BASF
We create chemistry

Chemical Recycling

A key technology on our way towards a circular economy

Dr. Christoph Jäkel
Vice President, Corporate Sustainability

Cautionary note regarding forward-looking statements

This presentation contains forward-looking statements. These statements are based on current estimates and projections of the Board of Executive Directors and currently available information. Forward-looking statements are not guarantees of the future developments and results outlined therein. These are dependent on a number of factors; they involve various risks and uncertainties; and they are based on assumptions that may not prove to be accurate. Such risk factors include those discussed in Opportunities and Risks on pages 139 to 147 of the BASF Report 2019. BASF does not assume any obligation to update the forward-looking statements contained in this presentation above and beyond the legal requirements.

Sustainability at BASF

Key measures

- **Climate protection**
  Decouple our CO_2 emissions from organic growth through a Carbon Management program
  ► **CO_2-neutral growth until 2030**

- **Sustainable product portfolio**
  Further increase our sales from “Accelerator” products, which make a substantial sustainability contribution in the value chains
  ► **€22 billion by 2025**

- **Circular economy**
  Invest in cutting-edge technologies to speed up the transition to a circular economy, such as our **ChemCycling™** project

Our purpose:

We create chemistry for a sustainable future

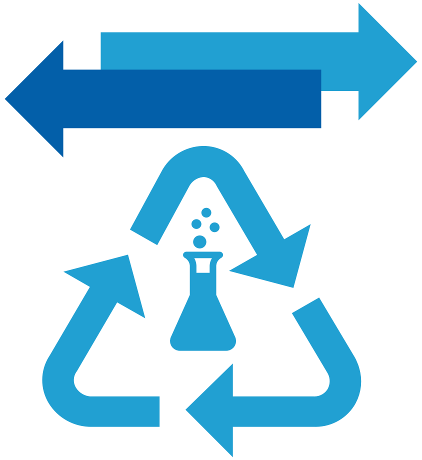
BASF
We create chemistry

Plastics production today

Plastics industry needs to adapt to a changing legislative environment

Highly efficient production of high-performance plastics

- Optimized system over 50 years
- Crude oil based
- Large variety of specialized plastics for demanding applications



Chemical recycling

Challenges

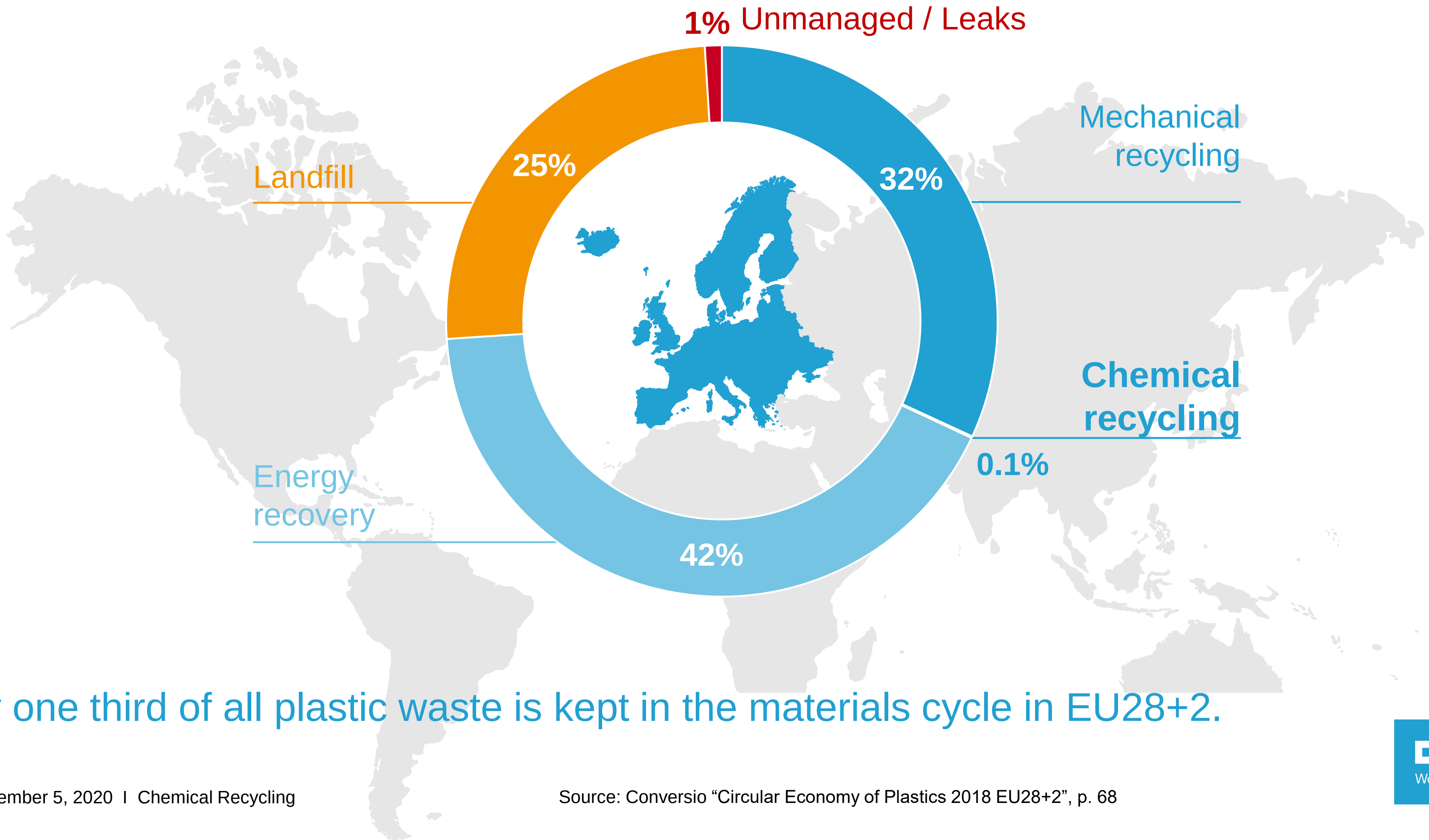
- **Public pressure** to reduce plastic waste (marine littering, landfill)
- Ambitious **legislation targets**
  - Reduce GHG emissions
  - Increase recyclability of plastics
  - Increase recycled content in plastics

Chemical recycling can handle the challenges while maintaining process efficiencies and plastics performance

BASF
We create chemistry

Today's recycling landscape for plastic waste

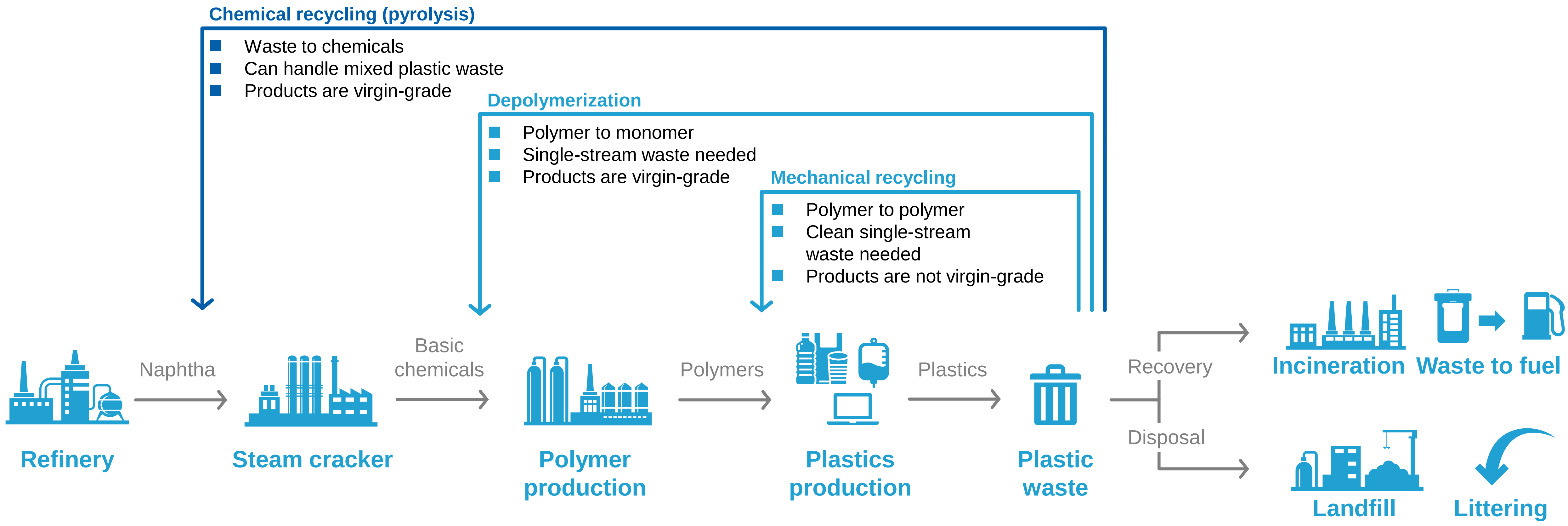
End-of-life treatment of 29 million tons of plastic waste in EU28+2 in 2018



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

Source: Conversio "Circular Economy of Plastics 2018 EU28+2", p. 68

Chemical recycling complements mechanical recycling and can contribute significantly to achieve EU recycling targets



Chemical recycling is one of many measures needed to reduce fossil resource consumption and to achieve a world free of plastic waste

BASF's ChemCycling™ project

Breaking new ground in plastics waste recycling

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
We create chemistry

Status of BASF's ChemCycling™ project
(October 2020)

Project start

Network and partnerships along the value chain developed

2018

First batches of pyrolysis oil fed into the Verbund

Certification system for recycled products developed together with ecocycle

First certified ChemCycling™ product prototypes realized with customers

2019

Presentation of customer prototypes at leading plastics trade show (K fair)

Investment into Quantafuel to jointly drive chemical recycling of mixed plastic waste

2020

First commercial applications with Ccyled™ material launched by customers

Collaboration agreements with New Energy

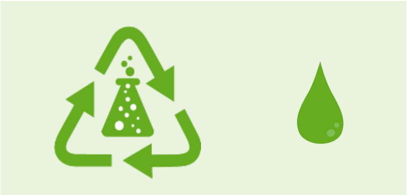
Investment into Pyrum to roll out their tire pyrolysis technology

BASF
We create chemistry

Allocation of recycled feedstock with the mass balance approach

Feedstock

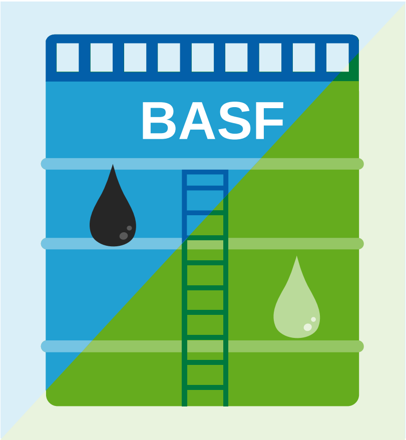
Fossil



Recycled

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

BASF Production Verbund



Utilization of existing Production Verbund for all production steps

Products

Conventional product (Ultramid®)

Mass balance product (Ultramid® Ccycled™)

Allocation of recycled feedstock to selected products

BASF
We create chemistry

Mass balance principle is widely used in certification schemes in different industry sectors

Palm oil & agriculture

Timber

Biofuels

Circular feedstocks

BASF
We create chemistry

ChemCycling™ contributes to a circular economy, saves resources and avoids emissions

- **Plastic waste is turned into feedstock** for the chemical industry
- Using recycled feedstock from plastic waste in chemical production helps to **replace primary fossil resources**
- **CO_2 emissions are avoided** in comparison to conventional plastic production and incineration of plastic waste

Regulatory support for chemical recycling needed

- Chemical recycling **needs to count towards recycling targets**
- **Incentives** for recycled content should apply to all kinds of recycling
- **Acceptance of mass balance approach:** mass-balanced recycled content should be supported to the same extent as single-sourced recycled content

Technology-open definition of recycling is key to address the plastic waste problem

BASF
We create chemistry

Today's capacities and quality of pyrolysis oil by far not sufficient to meet the demand

Example: Plastic packaging recycling

- Out of **17.8 million tons** of plastic packaging waste in Europe **~ 7.5 million tons** (42%) are recycled*
- With the EU target (**55%** of plastic packaging waste recycled by 2030), recycling demand for another **2.3 million tons** of plastic packaging waste arises
- Assuming an equal contribution of mechanical and chemical recycling to address the increased recycling rate (volume), approx. **100 pyrolysis plants** of current average scale **are required**

Commitment from large plastic producers to continuous investment in chemical recycling capacities needed

Pyrolysis plant landscape in EU

* Source: PlasticsEurope, Plastics – the Facts 2019

Summary

- Chemical recycling can handle the challenges ahead of today's plastics production, while maintaining **process efficiencies and plastics performance**
- Chemical recycling is **complementary to mechanical recycling** and is needed to achieve EU recycling targets
- Challenges regarding the **acceptance and technology** need to be tackled
- **Life cycle analysis** demonstrates that chemical recycling is a sustainable way to close the recycling loop for plastics
- Today's **capacities and quality of pyrolysis oil** are by far **not sufficient** to meet the demand
- **Cross-industry cooperation** and **continuous investment** in chemical recycling capacities and technology are required

BASF

We create chemistry

Life Cycle Assessment demonstrates that chemical recycling is a sustainable way to close the loop for plastics

Approach

Life Cycle Assessment (LCA) study commissioned by BASF, performed by a third-party in consistence with international LCA standards and reviewed by three independent and recognized experts

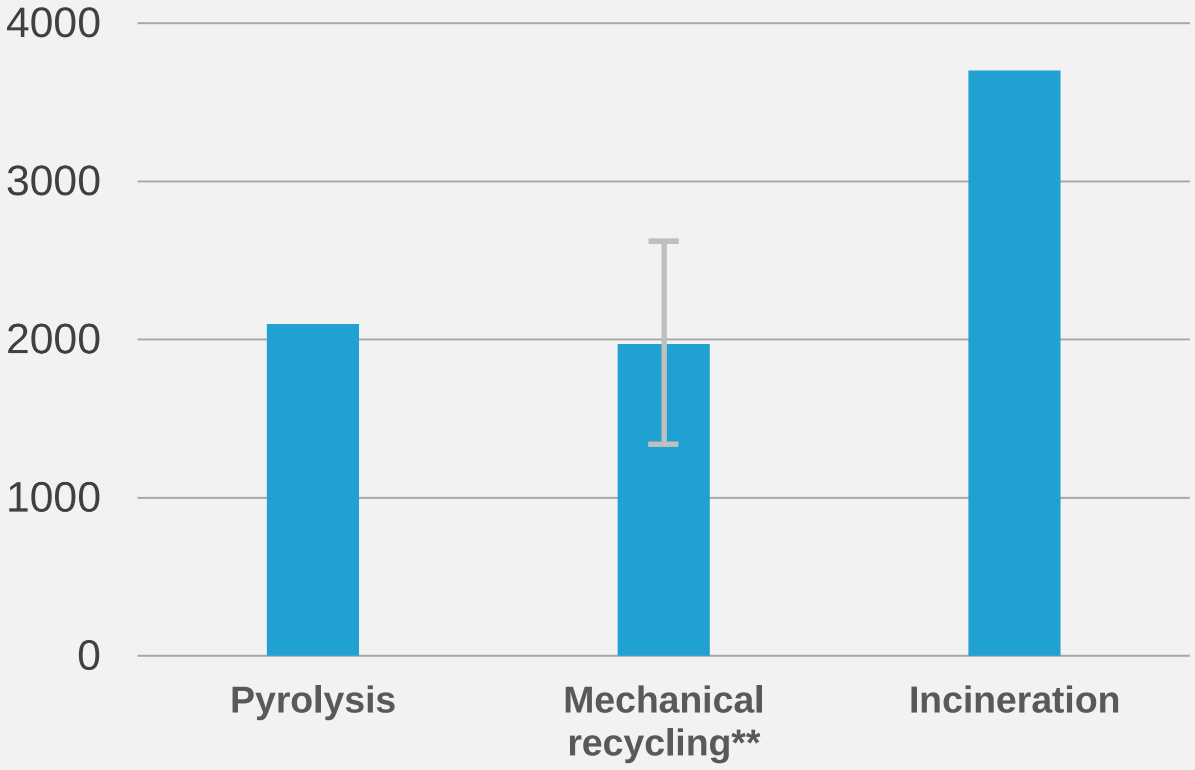
Results

- Pyrolysis of mixed plastic waste emits ~50% less CO_2 than incineration of mixed plastic waste.
- Manufacturing of plastics via chemical recycling (pyrolysis) or mechanical recycling of mixed plastic waste results in similar CO_2 emissions*.

* Differences in product quality (virgin grade quality for chemical recycling / non-virgin-grade quality for mechanical recycling) as well as differences in sorting losses are included in the calculation by applying the *Circular Footprint Formula* of JRC / EU Commission.

Comparison of CO_2 emissions of the life cycle of 1 ton of virgin plastics with three end-of-life options

CO_2 emissions [kg CO_2e/ton product]



Production and end-of-life treatment of 1 ton of plastics via pyrolysis emit 2,100 kg CO2e, whereas production and end-of-life treatment of 1 ton of plastics via mechanical recycling emits 2,000 kg CO2e. Production and incineration of 1 ton of plastics emits 3,700 kg CO2e.

** The error bar reflects the different scenarios by changing the quality factor and the material loss rates after sorting of waste. The value can vary +/-25%

BASF
We create chemistry