biorefine-2G

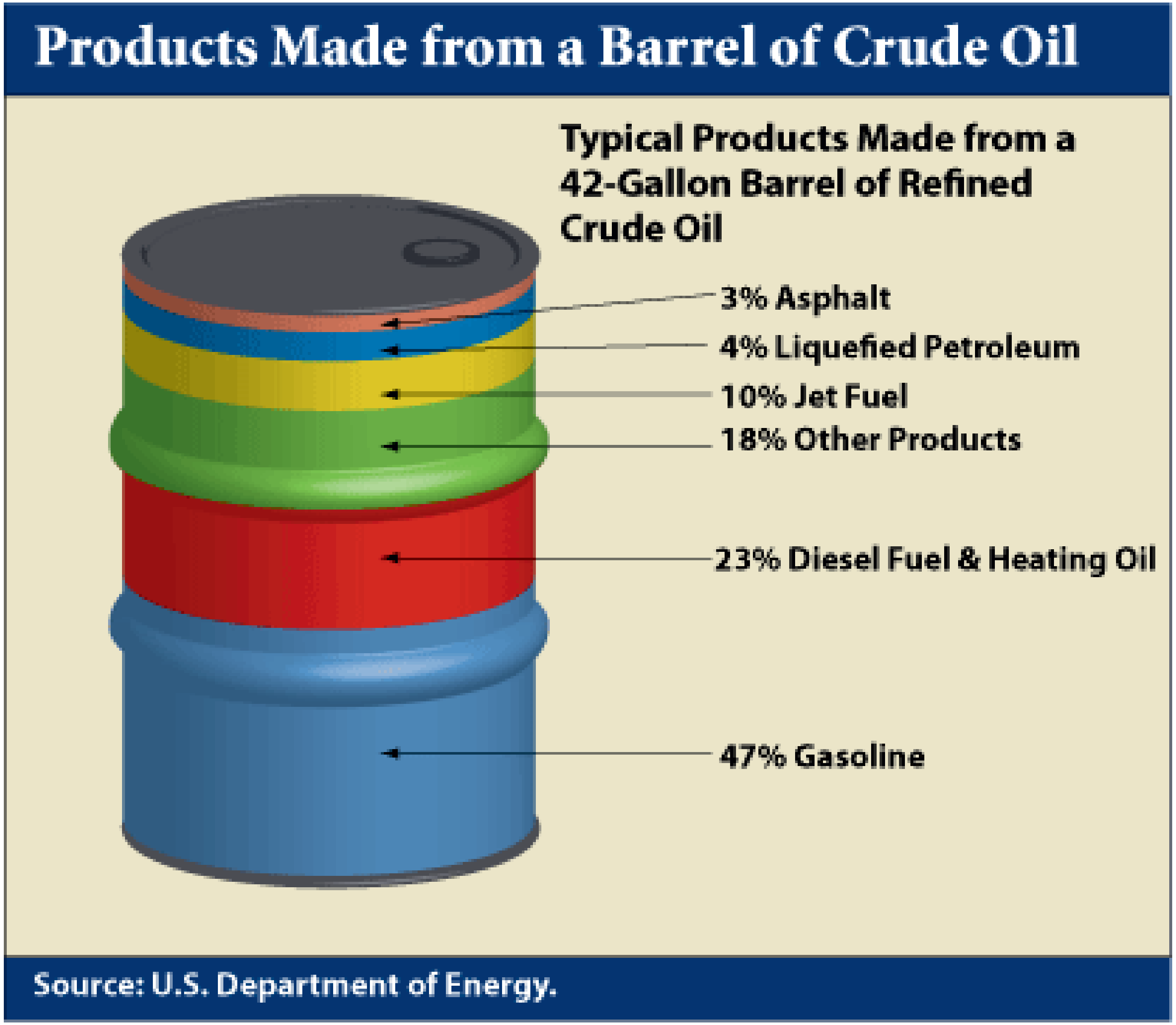
Utilisation of Waste Streams for Bioproducts and Bioenergy

http://www.biorefine2g.eu

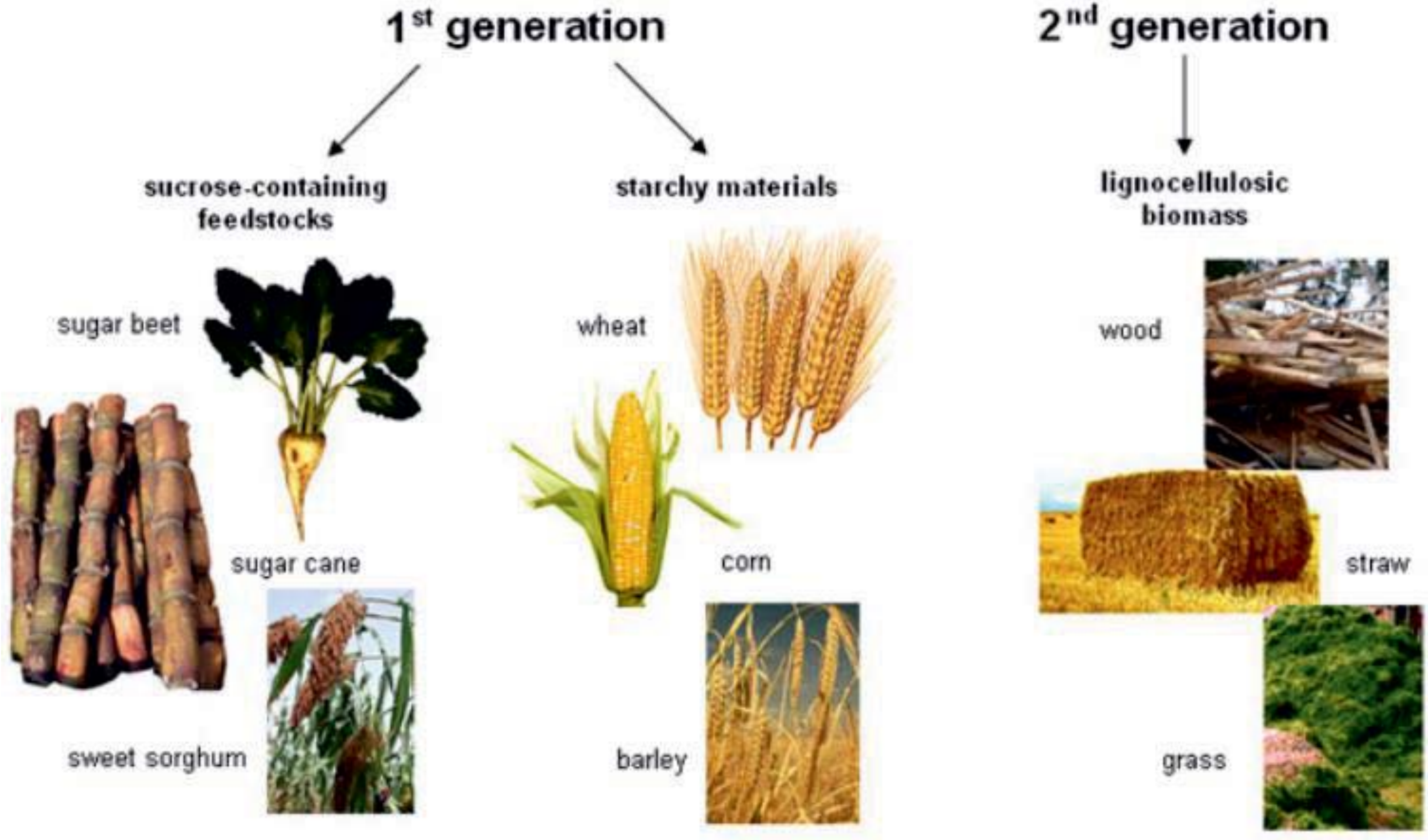
25th Edition
EUBCE 2017
European Biomass Conference & Exhibition
12-15 June | Stockholm Sweden
Stockholmsmässan

This project is co-funded by the European Union within the 7th Frame Programme. Grant Agreement n°613771.
The sole responsibility of this publication lies with the author. The European Union is not responsible for any use that may be made of the information contained therein.

Replacing the oil barrel



1st and 2nd generation feedstocks



1st and 2nd generation feedstocks

- C6 and C5 sugars
- lignin
- inhibitors

Reduction of GHG emissions

FUEL	Gasoline	Bioethanol 1G	Bioethanol 1G	Bioethanol 1G	Bioethanol 1G	Bioethanol 2G	Bioethanol 2G**
FEEDSTOCK	Oil	Crop/Corn	Crop/Corn	Crop/Corn	Cane	Agricultural residues	Agricultural residues
ENERGY SOURCE	Fossil	Fossil	Gas	Biomass	Biomass	Biomass	Biomass
EMISSIONS	100%	81%	72%	48%	22%	14%	0%*

* IEA future estimates, based on a review of recent studies
(Source: acc. to Wang et al, Env. Res. Letters, Vol. 2, 024001, May 22, 2007)
** optimized next generation plants

Koltermann et al (2014) “Cellulosic Ethanol from Agricultural Residues – An Advanced Biofuel and Biobased Chemical Platform”. *JSM Biotechnol Bioeng* 2(1): 1024.

Commercialized yeast fermentation processes

Borodina & Nielsen (2014) "Advances in metabolic engineering of yeast *Saccharomyces cerevisiae* for production of chemicals". *Biotechnol J* 9(5):609-20.

BioREFINE-2G

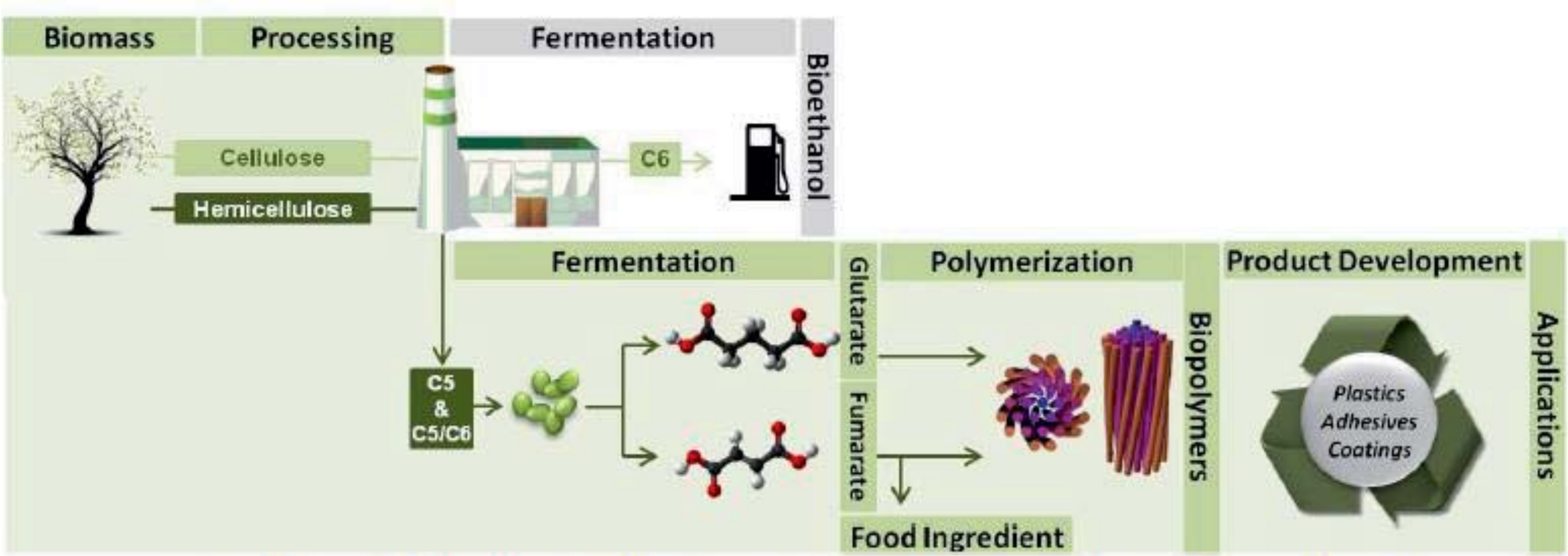
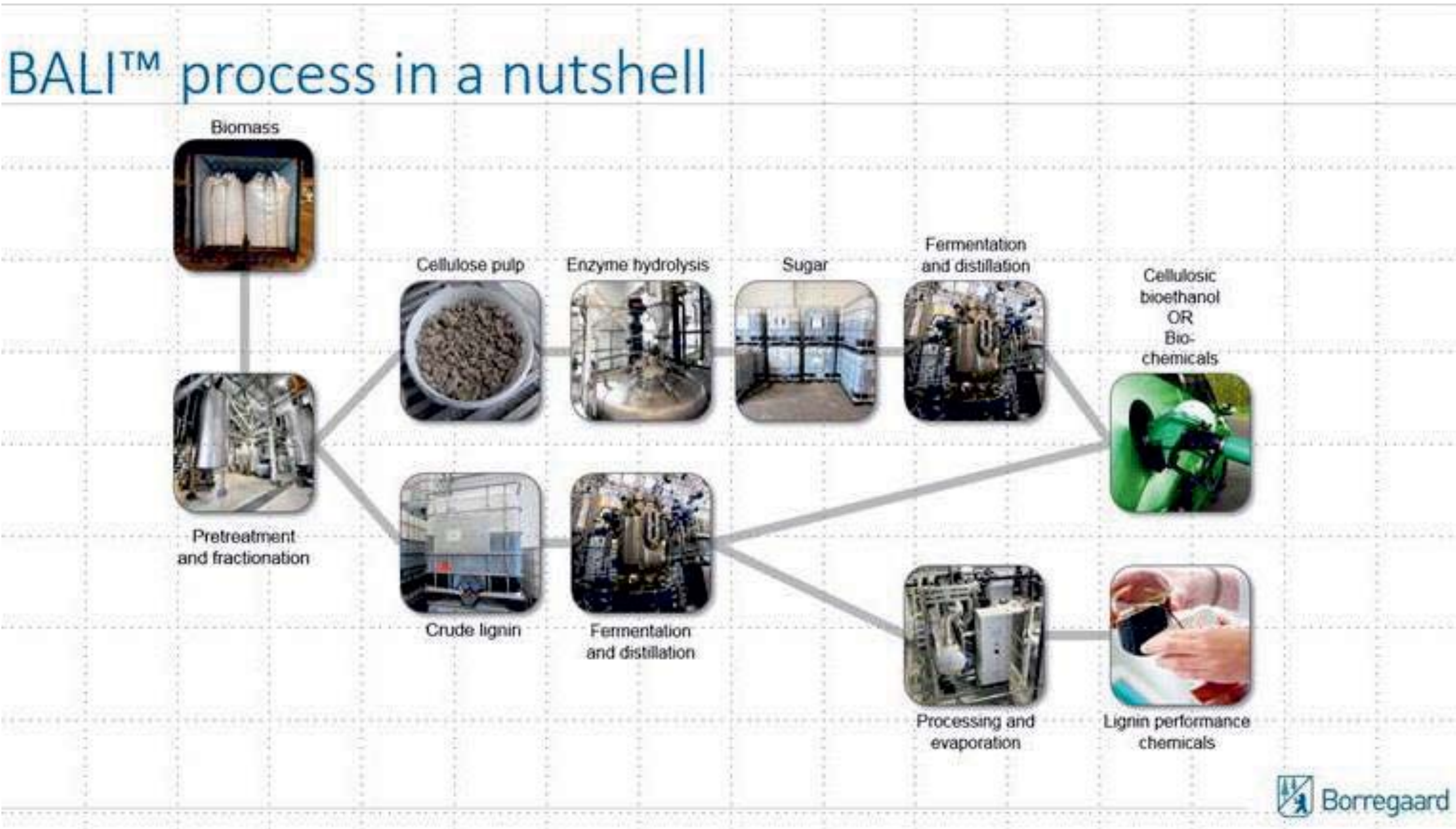
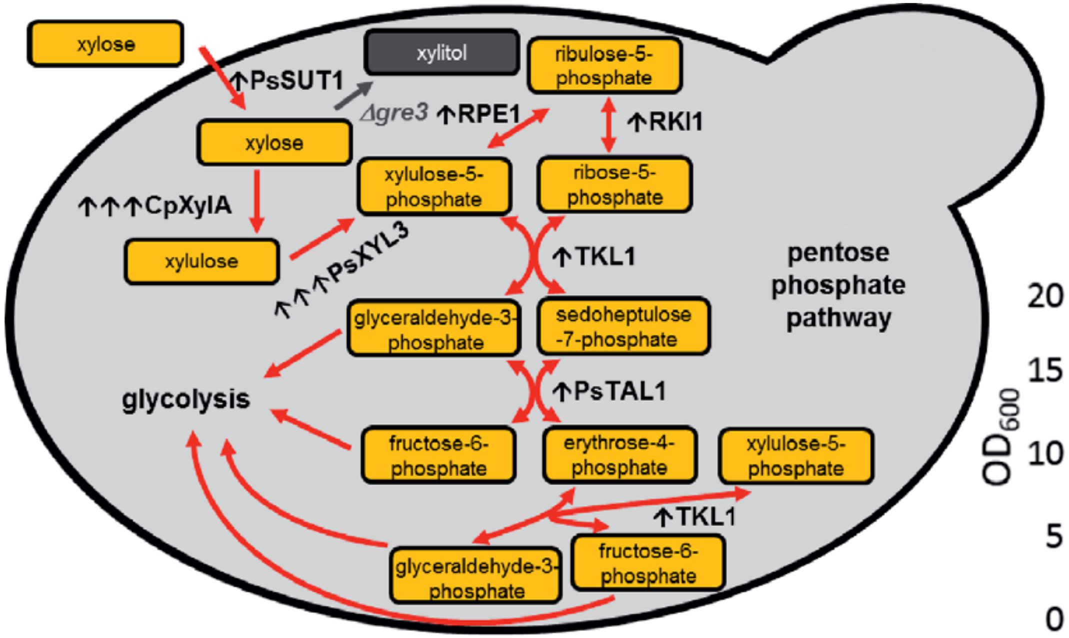


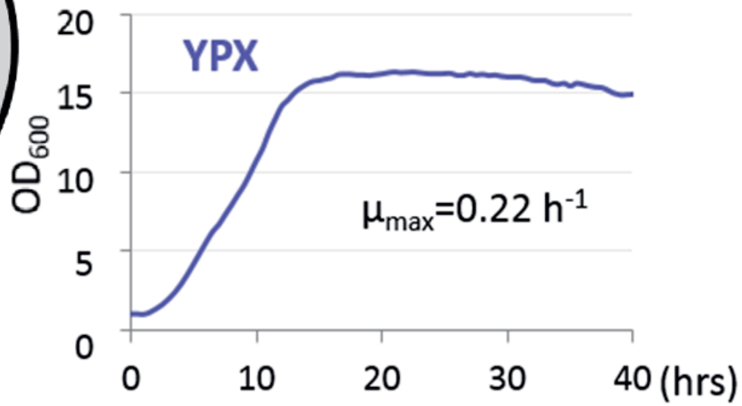
Figure 1: Schematic outline of the BioREFINE-2G concept. The main focus areas included with green background.

Biorefinery workflow



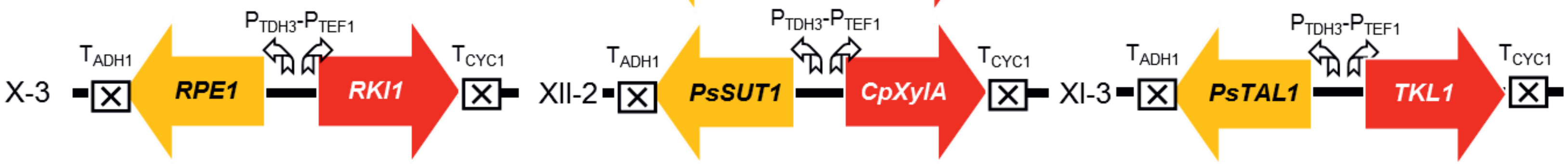
Industrial yeast engineered for xylose utilization





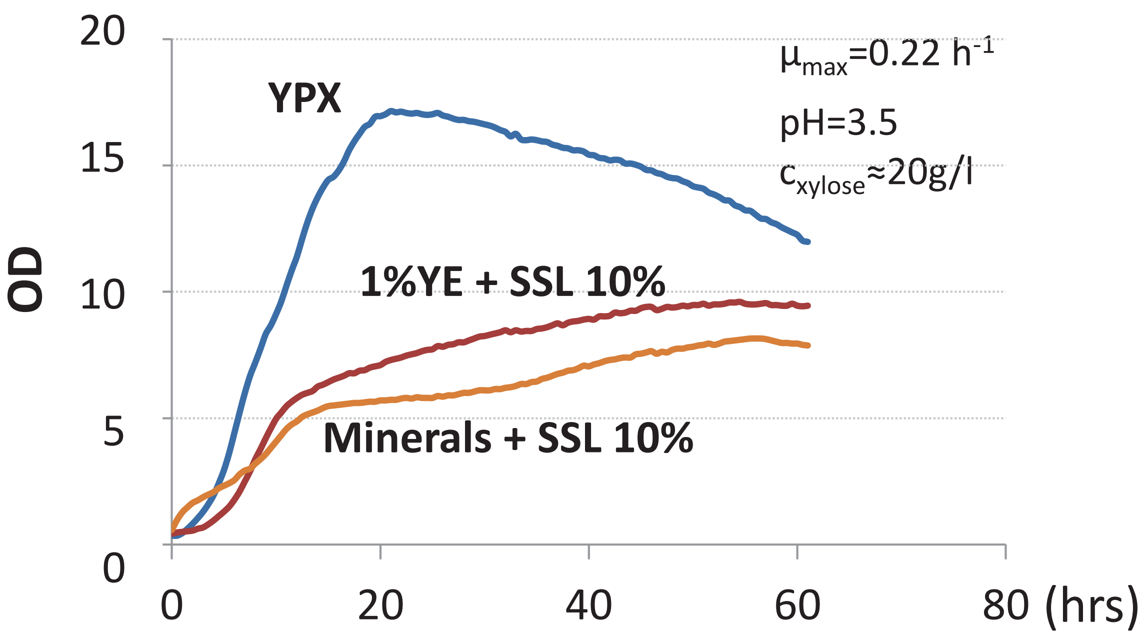
Cas9-mediated EasyClone-MarkerFree vector insertions & *GRE3* knock-out

6 copies of ***XylA*** gene



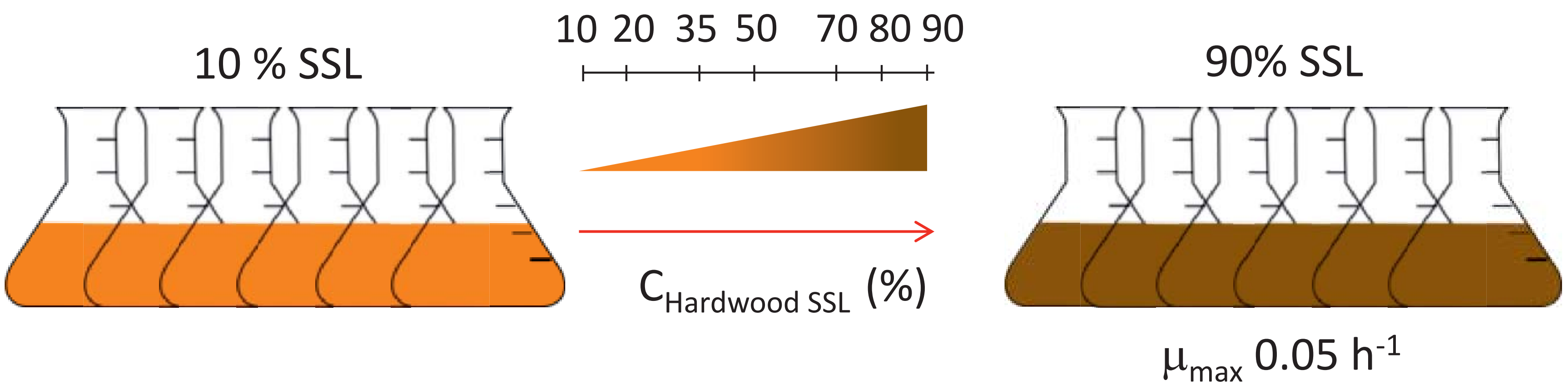
Stovicek et al. “EasyClone 2.0: Expanded toolkit of integrative vectors for stable gene expression in industrial *S. cerevisiae* strains“. *J Ind Microbiol Biotechnol*, 1:13.

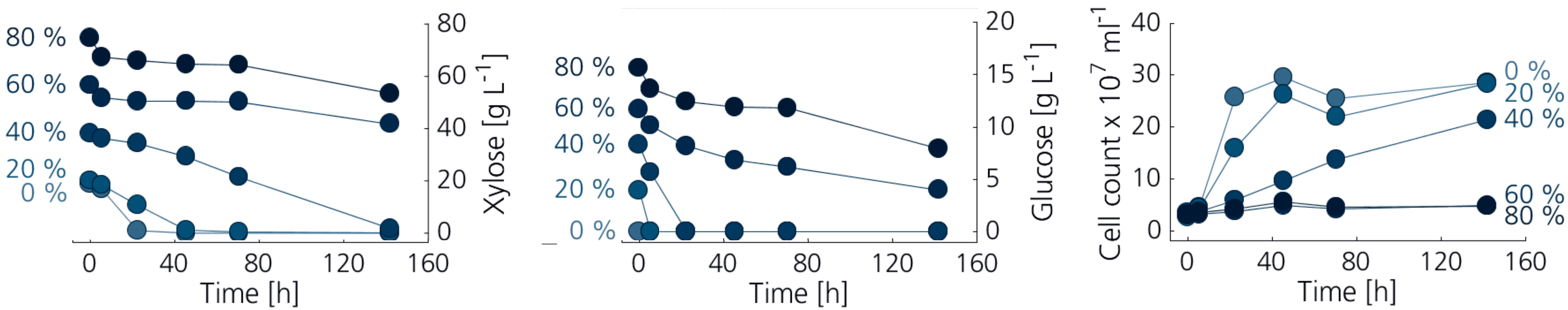
Adaptive Laboratory Evolution for strain performance in Hardwood SSL



- No growth in >20% Hardwood SSL at low pH

Adaptive Laboratory Evolution for strain performance in hardwood SSL





Downstream Processing

BIOREFINE-2G

Polymer-Grade Fumaric Acid from Fermented SSL

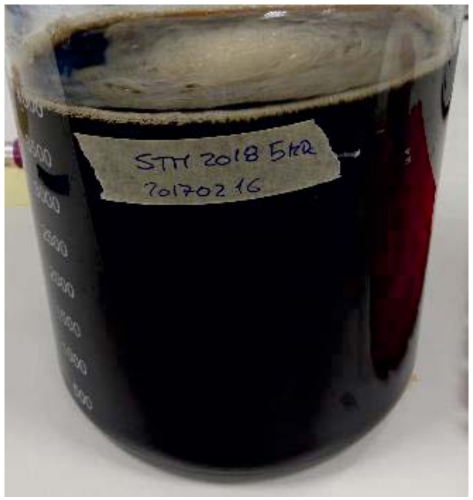
Fermentation broth:
- Fumaric acid
- Lignosulphonates and other SSL impurities
- Fermentation by-products

→

Multi-stage process:
- Minimization of raw material usage
- Minimization of side-streams

→

Fumaric acid:
- Grade suitable for polymerisation



↑

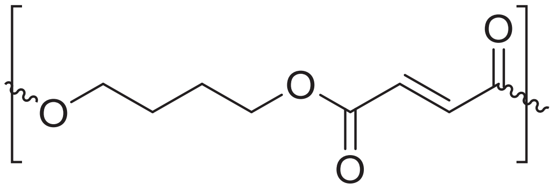
pH shift	Temperature shift
Recovery by precipitation	
Activated carbon polishing	
Final recovery by precipitation	

biotrend
Inovação e engenharia em biotecnologia

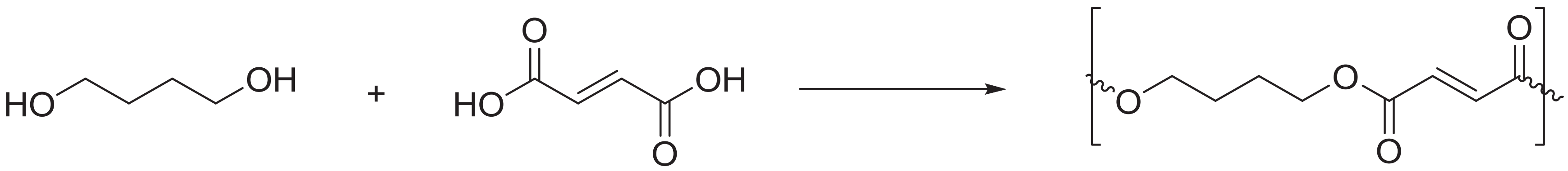
Fermentation **2017**, *3*(2), 13; doi:10.3390/fermentation3020013

Novel polymers - fumaric

Target compound

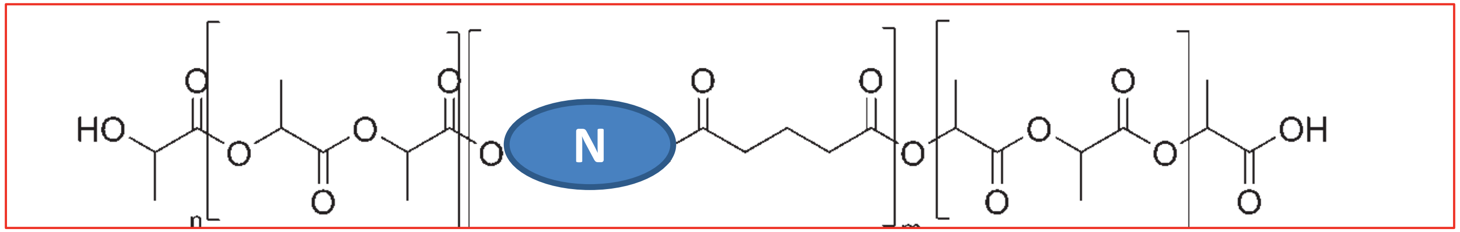


C_4-fumaric polyesters

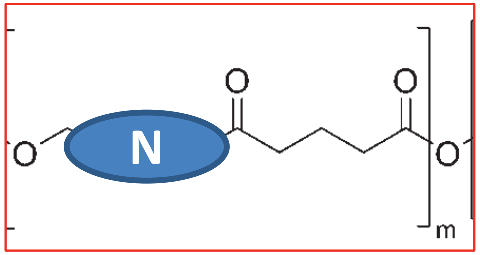


1,4-butanediol **fumaric acid** **C_4-fumaric polyesters**

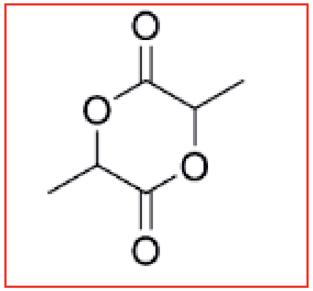
Novel polymers - glutaric



PLA-Glutaric Copolymers



+



Glutaric Copolymers

Lactide

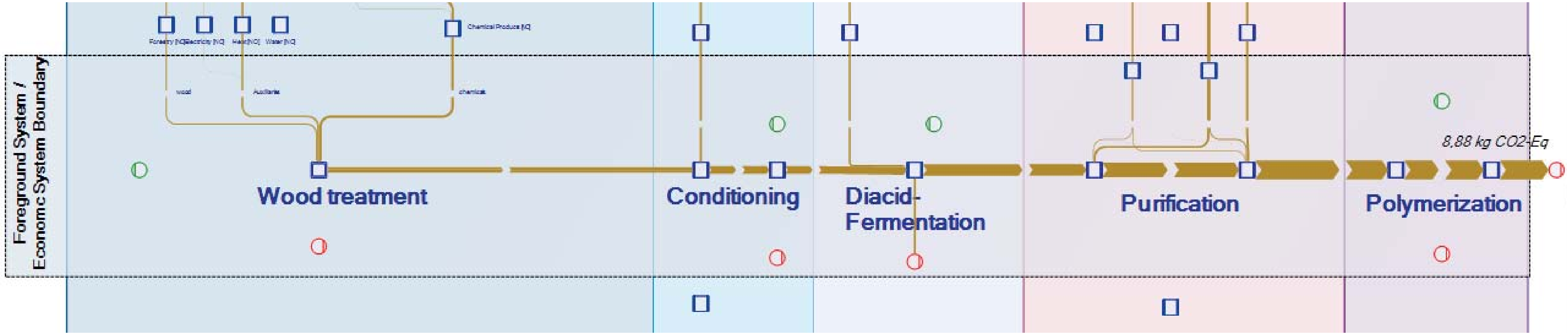
Novel polymers

• Polyurethane-derived products

Waterborne Polyurethane Dispersion (PUDs)

-Coatings and adhesives that use water as the primary solvent.
- Ecological material.
-Wide adhesion range and excellent stability values.
- Preparation of crystalline PUDs that adhere by melting.
- Application in flooring, fabric, leather, metal, wood, automotive…

Life Cycle Analysis



+Good social performance on wood treatment and fermentation plant

+Requires fewer fossil resources than conventional synthesis

+Use of waste streams prevents conflicts with food and feed production

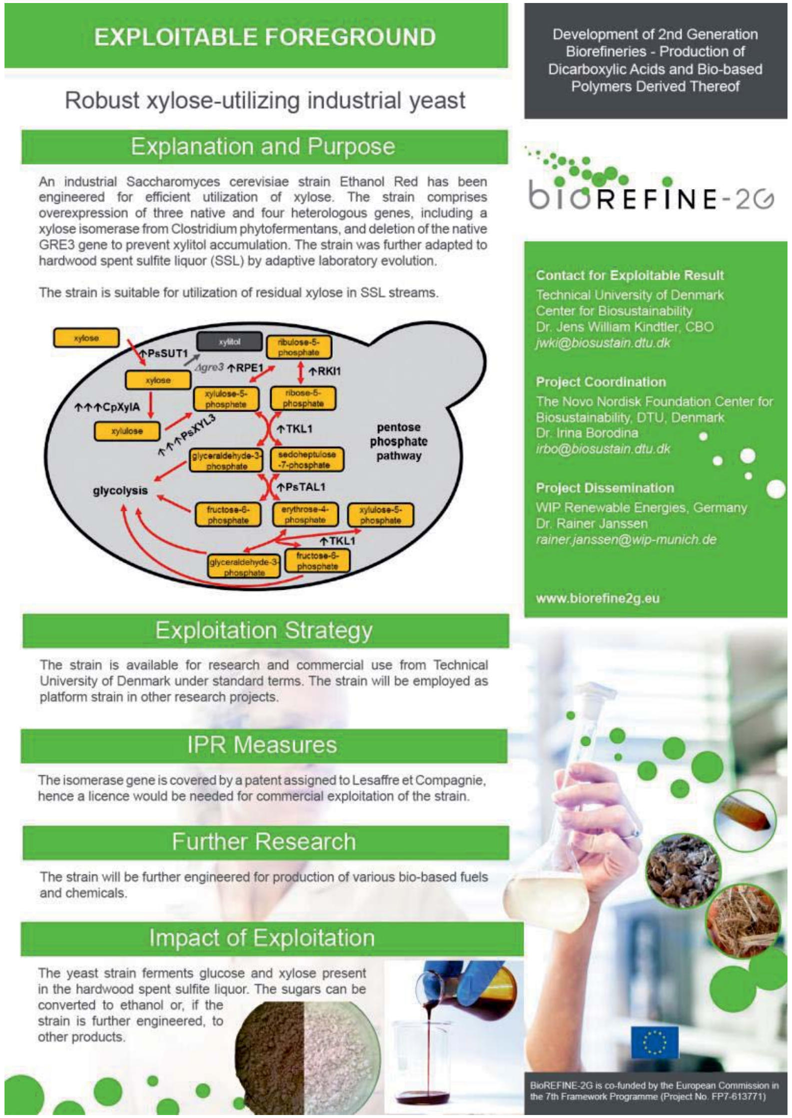
- Cost competitiveness requires high yields
- Conditioning of bio waste streams requires additional efforts
- Agriculture related impacts (land use, eutriphication...) higher than conventional synthesis

ifu hamburg
material flows and software.

BioREFINE-2G Exploitation Flyers

1) DTU: Robust xylose-utilizing industrial yeast
2) DTU: Genetic engineering toolbox for manipulation of industrial yeast strains
3) BIOTREND: Fumaric acid purification process from fermented lignocellulosic wastes
4) AIMPLAS: Novel polymerization methods by reactive extrusion to obtain new PLA-Copolymers with enhanced properties
5) ECOPOL: Polyesther synthesis in batch and reactive extrusion
6) IFU: Integrated Life-Cycle-Sustainability-Assessment

WIP



EXPLOITABLE FOREGROUND

Robust xylose-utilizing industrial yeast

Explanation and Purpose

An industrial Saccharomyces cerevisiae strain Ethanol Red has been engineered for efficient utilization of xylose. The strain comprises overexpression of three native and four heterologous genes, including a xylose isomerase from Clostridium phytofermentans, and deletion of the native GRE3 gene to prevent xylitol accumulation. The strain was further adapted to hardwood spent sulfite liquor (SSL) by adaptive laboratory evolution.

The strain is suitable for utilization of residual xylose in SSL streams.

Exploitation Strategy

The strain is available for research and commercial use from Technical University of Denmark under standard terms. The strain will be employed as platform strain in other research projects.

IPR Measures

The isomerase gene is covered by a patent assigned to Lesaffre et Compagnie, hence a licence would be needed for commercial exploitation of the strain.

Further Research

The strain will be further engineered for production of various bio-based fuels and chemicals.

Impact of Exploitation

The yeast strain ferments glucose and xylose present in the hardwood spent sulfite liquor. The sugars can be converted to ethanol or, if the strain is further engineered, to other products.

Development of 2nd Generation Biorefineries - Production of Dicarboxylic Acids and Bio-based Polymers Derived Thereof

BIOREFINE-2G

Contact for Exploitable Result
Technical University of Denmark
Center for Biosustainability
Dr. Jens William Kindtler, CBO
jwki@biosustain.dtu.dk

Project Coordination
The Novo Nordisk Foundation Center for Biosustainability, DTU, Denmark
Dr. Irina Borodina
irbo@biosustain.dtu.dk

Project Dissemination
WIP Renewable Energies, Germany
Dr. Rainer Janssen
rainer.janssen@wip-munich.de

www.biorefine2g.eu

BioREFINE-2G is co-funded by the European Commission in the 7th Framework Programme (Project No. FP7-613771)

www.biorefine2g.eu

BIOREFINE-2G

Development of 2nd Generation Biorefineries
Production of Dicarboxylic Acids and Bio-based Polymers Derived Thereof

Home | About BioREFINE-2G | Project Partners | News and Events | Publications & Reports | Contacts | Intranet Restricted access | Links

Project activities

- Strain development
- Process Development
- Polymerization Methods
- Scale up, Product Development and Final Validation
- Life Cycle Analysis
- Dissemination and Exploitation

Home

Welcome to BioREFINE-2G

The existing 2nd generation biorefineries utilize less than 20% of the biomass feedstock for ethanol production, and major side-streams are produced such as pentose and lignin waste streams, that are respectively used for biogas and energy production.
Converting the carbon from these waste streams into added-value products would increase the otherwise low profitability and improve the environmental benefits of the biorefineries. The suggested project **BioREFINE-2G** aims at developing commercially attractive processes for efficient conversion of pentose-rich side-streams from biorefineries into dicarboxylic acids, which can

News & Events

New BioREFINE-2G Flyer available (October 2016)

7th BioREFINE-2G Consortium Meeting

Munich, Germany
15-16 September 2016

6th BioREFINE-2G Consortium Meeting

Thank you for your attention !

Irina Borodina
irbo@biosustain.dtu.dk

This project is co-funded by the European Union within the 7th Frame Programme. Grant Agreement n°613771.