Biomass and Biorefinery: what can be really expected?

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Pdt French Competitiveness cluster « Industries and Agroresources »
Biomass application

Agroressources
Whole plant valorisation

New processes
BIOREFINERY

New Markets
Renewable products
Environment respect
Biorefinery concept

Access to biomass

Biomass

New industrial needs
Renewable carbon
Environment friendly products

New industrial tools
Biomass Green Chemistry
White Biotech

Markets

BioMolecules
Chemical intermediates, green glue, biolubricants, green surfactants

Bio Materials
Plant fibres & Biopolymers for Building, Textile, Plastics, Transport, Packaging

Bio Energy
Biofuels 2G & 3G, heat & electricity

Bio Ingredients
Food Ingredients, Cosmetic Ingredients, Bio-Actives, Nutraceutics

Sustainable Development
Plant biorefinery

PLANTS = BIOMASS

1\textsuperscript{st} Transformation

EXTRACTION - SEPARATION

FRACTIONATION - CRACKING

FONCTIONALISATION

AGRO-INDUSTRIAL PRODUCTS (INTERMEDIATES)

2\textsuperscript{nd} Transformation

FORMULATION

ENERGY

PETROLEUM INDUSTRIES

PAPER MILL

COSMETIC HYGIENE

POLLUTION TREATMENT

CLEANING

AAI

PLASTIC INDUSTRIES

FABRICS

METALLURGY

WOOD DERIVATIVES

BUILDING

CHEMICAL INDUSTRIES

PHARMACEUTICAL INDUSTRIES

- ENERGY
- PETROLEUM INDUSTRIES
- PAPER MILL
- COSMETIC HYGIENE
- POLLUTION TREATMENT
- CLEANING
- AAI
- PLASTIC INDUSTRIES
- FABRICS
- METALLURGY
- WOOD DERIVATIVES
- BUILDING
- CHEMICAL INDUSTRIES
- PHARMACEUTICAL INDUSTRIES

FATTY ALCOHOLS

ETHYLESTER

ALCOHOLS

POLYOLS

SURFACTANTS

ENZYMES

SUGARS

ORGANIC ACIDS

MODIFIED STARCH

DEXTRINS

RESINS

VITAMINS

PLASTICS

MONOMERS

POLYMERS

PLASTICS

RESINS

DEXTRINS

RESINS

VITAMINS

PLASTICS

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VITAMINS

PLASTICS

MONOMERS

POLYMERS
Plant biorefinery

Biobased Syn gas

Sugars
- Glucose
- Fructose
- Xylose
- Arabinose
- Lactose
- Sucrose
- Starch
- Cellulose

Direct fermentation
- Polymers & gums

Industrial
- Corrosion inhibitors, dust control, boiler water treatment, gas purification, emission abatement, specialty lubricants, hoses, seals

Transportation
- Fuels, oxygenates, anti-freeze, wiper fluids, molded plastics, car seats, belts, hoses, bumpers, corrosion inhibitors

Textiles
- Carpets, fibers, fabrics, fabric coatings, foam cushions, upholstery, drapes, lycra, spandex

Safe Food Supply
- Food packaging, preservatives, fertilizers, pesticides, beverage bottles, appliances, beverage can coatings, vitamins

Environment
- Water chemicals, flocculants, chelators, cleaners and detergents

Communication
- Molded plastics, computer casings, optical fiber coatings, liquid crystal displays, pens, pencils, inks, dyes, paper products

Housing
- Paints, resins, siding, insulation, cements, coatings, varnishes, flame retardants, adhesives, carpeting

Recreation
- Footgear, protective equipment, camera and film, bicycle parts & tires, wet suits, tapes-CDs-DVD's, golf equipment, camping gear, boats

Health and Hygiene
- Plastic eyeglasses, cosmetics, detergents, pharmaceuticals, suntan lotion, medical-dental products, disinfectants, aspirin
Petrochemicistry and Biorefinery

(Sanders et al., 2007)
Strategy to develop biorefinery

Bio-based feedstock

Logistic & pre-treatment

Biomass
Green
Chemistry

White
Biotechnology

Lab
Pilot plant
Industrial demonstration

Biobased products
biofuels, polymers, chemicals, ingredients

Markets
# Building blocks for chemistry

<table>
<thead>
<tr>
<th>Building Blocks</th>
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<tbody>
<tr>
<td>1,4 succinic, fumaric and malic acids</td>
</tr>
<tr>
<td>2,5 furan dicarboxylic acid</td>
</tr>
<tr>
<td>3 hydroxy propionic acid</td>
</tr>
<tr>
<td>aspartic acid</td>
</tr>
<tr>
<td>glucaric acid</td>
</tr>
<tr>
<td>glutamic acid</td>
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<tr>
<td>itaconic acid</td>
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<tr>
<td>levulinic acid</td>
</tr>
<tr>
<td>3-hydroxybutyrolactone</td>
</tr>
<tr>
<td>glycerol</td>
</tr>
<tr>
<td>sorbitol</td>
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<tr>
<td>xylitol/arabinitol</td>
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</table>
Succinic acid
Succinic acid: a new step toward integrated biorefinery

Sugar Refinery
Sugar Refinery
Sugar Refinery
Sucrose

Wheat Processing Mill
Glucose

Cellulose Hydrolysis Pilot
C5 & C6 sugars

Bioethanol plants

Succinic acid plant

Diethyl succinate

CO₂
Biorefinery: toward an industrial metabolism

"Les Sohettes"
Bazancourt - Pomacle

BUSINESS UNITS AND SYNERGIES

1. WATER Synergy: Recovery of condensate
   Chapter uses 22,100 m3 of surface condensate during the beach campaign.
   Advantage: economic gain in the power station and energy recovery.

2. STEAM Synergy
   A reciprocating steam unit.
   Advantage: industrial scale is secured.

3. EFFLUENTS Synergy
   Purification, storage, and disposal.
   Advantage: unit consists of comprehensive strategic approach.

4. PRODUCTS Synergy
   Products of coproduction are used as raw materials for another site.

5. R&D Synergy
   Research programs are led in cooperation with A.R.D. shareholders.

6. ENERGY Synergy
   Renewable production based on sugar cane.
   Advantage: Energy Synergy - use of bioenergy.

7. ORGANIZATION Synergy
   Within the frame of the R&D center, these organizational synergies
   reinforce the construction and operation facilities, naming programs...

8. Drilling Synergy
   Production of raw water.