eunomia

PET MARKET IN EUROPE

STATE OF PLAY 2022

PRODUCTION, COLLECTION AND RECYCLING

Natural Mineral Waters Europe
Natural Mineral & Spring Waters

Pioneering PET circularity since 1993
petcore EUROPE

PLASTICS RECYCLERS EUROPE

Unesda
Soft Drinks Europe

GLOSSARY OF TERMS

BOPET	Bi-axially Orientated PET
CITEO	French PRO
CONVERSIO	Conversio Market & Strategy GmbH
CONAI	Consorzio Nazionale Imballaggi (Italian PRO)
CPME	Committee of PET Manufacturers in Europe
DMT	Dimethyl terephthalate
DRS	Deposit Return Scheme
EPBP	European PET Bottle Platform
EFSA	European Food Safety Authority
EPR	Extended Producer Responsibility
EPRO	European Association of Plastics Recycling
EPS	Expanded polystyrene
EU27	European Union as of 2021
EU27+3	European Union + UK, Norway, and Switzerland
EUCERTPLAST	European Certification of Plastics Recycling
EUPC	EU-level trade association for European plastics converters
EUROSTAT	European Statistical Office
GPET	PET with added glycol, used for 3D printing applications
ICIS	Independent Chemical Information Service
MEG	Mono-ethylene glycol
MONO-MATERIAL	Product comprised of a single material
MULTI-LAYER	Product (typically tray or flexible packaging) made with multiple layers of (one or more) material
MULTI-MATERIAL	Product (typically tray or flexible packaging) made from more than one material
NMWE	Natural Mineral Waters Europe
PAYT	'Pay-as-you-throw': charging residents by weight or volume for disposing of residual waste

PEF	Polyethylene furanoate
PELLET	Sized at about 0.2 x 0.2 x 0.2cm, pellets are a standard material used in manufacturing and conversion
PET	Polyethylene terephthalate
PET FLAKE	'Flake' is often used within the PET industry, typically referring to a particle size below 2.5cm.
PETCORE EUROPE	PET Container Recycling Europe
POM	Placed on the market
PP	Polypropylene
PPWD	Packaging and Packaging Waste Directive
PRE	Plastics Recyclers Europe
PRO	Producer Responsibility Organisation
PRIMARY FORMS	Raw material input to product manufacturing processes i.e., pellets and agglomerates
PS	Polystyrene
PTA	Terephthalic acid
PTT	Pots, tubs, and trays
PVC	Polyvinyl chloride
RECOVINYL	An initiative of the European PVC industry to facilitate PVC waste collection and recycling
rPET	Recycled polyethylene terephthalate
RPM	Recycled plastic materials
RECYCLING	The process of taking plastic scrap into rPET
SUP	Single Use Plastic
TRAYS	Generally used in this report to describe packaging made predominately of thermoformed PET sheet and will include PTT packages other than trays

TABLE OF CONTENTS

ABOUT NATURAL MINERAL WATERS EUROPE

Natural Mineral Waters Europe represents almost 550 natural mineral and spring water producers in Europe, most of them small-and medium sized companies, operating in rural areas.

NMWE is dedicated to promoting the unique qualities of natural mineral and spring waters as well as sustainable use of water resources and circular economy. The association builds on the long heritage and tradition with environment and source protection at heart. By continuously encouraging its members to reach even more ambitious goals, NMWE plays a leading role in paving the way towards healthy, circular and sustainable European food systems, while supporting a green recovery.

ABOUT PETCORE EUROPE

PETCORE Europe (formerly PETCORE - PET COntainer REcycling) is the association based in Brussels since 1993 representing the complete PET value chain in Europe, from PET manufacture to conversion into packaging, as well as recycling and other related activities.

PETCORE Europe is at the forefront of working with all stakeholders to ensure the sustainable growth of PET as a packaging material of choice, while promoting increases in post-consumer PET collection and recycling. They produced the first guidelines for PET bottle recycling and have conducted annual surveys on PET recycling since 1997. They liaise with the European institutions about the importance of the PET value chain, especially as PET significantly contributes to the Circular Economy. Furthermore, they respond to any concern or issue raised by stakeholders. The membership of the association is formed by four leading industry sector European associations, i.e., CPME, EuPC, Forum PET Europe (the converters) and PRE (the recyclers). There are also a large number of individual companies involved in the PET value chain.

ABOUT PLASTICS RECYCLERS EUROPE

Plastics Recyclers Europe (PRE) is an organization representing the voice of the European plastics recyclers who reprocess plastic waste into high-quality material destined for the 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 €3 billion in turnover, 8.5 million tonnes of installed recycling capacity, 600 companies and over 20.000 employees.

PRE is a key stakeholder in the process of formulating, monitoring, and evaluating the EU policies that impact plastics recyclers. It promotes the use of quality plastic recyclates and offers concrete advice on how to develop innovative products and packaging with design for recycling. Via its decennial presence in Brussels and an extensive membership, PRE acquired considerable expertise on policy measures to improve the circularity of plastics.

ABOUT UNESDA Soft Drinks Europe

Established in 1958, UNESDA Soft Drinks Europe is the Brussels-based trade association representing the non-alcoholic beverages sector. Its membership includes 10 companies and 23 national associations from across Europe. UNESDA members are involved in the production and/or distribution of a wide variety of non-alcoholic beverages including still drinks, carbonates, fruit drinks, energy drinks, iced teas and sport drinks.

UNESDA's policy priorities are Sustainability (e.g., beverage packaging, collection, recycling), Responsibility (e.g., sugar reduction, school policies, marketing practices towards children and labelling) and Competitiveness (e.g., taxation, market access).

INTRODUCTION

This report, delivered by PRE in partnership with PETCORE Europe, NMWE and UNESDA Soft Drinks Europe, provides the latest data and trends on:

- The current state of the PET market in Europe;
- Key changes impacting the market and the resultant challenges faced by the supply chain; and
- What the future PET market will look like.

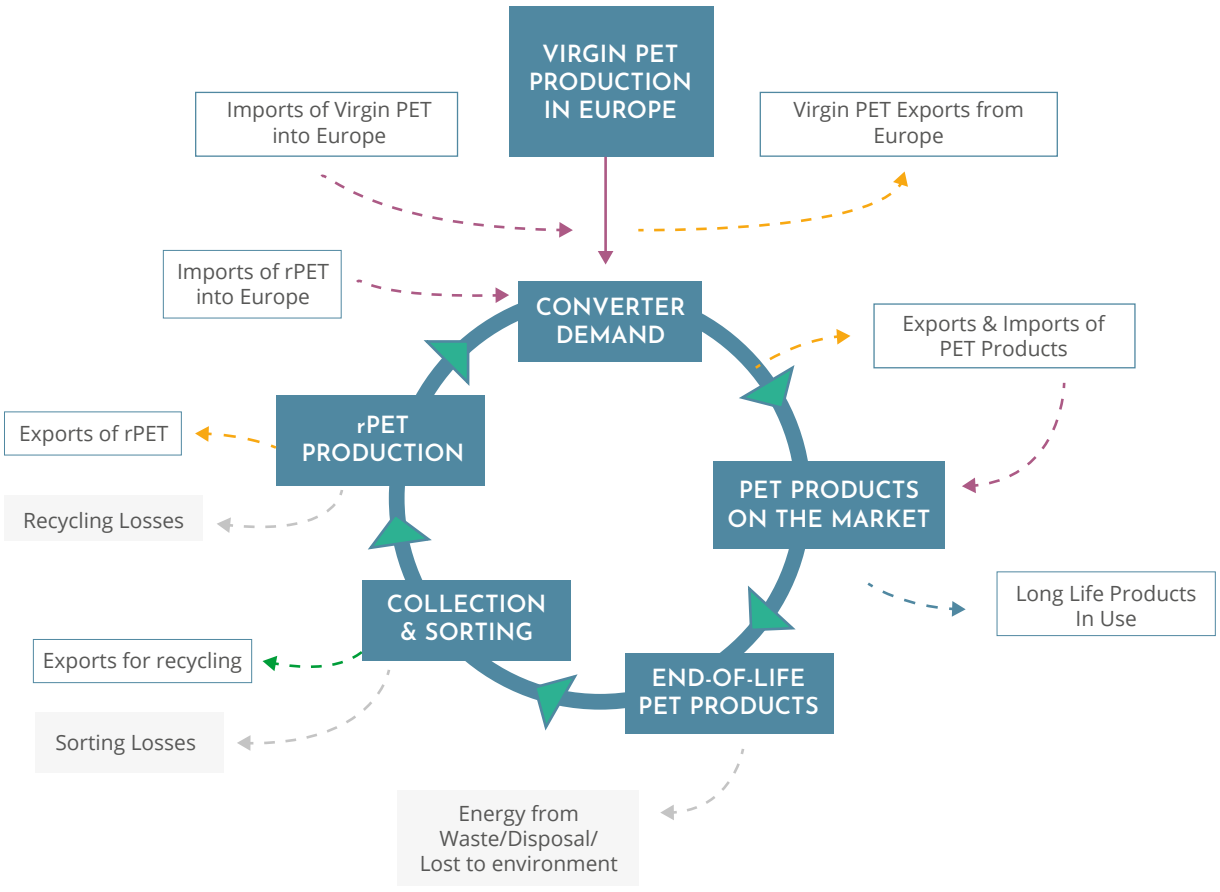
This is the second iteration of this market report, the first was published in 2020. The partners intend to continue to update and re-publish this 'State of the Market' report bi-annually to provide a narrative and assessment of the progress of the PET market in Europe.

The report uses best available data sources to present data estimates. The sources used include production data provided by the Committee of PET Manufacturers in Europe (CPME), PETCORE Europe, a survey of European Producer Responsibility Organisations (PROs), and the results of the Annual PET Recyclers Survey (PRE, 2020). Whilst the aim of this report is to provide data on the EU27+3, in some instances we have deviated from this due to data availability. Where this has happened, we have clearly noted changes in scope and have incorporated this into analysis wherever possible. While the reference year for data used in this report is 2020, updated positions on legislation or other new developments (e.g., DRS implementations) over the past year are also discussed within this report.

2. CURRENT STATE OF THE MARKET

Figure 1 illustrates the PET supply chain in the context of a circular economy.
The key elements are included within our analysis of the PET market, which can be found in this section[1].

Figure 1: PET Lifecycle in the Circular Economy, Source: Eunomia



PRODUCTION AND CONSUMPTION

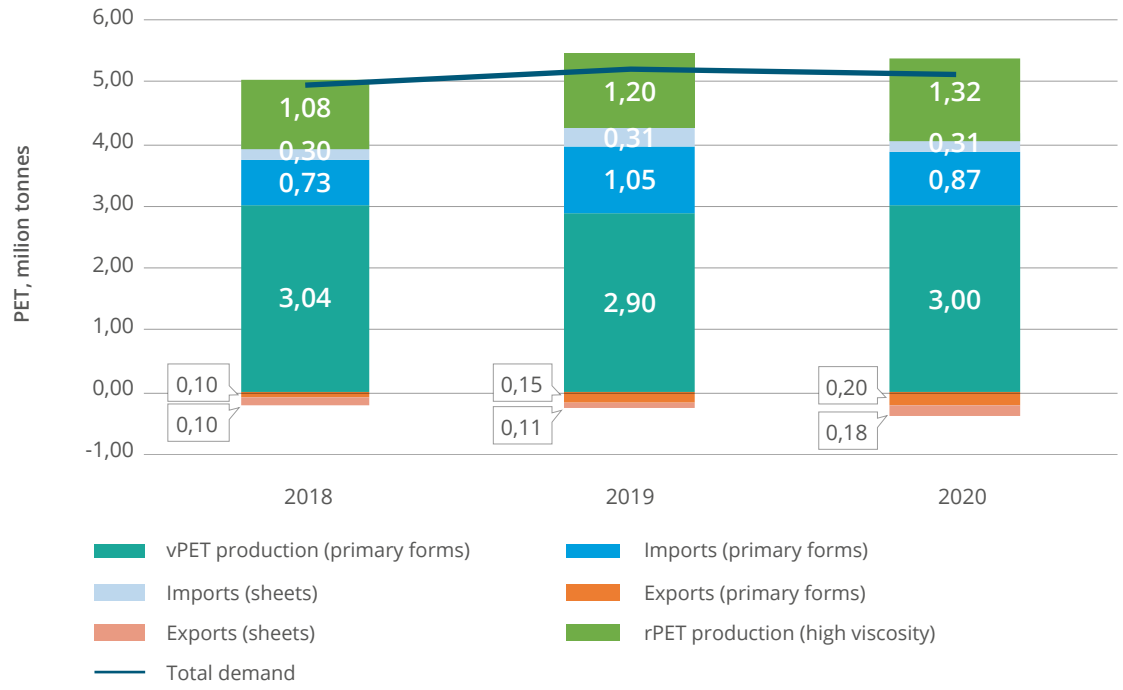
- TOTAL DEMAND FOR PET APPEARS TO BE STABLE OVER THE PERIOD SINCE THE PREVIOUS ITERATION OF THE REPORT (2018 - 2020).
- DATA SUGGESTS A SMALL POTENTIAL SHIFT AWAY FROM VIRGIN PRODUCTION AND IMPORTS, AND TOWARDS rPET PRODUCTION.

Net demand for PET in the EU27+UK was estimated at 5.1mt in 2020, of which 3.0mt was supplied from virgin PET production, 1.3mt from rPET production, and 0.8mt from imports (note this figure is for net imports). Figure 2 illustrates the production and demand of virgin and recycled PET within the EU27+UK (previously the EU28) over the period from 2018 to 2020.

This only includes higher viscosity PET (i.e., PET in primary forms with a viscosity number of ≥78 ml/g which is used for bottles, trays, and flexible packaging) and therefore excludes demand for polyester fibres. Additionally, rPET quantities are for rPET that is used in applications with a higher viscosity number. Therefore, rPET used in polyester fibres is not included in the report unless it is clearly stated as such. Data was not available for rPET in 2019, so a linear increase has been used as an approximation.

Figure 2: Total Demand for PET (Primary Forms and Sheet), 2018-2020 (EU27+UK)

Source: CPME, Eurostat, Annual PET Recyclers Survey (PRE)



Due to lack of availability, no data are included for preforms or final packaging formats in Figure 2.

Table 1 provides a breakdown of the data with imports and exports for primary form PET and sheets.

Table 1: Production and Demand of PET, 2018-2020 (EU27+UK)

Source: CPME, Eurostat, Annual PET Recyclers Survey (PRE)

	2018	2019	2020
IMPORTS (PRIMARY FORMS) (MT)	**0.73**	**1.05**	**0.87**
IMPORTS (SHEETS) ≤0.35 MM (MT)	**0.25**	0.26	0.26
IMPORTS (SHEETS) >0.35 MM (MT)	**0.05**	0.06	0.05
VPET PRODUCTION (PRIMARY FORM) (MT)	**3.04**	2.90	3.00
EXPORTS (PRIMARY FORMS) (MT)	**0.10**	0.15	0.20
EXPORTS (SHEETS) ≤0.35 MM(MT)	**0.06**	0.06	0.10
EXPORTS (SHEETS) >0.35 MM (MT)	**0.04**	0.04	0.07
rPET PRODUCTION (HIGH VISCOSITY) (MT)	**1.08**	1.20	1.32

In Table 1, import and export figures for sheet have been split into the two categories for sheet used by Eurostat. This is assuming that:

- Sheet of thickness >0.35mm is used for thermoforming of trays etc; and
- Sheet of thickness ≤0.35mm is used for films.

Whilst this assumption has been used throughout the report, the boundary for thermoforming trays may in fact be less than 0.35mm and is understood to be dependent on the manufacturing process. Therefore, some of what has been classified as film throughout this report may in reality be used in thermoforming. Both have been included here as packaging products, but it is important to note the differentiation between the two as the trade balance for each format varies. This has been explored in more detail in Section b.

Since 2018, total demand for PET has grown from 4.95mt to 5.12mt, representing an increase of approximately 3.4%. However, from this data alone, and as the demand in 2019 has been estimated at 5.21mt, it does not appear reasonable to conclude that the market is growing. Indeed, it would seem that the market has remained relatively stable over the period discussed.

Whilst the overall demand appears consistent, the composition of the sources of PET used to meet this demand has experienced a slight change. Table 2 displays a comparison between the sources used to meet the PET demand in 2018 versus those used in 2020. The table illustrates a small potential shift away from virgin production and imports and towards rPET production (for use in applications with a higher viscosity number). However, it should be noted that as this only compares two datasets, it should not be considered a trend. rPET production and end markets are therefore discussed in greater detail in Section f.

Table 2: Comparison in Composition of Sources Used to Meet PET Demand, 2018 vs. 2020

	2018	2020	difference (2020-2018)
EUROPEAN VIRGIN PRODUCTION	**61.3%**	**58.6%**	**-2.7%**
NET IMPORTS	**16.8%**	15.7%	-1.1%
rPET PRODUCTION	**21.9%**	25.7%	+3.8%

IMPORT AND EXPORT

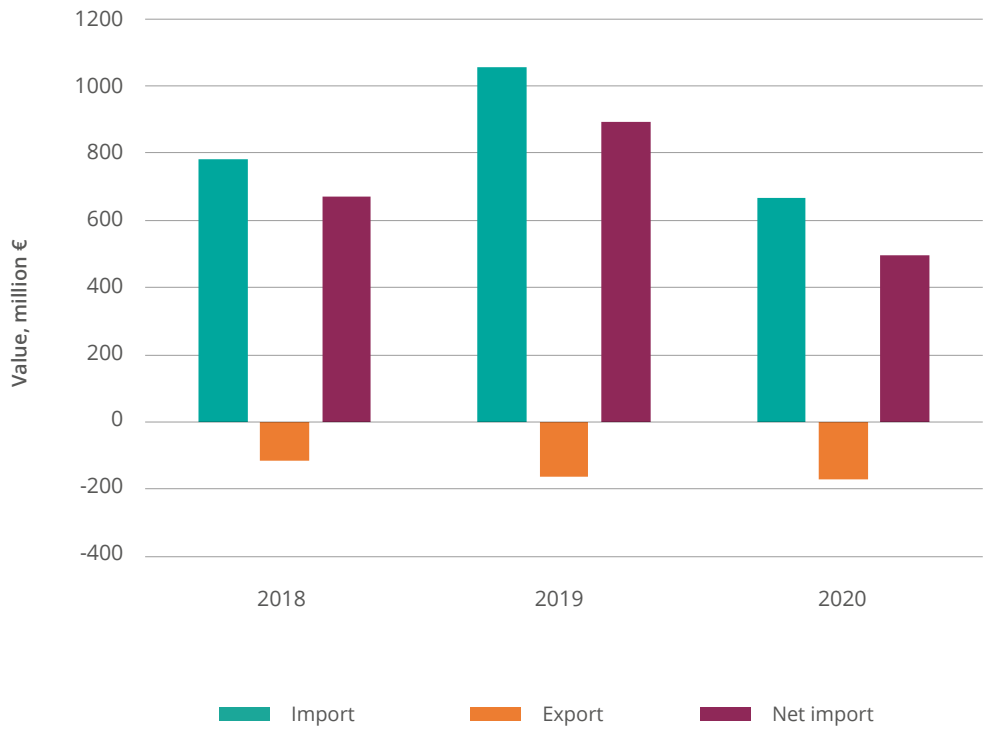
- THE EXPORT MARKET VALUE FROM THE EU27+UK IS SMALLER THAN THE IMPORT MARKET.
- ALMOST FOUR TIMES SMALLER FOR PRIMARY-FORM PET.
- A LITTLE OVER HALF OF THE VALUE FOR SHEET.
- THE BOTTLE EXPORT MARKET IS APPROXIMATELY 6% LARGER THAN THE IMPORT MARKET.

Primary form imports of PET with a viscosity number ≥78 ml/g (i.e., high viscosity PET) totalled €667m in 2020 whilst exports totalled €172m suggesting that imports are almost four times higher than exports. Figure 3 displays the value of imports and exports of primary form PET of the relevant viscosity in the EU-27+UK over the period of 2018 to 2020.

The import and export tonnages were provided by CPME and used in conjunction with cost per tonne data from Eurostat PRODCOM. The scope within this section is limited to EU-27+UK (i.e., Norway and Switzerland have not been included).

Figure 3: Value of Imports and Exports of PET in Primary Forms with Viscosity ≥78 ml/g in the EU27+UK, 2018-2020

Source: CPME and Eurostat, derivation



As demonstrated in the figure, the value of imports of primary form PET with viscosity number ≥78 ml/g into the EU27+UK has decreased drastically versus 2019 data. In 2019, these imports were valued at approximately €1.1bn whilst exports totalled €161m.

Over the timescale considered, the EU27 has consistently been a net importer of PET in primary forms. The EU27's negative trade balance has ranged from €893m in 2019 to €495m in 2020. Additionally, the EU27 has also traditionally been a net importer of PET sheet. Since 2018, the EU27 has consistently imported more sheet with thickness ≤0.35mm (i.e., film and some thermoforms). However, in 2020 exports of sheet with thickness >0.35mm exceeded imports. Whilst marginal, this net export of thick sheet reduces the number of PET trays on the market within the EU27.

According to PRODCOM data, the EU27+UK's largest trade partners for imports of primary PET are the Republic of Korea (€170m), Turkey (€125m), India (€125m), and Indonesia (€88m), between them contributing more than 61% of total import value. The United Nations (UN) international trade and statistics database, Comtrade, shows that since reporting of PET in primary forms was first differentiated by viscosity in 2017, only four of the highest importers of PET have increased the volumes of PET supplied into the EU27+UK – Indonesia, China, Egypt, and Switzerland – and only tonnages from Turkey and Indonesia did not drop in 2020 from 2019 levels[3].

Almost 70% of PET exported from the EU27+UK is to Ukraine (€65m), South Africa (€26), Algeria (€25m), and Switzerland (€18m). In the previous iteration of the report, the top four importers of EU27+UK PET were, in order, Switzerland (€25m), Ukraine (€22m), the USA (€14m), and Turkey (€12m).

Within the EU27+UK, the Netherlands, Germany, Spain, Belgium, Latvia, Lithuania, and Slovakia all have positive trade balances (in value terms) in respect of primary PET import versus export. At the time of writing the previous iteration of the report, only four Member States were in this position (Lithuania, the Netherlands, Spain, and Belgium).[4] Consistent with the findings of the previous report, Italy and France have the largest trade deficits measured by value.

"THE VALUE OF IMPORTS OF PRIMARY FORM PET WITH VISCOSITY NUMBER ≥78 ML/G INTO THE EU27+UK HAS DECREASED DRASTICALLY VERSUS 2019 DATA. IN 2019, THESE IMPORTS WERE VALUED AT APPROXIMATELY €1.1BN WHILST EXPORTS TOTALLED €161M."

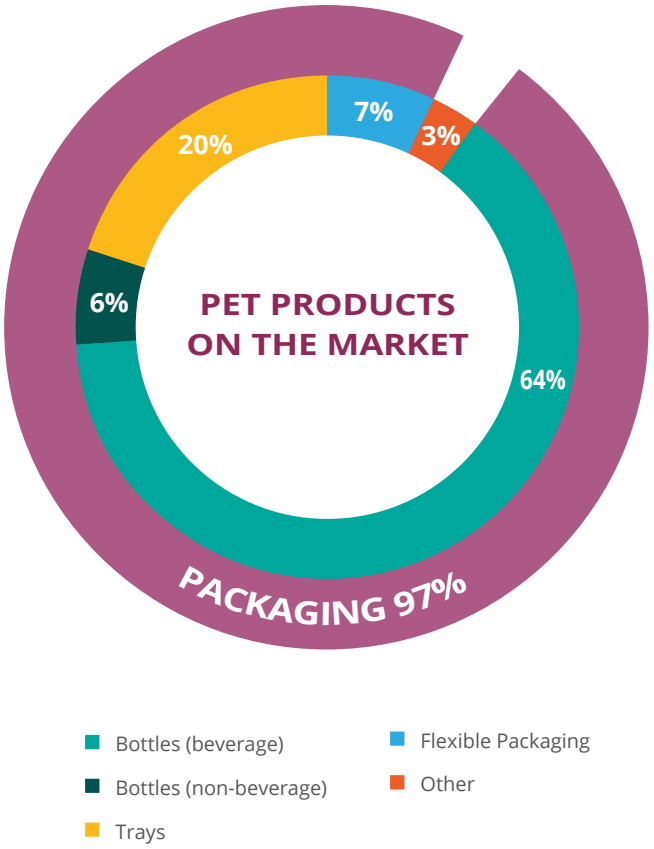
END MARKETS (PRODUCTS)

- 3.6MT OF PET BOTTLES AND 1.0MT OF PET TRAYS WERE PLACED ON THE EU27+UK MARKET IN 2020.
- THIS EQUATES TO AN INCREASE IN PRODUCTS PLACED ON THE MARKET OF 6% FOR PET BOTTLES AND 11% FOR PET TRAYS.
- CONSUMPTION OF ALL PET PACKAGING APPLICATIONS HAS GROWN SINCE 2020.

To obtain a reasonable estimate for the tonnages of bottles, trays, and other PET packaging products placed on the market in the EU27+UK in 2020, application splits for both virgin and recycled PET were required. An estimation of the demand split of virgin PET (having a viscosity number ≥ 78 ml/g) was provided by CPME and an estimation of the rPET application split was provided by PRE. These application splits, alongside the production and import/export data discussed in Sections b and c, infer that an estimated total of 3.6mt of PET bottles and 1.0mt of PET trays were placed on the market in the EU27+UK in 2020. This relates to an almost 6% increase in PET bottles and an 11% increase in PET trays compared to 2018 figures for the EU28+2. If 2020 data were available for the EU27+3, we can assume that this increase would be greater.

Figure 4 illustrates an approximate breakdown of PET product applications excluding fibre (polyester) and monofilament. This highlights the significance of the packaging sector in overall demand for PET.

Figure 4: PET Products on the Market,
Source: CPME and PRE data, derivation



PACKAGING (97%)

The main packaging product uses are:

- **BOTTLES (70%):** The largest use of PET is for bottles, and within that, drink/beverage bottles. Often, PET bottles are transparent, but opaque PET is used more extensively in some regions (e.g., milk packaging in France). There is a lack of reported data on the split between PET beverage and non-beverage bottles. However, based on a prior PETCORE Europe study by PCI, it is estimated that up to 8% of PET bottles are used for other food applications (for example, sauces) and cosmetic/hygiene products.[5]
- **TRAYS (20%):** PET in the form of sheet is used for other food packaging, primarily in blisters or thermoformed/thermoset food trays. Fully crystalline PET (treated so that polymer chains are parallel and closely packed) is opaque and can be used for oven-ready and microwaveable trays. Based on demand data for PET sheet, it is estimated that the amount of PET trays being placed on the market is approximately 1.0mt per annum.[6]
- **FLEXIBLE PACKAGING (7%):** A smaller amount of PET film/sheet is utilised for flexible film packaging, either as a mono-material or as a barrier layer in multi-material packaging. As a barrier, PET is combined with layers of other materials, such as PE, PP and/or aluminium. It is estimated that around 355kt of PET is used as flexible packaging annually.

OTHER PRODUCT SECTORS (UP TO 3%)

Outside of packaging applications, PET is also used for photographic films, X-rays, and electrical insulation. Occasionally, PET is also used to manufacture moulded components in the automotive industry.

PET FIBRE AND MONOFILAMENT APPLICATIONS

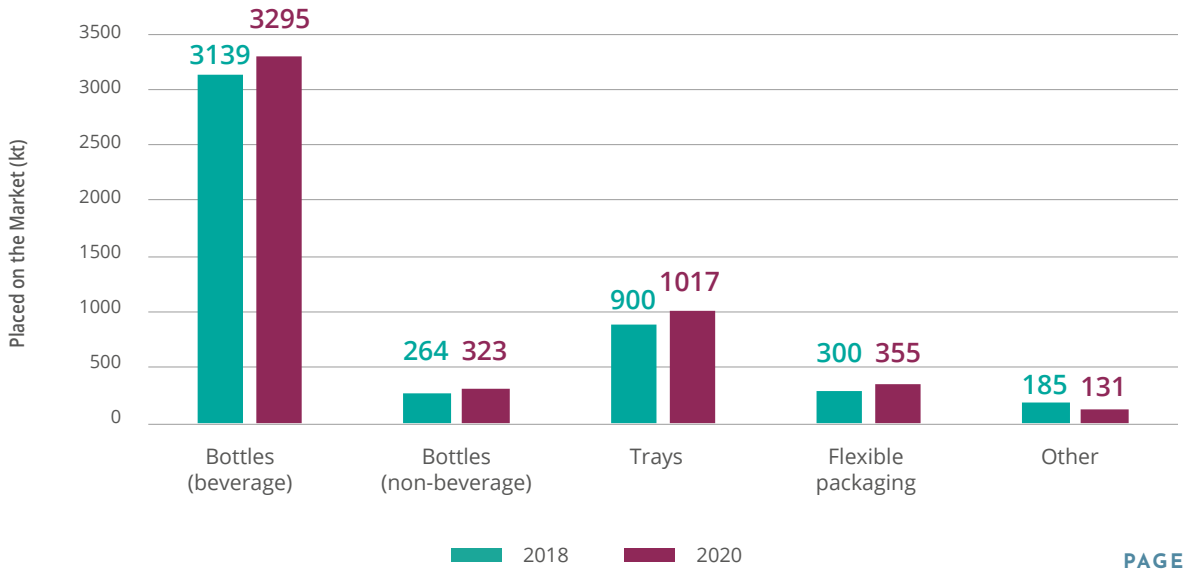
Except as an important end market for rPET, monofilament and fibre products have not been included within the considered applications in this report. PET can be used in monofilament or fibre form for strapping and extensively for fibre (as polyester) in woven, knitted, and non-woven textiles.

MARKET TRENDS OVER TIME

The tonnage of PET placed on the market has been shaped in the past decade by substantial growth in the consumption of both PET bottles (beverage and non-beverage) and PET trays. However, this increase in consumption has been partly offset by beverage bottle lightweighting, which is an increasingly common practice for manufacturers looking to address environmental concern whilst reducing unit cost.

Regardless, the consumption of PET for packaging continues to grow. Figure 5 displays the consumption of each of the major PET applications considered within this report in 2018 and 2020.

Figure 5: Changes in Placed on the Market Tonnages per Application, 2018 versus 2020



COLLECTION AND SORTING

- AN ESTIMATED 4.6MT OF PET RIGID PACKAGING ENDED ITS PRODUCT LIFE AND WAS AVAILABLE FOR COLLECTION IN 2020.
- OF THIS, APPROXIMATELY 49% (61% OF BOTTLES AND 21% OF TRAYS) WAS COLLECTED AND SORTED FOR RECYCLING ACROSS EUROPE.
- COLLECTION AND SORTING RATES FOR BEVERAGE BOTTLES WILL NEED TO INCREASE FOR MANY MEMBER STATES IN ORDER TO MEET THE SUP TARGETS.
- COLLECTION AND SORTING RATES FOR TRAYS AND FLEXIBLE PACKAGING WILL NEED TO INCREASE IN MANY MEMBER STATES FOR IT TO BE LIKELY THAT THOSE PACKAGES WILL BE CONSIDERED RECYCLABLE.

As the majority of PET products are single use and are quickly disposed of, it can be assumed that most products placed on the market within a year will become available for collection within the same timeframe. Therefore, based on the market data presented in the sections above, it is estimated that 4.6mt of rigid packaging material reached the end of its useful life in 2020, and was therefore available for collection across the EU27+UK. The large majority of this was PET bottles (3.6mt), with the remainder PET trays (1.0mt).

PET BOTTLE COLLECTION & SORTING

In 2020, 2.2mt of PET bottle bales were sorted for recycling. This roughly equates to a sorted for recycling rate of 61% for PET bottles in Europe. We would like to note that this does not account for any trays present in bottle bales that may be wrongfully included within PET bottle sorted for recycling tonnages. However, we expect this figure to be low and for the effects on the overall bottle recycling rate to be small. According to the Annual PET Recyclers Survey (PRE, 2020), this included the following proportions of bottle colours; clear and light blue bottles represented the majority of bottles (over 72%), whilst mixed coloured and opaque bottles accounted for approximately 27% and 1% respectively. We expect that this is likely an underestimation of the total clear and light blue bottles, as some countries do not have colour sorting for PET.

PET TRAY COLLECTION & SORTING

Some, but not all, Member States collect PET trays for recycling. Where PET trays are included within collection systems, they are predominantly collected with other plastic of mixed light packaging. In some cases, some of the tray content is then sorted into PET bottle bales. However, the PET used to manufacture trays has a different structure to that which is used to manufacture bottles. Tray PET has a lower intrinsic viscosity than bottle which means it is significantly more brittle. As a result, it produces more fines throughout the recycling processes, causing losses. Therefore, when PET trays are included within bottle recycling, the resulting recyclate is lower quality and the yield is less – with the trays essentially acting as a contaminant.

In order to prevent loss of quality, trays should be sorted from PET bottles for separate recycling and, ideally, into two separate streams – mono-material clear trays and multi-material clear trays. A third stream for coloured trays should be taken into consideration where possible. Capacity for separated PET tray recycling lines appears to have increased in the past few years. It is estimated that the tray recycling capacity will reach around 100ktpa of PET trays in the next 2 to 3 years which is 10% of trays placed on the market and little less than half of trays currently collected. Most of this capacity is orientated to

recycling clear and mono-material clear trays. Recycling capacities for multi material and coloured trays are in development and remain small at present.

In 2020, approximately 208kt of PET trays were separately sorted for recycling. Of this, roughly 46% was clear monolayer trays, 47% was clear multilayer, and 7% was black or coloured PET trays. As approximately 1.0mt of PET trays were available for collection, the sorted for recycling rate of PET trays in 2020 is estimated to be approximately 21%. Note that as the data was unavailable, this does not include values for the tonnage of trays present within PET bottle or other mixed plastic bales.

COLLECTION SYSTEMS

Based on the above analysis of bottle and tray collection and sorting, we estimate that 49% of total PET rigid packaging arisings were collected and sorted for recycling across the EU27+3 in 2020. We have been unable to provide an estimate of 'sorted for recycling rates' for each Member State in 2020, as available data was insufficient. However, in Section 4c we have explored the status of DRS in each Member State and have interrogated five case study countries in greater detail. It is worth noting that these schemes are for beverage PET bottles and do not, therefore, include PET bottles for other applications (such as detergents or personal care products). Greater transparency of reporting is required to improve confidence in collection and sorting.

In general, countries with DRS systems in place achieve higher sorted for recycling rates for in-scope products (i.e., certain beverage bottles). Nine of ten countries with established DRS, in Europe, have achieved sorted for recycling rates of 83% or higher. The tenth, the Netherlands, has a collection rate of 65% but this rate is for a scheme with just partial coverage as only bottles with volumes greater than 0.5l are included. The Netherlands extended this scheme to include smaller bottles in July 2021 and so it is expected that this rate will soon increase. As DRS in these countries only includes beverage bottles the resulting grade of PET bottle bales only includes food contact materials therefore, the collected packaging waste is of sufficient quality to meet the European Food Safety Authority's (EFSA) requirement for less than 5% non-food-contact PET within food-contact rPET. In addition, collecting bottles separately to trays (e.g., through DRS) ensures that the quality of bottle grade rPET is not impacted by the presence of tray materials.

Household collections, either via door-to-door collection or through the use of bring sites, often include PET packaging. These systems result in varied performance – it is currently estimated that the worst performers result in sorted for recycling rates of 22% while the best reach rates of 75%. This is with the exception of Belgium, who reports a sorted for recycling rate of 92% despite not having a DRS scheme in place. Figure 6 shows the range of performance recorded for different collection schemes in Europe.

Member States vary as to which colour fractions PET is sorted into. This is illustrated in Figure 7. Where mixed colour fractions contain large amounts of clear and blue PET, they may be further colour sorted.

Figure 6: Sorted for Recycling Rate for Collection Schemes in Europe

Source:PRE, PETCORE Europe, and NMWE (previously EFBW) [9]

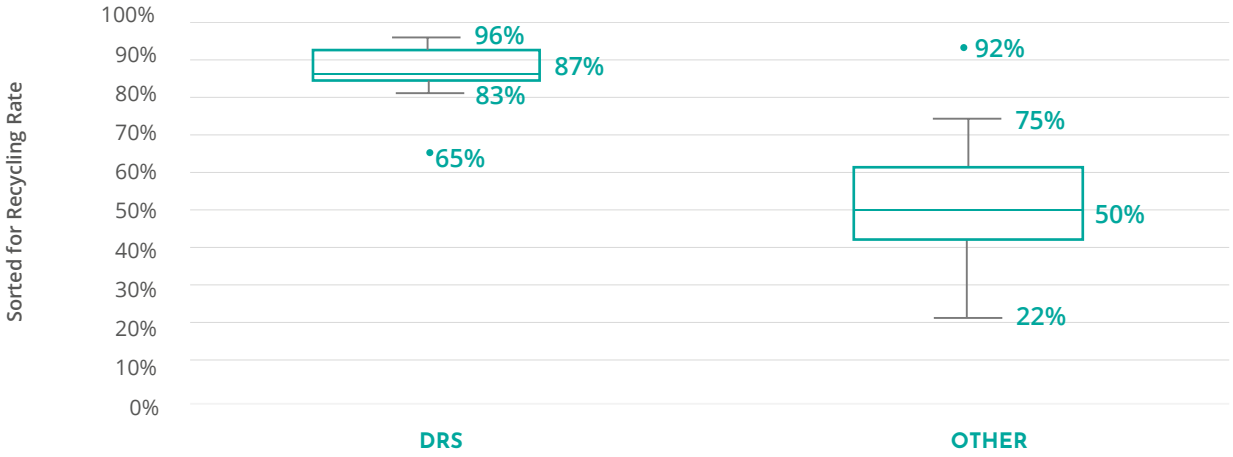
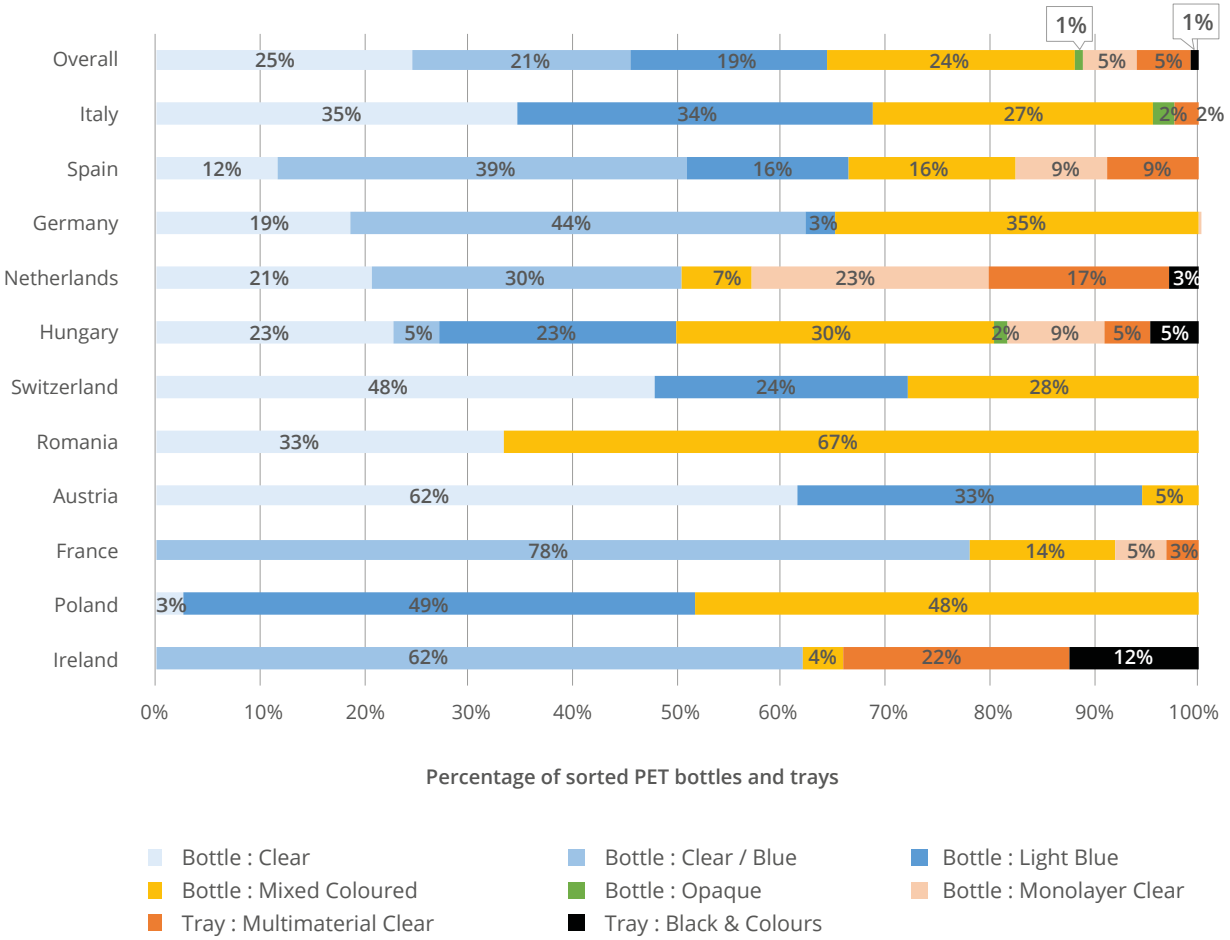


Figure 7: Proportions of Sorted Colours of PET Bottles and Trays in Countries with Available Data 2020

Source: Annual PET Recyclers Survey (PRE, 2020)



RECYCLING

- IN 2020, APPROXIMATELY 2.4MT OF PET WAS RECYCLED WITHIN THE EU27+3.
- OF THE 2.4MT INPUT INTO RECYCLING FACILITIES, 1.7MT OF FLAKE WAS PRODUCED.
- OF THE 632KT INPUT INTO EXTRUSION FACILITIES, 606KT OF PELLET WAS PRODUCED.
- THE AVERAGE CAPACITY UTILISATION OF PET WASH AND EXTRUSION FACILITIES WERE 87% AND 86% RESPECTIVELY.
- AN IMPROVEMENT IN DATA AVAILABILITY HAS INCREASED REPORTED TONNAGES FOR ALL MEASURED FACTORS RELATED TO RECYCLING.

PRE data shows that around 2.4mt of PET was recycled within the EU27+3 in 2020. Of this 2.4mt, following wash and flake processes, approximately 632kt was then processed further and pelletised via extrusion. Germany (21%), Spain (16%), Italy (12%), France (11%), and the UK & Ireland (11%) account for 71% of PET washing capacity in the EU27+3 (see Figure 8).

The EU27+3 has approximately 2.8mt of total input capacity for PET washing. According to respondents to the Annual PET Recyclers Survey (PRE, 2020), in 2020 the average utilisation of wash and flake plant capacity was estimated to be 87%, processing over 2.4mt of input and generating more than 1.7mt of flake output. This includes rPET destined for applications with a viscosity number <78 ml/g, i.e., for applications outside of packaging (for example, fibres). Following washing, some PET flake is sent for further recycling by extrusion into pellets.

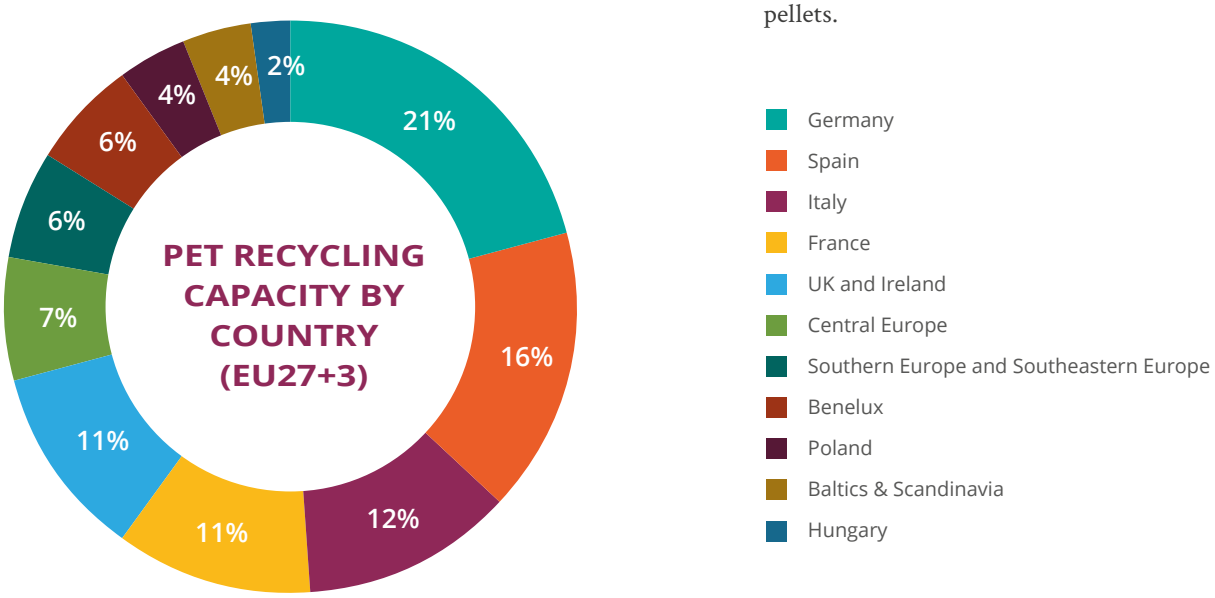


Figure 8 : PET Recycling Capacity by Country (EU27+3)

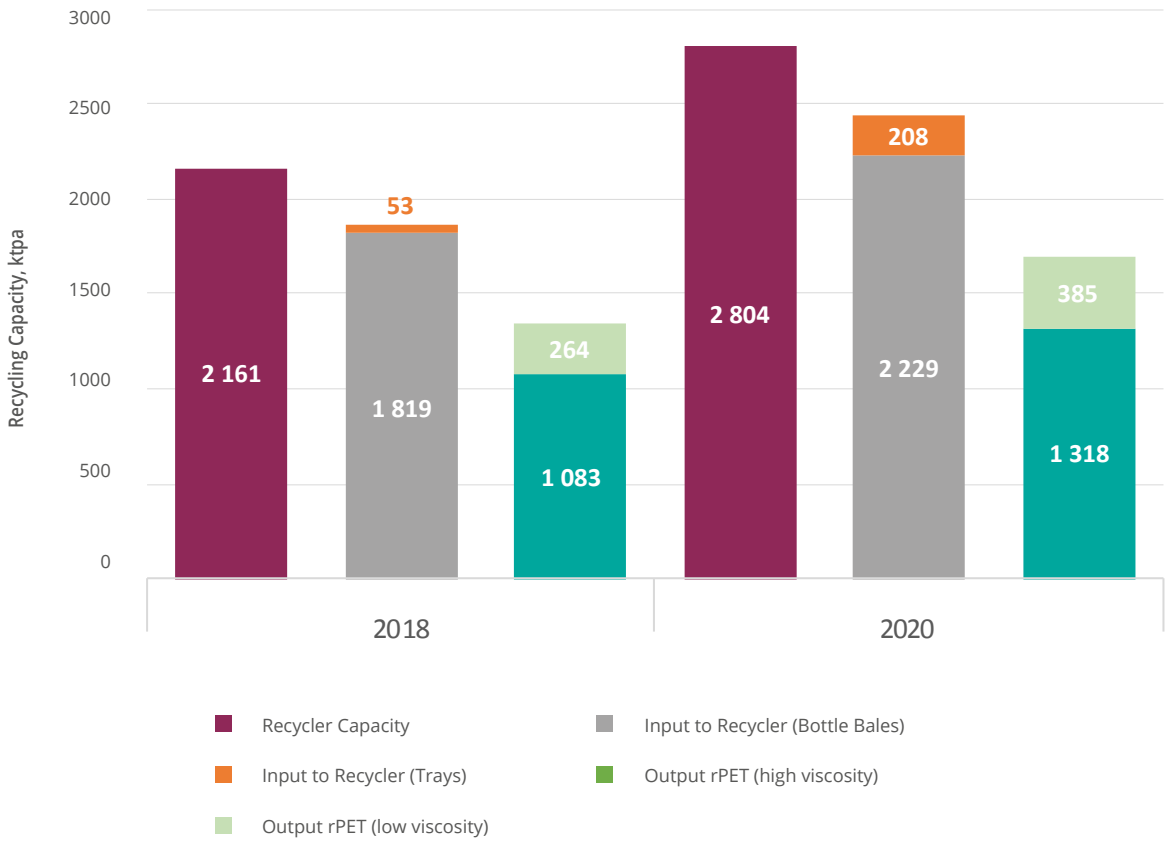
Source: Annual PET Recyclers Survey (PRE, 2020)

Following washing, some PET flake is sent for further recycling by extrusion into pellets. Total input capacity for PET extrusion is estimated to be approximately 736kt in the EU27+3According to respondents to the Annual PET Recyclers Survey (PRE), in 2020 the average utilisation of extrusion capacity was estimated to be 86%, resulting in approximately 632kt of pellet output.

When compared with the previous iteration of the report, an improvement on the data available for recycling capacity and production has resulted in increases in all measured factors. This can be clearly seen in Figure 9 where overall capacity has increased by 21% in two years.

Figure 9 : PET Recycling Capacity, Input and Output, 2018 versus 2020

Source: Annual PRE Recyclers Survey (PRE, 2020)



Given the greater level of data granularity available for 2020, alongside the total rPET production, Figure 9 includes the split between rPET produced and destined for low viscosity applications, and that which is destined for high viscosity applications.

END MARKETS (rPET)

- THE PRIMARY END MARKET FOR rPET IS PACKAGING.
- THE LARGEST SINGLE APPLICATION FOR rPET IN PACKAGING IN 2020 WAS TRAYS AND SHEETS (32%) FOLLOWED BY FOOD CONTACT BOTTLES (29%).
- THE ESTIMATED INFERRED RECYCLED CONTENT IN PET BOTTLES IN 2020 WAS 17%.
- THE ESTIMATED INFERRED RECYCLED CONTENT IN PET THERMOFORMS AND TRAYS IN 2020 WAS 52%.

PRE received end market data from members covering 906kt of recycled material. This figure represents 52% of the total market. This, alongside industry expertise, was used to identify estimates for the split of rPET applications. The resulting split can be seen in Figure 10. Here, rPET destined for both high and low viscosity applications have been included.

This data, when used in conjunction with other information laid out earlier in the report, can be used to calculate an estimate of recycled content in European bottle and tray production. The results can be seen in Table 3.

Figure 10 : End Markets for rPET (EU27+UK) in 2020 Based on Input from Industry Experts

Source: PRE expertise

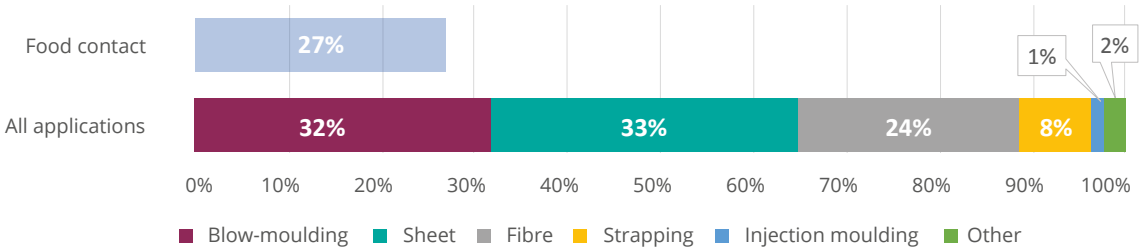


Table 3: Approximate use of rPET (EU27+UK) Compared to Total Primary PET Production in 2020

	rPET to Product Applications 2020, kt	EU27+UK Production, 2020, kt	Estimate of Recycled Content in 2020
Blow-moulding (food contact)	514	3.618	17%
Blow-moulding (other)	92		
SHEET	529	1017	52%
STRAPPING	125		
Injection moulding	19		
Other	39		
Fibres	385		
TOTAL	1.703		

PET NET EXPORTS FOR RECYCLING

Data on exports of PET sorted for recycling remain unavailable as Eurostat does not report PET exports separately to "other plastics". Currently, plastic exports include any scrap not recorded as PE, PP, PS, or PVC and may include mixed plastic bales. The best estimate is likely to come from comparing quantities of PET sorted for recycling with input tonnages to EU facilities. With the data available in this study, this provides an estimate of 67kt of PET (inclusive of non-PET material and moisture within bales) exported for recycling in 2020. This is a decrease of approximately 133kt versus 2018 estimates.

3. KEY CHALLENGES FACING THE RECYCLING MARKET

- DEMAND FOR FOOD GRADE rPET FOR BOTTLE PRODUCTION EXCEEDS SUPPLY AND THERE WILL NEED TO BE AN EXPANSION IN BOTH RECYCLING CAPACITY OF THIS GRADE AND SUPPLY OF SORTED BOTTLES OF SUFFICIENT QUALITY TO FEED THIS CAPACITY.
- TRAY RECYCLING CAPACITY WILL NEED TO SUBSTANTIALLY EXPAND FOR THIS APPLICATION GROUP TO BE CONSIDERED RECYCLABLE.
- THE QUALITY OF THE SUPPLY OF COLLECTED PET VARIES SIGNIFICANTLY BETWEEN AND AMONG MEMBER STATES. FACTORS CONTRIBUTING TO DIFFERENCES INCLUDE COLLECTION METHODS, BALE QUALITY, AND APPROACH TO MIXED PET WASTE.
- FURTHER IMPROVEMENTS IN DESIGN FOR RECYCLABILITY PRACTICES ARE LIKELY TO BE NEEDED TO FACILITATE MORE rPET BEING USED WITHIN ITS OWN APPLICATION CYCLE.

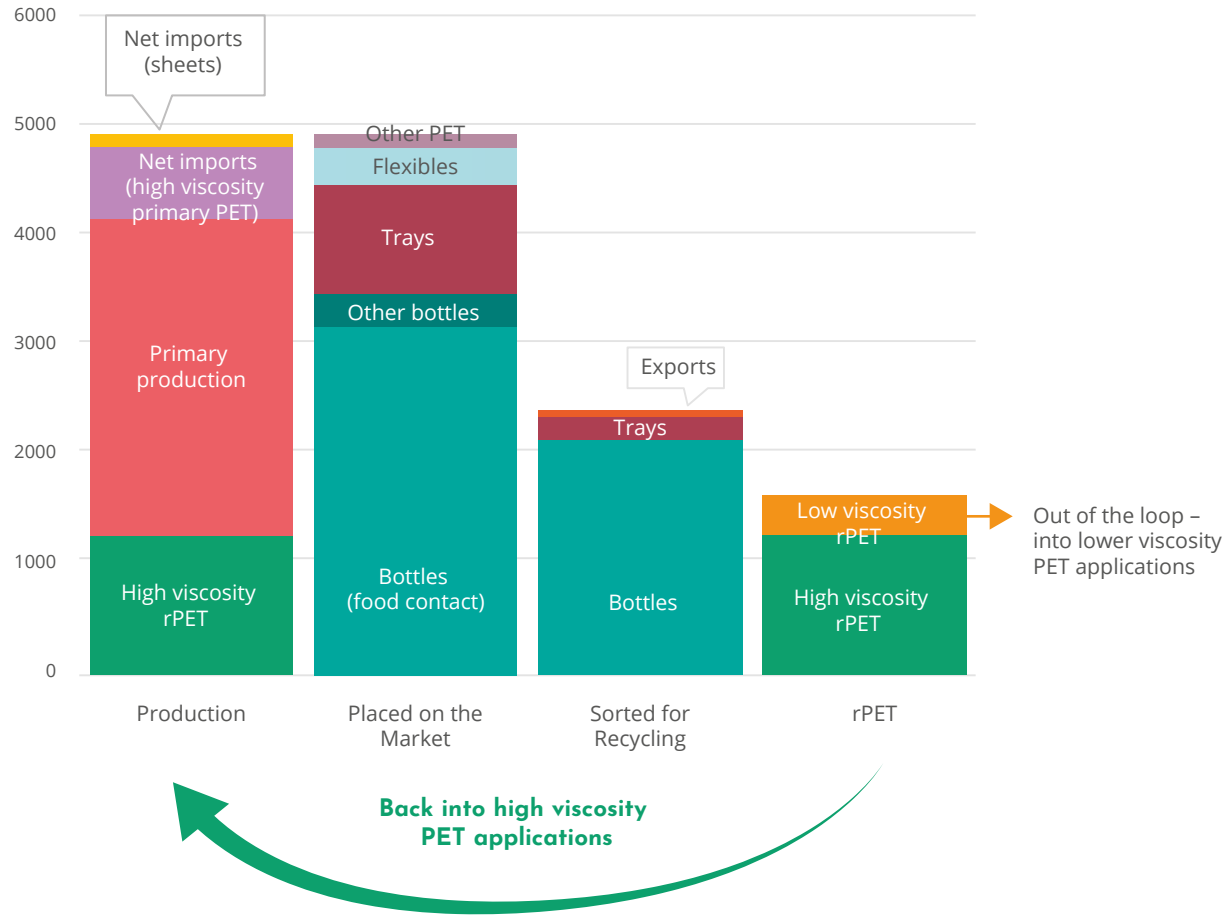
In the following section, the key challenges facing the PET recycling market in Europe have been explored. It takes the data from the previous section and looks at the PET mass balance across the supply chain, the recyclability of products, and the resulting impacts on the sorting and recycling industry.

QUANTITY: PET MASS BALANCE

Figure 11 shows the current mass balance of PET across the EU27+3. The stages are shown across the horizontal axis, with coloured blocks indicating the flows in or out at each stage. The major source of PET leakage from the recycling chain occurs in the initial stages of collection and sorting. When PET is collected for recycling, it is subsequently sorted and recycled to a high degree, with the vast majority recycled in the EU27+3.

Figure 11: Overall PET Mass Balance for the EU27+3 in 2020 [10]

Source: Eunomia [11]



These factors all contribute to a product stream that is capable of leading to high quality bales that can be more readily sorted and recycled into rPET. For PET trays, collection and sorting rates are much lower. As such, there are far fewer recycling lines for trays.

While there is still progress to be made with regards to collection and sorting of PET across the EU, the major challenge for fully bridging the gap in terms of mass balance, remains in the ability for collection and sorting systems to capture PET packaging and sort them into separated streams for recycling.

QUALITY: SUPPLY OF COLLECTED AND SORTED PET

The quality of the supply of collected and sorted PET is impacted by several factors throughout the waste management system. Several of the key factors have been interrogated in the following sections.

DIFFERENCES IN COLLECTION SYSTEMS

Currently, collection systems across the EU are not harmonised. Collection varies between DRS schemes (for beverages), door-to-door collection, and bring sites. Furthermore, the waste formats collected for recycling by Member States, and the combinations they are collected in, differ. This variation in collection system design, coupled with differing collection rates and performance, results in collected waste streams that are varied from the outset.

VARIATION IN BALE QUALITY

Material derived from door-to-door and bring collections often result in reduced bale quality. Higher levels of paper fibres and organic material present in household derived PET can increase costs and sorting losses, making it more expensive to sort and clean the material to a high standard. Sources of problems due to bale quality include:

- Unwanted polymers, such as PVC, which require further sorting and can impair the quality of the rPET produced; and
- Paper fibres, textiles, and glass shards that reduce production efficiency and cause losses of some PET in the wash plant processes.

Additionally, the presence of PET trays within PET bottle bales can negatively impact the quality of the PET flake. This is explored in further detail in the following section.

Furthermore, there are no EU-wide standard definitions for levels of transparent or coloured PET. As a result, different nations use different standards. This limits the potential for intra-EU trade between sorters and recyclers.

MIXED PROCESSING OF PET TRAYS AND BOTTLES

The material used to manufacture PET trays is significantly more brittle and so produces more fines when processed into flake. Therefore, when PET trays are included within bottle recycling, the resulting recyclate is lower quality and the yield is less – the trays essentially acting as a contaminant. In order to prevent loss of quality due to contamination, trays need to be sorted from PET bottles for separate recycling.

Whilst this is reasonably well recognised within industry, there are several other factors preventing widespread separation of PET trays from other waste streams. First, the quantities of material available are lower. Second, there is considerable variation in tray designs (e.g., multilayer vs. monolayer) that further dilute the available feedstock. It is estimated that the current market for PET trays consists of 60% multilayer PET trays and 40% monolayer. Whilst monolayer trays are easier to recycle, multilayer solutions are often necessary for their barrier properties. There are various initiatives, which are often led by prominent brands and retailers, to move away from multi-material trays where possible and thereby improve recyclability.

QUALITY: RECYCLABILITY AND rPET PRODUCTS

Ensuring that a product is readily recyclable requires more than simply using a technically recyclable material to manufacture the main body of the product. The presence of other components (such as closures, labels, inks) can prevent effective recycling, increase the costs of processing, and/or reduce the value of the secondary material obtained.

According to the definition released by PRE in association with the Associations of Plastics Recyclers (APR) in the USA, plastics must meet four conditions for a product to be considered recyclable:[12]

1. The product must be made with a plastic that is collected for recycling, has a market value, and/or is supported by a legislatively mandated programme.
2. The product must be sorted and aggregated into defined streams for recycling processes.
3. The product can be processed and reclaimed/recycled with commercial recycling processes.
4. The recycled plastic becomes a raw material that is used in the production of new products.

The definition references the economic viability of collection (in condition 1, with the concept of market value or legislative support) and/or recycling (in condition 3, with reference to commercial recycling processes).

Due to the variation in rigid PET packaging products on the market, the recyclability of PET is not a singularly defined metric. Table 4 examines each of the main PET product groups against each condition. The extent to which each product group meets the recyclability criteria is shown using a colour indicator. Green represents a high score, yellow indicates some challenges, and red highlights that a particular product group fails to meet the recyclability criteria. In addition to scoring product groups against individual criteria, we have also included an overall score for recyclability. Where useful, we have also included commentary within the relevant box on the table.

"ENSURING THAT A PRODUCT IS READILY RECYCLABLE REQUIRES MORE THAN SIMPLY USING A TECHNICALLY RECYCLABLE MATERIAL TO MANUFACTURE THE MAIN BODY OF THE PRODUCT. THE PRESENCE OF OTHER COMPONENTS (SUCH AS CLOSURES, LABELS, INKS) CAN PREVENT EFFECTIVE RECYCLING, INCREASE THE COSTS OF PROCESSING, AND/OR REDUCE THE VALUE OF THE SECONDARY MATERIAL OBTAINED."

Table 4: Recyclability Assessment of PET Rigid Product Groups

ASSESSED PET PRODUCT GROUPS FOR RECYCLABILITY	BOTTLES		TRAYS	
RECYCLABILITY CRITERIA	CLEAR LIGHT BLUE COLOURED	OPAQUE	MONO-MATERIAL	MULTI-MATERIAL/ POLYMER LAYERS
OVERALL				
COLLECTION	Widely collected.		No separation between mono- and multi-material trays during collection.	
SORTING	Widely sorted from mixed collections. Increasingly subject to DRS in many Member States therefore less contamination.	Quantities of opaque bottles in collected streams remain low. Current mechanical recycling techniques prevent opaque rPET from entering into lighter coloured applications. Not always considered economically viable to sort separately.	High proportions of trays currently sorted into bottle grades or into "mixed plastics".	High proportions of trays currently sorted into other grades. Multi-layer formats can be mis-sorted by sensor-based sorters (e.g., NIR technologies).
RECYCLING	Challenges posed by labels, adhesives and caps are generally overcome.	Some growth in the development of test plants for recycling opaque bottles. Development not yet significant enough to be considered effective.	Low tray recycling figures governed by less mature collection and sorting.	Some examples of emerging techniques for separating polymer layers but maturity is low and requires considerable further innovation. No commercial-scale recycling capacity at present.
END-MARKET	Coloured rPET derived from coloured bottles is only suitable for darker coloured applications.	Underdeveloped market for rPET derived from opaque bottles. Current mechanical recycling techniques limit opaque PET to dark coloured applications.	Lack of availability of rPET flakes resulting in underdeveloped market for rPET derived from trays.	Unless layers can be separated, any resulting rPET would be mixed polymer with very low market demand.

The table draws attention to the issues associated with PET tray recycling, which are also explored in Section 2dII.

Within the concept of recyclability, it is also possible to distinguish between uses of rPET that are closed loop and those that are open loop. Closed loop recycling sees a product collected, the material reclaimed, and the resulting recyclate reintroduced back into the same application. In contrast, open loop recycling recovers material from one product and cascades it into another application. For example, recycling PET bottles into fibres for carpets.

In some applications, there are handling and processing requirements that must be met for closed loop recycling to be permitted. For example, for closed loop recycling of food grade packaging, non-food grade contaminants cannot exceed 5%. To achieve such quality better collection practices with fewer contaminants are required. This is one reason why Member States are moving towards DRS for beverage bottles.

Closed loop recycling is often considered the priority solution as it maintains the value of the material and keeps resources within a target market. Some experts highlight that open recycling loops are not necessarily negative, particularly if the life span of the product is long. For example, bottles can be manufactured, used, and recycled within a matter of a few months. At the end of its product life and when its quality has degraded to a point it can no longer be used in that application, a bottle can then be recycled into fibres used to make carpet that may be in place for more than 20 years. However, rPET carpets are currently not being recycled and therefore this would means the cycle is finished. A combination of open and closed loop recycling is possible and can be complimentary. In this case it would require closed loop bottle recycling to be prioritised until the bottle degrades to the point it is no longer usable in that application and only then the material is used as an input into fibre manufacture for carpet applications.

The range of potential uses for rPET relate to its mechanical, visual, and odour properties. As clear and light blue bottles can be recycled back into similar coloured PET products, their original application can be maintained. Using current mechanical recycling techniques, mixed colour PET cannot be recycled into lighter colour applications but can find new application in same colour or darker coloured applications. The presence of opaque bottles within a recycling stream affects the clarity and transparency of the rPET. Therefore, the allowable proportion of opaque bottles within mixed colour bales is limited.

PET trays can be recycled back into PET trays. However, currently there are several barriers preventing circularity in this product application. Previously, the brittleness of the PET used to manufacture trays was considered a key barrier as it resulted in significant fines production, limiting yield, and inhibiting processability. However, this factor is perhaps less prevalent than other issues associated with collection, sorting, and recycling. Barriers are understood to include:

- A lack of widespread separate collection for trays;
- A lack of proper sorting facilities capable of separating PET trays from other packaging formats;
- The presence of multi-materials, multilayers, adhesives, and films leading to contamination (particularly light material fractions such as lidding films); and

A lack of dedicated tray-to-tray recycling plants.

Where products are not designed for recyclability, the impact they can have on not just their own recycling but also the entire recycling stream can be significant. To encourage good practice and support more effective recycling, several organisations have published Design for Recyclability (DfR) guidelines for the PET industry. Publicly available DfR guidelines have been published by:

- EPBP for PET bottles[13];
- PETCORE Europe for PET Trays and Thermoforms[14];
- RecyClass for all other plastic packaging[15].

These guidelines can be used to assess the recyclability of specific products against a number of relevant factors such as size, colour, additives, etc. Often, DfR guidelines use a traffic light system to outline conditions that must be met for a product to be considered to have full compatibility (and is therefore coloured green), limited compatibility (and is therefore yellow), or low compatibility (shown as red).

4. WHAT IS CHANGING?

- **FIGURE 12 SUMMARISES THE CONSUMER AND LEGISLATIVE PRESSURES ON THE rPET SUPPLY CHAIN AND THE AREAS OF RESEARCH AND DEVELOPMENT WITHIN EACH AREA OF THE SUPPLY CHAIN TO MEET THOSE PRESSURES.**

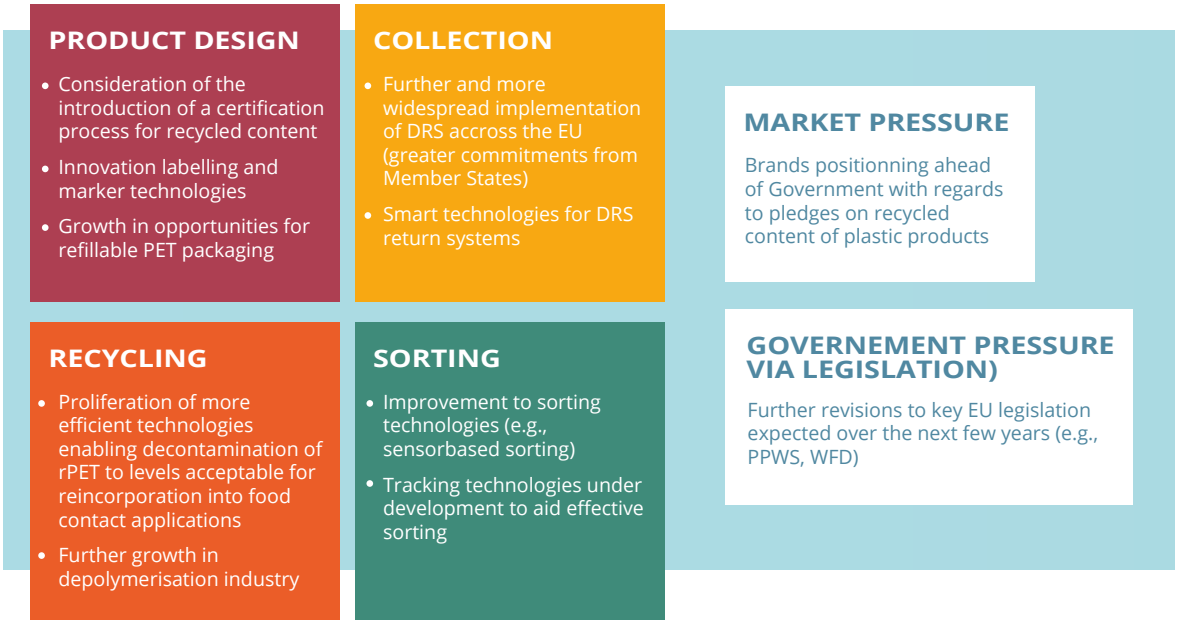


Figure 12: Changes Across the PET Market

Source: Eunomia

LEGISLATION

In the following section, the key changes to the PET landscape are explored, focussing on legislative and technical developments within the market.

The following legislation has resulted or will result in changes to both the collection and sorting of plastic for recycling within the EU27:

- The 2018 revision to the Packaging and Packaging Waste Directive (PPWD) established within European law, a 50% target for the recycling of plastic packaging by 2025, rising to 55% by 2030.
- The PPWD references the amended Waste Framework Directive (WFD), which requires in Article 8a, that the producer responsibility schemes cover the full net costs of the separate collection of packaging (including for the clean-up of litter), and that the fees charged to producers are modulated according to one or more of a range of criteria, including recyclability.
- In addition, Directive (EU) 2019/904 (the so-called Single-Use Plastics (SUP) Directive) introduced in 2019, set a collection target for beverage bottles of 77% by 2025, rising to 90% by 2029. The Directive also introduced mandatory recycled content requirements for PET beverage bottles of 25% by 2025 and 30% by 2030.
- The changes in the Basel Convention and subsequent amendment of the EU Waste Shipment Regulation could have a relatively limited impact on the PET recycling activities in the EU. For Intra-EU shipments the new green listed code is EU3011 and a limit of 6% of non-polymeric impurities were agreed by the Member States in their Correspondents Guideline No 12 [16], which PET waste bales would tend to comply with. For shipments to the EU27 of PET waste bales the situation is less clear cut as B3011 would be the green listed entry and have a limit of 2% non-polymeric impurities along with additional requirements on which polymers may be present in the waste shipment.[17]
- A new draft of Regulation 282/2008 on recycled plastic materials and articles intended to come into contact with foods, introduces requirements for collection stating that plastics must come from separate collection for recycling which is designed to minimise contamination of the collected waste. Additionally, it establishes requirements on certification of quality assurance of collection and pre-processing. The scope of the new regulation is further enlarged to cover a broad range of recycled plastics and defines an approval path for novel technologies. In addition, two technologies (i.e., PET mechanical recycling and closed loop) were identified as suitable for leading to a fast-track authorisation procedure for new applications.

In 2018 the European Commission published its 'Strategy for Plastics in a Circular Economy', announcing within its vision statement a fourfold increase in sorting and recycling capacity for plastics from 2015 to 2030, inviting voluntary commitments and pledges from industry groups across the supply chain.

In light of the average recycled content targets within the SUP Directive and the above urge by the Commission, beverage producers and brands have made a range of commitments and goals to incorporate recycled content within their bottles, and a number have introduced products containing up to 100% recycled content.[18] This ensures a growing level of demand for food-grade rPET for bottle-to-bottle recycling, which (unless producers import rPET) also requires a corresponding increase in tonnages collected and sorted for recycling.

REFILLABLE PET BOTTLES

The amount of goods placed on the market in Europe that are packaged in reusable packaging is relatively low at present. Refillable glass bottles are already a common practice in the HORECA (hotels, restaurants and cafes) sector and is increasing in retail. The revisions of the Packaging and Packaging Waste Directive could lead to policies intending to result in movements away from single-use packaging to reusable packaging.

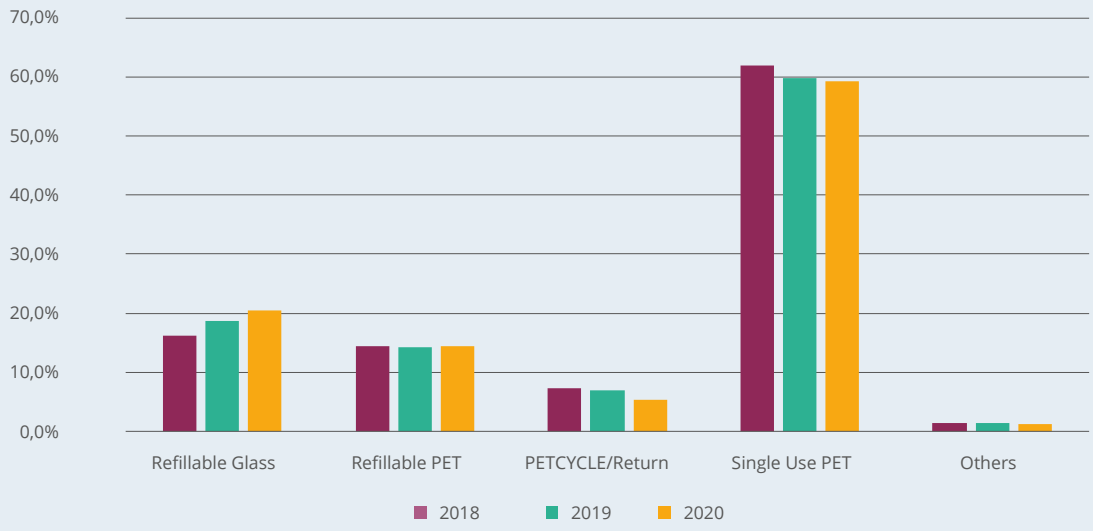
A well-established refillable system exists in Germany which is described in the case study below. While refillable glass bottle systems exist in other European countries, they are at a much smaller scale than Germany, and there is generally a lack of data available.

Box 1: German Case Study: Refillable PET Bottles

Germany has a long standing refillables system not only in the HORECA segments but also for private consumers. Although the market share for refillable beverage containers in Germany has steadily reduced since the 1990s, it still has a significant share (41.8% of the overall beverage market in 2019). Germany uses both glass and PET bottles in refillable formats across a range of beverage types and refillable PET bottles have a similar market share to glass refillable bottles across water and soft drinks but have no real market presence in the largest market for refillables which is beer.

This case study focuses on trends in the mineral water sector in Germany. The market share for reusable PET has reduced since 2015, but it has remained reasonably static at around 15% between 2018 and 2020. However, during the same period the market share for single-use PET bottles reduced while the market share for refillable glass bottles is increasing.

Figure 13: Market share developments by material and system in Germany 2018-2020 (water segment)

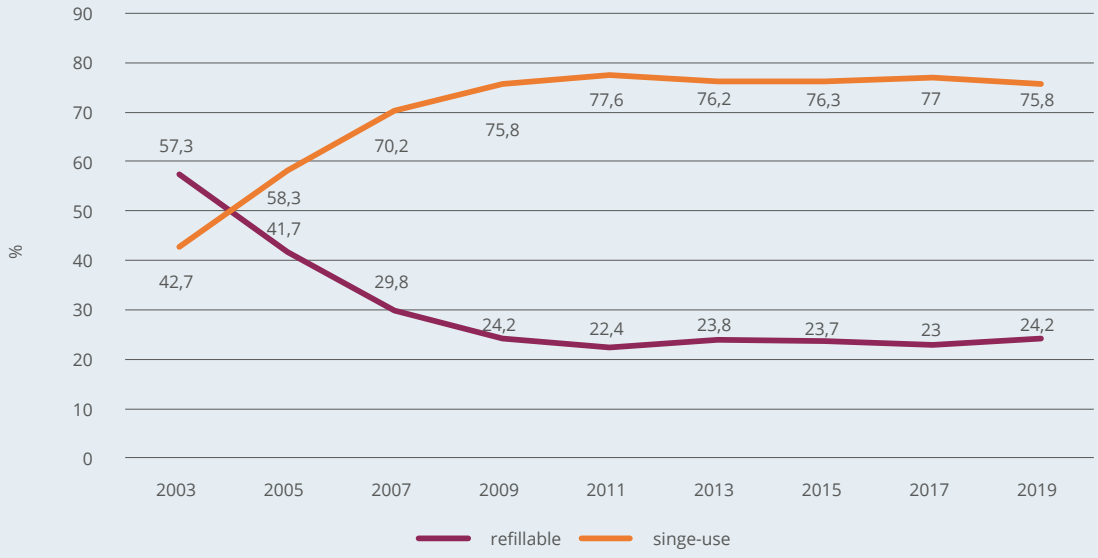


Due to their repeated use, refillable PET bottles need to be more robust than their single-use counterparts. In Germany, a 1 litre reusable bottle is typically around 60 grams whereas their single-use counterpart weighs typically between 20 and 24 grams. Genossenschaft Deutscher Brunnen (GDB, a procurement and sales cooperative of the German mineral waters) states that their bottles use up to 30% recycled content.

GDB currently state that refillable PET bottles are reused up to 20 times. Some evidence-based life cycle assessments used figures of between 14 and 16 reuses although those assessments are relatively old (latest was published in 2000).

Figure 14 shows the market share for refillable bottles in the non-alcoholic segment in Germany declining over the years. This is thought to be driven by the increased presence and market dominance of discounters, who due to lack of storage space exclusively sell single-use bottles.

Figure 14: Market share of refillable and single-use bottles in the non-alcoholic bottle segments, Germany



A number of other European countries have refillable container systems for beverages, however, there has been a similar or even more significant decline to that in Germany over the past decades.[23] In some countries, such as UK and Ireland, refillable beverage bottle systems have ceased to exist completely.[24] It is not clear what exactly has driven the decline. Likely reasons could include cost, convenience, transport distances, or lack of storage at retail. While the German case study above offers an example of how refillable beverage containers can work within a market, the feasibility of a refillable bottle system in other countries needs to be evaluated on a case-by-case basis.

Across Europe, a number of lifecycle assessments (LCAs) have been commissioned over the years to identify the environmental impacts of bottles in different beverage segments, comparing bottle materials and collection systems. There is currently no firm consensus on which bottle format is indeed the most environmentally beneficial one, and the LCA outcomes highly depend on the defined system boundaries within the analysis, such as packaging size, material (including recycled content), transport distances and collection rates.[25]

A move to or expansion of a refillable beverage bottle system requires major changes and therefore large-scale investments to the existing supply chains. It is therefore vital that if policies aimed at increasing reusable packaging are put in place, that sufficient consideration and transition time is given to each Member State. Further work is needed to ensure a thorough environmental assessment on a case-by-case basis. Any future policy and design of a refillable bottle system needs to be well considered to take into the challenges of specific geographical areas, relating to transport, storage and wash and refill facilities. It needs to be ensured that sufficient consideration and time is provided to allow the right enablers to be set up.

COLLECTION: FURTHER IMPLEMENTATION OF DEPOSIT RETURN SCHEMES

Targets for collection are becoming increasingly ambitious. The Single-Use Plastic Directive (SUPD) requires Member States to separately collect 77% of SUP bottles with caps and lids by 2025 and 90% by 2029. Whilst outliers (e.g., Belgium) have indicated that it might be possible to achieve satisfactory collection rates without DRS, most nations have recognised the need to implement DRS and it is widely considered the only way to meet separate collection targets for plastic beverage bottles by 2029. Furthermore, DRS has proven to result in a cleaner waste stream, free from the level of contamination experienced in mixed collection. This translates to an increase in the quality of the recycled output created.

Currently, eight EU Member States as well as Iceland and Norway have implemented DRS. A further 11 EU Member States, the UK and Turkey have taken the political decision to implement before 2025. Another six EU Member States are in discussion regarding DRS whilst the status of two countries (Italy and Luxembourg) is currently unknown. Table 5 displays the current status of DRS discussions in the EU27+3 at the time of writing, Figure 15 includes further detail.

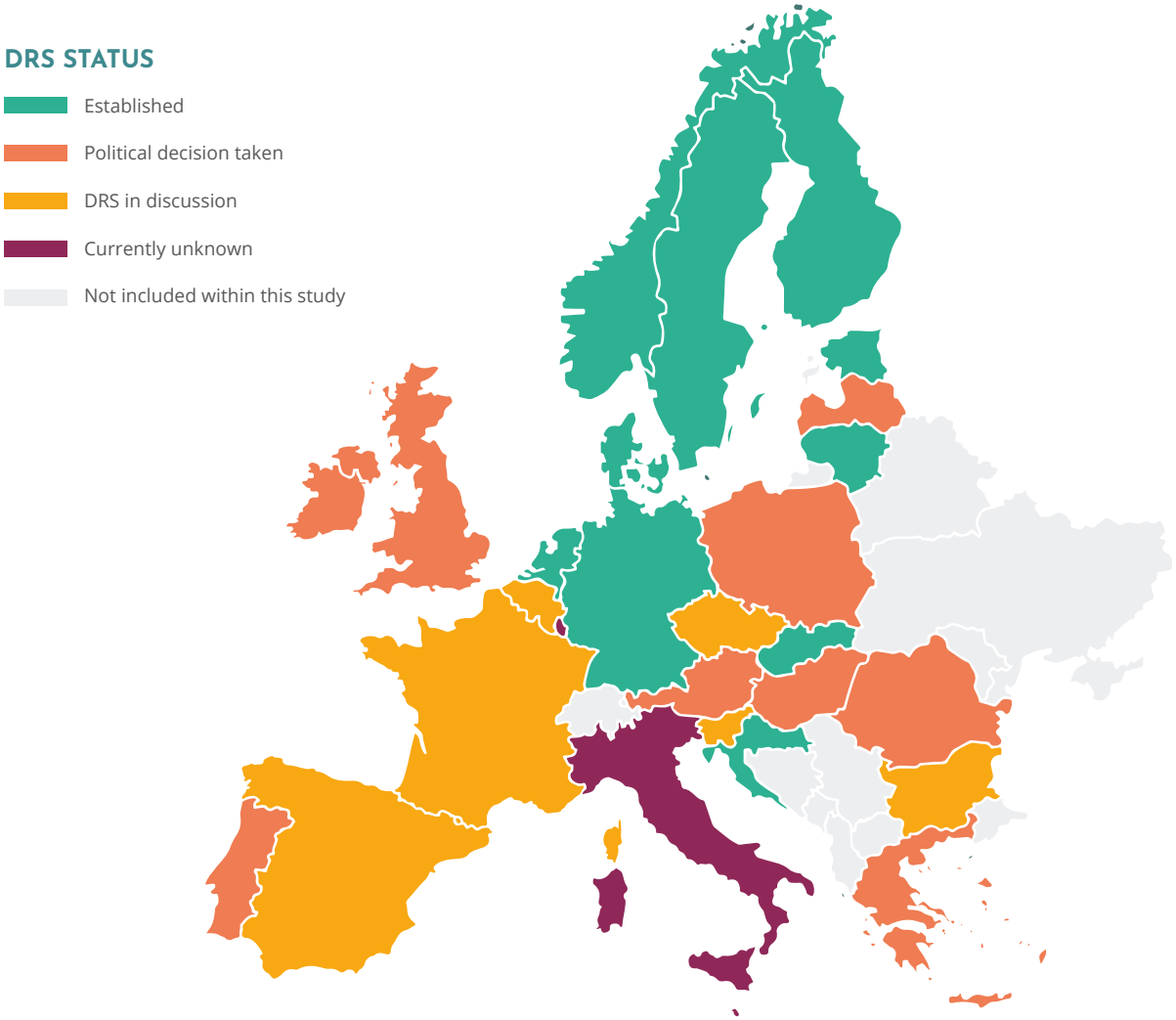
Table 5: Status of DRS Discussions in European Countries

Source: EPA Network[29], NMWE, TOMRA

DRS ESTABLISHED[26]		POLITICAL DECISION TAKEN[27]		DRS IN DISCUSSION	CURRENTLY UNKNOWN
ICELAND	1989	IRELAND	2022	BELGIUM	ITALY
DENMARK	2002	SCOTLAND		FRANCE	LUXEMBOURG
SWEDEN	1984	LATVIA		SPAIN	
NORWAY	1999	ROMANIA		SLOVENIA	
FINLAND	2008	TURKEY		BULGARIA	
ESTONIA	2005	MALTA		CZECH REPUBLIC	
LITHUANIA	2016	HUNGARY	2023		
CROATIA	2006	GREECE			
GERMANY	2003	POLAND	2024		
NETHERLANDS[28]	2005	PORTUGAL			
SLOVAKIA	2022	ENGLAND, WALES, N. IRELAND			
		AUSTRIA	2025		
		CYPRUS			

FIGURE 15: Status of DRS Discussions in the EU27+3

Source: Eunomia

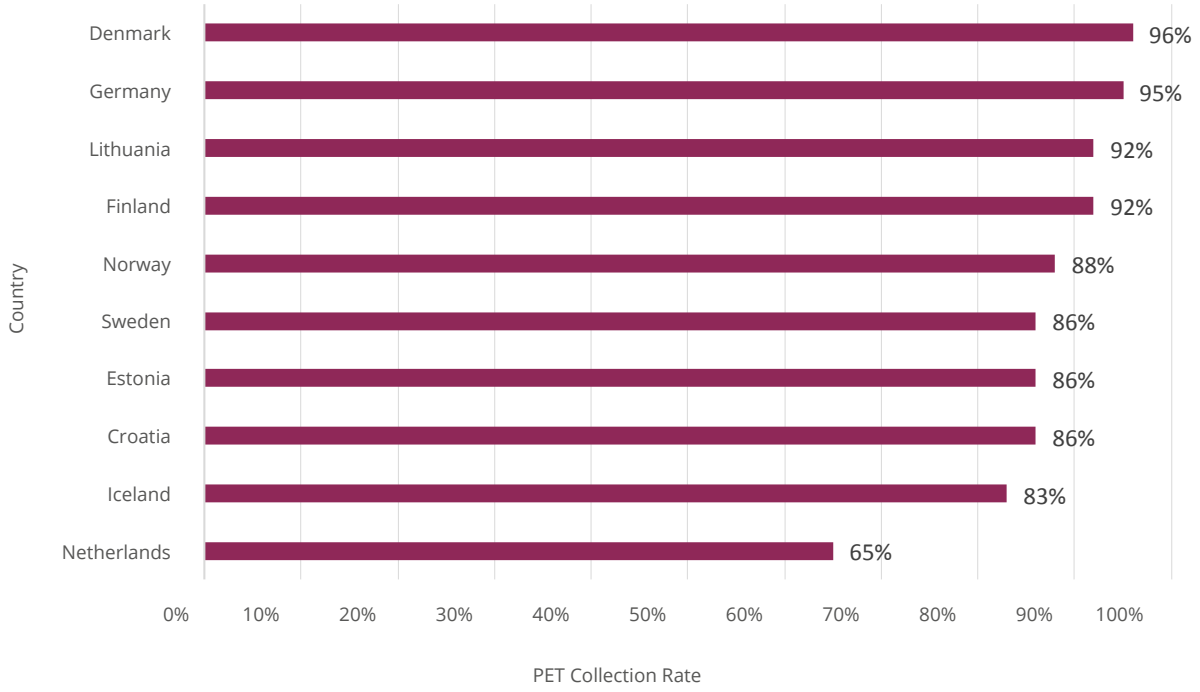


It is important to note that whilst target implementation dates have been included for the countries listed to have taken the political decision to implement DRS, these are often subject to change and delays. Additionally, different sources often identify slightly different implementation dates.

Countries that have implemented DRS systems tend to achieve relatively high collection rates, typically above 80% as is shown in Figure 16.

FIGURE 16: PET Collection Rates Across Countries with DRS Systems that Include PET

Source: PRE[30]



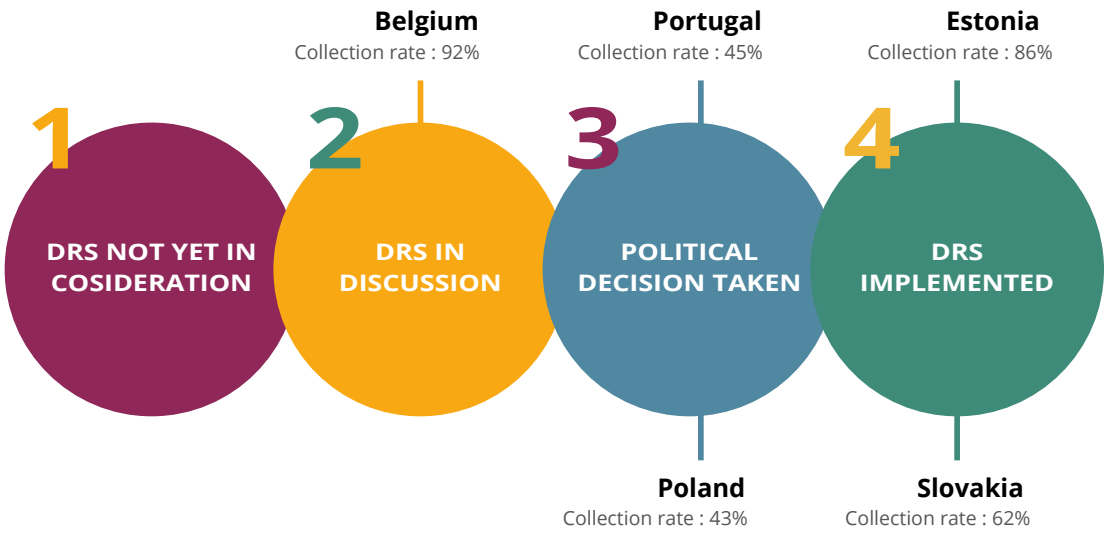
To better understand a range of different approaches to DRS, representatives from five Member States were interviewed regarding the status and progress within their nation. In the following sections, Belgium, Estonia, Poland, Portugal, and Slovakia have been explored as case studies. During the interviews and subsequent additional research, the following topics were explored:

- Rationale behind investigating DRS as an appropriate instrument for increasing collection and recycling rates for beverage PET;
- General attitude towards DRS;
- Challenges faced during initial discussions, scheme design, setup, and implementation; and
- Benefits experienced as a result of implementing DRS (if applicable).

The selected countries and their current status of DRS implementation can be seen in Figure 17 alongside current collection rates.

FIGURE 17: The Four Generic Stages of DRS Implementation

*Source: Eunomia; * Slovakia's collection rate is measured prior to DRS implementation*



In the following sections, the findings from the Member State interviews and supporting research have been explored and the key messages summarised.

BELGIUM

- DRS Status: DRS in discussion
- DRS implementation date: N/A
- PET collection rate: 92% [31]
- PET bottle deposit value: N/A

Belgium is historically one of the best performing countries in terms of collection rates for PET bottles, with current rates at 92%. The suggested key to achieving these high collection rates is a uniform collection system across the whole country. With high collection rates, DRS had previously not been a serious consideration for Belgium. However, according to industry experts there is a strong push from recycling networks promoting it as a solution for addressing littering. Additionally, the Belgian government has committed in the Belgian federal coalition agreement, to launch an investigation into whether incorporating a deposit scheme within the packaging tax is desirable.[32] In 2019, a pilot scheme collecting cans and plastics was implemented in Brussels.[33]

Political urgency to implement DRS is currently relatively low. Whilst Belgium has been classified here as "DRS in discussion", public conversations concerning its execution have been minimal. This, coupled with the country's already high collection rates, leave progress towards DRS in Belgium limited. Furthermore, PROs believe that the implementation of a new system may cause significant challenge whilst bringing little benefit. General attitudes among representatives is that existing EPR systems are able to meet all relevant packaging waste targets.

POLAND

- DRS Status: Political Decision taken
- DRS implementation date: 2024
- PET collection rate: 43%[34]
- PET bottle deposit value: TBC

With PET collection rates at 43%, Poland requires significant progress in order to meet the SUPD collection target of 90%. Whilst PET collection rates are low relative to many other Member States, Poland has successfully implemented effective collection systems for other material streams. For example, the country's glass bottle DRS consistently achieves return rates of 95%.

As a result of the need to improve PET collections, coupled with the success experienced with glass DRS, Poland began discussion regarding PET DRS in 2017. A Deloitte report examined the economic impacts of implementing DRS, concluding that it would come with significant cost.[35] As a result, DRS was originally labelled low priority for the Polish government.

Following introduction of the EU Single Use Plastic Directive, increased importance has been placed on the collection and recycling of PET. This appears to have caused Poland to re-examine DRS as a potential solution.

According to our expert interviews, rPET producers in Poland have become increasingly interested in DRS to boost recycled content in bottles. The Polish government published its plans for a DRS recently, and provisions in law may be established as early as middle of 2022. The government recognises the need for an ample transition period, which means that the actual implementation of DRS may not be until 2024.

While all stores will be required to charge a deposit, smaller (<100m2) establishments are not required to take back bottles due to their lack of storage space. It is envisioned that the DRS will cover PET beverage bottles for up to 3 litres and glass bottles for up to 1.5 litres. An inclusion of aluminium cans is currently not planned.[36]

PORTUGAL

- DRS Status: DRS agreed and implementation in progress
- DRS implementation date: 2023
- PET collection rate: 44.6%
- PET bottle deposit value: €0.15 (during pilot study)

Following parliamentary discussions, in 2018 Portugal enacted a mandate to implement systems to encourage deposit and return of beverage packaging for plastics, glass, ferrous metals and aluminium.[39,40] It was proposed that a pilot project would take place between 2021-2022 and full implementation would occur in 2022. Due to political delays, upcoming municipal elections, and the lack of enforcement of the legislation, the implementation is now expected to be delayed until 2023. Major PROs perceive 18-24 months as a realistic timeframe for implementation.

Municipalities are still in opposition of a DRS system, as they believe it would disrupt current operations, and are concerned about a reduction in income if good quality recycled material is lost to DRS. They believe they can meet recycling targets using current methods, and state a lack of evidence in the decision-making process for implementing DRS. However, their current collection rate of 44.6% is far below that being achieved by other DRS systems. The inclusion of glass in the DRS system is a major point of debate, as industry experts believe its inclusion will have a disproportionate effect on the cost of the DRS system. On the other hand, NGOs advocate for the inclusion of all material, stating the environmental impact and carbon footprint of glass as major reasons for doing so.

Additionally, PROs face the challenge of reporting to both an EPR and a DRS scheme in cases where they are dealing with multiple packaging types for their clients (for example snack packaging for EPR and plastic bottles for DRS) and are worried about the additional administrative burden of doing so. Overall, interviewed experts estimated that DRS may be significantly (up to three times) more expensive than the current recovery systems.

SLOVAKIA

- DRS Status: Dull DRS implemented
- DRS implementation date: 2022
- PET collection rate: 62%[41]
- PET bottle deposit value: €0.12[42](proposed)

Slovakia currently (reported prior to DRS implementation) has a collection rate for PET of approximately 62%. Whilst it has had in place a deposit scheme for glass bottles since 2003, DRS for plastics did not become a serious topic of discussion until late 2018, where ministers commissioned the Slovakian Institute for Environmental Policy for a case-study into the implementation of DRS in the country. This was largely driven as a response to the European Union's 90% plastic collections targets.

In the summer of 2018, the Institute for Environmental Policy was tasked with preparing a cost-benefit study on the implementation of DRS. With strong political backing, a law was passed by the National Council in September 2019 mandating DRS implementation. Following the legislation, a deposit return administrator was founded in March 2021, and is responsible for the creation, financing, and the co-ordination of DRS system, with the target of implementation in just 10 months (January 2022). This has caused several logistical and administrative challenges, with 18-24 months suggested as a preferable timeframe for implementation.

The implementation model was inspired by Scandinavian countries, as well as Estonia and Latvia, who were seen to have similar consumer attitudes and behaviours towards collection systems. Consultation with these existing schemes was stated as point of learning in developing the DRS system. Despite the short timeframe for implementation - leading to compromises in the coverage of the DRS system - the Slovakian DRS administrator expects the DRS system to outperform its target of 60% return rates in 2022.

DRS initially raised concerns by producers, retailers and local authorities prior to the law being passed. According to experts, producers were concerned with the financial cost associated with DRS. On the other hand, retailers were concerned with the additional logistics associated with DRS, and hence increased costs. Additionally, local authorities were hesitant in supporting a DRS system, amidst concerns about meeting their recycling targets with large amounts of high-value plastic removed from their collection streams.

In addition to the above stakeholders, support from the public was identified as a potential major challenge to successful implementation. In the Slovakian DRS system, collection points are only mandatory in big stores, meaning that public support leading to voluntary implementation is crucial to meeting targets. In 2020, a large campaign promoting the DRS system garnered large public support, ahead of full implementation in January 2022.

As of January 2022, Slovakia has officially implemented the DRS system.

ESTONIA

- DRS Status: Full DRS Implementation
- DRS implementation date: 2005
- PET collection rate: 85.6%[43]
- PET bottle deposit value: €0.10[44]

Estonia is one of the earliest adopters of DRS, having implemented its system in 2005. The process began in 2003-04 when the Minister of the Environment of the Baltic States agreed that DRS should be introduced to aid waste management, when Estonia became the earliest adopter of the system in the region. In the first year of introduction, Estonia was able to achieve a PET return rate of 70.2%, amidst a transition period for breweries and retailers. By 2010, the PET return rate had reached 91.5%. Since 2005, Estonia have twice increased the deposit value for packaging in attempts to increase return rates. The deposit value started at €0.06 and increased to €0.08 and €0.10, which has correlated with increased deposit rates. Initially, the main incentive for consumers was the return of their deposit value, however over time, media campaigns have increasingly focused on the environmental benefits and sustainability of DRS

systems. This line of messaging is seen as a more effective way of influencing consumer attitudes and working towards achieving 90% collection rates.

Previously, the main challenges faced by Estonia's attempts to introduce DRS were retail reluctance and consumer awareness. In 2005, very few countries had an operational DRS system, meaning understanding of the mechanics and the benefits of DRS were very limited. According to industry experts, awareness campaigns played a large role in increasing acceptance across stakeholders.

In working towards achieving higher collection rates, the current focus is to keep packaging return points both clean and pleasant for consumers and motivating return point owners such as retailers to do so. The perception of the cleanliness of the return points is seen as one of the barriers preventing the final 10-15% of the population who still do not regularly return packaging.

SORTING

Provided the economic benefit is clear, existing sorting technologies are largely capable of overcoming issues surrounding the adequate sorting of waste. Ongoing R&D continues to develop the speed and accuracy of automated sorting equipment such as visual identification systems (VIS) and Near-Infrared (NIR) technologies. This is supported by machine learning and AI algorithms to replicate or support the decisions of manual pickers.

In addition to optical waste identification processes, tracking technologies are also under development that may allow waste to be tracked through a system and sorted more efficiently. Chemical tracers, digital watermarking, and smart labels are all being explored as ways of conveying important material and product information. Chemical tracers and digital watermarks tag items by introducing machine-readable codes or identifiers onto a specific product.[45] Whilst these are not visible to the human eye, the right detection system on a sorting line can identify and decode the tag and use the obtained information to guide the products journey and sort it with significant accuracy.

In some emerging and more advanced approaches to waste tracking, optical identification processes are used in conjunction with tracking techniques, data analytics, mapping, and machine learning to further refine sorting ability.

RECYCLING

MECHANICAL RECYCLING

Mechanical recycling remains the primary end-of-life route for PET. The technology continues to experience incremental improvements as innovative separation technologies, cleaning processes, and filtration technologies are introduced. 'Super cleaning' has enabled decontamination of rPET to levels considered acceptable for incorporation back into food contact applications.

Whilst mechanical recycling can cause material degradation, research suggests that chain extenders, additives, and stabilisers can be used to improve the mechanical properties of rPET. Although initial research appears promising, long-term effects of such additives are not yet well understood and require further research before widespread implementation could be possible.[7]

DEPOLYMERISATION

Depolymerisation[46,47] is still a young industry (from a volume perspective) and is expanding the technologies which began in the early 1990's.

The plants treating PET waste in Europe are at various stages of development. Plants considered to have a technological readiness of either the "system is complete and qualified" or there is an "actual system proven in operational environment" are estimated to have a current input capacity of 68kt per annum of prepared post-consumer PET flake. They have demonstrated a range of processes, and the feedstock qualities (specifications) vary from process to process. This PET flake is derived mainly from, Type A (food grade, food use) and Type B (food grade, non-food use). A smaller number of the plants can take flake derived from Type C which is any other PET source. It should be noted at this point that there is a volume of collected PET waste, including industrial waste, that goes through chemical processing to become secondary products such as polyols, to be used in various outlets. This compliments the innovative process of circular depolymerisation processing in ensuring polyester waste is rejuvenated to new products.

The combined ambitions of are likely to result in a fast growth of this technology over the next few years. Some of this will be through expanding and building their own plants and some will come via offering licences for use of their technologies.[48] It is reasonable to forecast that by 2025 there could be capacity for circa 350kt per annum of collected post-consumer PET flake into depolymerisation processes in Europe which would produce an estimated 345kt per annum of regenerated PET monomers or virgin quality PET resin. Depolymerisation gives a much higher yield of output versus input, in comparison to other comparable chemical recycling processes.

Challenges still exist in the development of the depolymerisation market which will need to be overcome if depolymerisation is to increase to its full potential:

- Certainty that recovered monomers and oligomers from depolymerisation can be used for "food grade PET". At present all vPET resin made in Europe complies to regulation EU 10/2011.
- The Innovations in the market need to lead to investment.
- A consultation for amendments to the Regulation 282/2008 on recycled plastic materials and articles intended to come into contact with foods was published in December 2021 and discussions are ongoing. As there is no clear outcome from this consultation at the time of writing, the role that chemical depolymerisation may play in providing recycled content for food contact packaging remains uncertain at the moment.
- Building high volume (cross-border) feedstock supply chains for non-traditionally recyclable post-consumer and post-industrial PET waste streams.

5. WHERE NEXT?

- BY 2025, IT IS EXPECTED THAT 19 MEMBER STATES WILL HAVE DRS IN PLACE FOR PET BOTTLES.
- ASSUMING THE 90% COLLECTION RATE IS TO BE MET, THE EU IS LIKELY TO REQUIRE AN INCREASE IN RECYCLING CAPACITY OF AT LEAST ONE THIRD BY 2029.
- THE PET PACKAGING SECTOR IS MOVING TOWARDS HIGHER LEVELS OF CIRCULARITY.
- FURTHER SUPPORT, INNOVATION, AND MORE ROBUST DATA SOURCES ARE NEEDED IN ALL AREAS OF THE PACKAGING VALUE CHAIN TO ENSURE PROGRESS AGAINST TARGETS IS ACHIEVED AND MEASURED.

This section draws together our analysis of the current PET market and the key challenges facing recyclers in order to reflect on the future state of the market. This is set into the context of recent legislative changes and industry developments, and where/how the supply chain should focus its efforts in order to provide a robust view on the market as it continues to develop.

FUTURE STATE OF THE MARKET

DEMAND FOR PET IN PRODUCTS

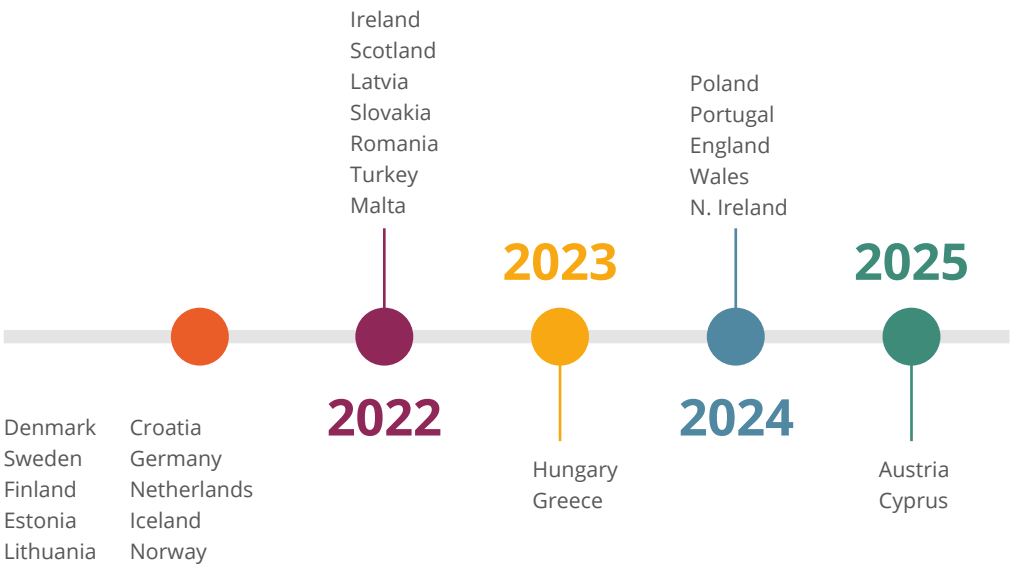
Plastic bottle consumption is expected to continue to grow, with average historic growth above 2% per year. Recycled content targets, if developed and applied to food packaging, could impact on volumes of food contact PET trays by shifting use from PP to PET. PET trays can be made with rPET, whereas currently there are no EFSA-approved processes for food-grade rPP from packaging.[49] Note that whilst PEF (polyethylene furanoate), a bio-derived polymer substitute for PET, is expected to enter the market in 2023, it would be a contaminant in the existing PET stream.[50] The separate sorting infrastructure required and consumer demand to use material that actually does get recycled, make it unlikely that PEF will gain a strong foothold in the European beverage market. It is worth noting that in 2017, PEF was expected to enter the market by 2020. This expectation has since been delayed until 2023.[51]

INCREASING COLLECTION RATES

With the right support and frameworks in place, the amount and quality of collected and sorted PET is expected to increase substantially over the next decade. As explored in Section 4d, a rapidly increasing number of Member States are committing to introducing DRS within the next few years. In addition to the eight Member States, Norway, and Iceland with DRS already in place, a further 11 (as well as the UK and Turkey) have preliminarily committed to introducing schemes by 2025. Of these, five Member States (and Turkey) aim to implement DRS by 2022 with a further two each year until 2025. This is shown in Figure 18. Six Member States currently remain in discussion, or their progress is unknown.

FIGURE 18: Timeline of Planned DRS Implementation

Source: Eunomia



As DRS implementation becomes more widespread, and with the SUP collection rate targets already in place, collection rates are likely to increase substantially on the lead up to 2025. If implementation dates remain correct, by 2025, there will be 19 Member States with DRS in place. The SUP Directive requires each Member State to achieve a 77% collection rate for beverage bottles by 2025 and 90% by 2029. Thus far, almost all countries with DRS in place are exceeding this collection rate and have collection rates of 83% of higher. The exception to this is the Netherlands, but as has already been stated, this is due to the partial coverage of the scheme which currently only includes large PET beverage bottles. This is expected to change rapidly following the inclusion of smaller bottles within the scope. Therefore, whilst there is likely to be a short delay during the time it takes for the schemes to be properly established, it can be expected that those Member States who are committed to implementing DRS before 2025 will improve their collection rates and make significant progress towards the SUPD targets.

Meeting European targets for the collection of PET beverage bottles by 2030 is expected to result in a 60% increase in tonnage of PET bottle bales available for recycling: an additional 1.0mt over the current tonnage of 2.0mt (assuming trays are sorted separately). This is based on the expectation that the collected weight target will be calculated under the assumption of a certain proportion of non-PET material in sorted streams.

As the PET tray recycling market continues to grow, more countries in EU27+3 are expected to expand their existing collection and sorting processes to increase output quantities of collected and sorted bales. With more developed recycling routes, PET trays could be expected to be collected and recycled at a similar rate to overall plastic packaging and reach a 50% recycling rate by 2025 and 55% by 2030.

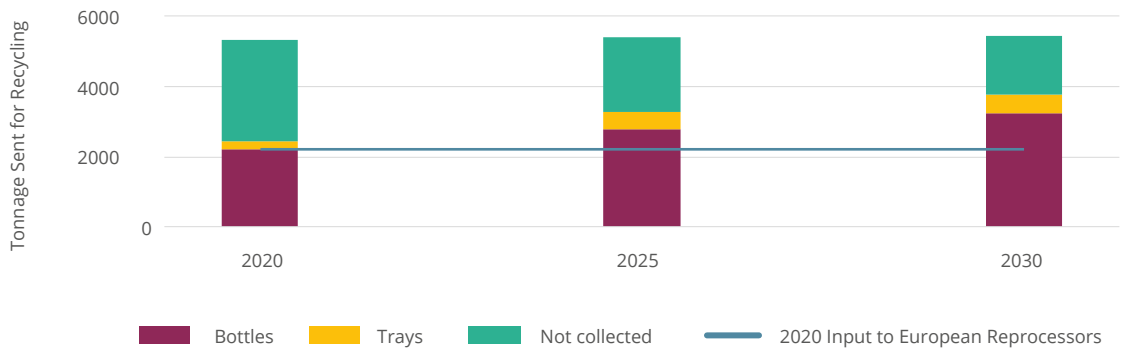
RECYCLING CAPACITY AND rPET PRODUCTION

The projected changes in collected PET in 2025 and in 2030 are shown in Figure 19. Even without assuming any growth in PET use in products, but assuming the 90% beverage bottle collection target is met, by 2029, the EU27+3 will require available recycling capacity to increase by more than a third if it is to process the tonnage of PET expected to be sent for recycling.

Through improvements in both the quantity and quality of PET collected and sorted, with particular focus to the separate recycling of PET trays, improvements in product design, and increasingly high-quality bottle collections from DRS, recyclers' yields could increase from an average of 71% of input in 2020[52] to 80% by 2030, resulting in a total of 3.0mt rPET output by 2030.[53]

FIGURE 19: Potential Increase in PET Sent for Recycling by 2030

Source: Eunomia. Note that this figure assumes no projected growth in PET use in products in order to project minimum likely growth in rPET recycling capacity



THE MARKET - rPET

EU27+UK demand for food-grade rPET for PET beverage bottle production is set to continue to grow rapidly in response to producers' pledges and average recycled content targets. So long as collection targets are met, the tonnage of available rPET should be considerably higher than that which would be needed to meet the minimum legislative 30% recycled content in bottles by 2030.

The PET packaging sector is moving towards higher levels of circularity, with individual convertors demonstrating what is possible by producing beverage bottles using 100% rPET from bottles, and trays made using 95% rPET.

MARKET SUPPORT

Several pieces of legislation have come into force to support increases in the recycled content used within plastic products and improvements in plastic product recycling. However, there remains a number of policy and R&D gaps which, in order to support the further development of markets for recycled PET within Europe, the industry needs to work together with European policy makers, to ensure that the increased quantity and quality of material collected can also feed high-quality recycling output into more mature markets.

A COMMON APPROACH TO ASSESSING RECYCLABILITY

CITEO in France, and to a lesser degree CONAI in Italy, both use eco-modulation of EPR fees to provide specific cost incentives for producers to ensure that products are designed to meet recyclability criteria. Eco-modulated fees should be used across all EPR schemes as an important way to help meet increased targets for the recycling of plastic packaging. It is important, however, that modulation criteria are harmonised across Member States. Without a unified approach, there is the potential for schemes to become increasingly diverse, complicating the landscape for producers and possibly introducing conflicting requirements that packaging formats are unable to meet. With the revision of the PPWD expected in 2022, it is possible that the harmonisation of EPR reporting requirements and modulation criteria could be on the horizon.

For the calculation of eco-modulated fees, and to provide additional clarity to brands who are aiming to increase the recyclability of their packaging, a common framework is needed. Recyclability should be assessed in the same way across the industry, underpinned by a clear definition, and with claims of recyclability tested against reliable protocols. As explored in Section 3c, Design for Recycling guidelines are one method to provide such a framework.

SORTED PACKAGING BALE QUALITY STANDARDS

As DRS is becoming increasingly widespread, it is expected that the quality of PET bottle bales will increase. Typically, DRS results in a waste stream with less contamination from both other materials, including other PET grades, and non-food contact materials. Processing bales with higher levels of non-PET materials increases the cost and complexity of sorting operations. Contamination from non-PET, and even non-target PET grades, reduces the quality of the rPET output. Furthermore, high levels of non-food contact PET material (>5% according to EFSA) would prevent rPET from being reused in food-grade PET applications.

Under EPR, PROs in certain Member States are involved in the contracting of sorting plants. Examples include CITEO in France and Duales System Deutschland (DSD) in Germany. In this scenario, there is a greater opportunity to mandate a certain quality of output. Where possible, common European quality standards should be agreed upon and implemented across industry. This would give recyclers the ability to refuse bales from collectors and sorters that do not meet the required minimum standard.

If, despite these actions, plastics cannot be sorted from other materials (e.g., paper and glass) to the standard required to obtain high enough quality bales, industry should consider collection plastics for recycling separately from other materials.

CERTIFICATION PROCESS FOR RECYCLED MATERIAL

Responding to consumer awareness, brands are making commitments to integrating recycled content into their products. There is currently no harmonised certification process in place to verify the claims made by brands and producers to guarantee the quality of recycled material they are incorporating. There is a need for greater certification and traceability in the supply chain, the components of which should be:

- An EU-wide quality certification (comparable to an EN643 standard for paper) for recycled polymers; and
- A Chain of Custody (CoC) certification management system of an unbroken chain of organisations legally owning the material throughout the supply chain, from the certified recycler output into the final product.

This would allow brands and producers to meet internal targets or legislative requirements regarding recycled content with confidence in the traceability of the material. It would also ensure that commitments to incorporate recycled content will create equivalent demand for certified recycled output from recyclers.

EUCertPlast, created by PRE, EPRO, EuPC and Recovinyl, is an existing quality certification scheme based on the European Standard EN 15343:2007. It is recognised by German and Italian authorities and could form the basis for an EU-wide certification.[54,55]

RecyClass has developed the Recycled Plastics Traceability Certification, a possible approach to measuring, tracing and verifying recycled content along the entire value chain of the material and which could provide the basis of a certification process if it finds acceptance by industry and policy makers. The certification approach is based on the principles of CoC and the Recycled Plastics standards. One of the advantages of the certification process is that the process can easily be adopted by any company which plays a part in the value chain and holds custody of the recycled plastics including but not limited to compounders, converters, blow moulders and brand owners.

FURTHER R&D

To continue to see progress in PET recycling, further innovation and research and development are needed in almost all stages of the value chain. The key requirements for R&D have been included here.

To aid better sorting, producers and brands should consider instigating a marker technology during the design of their product packaging. This could take the form of a digital watermark, chemical tracers, or another solution capable of relaying key information pertaining to a packaging format's origin and application. If harmonised across industry, this could allow for targeted sorting of high-quality PET streams to enable circularity. For example, if a specific chemical tracer is used on all food contact packaging, the recycling value chain will be more able to single out such formats, processing them in a way that meets contamination requirements and allows the resulting recyclate to once again be input into food contact applications. Alongside data information markers, the accuracy and efficiency of sorting could also be enhanced be the development and widespread uptake of automatic sorting technologies using visual data and machine learning to improve over time.

To improve mechanical recycling, additional R&D is needed in all processing steps including hot washing, de-inking, liquid separation, composition measurement, fines filtration, and odour reduction. In addition, there is a need to further develop the use of additives to enhance processing and performance properties. Whilst market drivers, such as the need for circularity in food contact applications, are instigating progress in each of these areas, further R&D remains necessary.

Finally, significant developments in depolymerisation technologies are needed if PET products are to move towards 100% recyclability. Depolymerisation has the potential to overcome current limitations of rPET associated with colour.

ROBUST DATA SOURCES

Whilst this report goes some way to examining the state of the PET market, it has also identified a number of data gaps with regard to the total PET supply chain and how it is changing over time. This data is needed to ensure that the EU27+3 continues to develop the appropriate capacity and technology to meet the demands of the changing packaging landscape.

To understand the rapidly changing market for PET recycling, more transparent data is needed at all points within the value chain. Furthermore, this should be regulated to some degree. It is possible that the revision to the PPWD may result in better data availability and robustness as measures may be introduced to harmonise EPR reporting requirement.

In particular, a better resolution of data is needed for:

- The amounts of PET packaging formats placed on the market, split into type, colour, and other design attributes affecting recyclability;
- The tonnages of PET packaging that is collected in each Member State, again split by format, application (e.g., beverages) and other relevant distinguishers (e.g., colour);
- The contents and quality in PET bales across different Member States; and
- Imports of material formats (bottles, flakes, pellets) into each stage of the recycling value chain.

A FINAL NOTE

Firstly, we would like to express our appreciation to the recyclers that responded to PRE's survey, and to PETCORE Europe, CPME, NMWE and UNESDA Soft Drinks Europe for contributing data and for your expert insights and thorough review of our findings. In order for progress to be made towards a circular economy within the PET industry and consumer demands and policy requirements to be met, robust data and forecasts on all actors in the PET value chain are needed.

The ongoing efforts within industry such as industry collaboration may in future close existing data gaps across the value chain of PET. In the meantime, it is important that European EPR schemes to gather and publish the necessary data to aid the understanding of the state of the market. This in return will engage relevant actors within the PET value chain and allow forward planning, aid investment decisions, and ultimately keep as much PET as possible within the European value as long as possible. Finally, a push towards design for recycling might be achieved if PROs agree towards a common recyclability assessment.

ANNEX

1. *The data included within this section is used in Section 3 to identify the key challenges facing the recycling market based on the PET mass balance across the EU27+3*
2. *Viscosity number (VN) is the term used by Eurostat to distinguish between two streams of PET. Intrinsic viscosity (IV) is the term commonly used by the PET industry. VN can be used to calculate IV and vice versa, i.e., there is a linear relationship between the two. A VN of 78 ml/g is equivalent to an IV of approximately 0.70 dl/g. Therefore, throughout this report, "high viscosity" refers to PET with a VN of ≥78 ml/g and an IV of ≥0.70 dl/g. Typically, film, sheet, and bottle grade PET has an IV of ≥0.70 dl/g. Fibre grade PET typically has an IV of <0.70 dl/g.*
3. *UN Comtrade Labs, UN Comtrade Database last accessed 11/11/2021, available at: https://comtrade.un.org/data/*
4. *Eurostat, PRODCOM: Statistics on the production of manufactured goods last accessed 11/11/2021, available at: https://ec.europa.eu/eurostat/data/database*
5. *PCI Wood Mackenzie (August 2017) PET Recycle Survey West Europe 2016*
6. *PCI (2013) A review of the PET Collection Stream in West Europe in Relation to PET THEROFORMS*
7. *Figure provided by PETCORE Europe*
8. *Zero Waste Europe (2020) The Netherlands move one step closer to better separate collection of plastic available here: https://zerowasteeurope.eu/2020/05/drs-the-netherlands/?mc_cid=1c97e1a50f&mc_eid=19d9c8ee9a*
9. *Plastics Recyclers Europe, Petcore Europe, and EFBW (2020) PET Market in Europe - State of Play: Production, Collection and Recycling Data, 2020*
10. *In Figure 12, as throughout the rest of the report, "lower viscosity PET applications" refers to applications using PET with a viscosity number <78 ml/g and "higher viscosity PET applications" refers to applications with a viscosity number ≥78 ml/g*
11. *Note that, as has been highlighted in the previous sections, the scope of data differs and is dependent on what was available at the time of writing*
12. *Food Packaging Forum (2018) Global Definitions of Plastics' Recyclability, available at: https://www.foodpackagingforum.org/news/global-definition-of-plastics-recyclability*
13. *European PET Bottle Platform (2019) Design Guidelines, available at: https://www.epbp.org/design-guidelines*
14. *PETCORE (2020) DfR Guidelines – PET Thermoforming Trays, available at: https://petcore-europe.org/images/pet/Design_for_Recycling_Guidelines_PET_Trays_Clear_Transparent_Jan_2020.pdf*
15. *RecyClass (2021) Design for Recycling Guidelines, available at: https://recyclass.eu/recyclability/design-for-recycling-guidelines/*
16. *https://ec.europa.eu/environment/system/files/2021-12/Correspondents%27%20guidelines%20No%2012%20final%20Nov%202021%20corr1.pdf*
17. *Any intra-EU shipment that does not conform to EU3011 would need to apply the EU48 code and any shipment of PET from outside the EU that does not comply with B3011 would need to apply Y48. Both EU48 and Y48 are so called "other waste" entries for which prior informed consent needs to be obtained from the country of dispatch, transit, and destination. Such prior informed consent is an additional lengthy administrative burden, but not a ban on shipments*
18. *Naturally Sustainable – NMWE, accessed 11 January 2022, https://naturalmineralwaterseurope.org/naturally-sustainable/*
19. *Confidential interview with industry stakeholder, November 2021*
20. *Genossenschaft Deutscher Brunnen (2021) GDB Reuse System in Germany, Bonn / Brussels, 2 March 2021*
21. *Alexander Dallmus (2021) Sind Glasflaschen besser als Plastikflaschen: Einweg oder Mehrweg? Welche Flaschen sind umweltfreundlicher?, accessed 13 December 2021, https://www.br.de/radio/bayern1/inhalt/experten-tipps/umweltkommissar/flaschen-glas-einweg-mehrweg-pet-umwelt-100.html*
22. *Wirtschaftsvereinigung Alkoholfreie Getränke e.V. (2020) WAFG Aktuell - Erfrischungsgetraenke - LP 15/2020*
23. *Reloop The Vanishing Refillable, accessed 14 December 2021, https://www.reloopplatform.org/beverage-sales-by-container-type-in-austria-16/*
24. *refillables.grm.org Western Europe's Experience with Refillable Beverage Containers – Reduce, Reuse, Refill!, accessed 14 December 2021, https://refillables.grrn.org/western-europes-experience-with-refillable-beverage-containers/*
25. *Industry associations, such as PETCORE Europe, have specialised working groups looking into the benefits and challenges of reusable packaging systems.*
26. *The dates included here are implementation dates.*
27. *The dates included here are planned implementation dates.*
28. *The Netherlands is currently undergoing an expansion of its DRS system. Smaller plastic bottles (i.e., having a volume of 1 litre or less) were introduced in July 2021.*

29 *EPA Network (2018) Deposit Return Schemes available at: https://plonesaas.devel4cph.eea.europa.eu/epanet/reports-letters/reports-and-letters/ig-plastics_working-paper_deposit-return-schemes.pdf*

30 *PRE (2020) PET Market in Europe: State of Play*

31 *PRE, Petcore Europe, and NMWE (2020) PET Market in Europe - State of Play: Production, Collection and Recycling Data, 2020*

32 *Zoete, T. (2020) Belgian coalition agreement – Linking a deposit return system to the packaging tax is a smart decision, https://recyclingnetwerk.org/2020/09/30/belgian-coalition-agreement-linking-a-deposit-return-system-to-the-packaging-tax-is-a-smart-decision/*

33 *Bottlebill (2021) Current and Proposed Laws - Belgium, https://www.bottlebill.org/index.php/current-and-proposed-laws/worldwide/belgium*

34 *Plastics Recyclers Europe, Petcore Europe, and EFBW (2020) PET Market in Europe - State of Play: Production, Collection and Recycling Data, 2020*

35 *Deloitte (2019) Deposit-Refund System (DRS) FACTS & MYTHS*

36 *Polish News (2021) Deposit for glass and plastic bottles. The Ministry of Climate and Environment explains - when will the deposit system start in Poland?, accessed 13 December 2021, https://polishnews.co.uk/deposit-for-glass-and-plastic-bottles-the-ministry-of-climate-and-environment-explains-when-will-the-deposit-system-start-in-poland/*

37 *Plastics Recyclers Europe, Petcore Europe, and EFBW (2020) PET Market in Europe - State of Play: Production, Collection and Recycling Data, 2020*

38 *TOMRA (2020) Deposit return system kicks off in Portugal with TOMRA for campus recycling, https://newsroom.tomra.com/nova-tomra-portugal/*

39 *TOMRA (2020) Deposit return system kicks off in Portugal with TOMRA for campus recycling, https://newsroom.tomra.com/nova-tomra-portugal/*

40 *Assembly of the Republic Law No. 69/2018 (System to Encourage the deposit and return of beverage packaging for plastics, glass, ferrous metals and aluminium)*

41 *Plastics Recyclers Europe, Petcore Europe, and EFBW (2020) PET Market in Europe - State of Play: Production, Collection and Recycling Data, 2020*

42 *The Slovak Spectator (2019) Slovakia will introduce a deposit scheme for PET bottles and cans in 2022, https://spectator.sme.sk/c/22210435/slovakia-will-introduce-deposits-on-pet-bottles-and-cans-in-2022.htm*

43 *Plastics Recyclers Europe, Petcore Europe, and EFBW (2020) PET Market in Europe - State of Play: Production, Collection and Recycling Data, 2020*

44 *Reloop Platform Global Deposit Book 2020 - An Overview of Deposit Systems for One-way Beverage Containers, https://www.reloopplatform.org/wp-content/uploads/2020/12/2020-Global-Deposit-Book-WEB-version-1DEC2020.pdf*

45 *Ellen MacArthur Foundation (2020) HolyGrail: tagging packaging for accurate sorting and high-quality recycling*

46 *Depolymerisation is the term used for chemical recycling of PET; in this case the term is used to describe depolymerisation of PET which is then used again in plastic production as a replacement of virgin PET.*

47 *PETCORE Europe have released a position statement titled "PET recycling by depolymerisation Position Paper by PETCORE Europe Depolymerisation Working Group" which explains the European developments in depolymerisation. PETCORE Europe currently has eleven (11) member companies in Europe (EU27+3) developing PET depolymerisation. Data has been collated under anti-trust rules to protect competitive activities. Individual company and innovator data has been collated by the auspices of the PETCORE-European Management Team under non-disclosure protection, https://www.petcore-europe.org/pet-monomer-recycling-special-industry-group.html*

48 *PETCORE Europe survey conducted with relevant members in late 2021.*

49 *EFSA website, https://www.efsa.europa.eu/en/publications/PP*

50 *European Bioplastics (2017) Bioplastics market data 2021, available here: https://www.european-bioplastics.org/market/*

51 *European Bioplastics (2017) Bioplastics market data 2017, available here: https://docs.european-bioplastics.org/publications/market_data/2017/Report_Bioplastics_Market_Data_2017.pdf*

52 *As derived from the annual PET Recyclers Survey (PRE, 2020)*

53 *80% yield of rPET aligns with the high end of the recycling yield ranges provided by PRE survey respondents. As more material is sourced from DRS collections and recyclability problems decrease, there is likely to be scope to increase yields further.*

54 *Full scheme details available at https://www.eucertplast.eu/downloads-links*

55 *Bund/Länder-Arbeitsgemeinschaft Abfall (LAGA, https://www.laga-online.de/) and Consorzio nazionale per la raccolta, il riciclaggio e il recupero degli imballaggi in plastica (COREPLA, http://www.corepla.it/).*

NATURAL MINERAL WATERS EUROPE

Place des Barricades 1
1000 Brussels - Belgium
Tel + 32 2 880 20 30
Fax + 32 2 880 20 35
info@nmwe.org
www.naturalmineralwaterseurope.org

PETCORE EUROPE

Avenue de Broqueville 12
1150 Brussels - Belgium
+32 2 315 24 88
info@petcore-europe.org
www.petcore-europe.org

PLASTICS RECYCLERS EUROPE

Avenue de Broqueville 12
1150 Brussels - Belgium
+32 2 315 24 60
info@plasticsrecyclers.eu
www.plasticsrecyclers.eu

UNESDA SOFT DRINKS EUROPE

Rue du Trône 14-16
1000 Brussels - Belgium
+ 32 2 737 0130
mail@unesda.eu
www.unesda.eu