Closing the Loop for Polyurethanes

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FSK Tagung

Threats to human existence

Climate Change

Threats to human existence

Biodiversity Loss

Threats to human existence

Environmental Pollution

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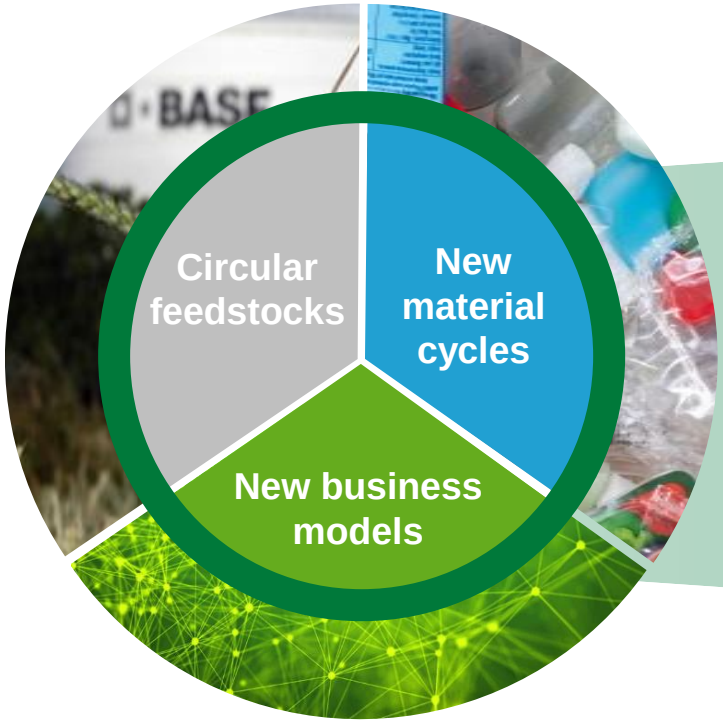
We aim to reach €10 billion sales from Loop Solutions for our customers by 2030



€5 bn
2023

Loop Solutions
Close the loop &
Extend the loop

€10 bn
2030

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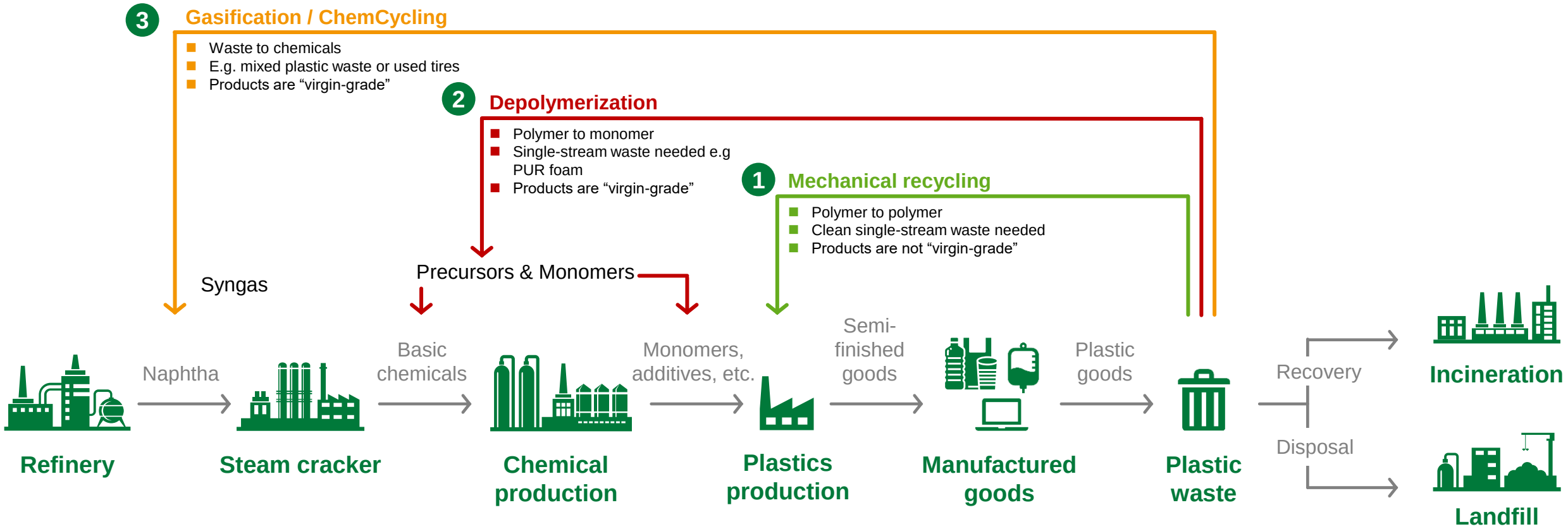
Possible loops for a successful transition to sustainability



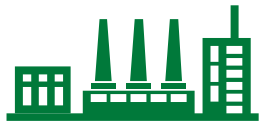
Elevating the standards

State of the art comparison of polyurethane waste treatment

Energy demand

Homogeneity of waste

Chemical treatment	Incineration	Gasification	Depolymerization	Mechanical treatment	PU waste composites	Mechanical recycling
	Known technology for energy recover	Broad range of waste can be treated incl. ASR	Decomposition to isocyanate & polyol		Recycled lightweight alternative	Enables closed loop process
	Linear technology & emission of greenhouse gasses	High energy process	Quality & complexity closely linked to accessible feedstock		Limited in application	So far only known for „Thermoplastics“



Plastics circularity builds on two key requirements

Recyclability

What happens at plastics end-of-life?

Recyclability
of plastics
at scale required

We look at the **USE** and **RECYCLE** phase

Circular content

How are plastics produced?

Obligatory quotas
for post-consumer waste
as feedstock

We look at the **MAKE** phase

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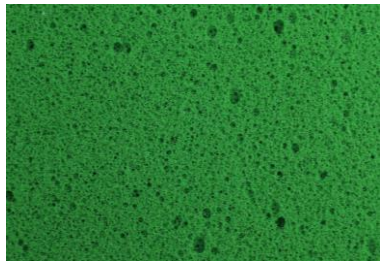
Mechanical recycling of PU via meltable foams



Thermoforming

Refoaming

Recycling

Closing the loop

TPU blend

Recycling Polyol

Meltable PU foams – footwear

Meltable BASF safety shoe PU

PESOL-based [ADS/MEG/DEG] + 4,4-MDI
water-blown, Index 100

virgin TPU

Compounding → **Injection molding**

New safety shoe TPU outsole

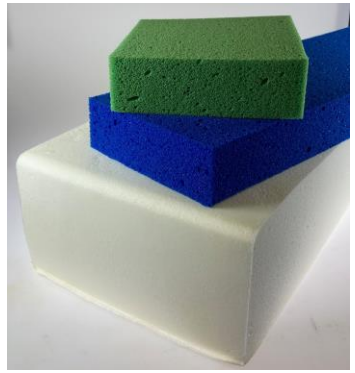
	PU safety shoe
Density [kg/L]	0.57
Hardness [Shore A]	52
Tensile strength [MPa]	7.3
Elongation [%]	500
Tear strength [N/mm]	7.3
Abrasion [mm³]	120

	virgin TPU*	+ 10% PU Foam	+ 20% PU Foam
Density [kg/L]	1.218	1.221	1.219
Hardness [Shore A]	61	60	60
Tensile strength [MPa]	34	21	22
Elongation [%]	790	860	800
Tear strength [N/mm]	64	44	40
Abrasion [mm³]	54	44	84

*PESOL-based [ADS/MEG/BDO] + 4,4-MDI
Index 1000

Meltable PU foams – furniture

Meltable BASF PU Flexible Foam



Density = 36 g/L

virgin TPU

Compounding → **Injection molding**

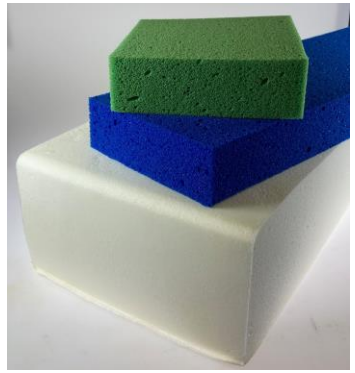
	PU Foam
Polyol [PG+PO/EO; OH number = 29 mg KOH/g]	96.04
Lupragen N201	0.79
H_2O	2.97
Additives	0.20
Lupranat MI	46.98
Index	95

	virgin TPU*	+ 10% PU Foam	+ 20% PU Foam
Density [kg/L]	1.1	1.1	1.1
Hardness [Shore A]	94	93	92
Tensile strength [MPa]	43	44	36
Elongation [%]	510	560	580
Tear strength [N/mm]	112	98	78
Abrasion [mm^3]	52	60	84

*PEOL + BDO + 4,4-MDI; Index = 1000

Meltable PU foams – furniture

Meltable BASF PU Flexible Foam



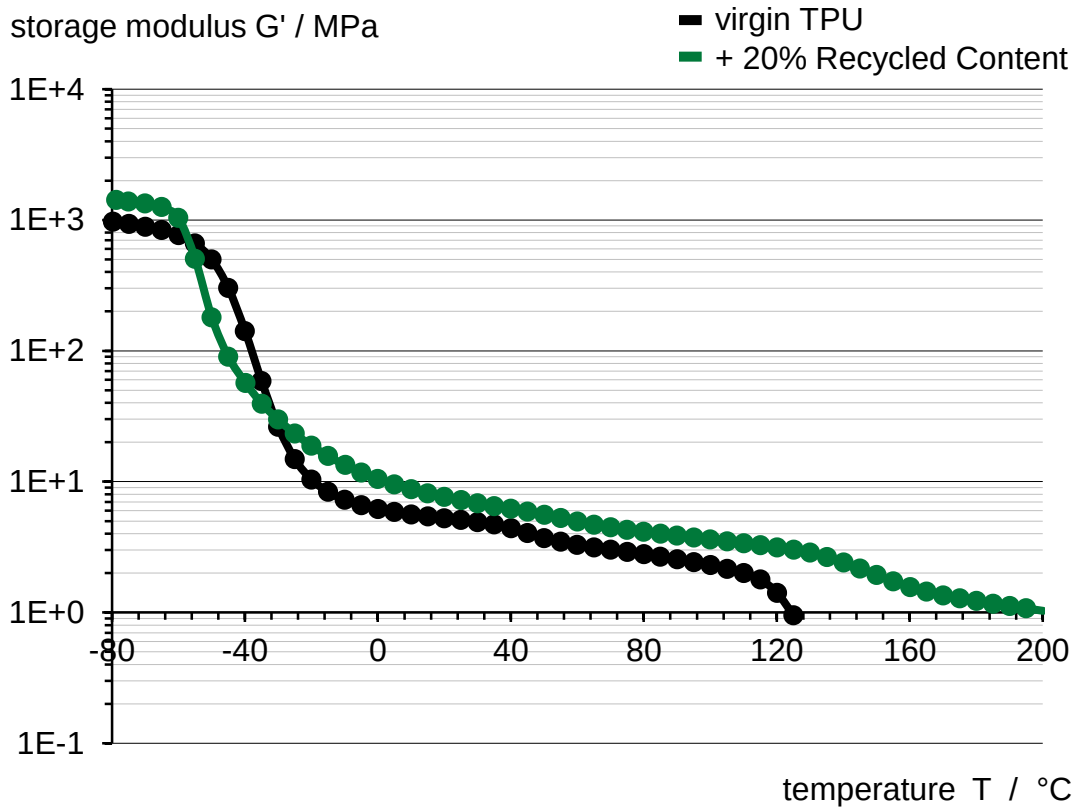
virgin TPU

Compounding

Injection molding

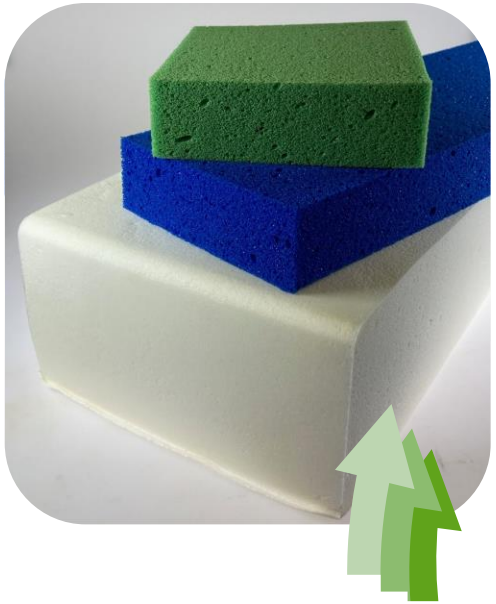
	PU Flexible Foam
Density [g/L]	54.0
Compr. strength 40% [kPa]	3.7
Hysteresis loss 70% [%]	21.2
Tensile strength [kPa]	118
Strain at break [%]	157
Compr. set [22h/70°C/50%)	8.8
Ball rebound [%]	58

DMA analysis of produced injection molds – storage modulus G‘ in MPA



Meltable PU foams – flexible foam / multiple recycling

Meltable BASF PU Flexible Foam

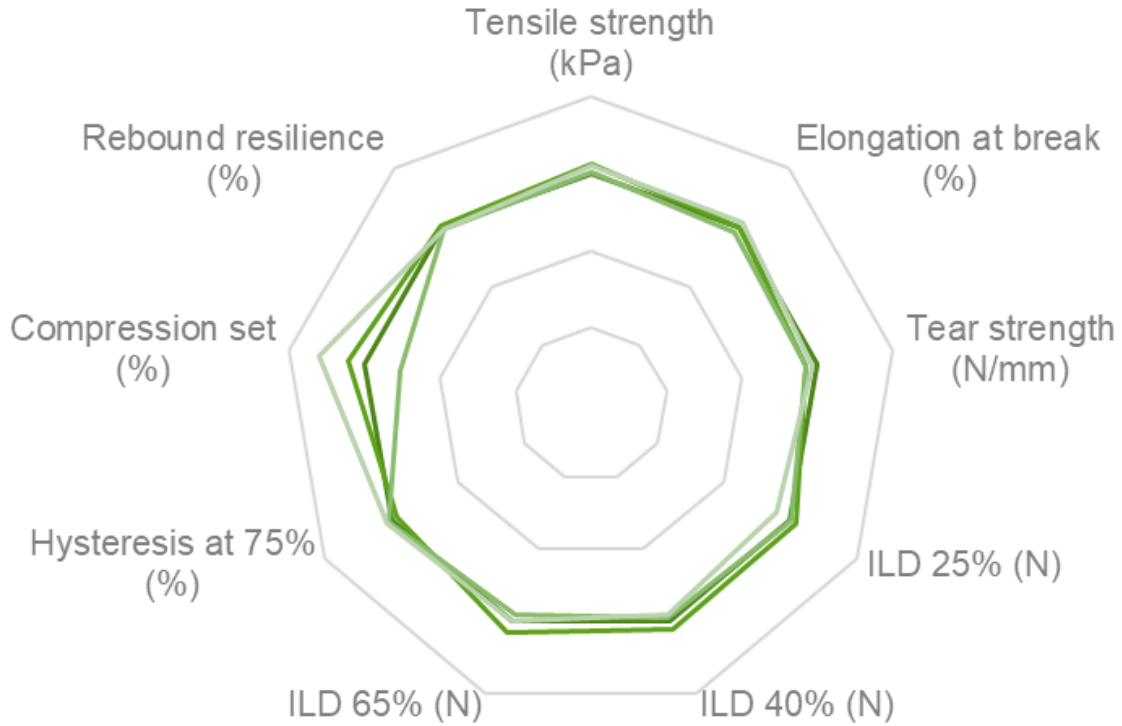


virgin PU-formulation

Recycling Process

Molded Foam

8% recycle-PU in flexible foam PU



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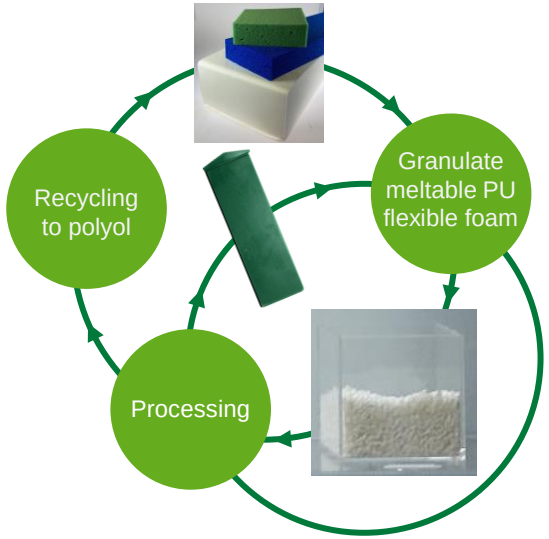
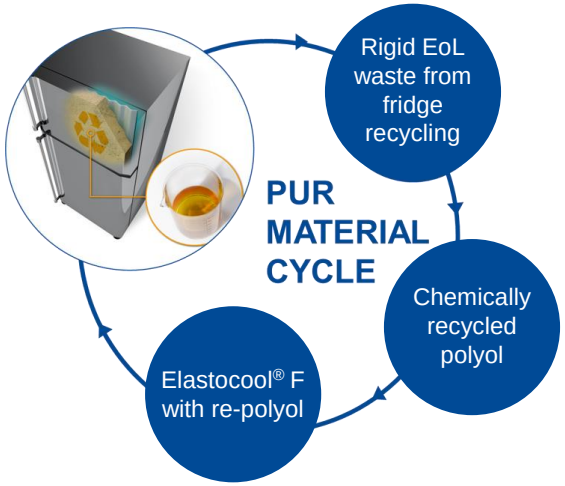
Closing the loop of PU – holistically

BASF activities on mechanical recycling, glycolysis, etc.

- ✓ Recycled Content < 30%
- ✓ Demonstrate general recyclability
- ✓ Closed and Open Loop
- ✓ No Separation of Polyol & Isocyanate

5-30%
Polyol





With *Vitra*, PU office chair foam can be mechanically recycled; **up to ~30%**

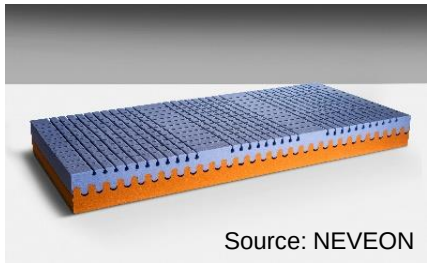
With *Rampf*, *Krauss-Maffei* and *Remondis* recycled content **up to ~20%.**

Full depolymerization solutions

- ✓ Recycled Content > 50%
- ✓ Demonstrate Recyclability
- ✓ Closed Loop
- ✓ Recovery of Isocyanates

Iso
>>50%
Polyol

Few robust chemical recycling technologies for *many* variable PU waste streams


Source: NEVEON

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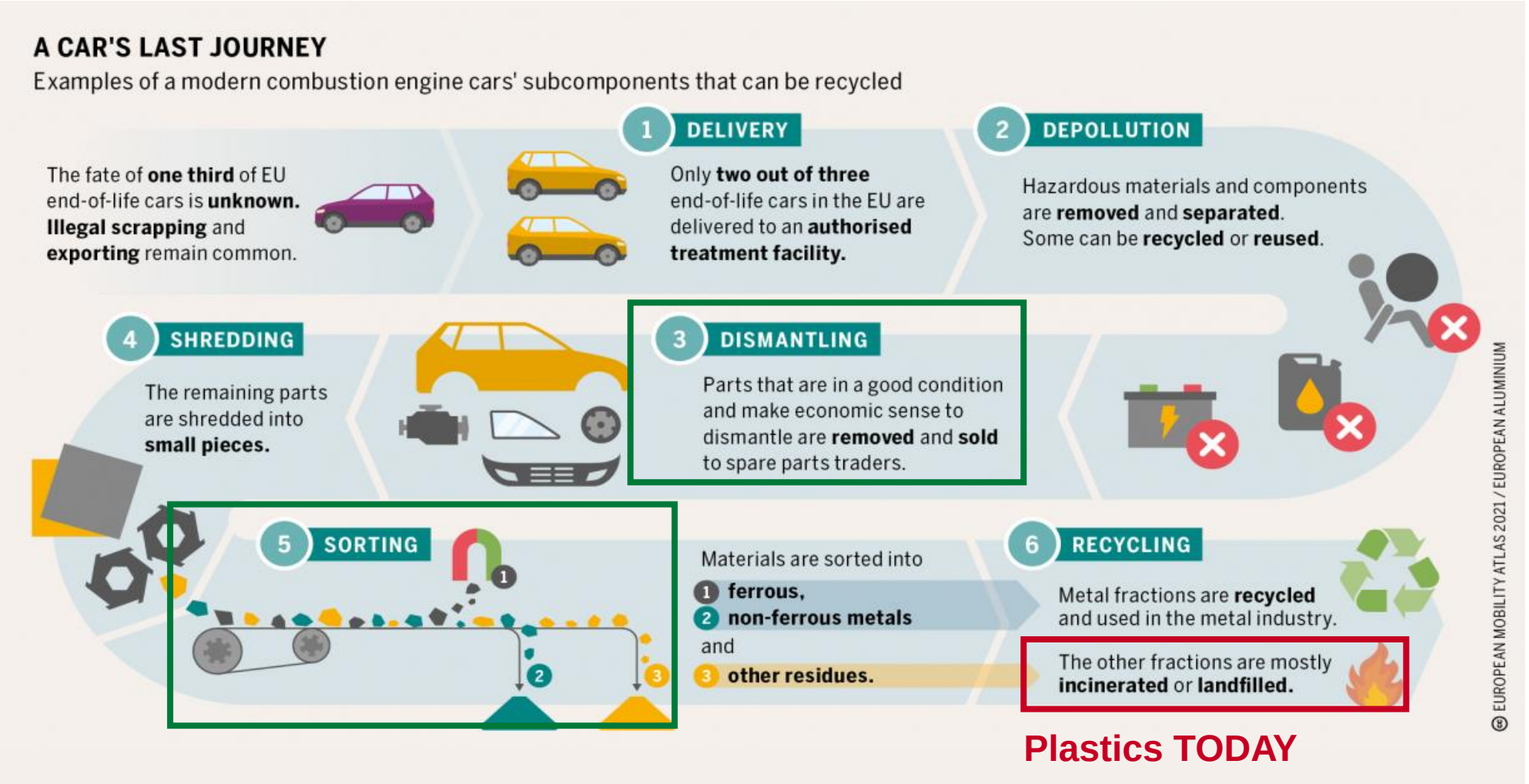
The challenge of closed loops



https://eu.boell.org/en/end-of-life-vehicles-final-destination
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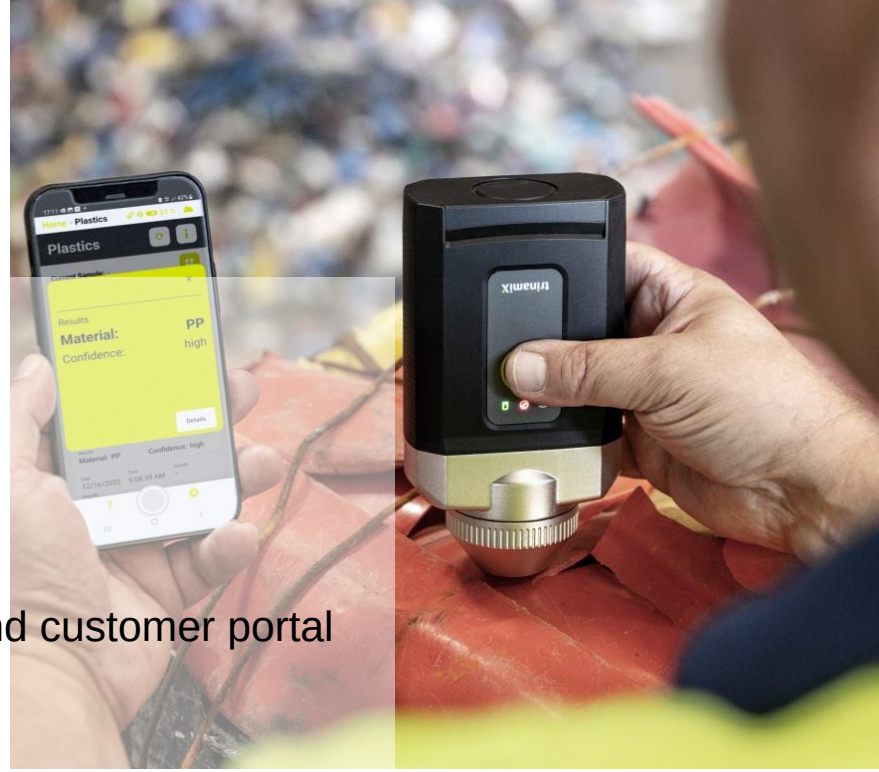
Closing the loop of PU – sorting trinamiX *Mobile NIR Spectroscopy*



- trinamiX GmbH was founded in 2015 as a wholly owned subsidiary of BASF SE
- trinamiX mobile Near-Infrared (NIR) Spectroscopy Solution **identifies plastics anywhere, anytime, in seconds**
  - portable handheld device, trinamiX cloud-based data analysis, a mobile app and customer portal
  - determines diverse compositions of different plastics
  - supports design for recycling, cleaner sorting and quality control
- **Recycling and recyclability are improved**, paying off for both the environment and businesses alike
- **Application for Footwear materials / Automotive flexible foams**
- Qualitative identification of midsole materials

* Without PolyTHF
** With PolyTHF

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Turn the recycling challenge …….

into a successful business

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We need (more) pioneers!

#OurPlasticsJourney

make use recycle

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