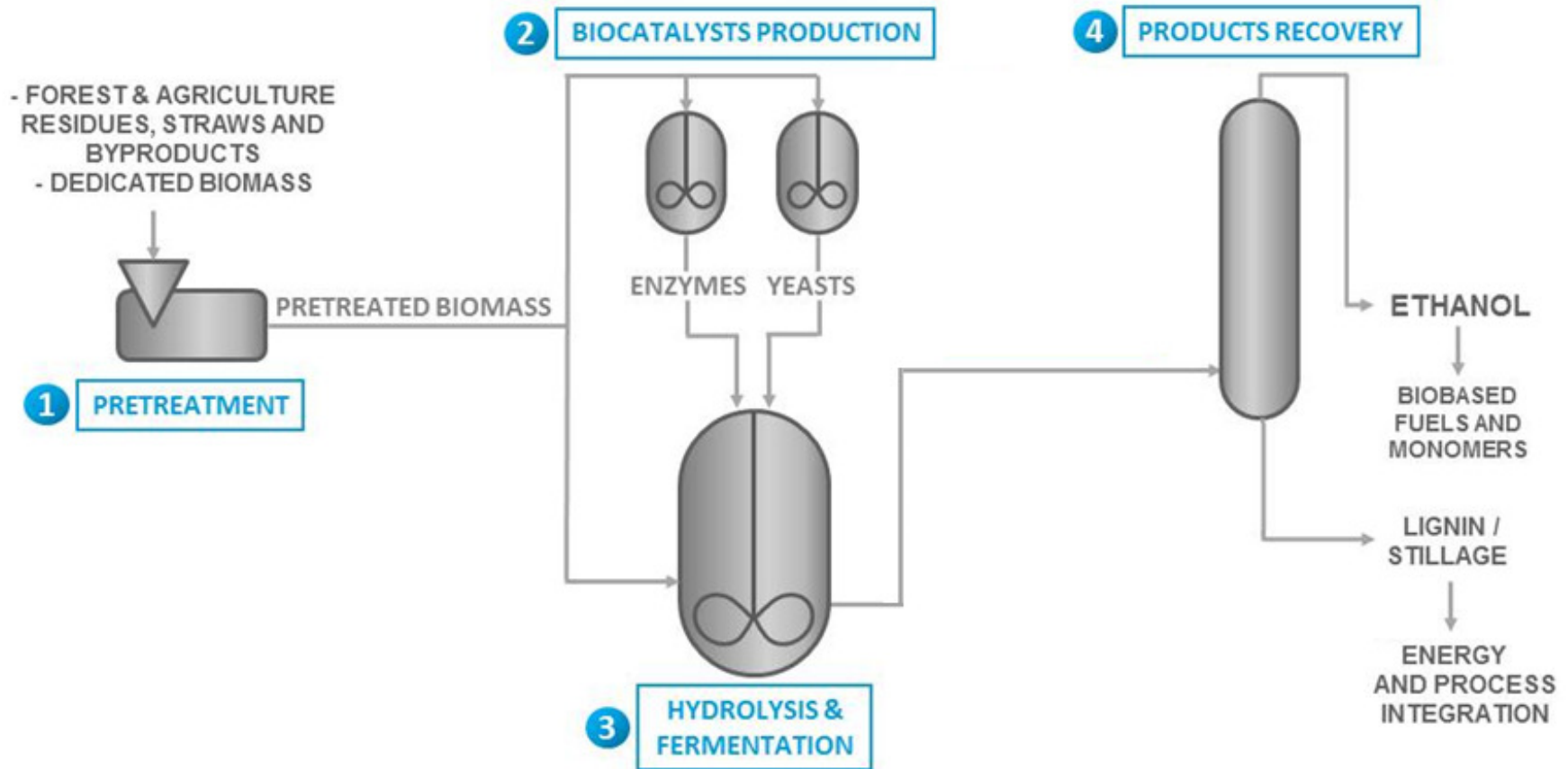
■ +2,200 data outputs

■ 10 dedicated technicians

■ 5,000 m²

FUTUROL PROCESS

- A simple and integrated 4-step process



■ BIOMASS



Aiming **worldwide technology deployment** and **reduced biomass storage**, numerous feedstocks have been studied at crop, lab and pilot scale (switchgrass, miscanthus, poplar, straw, bran, pulp, ...)

→ Consolidated results are available for wheat straw, miscanthus and poplar with high ethanol yields

■ PRETREATMENT

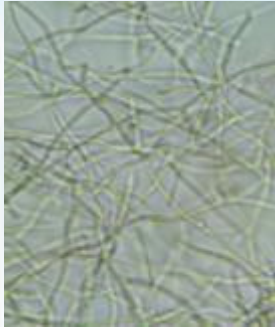


Futurol's selected and optimized pretreatment technology is a result of meticulous research studies.

Our **robust, simple and energy-efficient single-train** technology **continuously** processes different biomass feedstocks to a standardized pretreated substrate with:

- Low moisture content
- High hemicellulose hydrolysis yield
- High digestibility

■ ENZYMES



Tailor-made enzymes for cellulolysis and hemicellulolysis are:

- Designed and continuously adapted to the process
- Developed using lignocellulosic substrates allowing **on-site** production with **low production cost**
- Highly efficient → benchmark compared to the competitors

■ YEASTS



Yeasts have been developed and selected to:

- Ferment **both C6 and C5** sugars into ethanol
- Use lignocellulosic substrates for **on-site** propagation
- Present high **resistance to main inhibitors**, especially acetic acid

■ HYDROLYSIS AND FERMENTATION



Futurol's **one-pot process** allows **simultaneous** enzymatic hydrolysis of biomass and C5/C6 sugars fermentation which provides:

- CAPEX and OPEX minimization thanks to a simple and integrated process
- A unique synergy between biocatalysts
- Full C5 and C6 sugars conversion
- High ethanol yield and content

TECHNOLOGICAL ACHIEVEMENTS



■ PROCESS KEY FEATURES

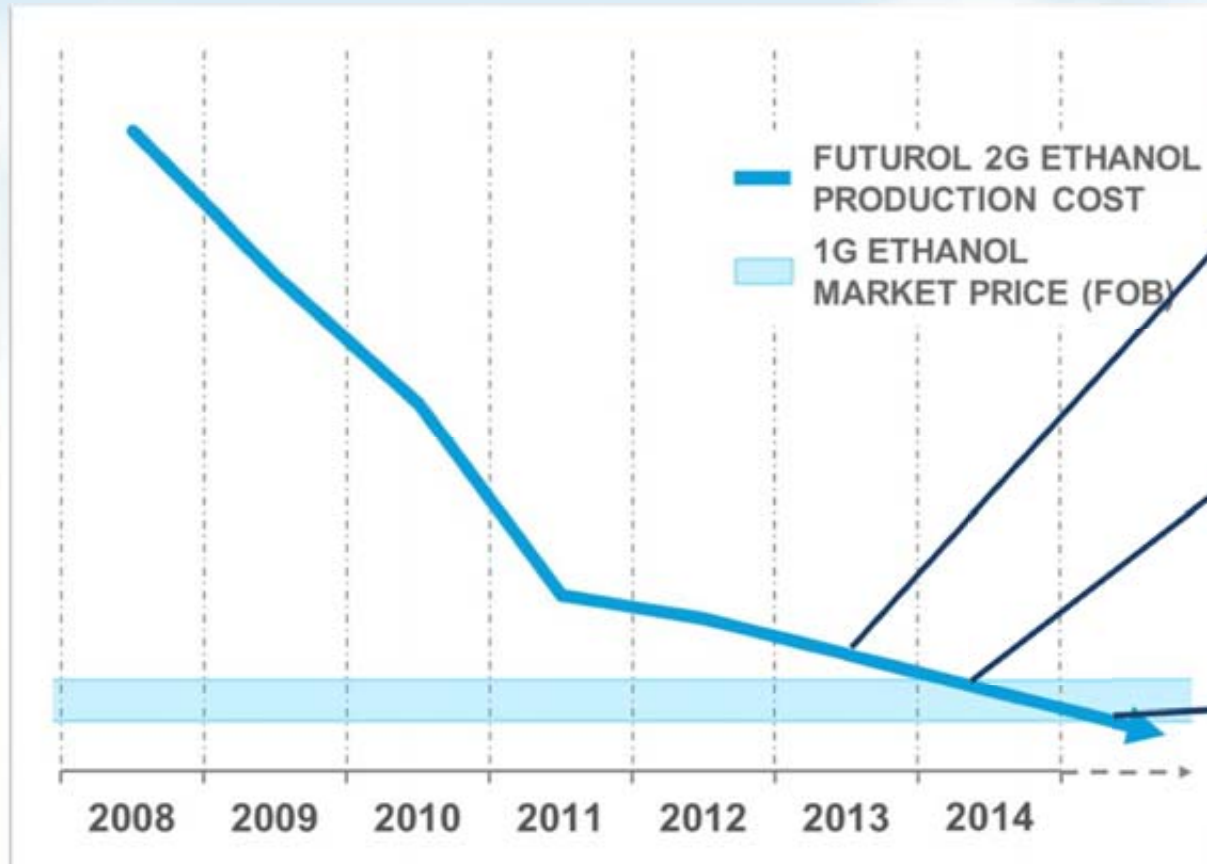
- More than 85% GHG reduction well to wheel compared to gasoline
- Simple and robust technologies and process configuration
- Feedstock flexibility
- **Energetic self-sufficiency, and more,** and intelligent water management strategies
- On-site biocatalyst production

■ INTELLECTUAL PROPERTY



- FUTUROL partnership is holding a portfolio of **25 patents** and more than **110 scientific communications** which continues to grow

ETHANOL PRODUCTION COST PROJECT EVOLUTION



Technological breakthrough

Fine tuning/final development

Process licensing

THE PROCESS LICENSING



- In collaboration with PROCETHOL 2G and as a licensor, AXENS:
 - Continuously takes part and follows the FUTUROL PROJECT 2nd generation ethanol process development
 - Is in charge of technical proposals, pre-sizing studies and basic engineering design
 - Provides customers with personnel training and technical assistance for start-ups and follow-up

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Contact : contact@projet-futurol.com
www.projet-futurol.com