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Driving sustainability with microorganisms

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Cautionary note regarding forward-looking statements

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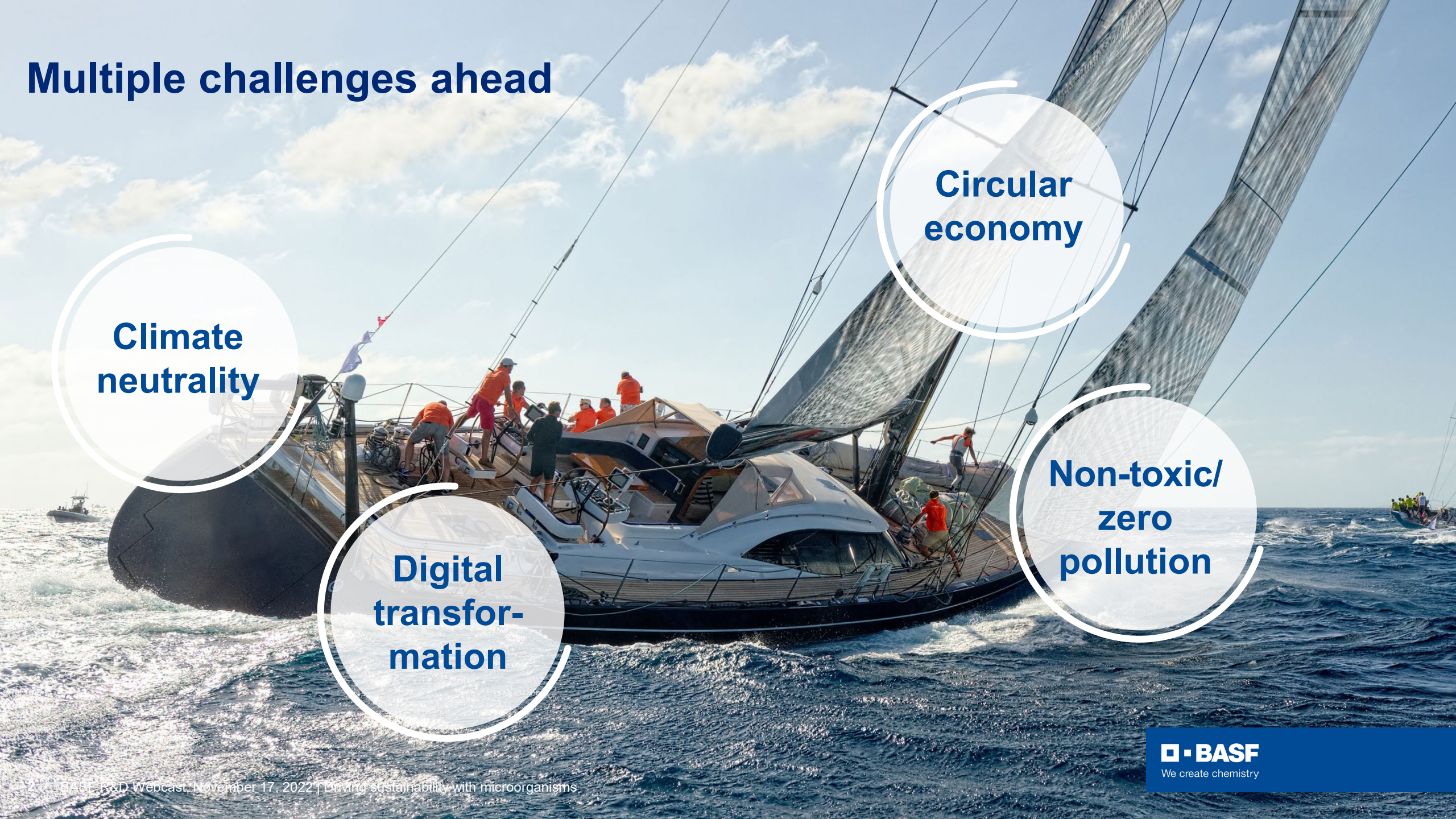
Multiple challenges ahead



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Continuous commitment to sustainability

Climate neutrality

- Invest in wind energy, PPAs
- CO_2-free hydrogen
- Electrification of processes
- Product carbon footprint

Circular economy

- ChemCycling™
- Recycling of polymers
- Battery recycling

Digital transfor-mation

- Strong focus on digitalization in R&D
- Supercomputer
- Process optimization through digitalization

Non-toxic/ zero pollution

- Portfolio steering
- Ecoefficiency analysis
- Biodegradables

Our global innovation setup benefits our customers and supports the transformation towards sustainability

Product research embedded in operating divisions to **adapt fast to rapidly evolving market trends, cater to customer requirements and drive innovation**

Research capabilities bundled in one research division with presence in all regions **to leverage BASF's Know-how Verbund**

Global network of top universities, research institutes and companies **drives innovation**

[1] BASF's Academic Research Alliances, academia, industry partners, startups

We operate the industry-leading innovation platform: Facts and figures 2021

10,000
Employees in R&D

Our target:
Resource-efficient solutions and business models to decouple growth from the consumption of finite resources

€2.2bn
Global expenditures for R&D, world leader in the chemical industry

>€11bn
innovation sales[1]

Our success factors
- Customer focus
- Digitalization
- Creativity
- Efficiency
- Collaboration with partners

New patents filed
820

[1] Sales generated with products launched on the market in the past five years that stemmed from research and development activities

Driving sustainability – a value chain perspective

Feedstock

From fossil-based to circular and alternative raw materials

Process

From energy-efficient to CO_2-free

Product

From risk-based to safe and sustainable by design

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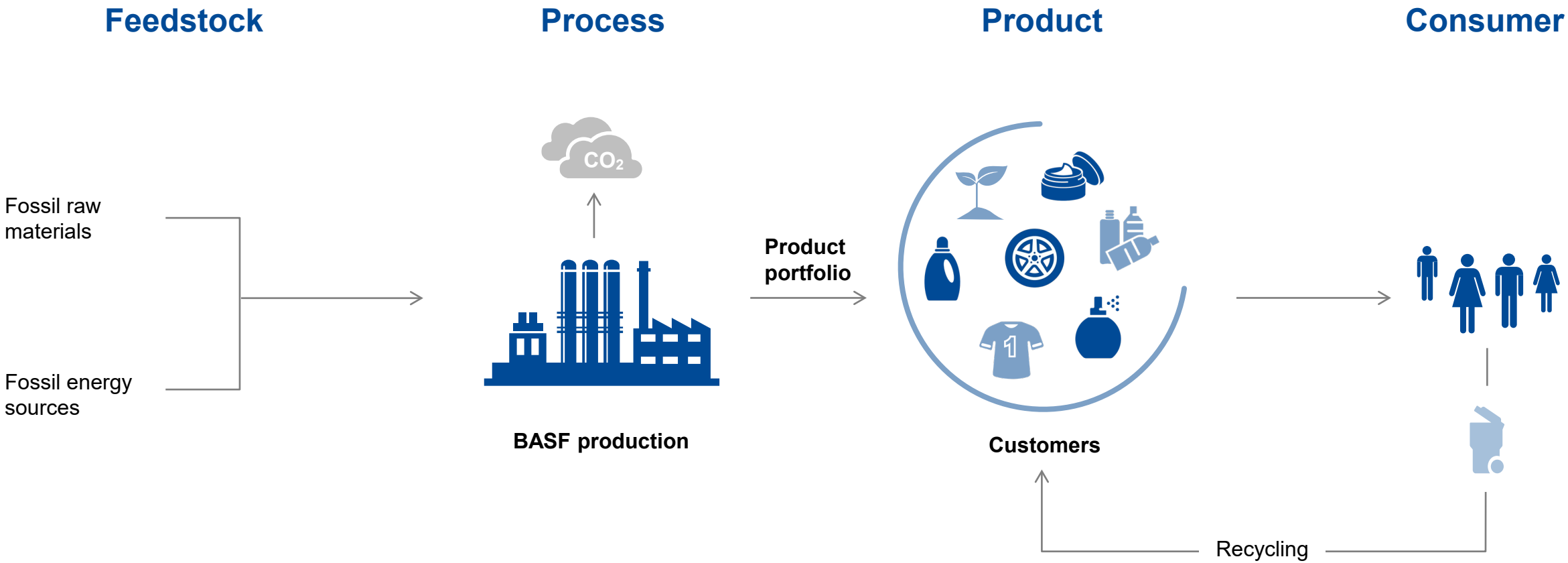
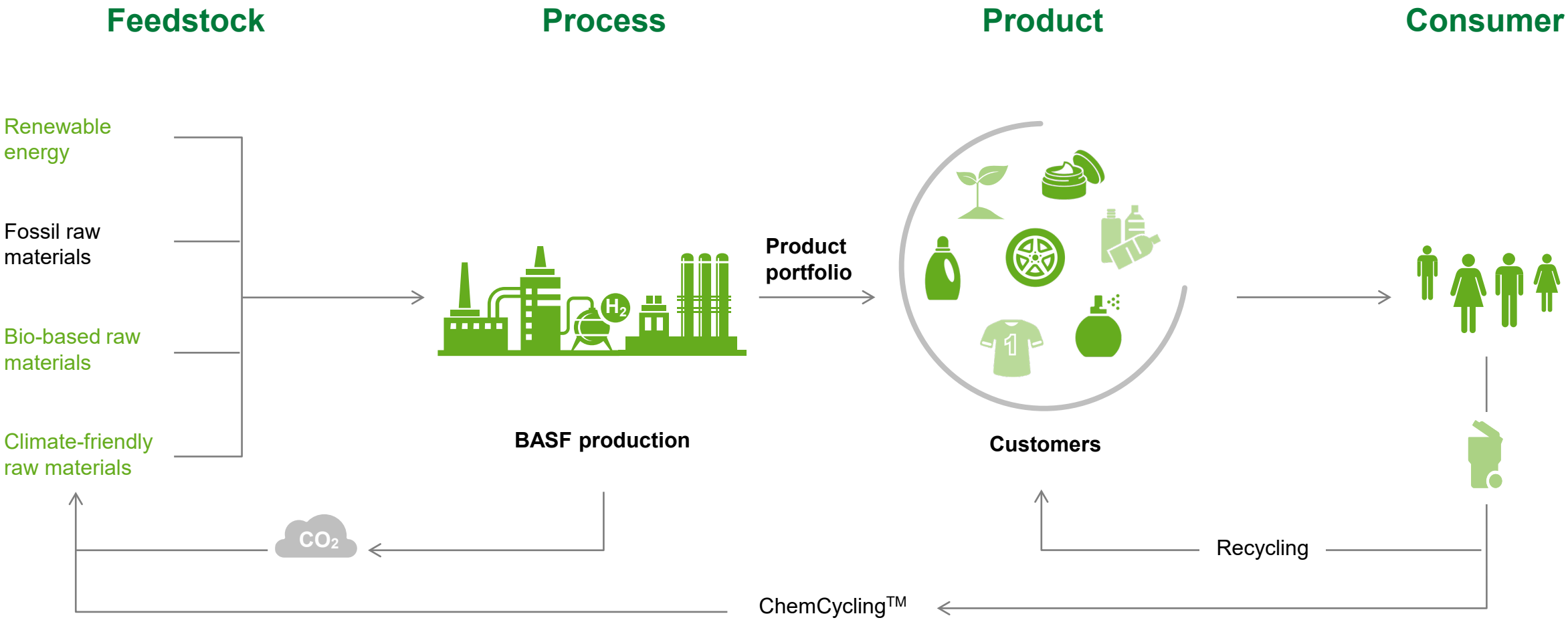
A conventional chemical value chain…



... and the result of a sustainable transformation



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Feedstock: Battery recycling

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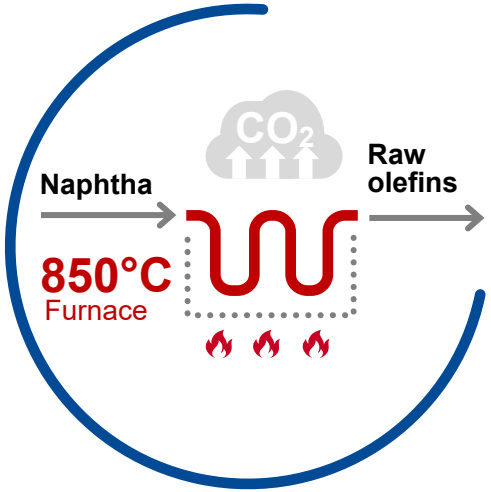
Process: From idea to commercialization

Conventional furnace

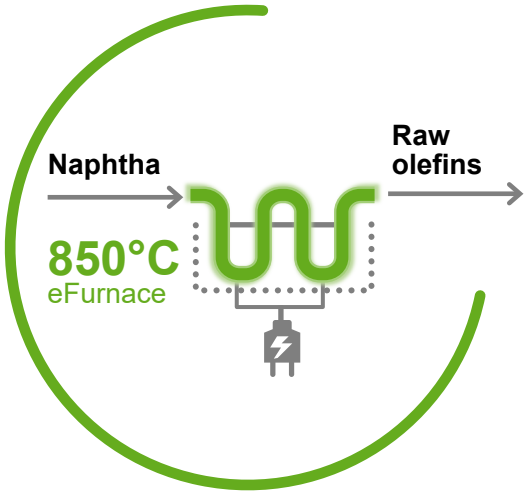


Long-standing experience in operating steam crackers

Pilot plant startup 2023

World's first electrically heated steam cracker furnace – funding is granted

eFurnace



- Engineering for commercial scale
- Focus on heat integration, power supply concept and space demand for revamps
- Potential to **reduce CO_2 emissions** by at least **90%**

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Product: Create additional value for our customers

Low-PCF products via mass balance

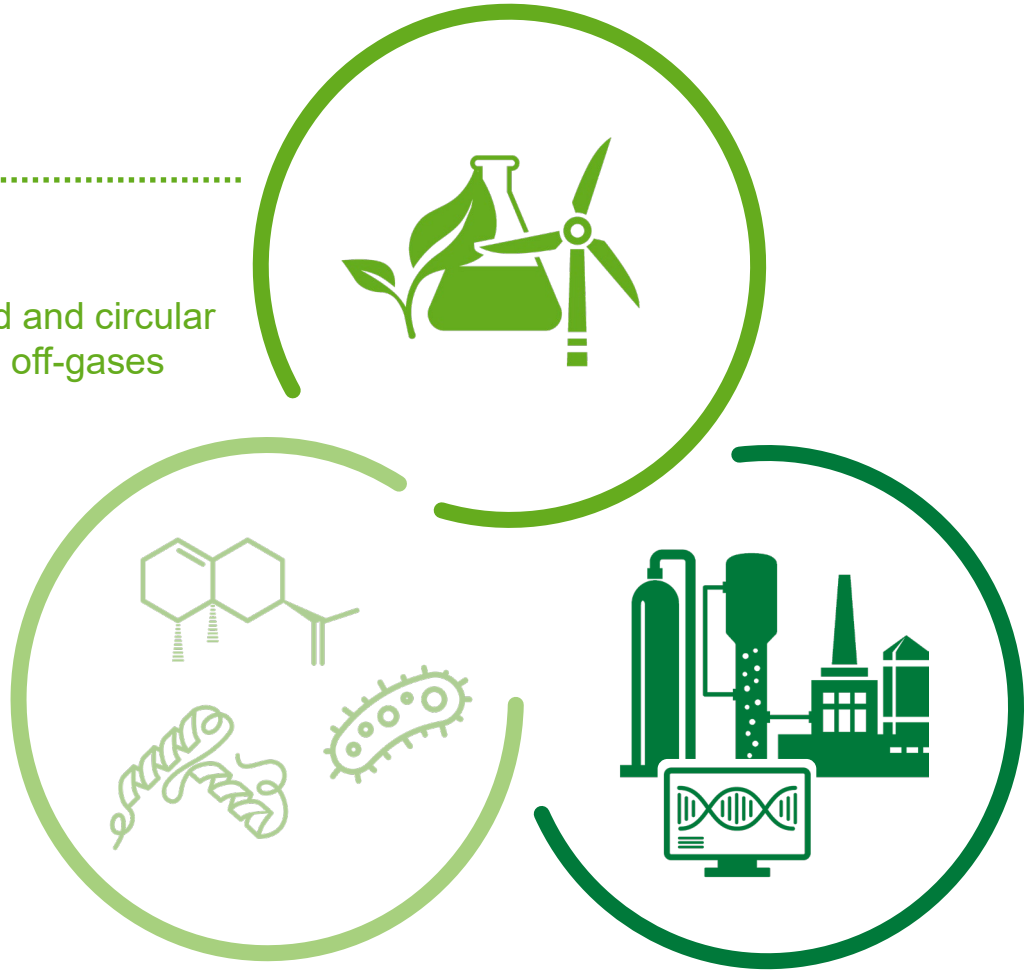
Product carbon footprint reduction[1] (compared to the fossil-based products)	-85%	-66%	-55%	-70%

[1] PCF values according to ISO 14040/44

Driving sustainability with microorganisms

Feedstock

Renewable-based
Fossil-based
Traceable, recycled and circular waste streams and off-gases



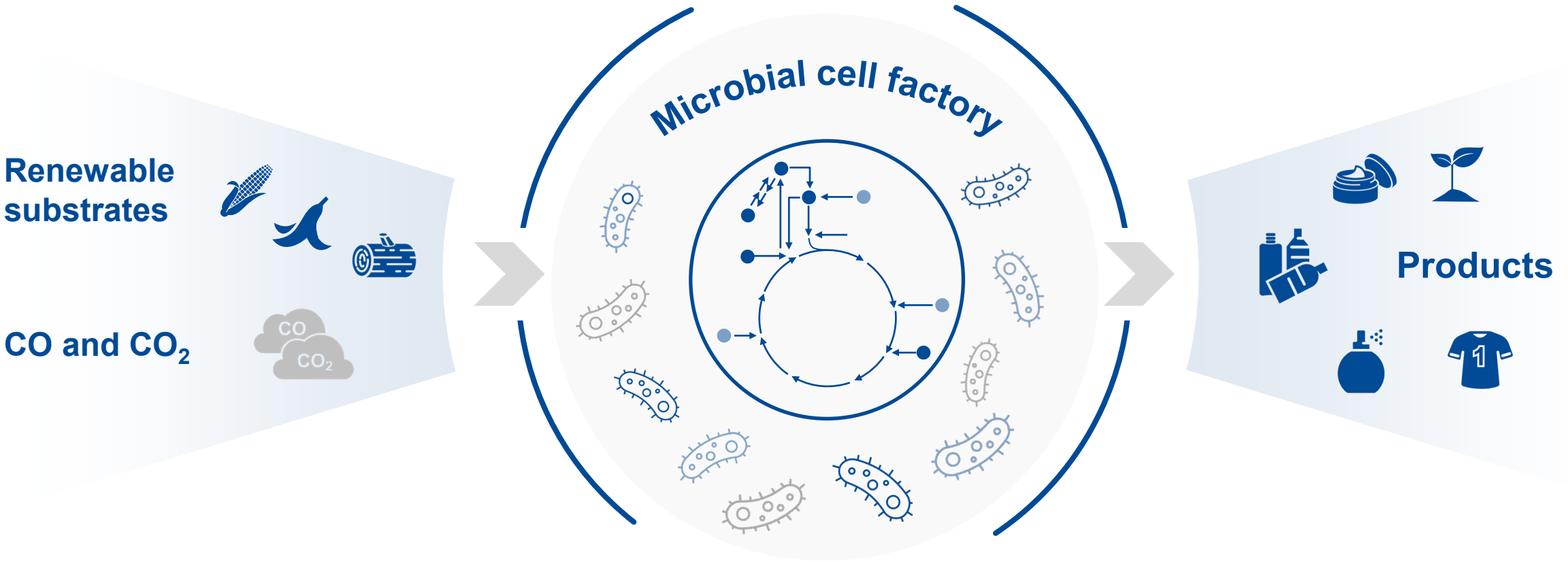
Product

(Bio)chemical/natural ingredients
Biosolutions (microorganisms)
Enzymes
Chemicals

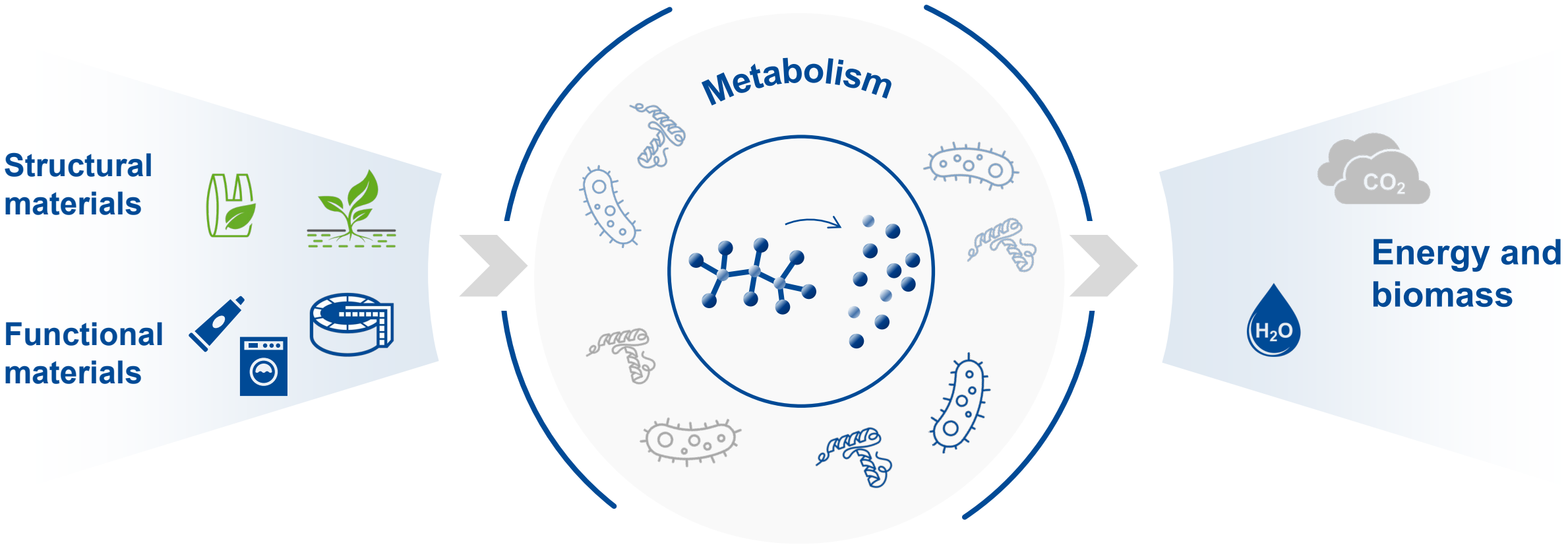
Process

Fermentation and biocatalysis
Genetic engineering
Computational biology
Directed evolution

Microorganisms produce molecules



Microorganisms digest molecules



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Biotechnology and biodegradability broaden BASF's capability to shape a sustainable future

Global **R&D** setup will support the strong growth in the upcoming years.

>€3.5bn

Sales 2021[1]

5 / 6

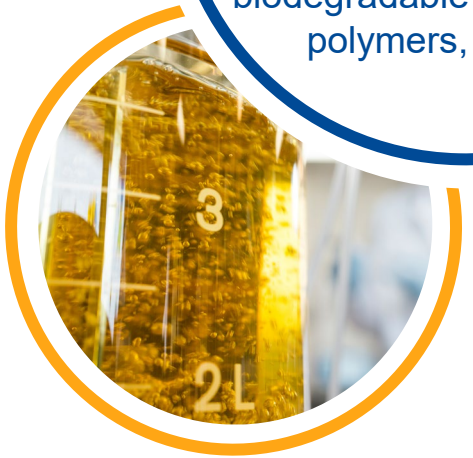
BASF segments

- Chemicals
- Materials
- Industrial Solutions
- Nutrition & Care
- Agricultural Solutions

>3,000

Products

Chemicals, surfactants, aroma ingredients, biosolutions for agriculture, proteins, biodegradable materials and polymers, enzymes



[1] Sales with products from white biotechnology and biodegradable materials/polymers

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Three facets of today’s topic

White biotechnology as one key element of BASF’s toolbox

BASF and LanzaTech – Alternative carbon sources for chemical value chains

From the fundamentals of biodegradability to sustainable products

White biotech enables a plethora of different products

Examples of launches and production startups

Schizophyllan
Biopolymer for enhanced oil recovery

Succinic acid
Solvent, e.g., for compostable plastics

Acrylamide
Diverse applications, e.g., in mining

Inscalis®
Specialty and row crops insecticide

Bacillus
Active ingredient for seed treatment in agriculture

Lavergy® Pro 106 LS
Lavergy® Pro 114 LS
Lavergy® C Bright 100L
Enzymes for laundry detergents

2012 — 2015 — 2018 — 2020

Before 2012

- >10 optically active intermediates and actives via biocatalysis
- Vitamin B_2 by fermentation

Natuphos E®
Enzyme for animal feed

Bacillus
Fungicide active ingredient for agriculture

New vitamin B_2
production strain (2nd generation)

Santalol
Fragrance ingredient

Natupulse®TS
Enzyme for animal feed

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BioSolutions by BASF: A complement to conventional crop protection

Bio fungicides
Serifel®

beneficial bacterium *Bacillus amyloliquefaciens* forms a strong shield of protection around plants

Bio insecticides
Velifer®

works by releasing the spores of the beneficial fungus *Beauveria bassiana,* controlling various pests

Bio seed treatment
Nodulator®

seed-applied inoculants help legumes fix more nitrogen

Beneficial nematodes
Nemaslug® 2.0, Nemasys® 2.0

microscopic worms which control a wide range of insect pests

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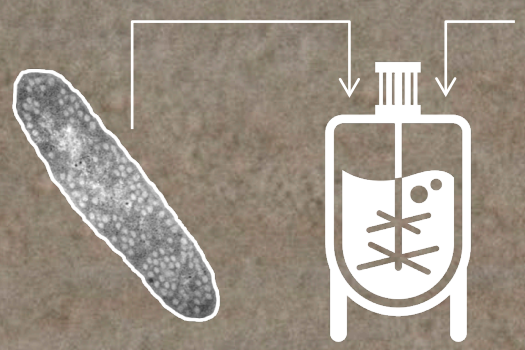
Isobionics: Fermentative production of flavors and fragrances



Intermediate →

Valencene | Santalol | Nootkatone | Bergamotene

Isobionics®

Rhodobacter

- Natural isoprenoid producer
- High product tolerance
- Scalable and robust
- No off-odors

Sustainability facts Santalol

- 100% free of endangered sandalwood trees
- Based on renewable resources
- Starting material is corn grown in Europe

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Detergent enzymes: Excellent washing performers, even at low temperatures

- **Detergent enzymes:** e.g., protease, amylase, cellulase, mannanase, lipase
- **Production process:** based on bacterial and fungal hosts

Benefits

- Lavergy® Pro series engineered and formulated proteases that remove tough stains at ambient temperatures
- Energy savings with lower wash temperatures
- Garment protection via Lavergy® C Bright (anti-greying protection)
- Bio-based and readily biodegradable

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Classical and alternative fermentation platforms: Integrating alternative carbon sources into chemical value chains


Starch sugars

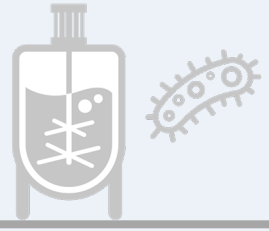

Fibrous starch


Lignocellulosic material


Bio-residues

Pretreatment
Saccharification
Purification

Carbo-hydrates



Classical fermentation

- **Enzymes**
- **Biologicals**
- **Polymers**


Off-gases

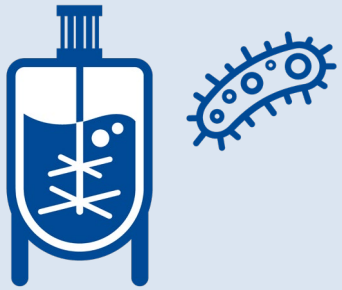

Process wastes


Agro residues


End-of-life materials

Pretreatment
Gasification
Purification

CO
CO_2
CH_4
H_2

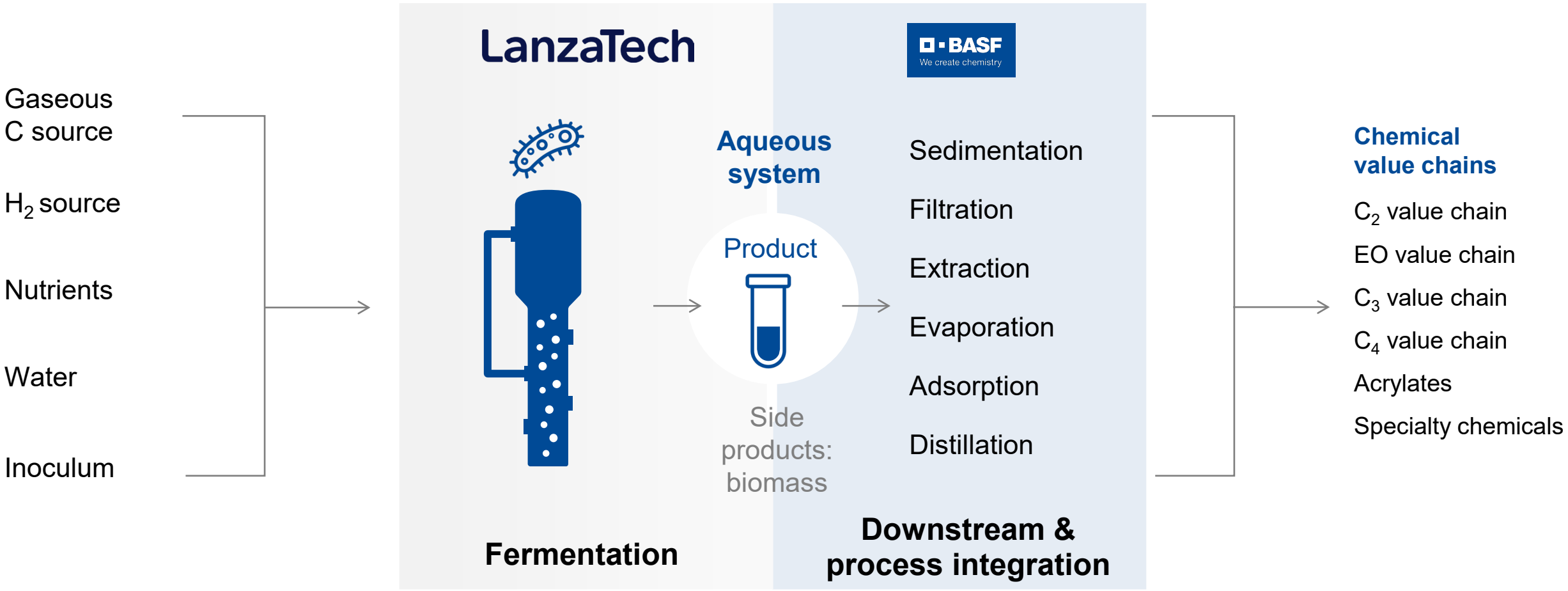


C_1-based fermentation platforms

Small molecules
e.g., ethanol

- **Chemicals**
- **Intermediates**
- **Proteins**

Combining competences and capabilities leads to success!



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