Renewable-based products in the chemical industry - BASF perspective

Lars Gustafsson
Senior Sustainability Manager Business Development Nordic/Baltic
Why renewable feedstock?

1. Competitiveness: product with a certain performance not accessible or at higher cost or market demand

2. Sustainability: Saving of fossil resources and climate protection
   - Vision 2050: a world in which nine billion people can live well, and within the planet’s resources

3. Opportunities: Customer / consumer demand and regulations

4. Raw materials: diversification of the raw material base

Four main drivers are influencing BASFs renewable-based portfolio.
Why do we create chemistry based on renewables?

1. Sustainability is a common future goal
2. Brand-owners addressing consumer demands
3. Market need for diversification of raw materials base
4. Enabling molecules not accessible via fossil routes

Four main drivers are influencing BASF's renewable-based portfolio.
Different approaches to a renewable-based portfolio

- **Products only accessible from renewables, e.g.**
  - Oleochemicals
  - Furandicarboxylic Acid
  - Enzymes
  - Schizophyllan (Biopolymer)

- **RRM-based drop-ins, e.g.**
  - 1,4-Butanediol
  - Succinic acid
  - Vitamin B2
  - Beta-carotin

- **Biomass balance products, e.g.**
  - Polyurethanes
  - Polyamides
  - Acronal Dispersions

---

24.09.2018
BASF purchases a broad range of renewable raw materials

<table>
<thead>
<tr>
<th>Oils &amp; Fats</th>
<th>Grains</th>
<th>Sugar</th>
<th>Wood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural oils</td>
<td>Starches</td>
<td>Raw sugar</td>
<td>Ligninsulfonate</td>
</tr>
<tr>
<td>Fish oil</td>
<td>Modified Starches</td>
<td>White sugar</td>
<td>Cellulose-Derivatives</td>
</tr>
<tr>
<td>Castor oil</td>
<td>Dextrose</td>
<td>Ethanol</td>
<td>Gum Rosin</td>
</tr>
<tr>
<td>Sebacic acid</td>
<td>Maltodextrin</td>
<td>Itaconic acid</td>
<td>Tackifier</td>
</tr>
<tr>
<td>Fatty acids</td>
<td>Gluconates</td>
<td>Citric acid</td>
<td>Furfural</td>
</tr>
<tr>
<td>Fatty alcohols</td>
<td></td>
<td></td>
<td>Tall oil sterols</td>
</tr>
<tr>
<td>Glycerin</td>
<td></td>
<td></td>
<td>TOFA</td>
</tr>
<tr>
<td>Stearates</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.4\% of BASF’s total raw material purchase are renewables.
Growing demand, but RRM are not intrinsically sustainable.
Palm and palm kernel oil

Wide-spread use in personal care and food applications

Unique chemical properties make substitution unfeasible to date

Supply chain complexity challenges traceability

Plantations cause deforestation and related issues of concern

Palm is an example for the sustainability dilemma of renewables.
BASF spurs sustainable certified oil palm products beyond time-bound plans

BASF 1st commitment renewed and extended
Target to source all oils RSPO* certified
Target to source main intermediates RSPO certified
Upcoming topics…

- Progress reporting
- Smallholder inclusion
- Free and Prior Informed Consent (FPIC), labor rights
- Forest and peatland protection
- Traceability

*RSPO = Roundtable on Sustainable Palm Oil
How do we work on our journey to Sustainable Palm?

Collaborate
BASF was one of the first members of the Roundtable on Sustainable Palm Oil (RSPO) and is a member of the High Carbon Stock Approach Steering Group.

Co-create for sustainability
Together with our partners we engage in smallholder inclusion.

Drive physical transformation
Our certified sites worldwide enable the shift towards sustainable palm.

More information: on.basf.com/palm-dialog or Twitter @BASF_palm
Bio based succinic acid
direct platform chemical – broad applications

Succinity GmbH – joint venture
of BASF (CI) and Corbion

- Production and sale of bio-based 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 start Montmeló, Spain Q1 2014
1,4-Butanediol (BDO) For additional value

- BDO based on renewable feedstock
- Production with patented process technology of Genomatica, USA
- One-step fermentation process based on sugars
- Key to making downstream products more sustainable
- Additional value for our customers e.g., in the plastics, textile and automotive industries
- First commercial volumes available since end 2013
Furandicarboxylic acid from renewable feedstock for Polyethylenefuranoate and more

- Synvina: Joint venture with Avantium, NL, striving for world leadership in furandicarboxylic acid (FDCA) and polyethylenefuranoate (PEF)
- Production and marketing of FCDA based on renewable feedstock, marketing of PEF
- FDCA main new building block for PEF with superior material properties
- FDCA-production at BASF’s Verbund site Antwerp, Belgium, planned
  - First comm.-scale FDCA plant
  - Capacity 50 ktons/p.a.
  - Technology licensing
ecovio® - bio-based and compostable

Consists of the compostable BASF polymer ecoflex® and polylactic acid (PLA) derived from corn

Applications:
- Bags: Fruit & Vegetable Bags, Organic Waste Bags, Shopping bags
- Agro: Mulch films, geotextiles
- Packaging: rigid and flexible packaging

Please note: bio-based and biodegradable are not the same
Applications:

- Agricultural films like clamp silage, silo bags, green house films
- Cheese ripening bags & other MAP bags/ pouches
- Very soft bags with high puncture and high tear resistance
- Vacuum Skin Packaging
Biomass Balance: groundbreaking way of deriving products from RRM

We create chemistry
Biomass is added at the very beginning of our production chain.
Our core – the BASF “Verbund”
Production site Ludwigshafen

- 10 square kilometers area
- > 160 production plants,
- 5,800 sales products and 12,000 components
- 21,000 vehicles on site
- 106 km road, 230 km rail, and 2,800 km over ground pipes
BASF’s Verbund

- Basic chemical production
- Sulfuric acid plant
- Acrylic acid plant
- Adipic acid plant

> 10,000 products
> 150 years technical optimization
## Filling the gap between traditional and dedicated production

<table>
<thead>
<tr>
<th>Traditional production</th>
<th>Biomass balance approach</th>
<th>Dedicated production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fossil feedstock</td>
<td>Biomass-derived, 3rd party certified</td>
<td>Bio-based ((^{14})C method)</td>
</tr>
<tr>
<td>Known performance</td>
<td>Same performance</td>
<td>Often different product properties</td>
</tr>
<tr>
<td>&gt;10,000 products available in production scale</td>
<td>&gt;10,000 products available in production scale</td>
<td>Not available for all products</td>
</tr>
<tr>
<td>Verbund production</td>
<td>Drop-in BASF Verbund production</td>
<td>Investment in new plants</td>
</tr>
<tr>
<td></td>
<td>Additional cost of “bio” feedstock</td>
<td>Additional cost of “bio” feedstock</td>
</tr>
</tbody>
</table>
Claims and certificates

“Fossil resource saving product. X % of the fossil feedstock required for the manufacturing of this product was replaced in the production site by renewable raw materials.”

Certified by TÜV SÜD

“The replacement of fossil through renewable feedstock reduces the greenhouse gas emissions by x t CO₂ equivalents per t product.”

Additional self-assessment of BASF for declaration according to ISO 14021
Examples for biomass balanced products

- Shampoo refill pack: packaging of hygiene articles in Japan (e.g. DNP)
- Sandwich panels with biomass balanced insulation foam (e.g. Falk)
- Indoor paints are using biomass balanced binders (e.g. CapaGeo)
- Biomass balanced superabsorber for diapers (e.g. HySorb® MB)

Customers from various industries are buying our BMB products.
Biomass Balance packaging example: SIG Nature Pack in Europe

Developing a pack solution that adheres to consumer demands, in addition to ensuring that it is innovative within the industry is no small feat. However SIG have created the world’s first aseptic pack 100% linked to plant-based renewable material – a solution that holds added value, meets the demands of the industry and has a clear core message.

Solid Credentials

Like FSC™, ISCC Plus and TÜV SÜD CMS 71 are recognised certification standards. They offer a sustainability certification for the renewable feedstock used for producing the plastics used in our packaging and provide strict traceability of the materials along the value chain via a mass balance system.
Biomass balance: Same products, clear advantages vs. other renewable building blocks

**Performance:**
- Renewable products have exactly the same performance as conventional products.
- Mass balance method can be applied to all products and formulations.

**Costs:**
- No investments in new plants required.
- No re-formulation costs required.
- No costs for testing required.
- Higher costs than for conventional products.

**Renewable content:**
- Renewable content can range from 25-100% for a single product.

**Implementation:**
- Easy and fast implementation – it is available today.
- No additional work required.
- Lead time 6-9 months.

**Sustainability:**
- Certified renewable feedstock.
- Full transparency and traceability.
For the use of renewable raw materials at BASF 4 different value drivers are crucial
- Competitiveness
- Sustainability
- Business Opportunity
- Diversification of raw materials base

Renewable Raw Materials are not per se sustainable

BASF offers bio-based materials as well as biomass balanced materials