Border-Crossing Biorefining Value Chains

Options for German-Italian Cooperation

25th September 2014
IFIB 2014
Genova, Italy

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*K*ADIB offers expertise in Industrial Bioeconomy

We strive to position profitable

Chemical and Energy Value Chains

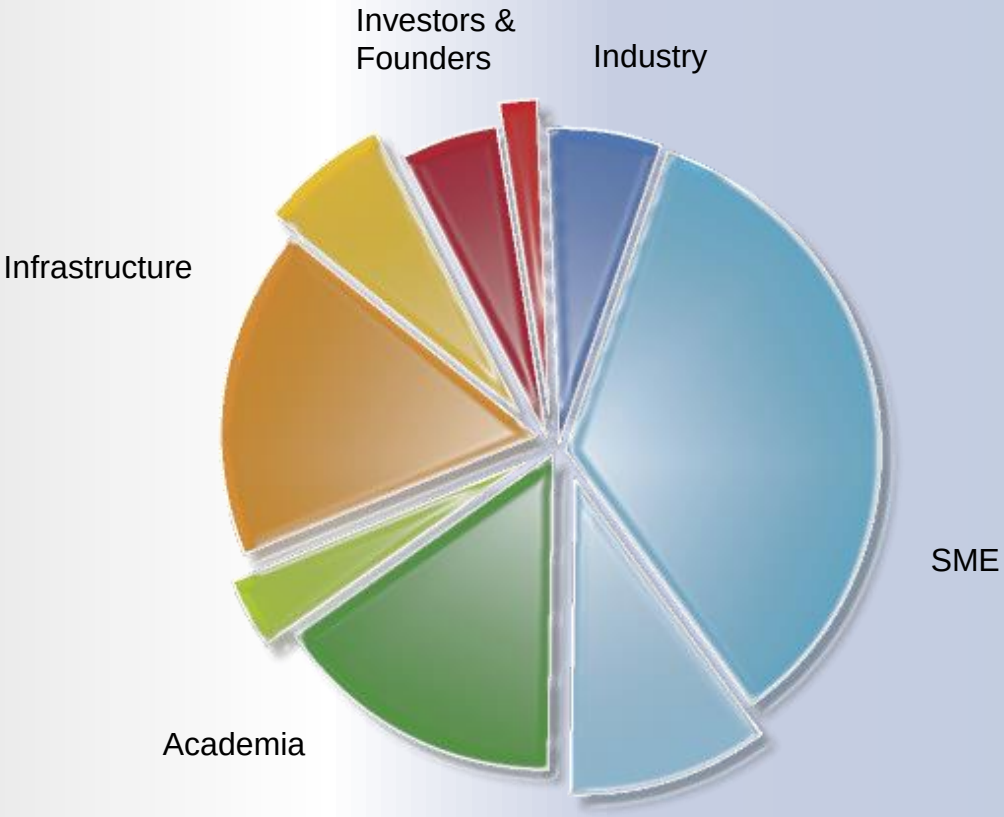
sustainably in the

Political, Economical, Societal, Technological, Legislative *and* ***Ecological***

environment and conditions.

www.kadib.de

CLIB2021 links Bioeconomy Stakeholders



highlighted segments show international members

100 Members

40 % SME

30 % international

60 bn EUR Sales

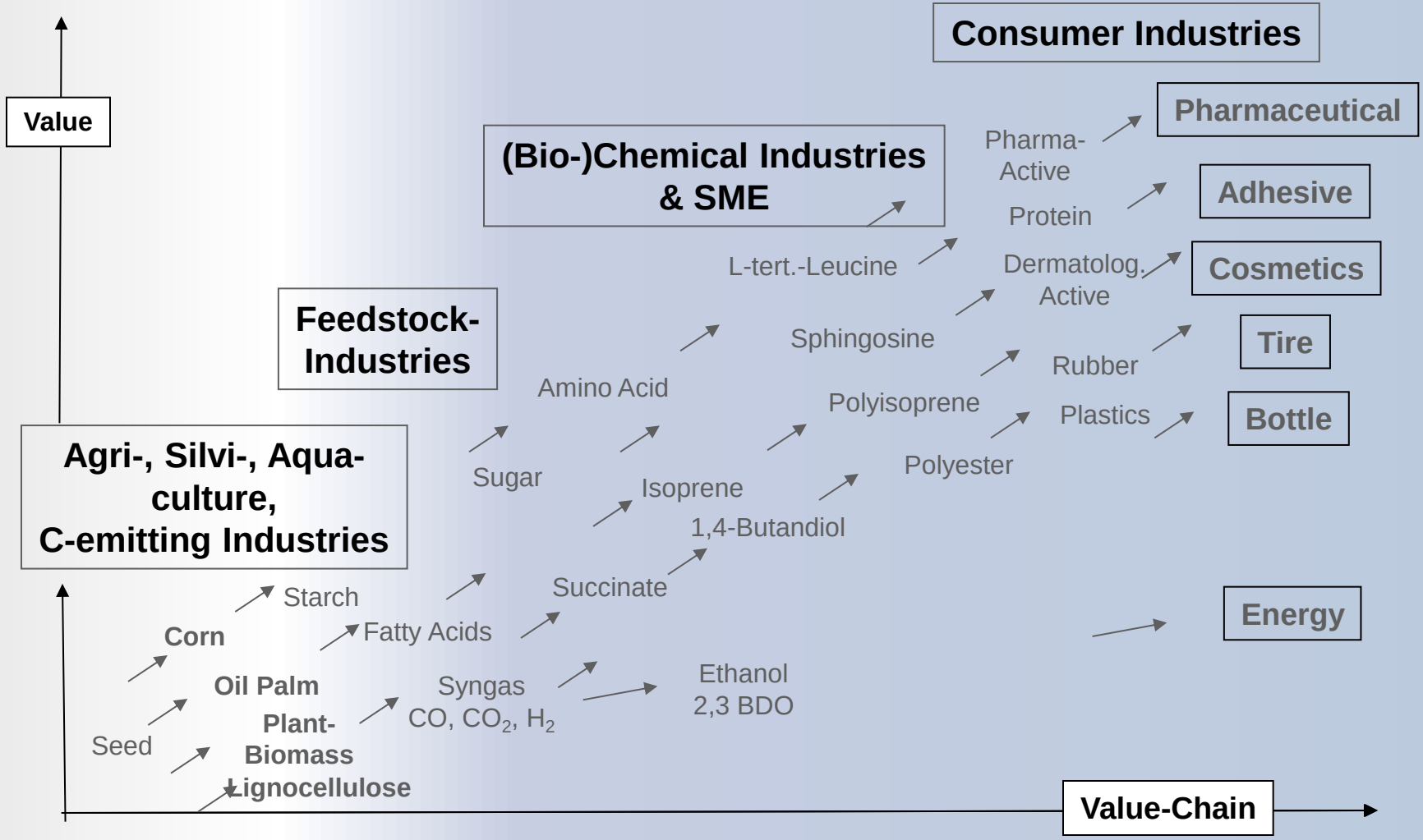
200 mio EUR Bio-R&D Budget

Funded by members and supported by:

Federal Ministry of Education and Research

Ministry of Innovation, Science and Research of the German State of North Rhine-Westphalia

Bioeconomy Value Chains affect diverse Industrial Sectors



Competitive Factors offer Cooperation Options

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Societal Drivers	Industrial Drivers	Competitive Factors
Sustainability economical ecological societal	Innovation	Product Performance
		Production Cost
	Flexibility	Feedstock Availability
	Cost	Regional Infrastructure

Process & Product Performance by Science & Industry Cooperation

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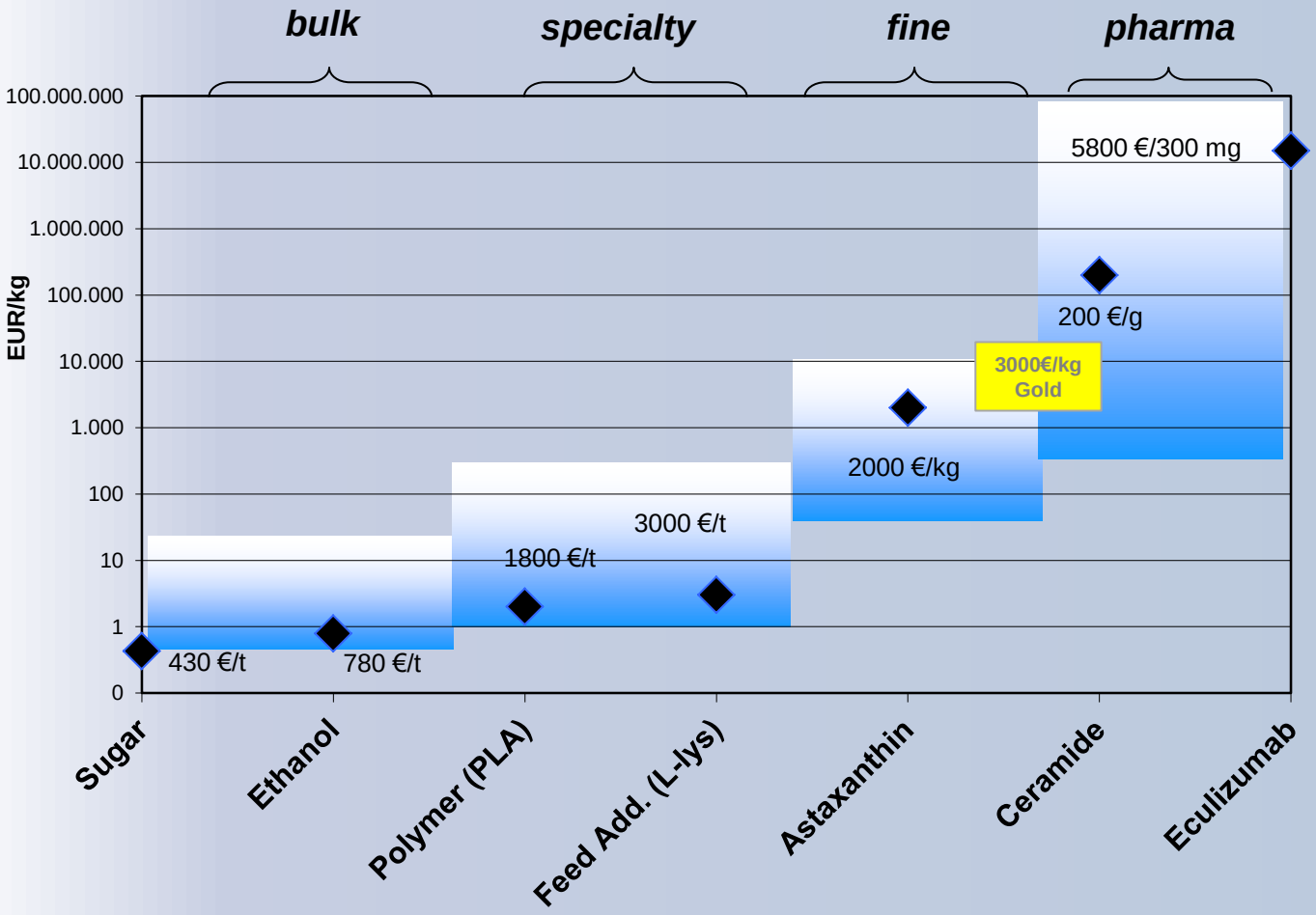
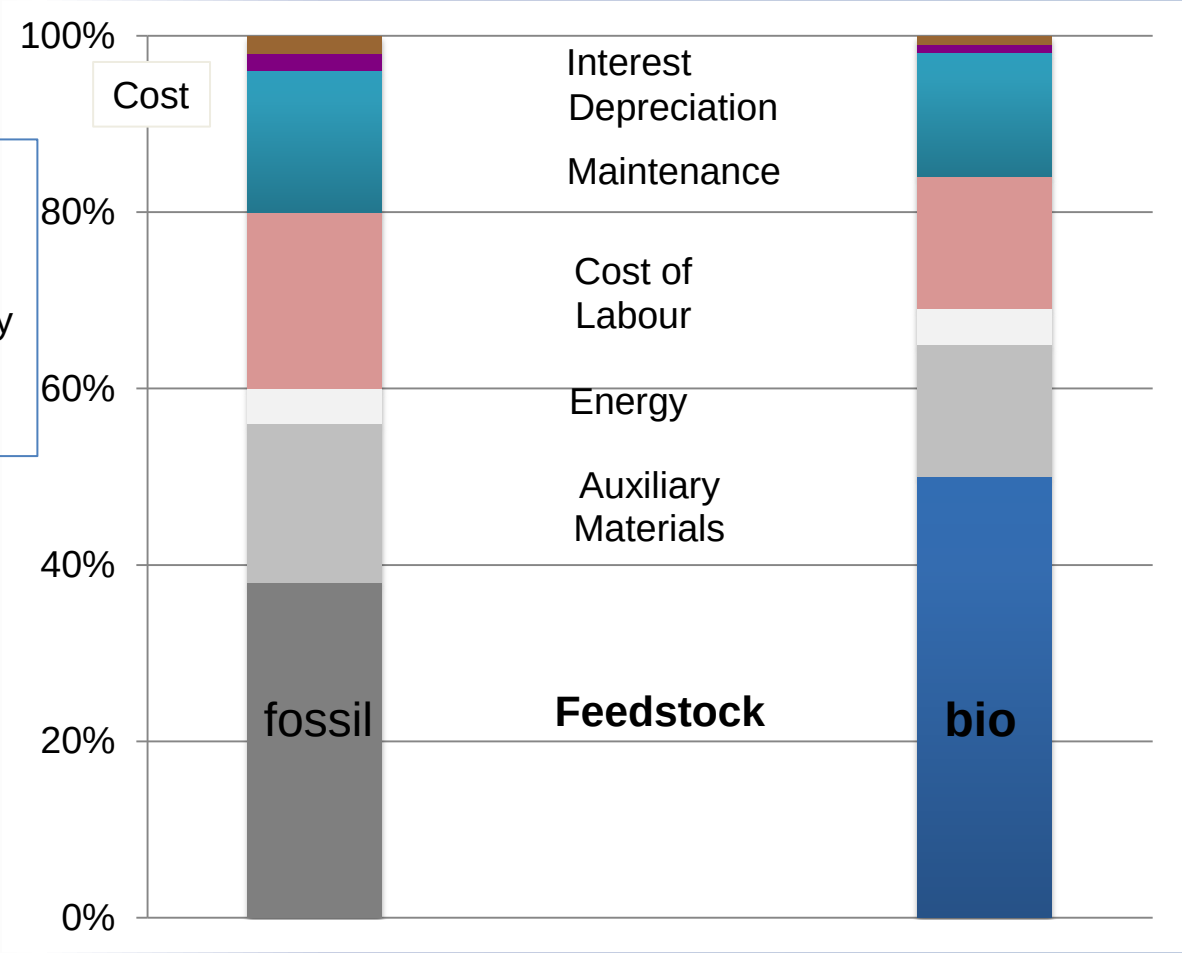
- **Performance**
- Cost
- RM Availability
- Infrastructure

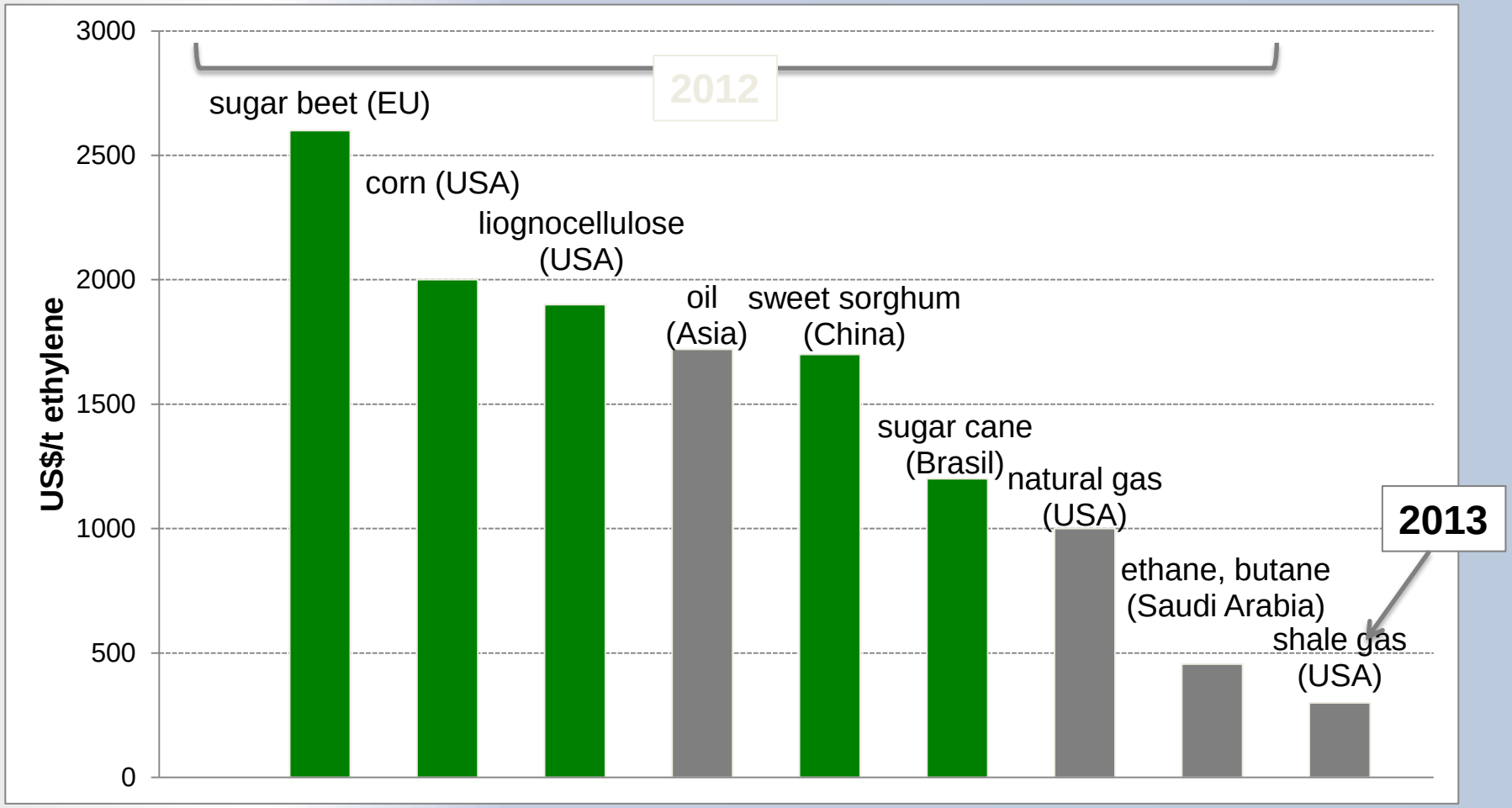


In Bulk-Production
Cost of Feedstock is Key

- Performance
- **Cost**
- RM Availability
- Infrastructure



Reducing Cost of Bio-Feedstock needs Science, Industry, Infrastructure



MIT Technical Review; Kevin Bullis;Shale gas will fuel a US manufacturing boom; 9.1.2013

Consumer-oriented Markets willing to Pay Premium

Tetra Pak signs Bio-LDPE supply deal in Brazil
JUNE 26, 2013

Tetra Pak has signed a supply agreement with Braskem for its **sugarcane-based low-density polyethylene (LDPE)**, which will be used in all Tetra Pak packages produced in Brazil. Tetra Pak said about 13bn biobased packages will be produced in Brazil.

Braskem said the LDPE made from sugarcane has the same technical properties as LDPE made from fossil sources. Braskem biopolymers are marketed under the trademark *I´m green*™. The company announced last month that it is planning to expand its 200 ktpy bio-PE production in Rio Grande do Sul with a 30 ktpy line producing sugarcane-based LDPE.

Fossil Feedstock Markets & biobased Bulk Chemicals interfere

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Carbon-Source	***Fossil***	***Bio***
Methane	⬆	
Ethylene	⬆	
Propylene	⇩	⬆ 2-Butene + Ethylene
Funct. C_3 Molecules		⬆ 1,3 propandiole
Butadiene	⇩	⬆ ω-amino lauric acid
Funct. C_4 Molecules		⬆ succinic acid
Aromatics	⇩	⬆ (lignin)

23.5.2013, CLIB Forum on Shalegas; K.Rübbert; Dechema (modified)

Big Chemical Industries step into Biochemicals

Succinity produces first commercial quantities of biobased succinic acid
Düsseldorf, March 3, 2014

Succinity GmbH, the joint venture between Corbion Purac and BASF for the production and commercialization of biobased succinic acid, has announced the successful start-up of its first commercial production facility. The plant, located at the Corbion Purac site in Montmeló, Spain, has an annual capacity of 10,000 metric tons...

BASF to build bio-BDO facility
MAY 14, 2013

BASF announced that it plans to begin production of bio-BDO using Genomatica's one-step fermentation process, which uses sugar for feedstock. "Currently we anticipate a plant capacity of 50,000 tons/year.....

CLIB^{2021} Consortium develops *new-to-the-world* Biochemical

An Alternative Raw Material for Polyamide 12

Evonik is operating a pilot plant for bio-based ω-amino lauric acid

Essen, July 30, 2013

The biobased ω-amino-lauric acid is an alternative to petroleum-based laurin lactam (LL). ALS replaces the monomer LL in the manufacture of sustainable high-performance plastics and yields an identical compound polyamide 12 (PA 12).

Over the long run, the entirely new process has the potential to **complement the butadiene-based production of PA12**.

Lubricants, Plasticizers and more from Plant Oils

Matrìca: Porto Torres inaugurates new green chemistry complex

Porto Torres, 16 June 2014

The ribbon was cut today at the first of the Matrìca green chemistry plants, the 50/50 joint venture between Versalis (Eni) and Novamont.

Daniele Ferrari, Chairman, and Catia Bastioli, Managing Director of Matrìca, - at the

- Bio-Feedstock Availability is Critical
- C-dependend Products to be Prioritized

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- Performance
- Replacebility
- Cost
- **Feedstock Availability**
- Infrastructure

Sönke Kraft aka Arnulf zu Linden

Christian Gahle, Nova-Institut GmbH

fotos: Wiikmedia.org

Global Production

Ethylene	140 mio t	containing	**120**	**mio t C**
Sugar	165 mio t	„	**69**	**mio t C**

EU

Ethylene	20 mio t	„	**17**	**mio t C**
Sugar	18 mio t	„	**8**	**mio t C**

Bioeconomy needs Total Biomass

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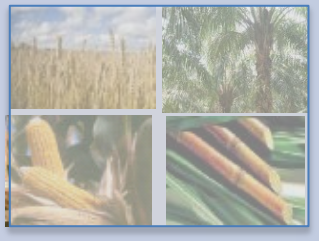
State-of-the Art	*Just Starting*	*Tomorrow*

Sugar-/Oil-Carbon

Lignocellulosic-Carbon



2nd gen. **Ethanol from Straw**

- **The world's first plant for the production of second generation biofuels has been opened in Northern Italy**

9.10.2013

The world’s first commercial-scale plant for the production of **bioethanol from non-food biomass** sources was officially inaugurated today before the Minister for Economic Development Flavio Zanonato and the local Authorities (President of the Regional Administration Roberto Cota, Mayor of Crescentino Marinella Venegoni, President of the Provincial Administration Carlo Riva Vercellotti).
The **Crescentino (Vercelli) bio-refinery** is owned by Beta Renewables, a joint venture between Biochemtex, a Mossi Ghisolfi Group engineering company, the American fund TPG (Texas Pacific Group), and the Danish company Novozymes, a world leader in bio-innovation.

2nd gen. Ethanol, Glycols and Power Technology exported

M&G Chemicals launches green revolution in the polyester chain
Shanghai – 18 November 2013

M&G Chemicals announces today its decision to construct a second-generation bio-refinery in the region of Fuyang, Anhui Province of China for the conversion of one million metric tons of **biomass into bio-ethanol and bio-glycols**.

The project is expected to be realized through a joint-venture with Chinese company Guozhen which will make available one million metric tons of **straw biomass** and use the lignin resulting as a by-product from the bio-refinery to feed a 45 MW cogeneration plant which will be constructed at the same time as the bio-refinery in the same site. M&G Chemicals will be majority partner of the bio-refinery and minority partner of the power plant.

The bio-refinery will employ PROESA™ technology licensed from Beta Renewables, a joint venture between Biochemtex (a company belonging to the Mossi Ghisolfi Group), US private equity fund TPG and Danish enzyme producer Novozymes.

2nd gen. **Lactic Acid from Non-food Crop**

Direvo develops consolidated bioprocess for lactic acid production from lignocellulosic feedstocks

Monday March 18 2013

Germany-based startup Direvo recently announced the development of a consolidated bioprocess for lactic acid production from lignocellulosic feedstocks.

Direvo claim that this is the first reporting of consolidated bioprocess for producing lactic acid from lignocellulose. Working with pretreated **Miscanthus grass**, Direvo fermented lactic acid on pilot scale in a single-step-synthesis

Bioeconomy
targets on Circular Value Chains

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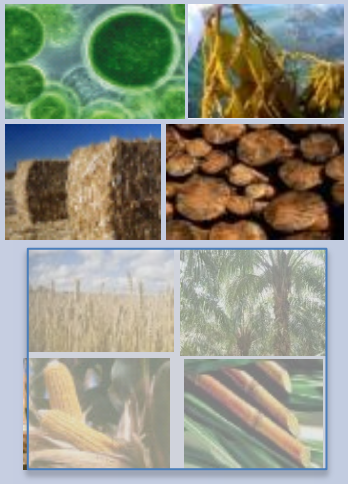
State-of-the Art	*Just Starting*	*Tomorrow*
Sugar-/Oil-Carbon	**Lignocellulosic-Carbon**	**CO_2 ,CO (Flue-, Syngas)**



3rd gen. **Feedstock triggers Cross-Sector Partnership**

2.9.2011 Lanzatech meets Siemens in CLIB-workshop

Siemens to Develop Ethanol From Steel-Mill Gases With LanzaTech

June 19, 2013

Siemens AG, Europe's largest maker of power equipment, agreed to develop systems that convert **waste industrial gases into fuel** using technology from LanzaTech NZ Ltd.

Siemens's Metals Technologies unit will collaborate with LanzaTech for 10 years to commercialize and market systems for the steel industry, the two companies said today in a joint statement.

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3rd gen. **Chemicals under Development**

Bacteria like the taste of syngas
Essen, 4.12.2013

For the first time, Evonik Industries has managed to use biotech methods to convert **syngas to pure 2-hydroxyisobutyric acid** (2-HIBA) under industrial conditions. 2-HIBA is a precursor used in the manufacture of PLEXIGLAS®. **Waste gas** is one example of a source of syngas. "We have shown that there is a safe way of using bacteria to turn syngas into a variety of products in the future," says Dr. Peter Nagler, Evonik's Chief Innovation Officer. In addition to 2-HIBA for the plastics industry, other products could include their derivatives for the cosmetics industry, or C4 alcohols for the paints and varnishes industry.

3rd gen. **Chemicals trigger Cooperation**

Evonik and LanzaTech
working on bio-processed precursors for specialty plastics

Essen, December 9, 2013
Synthetic biology to enable the production of bio-processed precursors for specialty plastics made of synthesis gas Essen (Germany) and Roselle (Illinois/USA).

Evonik Industries and LanzaTech have signed a three year research cooperation agreement which will see Evonik combining its existing biotechnology platforms with LanzaTech's synthetic biology and gas fermentation expertise for the development of a route to bio-processed precursors for specialty plastics from waste derived synthesis gas. In this route, microorganisms placed in fermenters are used to turn synthesis gas into chemical products. Synthesis gases comprise mainly of either carbon monoxide or carbon dioxide and hydrogen and can come from a variety of **gasified biomass waste streams including forestry and agricultural residues and gasified municipal solid waste.**

CLIB^{2021}: *3rd gen.* Chemicals form Cross-Border/Sector Value Chain

Gasification

Gas-Fermentation

Further Processing

Steel-Mill
Cement-Production

Public Utility Comp.

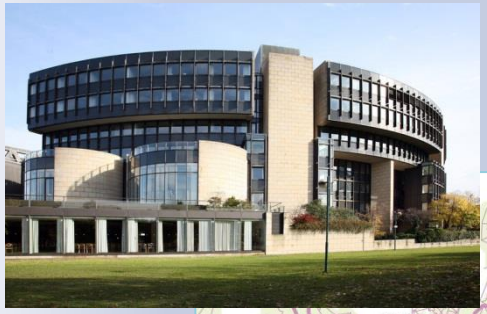
Concord Blue
Ecoloop

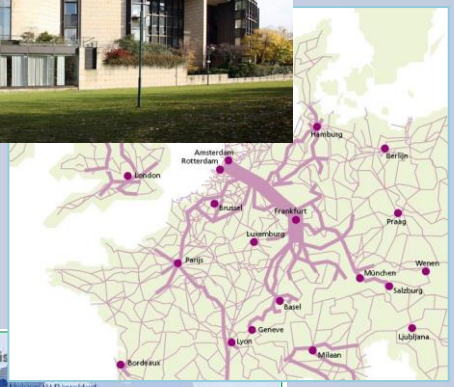
Lanzatech

Industry
SME

BIG-C: Regional Pillars of Competitiveness to attract New Value Chains

- Performance
- Replacebility
- Cost
- Feedstock Availability
- **Infrastructure**





Institutions

Infrastructure

Macroeconomic Environment

Human Capacity Building

Italy: Drawing Economic Benefit from Established Infrastructure

Versalis converts petrochemical plant into biorefinery

23.7.2014
The Italian petrochemical group Versalis is working on the conversion of two European sites. It has decided to develop itself, particularly in the biobased materials.

Matrica biorefinery in Porto Torres, Sardinia
Versalis, the chemical department of the Italian petrochem giant Eni, and Elevance Renewable Sciences, a US-based producer of specialty products based on natural oils, will enter into a strategic partnership. The two organisations have the ambition to develop and on an industrial scale a new metathesis technology to produce chemical products based on vegetable oils. Moreover, at the Porto Marghera site in Italy they will study the feasibility of producing **green ethylene** from renewable oil by metathesis, **benefiting from the infrastructure already present there.**

Global Competitivenes depends on Industrial & Regional Pillars of Competitiveness

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Industrial Demand

+ ***Regional Feedstock***
+ ***Transition Technologies***
+ ***High Performance***
  Products & Processes

Regional Issues

+ ***Regional Pillars of Competitiveness***
+ ***Demonstration of Feasability***
  technical, economical, ecological
+ ***Change of Mindset***
  public & private stakeholder management
+ ***Acceptance***
  feedstock, products, circular economy

Fields of German-Italian Cooperation

Research & Development
Human Capacity Building
Cross-border & Regional Infrastructure
Regional Strategies

Your Point of Contact: ASSOBIOTEC & CLIB^{2021}

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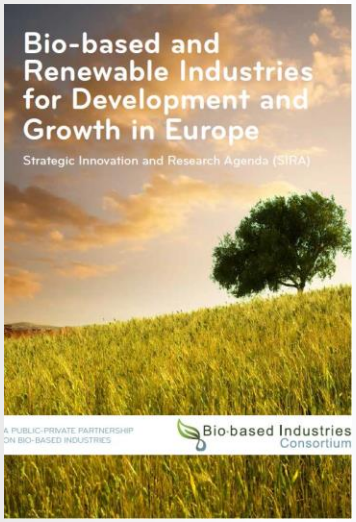
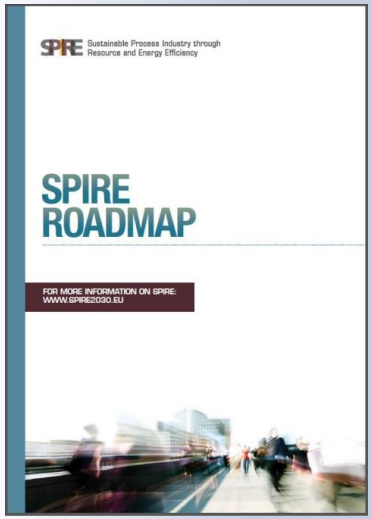
Horizon 2020





INTERREG Funding

10/2013 LOI Assobiotec/CLIB^{2021}

06/2014 German Delegation to Italy

09/2014 CLIB^{2021} presenting at IFIB2014 in Genova

11/2014 Assobiotec presenting at CIC2014 in Düsseldorf