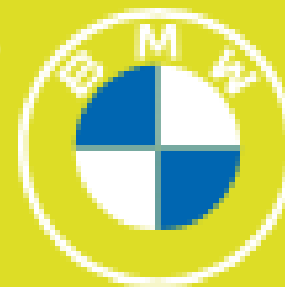


EXPERTS ALONG YOUR VALUE CHAIN

FOR SUSTAINABLE
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CONVERSIO
| market & strategy



BMW study
Automotive-grade plastic
recyclates

Conversio focus industries.

Every industry and every market has its own requirements and highly specific challenges. Let our analysis and consulting expertise benefit your business development in a targeted way.

A hexagonal graphic with a background of a molecular structure, featuring a central orange sphere surrounded by smaller black and red spheres.

**CHEMICALS
PLASTICS
MATERIALS
ENVIRONMENT &
CIRCULAR ECONOMY**

A hexagonal graphic with a background of several 3D rectangular blocks in shades of brown and tan, arranged in a staggered pattern.

**CONSTRUCTION
&
BUILDING TECHNOLOGY**

A hexagonal graphic with a background of an aerial view of a city, showing buildings and streets in a grid-like pattern.

**MECHANICAL & PLANT
ENGINEERING
DIGITALISATION
AUTOMATION
AUTOMOTIVE**

For many years, Conversio provides the Plastics Industry and the correlated plastic part users from the Packaging, Building & Construction, Automotive and E+E with important Facts & Figures on the Plastics Circular Economy

HOW HAS THE PLASTICS CIRCULAR ECONOMY EVOLVED?

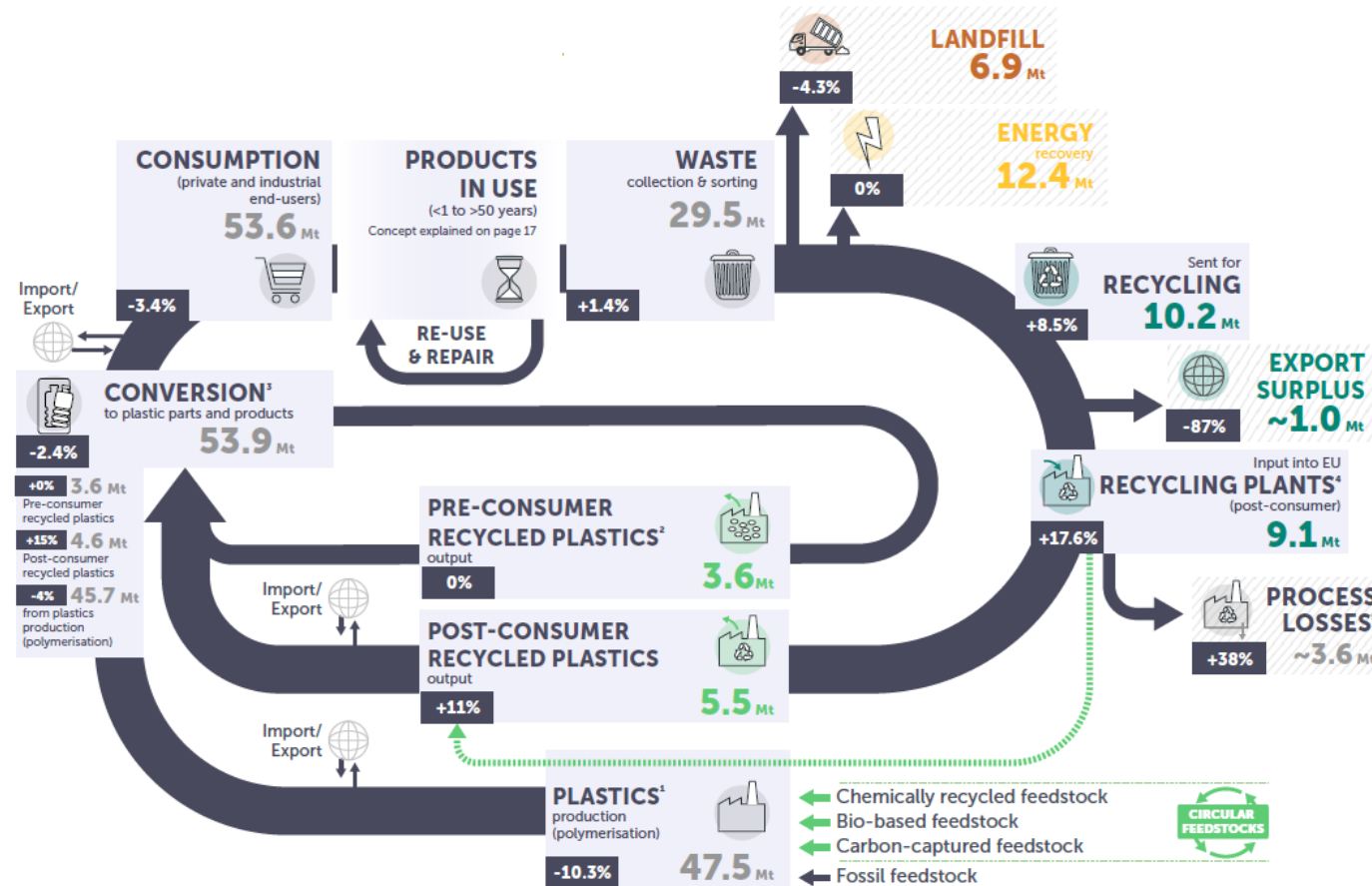
BETWEEN 2018-2020

From 2018 to 2020, a positive trend towards higher circularity emerged.

Plastics production (polymerisation) has decreased by 10.3%.

At the same time, the post-consumer plastics waste quantities sent to recycling have increased by 8.5%. Quantities sent to landfill decreased (-4.3%) and energy recovery remained the same for the first time since 2006. As a consequence, the supply of post-consumer recycled plastics increased by 11% compared to 2018, and their use into new products rose from about 4 million tonnes to 4.6 million tonnes – an increase of 15%.

This demonstrates an initial shift towards a higher share of recycled plastics in the manufacturing of new products (from 7.2% in 2018 to 8.5% in 2020).



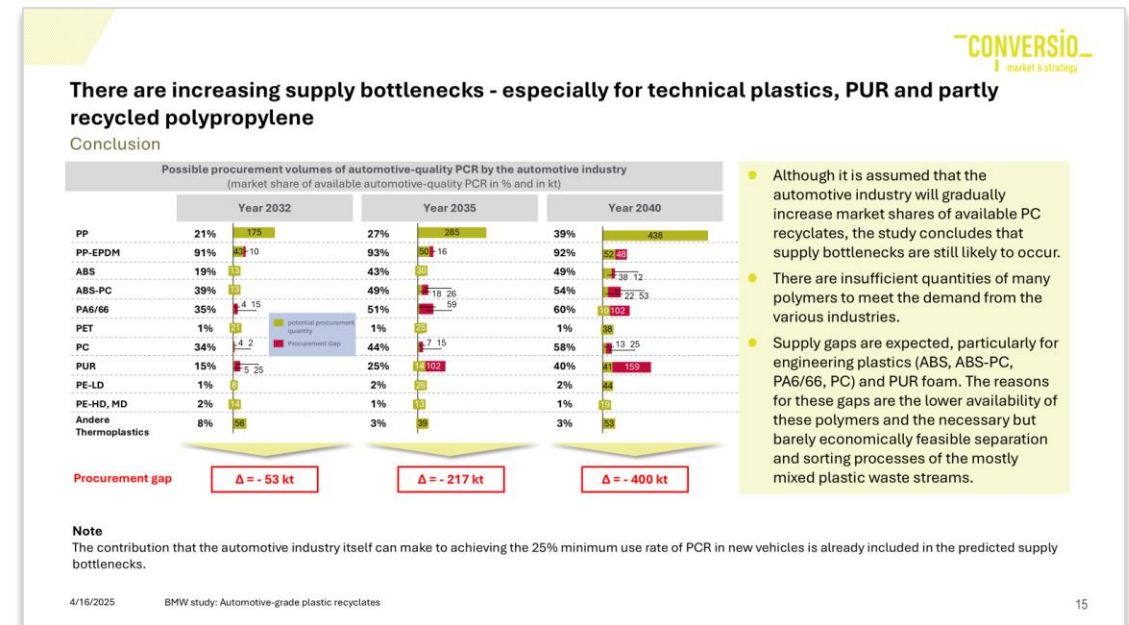
Study download

Study Scope

Project framework

Aim of the study and topics of today's presentation

- 1) Understanding the plastics (waste) flow
- 2) Development of availability, quantities and qualities of automotive-quality recyclates up to the year 2040 based on an **“ambitious scenario model”**.
- 3) **GAP analysis** for the years 2030, 2035 and 2040.
- 4) Identification of possible bottlenecks regarding waste management structures, technology, infrastructure, etc.
- 5) ... based on upcoming EU regulations, demands of competing industries as well as significant market players and their market position.



Study Scope

Project framework



Outline of the project

- ◆ Focus on post-consumer waste streams
- ◆ Target polymers and recyclates to consider:
PP, PP-EPDM, ABS, ABS-PC, PA6/PA66, PET, PE, PC,
PUR soft foam, other thermoplastics and other thermosets



Methodology

- ◆ Secondary research (analysis of waste statistics, business databases, Factiva, Eurostat, regulations, etc.)
- ◆ Conducting ~50 expert interviews with plastic manufacturers, recyclers, dismantling and shredding companies, tier1 suppliers and other experts
- ◆ Ambitious scenario-modelling, considering the objectives of current legislation drafts (PPWR, ELVR, etc.)

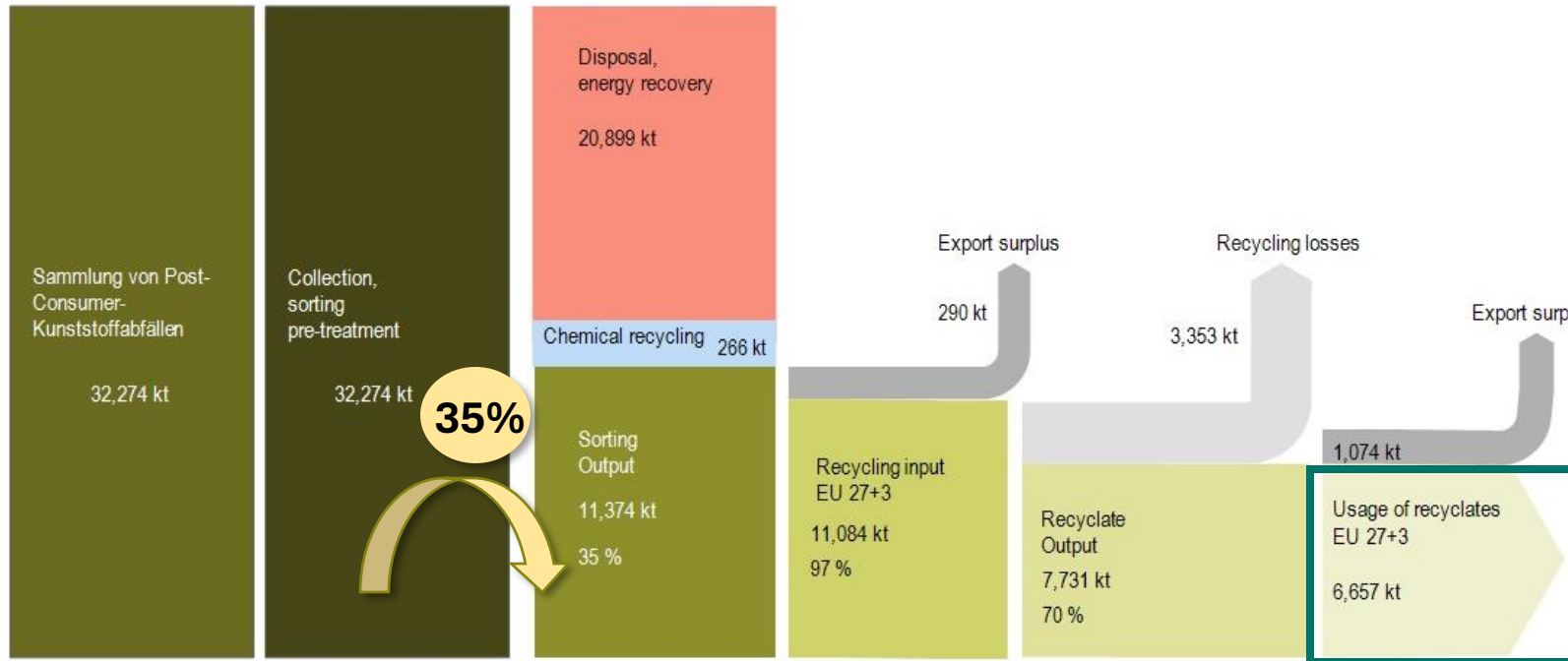


Region

- ◆ EU 27+3

What is the current situation of post-consumer recycled plastics in EU 27+3 countries?

More than 32 Mt of plastic waste are collected in EU 27+3, but only 7.7 Mt recyclates are produced



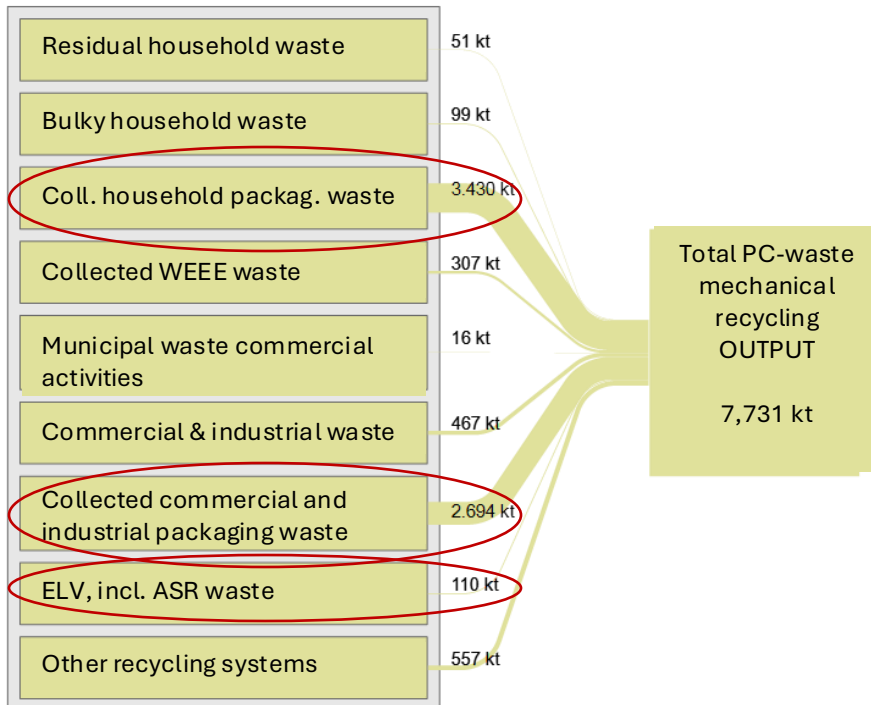
Only 20.6% of the plastic waste generated is ultimately available as recyclates for the plastic converting industry!

Figures include low- and high- quality post-consumer recyclates!

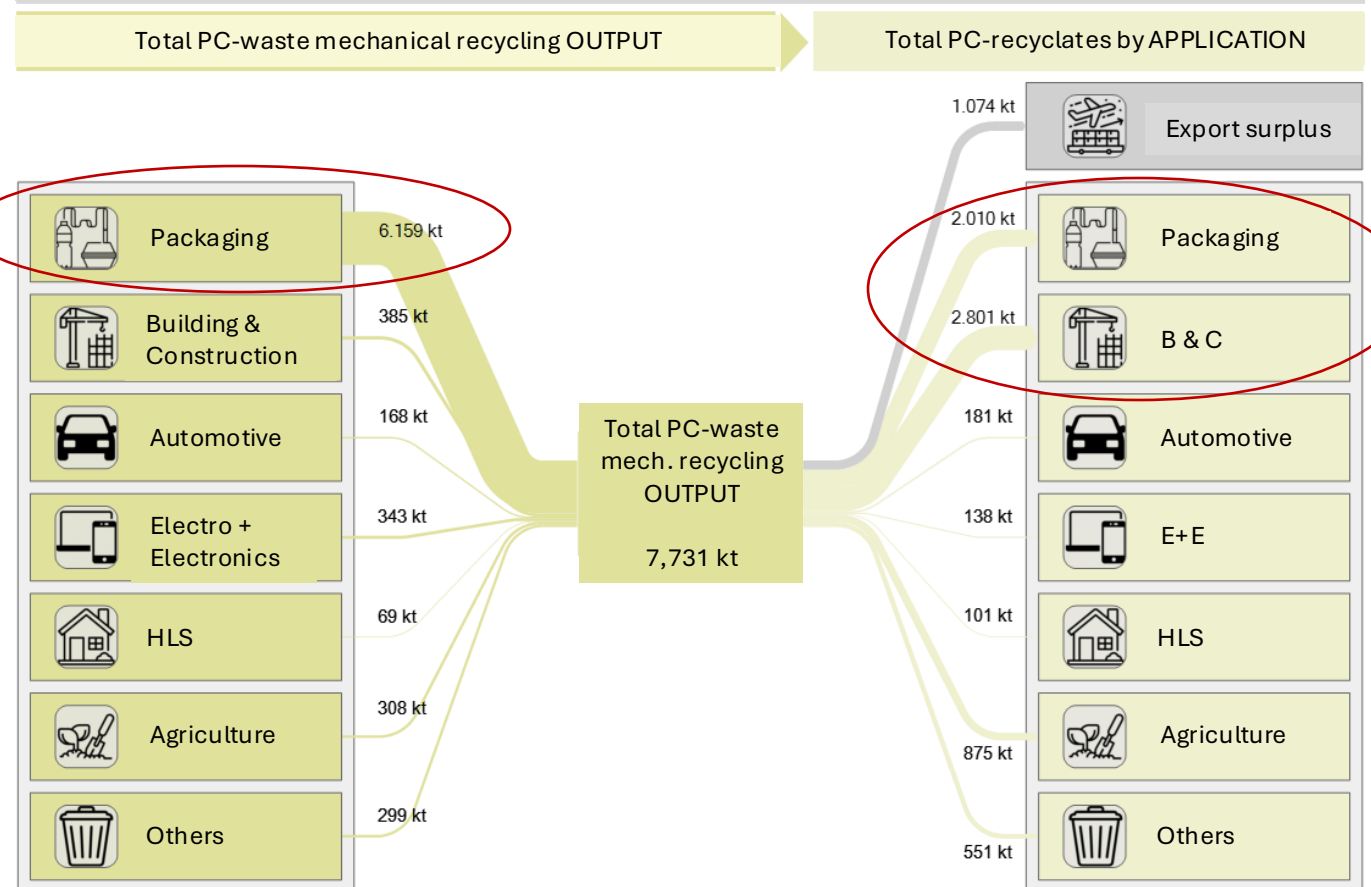
Where do PC-recyclates come from?

PCR mainly come from plastic packaging waste. Plastic recycling from ELV only to a very limited extent!

Recyclates by origin of the waste streams

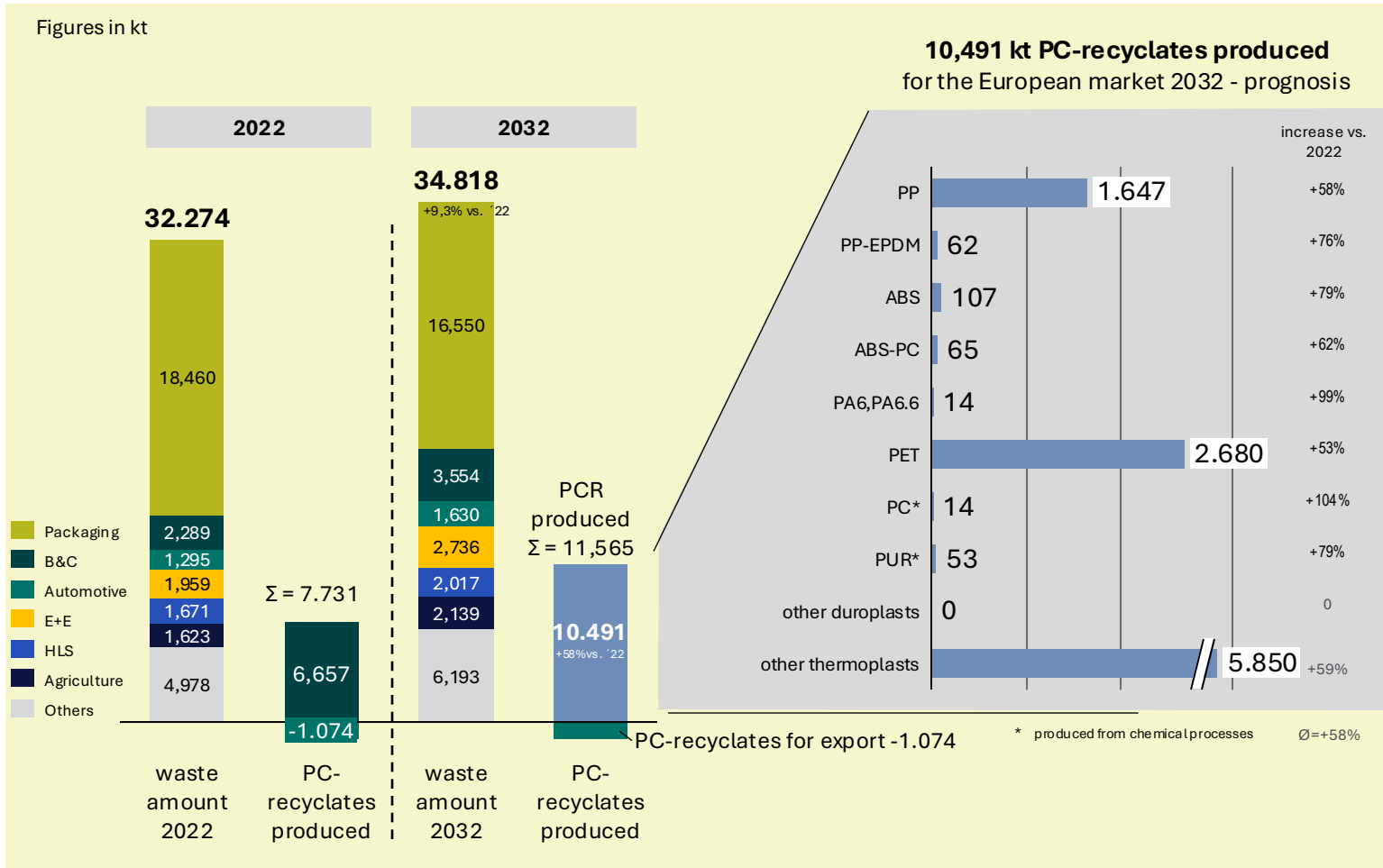


Recyclates by industry of origin and future use



How much recycled post-consumer plastic will be available by 2032?

Ambitious scenario shows intensive increases in recycling capacities in Europe – 10.5 Mt PCR produced for the European plastics processing market



Assumptions

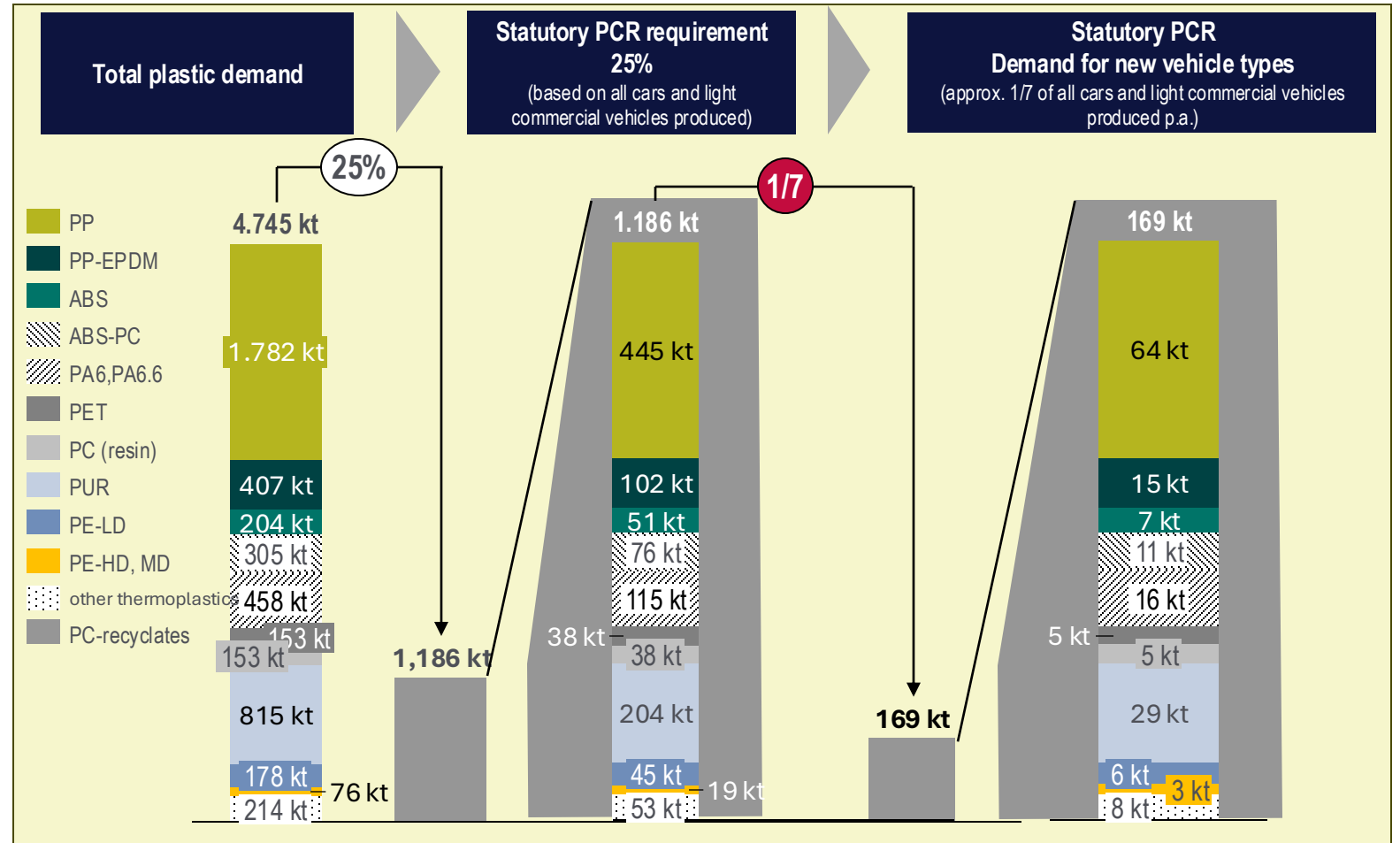
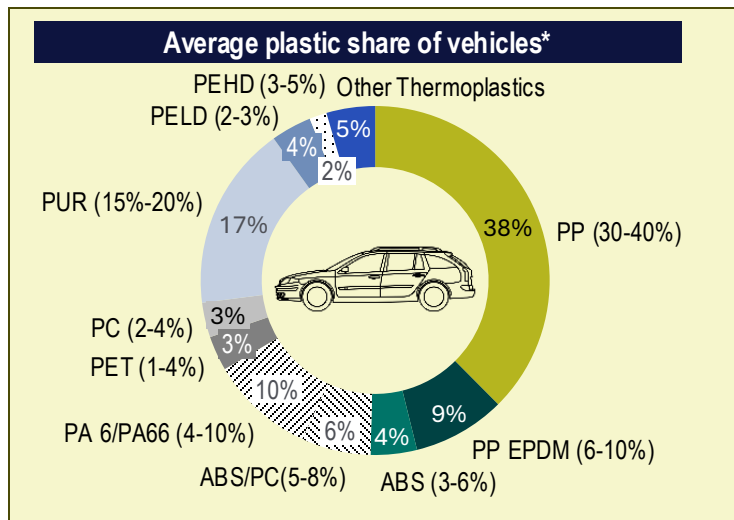
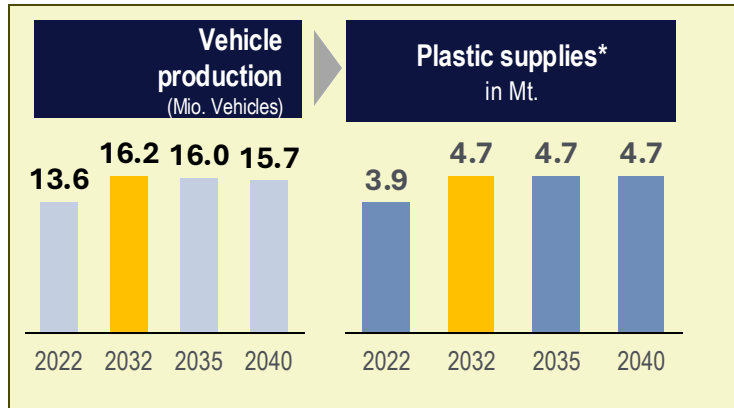
- Based on the PPWR regulations, the amount of **packaging** waste will fall by -5% by 2030 compared to 2018 levels and by -10% by 2035.
- Expected growth in plastic waste in all other application segments
- Increase of PCR production and availability (largest increase in volume for PO and PET) due to improvements in separate plastic collection (especially LVP) and the expansion and extension of recycling capacities.
- The amount of recycled PUR is also expected to increase. (Quantity indicated shows what can be produced from the mattress collection using chemical processes)

Conclusion

PCR quantity can be increased, if ... the corresponding input industries comply with the voluntary commitments and legal requirements for higher recycling rates.

What might be the implications of a minimum PCR utilization rate of 25% for the automotive industry in 2023?

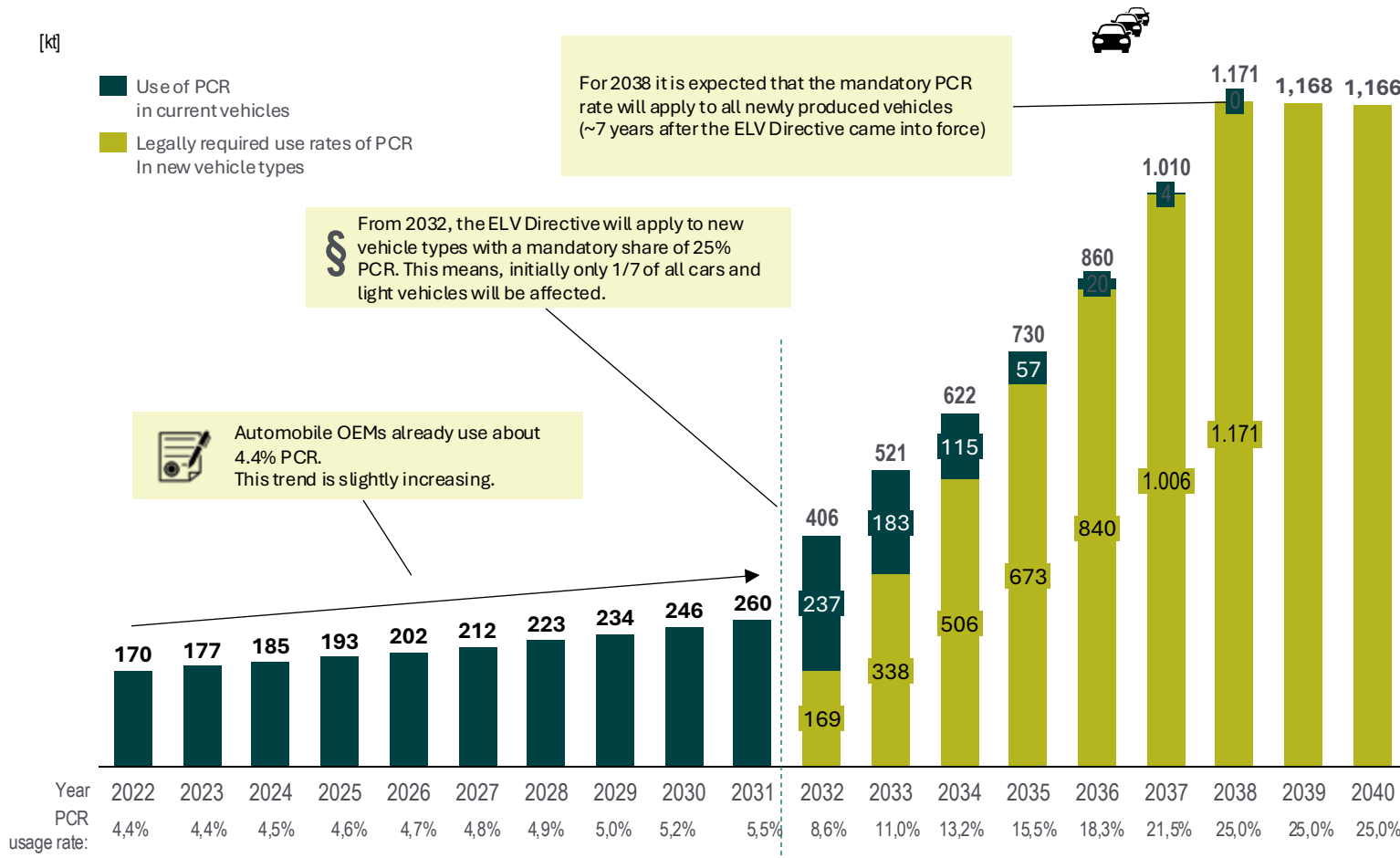
ELV directive will only gradually take effect when it comes into force in 2032, as the minimum 25% PCR target only applies to new vehicle types.



* Vehicles included include cars and light commercial vehicles. Plastics include polymers in accordance with the REACH regulation, TPE's elastomers and other duroplasts (with the exception of PUR foam) are excluded.

How will demand for PCR from the automotive industry develop after 2032?

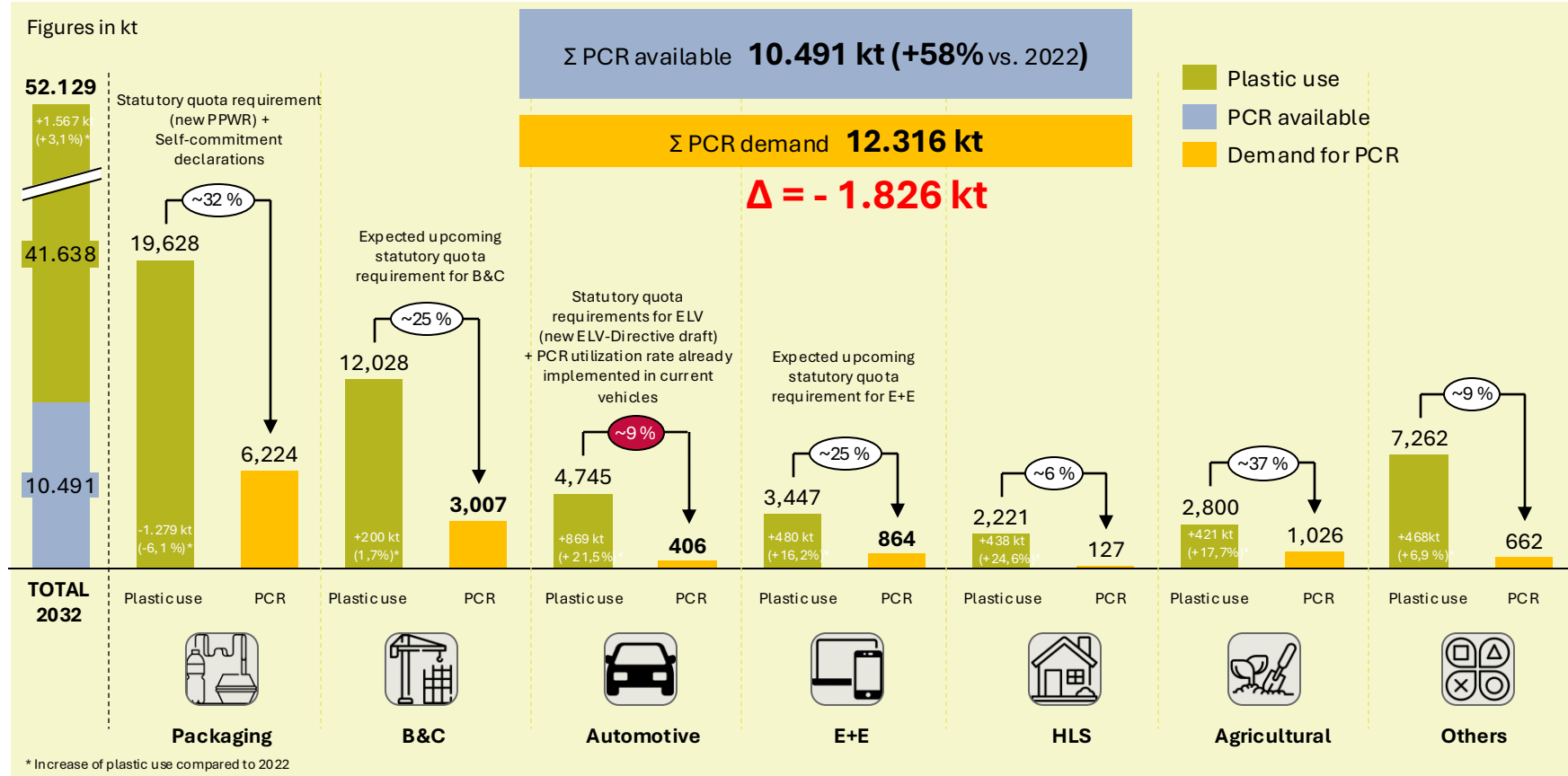
For 2038 it is expected that the mandatory PCR rate will apply to all newly produced vehicles
(~7 years after the ELV Directive came into force)



- Until 2031, automotive manufacturers will not be required to use post-consumer recyclates. However, OEMs are already using PCR today.
- By 2032, the demand for PCR will grow by ~4.7% p.a. due to market-related demand.
- From 2032, the ELV directive calls for 25% PC-recyclates in new vehicle types. It is assumed that about one-seventh (1/7) of all passenger cars and light vehicle types manufactured in 2032 are new vehicle models that must meet the mandatory PCR rate of 25%.
- In subsequent years, more and more new vehicle models will enter the European market, for which the mandatory recycle rate apply. The demand for PCR is therefore increasing.
- In 2038 (~7 years after the ELV Directive came into force), all vehicles manufactured will be affected by the mandatory recycle rate.
- The PCR quantity required is directly correlated with the vehicles manufactured in Europe. As a result of a negative growth forecast, demand for PCR will also decline slightly.

Is there enough PCR on the market to meet demand from all sectors?

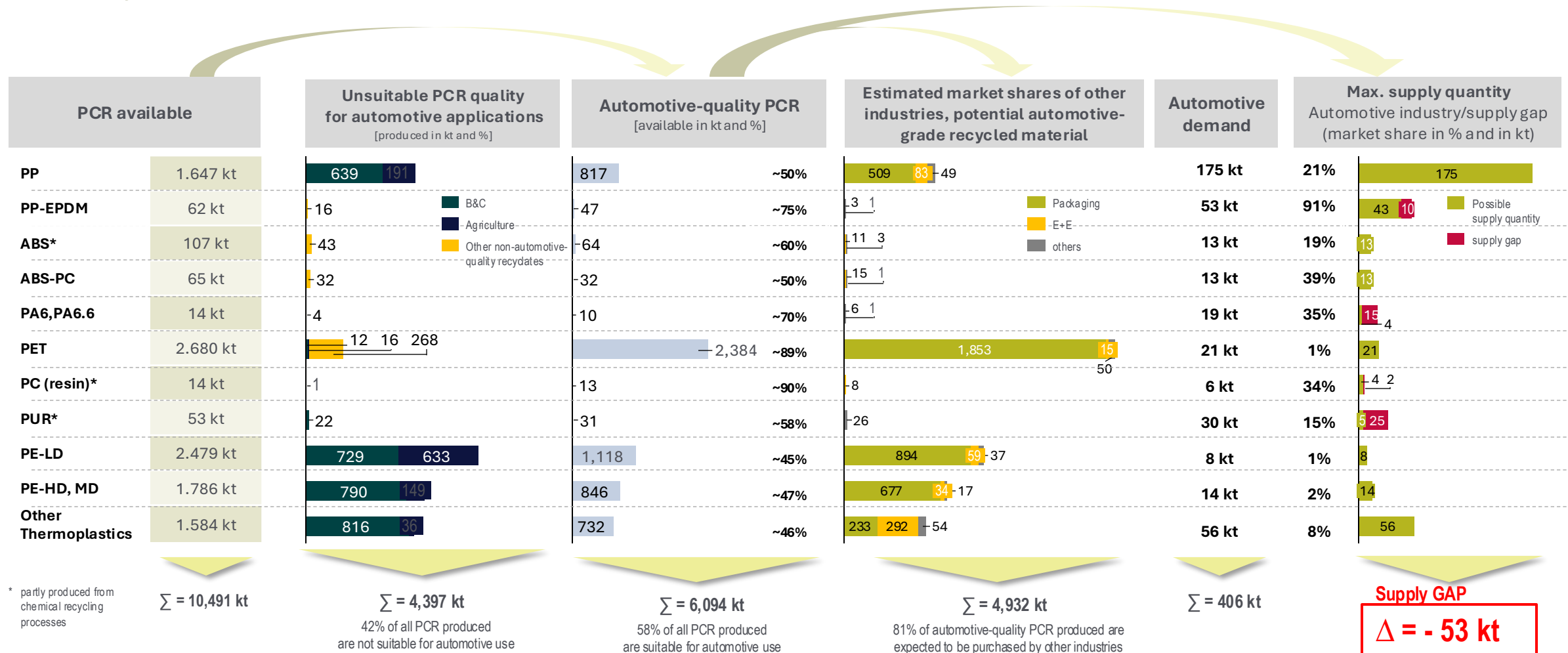
Considering the demand from Packaging, B&C and other sectors, there will be a gap of at least 1.8 Mt of recycled material by 2032



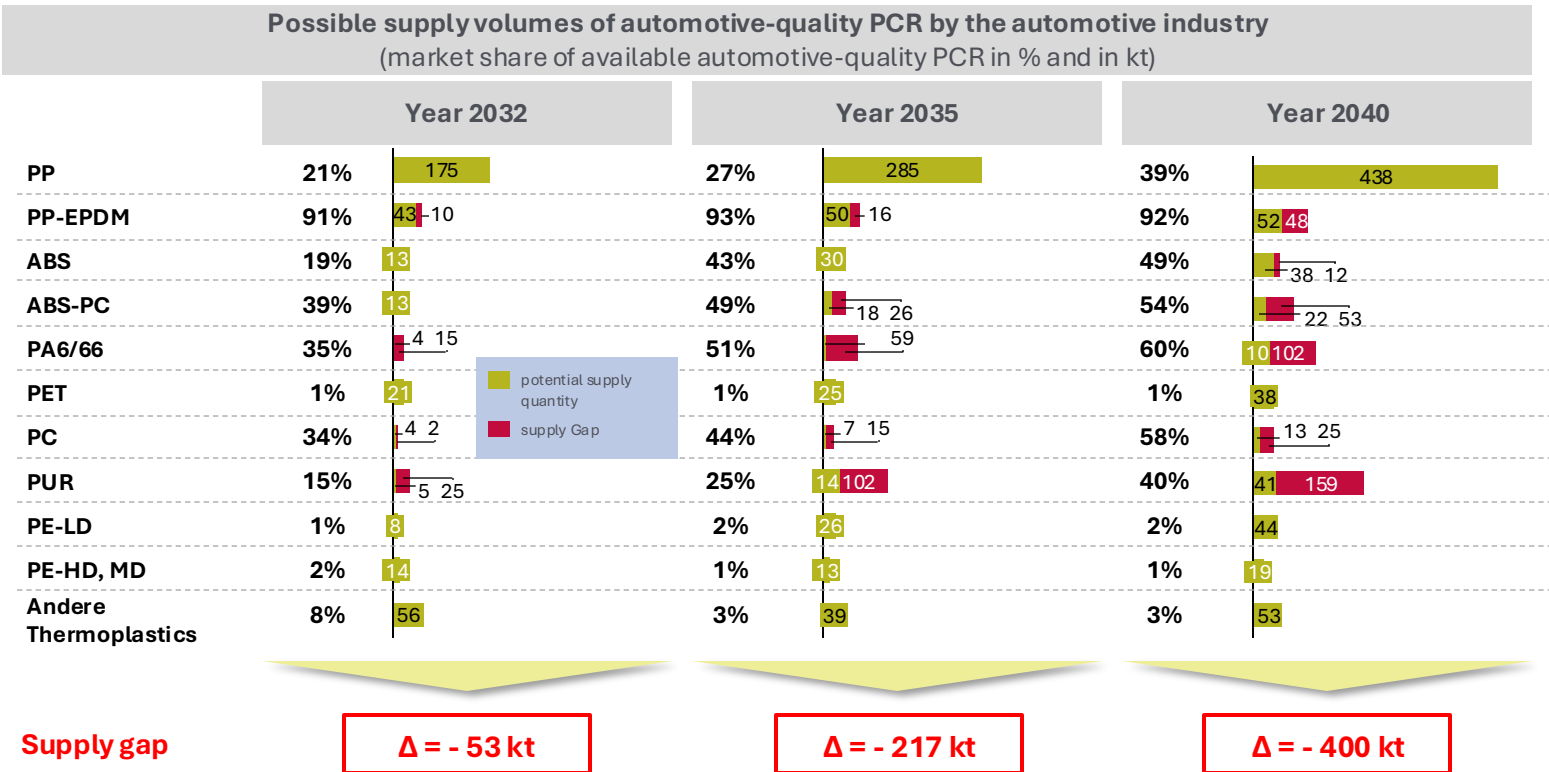
There will be intense competition for PCR between the sectors that use recycled plastic materials.

What is the supply gap for the automotive industry in 2032?

In 2032, the supply gap of PCR will be limited to about -53 kt, as only around 1/7 of all vehicles produced must meet the mandatory 25% PCR rate.



There are increasing supply bottlenecks - particularly for technical plastics and PUR



- Although it is assumed that the automotive industry will gradually increase PCR's market share, the study concludes that supply bottlenecks are likely to continue.
- Many polymers are not available in sufficient quantities to meet the needs of various industries.
- Supply gaps are expected, particularly for engineering plastics (ABS, ABS-PC, PA6/66, PC) and PUR foam. These gaps are caused by lower polymer availability and the necessary, but economically unfeasible separation and sorting processes for the mostly mixed plastic waste streams.

Note

The contribution that the automotive industry itself can make to achieving the 25% minimum use rate of PCR in new vehicles is already included in the predicted supply bottlenecks.

Study results on the development of the availability of automotive-grade plastic recyclates from post-consumer waste until 2040 against the backdrop of the redrafting of the ELV Directive

Conclusion



Supply bottlenecks for the automotive industry already expected for 2032

- ◆ **Supply bottleneck in 2023 still relatively low (52 kt), but it will increase to 400 kt by 2040**

- ◆ **Main reasons are ...**
 - **legal measures that also require a minimum PCR utilization rate in other industries – especially in packaging.**

 - **Disproportionately low development of plant capacities and infrastructure in the waste management and recycling industry** compared to the demand volume.

 - **Increasing PCR demand of the automotive industry** due to the successive expansion of minimum PCR use rate of 25% for the entire vehicle fleet for the period 2022 - 2038/2040.

Study results on the development of the availability of automotive-grade plastic recyclates from post-consumer waste until 2040 against the backdrop of the redrafting of the ELV Directive

Conclusion



Depending on the polymer type, supply bottlenecks may occur over time.

● **rPP (use of recycled polypropylene in packaging and building & construction)**

- Relatively good access to rPP as the automotive industry is probably willing to pay more for it.
- Nevertheless, the automotive industry will not be able to fulfil the 25% minimum PCR use rate solely through a disproportionate use of rPP in vehicle components.
- As available quantities are not sufficient to meet the demand from all industries, there will be intensive competition for rPP.

● **Engineering plastics and PUR**

- Increasing shortages of recycled **engineering plastics**.
- Significant increase in statutory PCR demand in the automotive and E+E industries combined with limited recycling of technical thermoplastic waste is leading to supply gaps.

● **Recycling technology for PUR foams is still under development**

- Expansion of plant capacities at a moderate pace, as there is little investment security
- Difficulties in the feedstock supply of homogeneous waste streams.
- The mattress industry (which supplies the main feedstock) itself is very interested in recycled PUR materials.

Study results on the development of the availability of automotive-grade plastic recyclates from post-consumer waste until 2040 against the backdrop of the redrafting of the ELV Directive

Conclusion



The production of PCR from end-of-life vehicle recycling is essential to fulfil the ELV quotas, particularly regarding engineering plastics

- Especially for the production of recycled engineering plastics (technical thermoplastics) feedstock quantities from end-of-life vehicle recycling are essential.
- Furthermore, only E+E waste is available as possible significant sources for the production of rABS, rABS-PC, PC, etc.
- To fulfil the minimum PCR use rate of 6.25% from end-of-life vehicles, dynamic development of the recycling industry with annual growth rates of 8.4% up to 2040 is necessary.
- This dynamic will not happen without the active participation of the automotive industry.
- Possible ways forward include participation in recycling value chains or commitments to purchase quantities at prices that cover recycling costs and investments.

Study results on the development of the availability of automotive-grade plastic recyclates from post-consumer waste until 2040 against the backdrop of the redrafting of the ELV Directive

Conclusion



Chemical recycling will only partially solve the supply bottlenecks

- Chemical recycling capacities in 2030 with a maximum input capacity of 2.2 Mt. About 0.6 Mt output capacity for Naphta and monomers for plastics production.
- Capacity expansions depend on acceptance guarantees from customers and the political framework conditions for the acceptance of chemical recycling.
- Output quantities are only partially available for the automotive industry, as other industries will also demand significant quantities to fulfil their statutory quota obligations. (e.g., food-contact packaging)