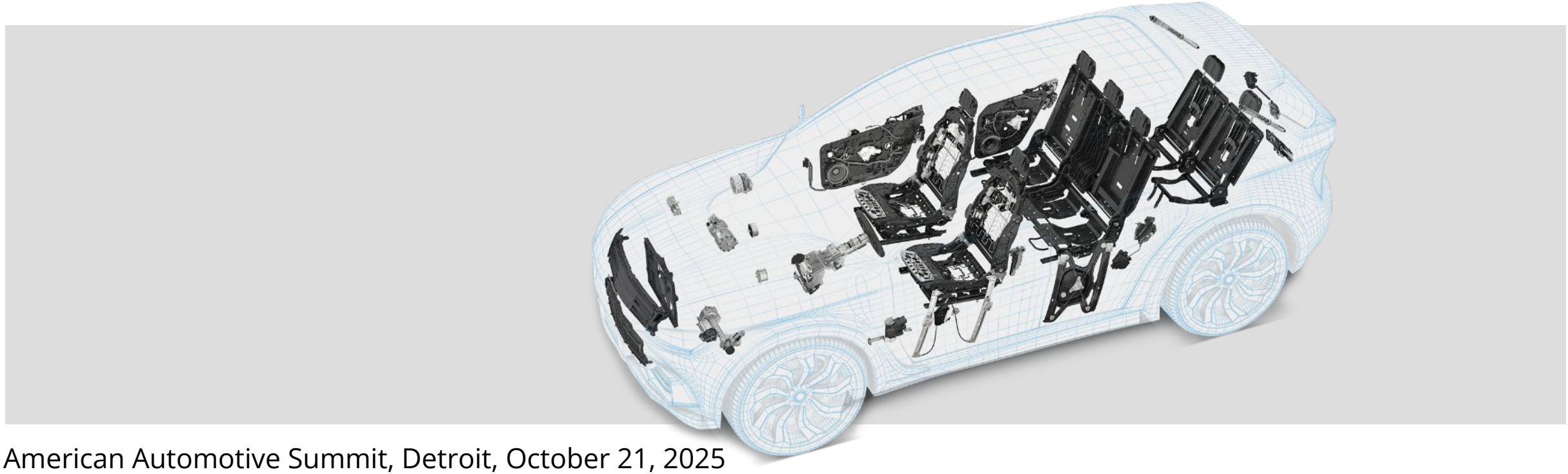
brose
Excellence in Mechatronics

System supplier of the international automotive industry



American Automotive Summit, Detroit, October 21, 2025

Agenda

Brose Group

Global footprint close to our customers

68
Locations in 24 Countries

80+
Customers

30,400
Employees globally (approx.)

Revenues 2025 (Plan)

7.8
EURbn

Innovation

354
EURm Investment

7
Percent of revenue invested in R&D

5,875
Patents

One in three new vehicle is equipped with at least one Brose product.

Current product range

We develop and produce for over 80 car manufacturers and 40 suppliers worldwide

Seat components and vehicle seats

Sensors for interior and exterior

Systems and components for vehicle doors

Electric motors for steering, braking systems and drive train

Drives for side doors and liftgates

Systems and components for thermal management

Systems and components for micromobility

Sustainable Polymers in Automotive Applications: Market Needs, Waste Hierarchy and Carbon Footprint

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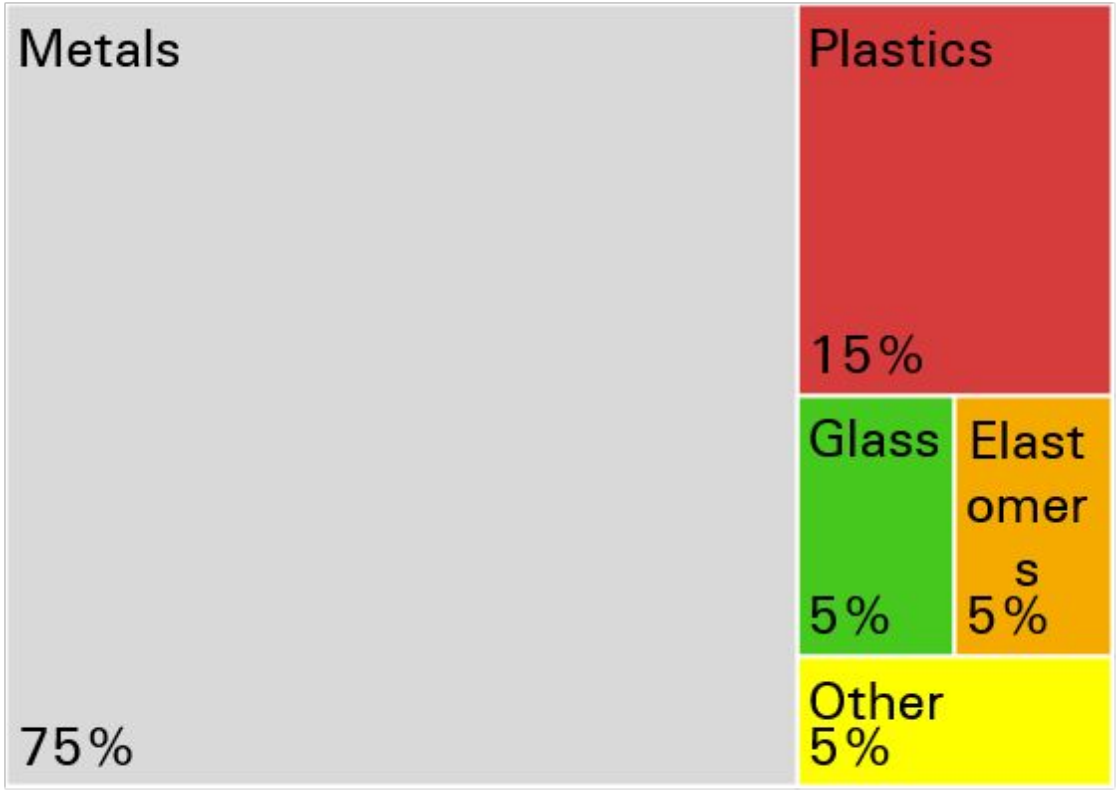
Excellence in Mechatronics

Agenda

Sustainable Polymers - Why?

The total scrap caused by End-of-Life Vehicles (ELVs) in the U.S. is estimated to be 12-15 millions tons, annually.



Comparison of ELV Regulations: EU, US, Mexico, Canada

Summary Table: ELV Regulatory Approaches

Jurisdiction		Binding ELV Regulation?	Recycled Content Targets?	EPR for Automakers?	Focus Areas
EU		Yes (Draft Regulation)	Yes	Yes	Circular economy, design, traceability, EPR
US (Federal)		No	No	No	Hazardous waste, battery recycling (DOE)
US (States)		Fragmented	No	Some states	Dismantling, hazardous materials, EPR pilots
Mexico		No	No	No	Best practices, border region cooperation
Canada		No (voluntary code)	No	No	Best practices, pollution prevention

Sustainable Polymers @ Brose

Customer & Legal Requirements / End-Of-Live-Vehicle Directive

	European Commission ELV Directive, Draft 07.2023	European Parliament ELV Regulation, Draft 01.2025	European Union Council General Adopted Position, Draft 06.2025
Recycling target per car (plastics incl. PU-foams)	**25%**	**20%** (potential increase to 25% after 10a)	6 years: 15%, start 2033, if adopted 2027 8 years: 20%, start 2035, if adopted 2027 10 years: 25%, start 2037, if adopted 2027
Post-consumer (PCR)	✅ **Yes**	✅ **Yes**	✅ **Yes**
Post Industrial (PIR)	❌ **No**	✅ **Yes**	❌ **No**
Chemical recycling	✅ **Yes**	✅ **Yes**	✅ **Yes**
Bio Based Plastics	❌ **No**	✅ **Yes**	❌ **No**
Circular economy	25%	15%	≥25%
Expected implementation	2025	Late 2026	Likely 2027

Sustainable Polymers
“Ideal”

Recycling of „clean“ single sourced, unaged, uncontaminated material

Process well known

Degradation predictable

recycling

Sustainable Polymers
“Reality”

Car manufacturing — Use phase — End of life

One customer, one spec.

~15 yrs / 200.000 km

Dust … Grease … Wax … Gas … Soap … Oil

multiple customers and specs

Aging & Contamination of plastics

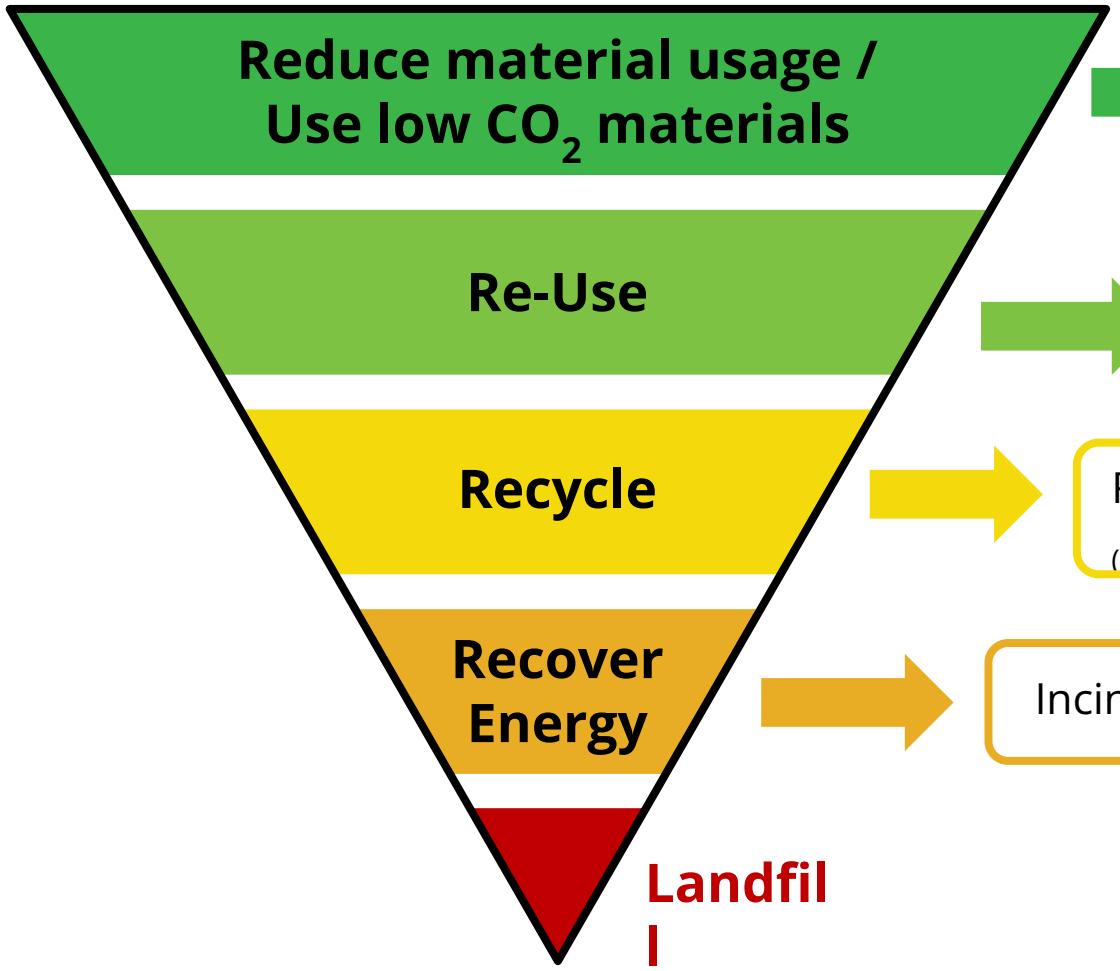
New regulations (e.g. REACH) — New specifications

recycling process / mix of different material grades / mix of modifiers / …

25% plastic recycled content
25% thereof from circular eceonomy!

Agenda

Sustainable Polymers
Waste Hierarchy



- Prevent high CO_2 materials wherever possible e.g. PP vs PA
- Most effective design to lower material usage Weight reduction via e.g. thin wall technology.

Re

Replacer

(current OEM

Incineration

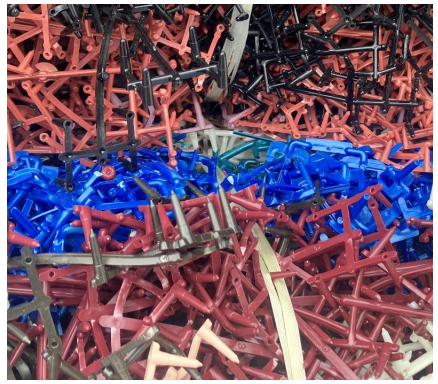
Agenda

Sustainable Polymers @ Brose
Customer & Legal Requirements

Some clarifying information on the abbreviations …

PIR ⇔ PrC (Post Industrial Recycled ⇔ Pre Consumer)

Waste retrieved from industrial processes.



VDA265 Draft ⇨ PrC-A ⇨ **Pre Consumer Automotive**

PrC-nA ⇨ **Pre Consumer non-Automotive**

PCR ⇔ PoC (Post Consumer Recycled ⇔ Post Consumer)

Waste after use.

VDA265 Draft ⇨ PoC-A ⇨ **Post Consumer Automotive**

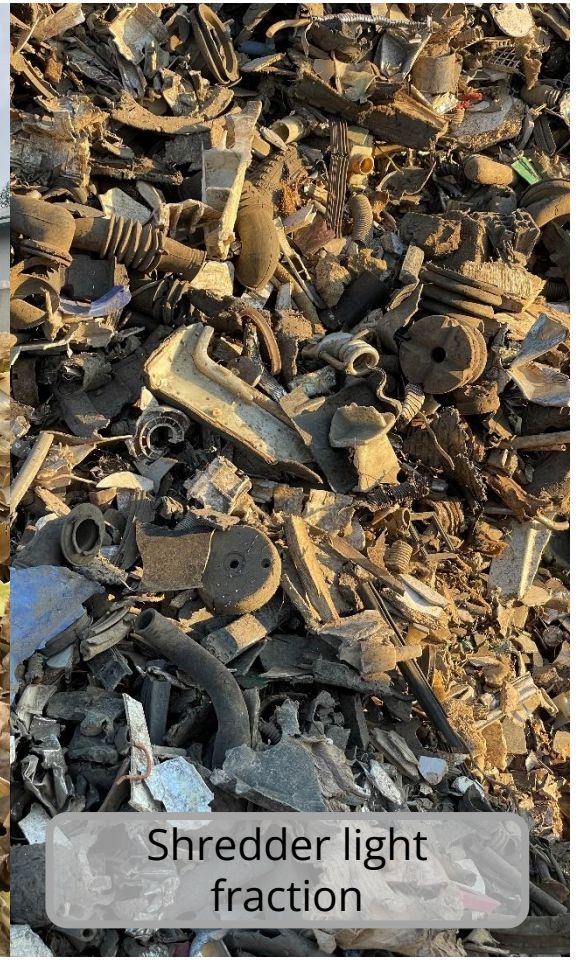
PoC-nA ⇨ **Post Consumer non-Automotive**

Sustainable PP LGF
Potential Post Consumer Feedstocks

One-time used carpet

Municipal waste
(e.g. DE “yellow bag”)

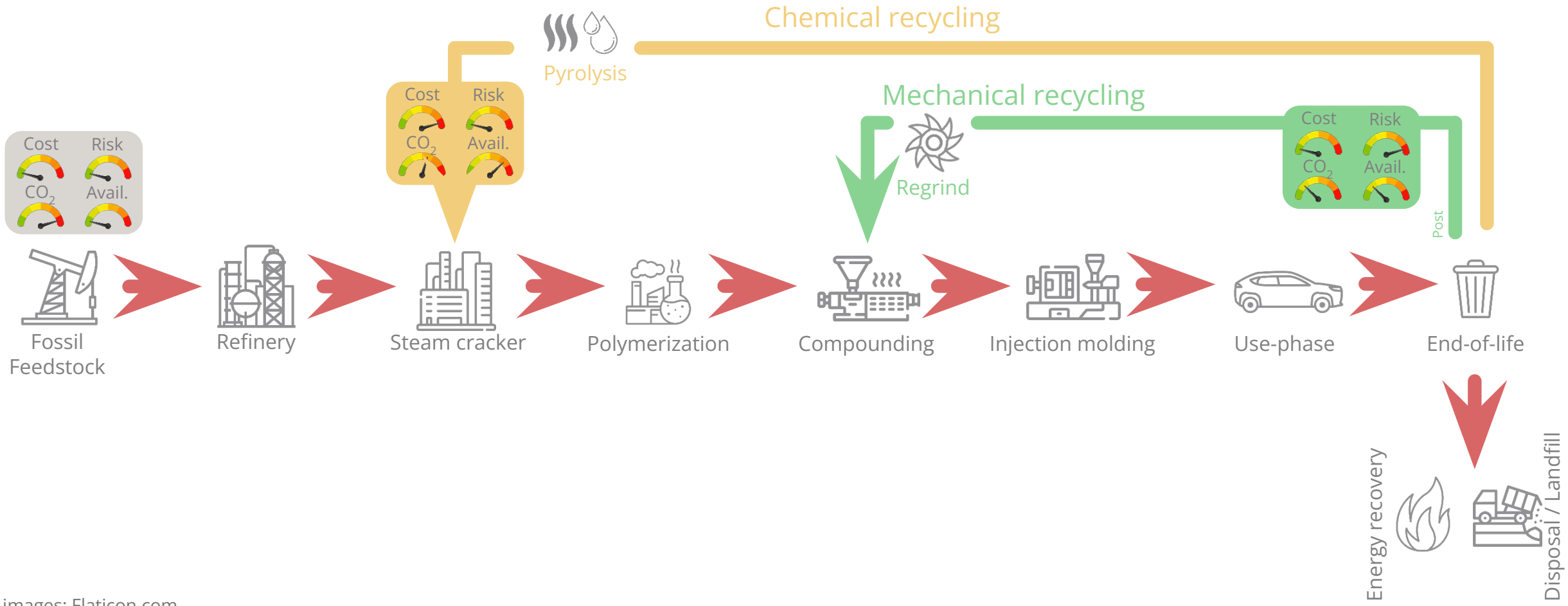
EOL oil tanks



Shredder light fraction

Sustainable PP LGF

Potential Post Consumer Feedstocks



images: Flaticon.com

Sustainable PP LGF

Potential Post Consumer Feedstocks

plastic

wood
paper
others

rigid

PP

others

grinding

Wash process + density separation

PE

PP

others

colore

grey

images: Flaticon.com

Sustainable PP LGF
TiO_2 in Recycled Materials

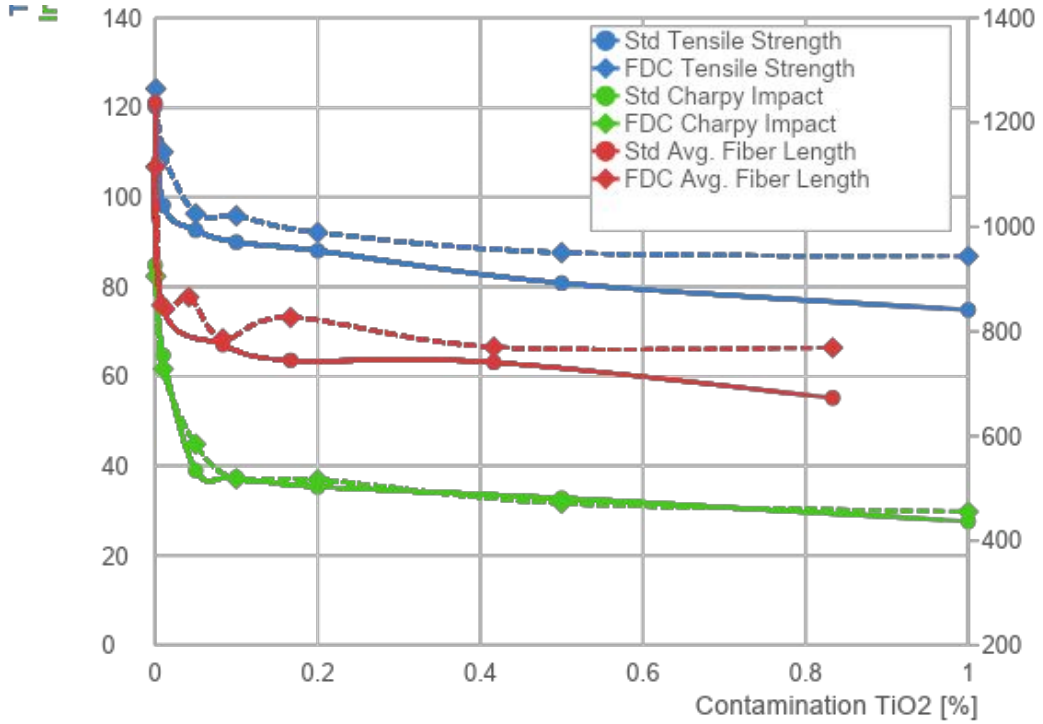
Titanium dioxide (TiO_2) is commonly used in plastics to provide white color and to harmonize other colors. On average, the concentration of titanium dioxide in plastics ranges from 1% to 10% by weight.

TiO_2 is abrasive, shortens fibers and reduces the mechanical properties significantly!

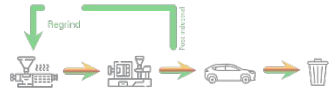
A **TiO_2** content of **0,01%** reduces

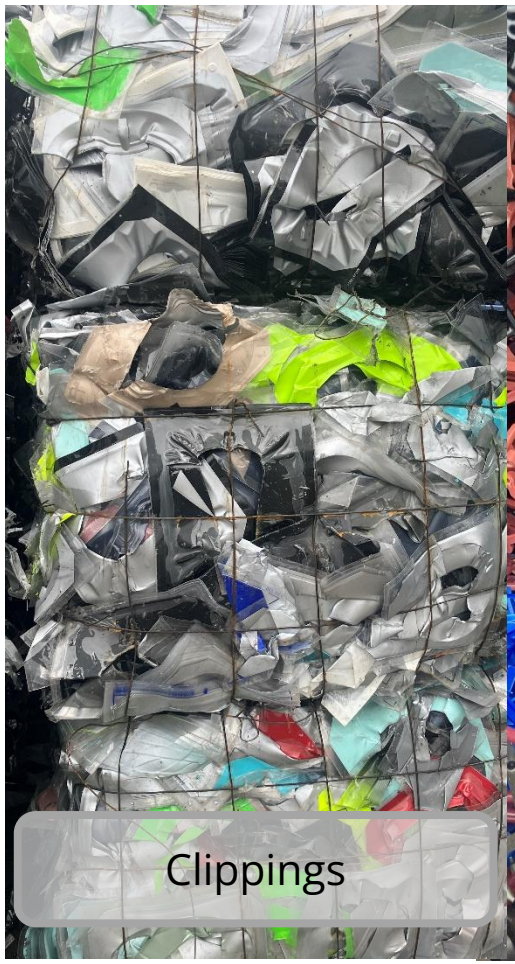
Tensile strength by ~20%
Impact Strength by ~25%
Strain @ break by ~15%
Fiber Length by ~30%

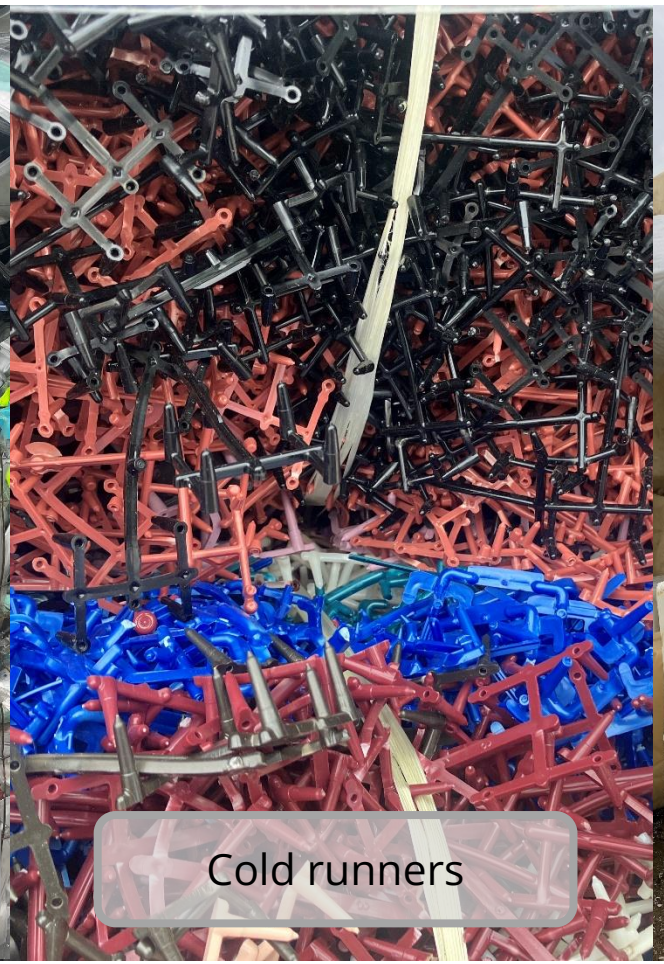
TiO_2 is a major concern and must be managed for successful development of recycled PP LGF



Sustainable PP LGF
Potential Post Industrial Feedstocks



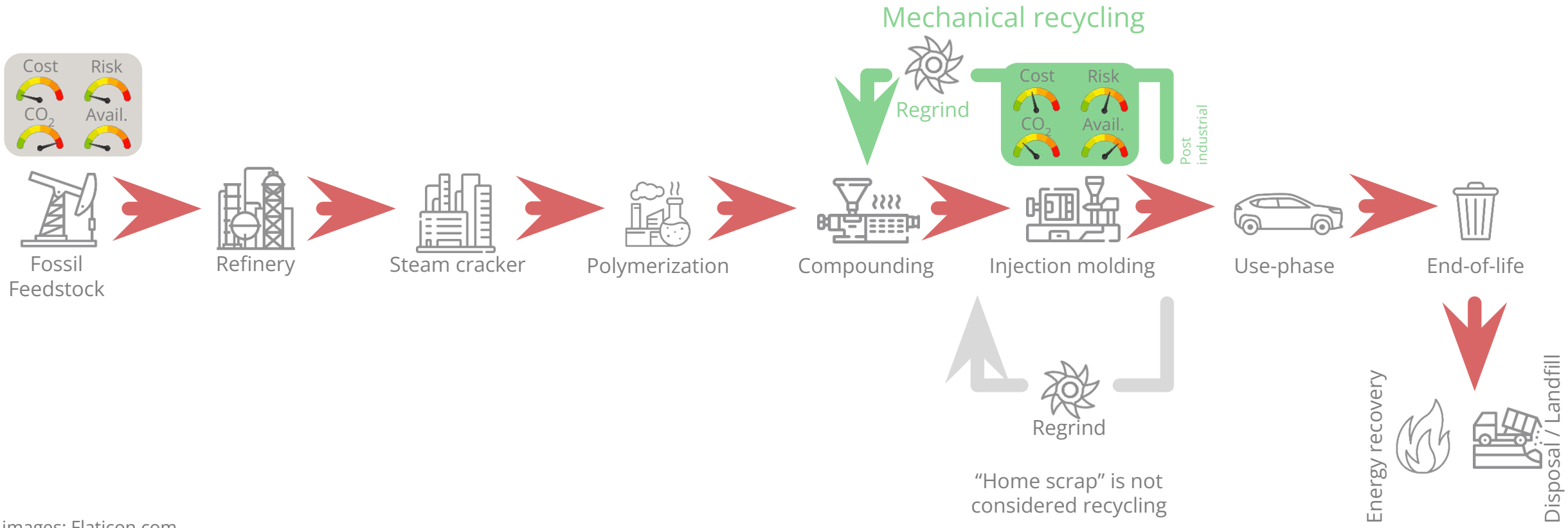

Clippings


Cold runners


Blocks from chemical industry

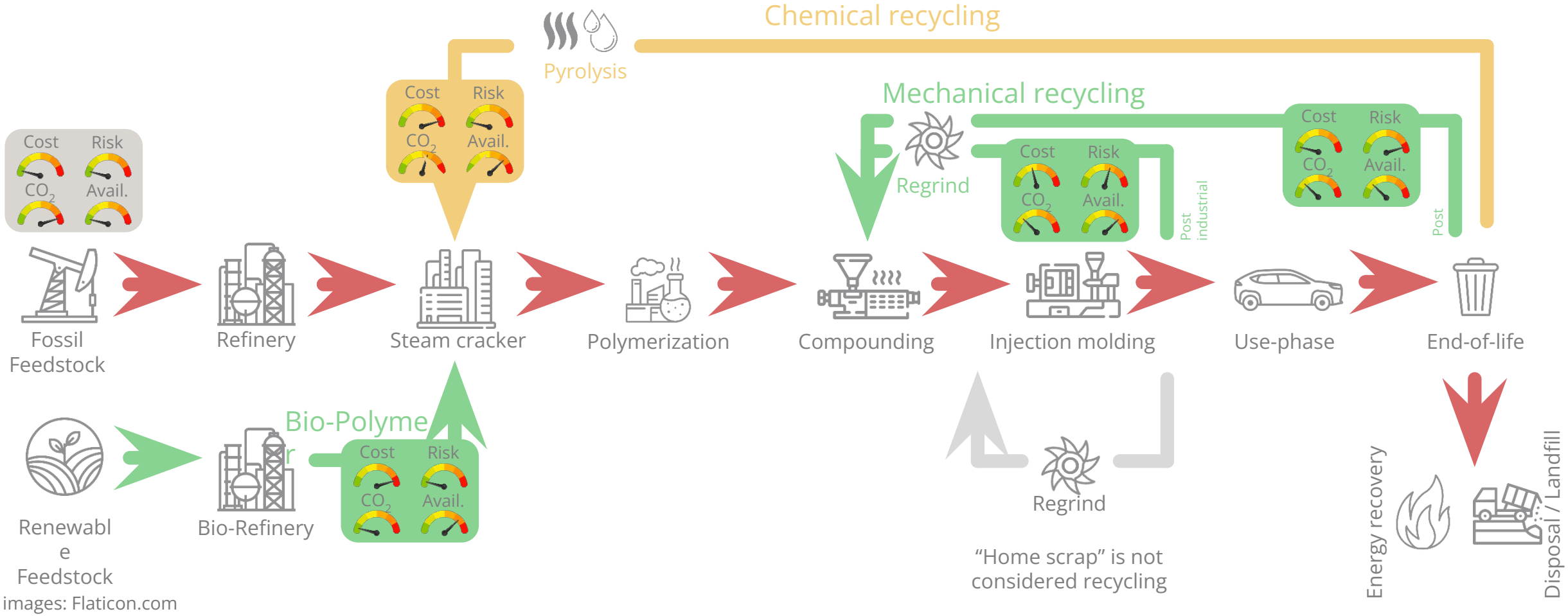

Start-up blocks

Sustainable PP LGF
Potential Post Industrial Feedstocks



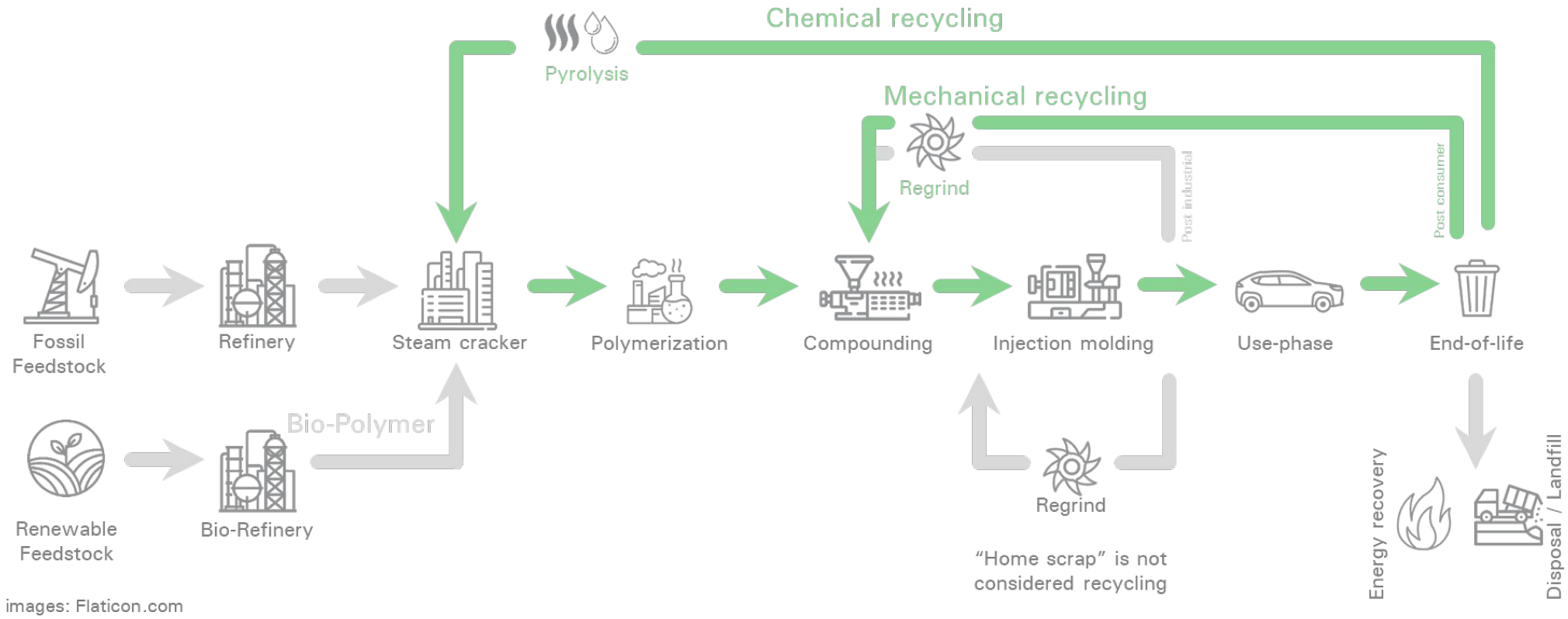
images: Flaticon.com

Sustainable PP LGF
Potential Feedstocks



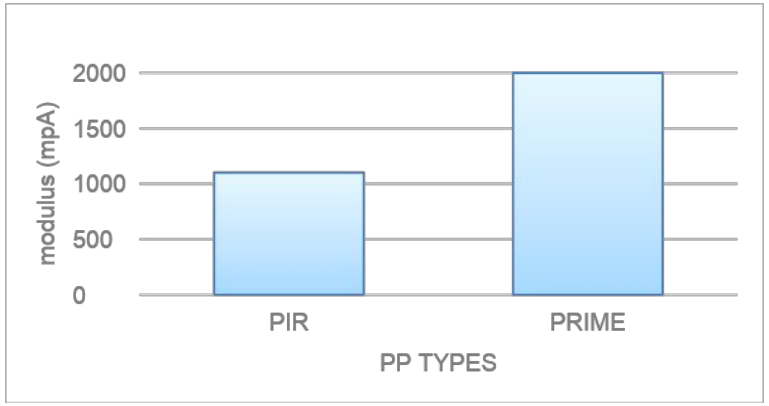
Sustainable PP LGF

Potential Feedstocks Considering ELV Regulation in Force

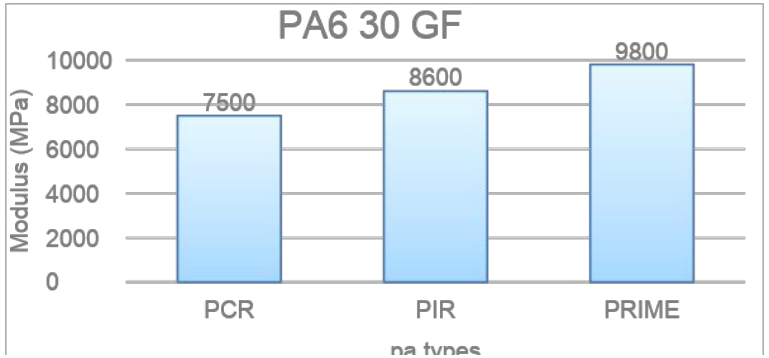


In line with the ELV Regulation draft, only PCR mechanical or chemical recycling are accepted towards the 25% target! PCR and Bio-Polymers are no longer counted as recycled feedstock.

Sustainable Plastics
Property Loss with Recycled Plastics



- PP PIR values reflect current rPP systems
- Mechanical property loss is significant
- Recycled content at higher levels critical (>25 – 30%)



- PA recycled streams show lower property loss overall
- Can use rPA at higher levels (60 – 70%)

Industry will need to accept a wider range of material properties!

Agenda

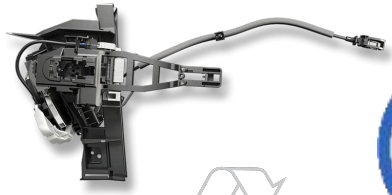
Sustainable Polymers @ Brose
Customer & Legal Requirements

Mercedes-Benz

20%

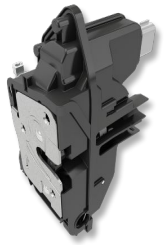
SEAT

25%



40%

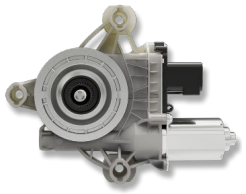
50%



100%

STELLANTIS

VOLVO



30%

LAND ROVER

10%

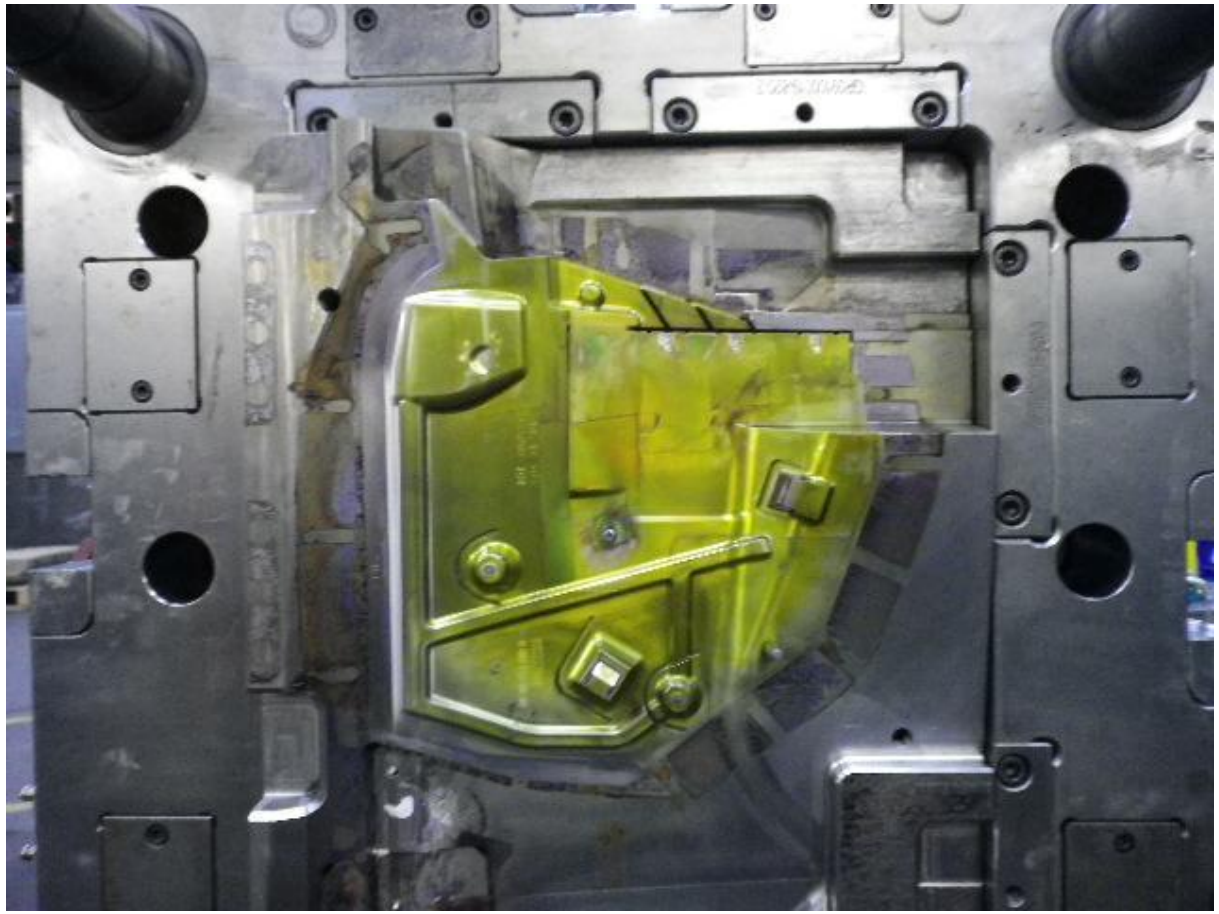
35%

European OEMs have already implemented requirements towards use of sustainable materials

Sustainable Polymers @ Brose
Lessons Learned

Bracket
(PP TX20)

Issue: Process interruptions due to deposits.
Frequent dry ice blasting required



Lessons Learned …

Feedstock contained also printed plastic film.
The ink used for printing caused the deposits.

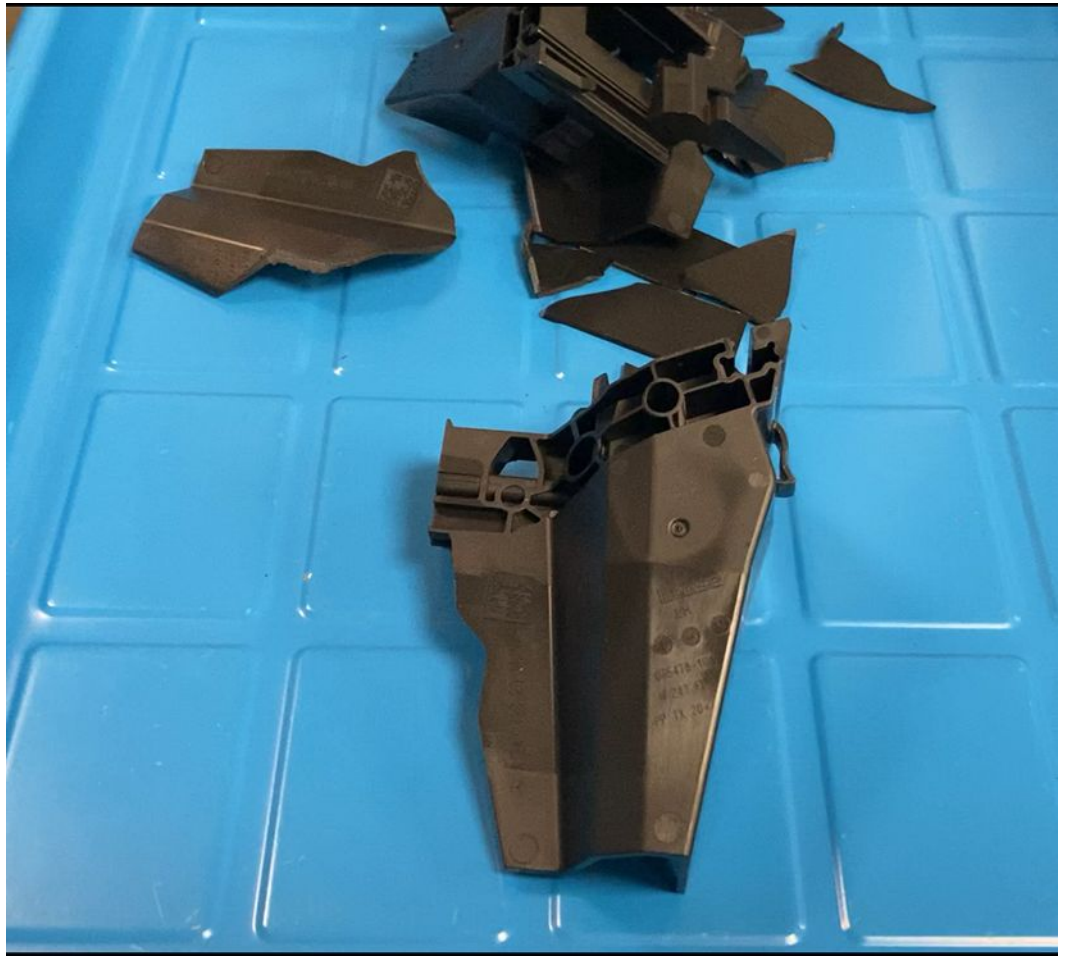
Supplier no longer uses the feedstock of printed plastic films.

Since then, there have been no more problems with deposits.

Sustainable Polymers @ Brose
Lessons Learned

Bracket
(PP TX20)

Issue: Brittleness caused breakage during assembly



Lessons Learned …

Material contaminated with special kind of Polyethylene which caused brittleness of material.

Polyethylene cannot 100% avoided in recycled materials. A lot selection based on an elongation to break value is agreed to.

Since then, there have been no more problems with broken MFBs during assembly.

Sustainable Polymers @ Brose
Lessons Learned

Fan Wheel
(PA6 GF30)

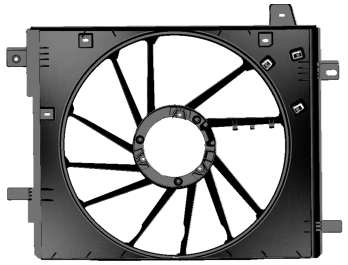
Issue: Visible blisters on the part surface / delamination

Lessons Learned …

Material contained Polyethylene (PE) as impact modifier.

In this specific tool, the PE got separated and caused the delamination.
Material without PE chosen for the project.

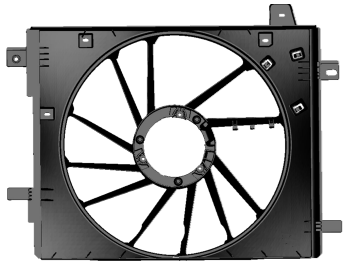
Sustainable Polymers @ Brose
Lessons Learned



Shroud
(PP LGF30)

Issue: Assembly

Sustainable Polymers @ Brose
Issues Brose Faced (... by now)



Shroud
(PP LGF30)

Issue: Assembly issues

Lessons Learned ...

Material batch was a mixture of Homo-, Copolymer PP with Polyethylene that caused lower compression strength. Identified a correlation tensile strength and other material characteristics - now part of the material specification.

Since then, there have been no more problems with a low compression strength.

Sustainable Polymers
Mechanical Recycled Polymers

Material cost

Recycled materials are driven by the demand and limited availability of the feedstock. Currently the recycled grades of good quality are more expensive than prime materials.
Risk □ price development not predictable
□ quality consistency unpredictable
Backup □ dual validation with prime material

Security of supply

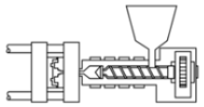
The feedstock for recycled materials can change during the project lifetime. Recycled material specification is unspecific for our needs.
Risk □ feedstock can run out, fluctuation in material performance
Backup □ dual validation with prime material

Emissions

Due multiple process cycles the emissions are higher on recycled materials (added shear and heat history). Further feedstock changes can cause issues.
Risk □ emissions not predictable
Backup □ dual validation with prime material

Mechanicals

Mechanical performance of prime material is higher. Batch to batch tolerances of recycled materials are higher than prime material.
Risk □ potentially more material required
Backup □ dual validation with prime material



Changes in materials can cause deposits, difficult demolding, interruption by foreign materials (metal, wood, stone, ...), ...
Risk □ potential production issues
Backup □ dual validation with prime material

Sustainable Polymers

Questions
?

Verfasser: ZQU-WM/Schlechtriemen, Martin