The Knowledge-Based Bio-Economy - from Concept to Practice: Experiences in Germany and Europe

Dr. Christian Patermann
Advisor to the State Government of North-Rhine Westfalia (NRW), Germany
The first economic institutions were based on energy (such as coal and nuclear energy), industry (such as steel) and agriculture.

Today, the progress in Europe grows by trading knowledge and innovation including bio-sciences.

An European Knowledge Based Bio-Economy is emerging.
What is the Knowledge-Based Bio-Economy?

**The knowledge base:** Advances in Life Sciences and Biotechnologies in convergence with other technologies such as nanotechnologies, chemistry, information technologies...

**The Bio-Economy:** Includes all industries and economic sectors that produce, manage or otherwise make use of biological resources including bio-waste.

The European bio-economy has an approximate market size of over €1.5 trillion, employing more than 22 million people

⇒ 4 Fs: Food, Fiber, Fuel and Feed

<table>
<thead>
<tr>
<th>Sector</th>
<th>Annual turnover (billion €)</th>
<th>Employment (million)</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>920</td>
<td>4.4</td>
<td>CIAA</td>
</tr>
<tr>
<td>Agriculture</td>
<td>210</td>
<td>15</td>
<td>COPA-COGECA</td>
</tr>
<tr>
<td>Paper/Pulp</td>
<td>400</td>
<td>0.3 direct (4 ind.)</td>
<td>CEPI</td>
</tr>
<tr>
<td>Forestry/Wood industry</td>
<td>150</td>
<td>2.7</td>
<td>CEI-BOIS</td>
</tr>
<tr>
<td>Industrial Biotech.</td>
<td>50 (est.)</td>
<td></td>
<td>McKinsey*</td>
</tr>
<tr>
<td>Total</td>
<td>1730</td>
<td>22.4</td>
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* estimated to be 10 % of sales within the chemical industry accounting for €125 million by 2010
What are the driving forces behind the Knowledge-Based Bio-Economy beyond competitiveness?

Global challenges like:

- Growing and aging populations
- Increased demand for high quality food and sustainable food production
- Increased incidence of food-related disorders (cardiovascular, obesity..)
- Increased demand for feed
- Increase in infectious animal diseases and zoonoses
- Danger of plant diseases, new pathogens and pesticides
- Limited resources of raw materials and energy
- Threat of global warming and other global changes (biodiversity loss etc)
What is the Knowledge-Based Bio-Economy offering?

• Improved health
  - Food with improved nutritional value, increased food safety, new treatments, diagnosis and vaccines against human and animal diseases, improved feed…

• Sustainability and a cleaner environment
  - Energy and water saving production and processes in agriculture and industry; decreased dependence of fossil resources;

• Support to rural development
  - Use of “set-aside” land; cultivation of new crops; decentralised production facilities

• Increased industrial competitiveness through innovative eco-efficient bio-based products
BIO4EU Study: The impact of modern biotechnology in human medicine & healthcare

- 9% - 30% of total turnover of applications in
  - diagnostics (e.g. HIV testing, cardiac assays)
  - vaccines (e.g. hepatitis B)
  - pharmaceuticals (e.g. insulin, antibodies)

- Biopharmaceutical market increased more than 6 times during last 10 years

Graph showing the biopharmaceutical market growth from 1.8 €bn in 1996 to 11.3 €bn in 2005.
BIO4EU study: The impact of biotechnology on primary production and agro-food

- Supporting ~18% of the input sectors’ turnover, e.g.
  - breeding and propagation,
  - veterinary and food diagnostics,
  - enzymes for food production

- Downstream use of these biotech products indirectly supports ~35% of the sector’s turnover
Biotechnology not (yet) widely applied in industrial production, processes, energy and environment, but...

- **Current applications and forecasts**
  - In 2005 biobased chemicals represents 7% of the market (\$77b in value) – in 2010 it is forecasted to cover 10% (\$125b in value)
  - 50,000 tons bio-plastic was produced in 2005 in EU (0.1% of the market share) - A market share of 1-2% by 2010 and 2-4% by 2020 are projected.
  - Increase of biofuels in transport to 10% by 2020 and of renewable energy to 20% within the total energy mix by 2020

- **Traditional biotechnology still prevails in bioremediation**
BIO4EU study: Contribution of modern biotechnology to environmental sustainability

- Environmental benefits
  - agriculture (production efficiency)
  - industrial biotechnology (resource use, emissions)
- Opportunity for helping address e.g. global warming or energy supply security (e.g. production and use of feed additive phytase)
The Knowledge-Based Bio-Economy also raises societal concerns

• New issues arise, e.g.
  – use of human tissue and cells
  – use of personal and genetic data
  – food versus fuel
  – environmental issues incl. sustainable use of biomass in countries of the third world
  – animal welfare issues, incl. animal cloning

which require monitoring and informed societal debate on its benefits and risks
The European Knowledge-Based Bio-Economy and globalisation

Europe has strengths for example:

- Excellent life sciences and biotechnology research base
- Strong chemical and enzyme industries
- Strong vaccine industry
- Strong food and feed industry, in particular food additives (70% world market share)
- High-tech textile industry
Figure 3-1 Distribution of biotechnology publications in the period 2002-2004 by country/region

Source: ETEPS, IPTS calculations.
RoW: rest of the world.
64% of the world's enzyme-producing companies are located in Europe. They produce about 75% of the global production of enzymes.

RoW: rest of the world
Source: ETEPS.338
The EU is the main world producer of vaccines

EU companies has developed about 26% of all recombinant vaccines currently available

Share of global vaccine production in 2005, by location of company headquarters.

Source: ETEPS°4, IPTS calculations.
The European Food Industry

- The food industry is the **leading manufacturing sector** in Europe in terms of turnover, value added, employment and number of companies, before automobile and chemical industry.

- The turnover of the food industry was 920 billions of euros in 2008, and is constantly rising by 1% annually.

- 20% world market share, but declining by 1% annually during the last five years.
High-Tech Textile Industry

- Next generation of intelligent personal protective equipment for better prevention and management of personal hazards, e.g.
  - New medical and health care textiles
  - Innovative textiles for protection against industrial hazards

- New light-weight – high strength construction materials
  - for safe, energy-efficient and easy-to-build/produce buildings or transport systems
The European Knowledge-Based Bio-Economy and Globalisation

Europe has strength - but our old and new competitors are moving forward:

**US** invest 3 times more than Europe in Biotech R&D

**US DoE** is co-financing bio-refinery pilot plants for $500m.

**BP** will invest $500m in a Energy Biosciences Institute at Univ. of California over the next 10 years and $250-300m together with Verenium to establish a cellulose refinery in Florida.

In addition DOE and the Department of Agriculture will invest approx. the same amount in collocated research institutes, primarily in California.
The European Knowledge-Based Bio-Economy and Globalisation

Europe has strength - but our old and new competitors are moving forward:

**China** invested between 2001-2005 12 billion Yuan (1.1 billion Euro) in biotech R&D- and is expected to double the investment within the next 5 years.

**China** is setting up a pilot factory for second-generation biofuel production.

The **Brazilian** government announced in 2006 a R$7b11 (2.6 billion Euro) Investments program to foster over the next 10 years the development of biotechnology.

**India** tripled its research budget for biotech from the period 1997-2002 to 2002-2007.
Bioeconomy in Europe

• **2002** – The EU launched a Strategy on Life Sciences and Biotechnology including a 30 points action plan.
• **April 2007** - The European Commission published a Mid Term Review of the Strategy putting forward a revised action plan
• **May 2007** - The new action plan incl. the KBBE-concept was welcomed and endorsed by the Competitiveness Council
• **January 2008** – The EC launched the Lead Market Initiative incl. Bio-Based products as one of the 6 areas of lead markets to be supported
• **February 2008** – The Commission proposed a new directive on Renewables with particular emphasis on sustainable biofuels
EU actions proposed in the mid-term review of the European Strategy on Life Sciences and Biotechnology:

- Promoting research and market development for a Knowledge-Based Bio-Economy
- Foster competitiveness, knowledge transfer and innovation
- Encourage informed societal debates on the benefits and risk of biotechnology
- Ensure a sustainable contribution of modern biotechnology to agriculture
- Improve the implementation of legislation
EU actions proposed in the mid term review of the European Strategy on Life Sciences and Biotechnology:

Actions promoting research and market development for a Knowledge-Based Bio-Economy

- Generating knowledge under the 7th Framework Programme (2007-2013) from basic research to applied research, research infrastructures, training and specific support to SMEs.
- Mobilise public and private research funding and reinforce coordination
- Launching of Joint Technology Initiatives among others on Innovative Medicine.
- Promote pilot plants to demonstrate the potential of bio-based applications
- Stimulate lead markets initiatives for eco-efficient bio-based products
THE EUROPEAN KNOWLEDGE-BASED BIO-ECONOMY

SOCIETAL NEEDS

“Fork to Farm”
Food, health and well-being

Life sciences & biotechnology for sustainable non-food products + processes

QUALITY ASSURANCE STRATEGIES TRACEABILITY, CONSUMER SCIENCE

STABILITY - BIODEGRADABILITY FUNCTIONALITY (Chirality)

ADVANCED FOOD TECHNOLOGIES, FOOD QUALITY DETERMINANTS, NUTRITION

WHITE BIOTECH CLEAN BIOPROCESSES RAW MATERIALS/WASTE

LOW INPUT FARMING - BIODIVERSITY ANIMAL HEALTH - RURAL DEV.

GREEN/BLUE BIOTECH OPTIMISED RAW MATERIALS

PROCESSING

PRODUCTION

Sustainable production and management of biological resources from land, forest, and aquatic environments
Lighthouse Priority Project:
“Develop a science-based work plan for EU-US collaboration on innovative and eco-efficient bio-based products”
Decision of the EU-Commission – Lead Market Initiative for Europe
Dec. 2007

6 Lead markets identified:

1. eHealth
2. High Tech Textiles
3. Sustainable Construction
4. Recycling
5. Biobased Products
6. Renewable Energy
Biobased Products

Definition: Products of renewable, biological plant resources

Bottle-necks:

- Delays in public acceptance because of uncertainties regarding product properties
- Unsatisfactory transparency of market

→ Demonstration plants are essential for higher acceptance and transparency!
How is KBBE implemented in various EU Member States?

3 Different Stages of Implementation of KBBE:

- **Integrated concepts and strategies** with different levels of integration (AT, BE, DE, IR, NL, TR)
- **No integrated strategies** BUT specifically KBBE-related policies and activities (CZ, FR, SE, UK)
- **More or less no specific activities and policies**, but acknowledgement of its political importance and potential (EE, GR, LT, SI, PT)
Integrated KBBE Concepts - Germany

• “Cologne“-Paper - „En route to the Knowledge-Based Bio-Economy“ during the German EU presidency in 2007
• Several Calls for Proposals with direct KBBE references
• High-Tech Initiative of the German Federal Government, linking with the KBBE-concept
• National Bio-Economy Technology Council, directly reporting to the Chancellor
Current Calls for Proposals with direct reference to KBBE in Germany

Federal Ministry of Education and Research:

- Competence Networks in Agricultural and Food Research
- Bioenergy 2021
- BioIndustry 2021
- Industrial Genome Research on Microorganisms (GenoMik-Industry)
- SynRG – Systems Biotechnology for sustainable resource production
- “Transnational PLant Alliance for Novel Technologies - towards implementing the Knowledge-Based Bio-Economy in Europe" (PLANT-KBBE) – Cooperation between DE-FR-ES-PT
- Excellence Cluster Competition
  - Breeding research and Breeding for energy plants
  - Support of the use of biomass for energy
  - Nutrition research for a healthy life
Current Calls for Proposals with direct reference to KBBE in Germany

Federal State Ministry of Innovation, Science, Research and Technology NRW:

- **Bio.NRW** - Industrial Biotechnology

ERA-NETs (with strong German participation):

- ERA-NET “Bioenergy”
- ERA-NET “Industrial Biotechnology”
- ERA-NET “Plant Genomics”
- ERA-NET “Eurotrans-Bio”
Example Agro cluster
- up to 40 Mill. € / 5 years

- Competence Network Food Chain Plus (FoCus),
  (coordinator: Univ. Kiel)

- Phänomics – a systems biological approach for
geno-phenotype mapping in the context of
performance, health and wellness of the companion
animals cattle and swine (coordinator: Univ. Rostock)

- Complex sensor technology for agricultural crop
research, breeding and canopy controlling:
CROPSENSe (coordinators: Univ. Bonn,
Forschungszentrum Juelich)

- Synbreed – Innovation cluster for synergistical plant
and animal breeding (coordinator: TU Munich)
KBBE Implementation in North-Rhine Westfalia -

Some reflections
Bio-Economy Turnovers 2006 in Manufacturing Trade in NRW

- Chemical Products: 52.7 Billion €
- Rubber & Plastic Goods: 13.1 Billion €
- Paper Trade: 8.1 Billion €
- Wood Trade: 3.4 Billion €
- Food Trade: 30.2 Billion €
- Textile Trade: 3.9 Billion €

Manufacturing Trade total: 26.6 Billion €

75% of Chemical Intermediates in Germany come from NRW (20 bill. €)

At least 30% of Manufacturing Trade in North-Rhine Westfalia is based on Bio-Economy

Source: Trade report 2007 – Food Economy in Figures – MUNLV, Germany
KBBE activities in NRW-1

• Installation of 16 specific clusters by the Government of North-Rhine Westfalia (i.e. on Chemistry, Biotech, Energy, Plastics) with strong links of content towards KBBE

• Foundation of a Cluster of Industrial Biotechnology (CLIB 2021) in NRW with funds of about 20 Mio. € by the Federal Government

• Foundation of an umbrella organisation “Bio.NRW” for bundling and linking-up of 8 various Bio-Regions in NRW, now speaking with one voice!

• Installation of a “local” agency for Bio.NRW by the State Government
KBBE activities in NRW-2

- Establishment of an KBBE Coordination Office for better coordination and streamlining of KBBE-activities in NRW
- Establishment of a competence cluster “Agro.NRW”
- Analysis of the potential of biobased products, processes and technologies in NRW
- NRW Stake-holder take part in the National Technology Council for Bio-Economy, founded by the Federal Republic of Germany in 2009
KBBE activities in NRW-3

• 1\textsuperscript{st} NRW call (Bio.NRW, 2008/2009) – “Industrial Biotechnology” (25 Mill.€)

• Call “Food” (2008), 10 Mill.€

• Energy research programme (3 pillars; 3\textsuperscript{rd} pillar: “Biological production of energy sources” with 3 elements:
  – Efficient crop cultivation to ensure the need of raw materials
  – Biorefineries – Production system of the 21\textsuperscript{st} century
  – Knowledge-based Bioeconomy

• Call “Forest and Forestry” being planned
KBBE Office at Forschungszentrum Juelich

Dr. Christian Patermann
Advisor to the NRW State Government for KBBE at Forschungszentrum Juelich
Email: patermann.chris@web.de

Dr. Heike Slusarczyk
KBBE Office at FZJ Corporate Strategy Forschungszentrum Juelich
Email: h.slusarczyk@fz-juelich.de
Thank you for your attention!