PLASTICS RECYCLERS EUROPE

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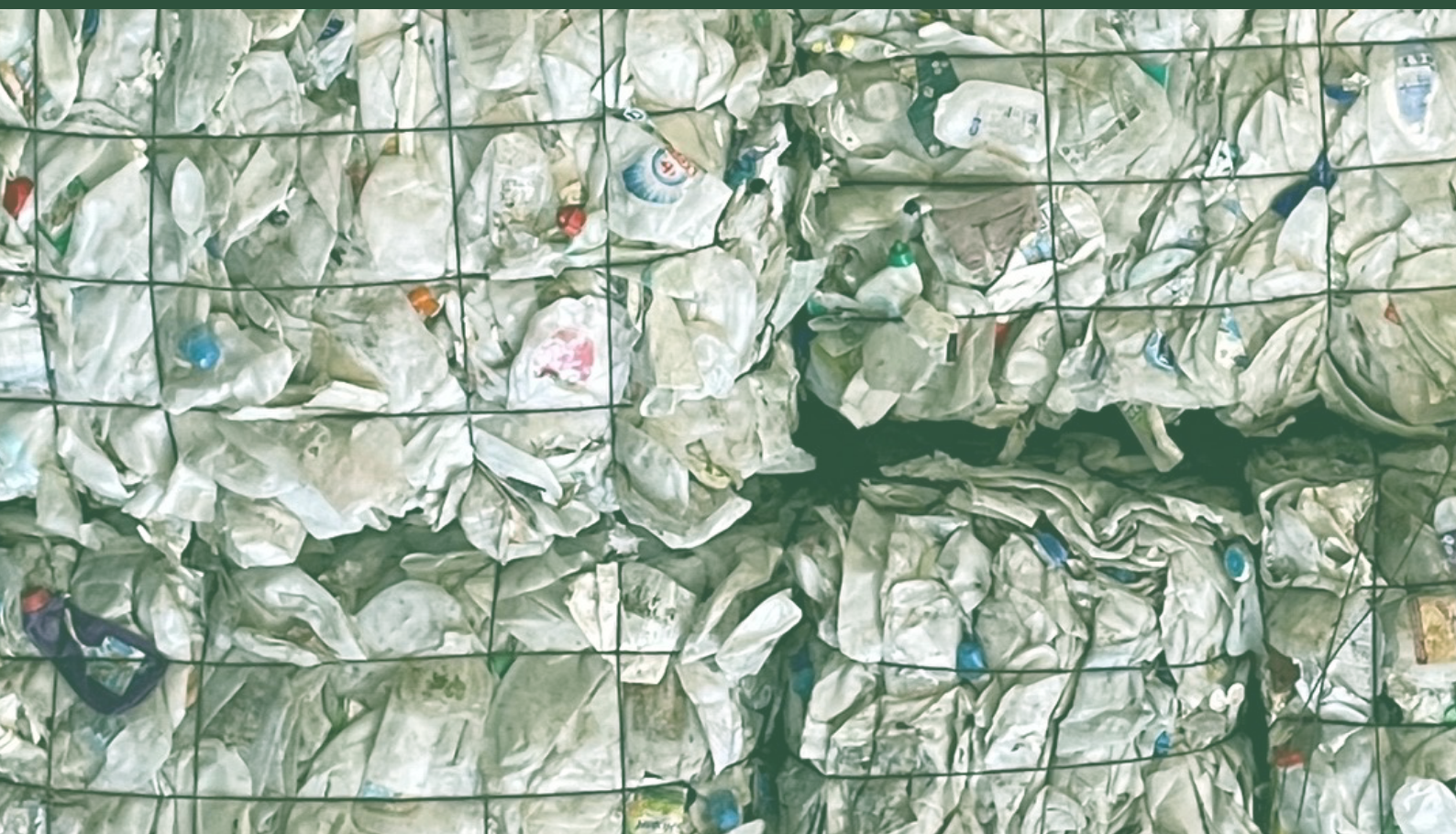
Independent Commodity Intelligence Services

HDPE & PP RIGIDS MARKET IN EUROPE

STATE OF PLAY

PRODUCTION, COLLECTION & RECYCLING DATA 2023



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GLOSSARY OF TERMS

DFR	Deposit Return Scheme
EFSA	European Food Safety Authority
ELV	End-of-life Vehicle
EPR	Extended Producer Responsibility
EU	European Union
EU27+3	EU member countries, Norway, Switzerland, and the United Kingdom
HDPE	High Density Polyethylene
MPO	Mixed Polyolefin
MT	Million Metric Tonnes
NIR	Near-infrared
PCR	Post Consumer Recyclate
PET	Polyethylene Terephthalate
PP	Polypropylene
PS	Polystyrene
PTT	Pots, Tubs, and Trays
PPWR	Packaging and Packaging Waste Regulation
PRO	Producer Responsibility Organization
PVC	Polyvinyl Chloride
rHDPE	Recycled High Density Polyethylene
rPET	Recycled PET
rPP	Recycled Polypropylene
SUPD	Single Use Plastics Directive
UK	United Kingdom

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ABOUT PLASTICS RECYCLERS EUROPE

Plastics Recyclers Europe (PRE) is an organisation representing the voice of the European plastics recyclers who reprocess plastic waste into high quality material destined for production of new articles. Recyclers are important facilitators of the circularity of plastics and the transition towards the circular economy. Plastics recycling in Europe is a rapidly growing sector representing over €9.1 billion in turnover, 13.2 million tonnes of installed recycling capacity, around 850 recycling facilities and over 30,000 employees.
www.plasticsrecyclers.eu

ABOUT ICIS

Independent Commodity Intelligence Services (ICIS) connects data, markets, and customers to create a comprehensive trusted view of global commodities markets, enabling smarter business decisions that help optimise the world's resources.

ICIS helps businesses across the chemical, fertilizer and energy markets make strategic decisions, mitigate risk, and capitalise on new opportunities. A trusted source and benchmark for price information and insight across key commodities markets worldwide. Our independent, transparent market intelligence informs thousands of quality decisions every day, taking the pressure out of negotiations and giving customers space for more innovative thinking.
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INTRODUCTION

This report presents the latest data and trends on the HDPE and PP rigids market in Europe in 2023, with additional insights on the 2024 market. It examines key developments shaping the industry, including production, demand, collection and recycling, while also addressing the main constraints and challenges facing the HDPE and PP rigids recycling market. Additionally, the report explores factors driving future growth and assesses potential market scenarios.

The report includes data for the EU27+3 (Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom) and the reference year for the data is 2023. Reference data comparisons are made with 2018, unless otherwise stated. The study uses the best available data sources to present data estimates. The sources used include ICIS HDPE and PP rigids production, consumption, and trade data, as well as interviews across the European rHDPE and rPP rigids supply chain. Additionally, the report incorporates results from PRE's HDPE and PP rigids recyclers survey and secondary research.

Disparities in reporting formats and gaps in data availability continue to pose challenges in achieving consistent data and therefore greater transparency across the rHDPE and rPP rigids value chain.

METHODOLOGY

The ICIS methodologies for production and trade are as follows:

TRADE

Country trade represents the import/export from/to a specific country. The annual import/export volumes refer to the total volumes imported/exported from 1 January to 31 December of every year.

ICIS obtains imports and exports data for the polymers reviewed, having access to the trade services provided by all the most significant countries of the world through their respective National Statistical Offices. A Harmonised System, used by all countries, has been in place for a number of years to collect and publish statistical trade figures under the same trade codes, so that compilations and comparisons among countries are made possible.

Comparisons between country-by-country export and import flows show that polymer data rarely correspond. In the frequent case of inter-trade between two countries, where in a given period imports declared by country A from country B do not correspond to exports declared by B to A in the same period, ICIS generally downloads the figures of the importing country. However, different adjustments are possible based on ad-hoc evaluations.

PRODUCTION

"Virgin" production refers to the output of material from polymer plants.

Production is calculated as the sum of "virgin" polymers produced from the respective monomers by the listed capacities and of post-consumer recycled material.

Historical production data of virgin polymers are sourced primarily from documents issued by producers, producer associations and National Statistical Offices. Certain data are obtained when carrying out specific market studies and can include industry publications.

After data collection, the consistency of "virgin" production data is further verified by making comparisons with installed polymer capacities and with key feedstocks' consumption.

Historical polymer production is updated and balanced with consumption country-by-country. In addition, preliminary production assessments are conducted for the major producing countries during the current year, consisting of published official data and ICIS experts' views.

COLLECTION RATE

To estimate the collection rate in the EU27+3 region, ICIS obtained data via primary research, including surveys and interviews with members of the value chain as well as via secondary research, leveraging published data by industry participants. There is a great discrepancy in the transparency level of information across the countries, so the data available was limited. Estimates have been made based on ICIS's experts' views and knowledge of the market. The results were then cross-checked against estimates based on input for recycling plants estimated by PRE through surveys and secondary research. The collection rate was then calculated by dividing the collected waste for recycling by the material placed on the market in the given year.

The volumes of material "sorted for recycling" have been estimated based on the input to recyclers' plants and a view of ICIS's market experts on waste trade. The "sorted for recycling rate" was then calculated by dividing the latter by the material placed on the market.

EXECUTIVE SUMMARY

PRODUCTION, COLLECTION & RECYCLING DATA, 2023

While the industry has made notable progress in recent years, the recycling capacity for HDPE and PP rigids has stagnated between 2022 and 2023. Key challenges in the market continue to hinder further expansion. Unlocking circularity for these plastics largely depends on higher collection rates, supported by better design-for-recycling practices, the adoption of advanced sorting technologies, the implementation of effective collection and sorting systems, and effective legislative support, including measures targeting unregulated imports of plastic materials.

No significant growth registered in the collection volumes of rigid HDPE and PP.

In 2023, 13.3 million tonnes of HDPE and PP rigids were placed on the European market. The waste generation dynamics for rigid polyolefin rigid applications differ significantly between the packaging and non-packaging sectors. Packaging, constituting approximately 75% of the total waste for both polymers, is characterized by its short-lived nature. It enters the waste stream within the same year of production, creating an immediate and substantial volume of waste that requires annual management.

Although the separate collection of rigids has been implemented in almost all EU27+3 countries, the reach of these systems to the wider population is still rather limited, as demonstrated by the low collection volumes. However, ensuring sufficient collection volumes is the imperative first step for achieving the EU recycled content targets.

Overcoming sorting barriers is crucial to boost efficiency for recycling of HDPE and PP rigids.

In 2023, approximately 2.7 million tonnes of rigid HDPE and PP were sorted as input for recyclers, representing 42% of the collected waste of these plastics. The gap between collection and the volume sent for recycling is due to several factors, including design for recycling incompatibilities, exports, and sorting challenges. Contamination from other plastics, food residues, and the varied shapes and sizes of HDPE and PP rigids pose challenges for sorting systems, limiting overall efficiency.

Of the total material sent for recycling, packaging accounted for 90%, with household waste making up the largest share (56%). Commercial and industrial packaging contributed 28-29%, while other packaging sources comprised the remaining 5-6%.

To unlock its full potential, the European recycling market for both HDPE and PP rigids must be further structured and matured.

European recycling capacity for both HDPE and PP rigids was at 3.5 million tonnes in 2023 with an estimated 300 recycling facilities. This capacity consists primarily of numerous small plants averaging 14,000 tonnes per year, alongside a smaller number of large-scale facilities exceeding 40,000 tonnes per year. Three-quarters of existing plants recycle both HDPE and PP rigid waste within the same facility. Growth has been stronger in highly populated markets, with Spain, Germany and Italy accounting for half of the total installed rigid HDPE recycling capacity. A similar trend is observed for PP, where Germany, Benelux and Spain make up almost 50% of the total rigid PP recycling capacity.

Although recycling capacity has doubled since 2018, growth stagnated between 2022 and 2023 due to weaker demand amid a global polyolefin oversupply, along with high inflation, rising energy costs, and competition from lower-cost imports of both virgin and recycled polymers.

HOW TO SECURE A CIRCULAR FUTURE FOR HDPE AND PP RIGIDS

A substantial rise in collection rates and increasing uptake of recyclability principles will be imperative.

The primary challenge in improving the circularity of HDPE and PP remains low collection volumes and material losses at the start of the value chain. Between 2018 and 2023, the collection rate saw no major increase, limiting the availability of recyclate. Additionally, the absence of a fully developed and implemented design-for-recycling framework, deposit-return systems (DRS), and the implementation of new efficient sorting technologies has further constrained the growth of rHDPE and rPP rigids. Expanding the adoption of design-for-recycling guidelines will not only enhance recyclability but also improve recyclate quality, enabling closed-loop recycling at a large scale, including for food-grade applications. Recyclability certifications will be central to achieving this.

Significant increases in recycling capacities of rigid polyolefins will be needed to meet the PPWR targets.

The Packaging and Packaging Waste Regulation (PPWR), which came into effect in February 2025, sets ambitious recycled content targets for plastic packaging, including HDPE and PP rigids. Meeting these targets, however, will require an additional 2 million tonnes of recycling capacity for rigid HDPE and PP by 2030 and a further 5.7 million tonnes by 2040. Besides boosting the capacities, equally important is ensuring the improvement of the quality of recycled materials to meet the growing demand in high-specification applications across various industries. The market analysis points to the need for a multi-faceted approach involving technological innovation, infrastructure investment, and potentially, regulatory frameworks to ensure that the supply of high-quality recycled materials can keep pace with ambitious sustainability targets.

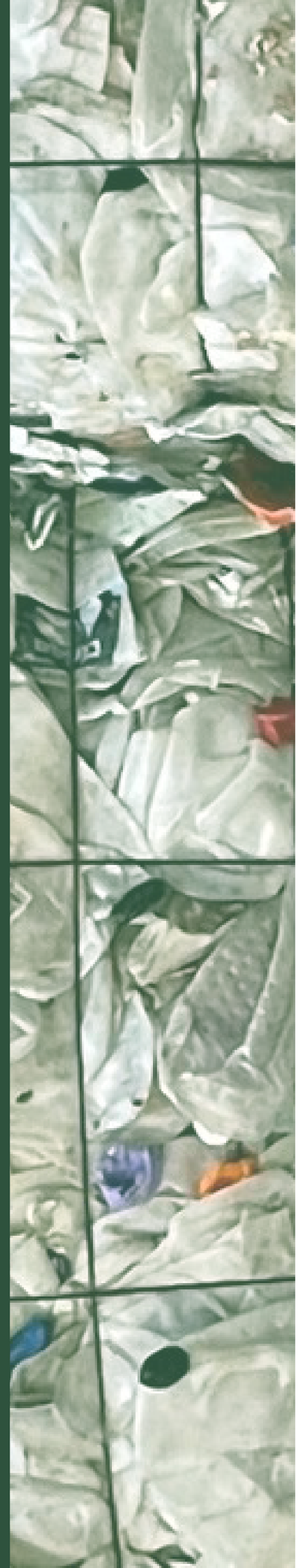
HDPE AND PP RIGIDS VALUE CHAIN OVERVIEW

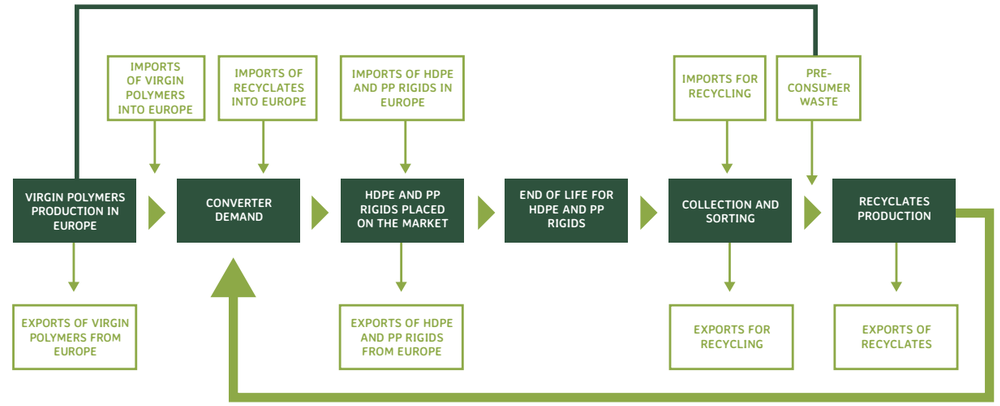
An overview of the HDPE and PP rigids value chain is presented in Figure 1, covering virgin resin production, converter demand, and the recycling process. In recent years, the market has become increasingly fragmented, with a widening range of rigid types and formats, driven by diverging demand trends across end-use sectors.

Strong demand in 2022 drove record-high recyclate prices, but in 2023, macroeconomic pressures, high energy costs, and competition from lower-priced virgin polyolefins led to a sharp decline in demand, further widening the price gap between virgin and recycled materials.

Challenges persist in the rHDPE and rPP value chain, particularly at the collection and sorting stage, where low collection volumes, contamination, and inefficient sorting – where best practices and technological advances have not yet been applied –result in material losses. Additionally, without a comprehensive and fully implemented design for recycling that addresses the needs of the full range of applications in which these recycled materials are used, recyclability at scale will be further hindered. A harmonised market for secondary materials in the region has yet to fully develop for HDPE and PP and requires investment across the value chain for it to evolve.

The following sections of this report provide a detailed discussion of the elements of this value chain in Europe, finishing with an outlook on future opportunities and challenges.





Note: There may be losses / leakages across each step of the value chain that haven't been represented above.

Figure 1: HDPE and PP rigids value chain overview

DEMAND

In 2023, the combined total converter demand of HDPE and PP (including both rigids and flexibles) in the EU27+3 region totalled 17.1 million tonnes. It is estimated that almost 85% of HDPE and about 67% of PP were consumed in rigid applications. The total consumption in 2023 represents a modest yearly average growth (CAGR) of 0.2% or, in absolute terms, an increase of 0.2 million tonnes in relation to 2018. As shown in Figure 1, HDPE and PP demand remained, in general, relatively stable over the period, at 6.7 million tonnes and 10.4 million tonnes respectively, except for the downturn in 2020. The primary contributor to this muted growth in demand comes from a combination of the COVID-19 pandemic, geopolitical and macroeconomic impacts.

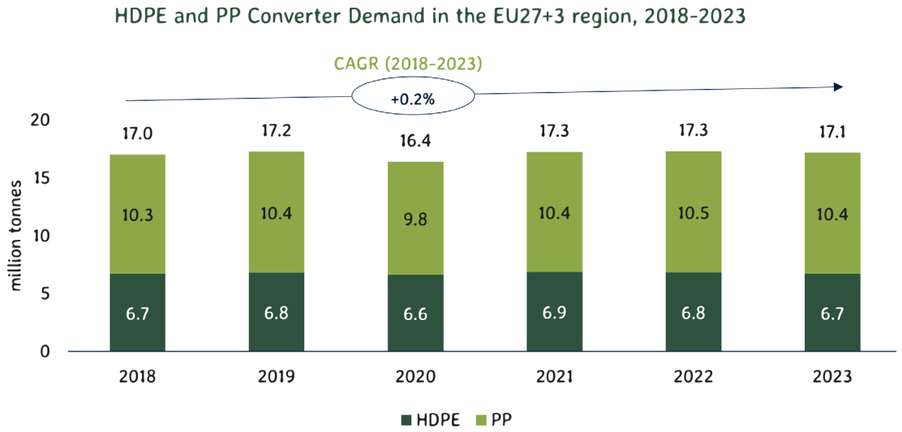


Figure 2: HDPE and PP converter demand including rigids and flexibles in the EU27+3 region, 2018-2023

Source: ICIS Supply & Demand Database

Following the 1.4% combined growth observed from 2018 to 2019, HDPE and PP demand was significantly impacted by the COVID-19 pandemic, shrinking 5% from 2019 to 2020. While the HDPE market saw a decrease of 2.7% in the region, PP demand was hit much harder, reducing by 6.5%. The difference in impact scale is mostly due to the larger exposure of PP to non-packaging sectors such as automotive and durable goods, which experienced greater impacts on demand as consumers postponed non-essential expenditures.

Demand recovered back to pre-COVID levels in 2021, however, the optimism was soon replaced by gloomy geopolitical and macroeconomic conditions over 2022 and 2023. The beginning of the Russia-Ukraine war in early 2022 led to energy prices spiking in Europe, triggering a subsequent rise in inflation and cost of living, which put pressure on end-consumer disposable income. The challenging macroeconomic scenario, with recessionary fears towards the end of the year, contributed to a bearish market sentiment that continued throughout 2023.

Over the year, economic uncertainties and reduced consumer spending continued to impact downstream demand for HDPE and PP, leading to a further reduction in volume demand of 0.7% in relation to 2022. For HDPE, converters noted weaker demand, even from sectors typically less sensitive to inflation such as food packaging. For PP, the automotive sector showed some recovery in relation to the previous year but did not compensate for the underlying poor demand from construction and durable goods markets.

PRODUCTION

In 2023, the combined HDPE and PP total production (including virgin and recycled material) stood at 15 million tonnes, showing a slight decrease of 0.3 million tonnes (or 2%) in relation to 2022 numbers, as illustrated in Figure 3. Over the past 5 years, total production followed a downward trend, presenting a -1.2% average annual growth (CAGR) from 2018 to 2023.

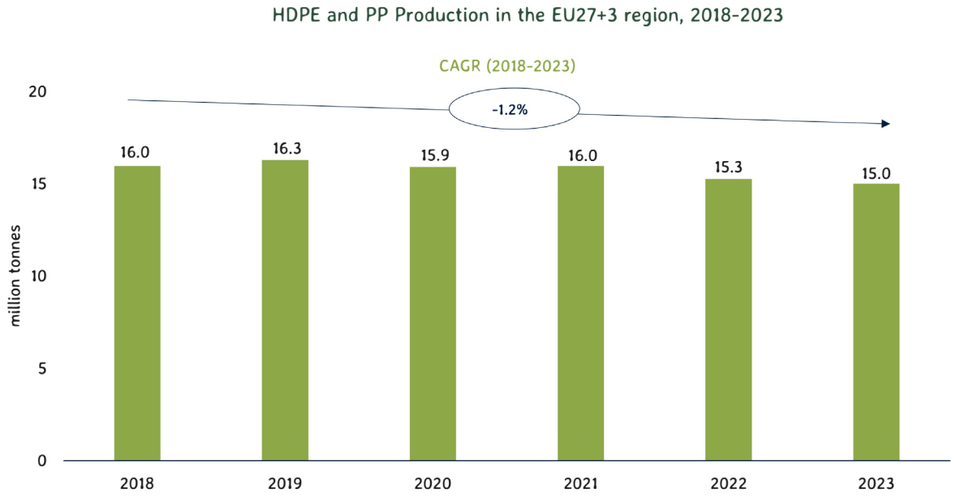


Figure 3: HDPE & PP total production in the EU27+3 region, 2018-2023.
Source: ICIS & PRE

Facing weak overall demand coupled with higher production costs in a global oversupply scenario for polyolefins, European producers have struggled with increased production costs and competition from imports of regions with significant cost advantages. Combined, these factors have been significantly impacting European production of virgin HDPE and PP, as shown in Figures 4 and 5. Some level of capacity rationalisation seems imminent in this scenario, with a major petrochemical player announcing the shutdown of a plant in France by the end of 2024 and other global players announcing strategic reviews of their European assets.

Recycled HDPE production remained relatively stable at 1 million tonnes from 2018 to 2023, increasing from ~0.8 million tonnes in 2018 to 1 million tonnes in 2023. However, virgin production followed a downward trend, driving the total production (of virgin and recycled) down by 1.6% on average per year (CAGR).

In the case of PP, recycled production oscillated during the same period, growing from 0.5 million tonnes to approximately 0.9 million tonnes by 2023. Similar to HDPE, virgin PP production in the region also declined, however, at a slower pace, leading to a total decline in production (virgin and recycled) of 1.0% yearly average (CAGR). Fiscal incentives to support the recovery of the construction sector in 2021 helped provide more support to the PP sector in comparison to HDPE. The impact of recyclates on virgin markets was marginal, given the greater overall demand and energy costs of production.

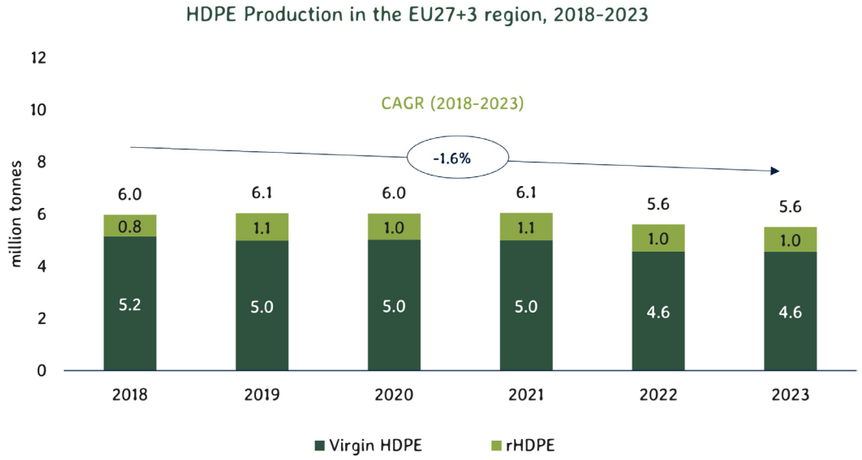


Figure 4: Virgin and recycled HDPE production in the EU27+3 region, 2018-2023.
Source: ICIS & PRE

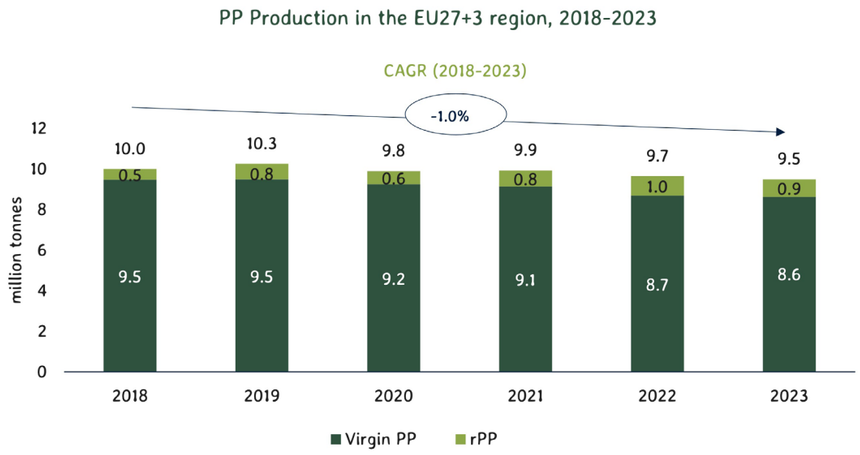


Figure 5: Virgin and recycled PP production in the EU27+3 region, 2018-2023.
Source: ICIS & PRE

HDPE & PP IMPORTS AND EXPORTS

EUROPEAN TRADE DATA AND TRADE BALANCE

As shown in Figure 6, HDPE imports into Europe (EU27+3) in 2023 totalled 1.9 million tonnes, while exports from the region came to 0.6 million tonnes. The region continued as a net importer, with the net trade position (imports minus exports) reaching 1.3 million tonnes in 2023, a relatively stable position, despite small volume fluctuations over this period.

For PP, as illustrated in Figure 7, imports totalled 2.0 million tonnes in 2023 while exports summed 1.1 million tonnes, the lowest figure since 2018. The resulting net-trade position was 0.9 million tonnes, which shows relative stability for the past three years, but also demonstrates a significant change in comparison to pre-COVID years. Effectively, the region changed from a balanced position in 2018 to a net importer by 2021 due to a decrease in exports (-0.4 million tonnes) coupled with a comparable increase in imports.

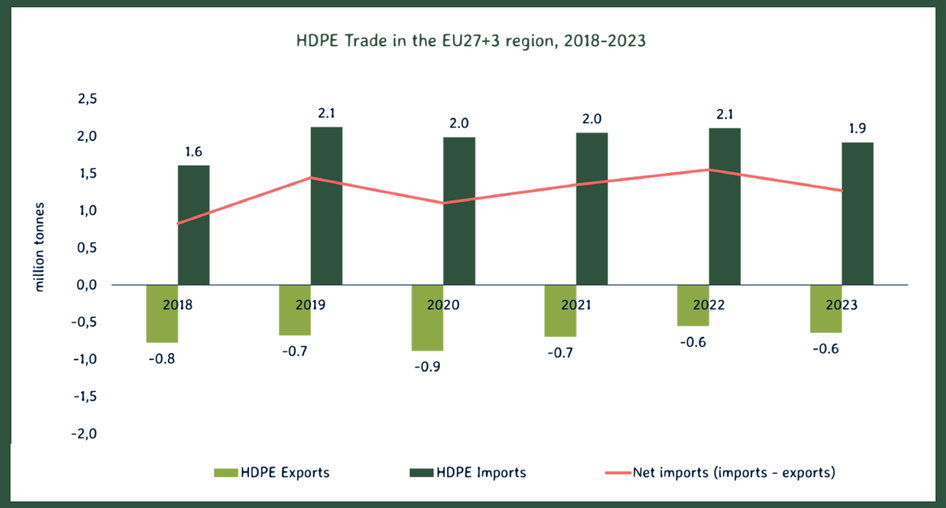


Figure 6: HDPE trade in the EU27+3 region, 2018-2023.
Source: ICIS Supply & Demand Database

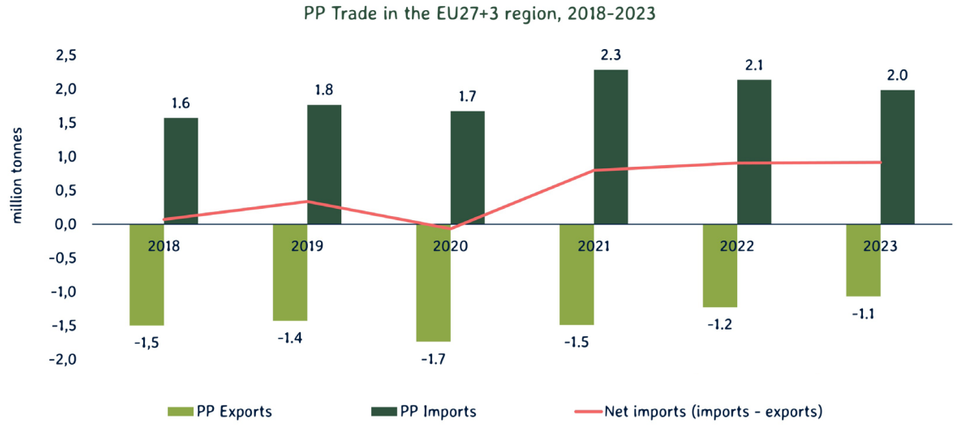


Figure 7: PP trade in the EU27+3 region, 2018-2023.
Source: ICIS Supply & Demand Database

Together, imports of HDPE and PP totalled 3.9 million tonnes in 2023. When compared with EU27+3 total production, the share of imports in 2023 was 34% for HDPE and 21% for PP. Whilst the shares showed a slight decline in relation to 2022 in light of weak demand, shares increased for both polyolefins since 2018, as shown in Figure 8. This shows that imports have been growing their share of the total market, thereby impacting domestic producers, particularly in PP.

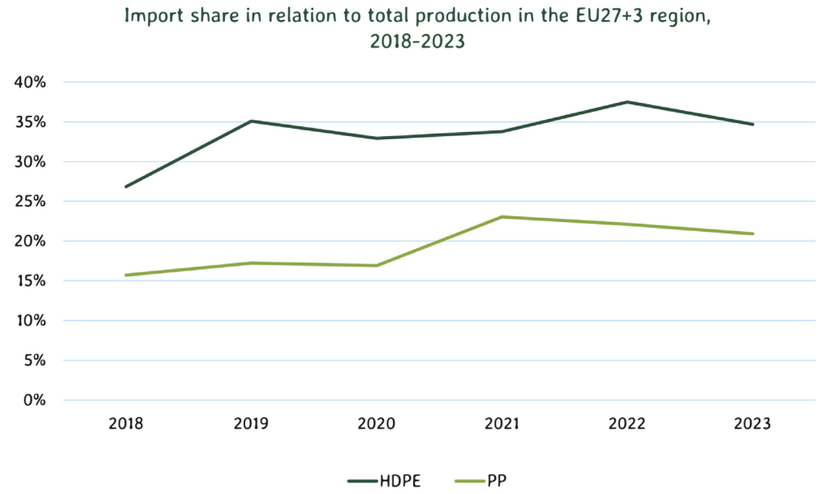


Figure 8: Import share in relation to total polymer production in the EU27+3 region (%), 2018-2023.
Source: ICIS Supply & Demand Database

Within the EU27+3 region in 2023, the largest importers of HDPE and PP include Germany (16%), Italy (15%), Belgium (12%), Poland (9%) and France (8%). These countries have consistently been key importers since 2018.

As shown in Figure 9, there are minor differences in terms of source countries for both HDPE and PP. Saudi Arabia was the main source of European imports for both polyolefins in 2023, accounting for one-third of each total as shown in Figure 9. In the case of HDPE, the United States (24%), South Korea (8%), Egypt (8%), and Qatar (7%), alongside Saudi Arabia, represented around 78% of total imports. For PP, South Korea (22%), Israel (7%), the United States (5%) and Vietnam (5%), together with Saudi Arabia, represented about 74% of total imports.

In terms of exports from the EU27+3 region, Belgium (23%) was the largest exporter of HDPE and PP in 2023, followed by Germany (19%), Netherlands (12%), France (9%) and Spain (6%). The main non-EU27+3 destinations in 2023 include Turkey (29%), China (12%) and the US (5%).

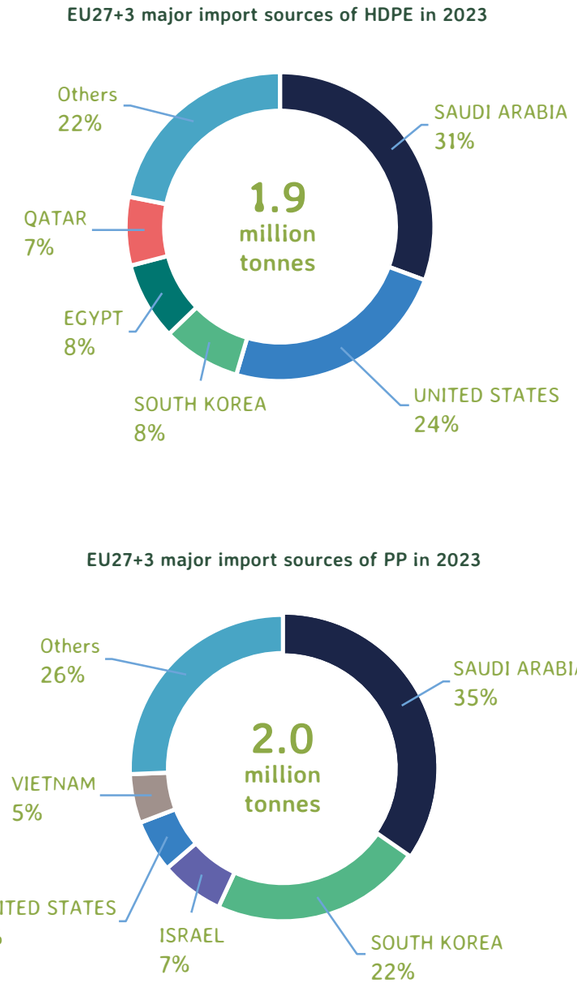


Figure 9: Major HDPE & PP import partners of the EU27+3 region in 2023.
Source: ICIS Supply & Demand Database

In terms of waste trade for HDPE and PP, it is challenging to determine the specific activity due to the lack of granularity and transparency in the waste data. Trade statistics for total plastic exports from the EU27 region do indicate some uplift in volumes in the past two years (+36% in 2024 in comparison to 2022), following a trend of decline up to 2021, as illustrated in Figure 10. Concerning total plastic imports into the region, these have been on a steady increase over the past few years, with a dip in volumes in 2023. The overall volumes of waste imports are on a lower scale in comparison to exports, as generally there is limited demand for low-quality, unsorted waste into the region. Recycled products would generate some demand, but overall, there has been low demand for imports of these materials due to the weak end demand across most applications, especially in 2023. This was compounded by the freight issues in 2024 that challenged the flow of materials and increased shipping costs, reducing the attraction of such trade.

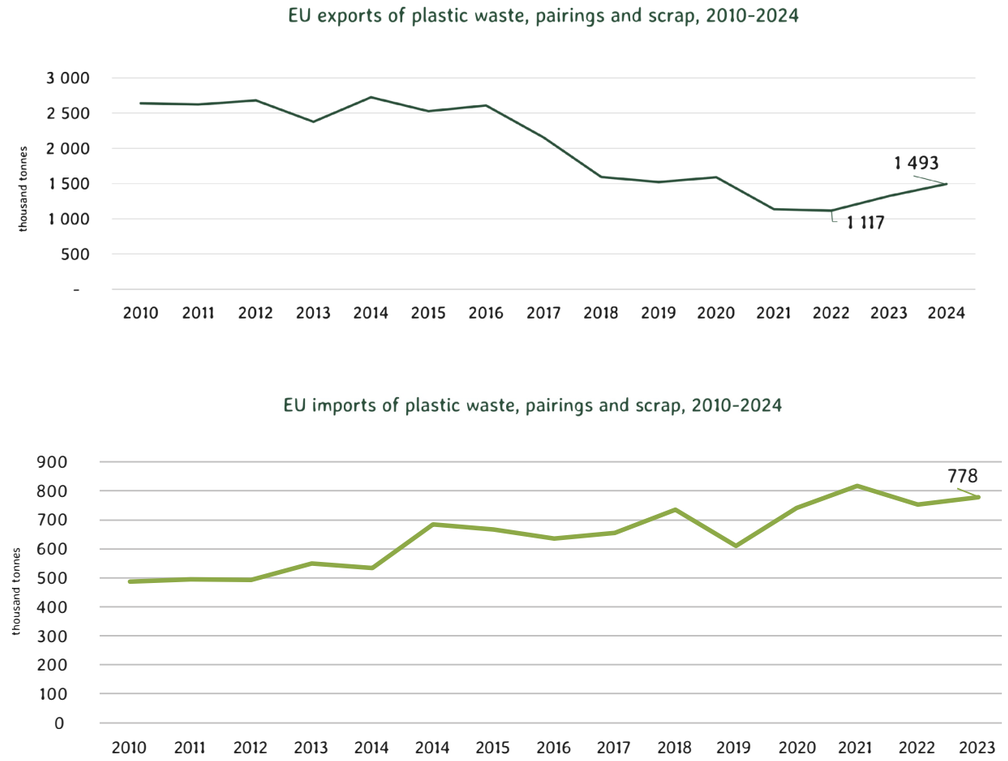


Figure 10: EU exports and imports of plastic waste, parings and scrap, 2010-2024.
Source: Eurostat

PP waste exports represented 12% of the total plastic waste exports of the EU in 2024, whereas HDPE reached 6% of the total[1]. The main EU27 exporters of PP in the last three years have been Germany (32%), Belgium (21%) and the Netherlands (20%) with Vietnam (36%), Indonesia (15%) and the United Kingdom (15%) as the main non-EU importers of this waste. For HDPE, Germany (26%), Spain (21%) and Belgium (18%) were the main EU exporters in 2024, with Türkiye as the main non-EU country absorbing half of the total volume.

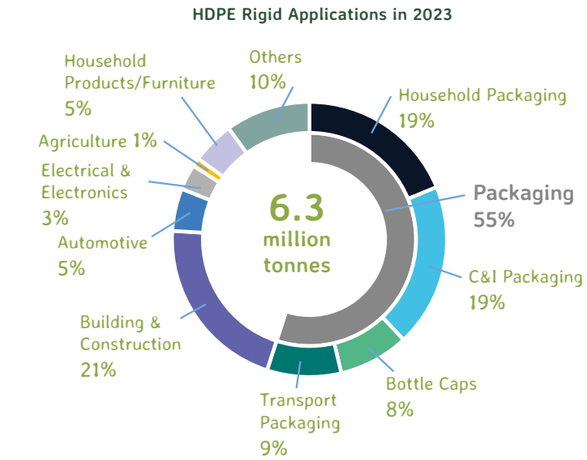
Concerning EU27 imports of plastic waste, PP represented around 11% of the total in 2024, while HDPE stood at 8%. At a country level, the Netherlands and Italy represented 60% of these imports during the last three years, with the United Kingdom (69%) as the main non-EU exporter, followed by some distance by Norway (4%) and Switzerland (4%). When it comes to HDPE, Italy (22%), Germany (17%) and the Netherlands (12%) were the main importers in 2024, with the United Kingdom (62%), Switzerland (20%) and Norway (9%) once more as the main exporters.

1.Eurostat, EU trade since 1988 by HS2-4-6 and CN8 [DS-045409]. HDPE waste trade data is only available since January 2024.

POLYMER APPLICATIONS

HDPE and PP are versatile and durable polymers with a diverse range of applications. The applications can be broadly classified into rigids and flexibles. It is estimated that almost 85% of HDPE in Europe (6.3 million tonnes) is consumed towards rigid applications, while about 67% of PP (7 million tonnes) is consumed in rigid applications. HDPE is known for its strength, impact resistance, and ability to withstand low temperatures, making it ideal for a variety of packaging needs, while PP is celebrated for its durability, high-temperature resistance, and excellent surface finish. PP's optical clarity and low moisture transmission also make it suitable for food packaging and personal care products.

As Figure 11 shows, about 55% of rigid HDPE is used for packaging applications, followed by the building & construction sector (21%), where HDPE is mainly used for the production of pipes & fittings and sheets. Other key HDPE applications include household products/furniture (~5%), automotive (~5%) and electricals & electronics (~3%). About 41% of the rigid PP applications are composed of packaging, followed by household products & furniture (~15%), automotive (~14%) and building & construction (8%). Other key applications include electricals & electronics (~6%), and agriculture (~3%). Moving forward, the growth in HDPE applications is expected to be largely stable, with limited change in shares, including for packaging. PP consumption towards automotive applications is expected to grow, strongly driven by electric vehicles and light-weighting trends.



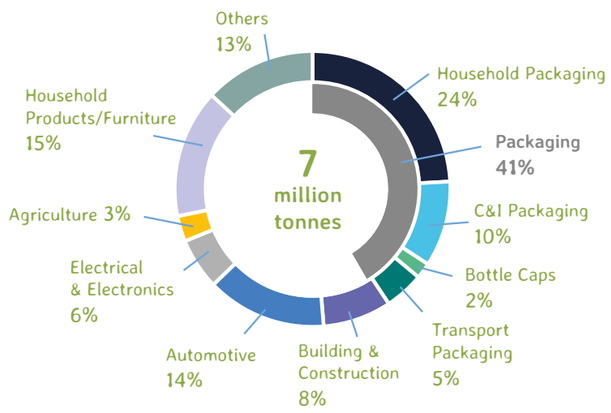


Figure 11: Key-End Markets for HDPE and PP in the EU27+3 region in 2023.
Source: ICIS

PACKAGING

Packaging forms the largest application sector for both HDPE and PP. Within packaging, household packaging and commercial & industrial packaging are the two key categories, followed by transport packaging, which is mainly reusable packaging, such as crates and pallets. Household packaging is the largest packaging segment for both HDPE and PP, which respectively accounted for 19% and 24% in 2023. Typically, rigid household packaging includes bottles, caps & closures, pots, tubs and trays used for packaging personal care products, household cleaners, food packaging, cosmetics, etc. While HDPE dominates the bottles & beverage caps market, PP is mainly used for pots, tubs, trays and non-beverage caps & closures applications.

Bottles & Containers

Owing to its high mouldability and impact resistance, HDPE is a preferred material for blow-moulded bottles and large containers. Blow moulded bottles are used in household and industrial chemical (HIC) bottle applications such as detergent, bleach, fabric softener, and agricultural chemicals such as pesticides and herbicides, leveraging their good resistance to solvents, corrosion and fracturing. HDPE bottles are also used in dairy, water, and juice packaging applications as well as pharmaceutical, medical, and cosmetics applications. Natural HDPE is largely used for juice and milk packaging, while coloured HDPE is used for non-food applications.

Pots, Tubs & Trays

PP is widely used for the production of pots, tubs and trays, which find their applications in yoghurt pots, margarine tubs, food trays, etc. PP has a low density, which makes it more lightweight than PET, and at the same time is more durable. HDPE is used for the production of trays for commercial use.

Caps & Closures

HDPE is widely used for the production of caps & closures for carbonated drinks, juices, water, milk, etc., mainly single-use caps. PP is commonly used for more durable applications such as cosmetics, personal care, food and household chemical caps and closures. PP with its high thermal resilience is well suited for hot-fill applications such as sauces and condiments. It also offers exceptional clarity, allowing products capped with PP closures to be practically transparent. Due to its high stress tolerance, PP also offers an advantage over HDPE, requiring good living hinge characteristics.

BUILDING & CONSTRUCTION

HDPE pipes are extensively used for water supply systems, drainage and sewage systems, as well as gas distribution systems. HDPE pipes are known for providing a reliable and leak-free distribution network, ensuring the efficient transport of water to various points of use. HDPE pipes are corrosion-resistant and provide a smooth inner surface, in addition to safety, durability and flexibility. The HDPE pipe industry conservatively estimates the service life for HDPE pipes to be between 50 and 100 years.

The flexibility of HDPE pressure pipe makes it well-suited for dynamic soils, including areas prone to earthquakes. It can accept repetitive pressure surges significantly exceeding the static pressure rating of the pipe. Its combination of flexibility and leak-free joints also allows cost-effective installation methods.

AUTOMOTIVE

Due to its light weight, high strength and chemical resistance, PP is widely used in the production of car bumpers, dashboards, wheel arch liners, door panels, headlight housings, car carpets, seat covers, etc. The use of rPP in automotive is set to increase further, driven by the adoption of Electric Vehicles and lightweighting trends. The latest end-of-life (ELV) proposed regulations mandate the use of recycled content, including specific targets for post-consumer recyclates (PCR) and closing the loop for this material[2]. HDPE also finds its applications in the automotive sector for the production of blow-moulded fuel tanks, motor oil containers, etc.

2. See Role of Legislation section

COLLECTION, SORTING AND INPUT FOR RECYCLING

HDPE AND PP RIGIDS WASTE MANAGEMENT IN THE EU27+3 REGION

In 2023, about 6.3 million tonnes of rigid HDPE and over 7.0 million tonnes of rigid PP were placed on the EU27+3 market. These polymers are used in several different applications, which also vary significantly in terms of the application lifespan. For packaging, which represents about 55% of HDPE and 41% of PP rigids applications, waste generation is likely to occur within a year or less, applications in building & construction (~21% of HDPE and ~8% of PP market) and household products/furniture (~5% of HDPE and ~15% of PP market) can last much longer, from a few years to many decades in the case of pipes, for example.

Figures 12 and 13 show the volume flow for HDPE and PP, respectively, in the EU27+3 region in 2023. The total rigid HDPE placed on the market was 6.3 million tonnes, from which 3.2 million tonnes were transformed into waste (51%), with a slowly higher rate for PP (46%), mainly explained by the lower share of rigid PP in short-life applications such as packaging. The rest of the HDPE and PP tonnages placed on the market are kept in more durable products, non-packaging related, such as pipes and fittings.

VOLUME FLOW OF HDPE RIGIDS IN THE EU27+3, 2023

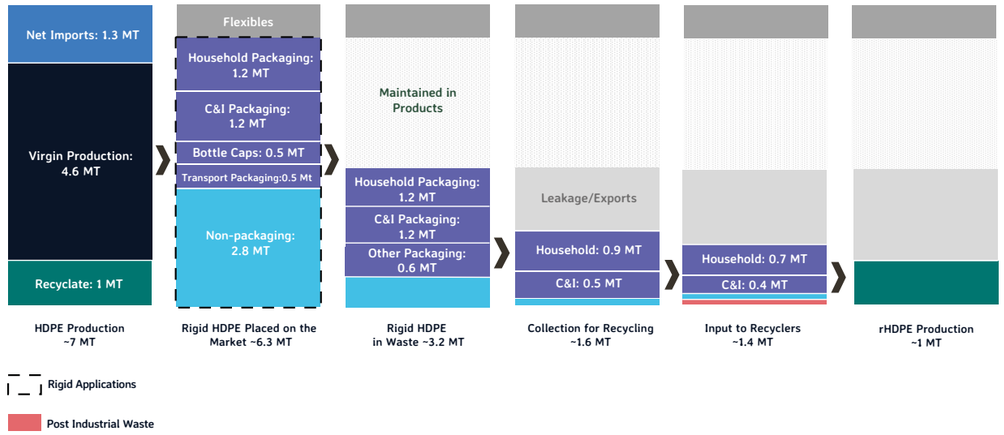


Figure 12: Volume flow of HDPE rigids in EU27+3 region in 2023.
Source: ICIS Supply & Demand Database, ICIS Research & Analysis, PRE, Market Experts

VOLUME FLOW OF PP RIGIDS IN THE EU27+3, 2023

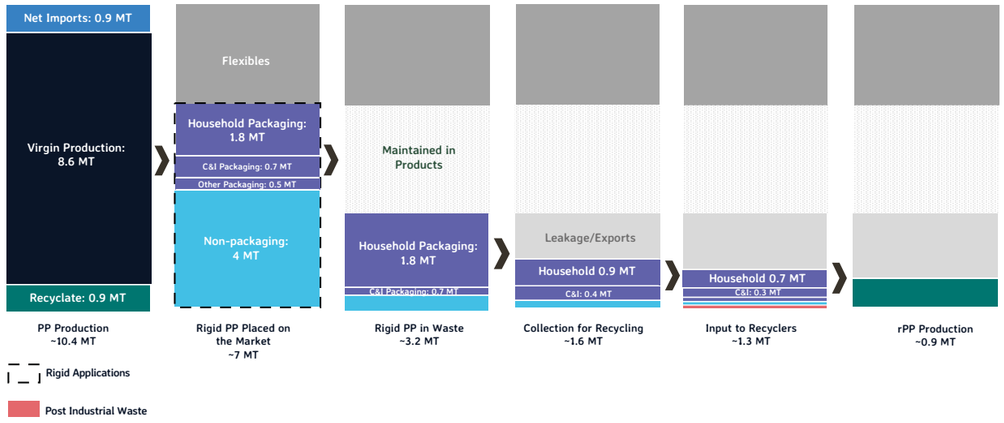


Figure 13: Volume flow of PP rigids in EU27+3 region in 2023.
Source: ICIS Supply & Demand Database, ICIS Research & Analysis, PRE, Market Experts

It is estimated that 3.2 million tonnes of rigid HDPE waste and 3.2 million tonnes of rigid PP were generated in 2023 in the EU27+3 region. Of these, respectively, it is estimated that ~51% and ~50% were collected for recycling. There are losses between the volume collected for recycling and input to recyclers, due to a combination of exports and leakage from the system, which occurs for both HDPE and PP. The waste generation dynamics for HDPE and PP rigid applications differ significantly between the packaging and non-packaging sectors. Packaging, which constitutes approximately 75% of the total waste for both polymer types, is characterized by its short-lived nature. These items typically enter the waste stream within the same year of production, creating an immediate and substantial volume of waste that requires annual management.

In contrast, non-packaging applications, such as those in building and construction, automotive, and electronics sectors, have considerably longer lifespans. These durable goods may remain in use for years or even decades before entering the waste stream. As a result, the waste generated from these sectors in any given year primarily consists of items produced and used in previous years, rather than current production. This delayed entry into the waste stream creates a more complex and gradual waste generation pattern for non-packaging applications, making their contribution to annual waste volumes less immediate and more challenging to track in the short term.

Even though separate collection for recyclables is largely in place in all the countries analysed in this study, the systems vary significantly in terms of coverage, convenience level and type. The reach of these systems is still limited in some countries for both HDPE and PP, as evidenced by the gap between waste generated and collected for recycling shown in Figure 12 and Figure 13. Countries with higher collection rates of HDPE and PP waste, such as Germany, Italy, Spain, the Netherlands, the UK and Belgium, have established collection systems for household waste with good market coverage and consumer participation. Extended producer responsibility (EPR) schemes that cover a wide range of HDPE and PP plastic packaging with a view to meeting collection rate targets set by legislation are also important and can influence progress towards higher collection rates. To ensure those higher collection rates can be realised and support the costs, particularly around waste management, the EPR schemes would benefit from greater harmonisation across the region. The involvement of the entire value chain encourages investment back into the system for continuous improvements in technology and infrastructure. Finally, demand for the waste is crucial to achieve higher collection rates and quality of the material.

Some countries also recover HDPE and PP rigids from residual/mixed waste, however, the majority of material in this stream is not recovered for recycling, either going to incineration (with or without energy recovery) or landfill. However, there is a trend to focus on recovering plastic from residual streams, in addition to the development of separate collection systems, but this development must deliver qualities to complement the existing streams. A trend that may continue given the need to recover more plastic, alongside regulatory developments restricting the landfilling of recyclable packaging, and technology developments in sorting and recycling. As well as being a stream targeted by some chemical recycling projects.

The different waste management systems currently in place across the EU27+3 region cover HDPE and PP rigids arising from waste streams that can mainly be divided into Household, Commercial & Industrial, Automotive, Building & Construction and Others. An overview of each one of these is presented in the following subsections.

HOUSEHOLD PLASTIC WASTE STREAM

The household waste stream is typically comprised of packaging items such as bottles, flasks, pots, tubs and trays (PTTs), and lids/caps, but it may also contain some volumes of non-packaging items, particularly from drop-off recycling sites, such as consumer goods, small furniture items and other items such as flowerpots.

The primary responsibility for household waste sits with municipalities, and these typically determine what is collected (mix of materials) and how (kerbside, bring). Working with the municipalities, producer responsibility organisations (PROs) look to optimise and standardise collection systems as well as provide funding.

All countries within the EU27+3 region had separate collection systems in place for rigid HDPE and PP packaging waste in 2023. The most common mechanism for collection of the light packaging fraction is through which rigid plastics are collected with other recyclable materials such as aluminium cans and cardboard. This is often the PMD (plastic, metal, drink cartons) system, which operates in many countries. There are examples of plastic-only collections, often seen in Scandinavia. In most countries, both door-to-door and bring-sites (e.g. collection points) collection systems operate, though the prevalence of each varies across countries. These systems are provided either directly by municipalities or indirectly through EPR schemes.

Even though separate collection is present across all countries, the systems vary significantly in terms of delivery method, coverage and effectiveness. While in countries such as Bulgaria, Austria and Greece, separate collection is mainly delivered through drop-off recycling sites, in the Netherlands and Belgium, most of the collection is done via door-to-door collection, and drop-off recycling sites are more common only in rural areas. In Sweden, an ordinance launched in 2024 requires that all households must have access to kerbside collection for their packaging waste by 1 January 2027 at the latest. Among other points, the purpose of the new ordinance is to increase the recycling of packaging and to reduce the amount of packaging waste.

From the coverage perspective, a major change was seen in Poland, where since 2017 the implementation of policies to facilitate and harmonise sorting resulted in all citizens being covered by a collection system focused on lightweight packaging fraction, similar to the "yellow bag" well established in countries such as Germany and France. In France, since 2016, coverage of the yellow bag has been gradually expanded to include not only plastic bottles but also PTTs as well as films. In a similar effort to simplify sorting for consumers and capture more waste, Belgium implemented the "new blue bag" in 2019, expanding separate collection to all types of plastic packaging - including PTT and flexible films. Covering the PTT stream in a separate collection is relevant for capturing more HDPE and, particularly, more rigid PP given its penetration in these applications.

In addition to expanding the separate collection systems, some countries have also started to implement measures to recover plastic waste from residual fractions (i.e. general waste). In the Netherlands, Sweden and Poland, this trend emerged as part of an effort to improve overall collection rates.

Sorting

Once collected, this waste stream is sorted in material recovery facilities (MRFs) in different ways. European standard EN 15347-1:2024 is available for the characterisation of sorted plastic waste. The document focuses on what details must be included in the specifications, not levels of contamination permitted. There is additional CEN standardisation work ongoing to develop separate standards with quality grades and characterisation of sorted PE and PP wastes. At the national level, waste specifications are set by extended producer organisations focusing on providing information on targeted polymers and the maximum levels of impurities present in plastic waste material.

MRFs play a crucial role in sorting HDPE and PP rigids. However, sorting can take place at multiple points in the supply chain, including additional secondary plastics sorting centres and ultimately at the pre-treatment step in recycling facilities.

The sorting process typically takes place using optical methods, such as near-infrared (NIR) technology, though an increasing number of projects are also combining it with AI to enhance differentiation between types, such as food and non-food packaging. Manual sorting is less common today, although still used in some parts of Eastern Europe, for example.

While HDPE is typically sorted separately into HDPE rigids bales, PP rigids can be separated into PP bales, which sometimes also include flexible PP. Additionally, HDPE and PP can also be sorted into mixed polyolefin (MPO) bales or, in the case of PP, mixed with rejected plastics from other sorting streams.

HDPE is typically sorted into rigids bales, with varying content levels typically including small items such as bottles and trays and attached lids and caps. In most cases, the packaging is composed of containers of varying colours from both food applications (e.g. juice and milk bottles, trays) and non-food contact uses (e.g. detergent, bleach, fabric softener bottles), which are typically sorted into mixed coloured bales. In Germany and the Netherlands, content levels are typically above 94%, whilst in Spain, content levels are specified as >90% (including moisture). However, in countries such as Ireland and the UK, where natural colour HDPE containers represent a relevant share of packaging (usually for food applications such as milk

and juice), a stream of natural colour HDPE bales is also produced. In the case of the UK, natural colour HDPE is a mature stream, mainly comprised of milk bottles, and it currently represents the only major source of food-grade HDPE bales in the region, though most of the supply is consumed domestically.

In the case of PP, sorting specifications are less homogeneous. Whilst countries like Germany and the Netherlands produce coloured-only PP bales mainly comprised of both rigid and flexible packaging materials with a minimum content of 96%, other countries, such as France, grade all household flexibles into a bale (PE, PP, multi-material). There are examples of sorting plants, typically newer, larger-scale operations, that sort PP flexibles into a single stream output found in the Netherlands, Sweden and Austria.

MPO bales are also common in some countries, such as France. The final use, however, varies depending on market conditions, being directly reprocessed into mixed pellets for construction applications or further separated into mono-material streams by recyclers. Another small but developing application for MPO is for chemical recycling (pyrolysis).

Additionally, PP rigids are often present in residual mixed plastic bales, some targeted for energy recovery and some taken by some recyclers or secondary sorting sites. These bales concentrate rejects from other plastic streams, often including PTT items made of PP, among other materials such as PS with some PVC and PE. Due to the plethora of forms, colours and sizes, PP sorting can be challenging, particularly for older sorting facilities, contributing to its presence in reject lines. Some of the secondary sorting does produce feedstock for chemical recycling.

The noted developments in the collection have also been followed by changes in sorting in some countries. Scandinavian countries have seen expansions in capacity: A new sorting centre in Sweden started operation in 2023, with a sorting capacity of up to 200,000 tonnes into 12 different streams (including rigid HDPE and rigid PP, as well as two grades of MPO laminates). In Denmark, the country's first large-scale plastic waste sorting facility started operations in 2024. The facility has an annual capacity of 160,000 tons of waste, with a focus on post-consumer plastic, representing a key step for the country's ambition to recycle 80% of plastic by 2030. Norway has also announced plans to set up local sorting infrastructure, and construction has started.

In Belgium, the fifth and last PMD sorting centre of the five initially selected to sort the "New Blue Bag" was inaugurated in Engis (Huy) in 2023. In France, the extension of the yellow bag to include complex plastics such as films and PTTs was accompanied by a wave of new sorting facilities coming on stream since 2019, counting with modern sorting systems. The initiative also included both modernisation of existing facilities and standardisation of sorting instructions to allow them to sort different types of plastic packaging, including pots, trays and films. In 2023, the rollout of the initiative achieved 98% of the population[3].

COMMERCIAL & INDUSTRIAL

The commercial & industrial waste stream includes bottles and containers as well as boxes, crates and drums from transport packaging waste. In the cases of small businesses, this stream is often covered by the municipal waste collection systems, where the waste is household-like, while for larger establishments, it is often managed by private waste management companies.

Plastic from RTPs (Returnable Transit Packaging) is often kept in a closed material loop for long periods of time. At their end of life, the crates are reground, and this reground material is turned into feed to make new crates. This secondary raw material is quality-tested, with properties comparable to the original material.

The majority of the countries in the EU27+3 region cover this stream in the household stream, and most of them have EPR schemes in place to cover it. Both France and Spain announced the implementation of EPR schemes for 2025.

3. CITEO (2023). Monitoring the quality of the materials

BOTTLE CAPS

Both HDPE and PP are widely used in bottle caps/lids, though for different end-uses. HDPE is commonly used as a material for caps and lids when transparency is not required. As this is the case for most PET beverage bottles, the expansion of deposit return scheme (DRS) systems across Europe has driven the increase in the capture of this stream. Whilst DRS systems are mature in countries like Sweden (1984) and Finland (1996), 2023 saw the start of the Romanian DRS system, while in 2024, Hungary and Ireland implemented their systems. Alongside DRS expansion, the rollout of "tethered caps", mandatory for single-use plastic beverages since July 2024 as part of the Single-Use Plastics Directive (SUPD), plays a key role in guaranteeing that the caps, which can be easily lost through the collection system due the small size, follow the same destination as the bottles.

PP, on the other hand, is more commonly present in larger caps or in cases where transparency is required (typically for non-food contact uses such as laundry detergents, cleaning products, etc). In these cases, while DRS expansion is expected to have a limited impact, EPR systems continue to be the main drivers for collection.

BUILDING & CONSTUCTION WASTE STREAM

The rigid HDPE & PP waste coming from building and construction streams is mainly comprised of pipes, often presenting a longer lifespan, usually decades or more. However, there are offcuts of waste produced when laying the pipes. In most countries, it is managed by private companies rather than by municipal collection systems. EPR schemes focused on recovering plastics from this stream are still very rare, though in France, legislation came into force in 2023[4], establishing a scheme that covers plastics among other materials.

Costs associated with dismantling and logistics continue to be the main challenges for the collection and sorting of this stream. Due to the long-term use, the presence of legacy chemicals along with additives such as flame retardants poses challenges for sorting and recycling.

AUTOMOTIVE ELVS

HDPE and PP rigids are both used in the automotive industry, but according to a study published by the JRC[5], PP is the most used polymer in cars. It is often present in non-structural car parts, wheel arches, bumpers and increasingly in under-hood applications, such as battery cases. HDPE is often present in fuel tanks, fluid containers or dashboards. The share of these plastics in cars is also expected to grow further, particularly in electric vehicles, to reduce weight and improve autonomy range.

Currently, this stream is mainly privately managed by authorized treatment facilities (ATFs). Collection of post-consumer plastics for recycling is quite limited, with the majority being sent to landfills or incineration facilities, due to metal recovery being prioritized because of economic factors and challenges related to contamination and appropriate sorting (which can occur either pre- or post-shredding)[6].There are some early developments in the increased post-shredding treatment of the light fraction to recover plastics. These developments are mainly driven by the new ELV regulations under discussion, which include targets on plastic recovery. Although data on ELV-WEEE plastics recyclers is outside the scope of this report, it is estimated that in 2023 the installed recycling capacity for ELV-WEEE plastics was around 750 thousand tonnes[7], with approximately one-third dedicated to ELVs.

OTHER

Other waste streams containing rigids HDPE and PP include oversized plastics coming from furniture and household products, more durable products with a longer lifespan than commodities. Collection of this stream for recycling is limited, with only a few countries having set specific EPR schemes targeting this.

4. FFB (2023). Construction site waste: what is PMCB?
5. European Commission - Joint Research Centre (2023). Towards recycled plastic content targets in new passenger cars and light commercial vehicles
6. Auto Recycling Nederland (ARN). Plastics in today's cars will still be used in car parts 20, 30 and even 40 years' time
7. PRE (2023). Plastics recycling industry figures 2023.

RECYCLING

CURRENT CAPACITY

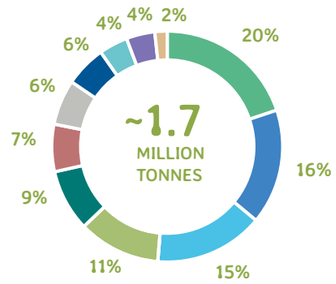
The polyolefin recycling process starts with the arrival of the waste feedstock (i.e. rigid HDPE and PP bales) at the recycling facilities, where it is shredded and washed, producing flakes/regrinds. These flakes/regrinds are then extruded into pellets, which can then be used to produce new products such as packaging, pipes, furniture, flowerpots, etc.

The steps involved in recycling rigid HDPE and PP waste are essentially the same, and hence it is possible that the same recycling facility can process both HDPE and PP. It is estimated that about 75% of the estimated 300 HDPE and PP recycling plants in Europe recycle both HDPE and PP waste in the same facility. These facilities have an average annual capacity of around 14,000 tonnes/year, with only a few players holding annual capacity above 40,000 tonnes/year.

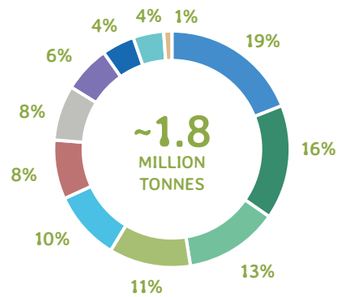
In 2023, the installed capacity for recycling rigid PP waste in the EU27+3 region stood close to 1.8 million tonnes, while that for rigid HDPE waste was just over 1.7 million tonnes. The largest average recycling facilities in terms of recycling capacity for HDPE and PP sit within the German, Benelux and UK markets. The recycling capacity has almost doubled in relation to 2018, but in spite of this, there was no significant growth compared to 2022.

Figure 14 shows the installed recycling capacity for rigid HDPE and PP per EU27+3 country group in 2023. Concerning HDPE, Spain and Germany account for the largest shares of about 20% and 16% respectively, followed by Italy with almost 15% of the regional capacity. UK & Ireland (11%), Benelux (9%) and France (7%) are the next countries with the largest capacities. Together, these 9 countries account for approximately 80% of the rigid HDPE recycling capacity. In relation to PP, Germany accounts for the largest share of about 19%, followed by Benelux with almost 16% of the regional capacity. Spain (13%), the UK & Ireland (11%) and Italy (10%) are the next countries with the largest capacities. Together, these 8 countries account for approximately 70% of the rigid PP recycling capacity.

HDPE recycling capacity in the EU27+3 region by country group in 2023



PP recycling capacity in the EU27+3 region by country group in 2023



COUNTRY GROUP DEFINITIONS:
- Balkans and Eastern Europe: Bulgaria, Croatia, Cyprus, Greece, Hungary and Romania
- Baltics and Nordic countries: Denmark, Estonia, Finland, Latvia, Lithuania, Norway and Sweden
- Benelux: Belgium and Netherlands
- Central Europe: Austria, Czechia, Slovakia, Slovenia and Switzerland

Figure 14: HDPE & PP recycling capacity in the EU27+3 region by country group in 2023.
Source: PRE

Some of this capacity development is a result of the demand for rHDPE and rPP materials to comply with the anticipated mandated targets and voluntary commitments from brand owners and has driven significant investment in this sector of the value chain.

While domestic recycling capacity has developed strongly since 2018, disparities in collection systems across the member states have prevented it from reaching its full potential, primarily due to weak end demand and a lack of available quality feedstocks. Moreover, the recycle demand in 2023 was relatively lower than in 2022 as a result of bearish macroeconomic conditions and high inflation minimising consumer purchasing power, substitution to comparatively low-priced virgin and off-spec polymers (largely in non-packaging sectors), cut-back in public construction projects due to negative macroeconomics and colder than average temperatures in the first half of 2023 blunting outdoor furniture demand. There was also some impact from lower-cost imports of recycled polymer from outside of the region. Besides, barring a few exceptions for PP, there was almost no year-on-year change in recycling capacity for these polymers from 2022 to 2023. Converters were working from existing stock amid the ongoing macroeconomic uncertainty and operated with just-in-time procurement in a number of instances. Recyclate demand for packaging applications, however, was less impacted as compared to non-packaging applications driven by sustainability targets.

INPUT MATERIAL

Around 1.4 million tonnes of HDPE and 1.3 million tonnes of PP were sent as input to recyclers in the EU27+3 region in 2023. This represents a sent-to-recycling rate of 43% for HDPE and 40% for PP in relation to the waste generated. This input then led to the production of 1 and 0.9 million tonnes of rHDPE and rPP, respectively, resulting in an average yield of 71% and 69%. The yield is defined as the ratio between the amount of waste recycled in a given recycling process and the input waste feedstock entering that recycling process[8]. The actual recycling rate was estimated to be around 32% for HDPE and 30% for PP, considering the weight of the waste materials that are actually reprocessed into products versus the generated waste[9] .

It is estimated that around 85% of the waste input to the recyclers was from post-consumer sources, while the remaining 15% was from the post-industrial stream. Packaging represented around 90% of the total input that HDPE and PP recyclers processed in 2023, mainly from household sources (56%), but also from commercial and industrial (28-29%) and other packaging sources (5-6%). Recycling rates and yields do vary depending on the waste stream processed. While HDPE and PP waste from household packaging is estimated to have a recycling yield of 70-80%[10], the yield for crates & pallets (included in the C&I stream) is estimated to range from 95-99%[11]. For the latter, it was also estimated that the sent-to-recycling rate for this material is 90-95%, with an average number of rotations over 50 and a maximum number of cycles of more than 50, even reaching 500 in some cases[12].

In 2023, Italy, Spain, Germany and the UK were the countries that processed the most tonnes of HDPE waste from household packaging origins, while Germany and the Netherlands were the leading countries for processing household packaging but for PP. In terms of the size of the recycling facilities, HDPE and PP recyclers processing household packaging as input material tended to be larger on average in terms of recycling capacity size than commercial and industrial packaging recyclers.

DEVELOPMENTS IN THE AREA OF CHEMICAL RECYCLING OF HDPE & PP

In 2023, there was just under 110,000 tonnes/year of operating installed input capacity for chemical recycling thermal depolymerisation plants in Europe, specifically targeting mixed plastic waste feedstock. In total, these added up to under 20 plants, the majority of which were demonstration or pilot plants, the first commercial plant only beginning operations in 2020. Pyrolysis technology remains the predominant operating thermal depolymerisation processing technology in the region, with the current gasification capacity just over 10,000 tonnes/year.

Also, the output from chemical recycling using thermal depolymerisation processes produces a virgin-like quality material suitable for use in the supply chain delivering polymers for use in food contact applications, if the input substances are proven to be of high purity. In Europe, the chemical recycling industry should develop as a complementary solution to mechanical recycling, in particular, avoiding competition when sourcing feedstock waste. Collaboration along the value chain improved, with partnerships for chemical recycling projects being announced with waste managers, technology manufacturers and end users.

However, several drivers also brought uncertainty to the market, challenging investment decisions, the timely start-up of new projects and the achievement of previously expected high operation rates. Project economics were impacted by high inflation rates across the region, particularly around Capital Expenditure (CAPEX), increasing costs that had been unforeseen and consequently delaying plant start-up dates. Demand for overall packaging fell in 2023 due to the cost-of-living crisis, which also impacted the plastic recycling industry. End users increasingly prioritised managing costs when evaluating their feedstock mix, which impacted the recycling sector as high-grade recycled polymers are often sold at a premium to virgin polymers.

Feedstock availability is also a challenge. The average chemical recycling plant has a higher input capacity than that of a mechanical recycling plant and therefore needs to secure access to significant volumes of waste to be able to scale up. While chemical recycling processes can accept more mixed polyolefins in plastic waste than mechanical recycling, certain requirements for this waste still need to be met, as some contaminants are very damaging to the process, e.g. moisture, oxygen and chlorine. Therefore, pre-sorting requirements are required. In addition, the quality of the feedstock waste entering the chemical recycling plant will also determine the yield and the quality of the output product. This requires investment and the development of collection and sorting infrastructure to meet the specific needs of chemical recycling plants.

8. European Commission - Joint Research Centre (2023). Towards a better definition and calculation of recycling.
9. European Commission - Decision (2011/753/EU) – Calculation Rules for Recycling Targets
10. PRE surveys
11. PRE and RCTP (Roundtable for Reusable Containers, Trays and Pallets)
12. RCTP (Roundtable for Reusable Containers, Trays and Pallets) survey

KEY END-MARKETS FOR R-HDPE / R-PP

In the last 3-4 years, the share of packaging applications for rHDPE and rPP has grown significantly, from representing 18% of the total rPP end-markets in 2018 to 30% in 2023, and from 25% to 38% for rHDPE[13], making it the largest sector for rPP and the second largest for rHDPE, after building and construction, which has been losing its share consistently. The share for packaging is set to grow further in the coming years. This was possible due to the value chain's continued commitment to sustainability. Packaging demand from brand owners, led by proposed mandatory, as well as voluntary targets, has supported the development of packaging applications for polyolefin recyclates.

As illustrated in Figure 15, it is estimated that in 2023, about 48% of rHDPE produced was used by the building & construction sector, where pipes and conduits are the predominant application for rHDPE, accounting for at least 90% of this 48%. The remaining 10% is allocated to various other building and construction materials. The packaging sector was the second largest end-market accounting for about 38% of rHDPE consumption. Within rHDPE packaging applications, household packaging is estimated to represent 55% of the market, while commercial and industrial (C&I) packaging accounted for the remaining 45%. In the household packaging segment, home-care products (i.e. cleaning products) dominate with 42% of these sub-end-markets, followed by cosmetics and personal care products at 32% . Food-contact applications, primarily milk bottles in the UK (which fall outside EFSA regulations), make up a significant portion, with the remainder distributed among other household packaging products. Within the previously estimated 45% for rHDPE in C&I packaging, crates and pallets may constitute nearly half of this subgroup of applications. The rest of the share is divided among IBCs, drums, cans, baskets, transport packaging, and other miscellaneous uses. Other applications outside building and construction and packaging, representing 14% of the total, as presented in Figure 15, included agriculture (6%), and other applications (8%) such as furniture, automotive, electrical and electronic appliances, etc.

The end-markets for rPP are more diverse as compared to rHDPE owing to the wide range of PP applications, even within consumer packaging. In 2023, close to 30% of rPP was consumed towards packaging applications. Within rPP packaging applications, commercial and industrial (C&I) packaging dominates with an 80% share, while household packaging accounts for the remaining 20%. The household segment of rPP packaging primarily serves cosmetics, personal care, and cleaning products. A small portion is allocated to food-contact applications, mainly in the UK, which operates outside EFSA regulations. However, it's worth noting that the overall tonnage for new rPP household packaging applications is relatively small. In the C&I sector, crates and pallets constitute approximately half of the volume. The remaining share is distributed among various products such as buckets, baskets, and other industrial containers. Building and construction was the second largest end-market with 27% of the consumption share (while pipes are a significant application, rPP is also utilized in various other building and construction materials), followed by automotive (14%), furniture (12%), and agriculture (8%). Other rPP applications (9%) included small volumes of electrical and electronic appliances, household leisure and sports goods and others. While the volumes are still very small, there is a growing interest from the electronics and appliances sectors.

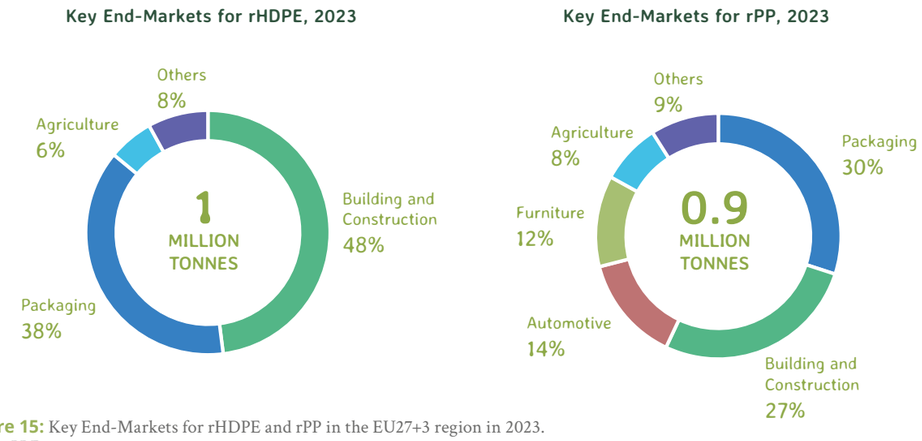


Figure 15: Key End-Markets for rHDPE and rPP in the EU27+3 region in 2023.
Source: PRE

13. PRE (2021). HDPE and PP market in Europe – State of Play.
14. PRE surveys

	rHDPE to Product Application 2023 (Est), Kt	Total Consumption, 2023, Kt	Implied rHDPE Usage Rate
Building and Construction	480	1326	36%
Packaging	380	3474	11%
Others	140	1516	9%

Figure 16: Implied rHDPE usage rate in the EU27+3 region, 2023.
Source: PRE, ICIS Analysis

	rPP to Product Application 2023 (Est), Kt	Total Consumption, 2023, Kt	Implied rPP Usage Rate
Packaging	270	2888	9%
Building and Construction	243	564	43%
Automotive	126	1021	12%
Furniture	108	1057	10%
Others	153	3592	4%

Figure 16: Implied rHDPE usage rate in the EU27+3 region, 2023.
Source: PRE, ICIS Analysis

The usage rate for rHDPE and rPP into packaging has seen a significant shift since the previous report, with the packaging share increasing from 4-5% in 2018[15] to 11% and 9%, respectively, in 2023, due to the efforts of the value chain to increase sustainability in its packaging. Similarly, draft legislation is generating more tonnages from both PP and ELV-WEEE recyclers now targeting new automotive and EEE applications.

Packaging demand for polyolefin recyclate at present remains largely in an open loop and is mainly for non-contact sensitive applications such as laundry detergents, dish cleaning liquids, etc. This is due to the absence of large-scale quantities of suitable waste volumes due to the composition of the waste stream with food and non-food bottles and PTT mixed together, making it challenging to separate. This creates higher contamination levels, higher demands on sorting technologies, a lack of traceability, the prevalence of mixed-recycling chains, the economics of sorting and separating, polymer weakening during the recycling process, etc. In the EU, the challenge for PET food-contact applications is heightened by EFSA technical guidance that 95% of the material used in food-contact-approved recycled material must have originated from a food-contact source. There is no equivalent percentage for HDPE or PP, as yet.

EFSA has previously given positive opinions to companies in Europe producing recycled polyolefins. For the most part, these are companies processing transport packaging for food in a closed loop. There is one example of a company in the UK which received an EFSA positive opinion for rHDPE produced from HDPE milk bottles. However, this rHDPE was determined unsuitable for the production of new HDPE milk bottles. It can be used only in the production of food contact trays, for whole fruits and vegetables, with up to 30% recycled content for the UK market.

Several projects are underway for the development of added-value applications, including contact-sensitive applications for both food and non-food uses for polyolefin recyclates:

1. **Project STOPP:** STOPP aims to create sustainable packaging solutions by innovating circular business models, testing consumer impact, and advancing recyclability with a specific tool (RecyClass). STOPP's objective is to generate relevant data to submit a dossier in accordance with Reg. 2022/1616.
2. **HDPE/PP/MPO Cap recycling:** Some large bottle recyclers in Europe are driving the ambition to have a closed loop on bottle caps.
3. **CosPaTox:** CosPaTox seeks to define toxicological safety guidelines for PCRs used in cosmetics packaging, with a first focus on polyolefins.
4. **FDA approval for mechanically recycled R-HDPE & R-PP for food contact applications:** There are European suppliers that have received letters of no objection (LNOs) from the U.S. Food & Drug Administration (FDA) regarding using specific grades of their mechanically recycled post-consumer plastics in food-grade packaging.

Packaging demand for recycled polyolefins is slated for continued growth in the future as the PPWR has become law and has set targets around recyclability, recycled content levels and reuse[16]. For R-HDPE, blow-moulding natural pellet prices remain the highest of any grade. This is because they predominantly serve the packaging market, where demand remains firmest on the back of ambitious sustainability targets and because supply remains structurally tight. Packaging consumption continued to outpace buying interest from other sectors, such as construction in 2023. Construction demand had fallen due to high material costs, substitution with off-spec virgin material or mixed recycled polyolefins, and negative macroeconomics. Players in downstream non-packaging applications continued to substitute for virgin amid comparatively low prices in that sector and amid macroeconomic weakness.

Demand for R-PP has increased significantly in the past 3-4 years on the back of ambitious sustainability targets from fast-moving consumer goods (FMCG) firms - which have a preference for recyclate derived from household post-consumer waste material due to its higher perceived marketability - and these targets far exceed current recycling capacity to produce the required grades. Alongside this is the lack of conducive investment conditions to build that capacity.

Nevertheless, demand is also increasing from other sectors such as automotive, white goods, and construction, which is also being driven by sustainability goals, but still remains price-sensitive in comparison to packaging.

There, however, still remains the challenge of sourcing sufficient recyclate volumes to fulfil the recycled content targets applied to PE & PP packaging, due to which some players have moved away or are considering moving away from HDPE and PP to other materials. For example, to polyethylene terephthalate (PET) in the case of HDPE applications and to HDPE in the case of PP bottle applications. The substitution can be attributed to higher recyclability, leading to relatively higher availability of good-quality recyclate. Currently, it is particularly challenging to use rPP in blow moulding applications due to technical challenges. There is also the issue of variability in PP MFI owing to the diverse nature of applications, whereas it remains relatively uniform in the case of HDPE bottles.

The impact of substitution has been seen across applications- a producer of dairy products switched its HDPE milk and cream products to PET, stating that European requirements around recycled plastics used in food-contact applications are "becoming increasingly stricter", and the company is adapting its policy to be in line with these requirements, leading to the move from HDPE to opaque PET. A consumer goods company producing cleaning products, personal care products, etc., changed some of their PP bottles to HDPE bottles in order to incorporate recycled content in the packaging. There are also challenges around rPP recyclate colour, for example, using grey coloured caps for cleaning products might not relate to the intent of 'cleanliness'. Quantifying these substitution trends is challenging due to the inherent variability across applications and brand owner preferences. The rapidly evolving regulatory landscape and ongoing technological advancements further complicate the ability to predict industry-wide shifts. Market-specific factors, such as infrastructure availability and consumer behaviour, lead to divergent trends across regions.

Some FMCG producers also began to reassess their sustainability commitments in light of the growing price delta with virgin plastic amid recessionary concerns in 2023, with the impact on demand being felt by the market throughout the year.

15. PRE (2021). HDPE and PP market in Europe – State of Play.

16. See Role of Legislation section

KEY CHALLENGES FACING THE HDPE / PP RECYCLING MARKET

QUANTITY: VOLUME FLOW ACROSS THE RECYCLING VALUE CHAIN

With an increasing demand for R-HDPE and R-PP not only for packaging but also for applications such as automotive, increasing output volumes based on PCR material requires dealing with several challenges across the value chain, such as increasing the collection volumes.

Starting from the volumes placed on the market to the recyclate produced, the biggest gap is at the very beginning of the value chain - collection. While there is a loss of plastic waste across the chain due to leakage to the residual stream, other aspects such as contamination, inefficient sorting, processing losses, design limitations leading to non-recyclability of some packaging, etc. are also relevant. Sufficient collection of plastic waste in separate recycling streams is imperative for the further development of this value chain. There is also some loss via exports to other regions, largely for the waste which is hard to process in local plants. However, with the tightening of global and regional policies around waste trade, the domestic availability of waste plastics volumes has been increasing.

Although separate collection (along with other recyclables) of rigids has been implemented in almost all EU27+3 countries, the reach of these systems to the wider population is still rather limited, demonstrated by the low collection volumes. One example is that not all municipalities operate separate collection schemes for all materials.

QUALITY

Recyclate quality continues to be a crucial aspect for continued growth in the recycling of HDPE and PP rigids. Quality is a result of several other key value chain elements such as design-for-recycling (or lack of), collection systems, consumer awareness and sorting infrastructure. In the case of HDPE, although the overall quality of recycled material has improved considerably in recent years, enabling a broader range of applications to develop, beyond pipes, is challenging. Mainly in managing the variety of colours and minimizing contamination, particularly with similar polymers such as PP. As for rPP, incorporating recyclates back into packaging applications, outside of C&I packaging, remains more limited than HDPE. PP is used in a wider range of applications, resulting in a greater variety of recycled material not only in terms of size and shapes but also colours and additives, posing a challenge for collection and sorting systems.

Enabling closed-loop recycling for food-grade applications is still the next stage for the chain, requiring developments across all four levers previously mentioned. Only small volumes of HDPE and PP are currently collected through DRS, primarily in the form of caps attached to PET bottles, mainly occurring now in Germany. This presents a significant challenge for producers in obtaining consistent, traceable, food-grade material that meets EFSA requirements for contact-sensitive applications.

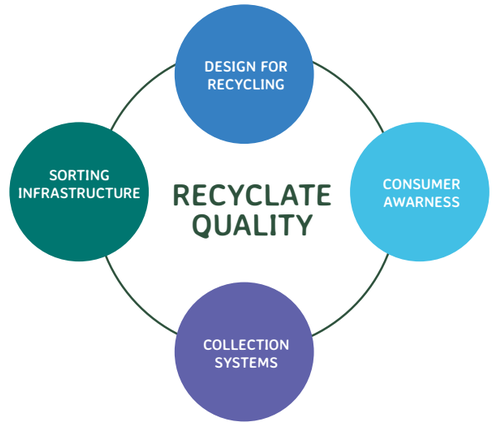


Figure 18: Key levers of recyclate quality.

RECYCLABILITY

To be recyclable, a product or packaging must be designed for recycling and recycled at scale, i.e. collected, sorted and recycled in practice. Therefore, all aspects of the value chain – manufacture, collection, sorting and recycling – contribute to achieving recyclability. Recyclability is important as it enables the industry to achieve recycling targets as set out in the regulation. For example, the PPWR proposal states a 55% recycling rate for packaging, and all packaging must be recyclable or reusable by 2030.

According to RecyClass, the key principles of design for recycling for packaging are:

- Choose plastics that have a recycling stream in the EU: HDPE, PP, PS and PET bottles and trays for rigid packaging and PE and PP for flexible packaging.
- Maximise the proportion of the main polymer and favour mono-material solutions: Recycling processes vary depending on polymer types, thus the use of components made of different polymers should be minimised. The combination of various types of plastic may complicate both the sorting and the recycling steps.
- Reduce colours and printing: Colours and printing cannot be removed during recycling, which reduces the visual aspect and quality of the recyclates.
- Encourage the use of removable decorations: It's preferable to use decorations that can be detached from the main plastic packaging and separated in the recycling process, as this prevents contamination of the plastic with labels, adhesives, sleeves, and similar materials.

Enable consumers to empty the packaging entirely: A large amount of product residues after the normal use phase of the packaging creates added contamination during recycling and results in extra water-treatment steps.

RECYCLABILITY OF RIGID HDPE

The recyclability of rigid HDPE depends on multiple factors, and on the context of the entire lifecycle of the polymers. Product and material design, end-use lifespan and existing collection and processing infrastructure all impact the recyclability of HDPE.

Two key barriers to improving HDPE recyclability include: the collection system and product design. Firstly, across the EU, the collection of HDPE, especially from post-consumer sources, is varied, as described earlier in the report.

Secondly, product design choices, such as the use of multiple polymers (e.g. blow-moulded HD bottle with PP cap and PE compliant membrane/insert; MPO injection moulded pallet) and labelling design, also the use of fillers taking the density over 1, are all impactful.

Traditional in-mould labelling for injection moulded packaging, where the printed label is fused directly with the item during the production process, makes it difficult, if not impossible, to remove the layer of print. The inks and materials used in the labels are melted alongside HDPE during recycling, impacting the final output colour and integrity, as they may cause volatiles or spots with unmelted particles, which might impact the mechanical properties negatively. New in-mould-label technologies have been developed, which are releasable during the recycling process, helping to avoid such issues.

Similarly, choices made for labelling affixed with adhesives, especially where metallised films are used for aesthetic or anti-theft, hygiene or copyright purposes, need to balance the durability and resilience to consumer use versus recycling. For example, for recyclers who commonly deploy cold washing during the process, the usage of adhesives that are releasable during the grinding and washing process under 40 °C is advantageous. For more challenging structures or to achieve contact-sensitive recyclates, improvements in washing technology, especially efficient friction-based hot washing of flakes, are one way these needs are being addressed within the recycling process.

Finally, the wide choice of colours and masterbatch additives has an ongoing impact on HDPE recycling. Some end-users choose distinctive colours to make differentiating the products easier, which is used both for safety (e.g. bright yellow packaging for corrosive home detergent products) and branding purposes. Some market players have called for a streamlined colour-coded approach which would enable accurate NIR sorting of fractions for distinct purposes and levels of contact sensitivity. If adopted at scale, such an approach may have a significant positive impact on sorting, which in turn will ensure reliable feedstock for overall improved recyclability.

All of the above, as well as the changeable nature of feedstock quality and quantity available to recyclers, means that even though HDPE is technically recyclable, there remains a gap between theoretical and actual recycling activities.

RECYCLABILITY OF RIGID PP

All of the factors and barriers discussed in the context of HDPE recyclability also apply to rigid PP. Currently, recycling at scale is more challenging for PP in terms of collection, sorting and recycling. Sorting of PP as a single polymer stream happens less than for HDPE, although this is changing. Furthermore, the mixed nature of the collection is even more impactful on consumer PP packaging used in transparent food-contact applications. However, there are some Novel Technology processes in development[17].

Meanwhile, where rigid PP is used in a very wide range of durable consumer goods or industrial performance applications, the use of additives (such as flame retardants) and stabilisers introduces further challenges for recycling. The inclusion of additives necessary for required performance creates a difficult-to-control mix of waste feedstock. These issues will likely become exacerbated even further when new legislation for key durable end-use applications (i.e. automotive) mandates minimum recycled content for components with the highest degree of safety standards and very restrictive performance requirements.

Furthermore, the availability of high-quality feedstock from durable application waste streams is disproportionate to specialised demand. This means that there is an ongoing mismatch of waste produced and collected from post-industrial and post-consumer sources, where unknown or legacy additives are present, and the current up-to-date production specifications. Simultaneously, some applications in the automotive or construction sectors, especially for mixed rigid PP and HDPE use, have a lifespan between five, ten, twenty-five, and up to a hundred years. These items will not be entering the recycling stream for a considerable time yet.

Overall, the fragmented nature of the end markets for rigid polyolefins, the nature of their chemical structure, and the additives and technological solutions, which produce the required performance, make polyolefin rigids' recyclability at scale more challenging.

17. See Technological Enablers section

CERTIFICATION

Standards are available in Europe for all stakeholders across the value chain: namely recyclers and recyclate end-users seeking to make third-party certified claims on the sustainability of their products. Most players in Europe choose to align with schemes focused on recyclability and proof of use of recycled plastics to demonstrate their efforts towards plastics circularity. Towards this end, RecyClass developed certification schemes for recycled plastics, partnering in 2023 with another European certification scheme to certify the origin of waste in recycling processes[18]. Additionally, RecyClass developed certifications for recyclability based on the design for recycling guidelines aligned with the US-based Association of Plastic Recyclers (APR) in 2023. RecyClass works with stakeholders to ensure these certification schemes are balanced for all value-chain participants.

Additionally, sustainability-focused and driven certifications are also available in the market to aid consumers in making environmentally sound decisions, such as the EU Ecolabel, the Blue Angel in Germany or the Nordic Swan in the Nordic countries.

In 2022, the European Standardization Organization CEN was tasked with the revision and redevelopment of key deliverables on plastic recycling, such as guidelines for design-for-recycling, quality grades for sorted plastic waste, and characterization of recyclates. These updates will work with the Packaging and Packaging Waste Regulation as considerations for the regulation. The standards are scheduled to be completed in mid-2025, but are likely to be delayed to the end of 2025.

COLLECTION

As previously mentioned, it is estimated that nearly 3.3 million tonnes of HDPE and PP rigids waste were collected for recycling in the EU27+3 region in 2023, resulting in a ~50% collection rate with respect to the waste generated. Therefore, over the period 2018-2023, the average collection rate for Europe did not shift significantly. Although material losses often occur during the different stages of processing, the most significant gap is observed at the collection stage, right at the start of the value chain.

Generally, rigid plastic packaging waste, including items made of HDPE and PP, is collected at the household level via a kerbside system, and either 'home separated' (i.e., disposed of in a separate bin by the consumer) or 'post home separated', meaning collected by the consumer with the rest of the waste and then sent to materials recovery facilities. This step is sometimes complemented by further sorting at the plastics recovery facility. While expanding such systems may indirectly increase the amount of collected material, the overall impact remains small since this application accounts for only about 5% of total polyolefins consumption. With no DRS in place targeting specifically HDPE and PP, material is mainly collected via kerbside or bring-in systems, with significant volumes being lost to the residual mixed waste stream. Even though most countries in the EU27+3 region have separate collection systems in place, they vary significantly from country to country, and internally between regions/municipalities of the same country. Equally important as collection infrastructure, availability and convenience, is communication and education of consumers/citizens on what and how to discard waste for recycling.

In addition to the volume issue, separate collection streams are desirable as they tend to present lower contamination levels in comparison to co-mingled collection systems, posing challenges for further downstream processing. Even though sorting significantly influences the quality of the stream, collection plays a crucial role in the material quality, particularly when considering odour aspects for polyolefin recyclates.

18. RecyClass (2023). EuCertPlast & RecyClass join forces to strengthen plastics recycling processes certification

SORTING

After collection, sorting is the second most critical step of the value chain. It is estimated that about 2.7 million tonnes of HPDE and PP rigids have been sorted for recycling in 2023. Increasing the effectiveness of HDPE and PP sorting is one of the key tasks for the industry to progress.

Sorting of packaging waste is an essential step to ensure smooth and effective recycling. In this context, sorting plays a key role in minimising the amount of rigid plastic packaging ending up in landfills or incinerators. As such, effective sorting and cleaning of the incoming waste is necessary to generate high-quality recyclates through mechanical recycling. As of today, European sorting facilities use mechanical sorting processes, where materials are sorted out based on their size, shape, colour, and material composition.

The first challenge is to minimise contamination of the mono-material bales and boost additional feedstock availability to produce mechanically recycled HDPE and PP for high-quality applications. Rigid polyolefins are used in a much greater variety of applications than some other polymers, which means that there is a greater variety of product shapes and sizes in the market. As described in the recyclability section, this can make sorting more challenging, particularly in the case of PP, which presents higher variation in terms of shapes and forms and is more commonly present in the PTT stream. Additionally, whilst some materials such as PET can be separated via density using a sink-float method, this cannot be applied to separate HDPE from PP since both materials will tend to stick together and float.

The use of NIR technology is therefore crucial to allow further separation of the different polymeric materials before and/or after the grinding step, while reducing contamination of PP into HDPE bales. Moreover, colour sorting allows further separation by colour, however, this mainly applies to transparent and transparent-coloured products, while black materials– commonly used in applications in agriculture, building & construction and automotive – cannot be detected by NIR, due to the presence of carbon black, as the technology cannot detect this additive.

ENERGY COSTS

As shown in Figure 19, following the peak in energy prices caused by the start of the Russia-Ukraine war in February 2022, Europe saw prices fall significantly over the second half of 2022. Wholesale energy prices did decrease in the second half of 2022, but were slow to be reflected in retail contracts, creating prolonged pressure on recyclers' margins throughout 2023. Even though prices came down from the record highs in 2023, they remained higher than pre-conflict values. In the case of natural gas, for example, average prices in 2023 were 65% higher than during the 2018-2021 period. Additionally, due to the structure of some energy contracts, the effects of higher electricity prices were delayed, impacting recyclers later in 2023.

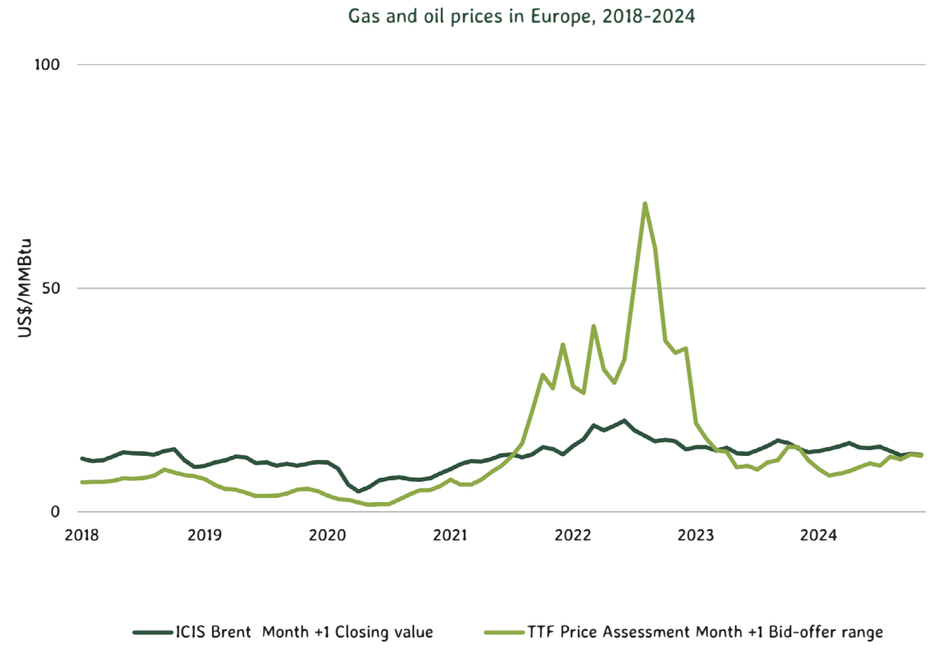


Figure 19: Gas and oil prices in Europe, 2018-2024
Source: ICIS LNG Edge

Whilst the reduction of energy costs eased the rationalisation risk that dominated the chain since Q3 2022, recyclers in Europe continued to be impacted as prices stabilised at higher levels than in 2021. Energy costs play a pivotal role in plastics recycling processes and typically represent 15-20% of total operational costs[19]. Continued higher prices suggest continued squeezed margins.

This factor added additional pressure to polyolefin recyclers already challenged by weaker demand from non-packaging sectors, such as construction, and substitution with low-priced virgin material in some cases.

19. PRE (2022). Circular economy for plastics at risk

PRICING DYNAMICS ACROSS THE VALUE CHAIN

Increased fragmentation in the HPDE and PP rigid markets has developed as demand for packaging has ramped up and been driven by sustainability goals over cost, while conversely, non-packaging remains largely driven by cost-saving. This has gone hand in hand with structural shortages of suitable packaging grade availability.

Macroeconomics and geopolitical conditions have driven different levels of growth across Europe and different government approaches, particularly on energy costs. Sector-specific legislation has created disparities between end-uses, which has resulted in differing willingness to pay for the same quality of material, widening the price ranges.

It is clear companies are trying to differentiate through standardisation and move up the value chain (on things such as MFI). A growing disconnection with virgin on both packaging and, to a lesser degree, non-packaging as rHDPE and rPP are increasingly driven by their own supply/demand fundamentals.

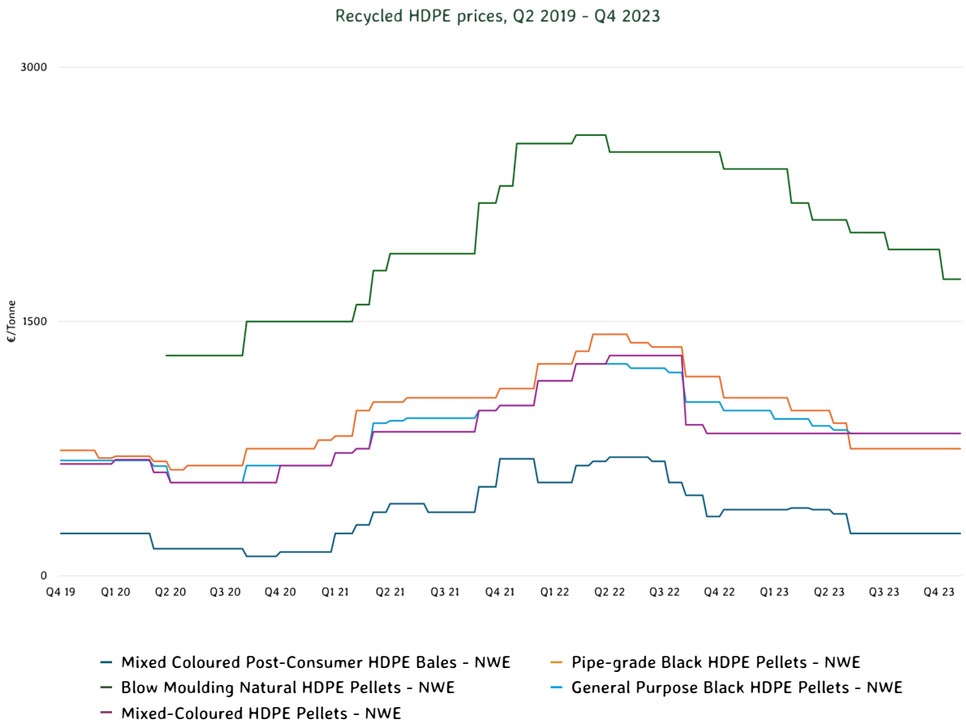


Figure 20: Historical pricing trend for virgin and recycled HDPE, 2019-2023
Source: ICIS

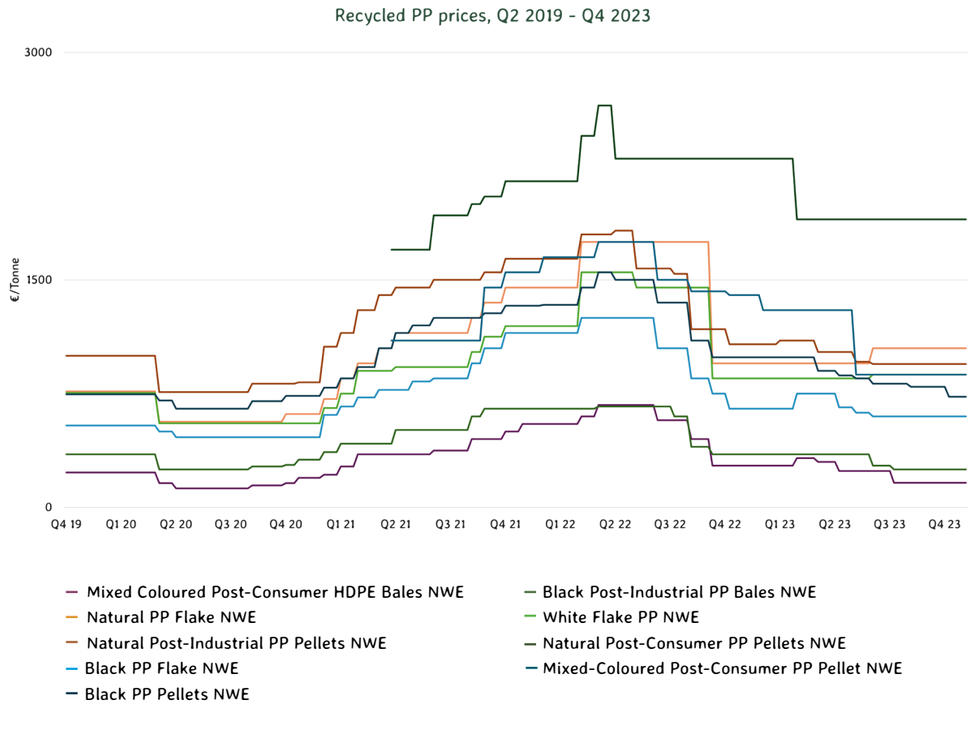


Figure 21: Historical pricing trend for virgin and recycled PP, 2019-2023
Source: ICIS

Demand built most significantly in 2022 with a stronger demand from packaging, which effectively priced non-packaging applications out of certain parts of the market. It is the packaging demand that has led to packaging capturing the majority share of high-quality grades, such as blow-moulding natural rHDPE. This has meant that injection moulding natural has largely disappeared from the market as the growth in demand for the blow-moulding grade has seen feedstocks diverted away to produce this higher value grade. Non-packaging grades still represent the vast bulk of recycled polyolefin demand. It is the largest end-user of the most widely available material, such as black and mixed colour recyclates.

The packaging sector is willing, if not able, to absorb price increases more than other end markets. Packaging is, proportionally, a much lower contributor to overall production costs than other applications, such as pipes, for example.

There were other factors contributing to a shift in recycled polyolefin prices. As discussed, with an energy-intensive process, electricity consumption in recycling plants is high. The rise in energy prices in Q1 2022 increased conversion costs by up to €200/tonne in some parts of Europe. The hangover of coronavirus-linked driver shortages also contributed to increased logistic costs.

In 2022, the market saw record-high prices across the chain in H1 and consequently good margins. This led to heavy investment by the sector as it was anticipated to continue throughout the year. However, the price spikes ended in H2 2022. And those higher energy, transport and logistic costs throughout the chain reduced margins for producers of recycled polyolefins in 2023. The cost-of-living crisis, which emerged during the year, added pressure to end-markets and ultimately margins throughout the value chain.

The bale market remains fragmented by region and end-use, with sectors such as construction and automotive already feeling the impact of negative macroeconomic headwinds, while packaging demand remains more robust.

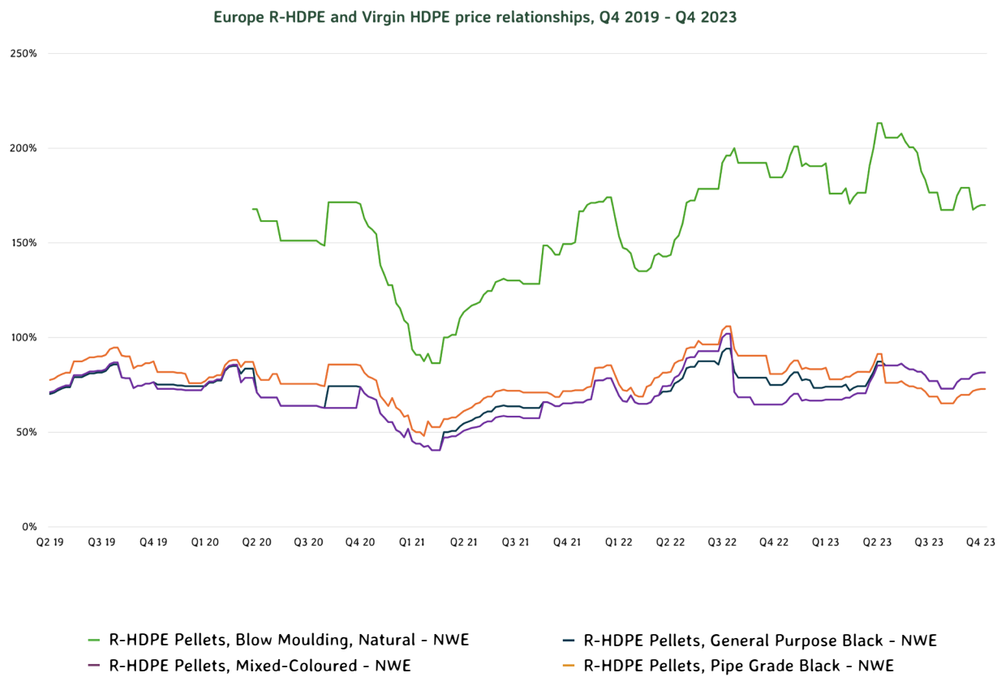


Figure 22: Price relationship between virgin and recycled PE, 2019-2023
Source: ICIS

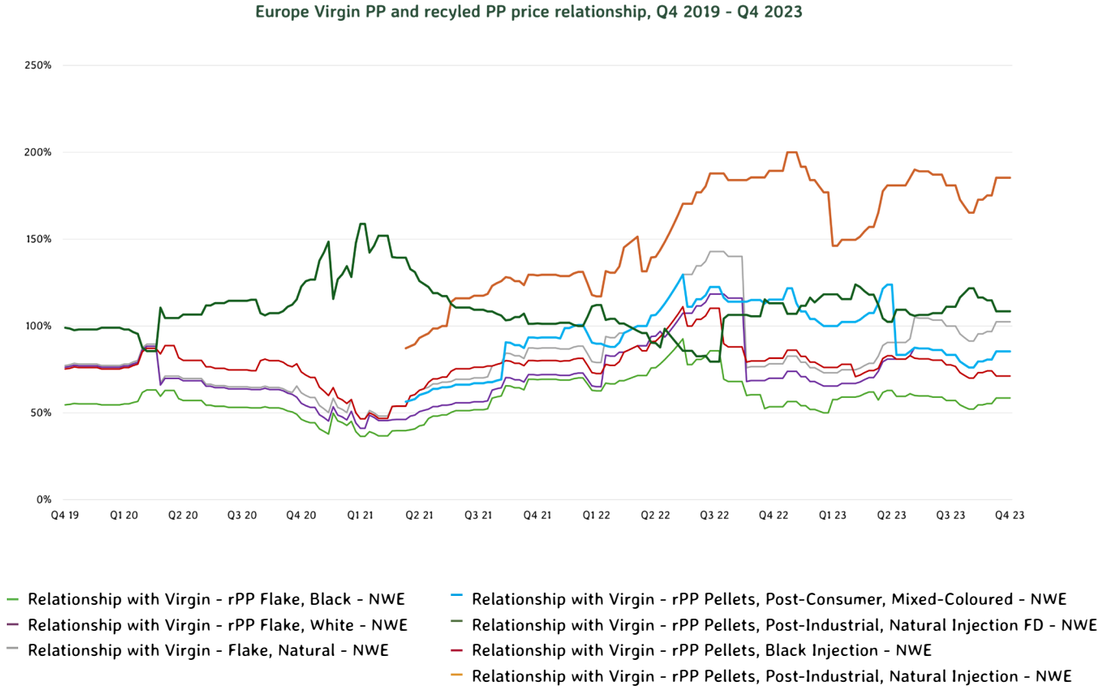


Figure 23: Price relationship between virgin and recycled PP, 2019-2023
Source: ICIS

For rHDPE, competition from lower-priced virgin markets threatened substitution away from recycled feedstocks. However, high feedstock bale costs – partly due to PROs controlling the material – made it difficult for pellet producers to lower prices without impacting margins. Some polymer substitution took place, particularly for cosmetics, where other recycled polymers such as rPET were seen as widely available.

The market conditions turned in 2023 when demand dropped dramatically, given the strong demand in 2022. Bearish macroeconomic conditions and high inflation minimised consumer purchasing power. This manifested in consumers switching to lower-cost FMCG or white brands, which typically adopt lower percentages of recycled content. Consumers' discretionary spending, especially for higher value transactions, such as those related to construction (home improvements, etc.), was also reduced.

Public spending on construction projects was cut back due to negative macroeconomics and colder- than-average temperatures in the first half of 2023, which blunted outdoor furniture market demand. Downstream players worked from stock, with ongoing macroeconomic uncertainty and switching to just-in-time procurement. Substitution to lower-priced virgin and off-spec markets increased. Added to this, converter summer shutdowns were extended.

As illustrated in Figure 23, packaging grades also fared better than non-packaging in rPP price levels. Particularly as non-packaging grades were prone to substitution by virgin. While packaging demand is the main buyer in the post-consumer grade of rPP even brand owners have become increasingly cost-sensitive since 2023 as a result of uncertain macroeconomic conditions.

In general, the construction and outdoor furniture sectors have been weak throughout 2022 to date. The greater cost sensitivity for these non-packaging applications, coupled with a tight supply of post-industrial bales resulting from limited input waste volumes entering the chain, sees prices trading in wider ranges through the chain.

An exception to the weak demand seen across most end-uses for rPP was the automotive sector, where players are still trying to catch up with reduced volumes during the semiconductor crisis, and hence demand from automotive only started to rebound in H2 2023.

KEY DRIVERS FOR RECYCLING

ROLE OF LEGISLATION

Regulations and directives impacting the plastics sector continue to build in Europe as it transitions to a circular economy. The key regulations affecting HPDE and PP are the Packaging and Packaging Waste Regulation (PPWR), and the proposed ELV Regulation (ELVR), which are influencing the market. Alongside these are the new Food Contact Materials regulations and the Single-Use Plastic Directive.

PACKAGING AND PACKAGING WASTE REGULATION (PPWR)

The European Commission proposed a new legislation package to supersede the existing Packaging and Packaging Waste Directive in November 2022. The legislative process is complete and the PPWR was officially published in the Official Journal of the European Union in January 2025 and came into force in February 2025.

The Regulation is legally binding for all Member States. Key to this legislation is the push towards circularity for packaging in Europe. The growth in usage of plastics in packaging, as well as single-use packaging, contribute to the growth in plastic packaging waste. The regulation aims to increase packaging circularity by addressing recyclability, including design for recycling, collection targets, improving the quality and grades of recyclates, mandating the use of recycled content, as well as driving the adoption of reuse and refill models. Figure 24 below presents some of the targets included in the regulation.

Recyclability	Recycled content targets	Reuse
• All packaging placed on the market shall be recyclable by 2030. • Packaging recyclability performance grades are to be established by packaging category and classified as grades A, B or C. • After 1 January 2030, any packaging that falls below grade C will be restricted from sale in the market. • After 1 January 2038, packaging classified below grade B will be banned from sale in the market. • By 2035, all packaging shall be recycled at scale.	• By 2030, 30% for contact sensitive packaging, excluding single-use bottles made primarily from PET. By 2040, 50%. • By 2030, 10% for non-PET contact sensitive packaging, except single-use plastic beverage bottles. By 2040, 25%. • By 2030, and 35% for all other packaging. • By 2040, 65% for single-use beverage bottles and all other plastic packaging.	• By 2030, 40% transport packaging used within the EU – including e-commerce – will need to be reusable and 'within a system of reuse'. Then 70% by 2040. • By 2030, 10% of grouped packaging boxes for stock keeping or distribution will need to be re-usable. Then 25% by 2040. • By 2030, 10% of sales packaging of distributors of alcoholic and non-alcoholic beverage required to be reuseable. Then 40% by 2040.

Figure 24: Overview of some of the targets proposed in the PPWR
Source: ICIS Research & Analysis

The definition of recyclability states that materials should be identified for collection, processing, recovery or reuse as part of a local government, business or another recycling collection program. Currently, for polyolefins, there are challenges to achieve this where systems or economics do not favour the extraction of individual polyolefin streams. Hence the need for improved design for recycling, collection and sorting infrastructure to produce higher quality recyclates for applications such as packaging and away from reuse in lower value applications.

The impact of this regulation has been felt in the market since it was announced in 2022, as the market prepared for the 2030 targets to come into force. Prices for packaging grades of recycled polyolefins, such as blow-moulding grades, have already seen increases. This reflects the rise in demand for recycled grades that will support packaging producers to get a head start on securing supply to meet the required targets. This new regulation shall boost demand, but the question remains whether the expansion in supply will match those growth rates in the same time frame. At the same time, as noted in the previous section, the initial surge in demand has slowed in recent months due to challenging macroeconomic conditions, high operational costs for recyclers, and pricing disparities between recycled plastics, virgin plastics, and imported materials. As a result, the long-term impact of the legislation remains uncertain.

FOOD CONTACT REGULATION 2022/1616

In October 2022, the European Commission introduced new regulations, replacing Regulation (EC) 282/2008. The Food Contact Materials (FCM 2022/1616) sets out the routes to obtain approval for food contact materials:

- suitable technology addressing previously evaluated processes where sufficient data is available, and
- novel technology for processes that have not yet been assessed.

The Regulation (EU) No 2022/1616 includes:

- New registration system for all recycling organisations, facilities and lines producing recycled materials for food-contact applications,
- Effective July 2023, only plastics containing recycled plastic manufactured with a suitable recycling technology may be placed on the market, unless manufactured with a novel technology,
- New governance on novel technologies, applicable to all technologies that are not yet suitable (e.g. mechanical PET recycling and closed-loop recycling),
- Effective October 2024, certification of quality assurance systems for collection, sorting centres and pre-processing operators,
- Exemption for recycling technologies producing a starting substance provided that it is included in the Union list of Regulation (EU) No 10/2011 and of a high degree of purity.
- Domestic competent authorities in exporting countries need to act on behalf of local applicants for the award of technology and production certificates.

Regulation (EU) 2022/1616 sets high-quality expectations for the safety of recycled plastics in food contact applications. The requirements, including those related to sources of waste and applicable collection systems, challenge the capability of polyolefins to comply with these regulations and have hindered progress in polyolefin circularity through mechanical recycling. As a result, the value chain increasingly looks to the development of solutions to produce the recycled feedstocks required for food contact applications, from chemical and mechanical processes.

SINGLE USE PLASTIC DIRECTIVE (SUPD)

In force since 2019, the SUPD was due to be transposed into local law by all EU member states by July 2021. Many member states have not met this deadline, and legal action by the European Commission was announced in 2022. To date, eight states have yet to have completed full transposal. Other member states have announced national reduction targets independent of the SUPD. The EU Commission has indicated that action will be taken on this situation, so it is anticipated that this will be resolved in time.

The targets around collection and recycled content impact mainly the HDPE market, as this is the main polyolefin used in beverage bottles outside PET. The collection target of 90% by 2029 may be achievable given the existing infrastructure around beverage bottle collection. However, the 30% recycled content target for 2030 presents challenges due to the FCM requirements and consequently may result in substitution away from HDPE where the food grade recyclate is unavailable.

A key item in the SUPD for the polyolefins industry was the ban on items that use HDPE and PP resins, namely, plastic cutlery, plates, straws, cotton buds and plastic balloon sticks. Although the overall volume of polyolefins used in these applications does not represent the bulk of total volumes in the market, it does have an impact on players serving these sectors.

In order to take into account also recycled plastic in beverage bottles that has not been obtained by mechanical recycling of PET waste, the Commission plans to draft an amendment of this Decision to include a methodology to calculate, verify and report recycled plastic content in beverage bottles that is based on the application of certain chain of custody models as defined in ISO 22095-2020. A mass balance approach may be included as an admissible chain of custody model to also account for plastic in non-PET bottles resulting from feedstock recycling. While a smaller end market for polyolefins, it will provide the capability for recycled polyolefins to be in adopted this sector.

A decision from the EU's Technical Advisory Committee (TAC) on mass-balance accounting rules under the SUPD has met some delays as further discussions with regulators took place. This is now due in 2025.

ELV REGULATION

In July 2023, the European Commission proposed an ELVR, replacing the ELVs Directive and the 3R Type-Approval Directive[20].

The proposal sets out circularity requirements for the design and production of vehicles, focusing on reusability, recyclability, recoverability and the use of recycled content. Specifically, it sets a minimum requirement of 25% recycled content for plastics in new vehicles, of which 25% must be recycled plastics from ELVs. The inclusion of a mandatory benchmark for recycled content is expected to stimulate investment in the technologies and infrastructure needed to efficiently recycle plastics from ELVs. The proposal also sets out information and labelling requirements for parts, components and materials in vehicles. In addition, the proposal includes targets for re-use, recycling and recovery, as well as an annual recycling rate of 30% for plastics in ELVs.

The demand based on the new targets is estimated to grow significantly. However, the challenge remains ensuring materials from ELVs are accessible through robust collection and sorting systems across the region. The trade of vehicles to secondary markets, typically outside the EU, means that the primary source of ELV is inaccessible. To this end, the proposal includes a ban on the export of used vehicles, which, although not formally in a waste stage, are at the end of their service life.

The wide range of polymer fractions in a car is typically painted or black, and NIR sorting technologies are unable to detect and separate them before the shredding process. Hence, solutions to separate before shredding will be key. OEM's contribution to the dismantling of vehicles or innovative solutions to enable this will be needed. Suggestions to reduce the number of polymers used in cars (around 150-200 polymer fractions) have also been put forward.

Overall, the impact of this legislation would be felt greatest by the rPP market. The dominant polymer utilised in cars would see buyers seek recycled grades of PP to meet any mandates for recycled content.

LEGISLATION IN OTHER EUROPEAN COUNTRIES

United Kingdom

The UK has taken an alternative approach with the introduction of the UK Plastic Packaging Tax, which came into force on 1 April 2022. In 2024, the rate was £217.83/tonne, applied to plastic components of packaging with less than 30% recycled plastic. The tax applies to domestically manufactured and imported goods. Following the EU Withdrawal Bill in 2020, the UK continues to follow REACH and EU/EFSA regulations until UK equivalent regulations are developed.

Further to consultation, in November 2024, the UK government announced it would support the use of mass balance for chemical recycling under the UK plastic packaging tax using a fuel-exempt accounting approach at the site level. The government also announced that it will phase out the use of pre-consumer materials as contributing towards recycled content thresholds in tax calculations.

Norway

As set by the Norwegian Ministry of Climate and Environment, Norway has set targets: municipalities must separate a minimum of 50% recyclable plastic waste by 2028, increasing to 60% and 70% by 2030 and 2035, respectively.

Norway follows the EU/EFSA regulations on food-contact materials, and the 2022/1616 is currently undergoing implementation.

Switzerland

The Swiss parliament has been reviewing the proposal for 'Strengthening Switzerland's Circular Economy' (20.433). Negotiations on the alignment of regulations with the EU are expected to be completed in 2025.

EXTENDED PRODUCER RESPONSIBILITY

Under EU law, Member States are obliged to establish EPR schemes including:

- Packaging (by the end of December 2024)
- Single-use plastic products (listed in the Annex of the Single Use Plastic Directive - PART E)
- WEEE (Waste Electrical and Electronic Equipment Directive and the RoHS Directive)
- Textiles
- ELVs

Packaging

Most European countries have existing EPR legislation focused on packaging, and all EU member states are obliged to introduce EPR for packaging by the beginning of 2025.

As EPR schemes are designed on a national level, they create disparities in fees and structure. The EPR scheme members can decide to adopt eco-modulated fees to incentivize specific behaviours, such as increased recycled content or improved recyclability through design guidelines. In Europe, 10 out of 27 countries have adopted eco-modulated fees. The United Kingdom has introduced eco-modulated

20. The proposed Regulation is currently being examined by the European Parliament and the Council under the ordinary legislative procedure.

fees starting from 2026/2027. The focus of the eco modulation fee structure can be slanted towards PET-related packaging, which can be addressed by further expansion of the schemes to other packaging types. Eco-modulation can encourage improved recyclability in products subject to the EPR, which ultimately should lead to improved recycling rates. The impact of eco-modulation on recycling rates in the rHDPE and rPP markets is yet to be realised.

Waste from Electrical and Electronic Equipment Directive (WEEE)

The regulations that stipulate producer and government responsibilities have been effective in establishing waste utilization streams for EEE. However, recycling of the plastic fraction is not the main focus of the extended producer responsibility mandates. More regulation driving demand for recyclate for circular use of plastics in EEE is needed, such as a minimum recycled content achieved with material from the WEEE stream.

Textiles

The targeted amendment of the Waste Framework Directive (WFD)[21] sets up EPR applicable for household textile products, articles of apparel, clothing accessories and footwear. It also requires Member States to ensure that producers of such products cover certain costs, such as the costs associated with the collection of used and waste textiles, the cost of carrying out surveys on the composition of mixed municipal waste or the cost of providing information on sustainable consumption, waste prevention and reuse. Moreover, Member States would be required to establish a register of producers of textile, textile-related and footwear products to monitor their compliance with the requirements of the EPR. Finally, those producers should designate PROs to fulfil their extended producer responsibility obligations. Those PROs would be required to establish a separate collection system for used and waste textiles in the territory of a Member State where they make the product available on the market for the first time.

Automotive

EPR for ELVs is currently limited to waste utilization. Producers have reporting and take-back obligations, which aim to increase the safety scrappage of ELVs. However, the ELVR proposed by the European Commission sets EPR requirements to increase the collection of ELVs and to compensate for the costs of improved treatment quality that cannot be offset by the value of materials and components recovered.

The UK has its own set of producer responsibility regulations, but currently the range of EPR obligations for producers in the UK does not promote polymer circularity in vehicles. Instead, ELV waste management is currently driven by the need to utilize potentially hazardous waste and the limitation of environmental impacts. Until bigger emphasis is put on automotive polymer circularity, producers in the UK are neither obliged nor incentivized to improve rates of recycled content use.

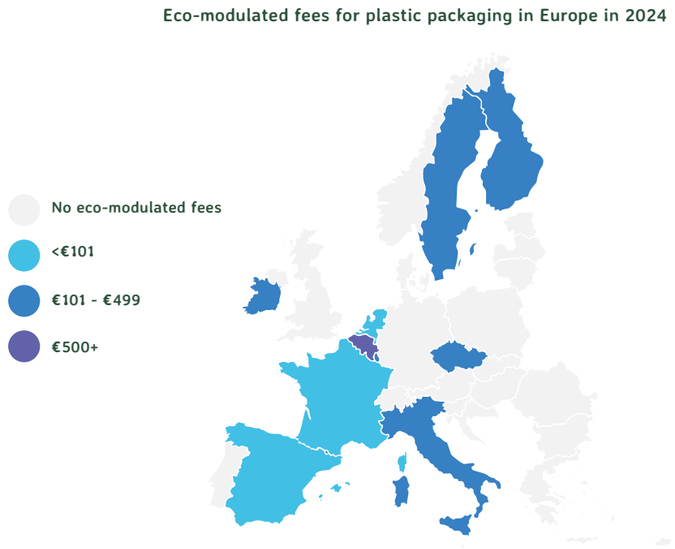


Figure 25: Eco-modulation fees for plastic packaging implemented in the EU in 2024
Source: ICIS Research & Analysis

21. Following the publication of the Commission's proposal in March 2023, both the European Parliament and the Council have adopted their negotiating positions. Interinstitutional negotiations started in late 2024 and a provisional agreement was reached in March 2025. The co-legislators are expected to confirm the agreement before the text is formally adopted.

Others

Construction, agriculture and pharmaceutical use are likely to see increased producer scrutiny as the sustainability of each of the sectors is scrutinized in the coming years. Some small producer-driven schemes for material collection are ongoing (e.g. empty blister medication packaging collection in pharmacies, specific fractions of building demolitions such as windows and flooring, or agricultural film collections). Such schemes are vital learning opportunities for producers and recyclers, but without comprehensive EPR schemes, they are constrained to those few players willing to invest.

EPR regulation can be a tool for improving sustainability, recyclability and recycling rates of different types of polymer end uses across Europe. Its increased adoption is anticipated to evolve in the near term, driving circularity forward.

REGULATORY DEVELOPMENTS IN SUSTAINABILITY TRANSPARENCY

The EU is developing a legislative framework to better protect consumers' rights, encourage environmentally friendly choices, and foster a circular economy that prioritizes reusing and recycling materials.

To effectively address greenwashing, the European Commission proposed the Green Claims Directive in March 2023, aiming to combat misleading environmental claims. The proposal defines minimum requirements for substantiating and communicating explicit environmental claims, ensuring that verification and certification are conducted by officially accredited verifiers authorised to carry out ex-ante verification of claims. Additionally, the proposal includes measures to regulate environmental labelling schemes, aiming to prevent their excessive proliferation.

Both the European Parliament[22] and the Council[23] have adopted their negotiating positions on the file. Interinstitutional negotiations between EU co-legislators kicked off in Q1 2025, with the aim of reaching a provisional agreement on the text.

The proposal targets explicit claims that:

- are made on a voluntary basis by businesses towards consumers;
- cover the environmental impacts, aspects or performance of a product or the trader itself;
- are not currently covered by other EU rules.

It also seeks to prohibit:

- generic environmental claims on products without proof;
- claims that a product has a neutral, reduced or positive impact on the environment because the producer is offsetting emissions
- sustainability labels that are not based on approved certification schemes or established by public authorities.

Additionally, the Directive to Empower Consumers for the Green Transition introduces a new product label highlighting extended guarantee periods. This initiative aims to raise consumer awareness about guarantees, enabling them to request repairs for faulty products at the seller's expense.

The new rules to empower consumers for the green transition provide a ban on:

- advertising goods that have design features that could reduce a product's lifespan
- making unproven durability claims in terms of usage time or intensity under normal conditions
- presenting goods as repairable when they are not

Sustainability, transparency and green credentials of products will also benefit from the two following directives:

- Corporate Sustainability Due Diligence (CSDD), and
- Corporate Sustainability Reporting Directive (CSRD).

In force since July 2024, the CSDD aims to bring sustainable and responsible corporate conduct within companies and their global value chains, focusing on human rights and environmental impacts. CSRD, in force since January 2023, requires large and listed companies to publish reports on the social and environmental risks they face, as well as how their actions impact people and the environment. With this information, investors and other stakeholders will be able to assess this impact as well as financial risks and opportunities from climate change and sustainability issues.

22. European Union - European Parliament legislative resolution of 12 March 2024
23. European Union - Council's General Approach of 17 June 2024

VALUE CHAIN COLLABORATION

There has been increasing activity within the polyolefin value chain to improve the availability of recycled products to the market. The challenging market conditions, namely macroeconomics and weak demand, have affected developments during 2023, with some projects rescheduled.

- With over 130 partners, the Digital Watermarks Initiative HolyGrail 2.0 is a program with the objective of proving the technical and economic viability of digital watermarks for accurate sorting of packaging waste at scale. The aim is that the digital watermark on the waste can be detected once in the sorting facility and decoded by a high-resolution camera on the sorting line, which is then able to sort the packaging in corresponding streams based on more specific attributes, such as food and non-food. This would result in higher accuracy in sorting streams and, therefore, higher quality recyclates, which is a particular challenge that has existed for polyolefin packaging recycling. This project is now moving into version 3.0.
- A converter and brand worked together to enable the recycling of coloured plastics by separating the colour streams with a unique sorting step, resulting in 50% recycled content for the coloured bottle packaging and expanding the recycled materials supply by utilising coloured material within a closed loop.
- A major labelling technology company run full-scale tests to refine recyclability guidelines for blow-moulded bottles for domestic and personal care use. The results include a revision of recommendations for label adhesive performance in cold versus hot washing recycling installations.
- Range of automotive projects from key producers in this space, including:

  - glass-fibre reinforced PP with 65% PCR

  - PP compound including 20% rPP from post-industrial waste to produce feedstock for car parts, including bumpers, trims, and body side mouldings

CONSUMER PRESSURE AND COMMITMENTS BY THE INDUSTRY

Many producers have responded, through voluntary targets and initiatives, to the rise in consumer pressure around the impact of plastic pollution on the environment and the expected action to address this.

Typically, the targets have focused on reduced plastic packaging, higher levels of recyclability and adoption, or increased use of recycled content or other sustainably sourced materials. A target of 100% recyclability by 2030 has been announced by many companies. Announced recycled content levels average 29%, to be achieved by 2025 by the signatories to the EMF Global Commitment.

Reflecting the lack of maturity of the recycling supply chain for polyolefins, the approach to commitments by most major producers has been considered more balanced. Some smaller brands have 100% blow-moulded HDPE bottles for the domestic market, making headway on delivering on commitments. Compared to other applications and end users, which are progressing much slower. The wide range of applications for HDPE and PP creates a challenge in finding recyclates that can meet the requirements for all applications. This has hindered the rate of progress and contributed to recent adjustments to target deadlines by some producers.

TECHNOLOGICAL ENABLERS

Technology developments should not only increase the overall quality and quantity of recycled polyolefin materials but also enable closed-loop recycling of HDPE and PP at a larger commercial scale. Additional potential benefits may also include a decrease in processing costs,due to increased process automation.

The key impacts of technological innovations are within sorting, including unlocking the potential for food-contact applications, as well as decontamination and stabilisation.

SORTING

Improving sorting for HDPE and PP rigids can be partly achieved by modernising existing facilities and investing in equipment upgrades, particularly NIR and optical sorting to enhance sortation by polymer type and colour and therefore improve recyclate quality. The effectiveness of these technologies is, however, dependent on further collaboration across the value chain to ensure that products put on the market are designed considering sorting technology capabilities/limitations.

Producing material suitable for food contact use is likely to require embracing additional emerging technologies for advanced detection, such as AI-assisted object recognition and the use of markers.

- AI-based object recognition: This technology uses image recognition based on AI technologies. The AI can be tailored to meet specific needs, due to its ability to detect various polymers when combined with specific sensors, or to sort materials into specific categories when paired with high-speed robots. Depending on the scope of the sorting, the AI analysis can focus on various aspects, such as the overall material composition, the ratio of food-grade to non-food-grade materials, or the reject rate to evaluate the proportion of recoverable items. The data generated allows for precise monitoring of the input material's composition. This technology has the potential to automatically detect brand types and stock-keeping units of plastic waste. The technology is being developed by both large machinery producers and some start-up companies.
- Markers (digital or chemical): Chemical markers are based on adding a chemical "barcode" to packaging, which can be detected by NIR or UV. The information chemical markers can provide is limited to polymer type and origin and cannot go to a more granular level.

Digital markers, which use a digital code, can provide more traceability relative to chemical markers. They can potentially even contain information about a particular producer and be scanned by a consumer with their smartphone. Detection of digital watermarks requires the installation of high-resolution cameras. A relevant example in this field is the HolyGrail 2.0 project, which focuses on digital watermarking technologies for accurate sorting and their business case when implemented at a large scale. In this initiative, both the technical and economic viability of these technologies are being investigated via the validation of prototypes and the review of existing and new business models.

All in all, both digital and chemical markers' approaches can potentially provide high effectiveness in terms of identifying material, but the progress of both is also subject to further improvements in the technologies to extract those materials from the waste stream earlier in the process.

Object recognition, according to some studies, appears to be an advantageous option in terms of costs over markers and can potentially be implemented on an individual plant level, which can facilitate its overall adoption. However, fragmentation of AI networks (each provider teaching machines based on their own databases) could cause delays in this technology's progress.

As for markers, it requires wider collaboration of the value chain in its adoption. Progress to date shows it to be a more reliable solution to ensure traceability of the origin of the material, which is necessary for producing recyclates for food-contact applications. AI object recognition can potentially match this level of efficiency if products are designed with further AI recognition technology used in mind, but this requires value-chain collaboration and maybe even new system-level regulation.

One of the more progressed projects in this area is aimed at producing rPP for food contact applications. The project initially planned to use fluorescent marker technology for the sorting and separation stage. Recently, the transition from markers to AI was suggested as potentially a more promising technology.

In addition to advanced detection, further secondary sorting into more granular fractions is required to produce high-quality recycled polymers.

DECONTAMINATION AND STABILIZATION

While sorting is essentially the first decontamination step, further impact can be achieved by applying not only cold but also hot washing.

Hot washing is aimed at removing labels, adhesives, organics and other contaminants. Fine filtration during the extrusion process and degassing also provides additional improvements, for example, in the area of deodorisation. All those measures help to improve the quality of the final recyclate.

One of the promising technologies is solvent-based purification (also called dissolution) as it allows to get to the stage of pure polymer removing the contaminants and additives. A few projects are currently being commercialised, having received investment from major petrochemicals and FMCGs.

While decontamination allows for an increase in the quality of output, materials are still subject to degradation with each cycle of mechanical recycling. That highlights the growing role of developing stabilisers which can enhance specific mechanical properties of polymers and prolong the life of the recycled polymers in terms of their number of cycles. Importantly, the use of additives should also be aligned with the recyclability guidelines to make sure it does not hinder technical capabilities to recycle the material further at scale.

FUTURE STATE OF THE MARKET

The following analysis assumes targets for recyclate usage across different sectors and timeframes, in line with industry commitments and regulations in place and proposed. These projections highlight the evolving landscape of polyolefin recycling and the challenges that lie ahead in meeting increasingly rigorous sustainability goals.

Moving to 2030, the PPWR targets take effect, and voluntary targets will fall in line with the mandates:

- 10% recyclate in contact-sensitive packaging,
- 35% recyclate in other packaging types, and

By 2040, the targets are expected to increase further, with:

- 25% recyclate in contact-sensitive packaging, and
- 65% recyclate in other packaging.

These targets reflect anticipated industry goals and regulatory expectations for increasing the use of recycled materials over time.

Looking ahead to 2030, an additional 1 million tonnes of HDPE recycling capacity will be required, indicating a growing demand that current infrastructure may be challenged to meet, as shown in Figure 26. By 2040, as PPWR's second phase of targets comes into effect, approximately 2.9 million tonnes of incremental R-HDPE capacity will be needed. However, it is crucial to emphasize that the quality of feedstock input to recycling facilities will ultimately determine the availability of recyclate suitable for packaging applications. This underscores the importance of not just quantity, but quality across the recycling chain. This significant increase highlights the long-term challenges facing the industry and the need for substantial investment in recycling and waste management infrastructure.

The situation for PP follows a similar, if not more demanding, trajectory. Figure 27 shows that almost 1 million tonnes of additional PP recycling capacity will be necessary by 2030, a similar increase compared to HDPE, reflecting the growing importance of PP in various applications. In 2040, to accommodate the higher level PPWR targets, an estimated 2.8 million tonnes of incremental rPP capacity will be required. This massive increase points to the critical role PP is expected to play in future packaging applications, and the corresponding pressure on recycling and waste management systems to keep pace.

This analysis underscores the importance of not only increasing recycling capacity but also improving the quality of recycled materials to meet the growing demand in high-specification applications across various industries. It highlights the need for a multi-faceted approach involving technological innovation, infrastructure investment, and potentially, regulatory frameworks to ensure that the supply of high-quality recycled materials can keep pace with ambitious sustainability targets. The projections also suggest that the plastic recycling industry is on the cusp of significant growth and transformation, with implications for manufacturers, recyclers, policymakers, and consumers alike.

However, given that HDPE and PP capacities stagnated in 2023, achieving these projections may be unrealistic. The plastics recycling sector continued to face significant challenges in 2024, including unfavorable macroeconomic conditions, high operating costs, price disparities with virgin materials, and an uneven playing field due to polymer imports. These factors collectively threaten the potential for growth and investment in the industry.

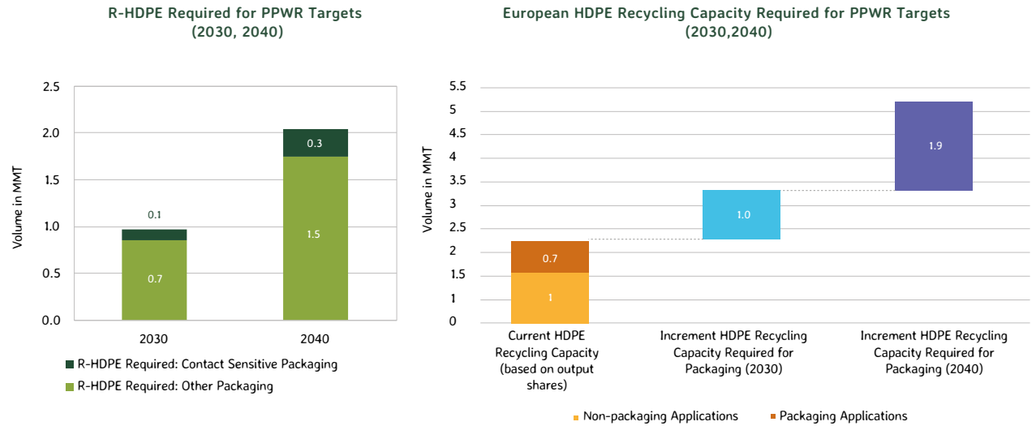


Figure 26: HDPE recycling capacity requirements for PPWR targets in 2030 and 2040
Source: ICIS Research & Analysis

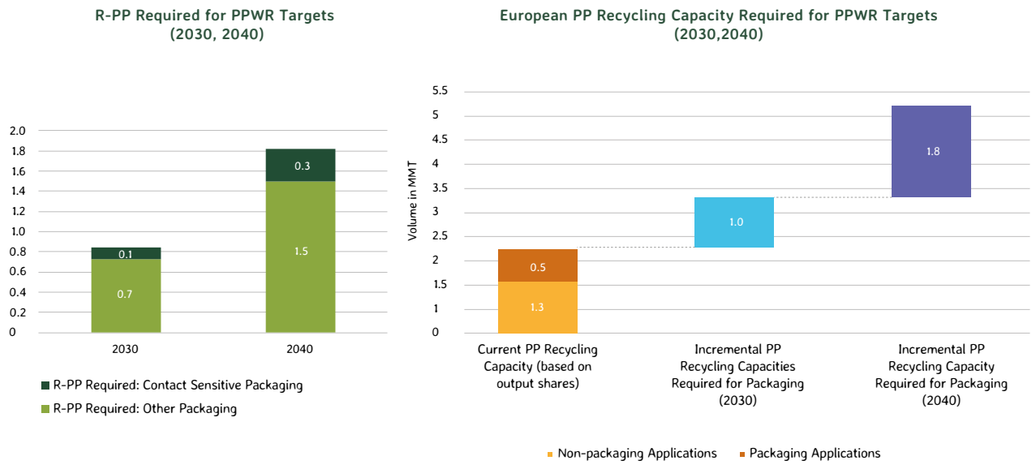


Figure 27: PP recycling capacity requirements for PPWR targets in 2030 and 2040
Source: ICIS Research & Analysis

CONCLUSION

Achieving circularity in the HDPE and PP value chain requires action on multiple fronts:

COLLECTION IS CRUCIAL TO UNLOCK RECYCLATE PRODUCTION

Collection remains the biggest bottleneck in the rHDPE and rPP rigids value chain due to factors such as leakage into residual waste streams, contamination, inefficient sorting, and design limitations that hinder recyclability. Sufficient collection of plastic waste in separate recycling streams is essential to increase recyclate production. While separate collection schemes are in place across most EU27+3 countries, the reach of these systems remains limited, as evidenced by low collection volumes and inconsistent participation across countries and municipalities. Overcoming these collection challenges is crucial to enhancing the flow of high-quality recyclate and advancing the circular economy for rHDPE and rPP. Although DRS for PET is expected to increase the collection of HDPE and PP rigids, additional volumes are expected to be limited given the small share of caps/lids in overall HDPE and PP applications.

DESIGN FOR RECYCLING

Wider adoption of Design for Recycling guidelines is crucial to improving the recyclability of rHDPE and rPP rigids. These guidelines aim to optimise product design, aiding sorting and therefore contributing to increased recyclate quality and volume. By incorporating design-for-recycling principles, manufacturers can improve not only recyclability but also recyclate quality. Recyclability certifications are key in advancing this effort, ensuring products are designed for recycling across the value chain.

DATA TRANSPARENCY

The disparity in reporting formats, together with gaps in data availability, continues to present challenges in achieving greater data transparency across the rHDPE and rPP rigids value chain. The lack of consistent, reliable data complicates long-term planning and development, particularly when it comes to optimising collection, sorting infrastructure, and recycling technologies. Standardising data reporting and improving data accessibility across the entire value chain are crucial for better decision-making and scaling up recycling capacities. EPR schemes can also support the development of more detailed data sets as they embed into the market. Greater data transparency will also support collaboration across stakeholders, ensuring the alignment of efforts towards improving recyclate quality and achieving circularity in the rHDPE and rPP rigids markets.

LEVERAGING TECHNOLOGY FOR BETTER SORTING

HDPE and PP rigids are used in a much greater variety of applications, including shapes and formats, which means that there is a plethora of products and packaging entering the waste streams. This can make sorting more challenging, particularly in the case of PP, which presents higher variation in terms of shapes and forms and is more commonly present in the PTT stream. While NIR technology combined with AI-based object recognition can improve the efficiency and accuracy of sorting, to address these challenges, novel technologies such as the use of digital and chemical markers hold promise for enhancing sorting capabilities and could significantly improve both the quality and quantity of recyclate recovered.

ENABLING FOOD-GRADE RECYCLATE

Closed-loop recycling for food-grade applications remains a critical next step for the HDPE and PP rigids value chain. The limited collection of HDPE and PP through DRS presents a major challenge in securing consistent, traceable food-grade material that meets EFSA standards for contact-sensitive applications. To overcome this, advancements in design for recycling, collection systems, and sorting technologies are essential. Only through these combined efforts can the industry increase the availability of food-grade recyclate suitable for closed-loop recycling in food packaging.

LEVEL-PLAYING FIELD

The European plastics recycling industry is facing significant challenges that cast serious doubt on the feasibility of meeting the PPWR targets for 2030 and 2040. The growth of installed recycling capacities has already slowed to its lowest rate in recent years, and if current market conditions persist, further stagnation—or even decline—is likely. A combination of plummeting demand, soaring energy and operational costs, and a surge in cheaper imports of polymers from outside the EU is putting domestic recyclers at a severe disadvantage.

NOTES

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