

# EBTP 2011 plenary session

Advances in biochemical pathway  
Main demo plants in Europe

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# Disclaimer

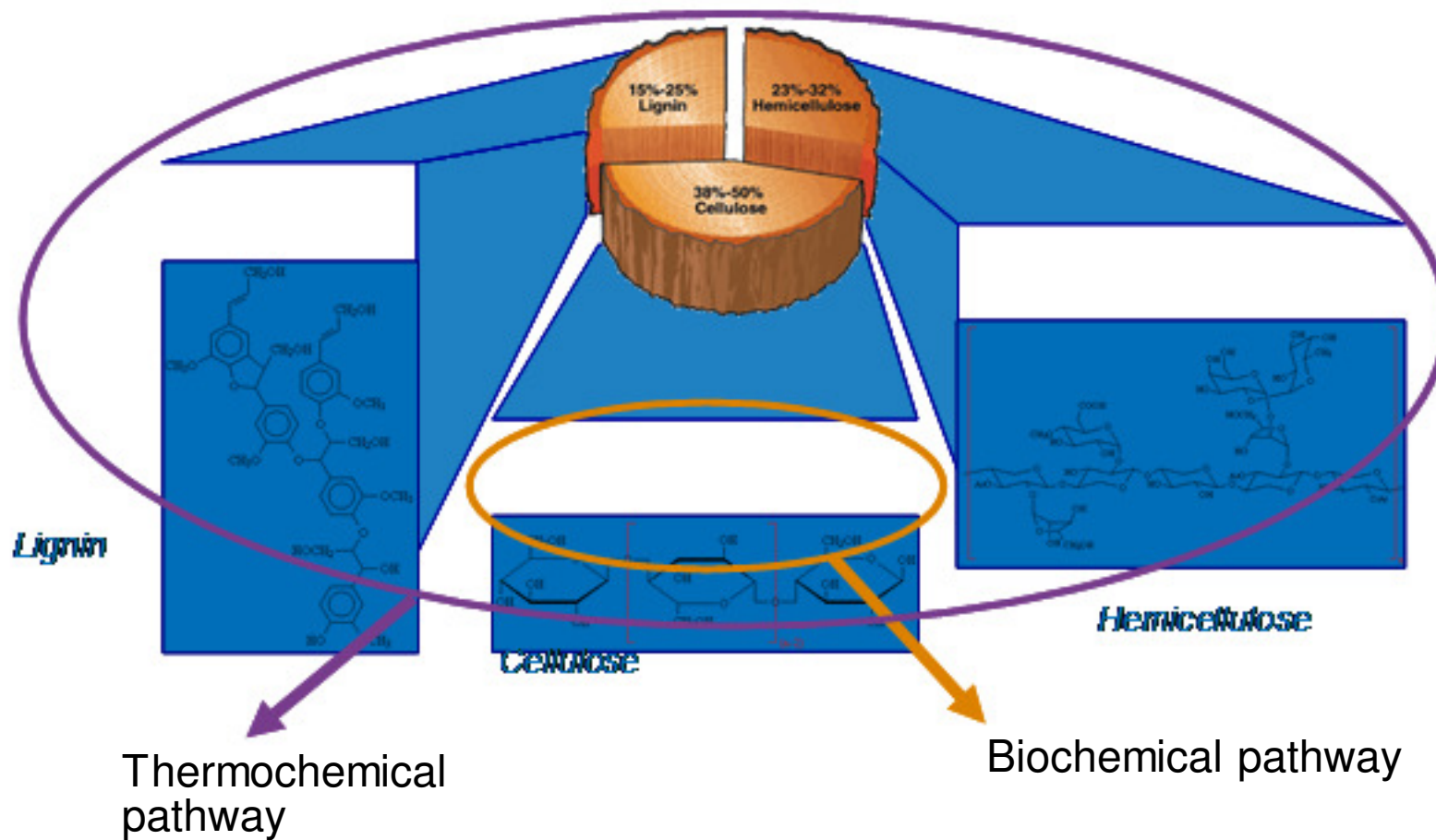
- The presenter has gathered most of the informations from public announcements and websites.
- Some deviations from factual situation may be presented.
- The presentation does not claim to be exhaustive.



## Biochemical Value Chains as defined in EIBI document

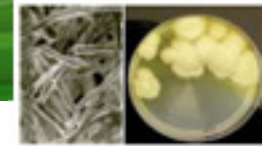
- Ethanol and other alcohols from ligno cellulose through chemical and biological pathway
- Hydrocarbons (fuels !) through biological and/or chemical synthesis from biomass containing carbohydrates
- *Bioenergy carriers produced by micro-organisms from CO<sub>2</sub> and sunlight*

# Ligno cellulose





# 2G Ethanol biologic generic process scheme



BACTERIA  
FUNGUS

ENZYMES

FERMENTABLE  
SUBSTRATES

YEASTS

WOODY AND AGRICULTURAL  
BY-PRODUCTS  
RESIDUES  
ENERGY CROPS



**PRETREATMENT**

PRETREATED  
BIOMASS

**ENZYMATIC or CHEMICAL  
HYDROLYSIS**

**DISTILLATION**

ETHANOL

**FERMENTATION**





# Main issues

- EtOH cost
  - enzymes
  - pre-treatment
  - C5 conversion
  - ...
- Feedstock availability
- Biorefinery integration
- G1 unit revamp
- Butanol ?



# Main EtOH G2 running demos (>1000t/y) in the EU

Plant Owner	Location	Input capacity (t/year)	Output capacity (t/year)
<b>Abengoa Bioenergy, Biocarburantes Castilla y Leon, Ebro Puleva</b>	Babilafuente, Salamanca, Spain	25 000 t/year (lignocellulosics, steam explosion, wheat/wheat straw, corn stover)	4 000
<b>Inbicon (Dong Energy)</b>	Kalundborg, Denmark	30 000 t/year (lignocellulosics, wheat straw)	4 300
<b><i>Chempolis Oy</i></b>	Oulu (Chempolis Oy R&D Center), Northern Finland	25 000 t/year (non-wood, non-food raw material)  formic acid pathway	running ?
<b>SEKAB Industrial Development AB (IDU Project)</b>	Örnsköldsvik, Sweden	lignocellulosics, flexible for wood chips and sugar-cane bagasse	4 500  running ?



# Abengoa facility

Start up september 2009  
The production process involves:  
Preparation of biomass  
Thermochemical pretreatment  
Enzymatic Hydrolysis  
and fermentation with enzymes  
and yeast  
Distillation to produce ethanol  
and a solid co-product







# Inbicon facility

Start up 2010  
Straw as feedstock  
Energy coproduction  
External production of  
enzymes

Inbicon Biomass Refinery at Kalundborg



# Main announced EtOH G2 demos (>1000t/y) in the EU

Plant Owner	Location	Input raw material	Output capacity (t/year)	Planned Start-up date
Biogasol (BornBio-Fuel 2)	Aakirkeby, Bornholm, Denmark	Lignocellulosics, various grasses, green waste, straw	4 000	2012
INEOS Bio	Seal Sands, Tees Valley, UK	Biodegradable household and commercial waste	24 000	2012
Mossi & Ghisolfi	Tortona, Piedmont, Italy	Lignocellulosics	20 000	2012
Procethol 2G	Pomacle, France	Lignocellulosics	8000	2015
SEKAB	Örnsköldsvik, Sweden	Lignocellulosics	47 500	2014
SEKAB	Örnsköldsvik, Sweden	Lignocellulosics	120 000	2016
Sud Chemie	Straubing, Germany	Agriculture waste, wheat straw	2 000	2011

# Main EtOH G2 running demos (>1000t/y) North America

Plant Owner	Location	Input capacity (t/year)	Output capacity (t/year)
IOGEN Corporation	Ottawa, Ontario, Canada	30 t/d (lignocellulosics, wheat, barley and oat straw)	1 600
BP (Jennings Demo Facility)	Jennings, LA, US	Lignocellulosics, sugarcane bagasse, switchgrass, wood products, .	4 180
KL Energy Corporation	Upton, Wyoming, US	33 500 t/y (lignocellulosics, wood waste, waste pulp, cardboard, paper)	4 500
Western Biomass Energy	Upton, Wyoming, US	Wood waste, pine chips	4 000

# Main EtOH G2 demo units outside EU

## • Running

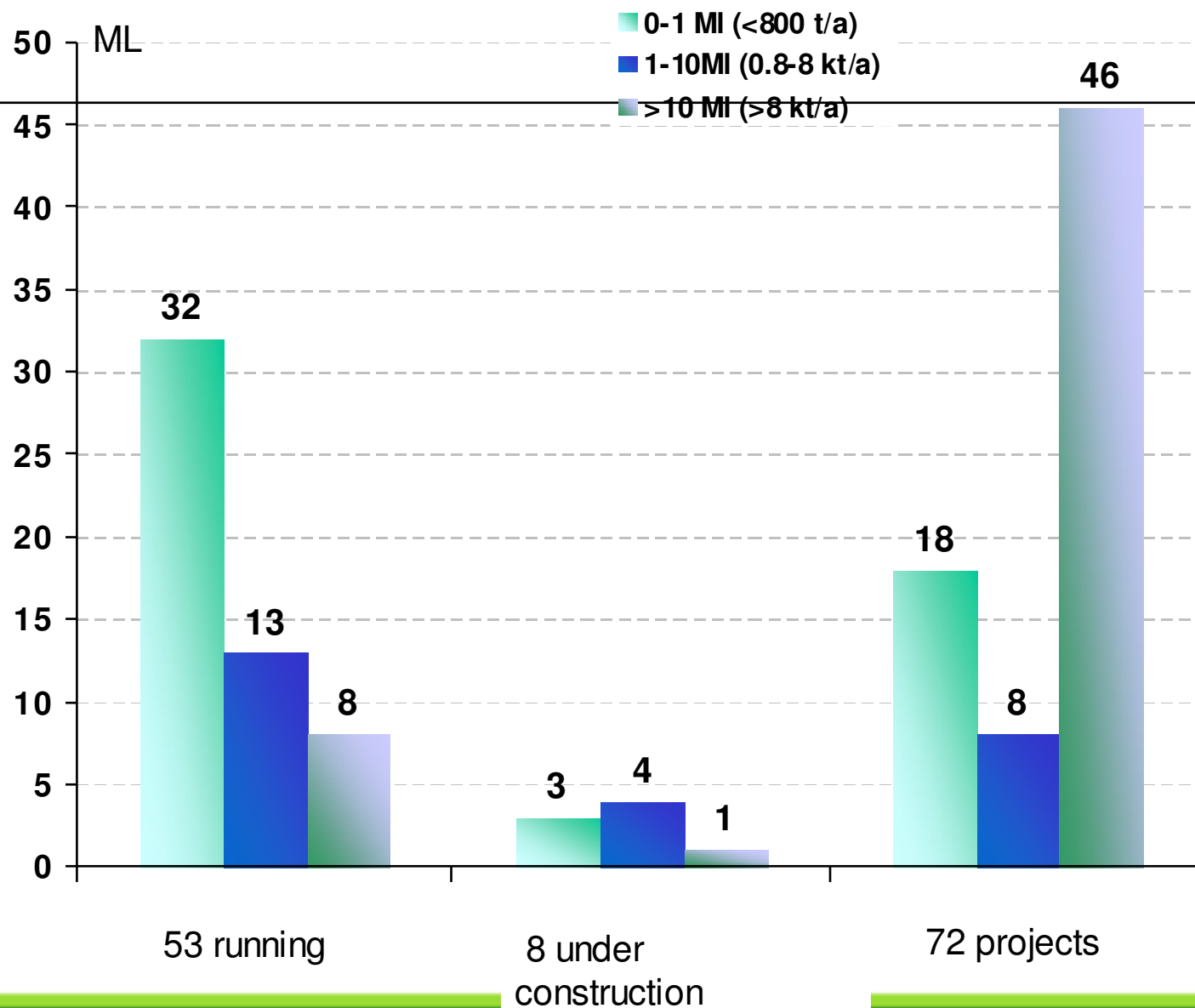
- BP/Verenium j-v – USA – 4180 t/y
- DuPont Danisco/UT-Genera Energy – USA – 1000 t/y
- KL Energy – USA – 4500 t/y
- Mascoma – USA – 1000 t/y
- Western Biomass Energy – USA – 4000 t/y
- Iogen – Canada – 1600 t/y
- Jilin Jiuxin Industry group – China – 30000 t/y
- Beijing Tiandi Riyue Biomass technology – China – 8000 t/y
- Chinese Academy of Agricultural Engineering – China – 4000 t/y
- Henan fuel ethanol – China – 8000 t/y (2 units)
- CNPC – China – 3000 t/y (2 units)
- Shandong Longlive Bioenergy – China – 40000 t/y
- Shandong Wande – China – 8000 t/y
- Shandong Xueling Starch – China – 3000 t/y
- ZTE Energy – China – 30000 t/y
- Bioethanol – Japan – 1000 t/y
- Kirin Brewery – Japan – 8000 t/y
- Kirov Biochemical – Russia – 15000 t/y
- Thai Roong Ruang Energy – Thailand – 25000 t/y

## • Announced

- Abengoa Bioenergy Biomass of Kansas – USA – 75000 t/y
- ADM - USA - 3000 t/y
- Allied Energy Services - USA - 60000 t/y
- BlueFire Ethanol - USA – 57000 t/y
- BP – USA – 100000 t/y
- Celunol - USA – 60000 t/y
- Colusa Biomass Energy – USA – 30000 t/y
- Fiberright – USA – 18000 t/y
- GulfEthanol – USA – 86000 t/y
- ICM – USA – 150000 t/y
- INEOS Bio - USA – 24000 t/y
- Mascoma – USA – 15000 t/y
- Novahol – USA – 75000 t/y
- Poet – USA – 93400 t/y
- University of Florida – USA – 5500 t/y
- IOGEN – Canada – 68000 t/y
- Bio-Dynamic - China - 200000 t/y
- China Agri-Industries – China – 10000 t/y
- Shandong Wande – China – 30000 t/y
- Bioethanol – Japan – Planned expansion to 3000 t/y
- Thai Roong Ruang Energy – Thailand – 25000 t/y
- Chempolis – Vietnam – 48000 t/y
- Colbiocel – Colombia – 90000 t/y
- KL Energy – Brazil – 3700 t/y
- Petrobras – Brazil – 11000 t/y



# Projects statistics





# Potential EtOH G2 announced capacities





## Other alcohols /new fermentation pathways

- Eastern siberia – biobutanol – 30000t/y
- Lanzatech - EtOH waste gas fermentation – NZ -1000t/y
- Gevo – butanol – 3000t/y (project of revamp of Ethanol plant)

No demo running >1000t/y

- Coskata – cellulosic EtOH fermentation of syngas
- Cobalt – butanol fermentation from sugar/cellulose
- Butamax – butanol from sugar
- Zechem – hybrid process



# Carbohydrates (sugar) to HC

- LS9 – fermentation pathway from sugar
- Amyris - fermentation pathway from sugar
- Virent - chemical pathway from sugar



# Conclusions

- Many announced projects all over the world
- Still some technical and economic issues for EtOH G2
- Other pathways developing
- Biorefineries ?