Gospodarka Obiegu Zamkniętego w BASF
Recykling chemiczny i równoważenie biomasą

dr Agata Kruszec
Market Development & Sustainability
BASF Polska

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Agenda

1. Zrównoważony rozwój i gospodarka obiegu zamkniętego w BASF

2. Alternatywna baza surowcowa w ramach Programu GOZ
   - Recykling chemiczny – ChemCycling™
   - Równoważenie biomasą – Biomass Balance
Heading towards a sustainable future
Our purpose:

We create chemistry for a sustainable future
What we want to achieve

We want to be a thought and action leader in the area of sustainability.

We want to increase the role of sustainability in our business decisions.

We want to show how we add value to society along the value chain.

Key measures

Decouple our CO₂ emissions from organic growth through a Carbon Management program.

Speed up the transition to a circular economy through a Circular Economy program.

Further increase our sales from Accelerator products, which make a substantial sustainability contribution in the value chain.
The linear economy: Take – make – dispose

The circular economy: Reduce – reuse – recycle

Circular Economy at BASF
We have three areas of focus: circular feedstocks, new material cycles and new business models

**Circular feedstocks**
We will increase the volume of renewable and recycled feedstocks from sustainable sources, also via the certified mass balance approach.

**New material cycles**
We design materials for circularity, develop solutions which improve or enable recycling and establish product-specific recycling loops.

**New business models**
We enter new markets, create smart digital solutions and offer new services which allow a decoupling of growth from resource consumption.
By using alternative raw materials, we can manufacture the same products in a more sustainable way.

**Renewable feedstock**

- Biomass Balance portfolio
  - Derived from biomass waste of agricultural production, crop or food processing, or residues
- Dedicated bio-based portfolio
  - Sustainably sourced resources, e.g. RSPO certified

**Recycled feedstock**

- e.g. ChemCycling™
  - Derived from post-consumer plastic waste or tires
Plastics, plastic waste & end-of-life options
Plastics play an important role in a sustainable and resource-efficient economy

Packaging
Plastics ensure food safety and reduce food waste

Building & Construction
Plastics ensure energy savings and long product life span

Automotive
Plastics ensure weight reduction, fuel-efficiency and safety
Plastic waste is a major global challenge
We must address end-of-life challenges to make full use of plastics’ benefits
Today’s recycling landscape for plastic waste
Fate of 30 million metric tons of plastic waste generated in EU28+2 in 2018

Only one third of all plastic waste is kept in the materials cycle in EU28+2.

The role of chemical recycling in a Circular Economy
Different loops are necessary for a successful transition towards circularity

ChemCycling™ is complementary to mechanical recycling.
Closing the loop for plastics with the ChemCycling™ project
BASF’s ChemCycling™ project
An innovative way to use recycled raw materials for demanding applications

Consumers use and dispose plastic products (e.g. packaging, tires)

Waste companies collect and sort the waste and supply BASF’s technology partners with it

Our partners convert the plastic waste into pyrolysis oil through a thermochemical process

Pyrolysis oil is purified to be used as feedstock at the beginning of BASF’s Verbund production

BASF can allocate the recycled feedstock to all chemicals produced in this Verbund via a certified mass balance approach

Our customers use these chemicals to make their own products
BASF’s cooperates with Quantafuel, Pyrum and New Energy
Partnerships are part of BASF’s efforts to develop chemical recycling as a business

- Pyrolysis of **mixed plastic waste**
- Start-up of plant in September 2020
- BASF supports further development of Quantafuel’s technology towards optimizing the output for the use as feedstock in chemical production

- Pyrolysis of **end-of-life tires**
- One production line in operation after 10+ years of optimization
- Ready for roll-out of technology, planning to build additional production lines with partners

- Pyrolysis of **end-of-life tires**
- One plant in operation after almost a decade of optimization
- Feasibility study underway that targets the adaption of New Energy’s technology to the conversion of other plastic waste streams

Pyrolysis oil from end-of-life tires is additional raw material source next to oil from mixed plastic waste, the use of which is the long-term focus of the ChemCycling project.
Examples for customers applications made with Cycled™ products

Commercial product –
in the German market since summer 2020

The innovative packaging based on recycled raw materials is a perfect match for our new Gutfried organic chicken meat sausage

Maximilian Tönnies, Managing Director
Zur Mühlen Gruppe

Prototyping

Plastics are vital to car manufacturing and have proven benefits during their use phase, however, plastic waste remains a major global challenge. Solving this issue requires innovation and joined-up thinking between regulators, manufacturers and suppliers

Chris Brown Senior Sustainability Manager, Jaguar Land Rover
Benefits of ChemCycling™
**Benefits of ChemCycling™ – Overview**

Why BASF is developing chemical recycling for use on industrial scale

<table>
<thead>
<tr>
<th>Complementary approach</th>
<th>Contributing to a circular economy</th>
<th>Virgin quality</th>
<th>Solution oriented</th>
<th>Replacing fossil resources and saving CO₂ emissions</th>
<th>Supporting our customers</th>
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<td>to existing recycling methods, thus overall recycling rates of plastic waste will be increased</td>
<td>as plastic waste is turned into feedstock for the chemical industry</td>
<td>products for demanding applications can be manufactured, e.g. food packaging or automotive parts</td>
<td>end-of-life option for high-performance plastics, e.g. multi-layer packaging</td>
<td>against conventional plastics production</td>
<td>in achieving their recycling targets</td>
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Virgin quality products for demanding applications can be manufactured, e.g. food packaging or automotive parts.

Supporting our customers in achieving their recycling targets.

Complementary approach to existing recycling methods, thus overall recycling rates of plastic waste will be increased.

Solution oriented end-of-life option for high-performance plastics, e.g. multi-layer packaging.

Contributing to a circular economy as plastic waste is turned into feedstock for the chemical industry.

Replacing fossil resources and saving CO₂ emissions against conventional plastics production.

Virgin quality products for demanding applications can be manufactured, e.g. food packaging or automotive parts.
Life Cycle Assessment of ChemCycling™
Basic Life Cycle Assessment (LCA) ChemCycling™
Conformity to respective ISO 14040 series

Three separate studies

- **Waste perspective:** Comparison of pyrolysis and incineration of mixed plastic waste
- **Product perspective:** Comparison of plastics based on pyrolysis oil and conventional plastics from primary fossil resources (naphtha)
- **Plastics quality perspective:** Comparison of the life cycle of 1t of virgin plastics with three end-of-life options

Panel decision

- “…the LCA study followed the guidance of and is consistent with the international standards for Life Cycle Assessment (ISO 14040:2006 and ISO 14044:2006).”
- The background report and review statement is available at: www.basf.com

Commissioner / LCA practitioner

- Dr. Christian Krüger
- Manfred Russ

Critical Review Panel

- Prof. Adisa Azapagic (Panel Chair)
- Dr. Florian Antony
- Simon Hann
Chemical recycling is attractive in terms of CO₂ emissions – the most discussed LCA indicator

- Pyrolysis of mixed plastic waste emits 50 percent less CO₂ than incineration of mixed plastic waste.
- CO₂ emissions are saved when manufacturing plastics based on pyrolysis oil under a mass balance approach instead of naphtha.
- Manufacturing of plastics via either chemical recycling (pyrolysis) or mechanical recycling of mixed plastic waste results in comparable CO₂ emissions.
Remaining hurdles
Chemical recycling technology is ready for large scale industrial use
Challenges remain to make technology more broadly applicable and to meet demand

All major plastics producers have engaged in partnerships to overcome technical challenges

**Challenge 1: Quality & Efficiency**
- Quality of pyrolysis oil is crucial for use as feedstock in chemical production network
- Need for continuous improvement of pyrolysis & purification processes to
  1) increase overall efficiency
  2) to address a greater variety in quality of mixed plastic waste (purification)

**Challenge 2: Volumes**
- Today’s capacities of pyrolysis by far not sufficient to meet the demand
- It is estimated that in the next twenty years several hundred chemical recycling plants will be required globally*

**Partnering is Key**
Example BASF & Quantafuel
- Quantafuel owns a unique integrated process of pyrolysis of mixed plastic waste & purification of the resulting oil
- Start-up of plant with a capacity of 16,000 tons in Q3 2020; optimization ongoing (according to plan)

Long-lasting commitment from big plastic producers to investment in chemical recycling capacities & technology is growing

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* Source: The PEW Charitable Trusts, Systemiq “Breaking the plastic wave”, p. 32
ChemCycling™ project

Status quo

- First commercial applications and several prototypes realized with customers
- Investments into Quantafuel and Pyrum and collaboration agreement with New Energy to secure supply of pyrolysis oil
- Technological support for partners to gain speed in process development and plant start-ups
- Mass balance allocation and products themselves are certified by independent auditors
- Life Cycle Assessment (LCA) shows how CO₂ emissions can be saved with ChemCycling

We are actively exploring chemical recycling’s potential and are constantly working to improve this innovative recycling technology
The biomass balance approach
BASF’s Biomass Balance Approach

- Requires **no reformulation** – identical product performance
- **Available** easy and fast for nearly all our products
- **Saves fossil resources** and **reduces greenhouse gas** emissions
- Drives the use of sustainable **renewable feedstock**
The Biomass Balance Approach: Replacing fossil resources in the current Production Verbund

**Feedstock**
- Fossil
- Renewable

**BASF Production Verbund**
- Use of renewable feedstock in very first steps of chemical production (e.g., steam cracker)
- Utilization of existing Production Verbund for all production steps

**Products**
- Conventional product
- Biomass Balance product
  - Allocation of renewable feedstock to selected products
Challenge: Recycled materials cannot be directed to one specific product

Therefore, an external certification system is needed.
Our solution: Certification and standardization

RedCert² ensures the correct allocation of recycled resources in BASF’s value chain.
Biomass Balance Approach can be compared to green electricity

**Biomass Balance Approach**

<table>
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<th>Feedstock</th>
<th>BASF Production Verbund</th>
<th>Products</th>
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<td>Fossil</td>
<td></td>
<td>Conventional product</td>
</tr>
<tr>
<td>Renewable</td>
<td></td>
<td>Biomass Balance product</td>
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**Green electricity**

- Wind power
- Photovoltaics
- Hydropower
- Biomass
- Consumer
- Coal power
- Nuclear power
Renewable raw materials need to be sourced sustainably

Use certified renewable raw materials
- Waste/residues are preferred renewable raw materials
- Independent sustainability certification from recognized schemes, e.g., REDcert-EU and ISCC-EU

Apply standardized sustainability criteria
- Minimum sustainability criteria as in EU RED*
- Greenhouse gas emissions savings
- Responsible biomass production
- Protection of areas with high biodiversity and large carbon stocks

* Renewable Energy Directive of EU Commission
Industries already benefit from our Biomass Balance products

- **HySorb® Biomass Balanced** – Sustainable superabsorber for baby diapers
- **Ultramid®** polyamide for textile application
- **R-M®** automotive refinish products
- **EU-REDcert-Methanol**
- **Glasurit®** automotive refinish products
- **Decorative effect paints with Acronal®**
- **Flexible films for new packaging made of Ultramid®**
- **Acronal® binders for interior paints**
- **Styropor packaging solution**

We create chemistry
BASF’s mass balance approach for products based on renewable and recycled feedstock

Technical Approach / Tool

Biomass Balance
- Renewable feedstocks used
- Co-processing with primary fossil feedstock
- Allocation to products via biomass balance (3rd party certified according to REDcert²)

ChemCycling™
- Recycled feedstocks used
- Co-processing with primary fossil feedstock
- Allocation to products via mass balance (3rd party certified according to REDcert²)

...for markets that seek....

- CO₂ emission reduction
- Identical chemical and physical properties
- Waste reduction
- Fossil resource savings
Dziękuję za uwagę!

dr Agata Kruszec
Market Development Project Manager & EMEA Sustainability Ambassador
BASF Polska
agata.kruszec@basf.com