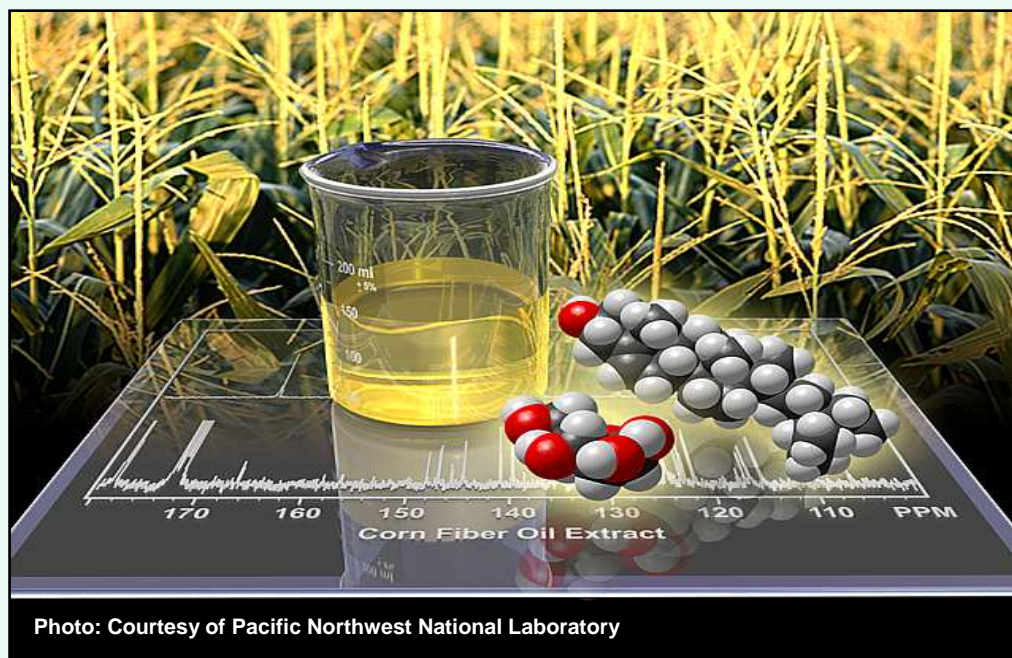


# Biorefinery - from policy issues to research and from knowledge to products



Dr. Dietmar Peters

Agency for  
Renewable Resources  
(FNR)

# Outline



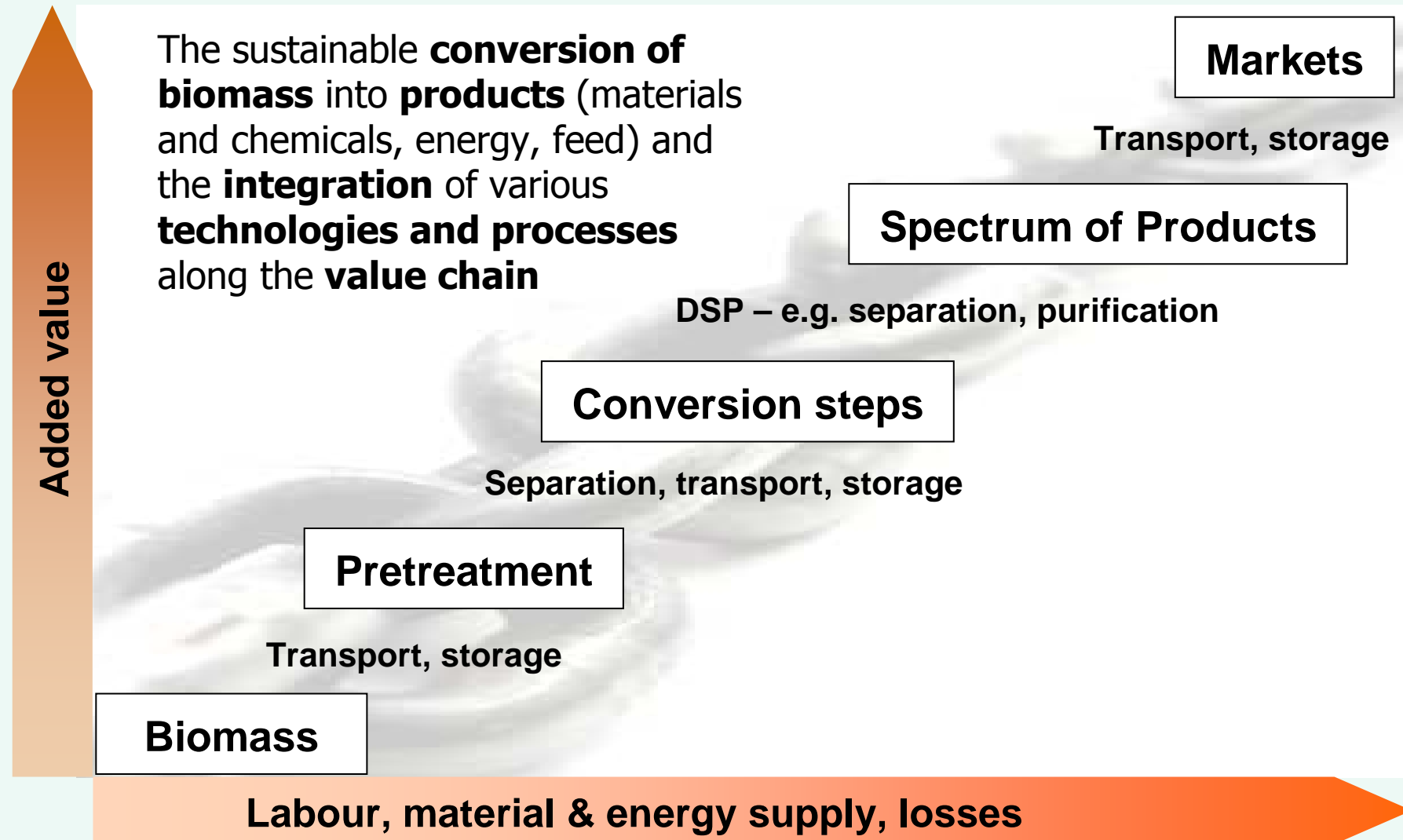
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- ▶ European strategies & policy on biomass and biorefineries
- ▶ European RTD on biorefineries
- ▶ German biorefinery policy and RTD



## Integrated biomass conversion

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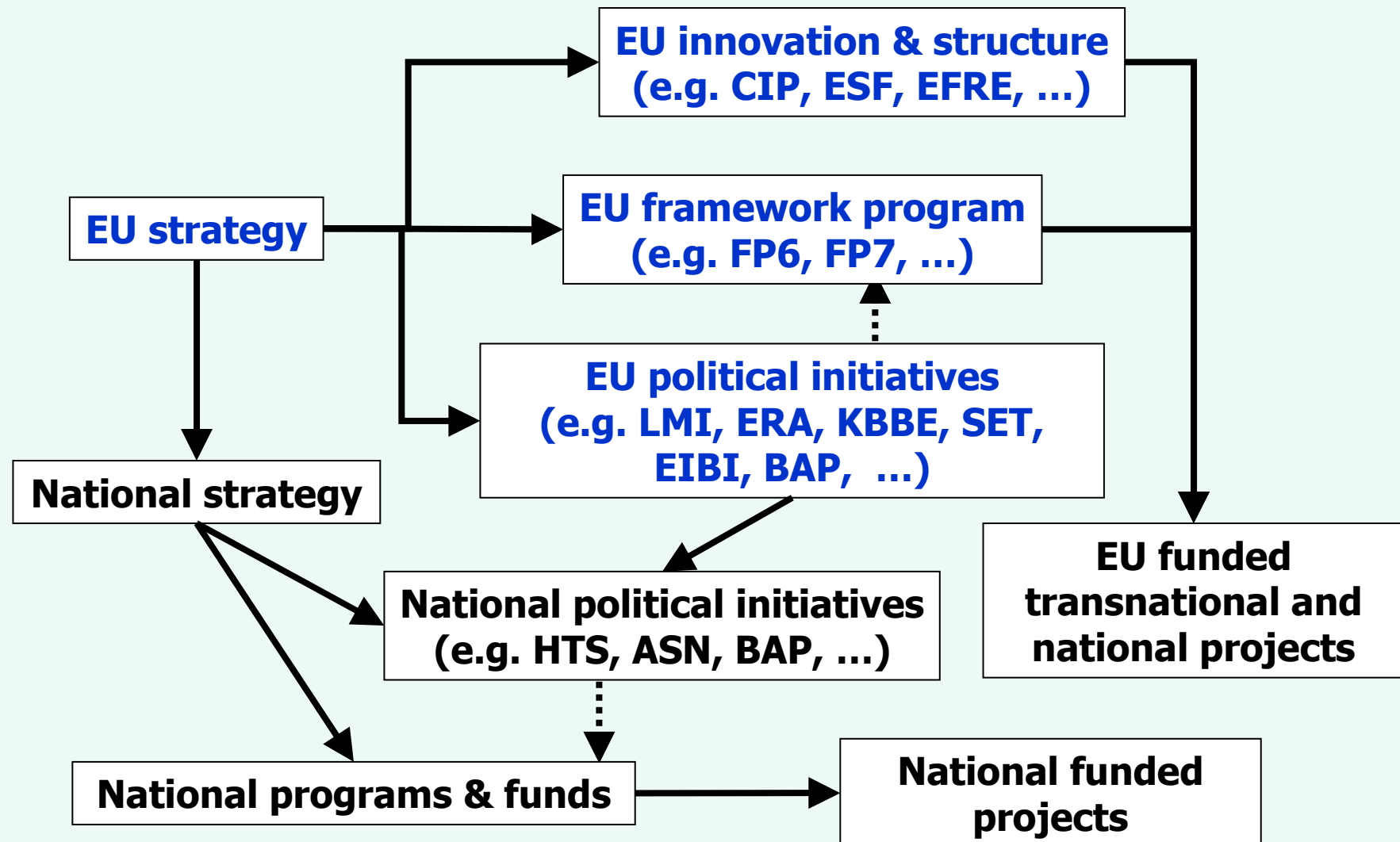
# Biorefinery

## Political frame in Europe



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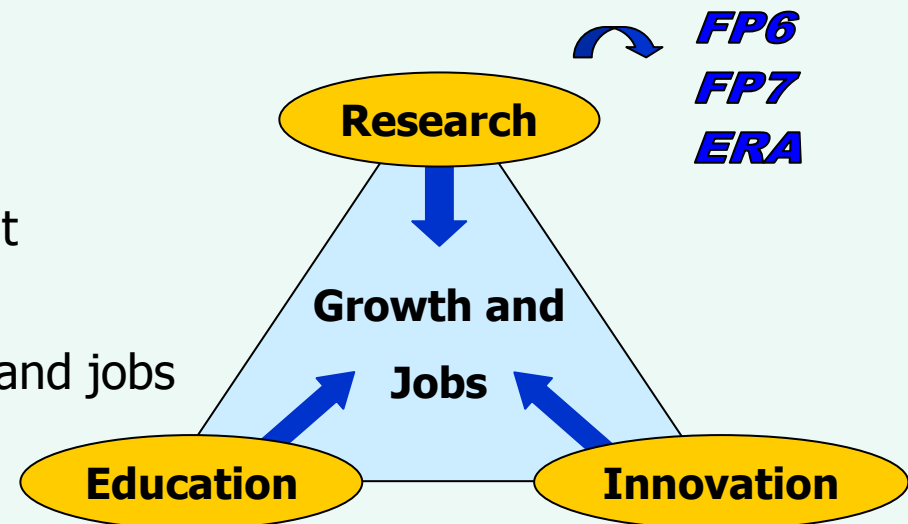


### ► „Lisbon Strategy“ (2000-2010)

- The „Lisbon Strategy“ has been implemented as an answer to globalisation. It aims at making the European Union the most competitive economy in the world, capable of sustainable growth with more and better jobs and greater social cohesion.

- Key areas:

- (1) Human capital
- (2) More research, development and innovation
- (3) Dynamic economy, growth and jobs
- (4) Greener economy



- Initiative „Towards an European Research Area (ERA)“

### ► „Strategy Europe 2020“ (2010-2020)



- Strategy was launched in March 2010 and will be implemented step by step after approval in June 2010
- Key areas:
  - (1) Intelligent growth – promoting knowledge, innovation, education and the digital society
  - (2) Sustainable growth – encouraging more efficient production in terms of resources, while at the same time promoting competitiveness
  - (3) Inclusive growth – increasing integration in the job market, acquisition of qualifications and the fight against poverty

Key areas are underlined by seven flagship initiatives



**FP7**  
**FP8**  
**ERA**

### ► Flagship initiatives of the „Strategy Europe 2020“

INTELLIGENT GROWTH	SUSTAINABLE GROWTH	INCLUSIVE GROWTH
<b>INNOVATION</b> „Innovation Union“  <b>EDUCATION</b> „Youth on the move“  <b>DIGITAL SOCIETY</b> „A digital agenda for Europe“	<b>CLIMATE, ENERGY AND MOBILITY</b> „Resource efficient Europe“  <b>COMPETITIVENESS</b> „An industrial policy for the globalisation era“ “	<b>EMPLOYMENT AND SKILLS</b> „An agenda for new skills and jobs“  <b>FIGHTING POVERTY</b> „European platform against poverty“



### ► Biorefineries and the „Strategy Europe 2020“

#### **SUSTAINABLE GROWTH**

#### **CLIMATE, ENERGY AND MOBILITY**

EU flagship initiative "**Resource efficient Europe**" to help decouple economic growth from the use of resources, by

- decarbonising our economy,
- increasing the use of renewable sources,



#### **BIOREFINERIES**

- modernising our transport sector, and
- promoting energy efficiency.



### ► Lead Market Initiative (LMI)

The Lead Market Initiative is the European policy for 6 important sectors that are supported by actions to lower barriers to bring new products or services onto the market.

The European Commission, Member States and industry work together to carry out the action plans for the 6 Lead Markets.

#### Market

- Bio-based products
- Renewable energies
- Sustainable construction
- eHealth
- Recycling
- Protective textiles

#### Policy

- Standardisation, Labelling and Certification
- Legislation
- Public procurement
- Sharing knowledge and funding opportunities



### ► Lead market Initiative (LMI)

#### Bio-based products



**Sector:** Industrial and consumer products based on renewable, biological raw materials such as plants and trees are part of the bio-based lead market. It also encompasses non-food new bio-based products and materials such as bio-plastics, bio-lubricants, surfactants, enzymes and pharmaceuticals.

**Challenges:** Uncertainty about product properties and weak market transparency hinder the fast take-up of the products.

The sector is characterised by large interdependencies and complex value chains across a wide range of products.

**Actions:** Improving standardisation, labelling and certification to ensure the quality and consumer information on the new products is part of the action plan. Public authorities can set an example with a coherent and coordinated approach across the different policy areas affecting bio-based lead markets.

### ► Strategic Energy Technology (SET) plan and European Industrial Bioenergy Initiative (EIBI)



 **EUROPEAN COMMISSION**  
European Research Area

## *The Strategic Energy Technology (SET) Plan*

- Joint strategic planning / New governance / Information System (SETIS)
- Three main pillars for implementation:
  - European Industrial Initiatives (EIIs)
  - European Energy Research Alliance (EERA)
  - Trans-European Energy Networks and Systems (transition planning)
- Increase resources, both financial and human
- Reinforce international cooperation



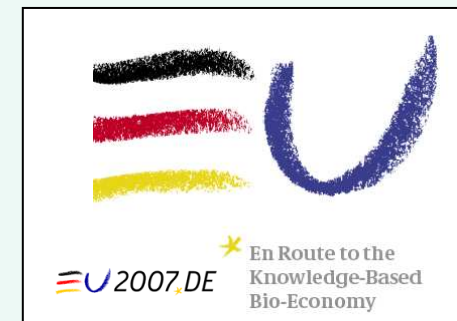
**EIBI**

**bioenergy-driven  
biorefineries**



### ► Knowledge based Bio-economy (KBBE)

- The term “bio-economy” includes all industries and economic sectors that produce, manage and otherwise exploit biological resources
- Key areas:
  - (1) Sustainable production and management of biological resources from land, forest and aquatic environments
  - (2) Food, health and well being
  - (3) Life sciences, biotechnology and biochemistry for sustainable non-food products and processes, **biorefineries**



Food, Agriculture and Fisheries, and Biotechnology  
Knowledge Based Bio-Economy (KBBE)

- Objectives of the „Lisbon Strategy“ were only partly reached, Strategy “Europe 2020” intends to correct, to adjust and to extend the „Lisbon Strategy“ on EU level

### Problem:

Integration of the Member States

- FP is a mid-/long-term program, whereas LMI was designed as a short-term 3-year-initiative

### Problem:

short-term market development scenario (3-5 years) is unrealistic, LMI turned out to be a mid-term perspective (5-10 years)

- EU Bio-economy paper is announced by the end of 2011

# Biorefinery

## RTD in Europe



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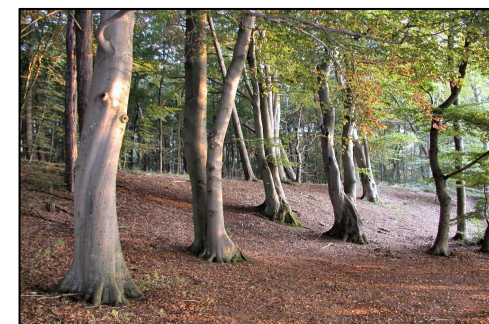
research<sup>eu</sup>



European Research Area



Food, Agriculture and Fisheries, and Biotechnology  
Knowledge Based Bio-Economy (KBBE)



### ► EU Framework programme missions

FP1-4: Knowledge generation

FP5: Problem solving

FP6: Integration and (re-)structuring

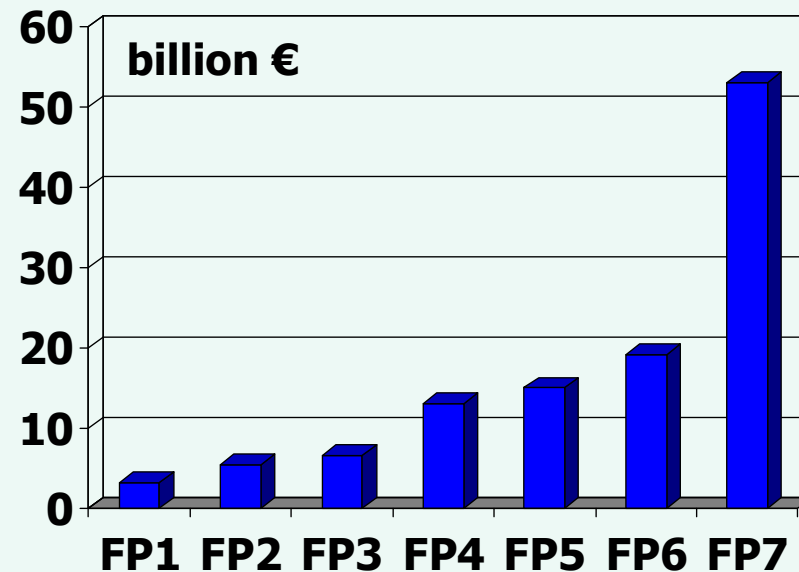
FP7: Knowledge for growth

<http://cordis.europa.eu>

<http://cordis.europa.eu/search/index.cfm>

<http://www.biomatnet.org/home.html>

<http://www.biomatnet.org/secure/projects.html>



Quelle: DG Research

## EU political frame & RTD

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### FP1 (1984-1987)

Focus: Bioenergy

Sub-themes: BAP, Energy from biomass

### FP2 (1987-1991)

Focus: Industrial biobased products

Sub-themes: **ECLAIR**, BRIDGE, JOULE.

### FP3 (1990-1994)

Focus: Integrated crop chains, green chemicals, fibre forestry/wood chain

Sub-themes: **AIR**, BIOTECH 1, JOULE 2/THERMIE

### FP4 (1994-1998)

Focus: Crops, chemical & biological products

Sub-theme: **FAIR**, Biotech 2, JOULE 3/THERMIE

### FP5 (1998-2002)

Focus: Integrated production, exploitation of biological resources

Sub-themes: **QLK 5**, QLK 3, GROWTH, ESSD

### FP6 (2002-2006)

Focus: Materials, Bioenergy, Networking (TP, ERA-NET)

Sub-themes: Life sciences, GROWTH, ESSD

### FP7 (2007-2013)

Focus: Biotechnology, Biorefineries

Sub-themes: **KBBE**, NMP, Energy

### FP8

Focus

Sub-themes:

?

### ► dedicated integrative biorefinery projects


- FP7: Star-COLIBRI – 2.000 k€
- FP7: BIOCORE – 13.900 k€
- FP7: EuroBioRef – 21.500 k€
- FP7: SUPRA-BIO – 12.600 k€
- FP7: AFORE – 7.900 k€
- FP7: HYPE – 3.700 k€
- FP7: DIBANET – 3.700 k€
- FP7: SUSTOIL – 990 k€
- FP7: GLYFINERY – 3.800 k€
- FP7: PROPANERGY – 1.800 k€
- FP7: BIOREF-INTEG – 995 k€



- FP2 ECLAIR:  
Whole crop biorefinery project
- FP3 AIR: no projects
- FP4 FAIR: no projects
- FP5: BESUB – 1.300 k€

- FP6: Biorefinery Euroview – 436 k€
- FP6: BIOPOL – 551 k€
- FP6: BIOSYNERGY – 7.000 k€

### ► Knowledge based Bio-economy (KBBE)



**Knowledge Based Bio-Economy:  
Where are we?**

FP6 (2002-2006)

- Creation of 7 Technology Platforms relevant to the KBBE
- A number of relevant ERA-NETs
- KBBE stakeholder conference (Sep 2005)

FP7 (2006-2013)

- Theme « Food, Agriculture and Biotechnology » to support the KBBE

Food, Agriculture and Fisheries, and Biotechnology  
Knowledge Based Bio-Economy (KBBE)

### ► FP7 Working Program „Agro-Bio-Food 2010“

- No specific biorefinery calls



### ► FP7 Working Program „Agro-Bio-Food 2011“

- Call „BioWASTE – Novel biotechnology approaches for transforming industrial and/or municipal biowaste into bioproducts“
- Call „Towards bio-industry – Biotechnology for renewable chemicals and innovative downstream processing“

**According to current planning, there are no dedicated integrative biorefinery calls in 2010/2011. Compared to recent years, only a limited number of biorefinery-related themes and a low budget for them are planned!**


# Biorefinery

## Political frame in Germany



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**The Federal Government's  
action plan for the industrial use  
of renewable resources**

### ► Political commitment

- High Tech Strategy „Plants: New roads in agriculture and industry“ (2006)
- High Tech Strategy „Climate protection, resource protection, energy“ (2009)
- „National Biomass Action Plan“ for bioenergy (2009)
- „Action Plan for the Industrial Use of Renewable Resources“ (2009)
- BioEconomyCouncil / BioÖkonomieRat (2009)

### ► Industrial commitment

- Position paper „Raw Material Change“ (2010)



**Biomass and Biorefinery**

# Biorefinery

## German political frame



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Bundesministerium für  
Ernährung, Landwirtschaft  
und Verbraucherschutz

Bundesministerium  
für Umwelt, Naturschutz  
und Reaktorsicherheit

### National Biomass Action Plan for Germany

Biomass and Sustainable Energy Supply



BAP: April 2009



Federal Ministry  
of Food, Agriculture and  
Consumer Protection

### The Federal Government's action plan for the industrial use of renewable resources



APIU: August 2009

# Biorefinery

The Federal Government's  
action plan for the industrial use  
of renewable resources

22

Action area 7:

7  
Industrial  
biotechnology and  
biorefineries



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## ► Objectives

- To develop a good technological knowledge base in Germany and further expand research infrastructure
- To conduct fundamental research into the development of biorefinery projects and ensure swift transformation of sustainable biorefinery projects from the research stage to commercial plants

## ► Actions

- Develop a roadmap towards biorefineries (by mid-2011)
- Create a federal biorefinery information network
- Establishment of pilot and demonstration plants
- Prioritise research into the following areas: better biotechnology, development of process technology, enhancement of products, enhancement of the resource base, improvement in technology

- Position paper **Raw material Change** of the German chemistry organisations GDCh, DECHEMA, DGMK und VCI
  - As far as fossil raw materials are concerned, crude oil – the current main carbon source – will be accompanied and replaced by other raw materials in medium-term; especially gas, coal, and biomass.
  - Biomass is the only source for renewable raw materials for chemistry.
  - „The development of biorefineries is the key for the integrated production of feed as well as chemicals, materials and fuel.“



January 2010

### ► BioEconomyCouncil / BioÖkonomieRat

- The research and technology council (founded in 2009) shall actively support the development of a German bio-economy. A better framework, an accelerated development of technologies and the determination of RTD issues are main objectives.
- Currently, four working groups with academic and industrial researchers are established : WG Soil, WG Plants, WG Animals, WG Biotechnology

### ► National Research Strategy BioEconomy

- The RTD agenda for a Bioeconomy which will define priority activities council (by the end of 2010)

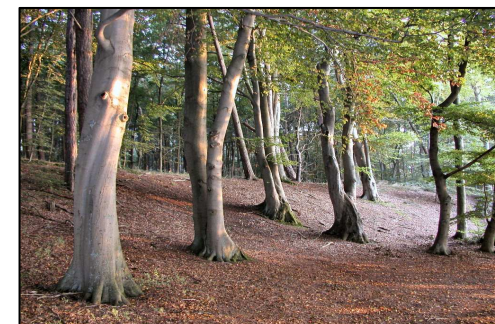


# Biorefinery

## RTD in Germany

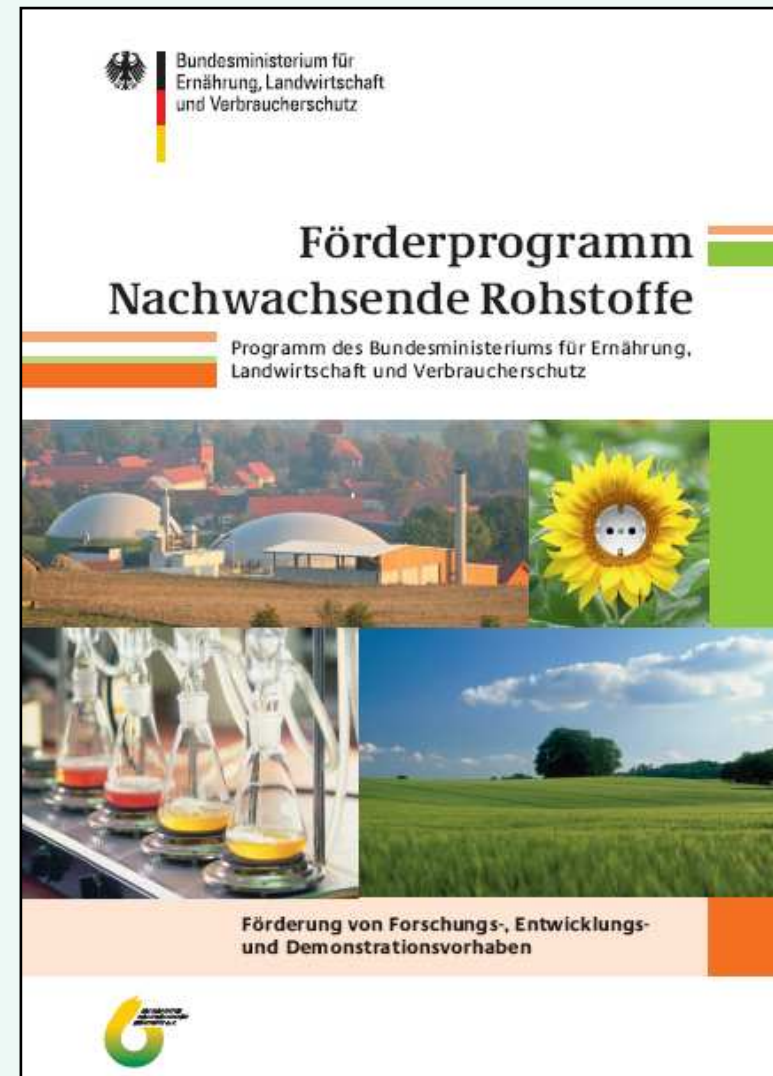


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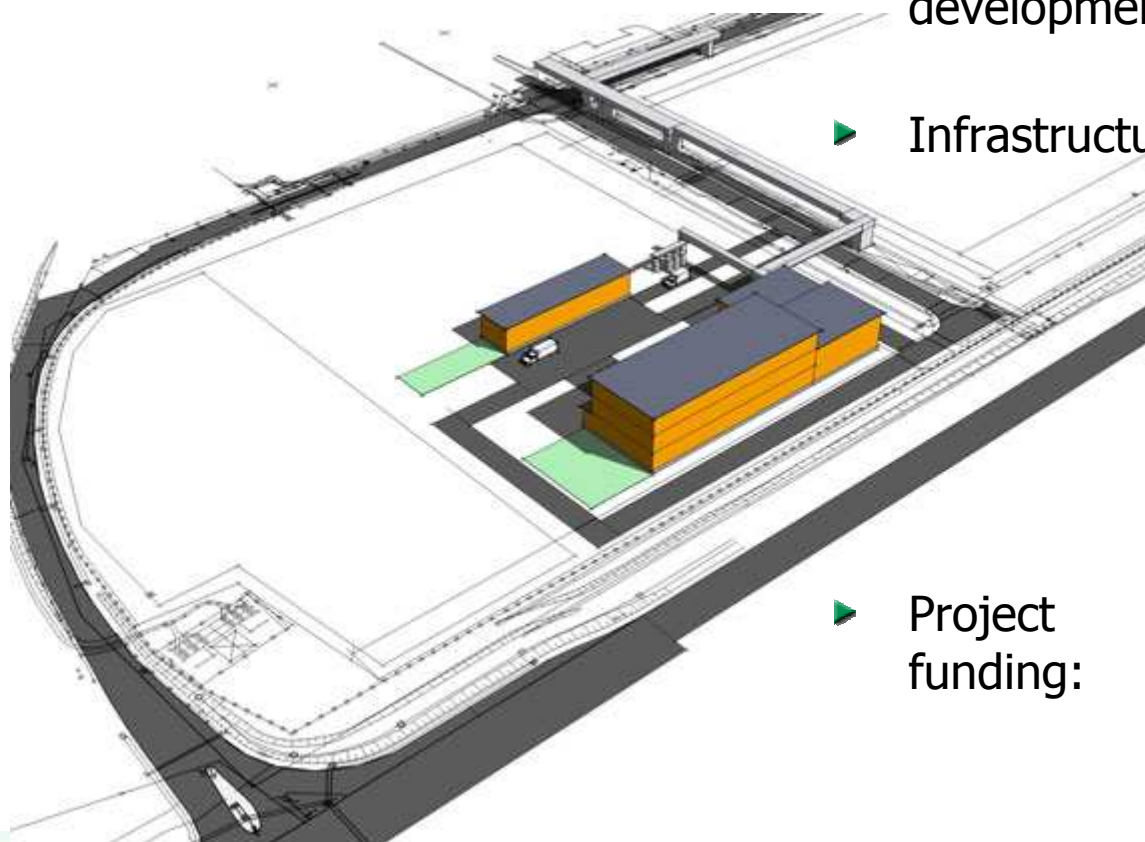
INFRALEUNA®

- ▶ **BMELV RTD Funding Programme** for research, development and demonstration projects for the use of biomass including biorefineries (since 1996)  
Funding budget: 50 Mio €/per year
- ▶ Guideline **Demonstration Projects** for bioenergy (since 2005)
- ▶ Call **Innovative Multiple Use of Renewable raw materials, Biorefineries** (from 24.04.2008)



### Biorefinery Development Centre for chemical and biochemical process development - CBP Leuna (from 2009)

**Budget: ~ 65 Mio. €**

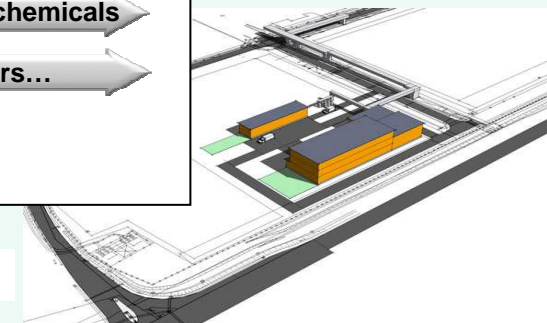
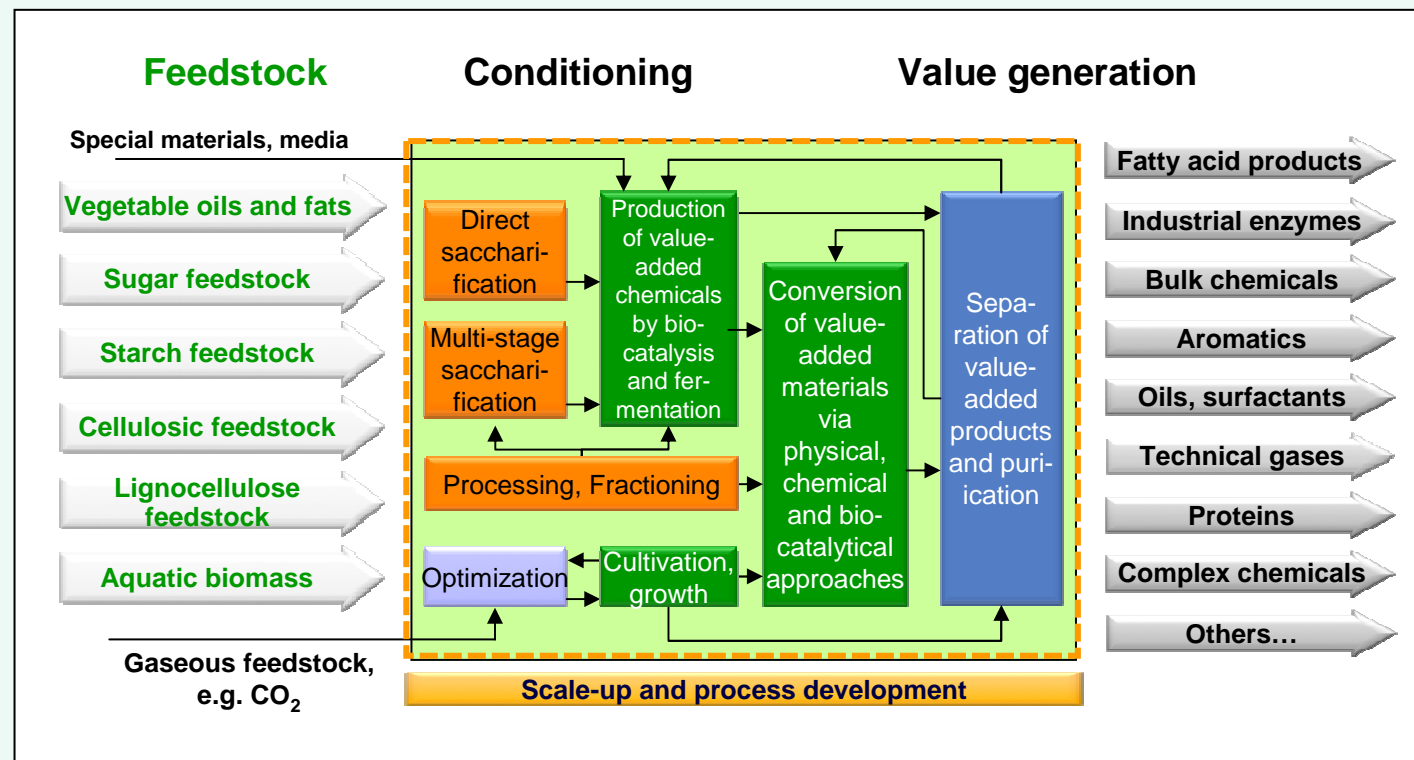


► Site development: 1 Mio € (InfraLeuna)

► Infrastructure: 26,1 Mio € (State Saxony-Anhalt)  
9,6 Mio € (FhG)

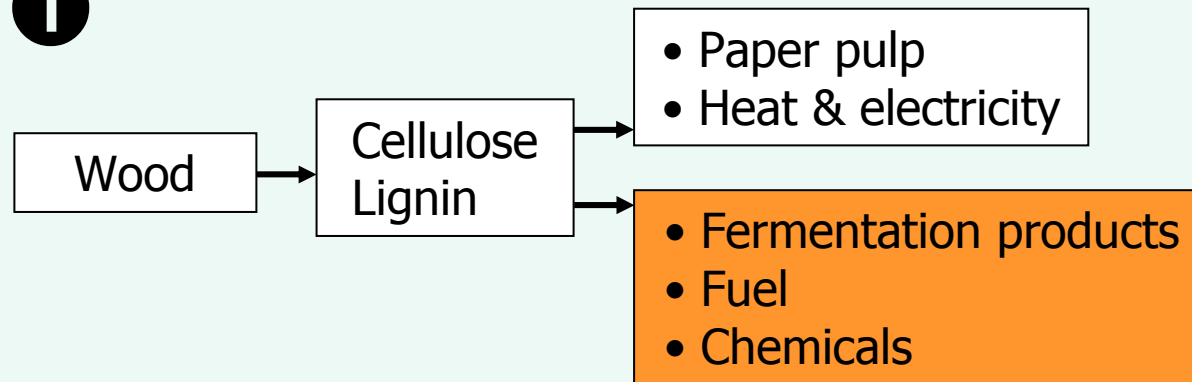
► Project funding: ~15 Mio € (BMELV)  
~13 Mio € (BMBF)  
~1 Mio € (BMU)

### CBP Leuna - Concept

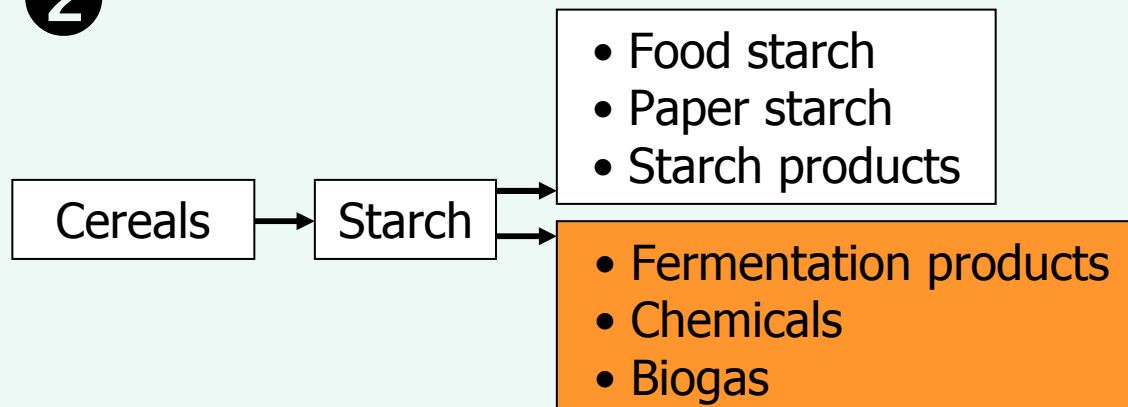


- **Bottom-up:** Extension of existing biomass processing sites (e.g. sugar mills, starch refineries, pulp & paper plants, oil mill, ethanol plants).

1



2



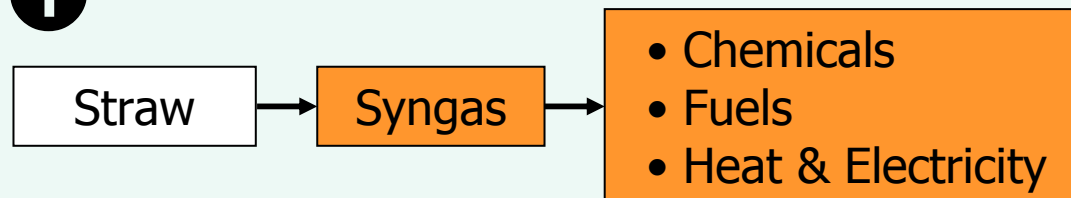
- ▶ **Starch/sugar biorefinery based on cereals/sugar beet**
  - Südzucker Sugar Mill and CropEnergies Bioethanol Plant in Zeitz (Saxony-Anhalt)
  - Production of sugar thick juice and white sugar as well as beet chips feed from sugar beet by the sugar mill
  - Production of ethanol and DDGS protein feed from cereals by the bioethanol plant
  - Alternative production of ethanol from sugar thick juice feedstock
  - RTD project ("Biorefinery2021") to develop the Site Zeitz to an integrated biorefinery including lignocellulose feedstock

Südzucker - CropEnergies

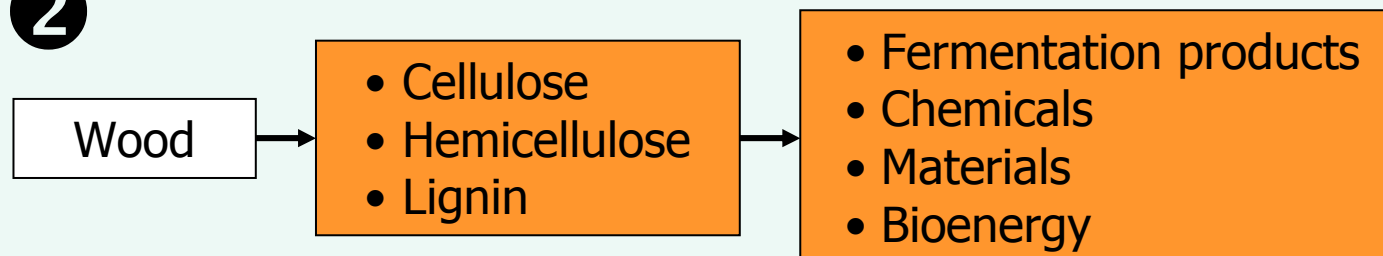


- **Top-down:** New developed, highly integrated sites to produce a broad variety of products for different markets from different, pre-treated and pre-separated (lignocellulosic) biomass fractions

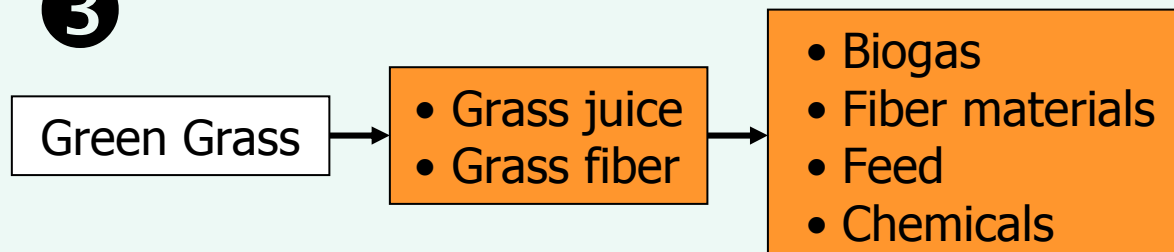
1



2



3



### ► Syngas biorefinery based on wood (Carbo-V®)

- Three-stage gasification with downstream Fischer-Tropsch-Synthesis (modified Shell-FT-Process)
- Demonstration plant with 50 MW<sub>th</sub> in Freiberg (Saxony) having a capacity of about 15.000 t/a

Choren Industries GmbH



### ► Syngas biorefinery based on straw (bioliq®)

- Decentralised fast pyrolysis to get pyrolysis oil, coke and gas
- Centralised gasification of a slurry (pyrolysis oil & coke) using a high pressure entrained flow gasifier with subsequent gas conditioning
- Downstream synthesis of biomass-to-liquid fuels
- Pilot plant (500 kg/h) in Karlsruhe (Baden-Wuerttemberg)

KIT



### ► **Lignocellulose biorefinery based on hard wood**

- Component separation (into cellulose, hemicelluloses, lignin) by an organosolv process; hydrolysis of carbohydrates to get fermentable sugars for various chemicals; materials and chemical use of lignin
- Phase 1: lab-scale research (2007-2009); Phase 2: pilot plant (2010-20132) at Chemical Site Leuna (Saxony-Anhalt) under construction

Consortium from academia and industry



INFRALEUNA®

### ► **Lignocellulose biorefinery based on straw (sunliquid®)**

- Component separation (into cellulose/ hemicelluloses, lignin) by an modified steam explosion process; hydrolysis of carbohydrates to get fermentable sugars for bioethanol; lignin use for energy
- Operating pilot plant and planned demo plant in Munich (Bavaria)
- Additional RTD project "Biofuels 2021"

Süd-Chemie AG



### ► Grass juice/fiber biorefinery based on green biomass

- Mechanical separation into grass juice and grass fiber
- Conversion of grass fiber to feed pellets
- Separation of lactic acid and proteins from grass juice
- Depleted grass juice is used for biogas generation
- Basic engineering for a planned pilot plant at Futtermittelwerk Selbelang (Brandenburg)



biopos e.V.

### ► Grass juice/fiber biorefinery based on grass

- Mechanical separation into grass juice and grass fiber
- Grass fibers are processed to get insulating material or re-inforced composites
- Depleted grass juice is used for biogas generation
- Production and demonstration plant in Brensbach (Hesse)

Biowert GmbH



- ▶ **Several RTD projects dealing with the conversion of biomass and developing technologies and processes which are useful for biorefineries**
  - **BMELV:** „RTD Program Renewable Resources“  
Funding: ~250 Mio € over 5 years, currently ~350-400 ongoing projects
  - **BMBF:** „BioIndustry 2021“, „BioEnergy 2021“, „Plant-KBBE“ and various other activities  
Funding: ~150 Mio € over 5 years
  - **BMU:** „Climate protection initiative – RTD Program Bioenergy Use“  
Funding: ~50 Mio € over 5 years
  - **BMWi:** various activities/projects in the frame of the programs AIF, ZIM and others
  - **BMVBS:** activities/projects in the frame of the program Kopa II
  - **DBU:** some projects for academia and SME



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