# Pushing boundaries in innovation and technology

## Conference presentation

# WHY IS INNOVATION AND TECHNOLOGY LEADER-SHIP MORE IMPORTANT THAN EVER?

# Inventor and leader in high-tech material solutions

## Covestro at a glance

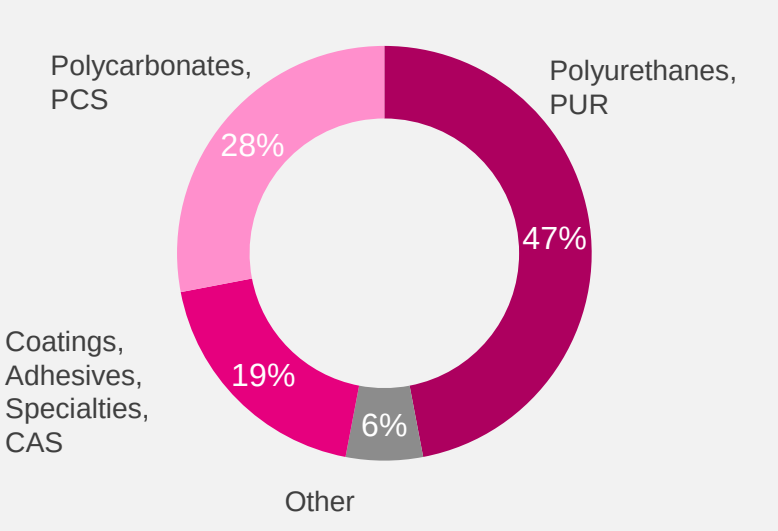
**€12.4bn**
Sales
2019

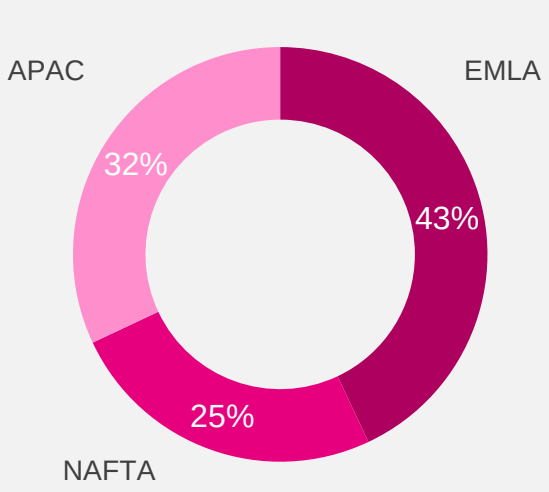
**#1**
Global producer of PU and its derivatives as well as PC[(a)]

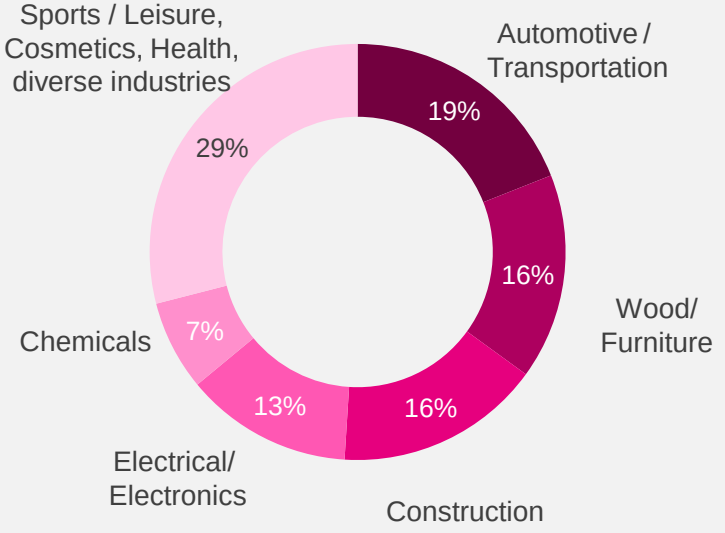
**4%**
Core volume growth
CAGR 2015-2019

**17,200**
Employees
(in FTE) 2019

**€266m**
R&D expenses
2019






Notes: (a) Based on total combined nameplate capacity for MDI, TDI and polyether polyols at year end 2019 as per Covestro estimates

# Number one producer globally and inventor of PU[(a)]

## Polyurethanes (PUR) at a glance

### Products

Polyurethane rigid foam is an excellent insulation material and adds to high energy efficiency in cooling units and buildings.

As soft foam polyurethane provides comfort, for example in mattresses, car seats and upholstery.

Covestro develops and produces the components of this versatile material.

**Key customer industries:**

### Sample applications

For comfortable cars

For sustainable houses

For cozy furniture

For robust sports equipment

**3.1%**

Core volume CAGR in 2015 - 2019[(b)]

**€5.8bn**

Sales 2019

**€648m**

EBITDA 2019



Notes:
(a) Based on total combined nameplate capacity for MDI, TDI and polyether polyols at year end 2019 as per Covestro estimates
(b) Adjusted 2017 figures to reflect the transfer of the specialty elastomers business from the Polyurethanes segment to the CAS segment as of January 1, 2018

# Number one producer globally and inventor of PC[(a)]

## Polycarbonates (PCS) at a glance

### Products

As a true high-tech material, polycarbonate is not only very robust, break-proof and light-weight, but also offers a high degree of design flexibility.

Polycarbonate is available in all colors ranging from crystal clear to deep black. It is an excellent substitute for traditional material such as glass or metal.

This allows for a wide variety of application possibilities ranging from vehicles to smartphones and laptops as well as lenses or large roofs.

**Key customer industries:**

### Sample applications

For trendy smartphones

For bright buildings

For light-weight cars

For safe medical products

**5.2%**

Core volume CAGR in 2015 - 2019[(b)]

**€3.5bn**

Sales 2019

**€536m**

EBITDA 2019



Notes: (a) Based on nameplate capacity at year end 2019 as per Covestro estimates

# Performance materials for coatings, adhesives and specialties

## Coatings, Adhesives, Specialties (CAS) at a glance

### Products

There is a vast application range of coatings and finishes made of Covestro polyurethane raw materials. They are used for protection and decoration.

In addition, the company produces pre-products for adhesives and sealants as well as for specialty films and elastomers.

Coating, Adhesives, Specialties (CAS) also supplies materials for cosmetics, textiles and medical goods.

**Key customer industries:**

### Sample applications

For long-lasting cosmetics

For robust floors

For fancy cars

For functional textiles

**2.1%**

Core volume CAGR in 2015 - 2019[(b)]

**€2.4bn**

Sales 2019

**€469m**

EBITDA 2019



Notes:
(a) Based on nameplate capacity at year end 2019 as per Covestro estimates
(b) All figures adjusted to reflect the transfer of the specialty elastomers business from the Polyurethanes segment to Coatings, Adhesives, Specialties segment as of January 1, 2018 as well as the termination of trading activities and reduced contract manufacturing

# Securing profitable growth in more challenging times

## Covestro key investment highlights

1. **Above GDP volume growth**
   driven by innovation and sustainability trends

2. **Leading and defendable global industry positions**
   as innovation and cost leader

3. **Management focus on driving efficiency**
   with streamlined structures to better adapt to market needs, focus on cost discipline and strict incentive targets

4. **Capital allocation focused on value creation**
   with commitment to profitable growth

5. **Full alignment of strategy with ESG criteria**
   embodied by non-financial targets

# Covestro set to outpace global long-term growth

## Structural growth drivers

| Trends … | and needs … | lead to demand for Covestro products |
|---|---|---|
| Climate change | Renewable energy<br>Lower energy buildings | Core volume growth, long-term average **~4%** |
| Urbani-zation | Energy-efficient lighting<br>Sustainable living | |
| Population & prosperity growth | Functional clothing<br>Food preservation | Global GDP long-term average **2-3%** |
| Increasing mobility | Goods transport<br>Conventional & E-vehicles | |



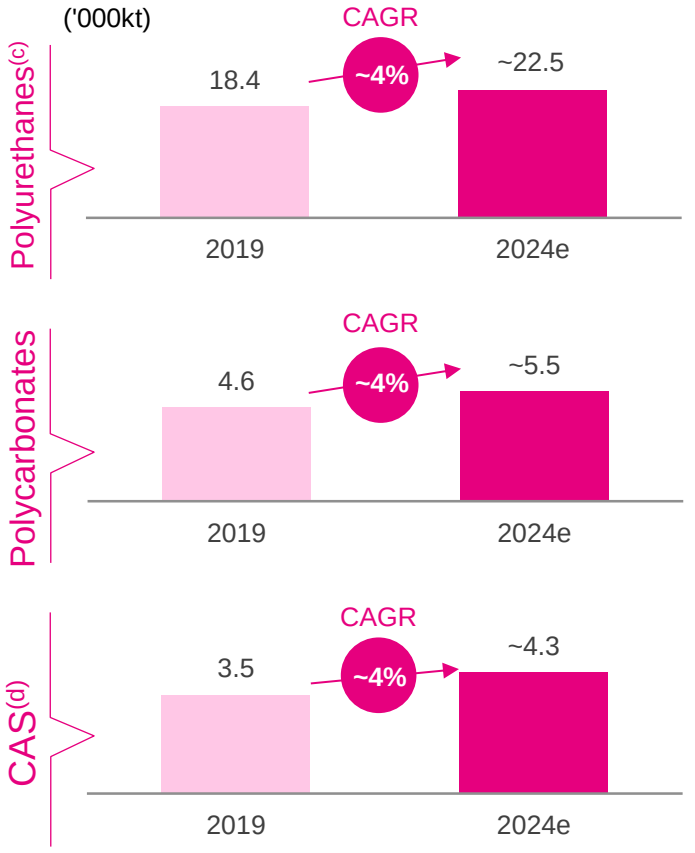
Notes: (a) Covestro estimate

# Industries grow above global GDP

## Structural growth drivers

| UN SDGs[a] | Needs to be served |
|---|---|
| related to climate change: | • Zero emission concepts<br>• Low-energy buildings |
| related to increasing mobility: | • Energy-efficient mobility<br>• Lightweight transportation<br>• E-mobility, autonomous driving |
| related to growing population: | • Food preservation<br>• Low-cost durable goods<br>• Medical applications |
| related to increasing urbanization: | • Affordable housing<br>• Living comfort<br>• Public infrastructure |

### Industry demand outlook[b] 2019e – 2024e






Notes:
(a) Most impacted goals out of 17 Sustainable Development Goals, set by the United Nations' "2030 Agenda for Sustainable Development"
(b) Assumes global GDP CAGR 2019 - 2024e of 2 - 3% as per Covestro estimates; (c) Comprises MDI, TDI and polyether polyols
(d) CAS = Coatings, Adhesives, Specialties; shows PU raw materials industry demand in coatings, adhesives and sealants (excl. architectural/textile coatings and solvent-borne polyacrylates); additionally TPU, elastomers and PC/TPU films

# 80 years of ideas and research

## Inventions at Covestro

**1937** Otto Bayer invents polyurethanes

**1953** Hermann Schnell invents polycarbonates

**1954** Kuno Wagner invents cross-linking agent for lightfast polyurethane coatings

**1959** Introduction of polyurethane in the fashion industry

**1962** Market launch of rigid polyurethane foam for insulating refrigeration systems

**1967** Presentation of the first car made almost entirely of plastic

**1982** Introduction of CDs made of polycarbonate

Polycarbonate used for the first time in automotive headlamps

**1985** First office machines made of flame-retardant polycarbonate composite

**1991** Introduction of polyurethane “memory” foam for mattresses

**1995** Films based on polycarbonate are introduced for security documents


**1998** First automotive glazing for the rear window of the Smart

**2001** Construction begins at the Covestro world-scale production site in Shanghai, China

**2011** Plant in Shanghai equipped with eco-friendly and efficient gas-phase phosgenation technology

**2012** Introduction of microcellular foam with improved insulating properties

**2013** Epoxy resins replaced by polyurethane resins in wind turbine rotor blades

**2014** Introduction of INSQIN® technology for a water-based polyurethane textile coating

**2015** First coating hardener made of renewable raw materials is introduced

TCG company acquired in order to expand market position in thermoplastic fiber composites

**2016** Start of production of foam components with $CO_2$ in Dormagen, Germany


**2017** Key chemical aniline won from renewable raw materials for the first time

**2019** Covestro Direct Store, a digital sales channel, launched

# Pushing boundaries in polymer innovation

## News from the Covestro labs in the past six months

- Joint development with **Toyota** Boshoku
- New PU composite concept with kenaf fibers
- 30 percent lighter than conventional material

**Sustainable solution in Toyota concept car ‚LQ'**

### New PC grades expand healthcare portfolio

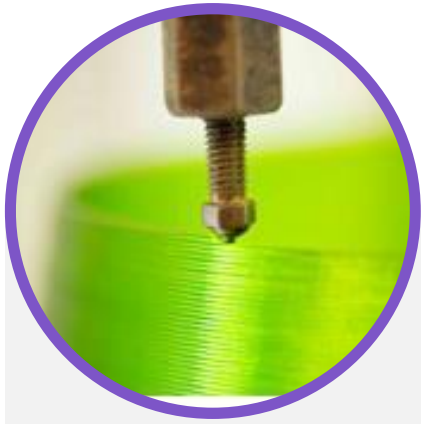
- New medical-grade PC for drug delivery and surgical devices
- Trend to self-administration of therapeutics
- Smooth delivery with low-friction PC

- Joint development with **Recticel** of circular materials
- Focus on using raw materials from sustainable sources, such as waste, plants and $CO_2$

**Closing cycles for PU mattresses**

### Effective shoe manufacturing with 3D printing

- Fully recyclable shoes made from thermoplastic PU powder and filament
- New material enables automated production via 3D printing at lower cost



- Covestro PC proved suitable for **Signify's** new luminaires
- Concept of circular economy combined with industrial scale production of 3D-printed luminaires

**100% recyclable PC for 3D-printed luminaires**



Notes: All shown innovation news have been published on covestro.com
PU = polyurethane; PC = polycarbonate

# Non-financial ambition supports growth strategy

## Covestro non-financial targets 2025

1. Our R&D project portfolio is aligned with UN Sustainable Development Goals

2. 100% of suppliers compliant with our sustainability requirements

TOGETHER FOR SUSTAINABILITY

3. Reduce specific greenhouse gas emissions by 50% by 2025

4. Ten million people in underserved markets benefit from our business solutions

5. Getting the most out of carbon

CARBON C PRODUCTIVITY

# Making wind power plants more efficient

## Climate change: renewable energy

| Trend | Need | Market | Covestro contribution |
|---|---|---|---|
|   | More durable and economical wind power plants  | Energy<br>Energy consumption(a)<br>CAGR: ~3%<br>Offshore wind energy(b)<br>CAGR: ~19% | **Novel components for wind power plants**<br>• Rotor blades: Polyurethane resins for more stability and durability<br>• Towers: Polyurethane materials for anti-corrosion coatings<br>• Undersea cables: Elastomers for protection systems |



Notes:
(a) BP, Energy Outlook, 2017 for 2015 – 2020 based on million tons oil equivalent
(b) Navigant, World Wind Energy Market Update, 2017, for 2016 – 2021 based on mega watt

# Reducing high energy consumption of lighting

## Urbanization: sustainable living

| Trend | Need | Market | Covestro innovation example |
|---|---|---|---|
| Urbanization  | Energy-efficient luminaires  | Furniture<br>Luminaire market[a]<br>CAGR: ~3%<br>Luminaire LED[a]<br>CAGR: ~12% | **100% recyclable PC for 3D-printed luminaires**<br>• Covestro polycarbonates proved suitable for Signify's new luminaires<br>○ allowing industrial scale production of 3D-printed luminaires<br>○ supporting a circular economy as a 100 percent recyclable material<br>• Signify – the world leader in lighting – makes energy-efficient LED lighting products and is first lighting manufacturer to produce 3D-printed luminaires on an industrial scale |



Notes: (a) Global Luminaires, Lighting Market Analysis and Forecast 2016, PennWell for 2015 - 2022

# Replacing harmful by water-based ingredients

## Population and prosperity growth: sustainable fashion

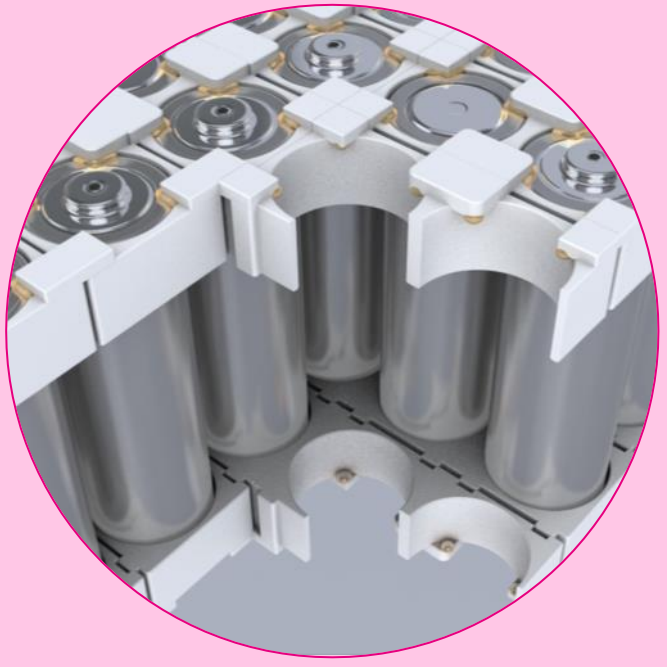
| Trend | Need | Market | Covestro innovation example |
|---|---|---|---|
|   | Sustainable and functional fashion  | Textile industry<br>Textile coating market(a)<br>CAGR: ~6%<br>Covestro relevant textile coating market(b)<br>CAGR: ~11%<br>Global warming potential(C)<br>–45% | **Waterborne, solvent-free materials for functionalized textiles**<br>• INSQIN® helps customers to meet their sustainability goals, e.g. through a ~45% lower carbon footprint than that of solvent-based systems<br>• Chemical and mechanical resistance at same excellent levels<br>• INSQIN® technology also includes a waterborne PU dispersion that is biologically degradable by microorganisms at the end of the product life cycle<br>• Enabling customers to offer biodegradable coatings and composite solutions for textile coating |



Notes:
(a) IAL PUD market report 2015 for 2014 – 2019
(b) Covestro estimates
(c) Measured in $CO_2$ equivalents, comparing textile coatings made using INSQIN® technology vs solvent-based systems

# Enabling efficient E-mobility and autonomous driving

## Increasing mobility

| Trend | Need | Market | Covestro innovation example |
|---|---|---|---|
|  | Reduced weight and new functionalities  | Automotive<br>Global car production[a]<br>CAGR: ~3%<br>Global hybrid and electrical car production[a]<br>CAGR: ~34% | **Polycarbonate blend drives efficient lithium-ion cell assembly**<br>• Joint development with Henkel to enable large-scale, automated and cost-efficient assembly of li-ion battery modules<br>• Fast curing times required – made possible by system of UV-transparent polycarbonate and UV-curing adhesives<br>• Dimensional stability within tight tolerances during production and when exposed to heat or humidity as well as low flammability rating at thin wall thicknesses<br>• Solution: Cylindrical li-ion battery cell holders made of a special Bayblend®, efficiently assembled with Henkel's Loctite AA 3963 battery assembly adhesives |


Notes: (a) LMC 2019 for 2018 – 2023

# Turning waste gas from steel factories into valuable plastics

## $CO_2$ as alternative carbon source

### Industry consortium **Carbon4PUR**

- Cross-sector project of 14 partners from seven countries, led by Covestro, funded by the European Union
- Objectives ot this 3-year project, initiated in October 2017, among others:
  - **Reduce carbon footprint** of polyurethane intermediates **by 20-60%** compared to today's polyurethane products manufactured from crude oil
  - **Save 70%** of **process energy** compared to conventional chemical processes
  - Provide – **first time from waste CO** – higher value **novel polyols** for the production of new, sustainable polyurethane applications (rigid foam and coatings) as an example of high value polymers, matching market needs
- To date, the project defined replication criteria and preferred sites for this industrial symbiosis
- Industrial-scale testing: In future, carbon in form of mixed waste gases from the ArcelorMittal plant in Fos-sur-Mer, France, could undergo catalytic transformations in the nearby Covestro plant to become a chemical feedstock for polyols

### Pan-European project partners

ArcelorMittal

covestro

MEGARA RESINS
ANASTASSIOS FANIS S.A.

RECTICEL

Academic and institutional partners

RWTH AACHEN UNIVERSITY

Technische Universität Berlin

DECHEMA

Imperial College London

UNIVERSITEIT GENT

Universiteit Leiden

cea

south pole group

Marseille Fos
The euromediterranean port

PNO



Notes: More information at https://www.carbon4pur.eu/

# Using $CO_2$ to produce foam raw materials

## Use of alternative raw materials

| Trend | Need | Market | Covestro contribution |
|---|---|---|---|
| Climate change  | Substitutes for fossil feedstock  | PU foams<br>$CO_2$ share of weight ≤20% | Use industrial waste $CO_2$ to produce polyols<br>• $CO_2$ replaces up to 20% of crude oil-based feedstock of polyols<br>• New production plant at Dormagen site and product brand cardyon® launched<br>• Recticel promotes foam mattresses with more than one-seventh of oil content replaced by $CO_2$-based chemicals<br>• Sports flooring producer Polytan installed first elastic subfloor using $CO_2$-based cardyon® as binder<br>• More $CO_2$-based products in development for applications in sport, appliances, etc. |

# Leading chlorine technology reduces energy consumption

## Use of energy-efficient process technology

| Trend | Need | Market | Covestro contribution |
|---|---|---|---|
| Climate change  | Energy-saving processes  | Chlorine<br>Reduced electricity consumption[a]<br>~25% | NaCl electrolysis with ODC[b]<br>• Energy usually accounts for about one third of the production costs for chlorine<br>• Covestro and ThyssenKrupp Uhde Chlorine Engineers developed proprietary technology<br>• Use of an oxygen-depolarized cathode (ODC) consumes around 25% less energy than conventional electrolysis<br>• Significant economic and ecological benefits vs conventional processes<br>• World-scale ODC chlorine plant planned in Tarragona, Spain |



Notes: (a) Compared to conventional processes
(b) NaCl = Sodium Chloride; ODC = Oxygen Depolarized Cathode

# Gas-phase phosgenation reduces energy consumption

## Use of energy-efficient process technology

| Trend | Need | Market | Covestro contribution |
|---|---|---|---|
| Climate change  | Energy-saving processes  | Isocyanates<br>Reduced consumption of electricity[(a)] ~60%<br>Reduced phosgene holdup[(a)] ~40% | TDI / HDI gas-phase phosgenation<br>• Proprietary process technology significantly increases plant throughput<br>• Reaction time for gas-phase phosgenation process is shorter than conventional process<br>• Reduced capex by 20% as plant size for a given capacity is smaller<br>• Reduced conversion cost due to lower energy demand and reduced solvent usage |



Notes: (a) Compared to conventional liquid phase phosgenation

# INNOVATION AND TECHNOLOGY TO LEAD THE WAY FORWARD – WHAT‘S AHEAD OF US?

# INDUSTRY TO TRANSFORM FROM A LINEAR TO A CIRCULAR BUSINESS MODEL

# Driving sustainability in all parts of the business

## Sustainability along the Covestro value chain

**Global trends** | **R&D** | **Raw materials** | **Production** | **Products to markets**

R&D resources allocated based on benefits for:

- People
- Planet
- Profit

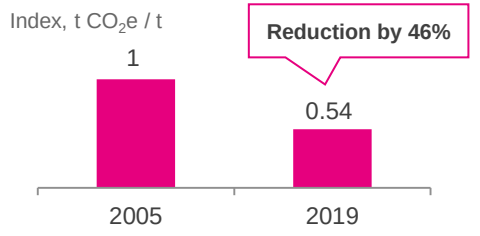
More sustainable input addressing customer needs and profit improvement:

Examples:

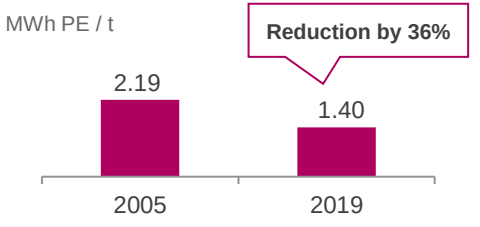
- C1 feedstock (e.g. $CO_2$)
- Bio-based feedstock (e.g. BDO[a])
- Low carbon energy

Cost efficiencies by energy-efficient process

**Specific greenhouse gas emissions[b]**




**Specific energy consumption[c]**




Address customer needs for more sustainable solutions (e.g. lightweight, durable, bio-based)

Examples:

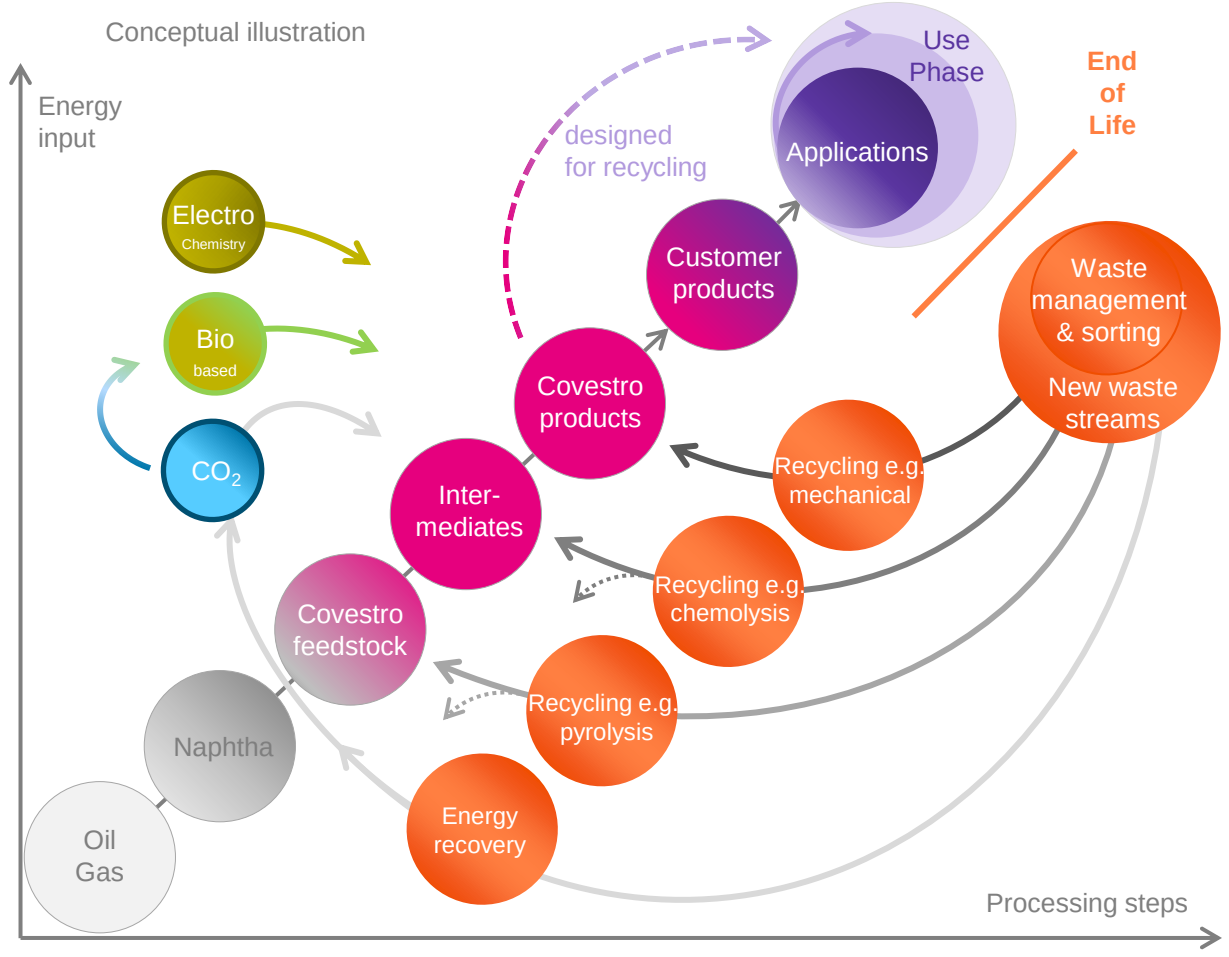
- INSQIN®, artificial leather
- Desmodur® Eco, coating hardener
- Baytherm® Microcell, insulation foam
- Makrolon®, e.g. LED lighting



Notes:
(a) BDO refers to 1,4-butanediol
(b) Cumulative annual %-change in the specific greenhouse gas emissions per metric ton of product manufactured, compared with the base year 2005
(c) Energy efficiency: quotient of equivalent primary energy and in-spec production volume at our main production sites

# Circular economy (CE) to keep carbon in the loop

## CE technology options under evaluation




### Global industry challenges of a circular economy

1. Provide a solution for the end of life of any material
2. Extract target molecules from waste streams and secure continuous access to waste-based feedstock as raw material
3. Decouple growth from fossil resources and keep valuable carbon in the loop as long as possible

### Covestro-related industries (PU, PC and others)

- Represent less than 10% of global plastic production, dominated by PE, PET, PP, PVC, PS
- Materials mostly not applied in single-use applications
- Offer few established collection streams
- Recycling technologies at early stage except some mechanical recycling; incineration no preferred option
- Covestro already commercializes products that contain alternative feedstock (bio-/$CO_2$-/waste-based)



Notes: Shown recycling technologies and energy recovery are illustrative examples only
Covestro definition of circular economy: holistic focus on end-of-life solutions and independence from fossil sources, keeping carbon in the productive loop as long as possible

# INDUSTRY TO FULLY LEVERAGE DIGITALIZATION

# Seizing opportunities in multiple dimensions

## Covestro digital strategy 2025

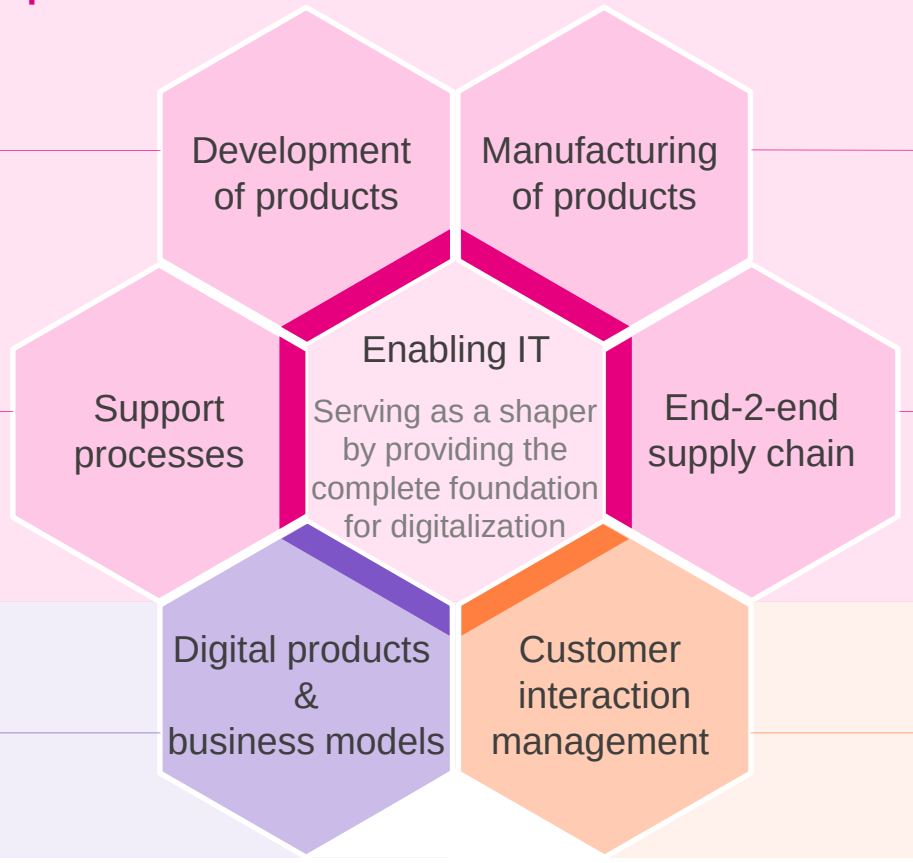
### Digital operations

Developing improved and new products and processes faster, using simulation technologies and levering on globally consistently generated R&D data

Increasing product quality and manufacturing profitability through process optimization and increased reliability

Developing lean and automated support processes (e.g. HR, Accounting, Controlling) to create competitive advantage

Enabling growth with a fully digital, autonomous end-to-end supply chain




### Digital business model

Building leading digital ventures and capturing new value streams for Covestro

### Digital customer experience

Turning customer insights into superior customer experience with optimal use of digital tools

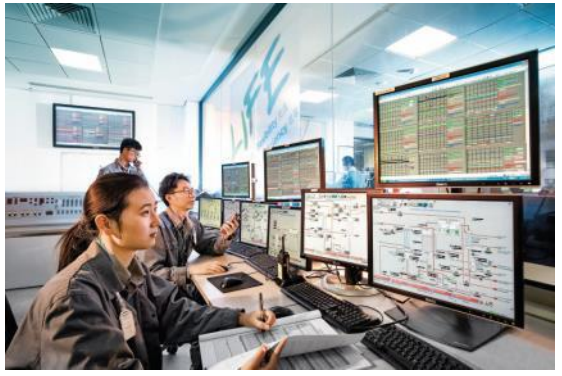
# Digitalization to increase operational efficiency

## Covestro digital operations

### New products and processes

- High performance computing for efficient research and development
- First product developed with support of computational chemistry launched in appliance application
- Shortened time to market and reduced resources for experimental work
- Computational chemistry helps to find catalysts for recycling polymers in the context of CE

### Plant availability



- AI-based models applied to data streams from production equipment support continuous asset monitoring
- Reduced maintenance efforts and spend as well as optimized replacement and service intervals

### Asset engineering

- iPEP (Integrated plant and engineering platform) to provide virtual image of existing plants, including all systems and processes
- Concept has been proven at Caojing and Antwerp site
- Improved quality engineering data and project management



Notes: AI = Artificial Intelligence
CE = Circular Economy

# Multiple channels to meet changing customer expectations

## Covestro digital customer experience

### Field sales / KAM / Inside sales

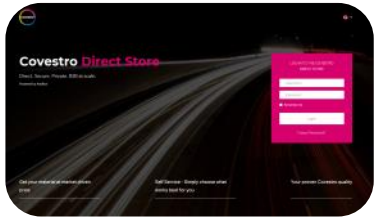
Protect and nurture business with large- and medium-size accounts supported by digital

Covestro interacts with and sells to customer directly and determines all elements of the offering


- Online solution center with product search, user stories
- Order management platform with document management, track & trace
- WeChat channel

### Covestro Direct Store

Serve digital-minded customers with tailored e-commerce offers




- Direct store on Asellion e-commerce platform
- Spot deals, auctions, forward deals
- 24/7 availability in a protected environment

### E-commerce platforms

Create leads and new business in long-tail on open platform in China

Offer context determined by 3rd party


- Authentic Covestro materials offered in flagship store on Alibaba 1688.com

### Distribution by 3rd party

Serve long tail customers who do not directly interact with us

Covestro without direct customer access

- Digital offering provided by third party



Notes: KAM = Key Account Management

# PUSHING BOUNDARIES IN INNOVATION AND TECHNOLOGY IS AT THE CORE OF COVESTRO

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