Workshop 17th November 2010, Reims:

Development of multi-product lignocellulose biorefinery technology – with focus on residues (pentoses, lignin) from cellulose ethanol production

Results of the Integrated Project BIOSYNERGY (FP6)
www.biosynergy.eu
Features Integrated Project BIOSYNERGY

- Bio mass for the market competitive and environmentally friendly synthesis of bio-products – chemicals and/or materials – together with the production of secondary energy carriers – transportation fuels, power and/or CHP – through the biorefinery approach.

- Development multiproduct cellulose-ethanol based biorefinery technology
- Focus on valorisation of residues from cellulose ethanol production
- Bioprocessing and thermochemical pathways combined
- Process development from lab-scale to pilot-scale

Duration: 01-01-2007 – 31-12-2010 (48 months). Budget: 13.4 M€, EC grant 7M€
7 Industries, 8 R&D Institutes and 2 Universities from 10 EU countries
Lignocellulosic Feedstock Biorefinery

Biorefinery is the sustainable processing of biomass into a spectrum of marketable products and energy (IEA Definition)

• **Aim**: to optimize revenues and minimize environmental impact
• **Multiple products**: transportation fuels, chemicals, electricity and heat
• **Challenging feedstock**: complex mixture of biopolymers (cellulose, hemicellulose, lignin) with differential behaviour to thermochemical and bioprocessing

- Physical-chemical pre-treatment & fractionation of lignocellulose
- Enzymatic hydrolysis of (hemi)cellulose
- Fermentation / chemical conversion of intermediates
- System integration
  - CHP from process residues
  - Heat integration, water recycle

Source: Kamm et al., Wiley-VCH, 2006
Multi-product biorefinery, Focus on residues cellulose ethanol: C5 and lignin valorisation

Physical chemical pretreatment & Fractionation

Enzymatic Hydrolysis

Cellulose

C6 sugars

Fermentation

Chemical Conversion

C5 sugars

Chemical conversion Enzymatic conversion

Fractionation

SC Depolymerisation

Lignin

Aqua-thermolysis

Biomass residues

CHP

Heat & Power to process

Ethanol

ABE

Xyloonic acid

(HMF) > 2,5 FDA

Furfural

Pentoside Surfactants

Phenolics Activated lignins

Resins / Thermosets

Integration in petrochemical refineries

Biomass residues

Ethanol

ABE

Xyloonic acid

(HMF) > 2,5 FDA

Furfural

Pentoside Surfactants

Phenolics Activated lignins

Resins / Thermosets

Integration in petrochemical refineries
Integration of results in Conceptual design biorefinery plant

Basic design for integral lignocellulose biorefinery plant at an existing cellulose ethanol site: AB BCyL plant, Salamanca.

- Targeted outputs:
  - bio-ethanol,
  - chemicals, materials, CHP
- 5 EtOH based biorefinery types
- design in final stage

BCyL cellulose ethanol demo plant AB, Salamanca, capacity 5 Million L EtOH/yr; 70 ton straw per day. Operational since Oct. 2009.
Workshop program (1)

Buffet lunch 13:00-14:00 . Workshop 14:00-17:30

14:00-14:15 Welcome and Project overview - J.H. Reith (ECN, NL), Project Coordinator

14:15–14:40 Pretreatment and fractionation of biomass – Robert Bakker (WUR-FBR, NL)
Highlights R&D & benchmark pre-treatment and fractionation of lignocellulose via alkaline, organosolv, acid hydrolysis, and mild-acid pretreatment. Reference steam explosion.

14:40-15:15 Innovative thermochemical conversion of biomass & lignin – Paul de Wild (ECN, NL).
Highlights of R&D on conversion of biomass and lignin via hybrid thermochemical processing and (catalytic) pyrolysis.

15:15-15:40 Advanced biochemical conversion of pentoses – Frédéric Monot (IFP Energies nouvelles, FR)
Focus on Acetone-Butanol-Ethanol (ABE) fermentation of straw hemicellulose hydrolysates and xylonic acid fermentation from xylose.

15:40-16:00 Coffee / tea break
Workshop program (2)

16:00-16:25 Innovative chemical conversion – Boris Estrine (A-R-D, FR)
Highlights chemical processing of pentoses and lignin incl.: furfural synthesis, surfactants, lignin depolymerisation, synthesis of 2,5-FDCA. Results of application testing.

16:25-16:50 Transformation of Abengoa Bioenergy BCyL cellulose ethanol demonstration plant into an integrated biorefinery - Reyes Capote (ABNT, ES)
Conceptual design & economic evaluation of cellulose ethanol based lignocellulose biorefinery with sections for valorisation of pentoses and lignin. Comparison of 5 biorefinery concepts.

16:50-17:15 Techno-economic and environmental projections of biorefinery concepts- Katie Chong (Aston University)
Identification of the most promising biorefinery chains for the EU, based on energy efficiency, economic performance, environmental impacts (LCA) and socio-economics. MCDA tool.

17:15-17:30 Discussion and closing