Renewables-based Chemicals

From raw material opportunities to increased performance

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Global New Business Development, Chemical Intermediates
BASF – We create chemistry

- Our chemistry is used in almost all industries
- We combine economic success, social responsibility and environmental protection
- Sales 2014: € 74.3 billion
- EBIT 2014: € 7.6 billion
- >112,000 employees
- 6 Verbund sites and 353 other production sites
Chemistry-based innovations
Growth fields and Technology fields

Global needs
- Resources, Environment and Climate
  - Transportation
  - Construction
  - Health & Nutrition
- Food and Nutrition
  - Agriculture
  - Energy & Resources
  - Consumer Goods
  - Electronics
- Quality of Life
  - Consumer Goods
  - Health & Nutrition

Customer industries
- Transportation
- Agriculture
- Construction
- Energy & Resources
- Consumer Goods
- Electronics

Growth fields
- Automotive Lightweight Composites
- Batteries for Mobility
- Enzymes
- E-Power Management
- Functional Crop Care
- Heat Management for Construction
- Organic Electronics
- Plant Biotechnology
- Water Solutions
- Wind Energy
- ...

Technology fields
- Materials, Systems & Nanotechnology
- Raw Material Change
- White Biotechnology
Enzymes from BASF enable innovative product and system solutions for various customer industries.

Existing activities

- Enzymes for animal nutrition (phytase, glucanase, xylanase)
- Establishing an enzyme platform based on several acquisitions

Targets

- Position BASF as an integrated enzyme supplier in strategically important markets (animal nutrition, detergents and cleaning agents, food and baking industry)
- Access new markets, e.g. in oilfield chemicals
We work on sustainable processes for using alternative raw materials such as natural gas, biomass and CO₂.

**Research focus**
- Exploration of natural gas, biomass and CO₂ as basis for raw materials
- Integration of competencies: synthesis, catalysis, process development and unit operations, high-throughput methods

**Examples of existing activities**
- Natural gas: Olefins from natural gas by using catalyst technologies
- Carbon dioxide (CO₂): Synthesis of formic acid and acrylates
- Biomass: Lignocellulose as a raw material
Innovation
Global Know-How Verbund

Thanks to our close cooperation with more than 600 partners in science and industries worldwide, we have created an international and interdisciplinary Know-How Verbund.

- Expenditures for R&D ca. €1.9 billion world leader in chemical industry
- Around 10,500 employees worldwide in R&D
- Around 3,000 research projects
- Sales target 2020: €30 billion from product innovations
- Technology fields: Materials, Systems & Nanotechnology; Raw Material Change; Industrial Biotechnology
3 Pathways to a Renewables-based Product Portfolio

Renewable Raw Materials

- **Existing Products**
  - Oleochemicals
  - Enzymes
  - Vitamins
  - ....

- **Drop-Ins**
  - 1,4 Butanediol
  - Succinic acid
  - Acrylic acid
  - ....

- **New Products**
  - Schizophyllan
  - FDCA
  - Pentamethylen diamine
  - ....

Strategy
Existing Products: Oleochemicals – BASF as integrated chemical producer

Oil from natural resources

Glycerol
- Esterification
- Alkoxylation

Fatty Acids
- Esterification

Fatty Acid Methyl Esters
- Ethoxylation

Fatty Alcohols

Existing Products:
- Partial Glycerides
- Polyether Polyols
- Fatty Acid Esters
- Alkyl Epoxy Esters
- Fatty Acid Ethoxylates
- Guerbet Alcohols
- Alkyl Polyglycosides
- Fatty Alcohol Ethoxylates
- Fatty Alcohol Sulfates
- Fatty Alcohol Ether Sulfates
- Fatty Acid Acylamido Betaines
- Fatty Acid Alkanolamides
- Epoxidized Vegetable Oils
- Ethoxylated Triglycerides
- Hardened Triglycerides, Hydrogenated Castor Oil, HCO
- Fat Liquors/Turkey Red Oil
Complementary Approach: Mass Balance for our Portfolio

**Feedstock**
- Fossil
- Renewable

**BASF Production Verbund**

**Products**
- Conventional
- Allocated

**Use of renewable feedstock in very first steps of chemical production (e.g., steam cracker)**

**Utilization of existing Production Verbund for all production steps**

**Allocation of renewable feedstock to selected products**
Drop-ins: Renewable BDO – from biomass to biobased textiles

Development scale
- Campaigned production by external tollers; several kt produced
- Material available for business development
- Produce additional downstream products (renewable PolyTHF®)

Commercial scale
- Invest and set-up a fully integrated production plant for 50 kt annual capacity
- Production of renewable BDO and derivatives

Full commercial scale planned in 3-5 years.
Marginal Producer Logic Example BDO Pricing

1,4-Butanediol (BDO) global cash cost curve
average cash costs 2013

The marginal producer sets the price

Commodity Business
→ Supply/demand balance: red line
→ New entries shift the curve
→ Size matters, capacity?
Succinic Acid as versatile Platform Chemical – broad applications

Succinity GmbH – Joint Venture of BASF and Corbion Purac

- Production and sale of biobased succinic acid (Succinity®) as platform chemical
- Broad applications in bioplastics, solvents, intermediates, polyurethanes, plasticizers
- Competitive process based on renewable resources and high performing proprietary micro-organism, capturing CO₂
- Economically and ecologically attractive alternative to petrochemical raw materials
- Production in Montmeló, Spain
FDCA as New Monomer for Polyesters

Sugar → 5-Hydroxymethylfurfural (HMF) → Furan dicarboxylic acid (FDCA) → PEF Products

Properties:
mp: 221°C (PET 253°C, PEN 271°C)
T_g: 87°C (PET 80°C, PEN 123°C)
Barrier:
O₂: > 6* PET
CO₂: > 2* PET
H₂O: > 2*PET

Superior material properties are driver for PEF
BASF is open to any kind of Partnerships

Broad range of activities across multiple divisions
Renewables-based Chemicals @ BASF

- BASF is active in a range of products made from renewable raw materials and develops opportunities for:
  - drop-ins
  - new products

- Success of Drop-ins is dependent on: Technology + Market + Strategy

- Success factors for New products are: Performance, Competition, Stamina

- Strong partnerships are key to establish new value chains
150 years

BASF

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