eunomia

PET MARKET IN EUROPE
STATE OF PLAY

PRODUCTION, COLLECTION AND RECYCLING DATA

EFBW
EUROPEAN FEDERATION OF BOTTLED WATERS

petcore Europe

PLASTICS RECYCLERS EUROPE

GLOSSARY OF TERMS

BOPET	Bi-axially Orientated PET
CITEO	French PRO
CONVERSIO	Conversio Market & Strategy GmbH
CONAI	Consorzio Nazionale Imballaggi (Italian PRO)
DMT	Dimethyl terephthalate
EPBP	European PET Bottle Platform
EFBW	European Federation of Bottled Waters
EFSA	European Food Safety Authority
EPR	Extended Producer Responsibility
EPRO	European Association of Plastics Recycling
EPS	Expanded polystyrene
EU28	European Union as of 2019
EU**28+2**	European Union + Norway and Switzerland
EU28+EFTA	European Union + European Free Trade Association (Iceland, Liechtenstein, 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-MATERIAL **MULTI-LAYER**	Product (typically tray or flexible packaging) made with layers of more than one material (other polymers and/or fibre, metal)

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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
REPROCESSING	The process of taking plastic scrap into rPET
SUP	Single Use Plastic

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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 €3bn in turnover.

ABOUT PETCORE EUROPE

Petcore Europe is the association representing the complete PET value chain in Europe since 1993.

Its mission is to ensure that the entire PET industry is well aligned to enhance its value and sustainable growth, to represent the PET industry before the European institutions and other stakeholders, to ensure that PET is positioned as an outstanding packaging material and recognised as environmentally sound, to support and validate innovative packaging solutions from a recycling perspective, and to work with all interested parties to ensure a continuous increase of PET post-consumer collection and recycling.

PET (PolyEthylene Terephthalate) is a strong but light-weight form of polyester. It is used to make containers for soft drinks, juices, drinks, water, edible oil, fresh food and dairy as well as household cleaners and other non-food applications. PET bottles and food containers, such as sheets and trays are perfectly recyclable while they help to reduce CO2 emissions and food waste.

ABOUT EFBW

EFBW is the voice of the bottled water industry, dedicated to promoting the unique qualities of natural mineral water, spring water and other types of bottled waters to EU institutions and international organisations.

Through its membership of national associations, bottled water companies as well as suppliers, EFBW represents almost 550 producers of bottled water across Europe.

INTRODUCTION

This report, delivered by PRE in partnership with Petcore Europe and EFBW, 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.

The partners intend to update and re-publish this 'State of the Market' report bi-annually.

The report uses best available data sources to present data estimates, alongside results from the first annual survey of PET recyclers.

Data was received from an estimated 69% of installed recycling capacity for PET across Europe (representing 1.4mt of capacity across 14 countries covering all major reprocessing locations).

The first years' data presented here will provide a benchmark from which to analyse future developments and trends, including outlining remaining gaps in data to support full supply chain analysis.

All data sources referenced in this report are listed in Annex.

2. CURRENT STATE OF THE MARKET

Figure 1 illustrates the supply chain of PET in the context of the circular economy. The key elements are covered in our analysis of the PET market within this section.

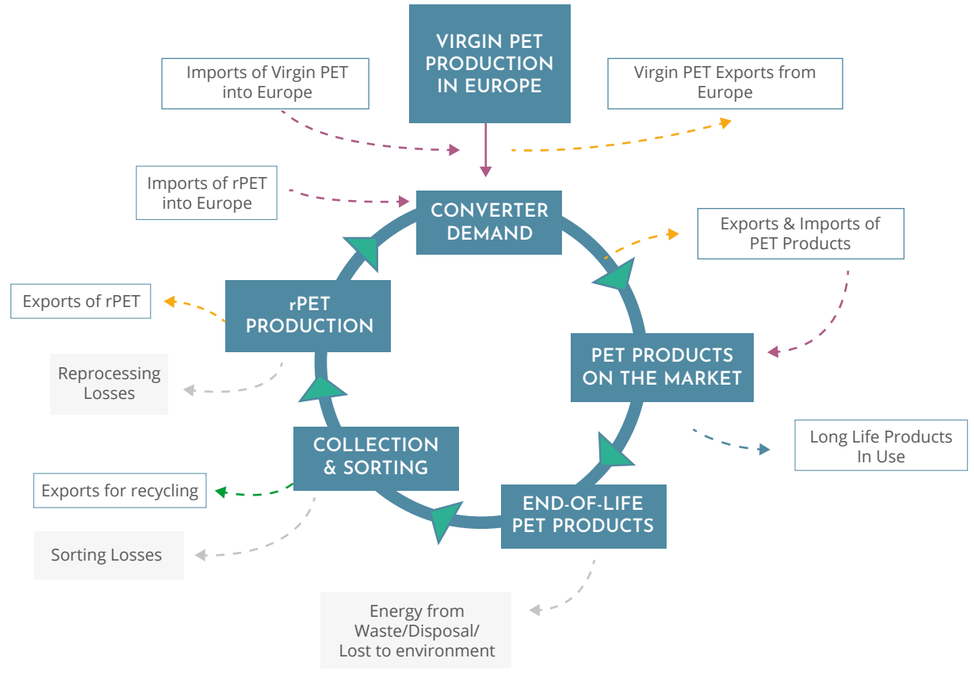


FIGURE 1: PET Lifecycle in the Circular Economy

The data provided in this section is used in Section 3 to identify the key challenges facing the reprocessing market based on the PET mass balance across the EU28.

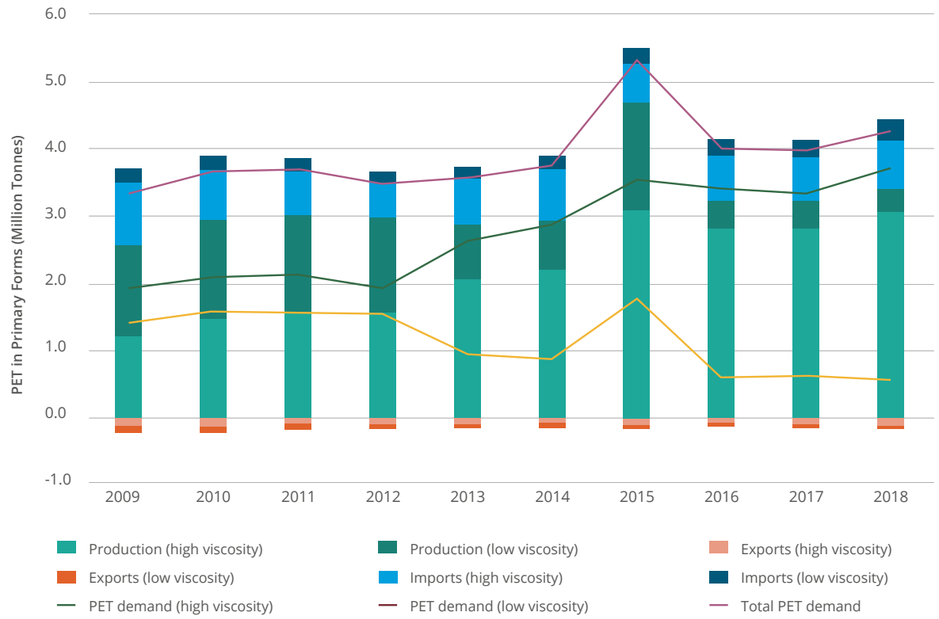
- **DEMAND FOR PET EXCEEDS PRODUCTION (WITHIN EU28+2 BOUNDARIES).**
- **THE LONGER-TERM TREND SHOWS OVERALL GROWTH IN PRODUCTION AND DEMAND FOR PET, PARTICULARLY IN HIGH VISCOSITY PET.**

PRODUCTION AND CONSUMPTION

Net demand for PET was estimated at 5.3mt in 2018, of which 3.0mt was supplied from virgin PET production, 1.4mt from rPET production and 0.9mt from imports.

Figure 2 shows Eurostat demand data for PET in 2018 of 4.3mt versus production of PET of 3.4mt i.e. only 70% of net EU28 demand is met by EU28 production/supply.[2,3] However, Eurostat data excludes a significant portion of the rPET produced.

FIGURE 2: Production and Demand of PET in Primary Forms, 2009-2018, EU28 (Source: Eurostat)



(Note: Figure 2 data excludes demand in textiles/fibres)

Eurostat's PET production data is distinguished by viscosity, which is related to the melting point, crystallinity and tensile strength of PET[4]. Higher viscosity resin is typically required for blow-moulding bottles than for sheet production. Production and demand levels for low viscosity PET in primary forms have fallen over the last decade from around 1.4mt of demand in 2009 to 0.6mt in 2018. However, demand for high viscosity PET has increased from 1.9mt in 2009 to almost 3.7mt in 2018. This has been met predominantly by an increase in production of high viscosity PET from within the EU28, with import tonnages remaining relatively stable over time.

The longer-term trend is of overall underlying growth. This growth is driven primarily by continued growth in demand for PET in plastic packaging applications (see section c.IV).

In addition to primary forms, imports of PET film and sheet significantly contribute to fulfilling the EU28's overall PET demand. In 2017, Eurostat reported that the EU28 produced 665kt of PET sheeting, enough to satisfy only 75% of the 887kt demand for PET film and sheet.

IMPORT AND EXPORT

- **THE EXPORT MARKET VALUE FROM THE EU28 IS SMALLER THAN THE IMPORT MARKET:**
  - **SIX TIMES LESS FOR PRIMARY-FORM PET**
  - **HALF THE SIZE FOR PET SHEET**
  - **JUST OVER 10% LESS FOR PLASTIC BOTTLES**

Primary-form PET imports into the EU28 are six times the value of those exported from the EU28, at a total import value of €1.1bn versus an export value of €180m. In tonnage terms, primary-form PET imports exceed exports by about 900kt.[5]

The EU28 is also a net importer of PET products. Across all PET applications – primary forms, sheets and bottles – the EU28 has a negative trade balance of over €1.4bn.[6] However the balance between imports and exports is much less for products than for the primary-form PET, with exports of PET sheet half that of imports, and exports of PET bottles only 10% less than the export market.

According to Prodcom data, the EU28's largest trade partners (for imports of Primary PET) over the period 2010 to 2016 have been the Republic of Korea (€203m), Turkey (€181m), India (€124m) and Indonesia (€77m), between them contributing more than 75% of the total import value.

Comtrade data shows that since 2012, Turkey and Indonesia have emerged as major sources of PET, whilst imports from Oman have declined. The majority of imports of PET sheet also come from Turkey, India and the Republic of Korea.[7] 60% of the total export of Primary PET from the EU28 is to Switzerland (€25m), Ukraine (€22m), USA (€14m) and Turkey (€12m).

Within the EU28, only Lithuania, the Netherlands, Spain and Belgium have a positive trade balance (in value terms) in respect of primary PET import versus export. Italy and France have the largest trade deficits, measured by value.[8]

"PRIMARY-FORM PET IMPORTS INTO THE EU28 ARE SIX TIMES THE VALUE OF THOSE EXPORTED FROM THE EU28, AT A TOTAL IMPORT VALUE OF €1.1BN VERSUS AN EXPORT VALUE OF €180M. IN TONNAGE TERMS, PRIMARY-FORM PET IMPORTS EXCEED EXPORTS BY ABOUT 900KT.[5]"

END MARKETS (PRODUCTS)

- 3.4MT PET BOTTLES AND 0.9MT PET TRAYS WERE PLACED ON THE EU28 MARKET IN 2018.
- TOTAL PET BOTTLE CONSUMPTION IN 2017 (BY WEIGHT) SLIGHTLY OUTPACED REGIONAL GDP GROWTH AT 2.9%.
- THE USE OF PET BOTTLES FOR NON-BEVERAGE ITEMS (SUCH AS HOUSEHOLD AND COSMETIC PRODUCTS) IS GROWING.
- CONSUMPTION OF PET FILM AND SHEETING (PRIMARILY FOR TRAYS AND FLEXIBLE PACKAGING) IS GROWING.

Based on applying 2016/17 growth rates to EU28+2 data from ICIS and Petcore Europe, and cross-checking PET tray figures with Eurostat reported demand for PET sheet, we estimate that a total of 3.4mt PET bottles and 0.9mt PET trays were placed on the market in the EU28+2 in 2018.[9]

Figure 3 shows an approximate breakdown of PET product applications (excluding fibre (polyester) and monofilament), highlighting the significance of the packaging sector in overall demand for PET.[10,11]

"WE ESTIMATE THAT A TOTAL OF 3.4MT PET BOTTLES AND 0.9MT PET TRAYS WERE PLACED ON THE MARKET IN THE EU28+2 IN 2018"

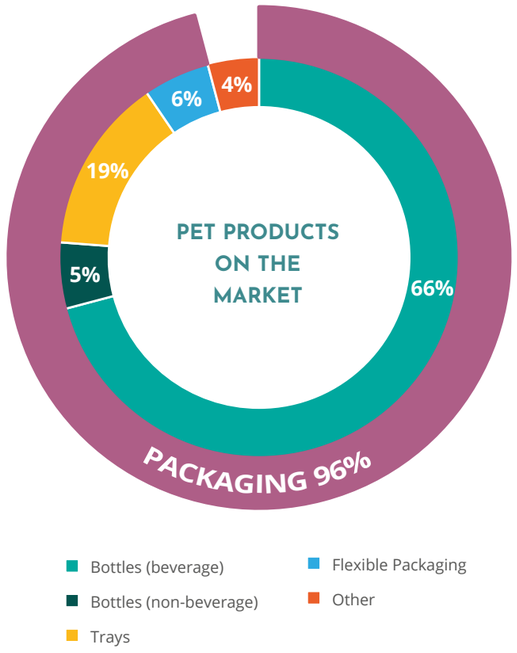


FIGURE 3: PET Products on the Market, derived from Eurostat data, Deloitte, and other studies. Excludes PET fibre and monofilament products (fibre and strapping).

PACKAGING (96%)

The main packaging product uses are:

- **Bottles (71%):** The largest use of PET is for bottles and, within that, drinks/beverage bottles. The large majority of PET bottles are transparent, but opaque PET is used more extensively in some regions (for example for milk packaging in France). There is a lack of reported data on the split between PET beverage and non-beverage bottles, but based on a prior Petcore Europe study by PCI, it is estimated up to 8% of PET bottles are used for other food applications such as sauces, and for cosmetic/hygiene products.[12]
- **Trays (19%):** PET in the form of sheet is used for other food packaging, primarily in blisters or thermoformed or 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 we estimate that the amount of PET trays being placed on the market is in the region of 0.9mt (between 0.8-1mt) per annum.[13]
- **Flexible Packaging (6%):** 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. PET flexible packaging is addressed in more detail in the 'Flexible Films' report that will be published by PRE in due course. Market experts estimate that approximately 300kt of PET per annum is being used in multi-material multi-layer films.

OTHER PRODUCT SECTORS (UP TO 4%)

PET is also used for photographic films, X-rays, and electrical insulation.

PET FIBRE AND MONOFILAMENT APPLICATIONS

In monofilament or fibre form it is used for strapping, and extensively for fibre (as polyester). Monofilament and fibre production, products, waste streams and recycling are not covered within the scope of this report, though are an important market for recycled PET.

MARKET TRENDS

The tonnage of PET products on the market has been shaped in the past decade by substantial growth in consumption of both PET bottles (both beverage and non-beverage) and PET trays. The growth in PET bottles has been partly offset by beverage bottle light-weighting (in response to environmental concern and to reduce unit cost). Nonetheless, in 2017, when compared to 2016, consumption of PET for bottles and food packaging across the EU28 continued to grow, with PET bottle consumption (by weight) slightly outpacing regional GDP growth at 2.9%.

The biggest growth in PET products is in the consumption of PET film and sheeting (primarily for trays and flexible packaging), which has grown at an average of 5.2% per annum since 2014.[14]

PET bottle consumption growth is not consistent across Member States. In 7 countries there was a decline in consumption from 2016 to 2017, and in a small number (notably Austria and Sweden) there has been reported a more consistent reduction over time.[15] As the data quality improves these trends should become more apparent.

COLLECTION AND SORTING

- AN ESTIMATED 4.3 MT OF PET RIGID PACKAGING ENDED ITS PRODUCT LIFE AND WAS THEREFORE AVAILABLE FOR COLLECTION IN 2018, OF WHICH 45% (1.9MT) WAS COLLECTED AND SORTED FOR RECYCLING ACROSS THE EU28.
- 52% OF PET BOTTLE ARISINGS WERE SORTED FOR RECYCLING COMPARED TO BETWEEN 16% AND 21% OF PET TRAY ARISINGS, REFLECTING LOWER CAPTURE RATES OF PET TRAYS IN COLLECTIONS AND ALSO A LESS DEVELOPED MARKET DEMAND FOR SORTED PET TRAYS.
- PET IS COLLECTED AND SORTED FOR RECYCLING FROM A RANGE OF SCHEMES ACROSS THE EU28, INCLUDING DEPOSIT RETURN SCHEMES (DRS) THAT ACCOUNT FOR UP TO 35% OF COLLECTED PET.

Given that the majority of PET products are single-use and quickly disposed of, we can assume that the majority of products placed on the market in a year will become available for collection in the same timeframe. Therefore, based on the market data presented above, we estimate that approximately 4.3mt of PET rigid packaging material ended its product life and was therefore available for collection in 2018 across the EU28, the majority of which (3.4mt) was plastic bottles, with the remainder (~900kt) being PET trays.

According to the PRE Recycler Survey, recyclers sorted the following proportions of bottle colours; clear and light blue bottles represented the majority of bottles (over 69%), whilst coloured and opaque represented just under 28% and 2% respectively.[16] Note these are likely to be an underestimate of the total clear and light blue bottles, as some countries do not have colour sorting for PET.

BOTTLE COLLECTION AND SORTING

In 2018, 2.0m tonnes of PET bottle bales were sorted for reprocessing, an increase of 5% on the previous year's data reported by Petcore Europe and continuing a trend of consistent annual increases. From 2013 to 2018, 'sent for recycling' rates (measured by the weight of sorted bales of PET bottles, prior to adjusting for non-PET material, PET trays and moisture) increased from 55.9% to in the region of 60%.[17] Assuming the tonnage of PET bottles sent to reprocessors is in the region of 88% of the collection weight, accounting for an estimated non-PET rate of 8% and a PET tray content of 4% (though the quality of data on these figures is low), the real 'sorted for recycling' rate of PET bottles is estimated at 52%.[18]

Therefore, the data gathered by PRE and Petcore Europe indicates that in the region of 1.78mt of PET bottles were sorted for recycling in 2018. This calculation reflects how recycling rates are likely to be reported in future following the elaboration of Implementing Decision (EU) 2019/665.[19]

PET TRAY COLLECTION AND SORTING

PET trays are not yet collected for recycling in a significant number of European regions. Where PET trays are targeted by collection systems they are collected with other plastic or mixed light packaging (see Table 1) and, in some cases, are subsequently sorted into PET bottle bales. **However, to ensure that the majority of PET trays sorted for recycling are, in fact, recycled, trays need to be sorted from PET bottles for separate reprocessing (due to the high loss rates when recycled alongside bottles).** PET trays are currently only sorted for separate recycling in some areas within France, the Netherlands, Spain, Germany and, only introduced recently, in Belgium.

Bale specifications vary between countries as to the extent to which PET trays are allowed within clear or coloured PET bottle bales.[20] Recently, reprocessors have reported an increasing quantity of trays present within received bottle bales. In many countries, PET trays often remain in mixed plastic fraction outputs from sorting plants.

Aggregate study and PRE survey data suggest that, in 2018, around 60kt of PET trays were separately sorted, with a further 90kt to 190kt present in PET bottle or other mixed plastic bales.[21] Given that approximately 900kt PET trays were available for collection, the sorting for recycling rate for PET trays in 2018 is estimated to be between 16% and 21%.[22]

COLLECTION SYSTEMS

Based on the above analysis of bottle and tray collection and sorting, we estimate that 45% of total PET rigid packaging arisings were collected and sorted for recycling across the EU28 in 2018. Table 1 shows how those arisings are collected in each country. It also shows whether a deposit refund scheme for beverage PET bottles is in place, together with 2017 estimates of total PET bottle (beverage and non-beverage) 'sorted for recycling' rates.

Note that this data is based on country and EPR scheme reporting; greater transparency of reporting is required in order to further improve the level of confidence in this data.

"BASED ON THE MARKET DATA PRESENTED ABOVE, WE ESTIMATE THAT APPROXIMATELY 4.3MT OF PET RIGID PACKAGING MATERIAL ENDED ITS PRODUCT LIFE AND WAS THEREFORE AVAILABLE FOR COLLECTION IN 2018 ACROSS THE EU28, THE MAJORITY OF WHICH (3.4MT) WAS PLASTIC BOTTLES, WITH THE REMAINDER (~900KT) BEING PET TRAYS."

TABLE 1: PET Bottle Collection Systems in EU28+EFTA

Country	Deposit Return Scheme (green = Y)	Predominant Household Collection System		PET Bottles Sorted for Recycling Rate 2017 (green = >80%)*
		Collection System	Collected With	
AUSTRIA	N	Door-to-Door	Light packaging (Light plastic & metal packaging, often including cartons)	73%
BELGIUM	N	Door-to-Door	Light packaging	85%
BULGARIA	N	Bring	Light packaging and glass	22%
CROATIA	Y	Bring	Light packaging	86%
CYPRUS	N	Door-to-Door	Light packaging	Not reported
CZECH REPUBLIC	N	Bring	Plastic packaging	67%
DENMARK	Y	Door-to-Door	Light packaging, in some regions glass	86%
ESTONIA	Y	Door-to-Door	Light packaging	86%
FINLAND	Y	Bring	n/a	92%
FRANCE	N	Door-to-door	Light packaging, and in some regions paper/card	47%
GERMANY	Y (excl. juices)	Door-to-door	Light packaging	95%
GREECE	N	Bring	Co-mingled material: Metals, glass, paper	28%
HUNGARY	N	Door-to-door	Light packaging	42%
ICELAND	Y	Bring	n/a	83%**
IRELAND	N	Door-to-door	Co-mingled material: Metals, glass, paper	62%
ITALY	N	Door-to-door / Bring	Light packaging, sometimes with glass	46%
LATVIA	N	Bring/ door-to-door	Plastic packaging	43%
LITHUANIA	Y	Bring, some door-to-door	Plastic packaging	92%***
LUXEMBURG		Door-to-door	Light packaging	58%
MALTA	Planned (2020)	Door-to-door	Metals, glass, paper	Not Reported
NETHERLANDS	Partial	Door-to-door / Bring	Plastic packaging	65%
NORWAY	Y	Door-to-door / Bring		88%
POLAND	Planned (tba)	Door-to-door	Co-mingled material: Metals, glass, paper	43%
PORTUGAL	Planned (2022)	Bring, some door-to-door	Packaging	35%
ROMANIA	Planned (2022)	Bring	Paper, glass, plastic, metal (additional fraction: wood)	52%
SLOVAKIA	Planned (tba)	Bring	Plastic packaging	Not Reported
SLOVENIA	N	Door-to-door	Light packaging and paper/card	41%
SPAIN	N	Bring/ door-to-door	Light packaging	37%
SWEDEN	Y	Door-to-door / Bring	Light packaging and paper/card	84%
UNITED KINGDOM	Planned (Scotland 2021, England/ Wales 2023/24)	Door-to-door	A mixture, often co-mingled (Paper & cardboard, plastic, glass, metal)	59%

Sources: ICIS and Petcore Europe (2019) Annual Survey on the European PET Recycle Industry 2017; BiPRO/CRI (2015), Assessment of separate collection schemes in the 28 capitals of the EU; Eunomia (2018), Early Warning Country Reports; other expert contributors.
**Based on PET Bottle Bales, so may contain some PET trays depending bale specifications. Individual country sorted for recycling rates are based on a 2017 data assessment and are understood to be underestimated in some cases*
***Recycling rates reported for 2018 as reported by CITEO and Endurvinnslan hf, the Estonian DRS operator.[23]*
**** Lithuania's reported rate increased following the introduction of a deposit return system. The 92% return rate for PET is reported by the Lithuanian DRS.*

Ten countries in EU28+EFTA have deposit schemes and several other countries – the UK, Malta, Romania, Portugal, Slovakia and Poland – are at varying stages of planning and implementing schemes.

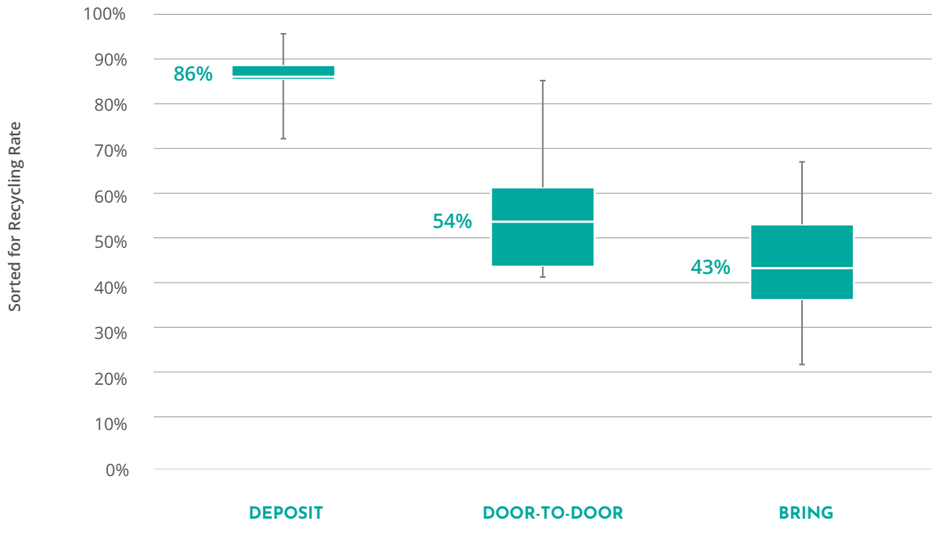
Nine out of the ten existing schemes have sorted for recycling rates of all PET bottles of over 83%. The tenth (Netherlands) has a scheme with only partial coverage of PET bottles (i.e. bottles larger than 0.5l in volume).[24] The most recent full implementation was in Lithuania, which resulted in an increase in the PET bottle collection rate from 32% to 92% in the first two years of the scheme.[25] In 2017, these ten countries accounted for 21% of all PET available for collection, but 35% of PET sorted for recycling.

Household collections – either via door-to-door or bring sites – also target PET bottles, usually alongside other light mixed packaging include PET trays. Door-to-door collections offer householder convenience, particularly in areas of low-rise housing, whereas bring site systems can be operated at a lower collection cost. Additionally, in several countries, PET packaging items are sorted and recovered from mixed household waste.

Figure 4 shows the PET bottle sorted for recycling performance according to system type. Door-to-door and bring schemes have a wide range in performance, with average sorted for recycling rates of 54% and 43% respectively. The DRS systems perform consistently highly in targeting beverage bottle PET for recycling, which results in an overall increase in PET recycling (as PET beverage bottles make up a significant portion of the PET available for collection). DRS systems also result in a high-quality collected PET bottle stream, low in non-PET material and free from PET trays, and provides for detailed and accurate data on the numbers of deposit-bearing containers sold and returned.

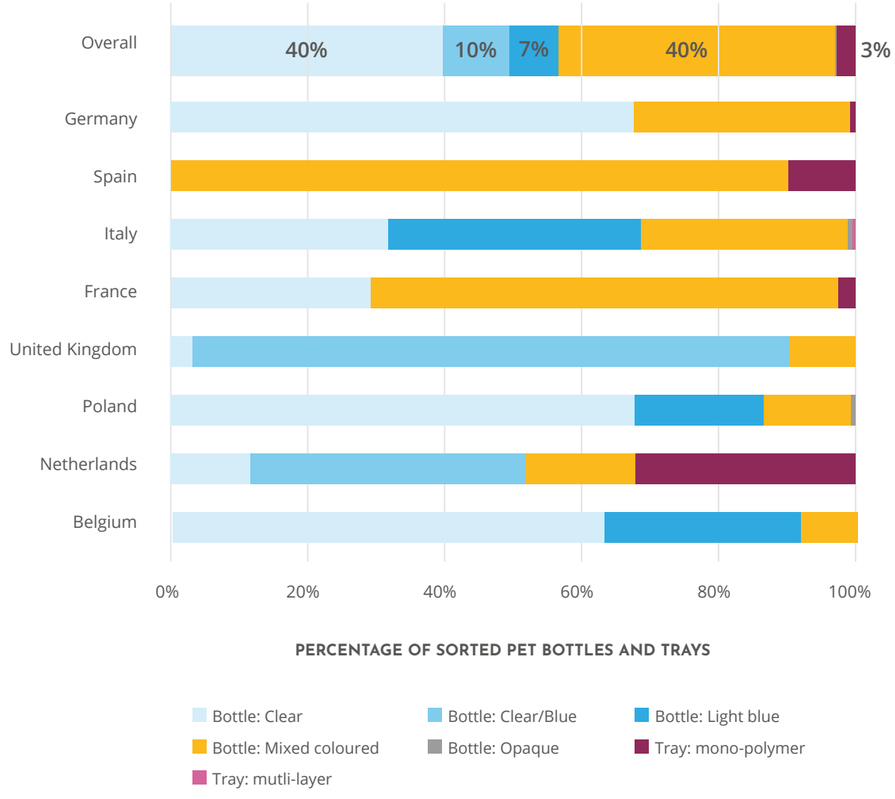
Note that other factors such as effective communications, residual/pay-as-you-throw (PAYT) policies will also affect sorted for recycling rates within each country.

FIGURE 4: Collection Scheme Performance Range Bottle PET 2018



Member states still vary as to which colour fractions PET is sorted into, as illustrated in Figure 5. Where mixed colour fractions contain large amounts of clear and blue PET they may be further colour sorted.

FIGURE 5: Proportions of Sorted Colours of PET Bottles and Trays 2018



REPROCESSING

- IN 2018 AROUND 1.9MT OF THE 2.1MT OF PET SORTED FROM COLLECTIONS WERE REPROCESSED WITHIN THE EU28+2. THE AVERAGE YIELD OF rPET WAS 73% OF INPUT TONNAGES. 1.35MT OF rPET OUTPUT WAS THEREFORE PRODUCED IN THE EU28+2.
- SINCE 2014 THERE HAS BEEN RELATIVELY LITTLE GROWTH IN CAPACITY, BUT SIGNIFICANT GROWTH IN INPUT VOLUMES AND CORRESPONDING UTILISATION/EFFICIENCY.
- PET TRAY REPROCESSING CAPACITY IN THE EU28 IS LESS WELL DEVELOPED THAN BOTTLE REPROCESSING CAPACITY, BUT WITH SOME SPECIALIST LINES INSTALLED RECENTLY OR IN DEVELOPMENT, THIS MARKET AREA IS GROWING.

PRE data shows that around 1.87mt of the 2.09mt of PET bales sorted from collections (inclusive of non-PET material, PET trays and moisture) is reprocessed within the EU28+2. Germany (23%), France (14%), Italy (14%) and Spain (14%) account for 65% of PET reprocessing capacity in the EU28+2 (see Figure 6).

The EU28+2 currently has approximately 2.2mt of total input capacity for PET reprocessing, which has grown from 1.5mt over the last decade. According to PRE survey respondents, in 2018 the average utilisation of plant capacity was estimated to be 86%, processing almost 1.9mt of input.[26] In 2018, output of rPET was 1.35mt.[27]

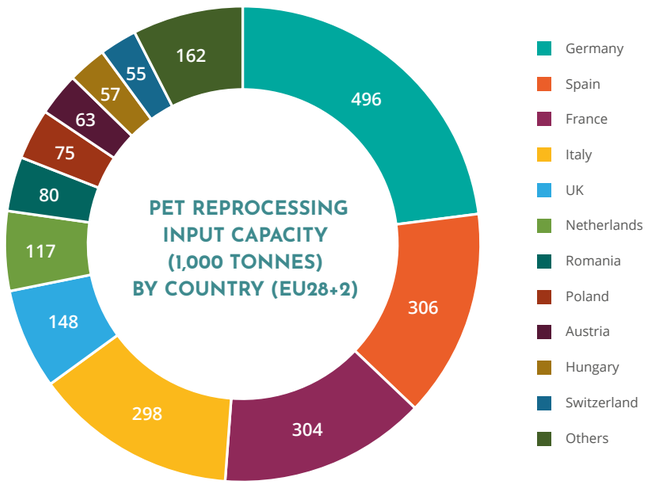
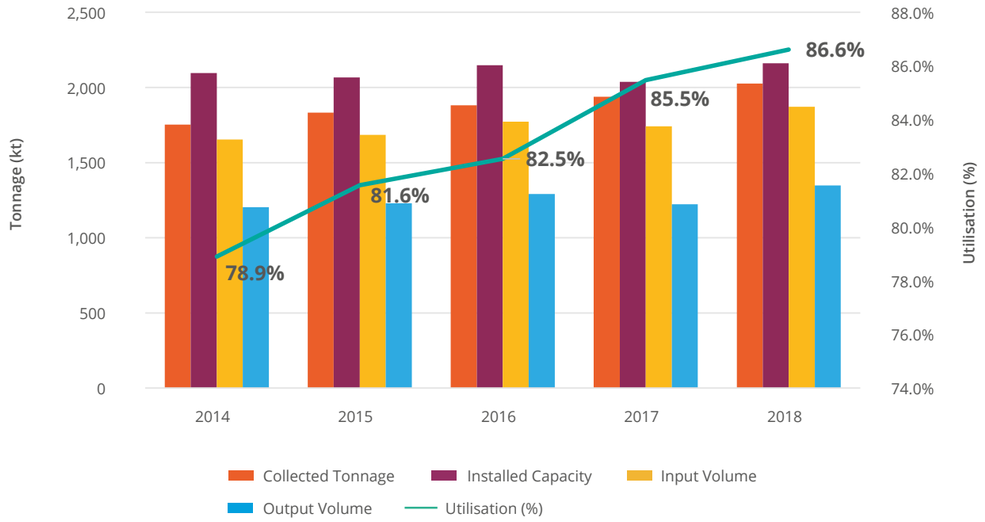


FIGURE 6: PET Reprocessing Input Capacity (1,000 tonnes) by Country (EU28+2)

Figure 7 summarises reported changes in reprocessing capacities for PET from 2014 to 2018, sourced primarily from ICIS/Petcore Europe reports. Since 2014 there has been relatively little growth in capacity, but growth in input volumes and corresponding utilisation.

Europe's reprocessing capacity is focused on the processing of PET bottle bales into flake or pellets. There is also a small but growing dedicated reprocessing capacity for PET trays in the EU28+2 though there are currently no existing data sources specifically tracking PET tray reprocessing capacity.

FIGURE 7: Change in European (EU28+2) PET Reprocessing Capacity over time [28]



Strong demand from bottle manufacturers resulted in the price of food-grade rPET continuing to rise; in 2018, the price of food-grade rPET stayed consistently higher than, and decoupled from price fluctuations in, virgin PET.[29]

- THE MAIN END MARKET FOR rPET IS PACKAGING, SPECIFICALLY BOTTLES FOR FOOD AND DRINK (18% OF rPET SOLD) AND BOTTLES FOR NON-FOOD (10%), AS WELL AS TRAYS & SHEETS (14% FOOD AND 16% NON-FOOD). FIBRE WAS ALSO REPORTED AS A KEY END MARKET, WITH ONE QUARTER OF ALL REPORTED rPET BEING SOLD INTO THAT MARKET.

END MARKETS (rPET)

PRE received data from members covering 1.4mt of installed PET reprocessing capacity (69% of the total market) across 14 countries covering all major reprocessing locations.

Survey respondents reported that the use of rPET in bottle-to-bottle recycling has been growing in response to manufacturer demand. The end markets reported are presented in Figure 8. 32% of rPET went to food-contact packaging applications and almost a quarter was sold for fibre.

Reprocessing capacity certified under the EuCertPlast[45] scheme has grown from 670kt to 840kt from 2018 to 2019, increasing coverage from 32% to 40% of total estimated capacity. This shows greater emphasis on the importance of demonstrating quality of the rPET produced and in providing robust data to enhance knowledge of the state of the market across the supply chain.

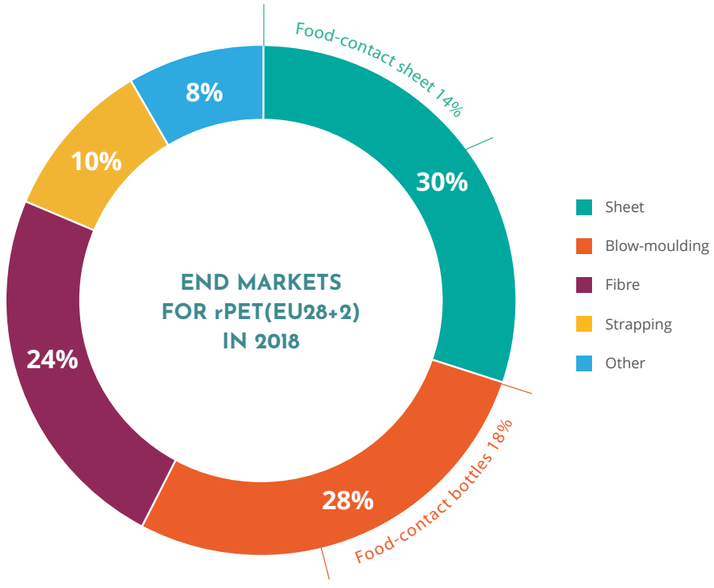


FIGURE 8: End Markets for rPET (EU28+2) in 2018 based on PRE survey respondents

Table 2 shows estimates of recycled content in European bottle and tray production, derived from comparing estimations of tonnages of rPET based on the survey respondent end markets reported above with production estimates (see Figure 3). Note that the data presented are only estimates, since the survey response may not be representative of the whole market and it does not take into account imports or exports of rPET.

TABLE 2: Approximate use of rPET (EU28+2) compared to European production (EU28) in 2018, Focus on Key Packaging Product Groups

	rPET to Product Application 2018, kt	Use in EU28 Production, 2018, kt	Estimate of Recycled Content in 2018
Blow-moulding (food contact)	238	3,400	11%
Blow-moulding (other)	135		
Sheet (food contact)	190	900	45%
Sheet (other)	215		
Other sectors (fibre, strapping, injection-moulding)	569		
TOTAL	**1,348**		

PET NET EXPORTS FOR RECYCLING

Data on exports of PET sorted for recycling are not readily available, as Eurostat does not report PET exports separately from 'other plastics', which includes any plastic scrap not recorded as PE, PP, PS or PVC, and may include mixed plastic bales. However, exports of 'other plastics' have fallen by 40% since 2016.[30] The best estimate of PET exports for recycling is likely to come from comparing quantities of PET sorted for recycling with input tonnages to EU facilities: this gives an estimated 200kt of PET (inclusive of non-PET material and moisture within bales) exported for reprocessing in 2018.

3. KEY CHALLENGES FACING THE REPROCESSING MARKET

- THERE IS INCREASING CONSUMER PRESSURE TO INCREASE RECYCLED CONTENT IN PRODUCTS. AS DEMAND FOR rPET INCREASES HOW DO WE THUS COLLECT AND SORT SUFFICIENT QUANTITY AND QUALITY OF PET FOR RECYCLING.
- A KEY CHALLENGE LIES IN HOW TO COLLECT, SORT AND REPROCESS PET TRAYS TO HELP MEET OVERALL PET DEMAND.
- THERE IS A NEED TO STRENGTHEN CURRENT PROGRESS TOWARDS WIDESPREAD APPLICATION OF RECYCLABILITY GUIDELINES INCLUDING, FOR PET TRAYS, NEW GUIDELINES PUBLISHED BY PETCORE, TO MAXIMISE HIGH QUALITY rPET PRODUCTION FROM COLLECTED REAMS.

This section explores the key challenges facing the PET reprocessing market in Europe. 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 resultant impacts on the sorting and reprocessing industry.

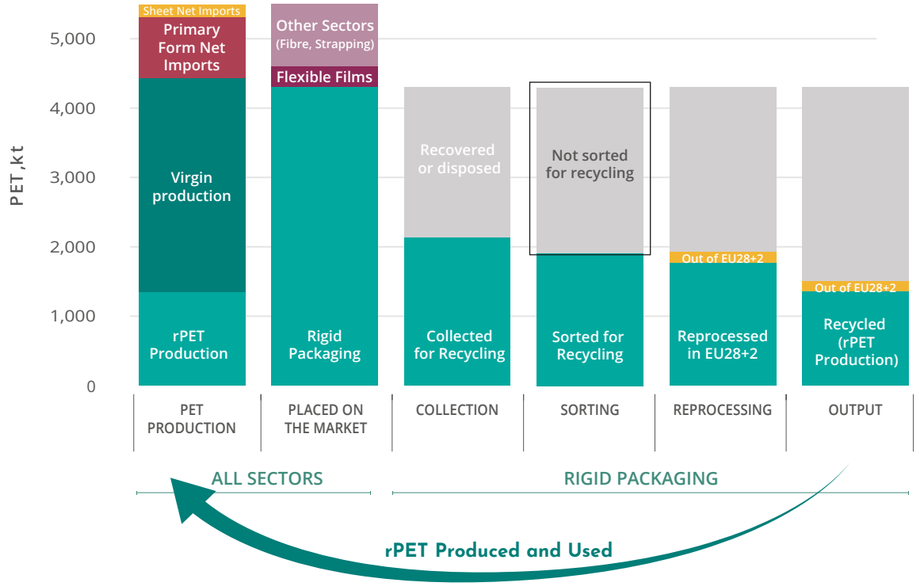
QUANTITY: PET MASS BALANCE

Figure 9 shows the current mass balance of PET across the EU28+2. The stages are shown across the horizontal axis, with coloured blocks indicating the flows in or out at each stage. The major source of leakage of PET out of the recycling chain is in the initial stages of collection and sorting. When PET is collected for recycling, it is subsequently sorted, reprocessed and recycled to a high degree, with the vast majority recycled in the EU28+2.

The figure does not, however, tell the whole story. The majority of PET that is currently collected, sorted and reprocessed is PET bottles; these are easier to target and collect through deposit schemes, leading to high quality bales that can be more readily sorted and reprocessed into rPET. For PET trays, collection and sorting rates are much lower. PET trays are more costly to reprocess per tonne of output, and there are far fewer separate PET tray reprocessing lines.

Whilst there is still some room for improvement in bottle PET collection and sorting across the EU28+2, the major challenge to fully bridging the gap in terms of mass balance lies in the ability for collection and sorting systems to capture PET trays going forward. This is particularly significant given that the growth of consumption of PET film and sheeting is outpacing that of PET bottles.

FIGURE 9: Overall PET Mass Balance, 2018



(Note: virgin production and import data is for the EU28 only (as no data for Norway or Switzerland) and the remainder are for the EU28+2).

QUALITY OF SORTED PET BALES

Bale quality is viewed by reprocessors as having deteriorated.[31] The reducing quality is particularly an issue with material derived from door to door and bring collections. The higher levels of paper fibres and organic material present in household derived PET can increase costs and sorting losses and make it more expensive to sort and clean the material to a high standard. PET trays are also often considered to contaminate PET bottle bales, because increasing the amount of PET trays within a PET bottle bale affects the quality of the PET flake. 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.

There are also no EU-wide standard definitions for levels of transparent or coloured PET, leading to different nations using differing standards, limiting the potential for intra-EU trade between sorters and recyclers.[32]

QUALITY: RECYCLABILITY AND rPET PRODUCTS

Ensuring a product is readily recyclable requires more than simply manufacturing the main product body from a technically recyclable polymer. Other features of product design (the use of closures, labels, inks) can hinder recyclability, and increase the costs of producing and/or reduce the value of secondary material. The technical and economic practicability of arranging the collection and onward sorting and management of the material must also be considered.

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

1. The product must be made with a plastic that is **collected for recycling,** has **market value** and/or is supported by a legislatively mandated program.
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 of reprocessing (condition 3, with reference to commercial recycling processes).

Table 3 examines each main PET product group against each condition; this clearly illustrates the challenges faced, in particular, in the recycling of PET trays. The table highlights the importance of considering all links in the supply chain when designing products, to ensure as much high-quality material can be collected and sorted as possible for future rPET production. Whilst this section focuses on the end-market drivers, the challenges in the collection, sorting and reprocessing of rPET will also need to be increasingly factored into future product design. This is explored further in the 'Where Next?' Section below.

Within the concept of recyclability, it is also possible to distinguish between uses of rPET that are circular (material is recycled into products into the same or an equivalent product group) versus a recycling cascade use, where rPET is used in alternative product groups with less demanding specifications. However, the viability of rPET derived from each product group for different kinds of product applications is not captured in most definitions of recyclability, including PRE's definition above.

The range of potential uses of rPET relates to its mechanical properties, visual properties (clarity, colour and consistency) and to odour. Whilst clear and light blue bottles can be recycled back into similar coloured PET products, mixed colour PET can be used only in darker colour applications. Opaque bottles affect the clarity and transparency of the rPET, and are tolerated within limits in mixed colour bales. There are relatively low levels of separately sorted Opaque bottles available for reprocessing.

PET trays can be reprocessed separately back into food-contact trays. However, the presence of multi-material multi-layer trays, adhesives, films and the brittleness of the material add to the challenges of maintaining a high quality circular model for this product group. Thus far, whilst processes for producing high-quality output from PET bottle bales are well developed, with 32% of rPET derived from bottles used in food-contact applications, the market for reprocessing PET trays remains underdeveloped. The different polymers in multi-material multi-layer trays cannot currently be cost-effectively separated and recycled, and are detrimental to the quality of rPET derived from other product groups.

TABLE 3: 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			No comprehensive collection scheme available throughout European regions	Not typically collected for recycling
SORTING		Low quantities in collected streams therefore not always economically viable to sort separately	High proportions of trays currently sorted into bottle grades or into "mixed plastics"	Certain combinations can be mis-sorted by sensor based sorters
REPROCESSING	Challenges posed by labels, adhesives and caps are generally overcome	Underdeveloped capacity for separate reprocessing of opaque bottles. Unwanted in other bottle streams	Underdeveloped capacity for separate reprocessing of trays. High yield losses if reprocessed on bottle lines. Higher adhesives and labels content.	Different polymer layers cannot be cost-effectively separated and affect quality of resulting rPET. No reprocessing 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	Underdeveloped market for rPET derived from trays	rPET that could be derived would be mixed polymer with very low market demand

Key: the extent to which each product group meets the recyclability criteria is shown with a colour indicator, with green representing a high score, yellow indicating some challenges, and red indicating un-recyclability against one or more of the criteria for recyclability

Where products are not designed for recyclability, not only are the products less likely to be recycled, but they have knock-on impacts on the rest of the recycling streams, increasing losses (and therefore disposal costs), increasing reprocessing costs and potentially reducing the quality of rPET. Some product trends currently create problems in increasing recyclability, such as the use of complex and multilayer packaging, or the emergence of PET with added glycol (PETG) and of PEF-based bottles. However, bio-derived PET – made from biological sources such as sugar cane residue – is compatible during recycling with petroleum-based PET.[33]

There are established design guidelines for recyclability, such as those produced by EBPB and Petcore Europe, against which packaging on the market can be assessed in order to understand how much of the PET packaging produced meets the guidelines.[34] There are now heightened levels of communication across the industry. For example, the RecyClass initiative has shown considerable success in engaging producers with practical, product-specific recyclability assessments.[35] Petcore Europe has established a working group on PET trays, in collaboration with leading producers, which has launched new guidelines for PET tray recyclability; it is hoped that this will gain widespread traction in order to facilitate significant future progress in PET tray recycling.

4. WHAT IS CHANGING?

- **FIGURE 8 SUMMARISES THE CONSUMER AND LEGISLATION PRESSURES ON THE rPET SUPPLY CHAIN -AND THE AREAS OF RESEARCH AND DEVELOPMENT WITHIN EACH AREA OF THE SUPPLY CHAIN TO MEET THOSE PRESSURES.**

LEGISLATION

The following legislation will result in changes to both the collection and sorting of plastic for recycling within the EU28:

- The revision to the Packaging and Packaging Waste Directive (PPWD) in 2018 established in European law a 50% target for the recycling of plastic packaging by 2025 which rises to 55% by 2030.
- The PPWD references the amended Waste Framework Directive (WFD), which requires, at 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. This compares to an average 2018 collection rate approaching 60% (52% excluding non-PET, PET-trays and moisture).

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.

The SUP Directive also sets targets for average recycled content within PET beverage bottles of 25% by 2025 and 30% by 2030. 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 100% recycled content.[36] 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.

> *"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"*

MARKET PRESSURE

Brands positioning ahead of governement position with regards to pledges on recycled content of plastics products

GOVERNMENT PRESSURE VIA LEGISLATION

- Revision to Packaging and Packaging Waste Directive (PPWD) in 2018
- Article 8(a) of the amended Waste Framework Directive (WFD)
- Directive (EU) 2019/904 (the so-called Singe-Use Plastics Directive)
- (VOLUNTARY only) Strategy for Plastics in a Circular Economy - vision statement includes fourfold increase in sorting and recycling capacity for plastics from 2015 to 2030

RESEARCH AND DEVELOPMENT

PRODUCT DESIGN	• Tackling specific recyclabiliy issues e.g. multilayer PET trays • Introducing innovations in labelling and inks to allow for better cleaning and improved output clarity
COLLECTION	• Smart technologies for DRS return systems • For household collections - focus on improvising householder engagement and participation in services, including minimising non-PET
SORTING	• Continuing to develop the speed and accuracy of automated sorting equipment (VIS, NIR), its ability to detect levels of legacy and organic additives, and the development of AI algorithms to replicate or support the decisions of manual pickers • An approach to programming materials for smarter sorting (e.g. through digital watermarking) would enable a step-change in sorters ability to produce high-quality outputs
REPROCESSING	**Mechanical** • 'Super-cleaning' processes to decontaminate recyclate that is suitable for food contact applications and with PET trays separately targeted • Investigating approaches to improve the separation of polymers with similar densities, ink removal processes and filtration processes **Chemical** • Still largely at the pre-commercial stage, however significant investment decisions and commercial capacity commitments have been announced in relation to chemical recycling processes over the past 18 months

FIGURE 10: Changes across the PET Market

TECHNOLOGY/RESEARCH & DEVELOPMENT

Research and development (R&D) is required to provide continual improvement in processes, solve particular problems in recyclability, and open up the potential for step changes in how collection, sorting and reprocessing is optimised for a circular economy.

DESIGN FOR RECYCLABILITY

Development of recyclability guidelines and adoption by producers of these guidelines can make processing of collected and sorted streams more viable and cost-effective. Petcore has published new guidelines on PET tray design for recycling, along with a protocol for evaluating recyclability.[37]

SORTING

Most problems in sorting can be dealt with by current technologies supplemented by manual operatives, provided there is a sufficient economic benefit. Ongoing R&D continues to develop the speed and accuracy of automated sorting equipment (VIS, NIR) and its ability to detect levels of legacy and organic additives. Research is also underway developing AI algorithms to replicate or support the decisions of manual pickers.

The widespread adoption of an approach to programming materials for smarter sorting would enable a step-change in sorters' abilities to produce high-quality outputs, allowing specific problematic products to be removed, or desirable products (e.g. food contact materials) to be selected in a highly targeted way. Markers for UV tracing and sortable black colourants can be used for smarter sorting (e.g. of black PET trays) and digital watermarking of containers and labels (such as technologies trialled in the Holy Grail[38] project) can allow for higher sorting efficiencies of, for example, beverage PET bottles or food-contact PET trays from a mixed plastic stream.[39]

MECHANICAL RECYCLING

State-of-the-art PET recycling plants employ 'super-cleaning' processes to decontaminate rPET to be suitable for food-contact applications, with PET trays separately targeted. Research in reprocessing technologies is currently being targeted at a number of areas including investigating approaches to improve the separation of polymers with similar densities, ink removal processes and filtration processes.[40]

"RESEARCH AND DEVELOPMENT (R&D) IS REQUIRED TO PROVIDE CONTINUAL IMPROVEMENT IN PROCESSES, SOLVE PARTICULAR PROBLEMS IN RECYCLABILITY, AND OPEN UP THE POTENTIAL FOR STEP CHANGES IN HOW COLLECTION, SORTING AND REPROCESSING IS OPTIMISED FOR A CIRCULAR ECONOMY"

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CHEMICAL RECYCLING

Chemical recycling of plastics generally refers to a range of different processes that can break down or depolymerise polymers into their original monomers or other chemical feedstocks. The feedstocks can then be reused as building blocks for new polymers or other chemical products. These processes are still largely at the pre-commercial stage; however, they are generating interest as a replacement for unsustainable feedstock sources.

"CHEMICAL RECYCLING OF PLASTICS GENERALLY REFERS TO A RANGE OF DIFFERENT PROCESSES THAT CAN BREAK DOWN OR DEPOLYMERISE POLYMERS INTO THEIR ORIGINAL MONOMERS OR OTHER CHEMICAL FEEDSTOCKS. THE FEEDSTOCKS CAN THEN BE REUSED AS BUILDING BLOCKS FOR NEW POLYMERS OR OTHER CHEMICAL PRODUCTS"

As a condensation polymer the polymerisation of PET is, by its nature, a reversible process. This means that the polymer can be easily depolymerised to its original building monomers and then re-polymerised again, resulting in infinite recycling possibilities.

The main processes for depolymerisation of PET are as follows:

- Glycolysis – adding polymer with mono-ethylene glycol (MEG) under controlled conditions to generate BHET (bis 2-hydroxyethyl terephthalate), which can be followed later by hydrolysis to generate PTA/MEG.
- Hydrolysis – adding polymer with water (H2O) under controlled conditions, to directly generate PTA/MEG.
- Methanolysis – adding methanol to the process to generate DMT and MEG.

All processes have been in development for many years; however, with the advent of the circular industrial process revolution, interest in these processes is escalating. With demonstration plants already developed globally, scale up is expected to progress as demand grows for recycled content in PET products.

Difficult to recycle trays, multi-layer and contaminated packaging materials could be recycled through these processes, leading to a higher recycled content of PET above that which can be achieved by mechanical processing alone. With refinement of the purification steps, monomers of suitable purity will be able to be used in production units for virgin polymer, enhancing the ability for a fully closed-loop recycling system for PET.

5. WHERE NEXT?

This section draws together our analysis of the current state of the PET market and the key challenges facing reprocessors 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 and how the supply chain should focus its efforts going forward in order to provide a robust view on the market as it continues to develop.

- **PET OUTPUT IS PROJECTED TO POTENTIALLY INCREASE EU-28 SUPPLY OF TOTAL CONVERTER DEMAND FOR PET FROM 24 % (2018) TO 55% BY 2030.**
- **BY 2030, THE EU-28 WILL REQUIRE DOUBLE THE CURRENT EU28+2 rPET REPROCESSING CAPACITY TO PROCESS THE TONNAGE OF PET EXPECTED TO BE COLLECTED IF EUROPEAN TARGETS ARE MET.**
- **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 ON, TOGETHER WITH EUROPEAN POLICY MAKERS, TO ENSURE THAT THE INCREASED QUANTITY OF MATERIAL COLLECTED CAN ALSO FEED HIGH-QUALITY RECYCLING OUTPUT INTO MORE MATURE MARKETS.**
- **THIS REPORT IDENTIFIES A NUMBER OF GAPS IN DATA REGARDING THE TOTAL PET RECYCLING CHAIN AND HOW IT IS CHANGING OVER TIME. THIS DATA IS NEEDED TO ENSURE THAT THE EU-28 CONTINUES TO DEVELOP APPROPRIATE CAPACITY AND TECHNOLOGY TO MEET THE DEMANDS OF THE CHANGING WORLD OF PACKAGING.**

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. Demand for PET sheet has been increasing at a faster rate of 5.3% since 2014. 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.[41] Note that whilst PEF (polyethylene furanoate), a bio-derived polymer substitute for PET, is expected to enter the market in 2020, it would be a contaminant in the existing PET stream.[42] 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.

Having a clear definition of design for recyclability, alongside a common framework for product-level assessments and financial incentives, should:

- continue to decrease the proportion of coloured PET, ensuring more rPET is suitable for colour-sensitive product applications (e.g. bottles, film, sheet); and
- reduce PVC, adhesives and paper fibres, thereby reducing losses in processing and improving the visual and mechanical properties of outputs.

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.

Collection rates are likely to remain similar in 2019 and 2020, though over the next few years several Member States are planning to introduce deposit schemes. The SUP target requires each Member State to achieve a 77% collection rate of beverage bottles by 2025 and 90% by 2029. In order to meet these targets, it is likely that more States or EPR schemes will adopt full or partial DRS, resulting in higher quantities of PET beverage bottle bales suitable for cost-efficient high-quality recycling and production of food-grade rPET. Meeting European targets for the collection of PET beverage bottles by 2030 is expected to result in around a 60% increase in tonnages of PET bottle bales available for reprocessing: an additional 1.2mt 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 including an assumption of a certain proportion of non-PET material in sorted streams.[43]

As the PET tray recycling market continues to grow, more countries in EU28 are expected to expand their existing collection and sorting processes to increase output quantities of collected and sorted bales. With more developed reprocessing 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.

Reprocessing Capacity and rPET Production

The projected changes in collected PET in 2025 and in 2030 are shown in Figure 11.

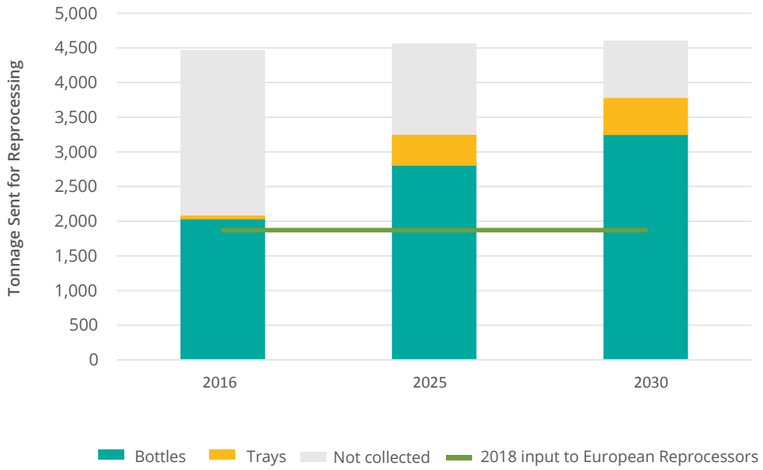

FIGURE 11: Potential Increase in PET Sent for Reprocessing by 2030

Even without assuming any growth in PET use in products, but assuming the 90% beverage bottle collection target is met, by 2030, the EU-28 will require more than double the current EU28+2 rPET reprocessing capacity 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, in particular the separate reprocessing of PET trays, improvements in product design, and increasingly high quality bottle collections from DRS, reprocessors' yields could increase from an average of 73% of input in 2018 to 80% by 2030, resulting in a total of 3mt rPET output by 2030.[44]

With the above increases in collection rates, coupled with improved design for recyclability and higher bale quality, rPET output is projected to potentially increase EU-28 supply of total converter demand for PET from 24 % (2018) to 55% by 2030.

THE MARKET - rPET

EU-28 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 what would be needed to meet the minimum legislative 30% recycled content in bottles.

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

In 2019, increasing proportions of rPET are going to bottle manufacturers to meet increased demand; this is evident in high prices for food-grade rPET. The interaction between, on the one hand, increasing demand from the packaging sector for rPET, and, on the other hand, increasing production of rPET as collection improves is expected to be the major dynamic shaping the evolution of the rPET market. Coupled with the scaling-up of chemical processes to support the removal of colouration for those more difficult to recycle material streams (mixed colour bottles and lower quality/non-beverage bottles rejected from sorting), longer-term the ambition is that the PET on the market will move towards being 100% recyclable, with 100% recycled content.

MARKET SUPPORT

A number of pieces of legislation have come into force to support increases in the recycling of and a higher recycled content within plastics products. 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 on, together with European policy makers, to ensure that the increased quantity 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 use eco-modulation of fees to provide specific cost incentives for producers to ensure products meet recyclability criteria. Eco-modulated fees should be used across all EPR schemes as a key way of helping to meet increased targets for the recycling of plastic packaging.

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. This framework needs to be based upon:

- technical data and current/latest processes; and
- capacities of recyclers to recycle products without prohibitive cost.

In addition, such a framework should be:

- updateable in response to developments in technology and processes; and
- able to assess recyclability at the level of individual products.

RecyClass could provide the basis for such a framework. In conjunction with Petcore Europe, RecyClass has now developed protocols for PET trays. EPBP has published a test protocol for the recyclability of innovative PET bottles.[45] PRE has also released a definition of recyclability in cooperation with the Association of Plastics Recyclers in the US, taking into account the viability of collection and reprocessing (see Section 3).

SORTED PACKAGING BALE QUALITY STANDARDS

Processing bales with higher levels of non-PET material increases the cost and complexity of reprocessing operations and of producing quality rPET. Where PROs are involved in contracting sorting plants, such as CITEO in France or Green Dot in Germany, there is a greater opportunity to mandate a certain quality of outputs. Common European quality standards for sorted packaging bales could be agreed upon and implemented across the industry, which would place the onus on collectors and sorters to reduce problematic materials within sorted bales. If the required bale standards cannot be achieved by better quality sorting of plastics collected with other materials (papers and glass), then the industry should consider the collection of plastics recycling separately from papers and glass.

CERTIFICATION PROCESS FOR RECYCLED MATERIAL

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

- a 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 reprocessors.

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.[46,47] EuCertPlast certification of PET capacity rose from 32% to 40% of EU28+2 installed capacity between 2018 and 2019.

FURTHER R&D

To achieve a step-change in the technological potential of current sorting machinery, producers and brands should align behind an information solution for product packaging (such a digital watermarking) that opens up new opportunities for targeted sorting of high-quality output PET streams.

In addition, the role of chemical recycling in moving all PET products towards being 100% recyclable and allowing high levels of recycled content without colour issues is expected to require additional sorting activities that will need to be integrated into existing mechanical recycling operations.

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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 regarding the total PET supply chain and how it is changing over time. This data is needed to ensure that the EU-28 continues to develop appropriate capacity and technology to meet the demands of the changing world of packaging.

“THIS REPORT IDENTIFIED A NUMBER OF DATA GAPS REGARDING THE TOTAL PET SUPPLY CHAIN AND HOW IT IS CHANGING OVER TIME. THIS DATA IS NEEDED TO ENSURE THAT THE EU-28 CONTINUES TO DEVELOP APPROPRIATE CAPACITY AND TECHNOLOGY TO MEET THE DEMANDS OF THE CHANGING WORLD OF PACKAGING.”

To understand the rapidly changing market for PET recycling there is a need for PROs to produce a better resolution of data on:

- the amounts of PET trays, PET beverage and PET non-beverage bottles placed on the market;
- the amounts of particular packaging products placed on the market and that are relevant to distinct recycling streams, including split by colour and type (multi-material/mono-material);
- continued improvements in the quality of PET-specific consumption data reported by PROs, to determine more detailed trends over time; and
- the full chain of custody and amounts of plastic exported for recycling, both to improve understanding of how much is exported, but more critically to help ensure that plastic sent for recycling is appropriately recycled to high environmental standards.

To understand the rapidly changing market for PET recycling there is a need for the PET recycling and reprocessing industry to produce a better resolution of data on:

- the amounts of non-PET content and PET trays in PET bales to support more accurate determination of ‘sorted for recycling’ rates for the various rPET streams; and
- a fuller picture of the development of rPET end markets across all reprocessors.

A FINAL NOTE

In order to continue to meet the demands of consumers, the legislative requirements and make good progress towards a circular PET economy, all elements of the supply chain need to be aligned. Through this, we will be able to provide robust data and forecasts on the components of PET available for collection, sorting and reprocessing. If PROs adopt a common recyclability assessment framework, this will incentivise producers to continue stepping up their engagement with designing products that meet the right recyclability criteria.

We would like to take this opportunity to thank the recyclers representing 69% of installed capacity that responded to PRE's survey, and to Petcore Europe and EFBW for contributing data, review and insight. We end with a call to all PRE members to help us to get the additional data listed so that we can continue to build on our understanding of the state of the market, enable forward planning, work on your behalf to engage relevant supply chain players at the right time to help investment decisions, and ultimately keep as much PET in the European supply chain as possible for as long as possible.

EUNOMIA I PET MARKET IN EUROPE : STATE OF PLAY

ANNEX

1. *A certification scheme focusing on traceability of plastic materials (throughout the entire recycling process and supply chain), and on the quality of recycled content in the end-product. More information available at: https://www.eucertplast.eu/.*
2. *Eurostat, PRODCOM: Statistics on the production of manufactured goods; last accessed: 19/06/2019 https://ec.europa.eu/eurostat/data/database.*
3. *Plastics Europe (2018) Plastics – the Facts 2018.*
4. *Anton Parr GmBH, Intrinsic Viscosity as Quality Control Parameter of PET, https://www.muser-my.com/wp-content/uploads/2018/11/C72IA036EN-A.pdf.*
5. *Eurostat, PRODCOM: Statistics on the production of manufactured goods; last accessed: 19/06/2019 https://ec.europa.eu/eurostat/data/database.*
6. *As above.*
7. *UN Comtrade Database, last accessed: 19/06/2019 (https://comtrade.un.org/data/).*
8. *Eurostat, PRODCOM: Statistics on the production of manufactured goods; last accessed: 19/06/2019 https://ec.europa.eu/eurostat/data/database.*
9. *ICIS and Petcore Europe (2019) Annual Survey on the European PET Recycle Industry 2017.*
10. *Derived from: Eurostat, PRODCOM: Statistics on the production of manufactured goods; last accessed: 19/06/2019 https://ec.europa.eu/eurostat/data/database; Plastics Europe (October 2017) Post-consumer Plastic Waste Management in European Countries 2016; Deloitte, PRE (May 2015) Increased EU Plastics Recycling Targets: Environmental, Economic and Social Impact Assessment.*
11. *Shown in a graphic by Plastics Europe Market Research Group and Conversio Market and Strategy GmbH; featured in Plastics Europe (2018) Plastics – the Facts 2018.*
12. *PCI Wood Mackenzie (August 2017) PET Recycle Survey West Europe 2016.*
13. *PCI (2013) A review of the PET Collection Stream in West Europe in Relation to PET THEROFORMS.*
14. *Eurostat, PRODCOM: Statistics on the production of manufactured goods; last accessed: 19/06/2019 https://ec.europa.eu/eurostat/data/database.*
15. *ICIS and Petcore Europe (2019) Annual Survey on the European PET Recycle Industry 2017.*
16. *PET Bottle Sorted Bale Colour Breakdown 2018 (source: PRE Recycler Survey 2019).*
17. *Prior PETCORE published studies.*
18. *Contamination and tray content assumptions based on data from ICIS and Petcore Europe (2017) Annual Survey on the European PET Recycle Industry).*
19. *Commission Implementing Decision (EU) 2019/665 of 17 April 2019 amending Decision 2005/270/EC establishing the formats relating to the database system pursuant to European Parliament and Council Directive 94/62/EC on packaging and packaging waste, viewable at https://eur-lex.europa.eu/legal-content/GA/TXT/?uri=CELEX:32019D0665.*
20. *ICIS and PETCore Europe (2017) Annual Survey on the European PET Recycle Industry.*
21. *ICIS and Petcore Europe (2019) Annual Survey on the European PET Recycle Industry 2017.*
22. *This range is lower than the 2014 collection for recycling rate of 30% reported by Deloitte, which may reflect the discrepancy between amounts collected and sorted for recycling (Deloitte, PRE (2017) Blueprint for plastics packaging waste: Quality sorting & recycling).*
23. *Flöskumóttaka Endurvinnslan website, (Last accessed 05/11/2019); http://endurvinnslan.is.*
24. *ICIS and Petcore Europe (2019) Annual Survey on the European PET Recycle Industry 2017.*
25. *USAD (2019), Lithuania's Deposit System, available from https://www.zalohujme.cz/wp-content/uploads/2019/01/LT-DRS-1.pdf.*
26. *PRE Data.*
27. *PRE Data (1.9mt of input multiplied by the average reported yield percentage).*
28. *ICIS and Petcore Europe (2019) Annual Survey on the European PET Recycle Industry 2017); PCI Wood Mackenzie (August 2017) PET Recycle Survey West Europe 2016; Petcore (July 2015) Post-Consumer PET Recycling in Europe 2014 and prospects to 2019.*
29. *ICIS and Petcore Europe (2019) Annual Survey on the European PET Recycle Industry 2017.*
30. *Eurostat, PRODCOM: Statistics on the production of manufactured goods; last accessed: 19/06/2019 https://ec.europa.eu/eurostat/data/database.*
31. *ICIS and Petcore Europe (2019) Annual Survey on the European PET Recycle Industry 2017.*
32. *As above.*
33. *Association of Plastic Recyclers (2018) APR Design Guide for Plastics Recyclability, https://www.plasticsrecycling.org/images/pdf/design-guide/Full_APR_Design_Guide.pdf.*
34. *Guidelines for PET bottles available https://www.epbp.org/design-guidelines/products; EPBP guidelines and Petcore Europe guidelines for PET thermoform trays available from https://plasticsrecyclers.eu/downloads.*
35. *RecyClass, https://recyclass.eu/.*
36. *Coca-Cola, 50% by 2020; PepsiCo, 33% by 2025; 100% recycled water bottles include Highland Spring and Nestle Pure Life.*
37. *Available from https://www.petcore-europe.org/working-groups/198-design-for-recycling-guidelines-for-pet-trays.html.*
38. *For project information see https://www.newplasticseconomy.org/assets/doc/Holy-Grail.pdf*
39. *Pioneer Project Overview: HolyGrail: tagging packaging for accurate sorting and high-quality recycling, available from https://www.newplasticseconomy.org/assets/doc/Holy-Grail.pdf.*
40. *Suschem (2018) Plastics Strategic Research and Innovation Agenda in a Circular Economy.*
41. *EFSA website, https://www.efsa.europa.eu/en/publications/PP.*
42. *European Bioplastics (November 2017) Annual market data update presentation, https://www.european-bioplastics.org/global-market-for-bioplastics-to-grow-by-20-percent/ ; European Bioplastics (2017) Bioplastics market data 2017, https://docs.european-bioplastics.org/publications/market_data/2017/Report_Bioplastics_Market_Data_2017.pdf.*
43. *Here 8% of collected material is assumed not to be PET bottles and is used as in section 2.d.I. Given that average plant rPET yields are only 73% of input tonnages, better data may show the adjustment needed to account for quantities of moisture, labels, and non-PET content is substantially higher than 8%. However, this assessment may also slightly overstate the need for capacity if collection moves predominantly to DRS and so non-PET content in sorted streams reduces.*
44. *80% yield of rPET aligns with the high end of the reprocessing 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.*
45. *Protocol available from https://www.epbp.org/page/8/downloads#downloads_41.*
46. *Full scheme details available at https://www.eucertplast.eu/downloads-links.*
47. *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/).*

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