

SECONDARY RAW MATERIALS AND WASTE ACCOUNTING

Contract n° 2019.0376

Task 3: Study of plastics in EU

Report, final

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1. Objectives

The aim of task 3 of this project is to use information from waste accounts (from task 1), material flow accounts and asset accounts (from task 2) for a detailed study of flows of plastics in the EU, including in particular the quantification of imports, domestic production, consumption, recycling and other types of waste treatment. The task is considered as a feasibility study. The produced data are one-off estimates.

As a result of this task, a Sankey diagram shall be compiled that shows the plastic flows from plastic production to final treatment, including the circular flows back into the economy. The underlying data and methodology is presented in this report.

2. Scope and definitions

As a starting point, this study uses the term ‘plastics’ as defined in Directive (EU) 2019/904 on single-use plastics (SUP-Directive)¹ in Article 3(1):

“Plastic’ means a material consisting of a polymer as defined in point 5 of Article 3 of Regulation (EC) No 1907/2006², to which additives or other substances may have been added, and which can function as a main structural component of final products, with the exception of natural polymers that have not been chemically modified.”

The definition and the scope of the Directive are further elaborated in indent 11 and can be summarised as follows.

For the purposes of the SUP Directive plastics includes:

- Polymers manufactured from fossil or synthetic substances;
- Polymers manufactured from bio-based substances; and
- Polymers manufactured with modified natural polymers.

The definition excludes:

- Natural polymers that have not been chemically modified as they occur naturally in the environment; and
- Paints, inks and adhesives containing polymeric materials.

For the purpose of task 3 of this project, further exclusions were agreed with Eurostat for:

- Synthetic rubber; and
- Textiles produced from plastic fibres.

Synthetic rubber and textiles have very different life cycles from other plastic products and should therefore be investigated separately. Their consideration would make the exercise overly complex.

As a result, **the work under task 3 focusses on plastics products of the CPA group 22.2 “Plastic products”** which includes intermediate or final products, produced by such processes as compression moulding, extrusion moulding, injection moulding, blow moulding and casting.

The work under task 3 thus excludes the following CPA groups:

- synthetic rubber (CPA 20.17) and rubber products (22.1),

¹ Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment (single-use plastics) (OJ L 155, 12.06.2019, p.1)

² REACH Regulation ((OJ L 396, 30.12.2006, p. 1))

- paints and varnishes (CPA 20.3),
- man-made fibres (CPA 20.6), and
- glues (CPA 22.52).

3. Methodological approach and structure of the report

Based on the defined scope of the task, the different stages of the life cycle of plastics are defined, starting with the production of the primary plastics and ending with the final treatment or the return of recyclates into the economic cycle. The description of the life cycle builds the structural basis for the data collection and the material flow (Sankey) diagram to be produced.

In the second step, data on the different stages of the life cycle were researched. The main sources selected and used for the analysis are the following:

- Production and trade statistics (see chapters 5.1 and 5.2);
- Data from PlasticsEurope on plastic converters demand (see chapter 5.3);
- Data from the state of play reports of the Circular Plastics Alliance (CPA) (see chapter 6);
- Waste accounts data from task 1 (chapter 7); and
- Monitoring data for packaging, end-of-life vehicles (ELV) and waste electrical and electronic equipment (WEEE);

Waste statistics data collected under the Waste Statistics Regulation (WStatR) were not used as a separate source as these data are integrated in the waste accounts model.

The geographical scope is the EU27. The reference year of the analysis is 2016 because this is the base year of the waste accounts compiled under task 1. Where available, data for more recent reference years are also presented. Data for 2016 often refer to the EU28 as the UK was still an EU Member State then. Where possible, the respective data were adjusted to the EU27.

In chapter 8, the data sources are analyzed and described separately and then compared and discussed along the main application sectors of plastic products as follows:

- Packaging
- Building and construction
- Automotive
- Electrical and electronic equipment
- Agriculture
- Households, leisure, sports

For each sector, the data for the different stages of the plastics life cycle are presented and discussed in view of their quality and usability for the plastic (Sankey) flow diagram.

Based on this discussion, the data are compiled and the plastics (Sankey) flow diagram presented in chapter 9.

In chapter 10, the results are discussed in view of the data quality and availability. In view of the results of task 1, the comparison and discussion of the data on plastic waste generation and treatment is seen as an important validation and double check exercise and to draw conclusions on limitations and options for improvement.

4. Life cycle of plastics

For the purposes of this task, the life cycle of plastics is divided into three stages: production, consumption and waste treatment. The stages are specified in more detail in the following paragraphs.

4.1. Production of plastics

The production of plastic products usually takes place in two steps that are carried out in different NACE groups/classes:

- the production of primary plastics in **NACE 20.16 ‘Manufacture of primary plastics’**, and
- the conversion of primary plastics into semi-final or final plastic products in **NACE 22.2 ‘Manufacture of plastics products’**.

The production is therefore sub-divided for analysis and in the flow diagram into these two production steps along the definition of the NACE class 20.16 and NACE group 22.2.

4.1.1. NACE 20.16 ‘Manufacture of primary plastics’

NACE class 20.16 includes *‘the manufacture of resins, plastics materials and non-vulcanisable thermoplastic elastomers, the mixing and blending of resins on a custom basis, as well as the manufacture of non-customised synthetic resins.*

This class includes:

- *manufacture of plastics in primary forms:*
 - *polymers, including those of ethylene, propylene, styrene, vinyl chloride, vinyl acetate and acrylics*
 - *polyamides*
 - *phenolic and epoxide resins and polyurethanes*
 - *alkyd and polyester resins and polyethers*
 - *silicones*
 - *ion-exchangers based on polymers*

This class also includes:

- *manufacture of cellulose and its chemical derivatives*

This class excludes:

- *manufacture of artificial and synthetic fibres, filaments and yarn, see 20.60*
- *shredding of plastic products, see 38.32’ (Eurostat, 2008)*

The primary plastics produced are then further processed to a variety of products in other NACE groups/classes, in particular in:

- NACE 22.2 ‘Manufacture of plastics products’
- NACE 20.3 ‘Manufacture of paints, varnishes and similar coatings, printing ink and mastics’
- NACE 20.6 ‘Manufacture of man-made fibres’
- NACE 20.52 ‘Manufacture of glues’

4.1.2. NACE 22.2 ‘Manufacture of plastics products’

At the second production stage, only the products of NACE group 22.2 are considered for this study. NACE 22.2 *‘comprises processing new or spent (i.e., recycled) plastics resins into intermediate or final*

products, using such processes as compression moulding; extrusion moulding; injection moulding; blow moulding; and casting. This includes

- *Manufacture of plastic plates, sheets, tubes and profiles (NACE 22.21), comprising semi-manufacture and finished products;*
- *Manufacture of plastic packing goods (NACE 22.22) like plastic bags, sacks, containers, boxes, cases, carboys, bottles etc.;*
- *Manufacture of builders' ware of plastic (NACE 22.23) like Manufacture of builders' ware of plastic like doors, windows, tanks, floor, wall or ceiling coverings, plastic sanitary ware and artificial stone (e.g. cultured marble)*
- *Manufacture of other plastic products (NACE 22.29) like plastic tableware, kitchenware, toilet articles, etc.' (Eurostat, 2008)*

Please note: The manufacture of several specific final products made of plastics like luggage, footwear, furniture, mattresses, sports requisites, games and toys, medical appliances and safety equipment are not included in NACE 22.2 but in other NACE classes which are not considered in the following analysis.

4.2. Consumption of plastic products (Use phase)

The consumption side describes the use of the final (plastic made) products by private and industrial end-users. The annual consumption reflects also the amount of plastics that is added to the stock.

4.3. Waste treatment

Waste treatment covers the whole treatment chain, from collection to final treatment. The input into waste treatment includes pre-consumer and post-consumer waste. The post-consumer waste reflects the amount of plastic products that leave the consumption as waste thus reducing the stock of plastics in use.

Waste treatment includes all types of treatment operations, from preparatory treatment steps to final treatment. Final treatment comprises the reprocessing of waste into secondary raw materials (recyclates) or fuels, the thermal treatment of waste, the accumulation of waste on landfills or for backfilling or the release of waste into the environment.

5. Data on production, trade, and consumption of plastics

The main data sources used for the compilation of data for the Sankey diagram are the following:

- Statistical data on the production and trade of products from NACE 20.16 and NACE 22.2
- Data on the demand of primary plastics by plastic converters from PlasticsEurope

The data are presented in the following chapters 5.1 to 5.3 and subsequently compared and discussed in view of the Sankey diagram in chapter 5.4.

5.1. Production, trade and apparent consumption of primary plastics (NACE 20.16)

The production data for NACE 20.16 and the related trade data (PRODCOM data code DS-066341) were downloaded from Eurobase and analysed in order to determine the production volume, the imports and exports and to calculate the apparent consumption of primary plastics. For all PRODCOM headings of NACE 20.16, production and trade are reported in kg. No conversion from other units was necessary.

Table 1 shows the results for the EU27 for reference year 2016, aggregated by main polymers. The detailed data by PRODCOM-Codes are shown in Table 16 in the Annex. The total production of primary plastics in 2016 amounted to 67.2 Mt. 14.9 Mt were exported and 11.0 Mt were imported in the same year. This results in an apparent consumption of 63.4 Mt.

Table 1: Production, export, import and apparent consumption of primary plastics in the EU27 in 2016, based on production and ITG statistics (in 1 000 t)

Type of polymer	CPA / PRODCOM	Production	Export	Import	Apparent consumption
Polymers of ethylene (PE)	201610	13,663	3,729	4,513	14,446
Polymers of styrene (PS)	201620	5,044	892	578	4,730
Polymers of vinyl chloride (PVC) or of other halogenated olefins	201630	7,091	1,817	593	5,867
Polycarbonates (PC)	20164040	1,135	233	92	993
Polyethylene terephthalate (PET)	20164062 20164064	2,931	325	988	3,594
Polymers of propylene (PP) or of other olefins	201651	12,194	2,241	1,785	11,738
Polyamides (PA)	201654	2,440	629	307	2,117
Polyurethanes (PUR)	20165670	3,363	473	65	2,955
Other polymers	2016*	19,370	4,558	2,114	16,926
Total	2016	67,230	14,898	11,035	63,367

*All PRODCOM headings under NACE 20.16 not covered elsewhere in the table

The predominant polymers are Polymers of ethylene (PE) and Polymers of styrene (PP) which account for 22.8 % and 18.5 % of the total apparent consumption respectively. Further important polymers are Polymers of vinyl chloride (PVC) (9.3 %), PS incl. expanded PS (7.5 %), PET (5.7 %), PUR (4.7 %), PA (3.3 %) and PC (1.6 %). Together, these polymers account for 73 % of the primary plastics.

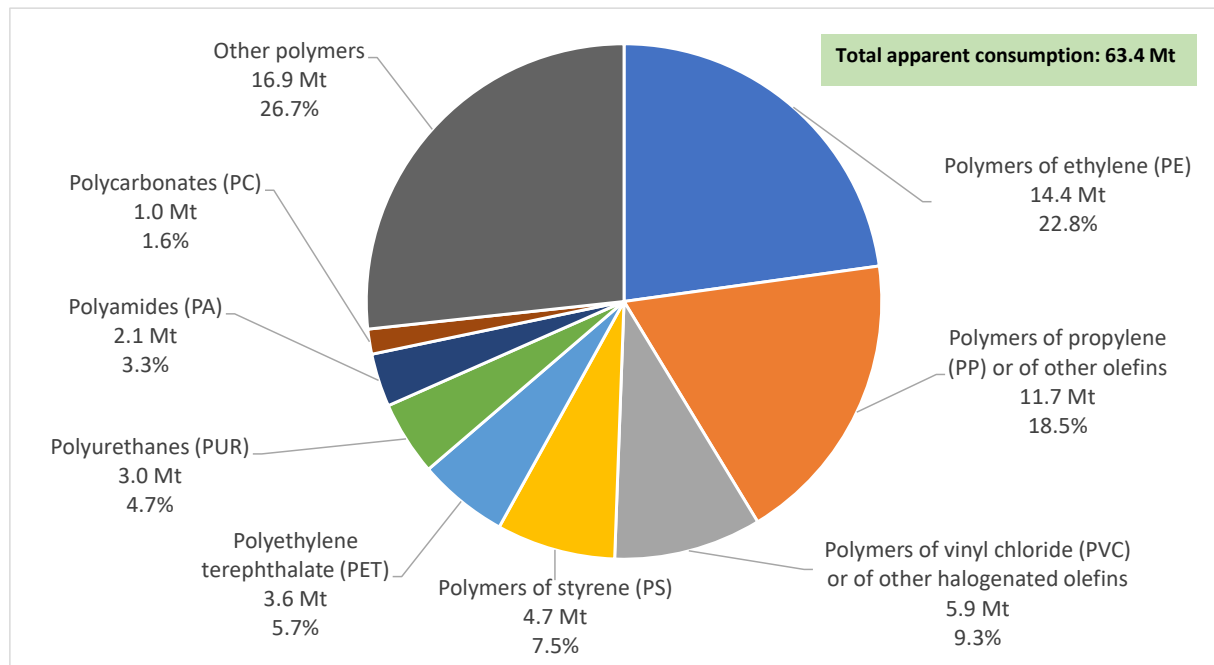


Figure 1: Apparent consumption of primary plastics in the EU27 in 2016 by polymer type

The primary plastics produced are further processed in NACE class 22.2 (and also in other NACE classes as described in chapter 4). The further investigation focusses only on the manufacture of plastic products in NACE 22.2.

5.2. Production, trade and apparent consumption of plastics products (NACE 22.2)

Data on production, trade and apparent consumption of products from NACE 22.2 were produced in the same way as for NACE 20.16. Differently from NACE 20.16, some PRODCOM headings are reported in the unit 'piece' and had to be converted into kg. For this, conversion factors from Annex VI of the MFA questionnaire were used. In case conversion factors were missing, factors were based on internet research.

For some products, only the monetary value has to be reported. This concerns for instance the CPA sub-category 22.29.91 'Manufacturing services of other plastic products'. No conversion was possible in these cases (respective products not considered). The detailed data by PRODCOM-Codes are shown in Table 17 in the Annex.

Table 2 shows the production, export, import and apparent consumption of plastics products in the EU27 for reference year 2016 and the breakdown by NACE classes. The detailed data by PRODCOM codes are shown in Table 17 in the Annex.

According to production statistics, 48.8 Mt of plastics products were manufactured in 2016 in the EU27. 6.5 Mt were exported and 5.0 Mt were imported in the same year. This results in an apparent consumption of 47.3 Mt.

Table 2: Production, export, import and apparent consumption of plastics products in the EU27 in 2016, based on production and ITG statistics (in 1 000 tons)

NACE description	NACE code	Production	Export	Import	Apparent consumption
Manufacture of plastic plates, sheets, tubes and profiles	22.21	19,608	3,202	2,070	18,476
Manufacture of plastic packing goods	22.22	19,157	1,638	1,280	18,799
Manufacture of builders' ware of plastic	22.23	6,370	1,049	635	5,956
Manufacture of other plastic products	22.29	3,695	612	966	4,048
Manufacture of plastics products	22.2	48,829	6,501	4,951	47,279

About 40 % (18.8 Mt) of the apparent consumption are plastic packaging goods. Plates, sheets, tubes and profiles, which may be intermediate or final products, account for 18.5 Mt or 39 % of the consumption. Builders' ware amounts to 6.0 Mt or 13 % and other plastic products to 4.0 Mt or 8 %. As mentioned above, products of CPA sub-category 22.29.91, which includes for instance plastic parts for machinery and mechanical appliances, for electrical machinery and equipment and for railway, land vehicles and aircraft could not be determined and are therefore not considered in this study.

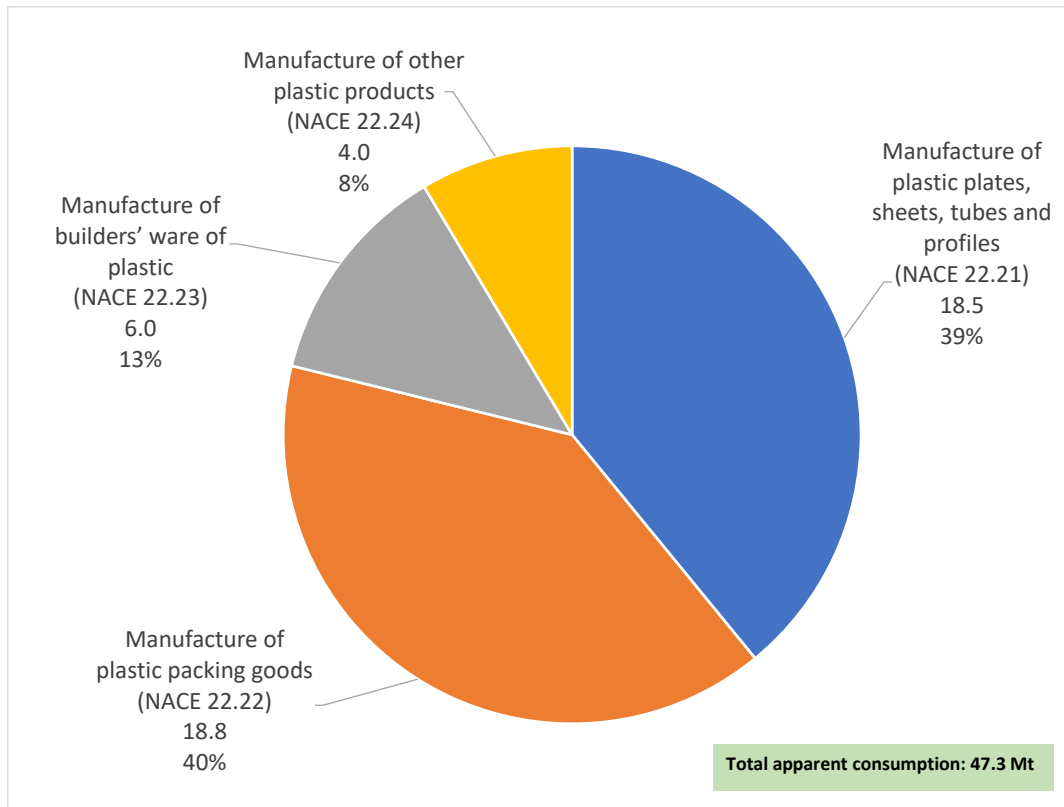


Figure 2: Apparent consumption of plastics products in the EU27 in 2016 by NACE class

5.3. Demand of primary plastics by plastic converters (PlasticsEurope)

PlasticsEurope, the European association of plastics manufacturers, publishes in their annual publication 'Plastics – The facts' data on the demand of primary plastics by plastic converters in Europe. The data refer to the EU27 +3 (UK, NO, CH) and are based on information on the member companies, which are producing around 90 % of all polymers in Europe.

The data are broken down by main application segments into:

- packaging
- building and construction
- automotive
- electrical and electronic
- agriculture
- households, leisure sports
- other applications

The data cover thermoplastics and thermosets but exclude adhesives, coatings, paints and varnishes, PET fibers, PA fibers, PP fibers and polyacryl-fibers. The data on the converters demand do not relate directly to NACE classification. However, from the specification of the data coverage we conclude that the converters demand largely corresponds with the input into NACE 22.2.

As indicated above, the published data refer to the EU27 plus UK, NO and CH. For the purposes of this study, the data were adjusted to the EU27 by subtracting the demand of UK, NO and CH. For UK, the share of the demand is known from the annual publications and amounted in 2016 to 7.5 % of the total

demand. For No and CH, the share is estimated at 2 % of the total, based on personal communication with PlasticsEurope (PlasticsEurope, 2022). It was assumed that the breakdown by application segment is the same for EU27 as for the EU27+3.

Table 3 shows the data adjusted to the EU27. The original data published by PlasticsEurope for the EU27+3 are included in Table 18 in the Annex.

Table 3: Demand of primary plastics by plastic converters in the EU27 from 2016 to 2020, broken down by application segment (in Mt)

Application segment	2016	2017	2018	2019	2020
Packaging	18.0	18.4	18.5	18.3	18.1
Building & construction	8.9	9.2	9.2	9.4	9.1
Automotive	4.5	4.7	4.6	4.4	3.9
Electrical & electronic	2.8	2.9	2.9	2.9	2.8
Household, leisure & sports	1.9	1.9	1.9	1.9	1.4
Agriculture	1.5	1.6	1.6	1.6	1.9
Others	7.5	7.8	7.8	7.7	7.5
EU27	45.2	46.4	46.4	46.1	44.7

According to adjusted data, 45.2 Mt of primary plastics were processed in 2016 to semi-final or final plastic products in the EU27. The total as well as the shares of the application segments have remained rather constant since 2016.

Around 18 Mt or 40 % of primary plastics are used to produce packaging material. With 8.9 Mt or 20 % the building and construction sector is the second most important application segment for plastic products. About 4.5 Mt (10 %) and 2.8 Mt (6%) of primary plastics are used for the automotive sector and for electrical and electronic products respectively. For 7.5 Mt or 17 % of the total demand the field of application is not specified in the data of PlasticsEurope.

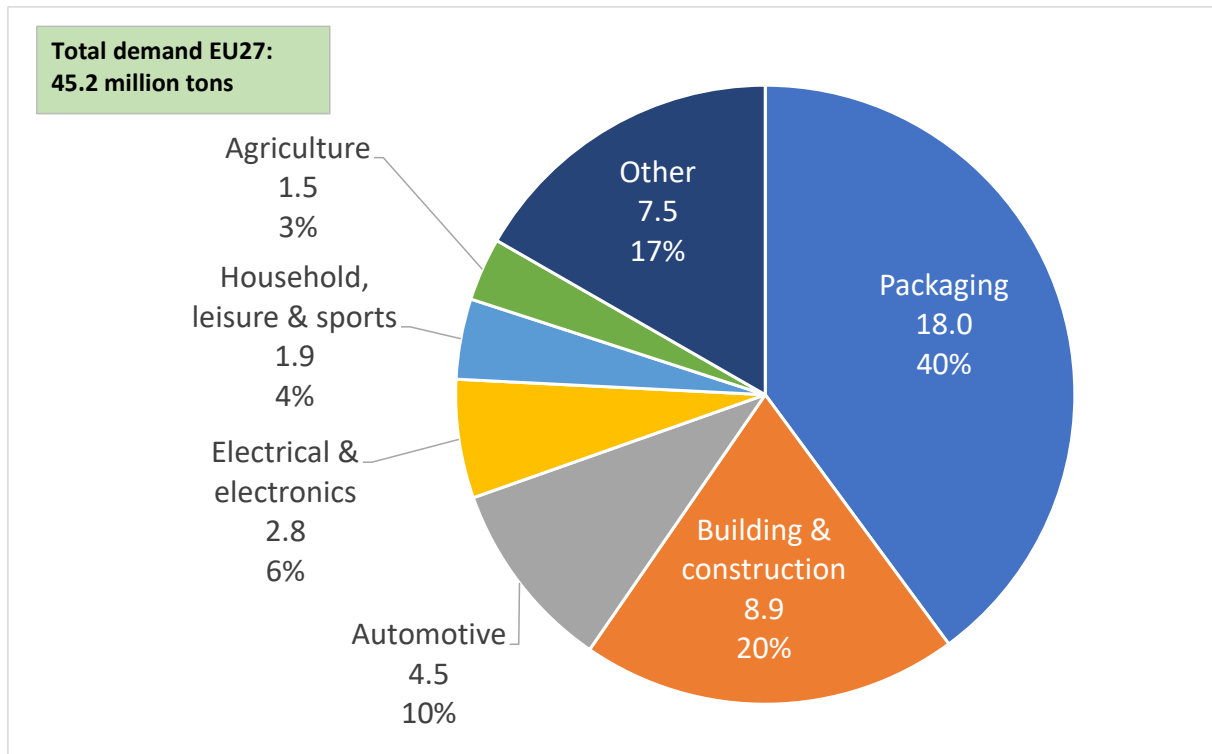


Figure 3: Converter's demand of primary plastics by application segment in the EU27, 2016 (Plastics Europe, adjusted by Argus)

It is important to note that the converters demand does not reflect the final consumption of plastics in products in the EU for several reasons:

- The data reflect the use of primary plastics by converters but not the use of recyclates, i.e. the total amount of plastic used will be higher.
- To determine the consumption, imports and exports for plastics products need to be considered.
- The amount of products will be lower than the demand / input due to the amount of production waste that arises during the manufacture of plastics products.

5.4. Discussion of data in view of the Sankey diagram

The statistical data on the production of primary plastics is taken as starting point of the Sankey diagram. Hence, it is assumed that 67.2 Mt of primary plastics are produced in the EU27 of which 63.4 Mt are further processed in the EU (apparent consumption).

The amount of primary plastics that is used for plastic products within the scope of task 3 is derived from the converters demand estimated by PlasticsEurope and adjusted to the EU27. We assume that the converters demand of primary plastics of 45.2 Mt corresponds to the input of virgin material into NACE 22.2. The difference of 18.2 Mt between the apparent consumption of primary plastics (63.4 Mt) and the converters demand (45.2 Mt) is assumed to be used to produce products like fibres, paints and varnish, sealants, adhesives and others that are not further considered under task 3 of this project.

The apparent consumption of products from NACE 22.2 of 47.3 Mt is not used as estimate for the final consumption of plastics products for intermediate uses and final uses in the EU27 because the amount is probably underestimated due to products not covered. In chapter 8, information from other sources is used to check and verify these figures and assumptions for the different fields of application.

6. Circular Plastic Alliance: Data from the State of Play reports

The Circular Plastics Alliance is an initiative under the European Strategy for Plastics. The European Commission (EC) launched the Circular Plastics Alliance (CPA) in December 2018 to help the plastic value-chain meeting their pledged goal of placing on the EU market each year 10 million tonnes (Mt) of plastic recyclates in final products by 2025. The Alliance covers the full plastics value chain and included by May 2020 270 organisations representing industry, research organisations, and public authorities. (CPA, 2021a).

The CPA has established separated working groups for the segments packaging, automotive, construction, electrical and electronic equipment (EEE) and agriculture. The working groups have produced state of play reports on the generation and recycling of plastics and estimates on how to achieve the 10 Mt target for each of the segments. The results of this work are summarised in the document "Roadmap to 10 Mt recycled content by 2025" (CPA, 2021a).

Table 4, which is taken from the Roadmap report, summarises the status of plastic waste collection and recycling for the five segments. The data are considered in the discussion of plastic waste flows by segment in chapter 8. A more detailed description of how the segment-specific data were produced can be found in the state of play reports for the respective segment.

The CPA estimates that the current demand of plastics for the application segments covered by the CPA roadmap amounted to around 38 Mt per year in the considered period. It is further estimated that 9.2 Mt of plastic waste were sorted for recycling which resulted in the production of 5.3 Mt of recyclates.

It is important to note that the data refer to the EU28 and to post-consumer waste only.

Table 4: Overview of collected and sorted waste by sector (CPA Roadmap, Page 10) (in tons)

Segment	Ref. Year (s)	European converters plastic demand	Tonnes of plastic waste collected	Tonnes sorted for recycling	Percentage sorted for recycling	Tonnes recycle produced in the EU	Percentage recycle production out of sorted for recycling
Agriculture ³	2019	721,500 ⁴	756,000 ⁵	756,000 ⁶	100%	334,000	44%
Automotive ⁷	2019	5,100,000	1,500,000	350,000	23%	150,000	43%
Building & Construction ⁸	2018	10,137,600 ⁹	1,746,000	450,000	26%	340,000	76%
Packaging ¹⁰	2016-2019	20,428,800	16,119,000	6,955,000	43%	3,906,000	56% ¹¹
WEEE (Household only)	2016	1,749,030	752,500	717,589	95%	561,373	78%
Total		38,136,930	20,873,500	9,228,589	58%	5,291,373¹²	59%

7. Results of the Waste Account Model

The information on the generation and treatment of plastics waste used for the determination of plastics flows is based in the work carried out under task 1 (waste account). For this purpose, the waste accounts were analyzed at the level of material components. The relevant results are presented in the following two chapters separately for the waste generation (supply) and the waste treatment (use).

In chapter 8, information from other sources is used to check and verify the results of the waste accounts exercise.

³ Data based on Survey undertaken by AEP Europe on behalf of the CPA working group for agriculture EU28+2.

⁴ This figure includes only non-packaging plastic products used directly by farmers in their production activities, with agronomic effect.

⁵ Including soilage.

⁶ This figure includes 40 % soilage rate. The plastics content is 443.950 tonnes.

⁷ Data based on PlasticsEurope Report "The Circular Economy for Plastics" (2019).

⁸ Data based on PlasticsEurope Report "The Circular Economy for Plastics" (2019), tonnes of recyclates produced based on estimates and discussion with the consultancy Conversio, experts in this field.

⁹ Placed on the market data for a given year, bears relevance to data for waste collected due to the long service life of the products.

¹⁰ PCEP (LDPE / LLDPE, HDPE, PP): PO waste collection, and Recycling in European countries 2016. Conversio for PlasticsEurope; PETCORE: ICIS and PETCORE Europe Annual Survey on the European PET Recycle Industry by 2017; SCS: Internal information 2017. EUMEPs: Survey carried out of EUMEP national members. Data relates 2019. Data relates to EU +2 (with the UK being within the EU at the time data was collected) other than PETCORE which relates to 28 of the countries in EU+2.

¹¹ This number considers exports, where around 23 % of sorted packaging waste was exported. 73 % is the yield of recyclates produced from sorted plastic waste supplied EU+3 recyclers. L 365. 31.121994, p. 10 u OJ L 137. 24.072012, p. 38-71

¹² Difference 4.9 Mt reported by PlasticsEurope is explained that the 5.3 Mt include pre-consumer materials. This number, combined with the other industry sectors not participating to the CPA, gives the 6.35 Mt 2020 baseline scenario.

7.1. Supply of plastic waste

Under task 1, the generation of waste was determined at the level of waste categories, material flows, and material components based on waste statistics in combination with waste composition data. In addition, a literature-based estimate of plastic by-products that are presumably not reported in waste statistics, was produced and added.

Table 5 shows the supply of waste categories with significant plastic content, the assumed percentage of plastic waste within these categories, and finally the calculated amounts of plastic waste contained in these wastes.

Table 5: Domestic supply of plastic-containing waste categories and estimated share of plastic components, EU27, 2016

EWC-Stat category		Primary domestic waste supply 1 000 t	Estimated share of plastic components	
			weight-%	1 000 t
W05	Health care and biological wastes	1,570	30%	474
W074	Plastic wastes	10,340	100%	10,340
W08A	Discarded equipment	3,750	27%	1,008
W081	Discarded vehicles	6,240	11%	717
W0841	Batteries, accumulators wastes	1,010	10%	101
W101	Household and similar wastes	135,250	13%	17,583
W102a	Mixed, undifferentiated materials / packaging	9,990	58%	5,763
W102b	Mixed, undifferentiated materials / rejects	4,850	10%	485
W121	Mineral C&D wastes	12,578	2%	252
P-38.32.33	Plastic by-products	2,250	100%	2,250
Total domestic plastic waste supply		-	-	38,972

Based on this analysis, the total domestic generation of plastic waste in the EU27 is estimated at 39 Mt. Considering imports of plastic waste, the amount increases to 40.4 Mt (see Table 6).

High amounts of plastic waste are contained in the categories W101 'household and similar wastes' (17.6 Mt), W074 'plastic waste' (10.3 Mt) and in W102 'mixed and undifferentiated waste/packaging' (5.8 Mt).

Table 6 shows the plastic waste by waste categories and by origin (economic activity, households, imports). The data are further illustrated in Figure 4. More than half to the total plastic waste (20.9 Mt) is generated by households, followed by the service sector (NACE G-U excl. G46.77) with 8.6 Mt. Plastic waste from other economic activities accounts for 9.5 Mt and imports for 1.5 Mt.

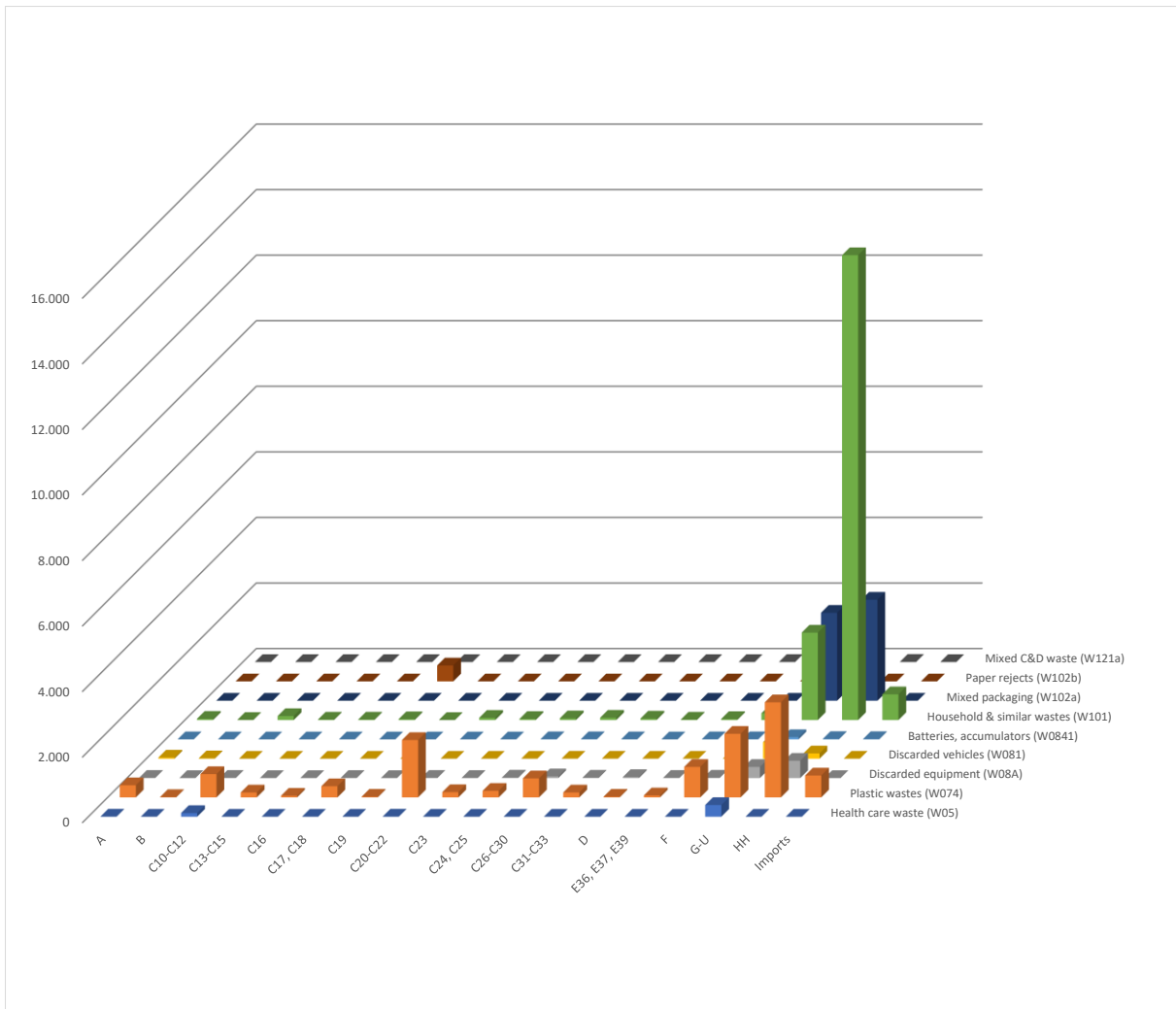


Figure 4: Plastic material in waste supply in the EU27 by EWC-Stat category and by economic activity (NACE) for reference year 2016 (in 1 000 tons)

Table 6: Plastic material in total waste supply in the EU27 by EWC-Stat category and by economic activity (NACE) and households for reference year 2016 (in 1 000 tons)

EWC-Stat category	A	B	C10-C12	C13-C15	C16	C17, C18	C19	C20-C22	C23	C24, C25	C26-C30	C31-C33	D	E36, E37, E39	F	G-U (ex. G4677)	HH	Total (TOT_HH)	Import prim. waste	Import sec. waste	Total supply
W05 Health care and biological wastes	3	0	112	0	0	0	0	3	0	0	0	0	0	0	0	356	0	474	1		475
W074 Plastic wastes	370	10	710	150	50	340	20	1 750	160	200	580	150	20	60	930	1 940	2 900	10 340	0	667	11.007
W08A Discarded equipment	5	0	5	0	0	3	0	5	3	13	51	11	30	5	11	339	527	1 008	0		1.008
W081 Discarded vehicles	34	11	0	0	0	0	0	0	0	0	1	1	0	0	1	505	162	717	1		718
W0841 Batteries, accumulators wastes	3	0	0	0	0	0	0	0	0	5	5	2	0	3	4	68	11	101	1		110
W101 Household and similar wastes	38	4	121	13	14	25	1	68	34	52	70	46	13	30	205	2 668	14 182	17 583	93	692	18.367
W102a Mixed, undifferentiated materials / packaging	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2 683	3 081	5 763	0		5.763
W102b Mixed, undifferentiated materials / rejects	0	0	0	0	0	485	0	0	0	0	0	0	0	0	0	0	0	485	0		485
W121 Mineral C&D wastes	0	1	0	0	0	0	0	0	2	1	0	0	1	3	233	4	6	252	0		252
Total plastic waste residuals	454	26	948	163	64	852	21	1 826	198	271	708	209	63	101	1 384	8 562	20 869	36 722	103	1 359	38.185
P-38.32.33 Plastic by-products	0	0	0	0	0	0	0	2 250	0	0	0	0	0	0	0	0	0	2 250	0		2.250
Total plastic waste	454	26	948	163	64	852	21	4 076	198	271	708	209	63	101	1 384	8 562	20 869	38 972	103	1 359	40.435

7.2. Use of plastic waste

Table 7 shows the results of task 1 regarding treatment (use) of plastic waste by waste category and by type of treatment. The data are further illustrated in Figure 5 and Figure 6.

Table 7: Use of plastic material in the EU27 by EWC-Stat category and by type of treatment (in 1 000 tons)

EWC-Stat category		Total use	Of which treated by						
			Recycling (RCV_R)	Energy recovery (RCV_E)	Incineration (DSP_I)	Back-filling (RCV_B)	Land-filling (DSP_L)	Other disposal (DSP_OTH)	Export (EXP)
W05	Health care and biological wastes	475	0	257	205	0	12	0	0
W074	Plastic wastes	11,007	4,421	2,689	40	70	1,179	0	2,609
W08A	Discarded equipment	1,008	576	280	3	0	150	0	0
W081	Discarded vehicles	718	190	181	0	0	341	0	6
W0841	Batteries, accumulators wastes	110	53	53	0	0	4	0	1
W101	Household and similar wastes	18,367	543	8,349	809	5	8,580	1	79
W102	Mixed, undifferentiated materials / pack.	5,763	3,220	1,961	0	0	581	0	0
W102	Mixed, undifferentiated materials / rejects	485	0	485	0	0	0	0	0
W121	Mineral C&D wastes	252	90	102	2	0	57	0	0
Total (w/o by-products)		38,185	9,093	14,357	1,059	75	10,904	1	2,695
P-38.32.33	Plastic by-products	2,250	2,250	0	0	0	0	0	0
Total		40,435	11,343	14,357	1,059	75	10,904	1	2,695

According to the results of task 1, 28.1 % of plastic waste were recycled, 38.1 % were incinerated, mainly with energy recovery, 27.0 % landfilled and 6.7 % exported.

Figure 6 shows, which waste categories contribute to recycling. Separately collected plastic waste (W074) that comprises production and separately collected consumption waste contributes 39 % of the recycled amount. Plastic packaging from the mixed collection of packaging waste accounts for 28.4 %. Around 20 % are industrial plastic wastes classified as by-products. About 13 % of recycled plastics comes from the remaining waste streams.

In chapter 8, information from other sources is used to check and verify the results of the waste accounts for the different application segments.

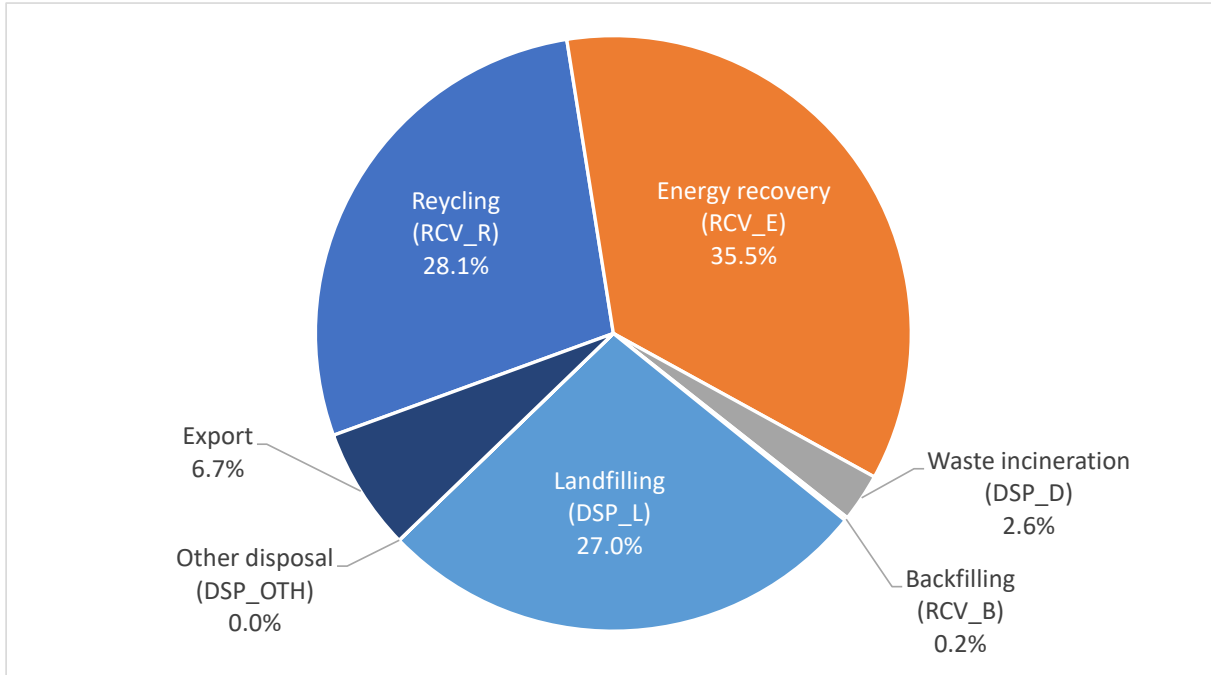


Figure 5: Final treatment of plastic waste in the EU27, 2016

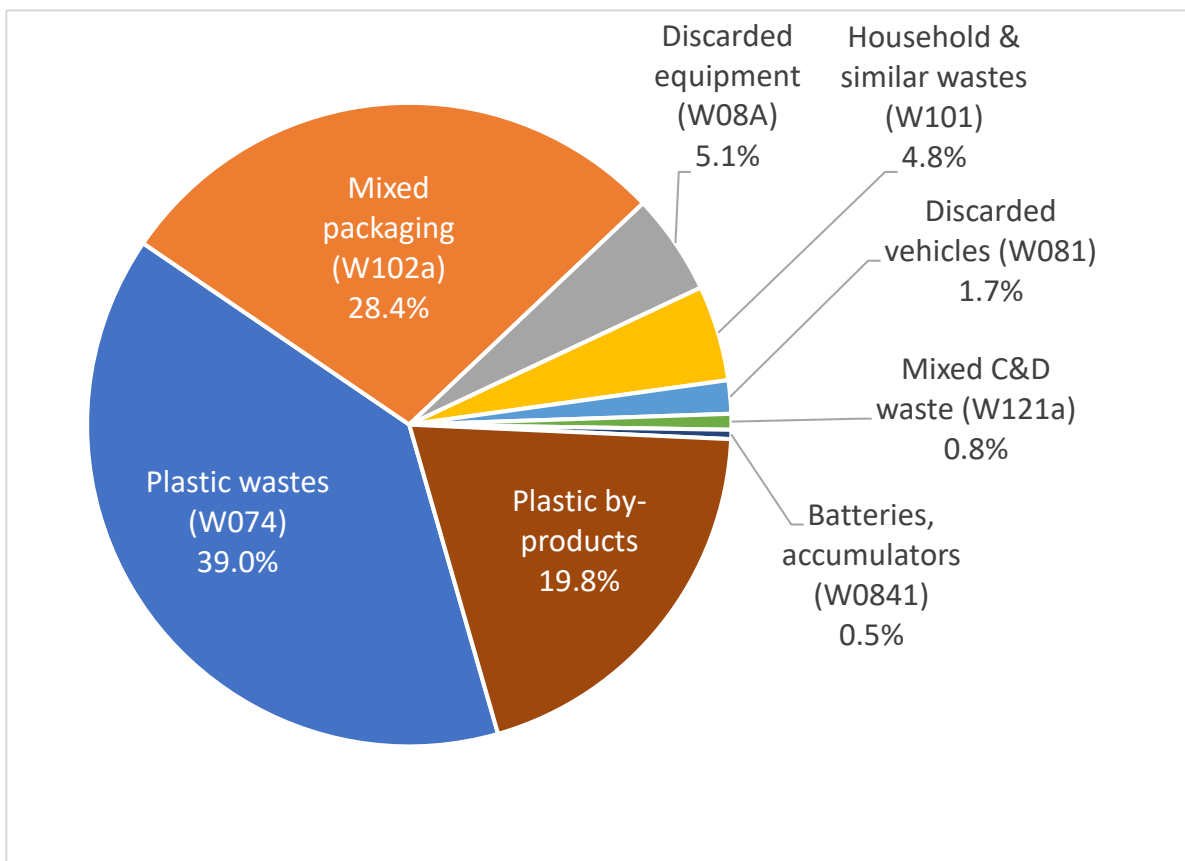


Figure 6: Sources of plastic waste recycled by waste category, EU27, 2016

8. Investigation of plastic flows by application segment

In the following, available data on the production, consumption, waste generation and treatment of plastic waste are presented and discussed separately for the different application segments of plastics.

The main data sources used are:

- Production and trade statistics (see chapters 5.1 and 5.2);
- Data on converters demand from PlasticsEurope (see chapter 5.3);
- Data from the state of play-reports of the Circular Plastics Alliance (CPA) (see chapter 6);
- Waste accounts data from task 1 (chapter 7);
- Monitoring data for packaging, end-of-life vehicles (ELV) and waste electrical and electronic equipment (WEEE);
- Other sources, where available.

The data for the different stages of the life cycle are presented and then discussed in view of their quality and usability for the plastic flow diagram.

The comparison and discussion of the data on plastic waste generation and treatment is seen as an important exercise to validate the results of task 1 and to draw conclusions on limitations and on options for improvement.

However, it is important to note that the possibility to relate the waste accounts to the application segments are limited and quite different depending on the segment:

- For the segments ‘automotive’ and ‘electric and electronic’ waste accounts data can be well related to data from other sources because there exist product-specific waste categories for these applications (i.e. discarded vehicles (W081), discarded equipment (W08A)) that allow to allocate the waste to the generation source.
- For the segments ‘packaging’, ‘building and construction’ and households, leisure, sports’ the possibilities for comparison are very limited because waste from these applications is found in different waste categories (e.g. plastics waste (W074), household and similar waste (W101), mixed and undifferentiated wastes (W102) and mixed with plastics from other applications. The plastic waste contained in these waste categories can therefore not be assigned to a specific application segment.

8.1. Packaging Waste

8.1.1. Production and consumption of plastic products in packaging

According to the data from PlasticsEurope, the packaging sector is the largest application segment for primary plastics in the EU. In 2016, the converters demand for this segment amounted to 18 Mt or 40 % of the total demand (see chapter 5.3, Table 3). The demand has increased steadily since 2016 to 18.5 Mt in 2018 and has shown a decreasing trend since, amounting to 18.1 Mt in 2020 (see Table 3). The segment “automotive” is not clearly defined in the publication of PlasticsEurope but from the wording we assume that the production of transport means like trains, airplanes, ships etc. are not covered.

Plastic packaging is mainly made of polyethylene (48 %), polypropylene (23 %) and polyethylene terephthalate, which account together 92 % of the polymers used. Other polymers (8 %) comprise polystyrene, polyvinylchloride, expanded polystyrene and other polymers. For more detailed data, please refer to

Table 25 in the Annex.

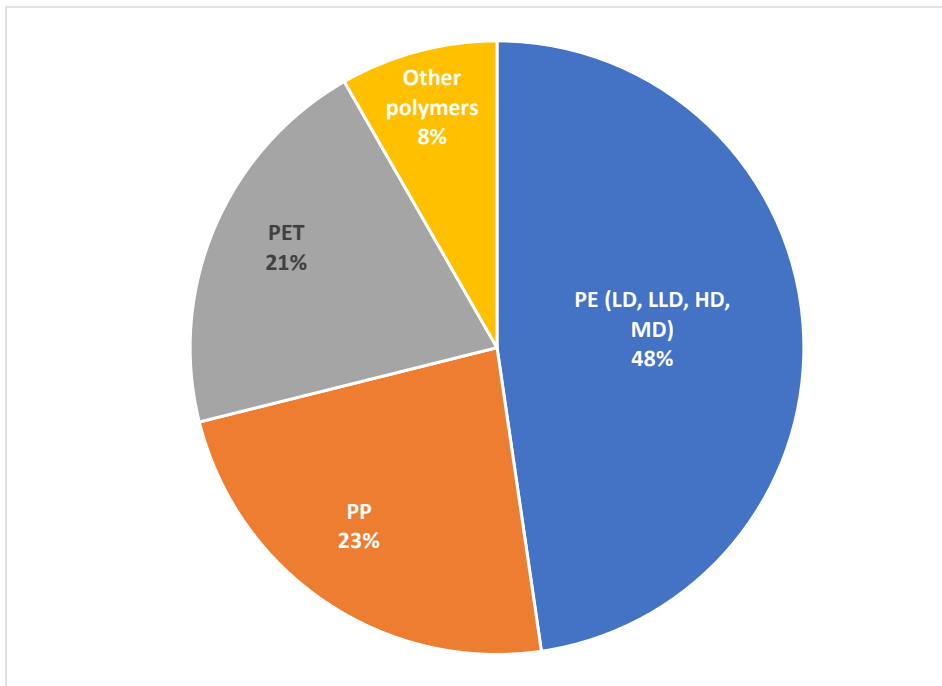


Figure 7: Polymers used for packaging production in the EU in 2020 (PlasticsEurope, 2022)

In the following chapters, packaging data from various sources are presented, compared and assessed in view of the Sankey diagram.

Production and trade statistics

The NACE includes a separate class for the 'manufacture of plastic packaging goods (NACE 22.22). The production, trade and apparent consumption of the products of this NACE class are shown in Table 17. The statistics report a production volume of 19.2 Mt for 2016. Considering the exports of 1.6 Mt and the imports of 1.3 Mt, this results in an apparent consumption of 18.8 Mt of plastic packaging goods. The detailed data by PRODCOM codes are shown in Table 8.

Table 8: Production, export, import and apparent consumption of plastic packaging goods (NACE 22.22) (in tons)

CPA code	CPA label	Production	Export	Import	Apparent consumption
222212	Sacks and bags (including cones), of other plastics than polymers of ethylene	442.170	78.200	84.668	448.638
222213	Boxes, cases, crates and similar articles of plastics	2.392.243	351.533	248.172	2.288.883
222214	Carboys, bottles, flasks and similar articles of plastics	7.484.281	572.077	211.995	7.124.198
222219	Other plastic packing goods	6.007.970	401.205	259.805	5.866.570
2222 total	Plastic packaging goods	19,156,917	1,638,096	1,280,082	18,798,904

8.1.2. Generation and treatment of plastic waste from packaging

In the following, data on waste generation and treatment of packaging in the EU are shown and compared from various sources.

Packaging monitoring data pursuant to the Packaging-Directive

Under Directive 1994/62/EU on packaging and packaging waste¹³, EU Member States have to report annually the amount of packaging generated and the amounts recovered. The reporting includes lightweight plastic carrier bags¹⁴. For recovery, a breakdown has to be provided by energy recovery, other recovery and recycling. The amounts recycled are further broken down by 'Recycling in the Member State', 'Recycling in other Member States of the EU', and 'Recycling outside the EU'. The available data for the breakdown of recycling are extremely incomplete (less than 1% of total recycling for 2014 to 2017, 85% for 2018), so that estimates had to be created and gaps to be filled in order to arrive at the figures shown in Table 9 for the EU27. In the Annex, the data basis and the way of estimation is presented in Table 20 and Table 21. Furthermore, Table 10 shows the corresponding data for the EU27 plus NO, UK and CH in order to enable a comparison with the figures available from PlasticsEurope and the Circular Plastics Alliance. The data used and estimations applied for NO, UK, and CH are also presented in the Annex (Table 22 to Table 24).

In 2016, EU Member States reported a total of 14 Mt or 31.6 kg/cap of Packing waste generated (Table 9). The corresponding figure for the EU27 plus UK, CH, and NO is 16.8 Mt. The trend over time is characterized by a steady increase with average growth rates from 2014 to 2018 of 3 % (EU27) and 2.8 % (EU27 plus NO, UK and CH). The reported amounts for recycling 2016 are 5.9 Mt for EU27 and 7.2 Mt for EU27 plus NO, UK and CH, with corresponding share from generation of 42 % and 43 %, respectively.

Table 9: Packaging waste generated, recovered, and recycled according to the monitoring data pursuant to the Packaging-Directive, EU27 (in tons)

Eurostat label	2014	2015	2016	2017	2018
Waste generated	13,187,608	13,663,999	14,037,118	14,550,476	14,817,435
Recovery total, of which	9,768,454	10,272,462	10,788,911	11,218,168	11,616,632
Recovery - energy recovery from packaging waste	4,510,722	4,732,887	4,831,342	5,147,595	5,468,909
Recovery - other	8,729	10,645	9,834	7,131	8,781
Recycling, of which	5,249,004	5,528,930	5,947,735	6,063,442	6,138,942
Recycling in other Member States of the EU	974,850	1,026,838	1,104,618	1,126,108	1,140,130
Recycling in the Member State	4,191,677	4,415,216	4,749,660	4,842,060	4,902,351
Recycling outside the EU	82,477	86,876	93,457	95,275	96,461

¹³ Directive 1994/62/EU of the European Parliament and Council of 20 December 1994 on packaging and packaging waste, OJ No L 62 04.07.1994, last amended 14.6.2018.

¹⁴ See Annex I, Illustrative examples for criterion (ii), of Directive 1994/62/EU.

Table 10: Packaging waste generated, recovered, and recycled according to the monitoring data pursuant to the Packaging-Directive, EU27 plus UK, CH, and NO (in tons)

Eurostat label	2014	2015	2016	2017	2018
Waste generated	15,850,723	16,396,941	16,787,594	17,342,444	17,717,101
Recovery total, of which	11,235,131	11,780,778	12,553,704	13,027,969	13,441,772
Recovery - energy recovery from packaging waste	4,966,828	5,167,544	5,385,201	5,706,456	6,053,116
Recovery - other	8,729	10,645	9,834	7,131	8,781
Recycling, of which	6,259,575	6,602,589	7,158,669	7,314,382	7,379,875
Recycling in other Member States of the EU	1,284,658	1,358,769	1,478,122	1,515,559	1,527,662
Recycling in the Member State	4,600,845	4,848,416	5,235,794	5,342,135	5,397,742
Recycling outside the EU	374,073	395,404	444,753	456,688	454,471

Comparison of the monitoring data with Information from CPA, Plastics Europe and JRC

Table 11 shows the monitoring data in comparison to data from CPA, PlasticsEurope and JRC. It is important to note that the naming of the parameters is quite different for the three sources. For this reason, the labels of all sources were kept, and it was attempted to place comparable categories in the same row, e.g., recycling in monitoring data rather corresponds to outputs of sorting (CPA: 'Sorted waste', PlasticsEurope: 'Send to Recycling').

JRC is the only source that provided separate collection of packaging waste. This value was put in the same row as sorted waste to avoid a separate row with only one figure.

The figures in italics (monitoring data) are estimated as mentioned above and the underlined figures were calculated as follows:

- The total amount incinerated or landfilled from JRC (12.8 Mt) was split into the amount of losses from the production of recyclates (0.7 Mt) and the sum of the amounts directly treated from mixed waste (10.1 Mt) or lost during sorting (2 Mt), amounting together to 12.1 Mt.
- In the PlasticsEurope data sources used, the amounts of packaging waste collected were provided together with percentages landfilled, sent to recycling or subject to energy recovery. These percentages were used to calculate the corresponding amounts.
- PlasticsEurope also provided the percentages that result for recycling, if the new calculation points (Input to recycling plants) are considered (22.5% and 29% for 2016 and 2018, respectively). These were used to calculate the input to recycling plants for comparison.

The selection of data covers the monitoring data for the base year of this study (2016) and EU27. The other years and geographical coverage were selected as such as to enable a comparison to the other sources (EU27: 2017; EU27 plus UK, CH, and NO: 2016 and 2018). In the headers of the table and in the text 'EU27 plus UK, CH, and NO' is referred to EU27+3. For comparison the table contains in the right column also data for all post-consumer plastic waste 2018.

Table 11: Comparison of the monitoring data with Information from CPA, Plastics Europe and JRC (in 1 000 tons), for comparable reference years and geographical areas plus 2016 for EU27

Parameter Eurostat	Monitoring data on plastic packaging waste				CPA data on plastic packaging ¹⁾		Data of JRC 2017 ³⁾		Data of Plastics Europe (PE) ⁴⁾			
	EU27		EU27+3		Parameter CPA	EU27+3	Parameter JRC	EU27	Parameter PE	(EU27 +3)		
	2016	2017	2016	2018		2016 ²⁾		2017		2016	2018	Post-consumer plastic 2018
Waste generated	14.037	14.550	16.788	17.717	Collected waste (=3+4+5)	16.119	Generation	17.080	Waste collection	16.700	17.800	29.100
not covered	:	:	:	:	3 Disposal	3.189	Incineration or LF	<u>12.130</u>	Landfill	<u>3.407</u>	<u>3.293</u>	7.200
Recovery	10.789	11218,2	12554	13.442	not covered	:	not covered	:	not covered	:	:	:
Energy Recovery	4.831	5147,6	5385	6.053	4 Energy Recovery	5.975	not covered	:	Energy Recovery	<u>6.480</u>	<u>7.031</u>	12.400
Recovery - other	10	7,1	10	9	not covered	:	not covered	:	Chemical recycling	:	:	100
Recycling	5.948	6063,4	7159	7.380	5 Sorted waste (=6+7)	6.955	Separate collection	6.960	Sent to recycling	<u>6.814</u>	<u>7.476</u>	9.400
Recycling in other EU-MS	<i>1.105</i>	<i>1126,1</i>	<i>1478</i>	<i>1.528</i>	not covered	:	not covered	:	not covered	:	:	:
Recycling in the MS	<i>4.750</i>	<i>4842,1</i>	<i>5.236</i>	<i>5.398</i>	6 Input to recycler (EU+2)	5.339	not covered	:	not covered	:	:	:
Recycling outside the EU	93	95	445	454	7 Export outside EU+2	1.616	Export outside EU	1.830	Export outside EU+2	:	:	1.900
not covered	:	:	:	:	8 Input to recycling process (EU+2)	4.006	Recycling	3.130	Input recycling plants	<u>3.758</u>	<u>5.162</u>	7.500
not covered	:	:	:	:	not covered	:	Incineration or LF	<u>690</u>	unknown ⁵⁾	:	:	2.600
not covered	:	:	:	:	9 Output recycler (EU+2)	3.906	Secondary material	2.440	Recyclates produced	:	:	4.900
not covered	:	:	:	:	Not covered	:	Not covered	:	Recyclates in new products	:	:	4.000

 Notes: *Italics* = estimates, underlined = calculated

¹⁾ Source: CPA (2020b): Plastic Packaging Collection and Sorting, State of play report for the Circular Plastics Alliance.

²⁾ Source: Antonopoulos, 2021 (JRC): Recycling of post-consumer plastic packaging waste in the EU: Recovery rates, material flows and barriers.

³⁾ 72% (2016), 21% (2017), 7% (2019)

⁴⁾ Sources: PlasticsEurope (2018): Plastics – the Facts 2018. PlasticsEurope (2019c): The circular economy for plastics. A European overview.

⁵⁾ Loss or export of recyclates

It can be seen in Table 11 that the Eurostat data for waste generation 2016 for EU27+3 (16.8 Mt) are fairly similar to the data on waste collected of the CPA (16.1 Mt) and PlasticsEurope (16,7 Mt) with the same geographical coverage. The same applies to the 2018 values of PlasticsEurope (17.8 Mt) and the estimates based on Eurostat data (17.7 Mt). The figure on waste collection from the JRC for the EU27 2017 (17.1 Mt¹⁵), however, is much higher than the corresponding amount from the monitoring data (14.6 Mt), although the study claims that they have used Eurostat data. In fact, if the EU28 is calculated for 2017 from the tables in the Annex for EU27 and the UK, 16.8 Mt results, so that it appears that the value of the study is closer to the former EU28 figure than that of EU27.

For energy recovery, the Eurostat data 2016 for EU27+3 (5.4 Mt) are again similar to the corresponding data of the CPA (6.0 Mt) and PlasticsEurope (6.5 Mt). For JRC, no separate data for energy recovery are available.

For 2016, the landfill data for EU27+3 of PlasticsEurope (3.4 Mt) are similar to the disposal data of CPA (3.2 Mt). The monitoring data do not contain figures for landfill, while the JRC-data provide only a combined figure for incineration and landfill.

The figures on recycling are most interesting. In the monitoring data, 7.2 Mt are reported for 2016 and EU+3, which is similar as the figure of 'sorted waste' by CPA (7.0 Mt) or 'sent to recycling' by PlasticsEurope (6.5 Mt). Similarly, the corresponding data for 2018 from monitoring (7.4 Mt) and PlasticsEurope 7.5 are almost equal.

There are no further monitoring data along the process chain, but interesting data from CPA and JRC, resulting in figures for production of recyclates between 2.4 Mt for EU27 in 2017 and 3.9 Mt for EU+3 2016. The corresponding inputs to the recycling process are 3.1 Mt for EU27 in 2017 (JRC), 4.0 Mt for EU+3 2016 (CPA) and 3.8 Mt for EU+3 2016 as well as 5.2 Mt for 2018 (PlasticsEurope). The recycling rates are difficult to estimate, due to the unknown whereabouts of the sorted waste that is exported to non-EU-countries.

These extra-EU-export figures are extremely different. The monitoring data are far lower than those from the other sources (less than 0.5 Mt in all cases). They were, furthermore, largely estimated and seem therefore not very reliable. The JRC data with 1.8 Mt (EU 27, 2017) and CPA data with 1.6 Mt (2016 EU+3) seem more credible and come close to the figure of PlasticsEurope for all post-consumer plastic waste exported (1.9 Mt). The comparison is further complicated by the different coverage of what is meant by extra-EU, since these extra-EU-exports from the view of the EU27 includes exports to NO, CH and UK, while from the view of EU+3 they do not.

The following can be concluded from the comparison: The recycling figures used in the waste accounts and in the monitoring data, measured at the output of the sorting process are much higher than those which consider further losses and result for all four data sources used in values between 41% and 43% for plastic packaging. For the data on all post-consumer plastic waste 32% result for EU+3 in 2018 (PlasticsEurope). The corresponding rates for the measurement point 'input to recycler' are 35% for CPA data and 29% for JRC data, when it is assumed that the exported waste is also an 'input to recycler'. If only the 'recyclates produced' are considered, the corresponding figures are 34% (CPA) and 23% (JRC), when the exported amounts are included and the same rates of losses from recyclate production are applied (CPA: 2%, JRC: 22%).

8.1.3. Summary and discussion in view of the Sankey-diagram

According to data from PlasticsEurope, in 2016 about 18 Mt of primary plastics were used in the EU27 for packaging production. The secondary material produced from plastic packaging was 2.4 Mt in 2017 according to JRC for EU27, 3.9 Mt based on CPA-figures, which are mostly for 2016, and 2.5 Mt calculated from PlasticsEurope data, the latter two for EU+3. Using 2.5 Mt as estimate and assuming that this material is completely used for the production of new packaging, 20.5 Mt result as the total

¹⁵ Of which 10.1 Mt (59%) mixed collection and 7.0 (41%) separate collection

production value for plastic packaging. This is almost equal to the converters demand for plastic packaging stated by CPA (20.4 Mt, see Table 11) and corresponds well to the 19.1 Mt taken from the production statistics (see Table 2), particularly if the produced recyclates (ca. 2.5 Mt) are also used for other plastic products than packaging. If then imports and exports of plastic packaging are taken into account, the apparent consumption of 18.8 Mt results for the EU27 in 2016 (see Table 2). Assuming that the apparent consumption is similar to the amount of packaging put on the market and that this again is similar to the amounts of packaging generated, the figure of 14.7 Mt from the monitoring data appears to be too low. This could be due to an underestimation of the monitoring data, which are often based on the reporting of licensed packaging, so that unlicensed materials are not fully covered. On the other hand, there may be plastic packing items in the industry like plastic drums, which may have a longer lifetime and are thus added to the stock. For the Sankey, a consumption of 18.2 Mt is seen reasonable, while for the converters demand of primary plastics the figure of plastics Europe is used (18 Mt, see Table 3).

The data on waste generation and treatment are taken from task 1. Hence, the arising of plastic waste from packaging in the EU27 cannot be exactly determined in the model, since plastic packing is found in the following EWC-Stat categories:

- Plastic wastes (W074);
- Household and similar wastes (W101); and
- Mixed, undifferentiated materials / packaging (W102a) (5.8 Mt).

Only the third category explicitly contains plastic packaging. The categories W074 and W101 contain also plastics from other segments and even pre-consumer waste from production (W074, 2.25 Mt).

8.2. Building and construction

8.2.1. Production and consumption of plastic products used in the construction and building sector

According to PlasticsEurope, the building and construction sector is the second largest end use market for plastics in Europe after packaging.

According to state of play report of the CPA for plastic waste from construction (CPA 2020d), the main applications for plastics in the construction and building Sector are:

- Flooring;
- Roofing;
- Windows, doors and related building products;
- Pipes;
- Building profiles, cladding;
- Insulation materials;
- Cables; and
- Building membranes.

Figure 8 shows the polymers used in the building and construction sector according to PlasticsEurope. The main polymers used are PVC, which makes up about 34 % of the demand, followed by the family of PE with 18%, expanded PS with 13%, PUR with 25 % and PP with 8%. (PlasticsEurope, 2022)

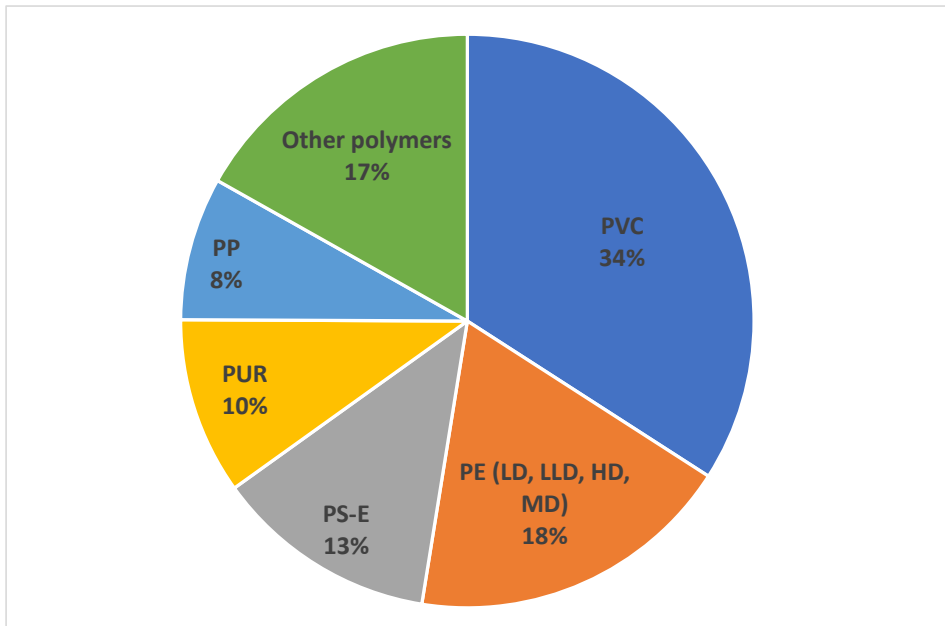


Figure 8: Polymers used in the building and construction sector in the EU27+3 in 2020 (PlasticsEurope, 2022)

Data on the production and consumption of plastics and plastic products for the building and construction sector are available from production and trade statistics and from PlasticsEurope.

Production and trade statistics

The NACE includes a separate class for the ‘manufacture of builder’s ware’ (NACE 22.23). The production, trade and apparent consumption of the products of this NACE 22.3 for 2016 are shown Table 12. The production volume of builder’s ware in the EU27 amounted to 6.4 Mt. Considering the exports of 1.1 Mt and the imports of 0.6 Mt, this result in an apparent consumption of 6.0 Mt of plastic builder’s ware. The main product groups are ‘door, windows, frames, etc.’ (CPA 22.23.14) and ‘floor, wall or ceiling coverings’ (CPA 22.23.11) with an apparent consumption of 2.4 Mt and 1.3 Mt respectively.

NACE class 22.23, however, does not cover all products used in building and construction. Products like tubes, pipes, hoses, plates, sheets, films, fittings and other plastics products, of which a significant part will also be used in the construction sector, are covered by NACE class 22.21 and cannot be allocated to the final application. Accordingly, the real production and use of plastics products is higher than the total of CPA 22.23.

Table 12: Production, export, import and apparent consumption of 'plastic builder's ware' (NACE 22.23), EU27, 2016

CPA code	CPA label	Production	Export	Import	Apparent consumption
222311	Floor, wall or ceiling coverings of plastics, in rolls or in the form of tiles	1,286,096	382,437	397,007	1,300,667
222312	Baths, wash-basins, lavatory pans and covers, flushing cisterns and similar sanitary ware, of plastics	865,913	-	-	865,913
222313	Reservoirs, tanks, vats and similar containers, capacity > 300 l, of plastics	202,615	30,683	13,262	185,194
222314	Doors, windows and frames and thresholds for doors; shutters, blinds and similar articles and parts thereof, of plastics	2,775,064	480,646	113,845	2,408,263
222315	Linoleum and hard non-plastic surface floor coverings, i.e. resilient floor coverings, such as vinyl, linoleum etc.	88,001	24,915	11,856	74,942
222319	Builders' ware of plastics n.e.c.	1,152,011	130,480	99,194	1,120,725
2223 total	Manufacture of builders' ware of plastic	6,369,699	1,049,160	635,165	5,955,703

PlasticsEurope

Based on data from PlasticsEurope, the amount of primary plastics used by converters for construction products for 2016 in the EU27 is estimated at 8.9 Mt or 19.7 % of the converters demand (see Table 3). The converters demand is thus significantly higher than the apparent consumption of products from CPA 22.23 and is assumed to be closer to the consumption of plastics in this segment.

8.2.2. Generation and treatment of plastic waste from building and construction

Data on waste generation and treatment are available from task 1, from PlasticsEurope and from the CPA SoP report for (CPA 2020d).

Waste accounts

The generation of plastic waste cannot be retrieved directly from the waste accounts data but can be estimated from the supply table (Table 6) by adding up:

- the amounts of plastics reported under NACE F for the waste categories W074 (930 kt) and W101 (205 kt) and
- all plastic waste contained in waste category W121 (252 kt).

This calculation results in an estimated generation of 1.39 Mt of plastic waste from the construction sector.

Data on the treatment of plastic waste cannot be determined based on the waste accounts because such waste may be contained in different waste categories together with other plastic waste. An allocation of the treated waste to the generating sectors is not possible in this case (for explanation see also the introduction to chapter 8).

PlasticsEurope

The generation and treatment of plastic waste from building and construction was investigated by the consultant Conversio on behalf of PlasticsEurope. The results for the EU27+2 and for reference year 2018 are shown in Table 13.

Conversio estimates that in 2018 1.76 Mt of plastic C&D waste were generated of which 26 % were recycled, 47.5 % treated by energy recovery, and 26.5 % were subject to disposal/landfilling.

Table 13: Building & construction post-consumer plastic waste generation EU 28+2 in 2018 (kt)

Type of plastic	Total waste generation		Total	Recovery				Disposal/landfill Total	
	in kt	in %		There of Mechanical recycling		There of Energy recovery		in kt	in %
			in kt	in %	in kt	in %			
PE-LD	90	5.1	70	24	27.0	46	51.0	20	22.0
PE-HD	225	12.8	164	54	24.0	110	49.0	61	27.0
PP	130	7.4	95	30	23.0	65	50.0	35	27.0
PS	30	1.7	21	2	7.0	19	64.0	9	29.0
EPS	140	8	95	13	9.0	83	59.0	45	32.0
PVC	910	51.7	683	309	34.0	373	41.0	228	25.0
Other	235	13.4	172	18	7.5	154	65.5	63	27.0
Total	1760	100.1	1300	450	26.0	850	47.5	460	26.5

It can be seen from the table that PVC accounts for about half of the generated waste and for 69% of the mechanically recycled waste.

CPA

The CPA relies on the data from PlasticsEurope cited above but distinguishes between plastics sorted for recycling (450 kt) and the recyclate produced in the EU (350 kt), which indicates that the figure of PlasticsEurope for mechanical recycling reflects the separated plastics waste but not the final recycling.

8.2.3. Summary and discussion in view of the Sankey-diagram

From PlasticsEurope, the data on the converters demand of primary plastics for the segment building and construction of 8.9 Mt is available. As the apparent consumption of 'plastics builder's ware' derived from official statistics seems obviously incomplete, the converters demand is taken as an estimate for the consumption of plastics product in this segment.

Estimates of waste generation range between 1.4 Mt (2016) from task 1 and 1.76 Mt (2018) from PlasticsEurope. The result from task 1 therefore looks plausible.

However, both estimates are clearly lower than the estimated assumed consumption of 8.9 Mt. The difference theoretically implies an annual increase of stock of more than 7 Mt. Considering that many plastic products used for building and construction have a long use phase of up to several decades, and an ongoing increase of the stock seems plausible. The annual increase by more than 7 Mt nevertheless seems very high. No further data were available validate this result.

The difference is astonishingly high and indicates a significant annual increase of the plastic stock in buildings. Probably not the only explanation. Possibly a certain amount of pipes and plastics used in civil engineering underground may be left in the ground after use and may not show up as waste.

8.3. Automotive sector

8.3.1. Production and consumption of plastic products in vehicles

Data related to production and consumption of plastics in the automotive segment are available from PlasticsEurope and can be roughly estimated on the basis car registrations and information on average plastic contents.

PlasticsEurope

According to the data from PlasticsEurope, the automotive sector is the fourth largest application segment for primary plastics in the EU. In 2016, the converters demand for this segment amounted to 4.5 Mt or 10 % of the total demand (see chapter 5.3). The demand has increased constantly since 2008 to 4.7 Mt in 2017 (Mehlhart et al., 2018) and has shown a decreasing trend since, amounting to 3.9 Mt in 2020 (see Table 3). The segment ‘automotive’ is not clearly defined in the publication of PlasticsEurope but from the wording we assume that the production of transport means like trains, airplanes, ships etc. are not covered.

The use of plastics in the automotive sector is characterised by a broad variety of polymers. The most important ones are polypropylene (22 %), polyurethane (14 %) and polyethylene (12 %), which account together for about half (47 %) of plastics used. The other half comprises a variety of thermoplasts (ABS, SAN, PA, PC, etc) and 7 % of other plastics (PlasticsEurope, 2022).

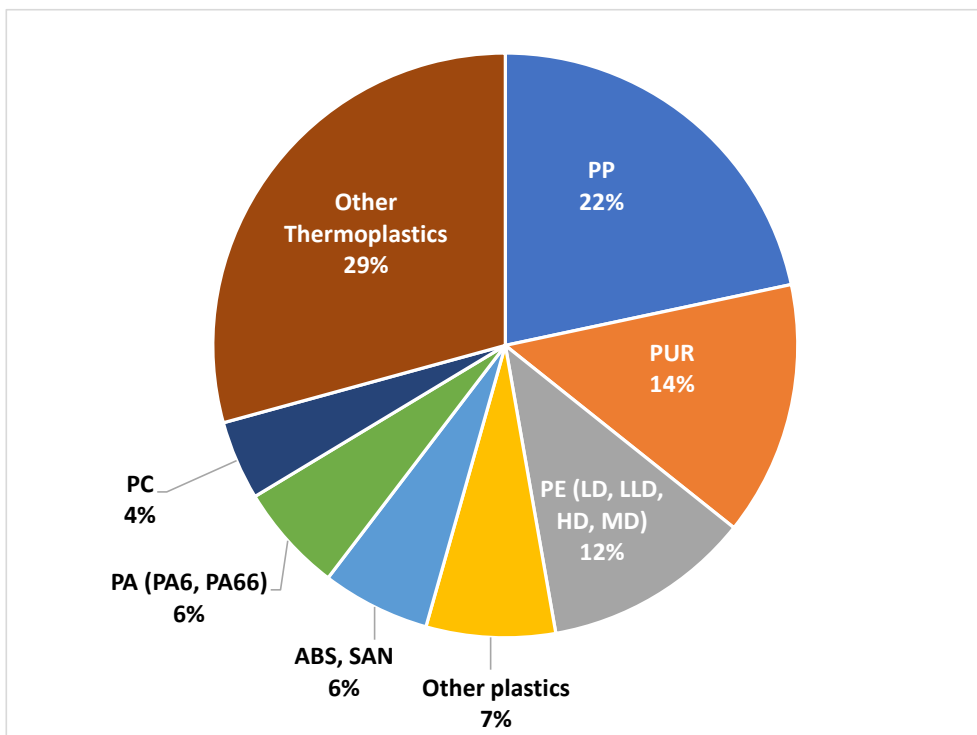


Figure 9: Polymers used in the automotive sector in the EU in 2020 (PlasticsEurope, 2022)

Estimates based on car registrations

The amount of plastics put on the market annually as part of vehicles can be roughly estimated based on the cars that are newly registered each year, the average weight of the vehicles and the average share of plastics contained.

The share of plastics in vehicles and the type of polymers used varies across brands and over time. According to the CPA SoP report on the automotive segment, the average share of plastics has increased between 2000 and 2020 from about 10% to 15%. This corresponds with the increase in plastics demand for the automotive sector mentioned earlier in this chapter.

In the study ‘Supporting the evaluation of the Directive 2000/53/EC on end-of-life vehicles’ (Trinomics, 2020) carried on behalf of DG ENV the following data are used for the estimation of plastics in vehicles:

- average vehicle weight: 1,088 t/vehicle

- average share / content of plastics: 14.6 % and 158 kg/vehicle respectively

In 2016, 13.9 million vehicles that fall under the ELV Directive were newly registered in the EU27 (ACEA, 2022a and 2022b). This includes 11.9 million passenger cars (category N1) and 0.15 million light commercial vehicles below 3.5 tonnes total mass (category M1) which were newly registered in the EU27. Applying the above average values to this figure results in an amount of 2.2 Mt of plastics that are put on the market together with new vehicles. We consider this amount as a lower limit of the estimation range as it does not consider vehicles like lorries, motorcycles, trailers, buses, tractors and special vehicles that do not fall under the ELV Directive and for which no estimations of the plastic content are available. We therefore assume that around 3 Mt of plastics were added to the stock in 2016 through vehicles of all types.

According to Trinomics (2020), around 288 million of vehicles falling under the ELV were registered in the EU28. Assuming that the UK accounts for about 15 % of these vehicles, this results in an estimated number of 245 million vehicles in circulation in the EU27. Depending on the applied factor for the plastic content, the stock of plastics in such vehicles in 2016 is estimated to range between 30 Mt and 39 Mt (35 Mt). Again, this figure does not consider the contribution of vehicles not covered by the ELV Directive.

8.3.2. Generation and treatment of plastic waste from vehicles

Data related to the generation and treatment of plastics from vehicles are available from task 1, from ELV monitoring data and different studies.

Waste accounts

Under task 1 of the project, the generation (total supply) of discarded vehicles in 2016 was determined as 6.2 Mt, containing 718 t of plastics. (see Table 6). The amount of plastic waste is calculated with an average plastic content of 11.5 weight-%. Considering the increase of the plastics content over time and the average age of ELV of 15 – 22 years (Trinomics (2020)), this coefficient seems appropriate. It is further estimated that 26 % (190 kt) of the plastic from vehicles is recycled, 25 % (181 kt) energetically recovered and 48 % (341 kt) disposed of at landfills. A small part of the plastic waste is exported (see Table 7). In the following, these results are compared with data from the ELV monitoring and with information from literature.

ELV monitoring data pursuant to the ELV-Directive

Under the ELV Directive, EU Member States have to report annually the amounts of end-of-life vehicles generated and the quantities recycled, recovered and disposed of in order to prove the achievement of the legally defined recycling and recovery targets.

For 2016, EU Member States reported a total generation of 5.1 Mt of end-of-life vehicles. The reported amount is thus by 0.9 Mt lower than the 6.2 Mt of ‘discarded vehicles’ determined under task 1. Possible reasons for the difference could be the broader coverage of the waste category ‘discarded vehicles’, which includes not only ELV but all types of vehicles, and/or the possibility of double-counts in waste statistics resulting in an overestimation of the amount determined under task 1.

The ELV monitoring data do not allow to derive recycled amounts specifically for the plastic contained.

Information from CPA and other sources

In the CPA SoP report on the automotive sector (CPA, 2021e), the amount of plastic waste collected is reported with 1.5 Mt per year. This figure seems to be based on data from ACEA that approximately 10 million vehicles are deregistered every year. Assuming that all these vehicles become waste and have an average plastic content of 15%, this results in a plastic waste amount of about 1.5 Mt.

However, considering the information from waste statistics and from the ELV monitoring, the amount of 1.5 Mt of plastic waste from vehicles seems to be an overestimation 1.) because the number of vehicles that is actually treated in the EU is significantly lower than the number to be expected on the

basis of deregistrations, and 2.) the plastics content of the vehicles that become waste today is lower than that of new vehicles.

The statistical gap between the number of deregistrations and the lower number of end-of-vehicles ending up in the EU's waste treatment system has been observed since several years and was subject to different studies. According to Trinomics (2020), 11.2 million end-of-life vehicles falling under the ELV Directive left the stock of registered vehicles in 2017 in the EU28. Of these, 6.57 million were reported as ELVs and 0.87 million were reported as exports of used cars to non-EU countries. This leaves a gap of 3.77 million (34 %) of vehicles with unknown whereabouts. It is assumed that these vehicles are either exported (as used vehicles or ELVs), with this export not being reported, or dismantled but not reported as discarded vehicles within the EU. (Trinomics, 2020). Figures on the amount of unreported ELV exports are not available.

Considering the observed gap between deregistered vehicles and ELV treated in the EU, the estimate of 718 kt of generated plastic waste from discarded vehicles seems to be in a realistic range.

In view of the **recycling** of plastic waste from vehicles, the CPA roadmap estimates that, in 2018, 350 kt (23 %) of the assumed total of 1.5 Mt of plastics were sorted for recycling, and that finally 150 kt or 43 % of the sorted plastics were reprocessed into recyclate.

As cited above, the waste account modelling resulted in an estimate of 190 kt of recyclates produced from discarded vehicles in the EU27. The figure is therefore within a plausible range, but considering that the geographical scope of the figures is different (EU27 versus EU28), the assumptions concerning the recycling efficiency in the waste accounts model might be too optimistic.

8.3.3. Summary and conclusions in view plastics flows related to (W)EEE

Based on data from PlasticsEurope, it is estimated that in the EU27 about 3.5 Mt of primary plastics are used for products for the automotive industry. Based on the number of registered cars, the average weight and the average share of plastics per vehicle, it is assumed that the amount that is actually put on the market (consumption) is lower (e.g. because of exports of new cars) and amounts to about 3 Mt in 2016. This estimate refers to the automotive sector only but not to the production of other means of transport like trains, ships or airplanes.

The data on waste generation and treatment are taken from task 1. Hence, the arising of plastic waste from discarded vehicles in the EU27 is estimated at 718 kt. This figure is significantly lower than the 3 Mt that are added to the stock. Assumed reasons for the significant discrepancy are:

- The share of plastics in vehicles has significantly increased in recent years so that the plastic content in newly registered cars is clearly higher than the content of the vehicles that become waste after 15 to 22 years;
- A significant share of vehicles leaves the EU, as used vehicles or as ELV, so that the waste is treated abroad.
- An unknown share of vehicles may be treated in the EU without being reported as ELV. In this case the respective wastes would be included in the waste accounts data, but under other waste categories than discarded vehicles (W081).

Based on task 1, it is estimated that, in 2016, 190 kt (26 %) were returned to the economy as recyclate. The comparison of this figure with information from other sources indicates that the estimated yield of recyclate from discarded vehicles might be overestimated in the waste accounts model. Considering the absolute figures, the impact on the flow model is small.

8.4. Electrical and electronic equipment

Electrical and electronic equipment comprises a highly diverse spectrum of appliances, from smartphones to washing machines to photovoltaic modules. The products vary significantly in view of the share and also the type of plastics contained.

8.4.1. Production and consumption of plastics in EEE

Data related to the production and consumption of EEE are available from PlasticsEurope and from WEEE monitoring data. Data on the volume of production and trade from official statistics are not available because for PRODCOM entries related to plastic parts for electrical and electronic equipment the monetary value has to be reported but not the volume.

PlasticsEurope data

According to PlasticsEurope data, in 2016 about 2.8 Mt of primary plastics 6.2 % of the converters demand were used for the production of electrical and electronic equipment (see Table 3).

Circular Plastics Alliance

In the CPA roadmap the converters demand for EEE is estimated at 1.75 Mt. This amount refers to household EEE only and reflects the plastic content in 7.9 Mt of household EEE, which corresponds to a plastic content of about 22 weight-%.

Data from WEEE monitoring

Under Directive 2012/19/EU on waste electrical and electronic equipment (WEEE)¹⁶, EU Member States have to report annually the amount of EEE put on the market (POM), the amounts collected and on the treatment of the collected amounts. The POM data can be used to roughly estimate the amount of plastics put on the market annually in the EU27 by means of the average plastic content. For the work under task 1, an average plastic content of 27 weight-% over all types of equipment was determined on the basis of literature. In 2016, EU Member States reported a total of 8.5 Mt or 19.1 kg/cap of EEE put on the market. An average of 27% of plastic results in an amount of 2.3 Mt of plastics put on the market annually as part of EEE.

8.4.2. Generation and treatment of plastic waste from WEEE

Data related to the generation and treatment of plastic waste from WEEE are available from task 1, from the CPA roadmap, from the WEEE monitoring and from studies.

Waste accounts

Under task 1 of the project, the generation (total supply) of discarded equipment in 2016 was determined a 3.75 Mt containing 1.0 Mt of plastics. (see Table 6). The amount of plastic waste is calculated with an average plastic content of 26.9 weight-%. The factor used under task 1 is thus higher than factors used in the CPA report for household EEEE (22%). Based on the waste accounts model, recycling is determined at 57% (576 kt), energy recovery at 28% (280 kt) and landfilling at 15% (150 kt). In the following, these results are compared with data from other sources.

Data from WEEE monitoring

According to the WEEE monitoring data, 3.6 Mt were collected in 2016, corresponding to 42% of the quantities put on the market in the same year. When using the plastic content as for the waste accounts (26,9 weight-%), the waste stream contains around 960 kt of plastics.

The WEEE monitoring data do not allow to derive recycled amounts specifically for the plastic contained.

¹⁶ Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE)

Circular Plastics Alliance

The CPA provides data on the collection and recycling of plastics from household EEE only. It is assumed that 718 kt of plastics are sorted for recycling and 561 kt are produced in the EU.

8.4.3. Summary and conclusions in view plastics flows related to (W)EEE

According to data from PlasticsEurope, in 2016 about 2.8 Mt of primary plastics were used the EU27 for electrical and electronic equipment. Based on WEEE monitoring data, it is assumed that the amount of plastics that is actually put on the market is lower than the demand and amounted to about 2.3 Mt in 2016.

The data on waste generation and treatment are taken from task 1. Hence, the arising of plastic waste from discarded equipment in the EU27 is estimated at 1.0 Mt. This figure is significantly lower than the 2.3 Mt that were added to the stock in the same year. One possible reason for the difference is certainly the constant increase of EEE put on the market in the EU in combination with the long use-phase of some products which leads to an increase of the stock. Further assumed reasons are net export of used equipment and the reporting, i.e., the treatment in the EU without being reported as WEEE. In this case the respective wastes would be included in the waste accounts data, but under other waste categories.

8.5. Agriculture

8.5.1. Production and consumption

Non-packaging plastic products are used in vegetable production and in animal production.

Typical uses in vegetable production include:

- Films for greenhouses, small tunnels, mulching, protective coverings,
- Protective nets (anti-hail net, insect and bird protection nets, etc.),
- Pipes and tubes for irrigation,
- Horticulture twine.

Typical uses in animal production include:

- Stretch films,
- Silages,
- Bale nets and twines.

Polymers used in agriculture are LDPE for films and pipes accounting for 81 %, followed by PP for films and twines with 11 %, and HDPE for nets with 8 % (CPA, 2020a)

According to data from PlasticsEurope, about 1.5 Mt of primary plastics were used in 2016 for the production of agricultural plastic products in the EU27.

According to the CPA State of Play report (CPA, 2020a) for agri-plastics, the consumption is significantly lower than the converters demand and amounted to 722 kt in 2019. This figure corresponds well with the sales figures for agricultural plastics published by APE Europe, the non-packaging plastics products' association for agriculture (<https://apeeurope.eu/statistics/>), which reports 708 kt and 711 kt for 2018 and 2019, respectively.

Data from production and trade statistics are not helpful here as it is not possible to identify plastics products used in agriculture.

8.5.2. Waste generation and treatment

Waste accounts

The waste accounts compiled under task 1 do not allow to determine the generation and recycling of agricultural plastic products listed above, as these products can be found in different waste categories together with other plastic products like packaging. If at all, the order of magnitude of the generated waste can be assessed. Pursuant to the results of task 1, the sector agriculture, forestry and fisher produced a total of 454 kt of plastic waste over all waste categories. Specific agricultural products are expected to be contained either in the waste category 'plastic wastes' (W074), if collected separately', or in 'household or similar wastes', if disposed of as mixed waste. These two categories include 408 kt of plastics which certainly consists not only of specific agricultural products but also of packaging and other plastics. Hence, 400 kt are considered as an upper estimation limit for the amount of agricultural plastic waste based on waste statistics.

CPA roadmap

When producing data on the generation and collection of agricultural plastic waste, the soilage of the plastics has to be considered. In the CPA document on agricultural plastics it is assumed that, that the weight of agri-plastics is by the factor 1.63 higher than the weight of the unused plastics. According to the CPA document, 756 kt of soiled plastics or 444 kt of clean plastics were collected separately for recycling by the existing recovery schemes. From the collected amount, 335 kt of recyclate were produced. It is not clear from the document whether this amount is an export estimate, or a figure based on measurements of the recovery schemes.

8.5.3. Discussion of data in view of the flow model

For the Sankey diagram, the demand of primary plastics for agri-plastics are based on the data from PlasticsEurope (1.5 Mt) whereas for the consumption of agri-plastics the lower amount from the CPA-document is used (722 kt). The difference is presumably due to net exports of agri-plastics.

It is assumed that for agricultural plastics the waste generation is approximately equal to the consumption in a given year. Agri-plastic are consumables, and no stock building takes place.

The very rough estimate of generation of non-packaging plastic waste in agriculture based on waste accounts (about 400 kt as upper estimation limit) is significantly lower than the consumption and the expected amount for waste generation. Potential reasons for the difference might be:

- Undercoverage of waste statistics; waste data collection in NACE A is known to be challenging, in particular in countries where the agriculture is characterised by a high number of small farms.
- problem of sector allocation: e.g. separately collected waste by recovery schemes is reported under another sector than NACE A (e.g. in NACE E38 collection?)

8.6. Households, leisure, sports

According to data from PlasticsEurope, about 1.9 Mt of primary plastics were used in 2016 for the production of products in the segment 'households, leisure, sports' in the EU27. This segment includes for instance kitchen- and other houseware, toilet articles, toys, office or school supplies etc.

The production and trade of articles in this segment can only partly be identified in official statistics. Data for some products that can be allocated to this segment are shown in Table 14.

Although the list is certainly incomplete the data indicate that the domestic production of 2.1 Mt is higher than the estimated demand and that there are net imports of these products which lead to an apparent consumption of 2.3 Mt in 2016. Being aware that the list of products for this segment is

incomplete, the apparent consumption of 2.3 Mt is used in the flow diagram as estimate for the consumption of plastic products from this segment.

Table 14: Production, trade and apparent consumption of products allocated to the segment 'households' in the EU27, 2016 (tonnes)

PRODCOM code	PRODCOM label	Production	Export	Import	Apparent consumption
22292320	Tableware and kitchenware of plastic	1.355.810	90.669	216.470	1.481.612
22292340	Household articles and toilet articles, of plastics (excluding tableware, kitchenware, baths, shower-baths, washbasins, bidets, lavatory pans, seats and covers, flushing cisterns and similar sanitary ware)	588.425	78.631	120.245	630.040
22292500	Office or school supplies of plastic (including paperweights, paper-knives, blotting pads, pen-rests and book marks)	153.120	19.711	69.423	202.832
22292910	Hard rubber or plastic combs, hair-slides and the like (excluding electro-thermic hairdressing apparatus)	655	688	5.673	5.640
22292915	Hairpins, curling pins, curling grips, hair-curlers and the like, and parts thereof, of plastic (excluding electro-thermic hairdressing apparatus)	80	-	-	80
Sum		2,098,089	189,698	411,812	2,320,203

No data are available on the waste generation and treatment of plastics from this specific segment, neither from the work under task 1 nor from other sources.

8.7. Other applications

All applications of plastic products not included in the segments discussed in the previous chapters are summarised under 'other applications' Based on PlasticsEurope, the demand of primary plastics in the EU27 for other applications is estimated at 7.5 Mt or 17% of the total demand.

At the level of consumption, the quantity 'other applications' is determined as difference between the estimated total consumption and the sum of the consumptions of the specified application segments.

8.8. Production waste (Pre-consumer waste)

Nearly all published data on plastics refer to post-consumer waste only. Waste from the production and processing of plastic products (here referred to as pre-consumer waste) is mostly not covered.

Post-consumer plastic waste is certainly the more important and more challenging plastic flow in view of the efforts needed to increase the recycling and circular use of these materials.

Pre-consumer plastic wastes are usually not contaminated. They can be collected separately by polymer and by colour at the place of generation and have thus good prerequisites for being recycled. Recycling is mostly economically reasonable and viable. Thus, it can be assumed that pre-consumer wastes are recycled to a large extent. Nevertheless, it is important to know the respective quantities in order to have the full picture on the plastic flows.

Published data on pre-consumer wastes are scarce. Under task 1 of the project, the amount of pre-consumer waste was estimated at 4.5 Mt, based on literature and on waste statistics. It was estimated that half of this waste (2.25 Mt) is reprocessed into recyclates in waste treatment facilities and thus

covered by waste statistics. The other 2.25 Mt are assumed to be by-products that can be reprocessed without entering the waste treatment system and are thus not covered by waste statistics.

The association PlasticsEurope focusses in their annual publication “Plastics – the facts” on post-consumer waste but provided information on pre-consumer waste on request through personal communication (PlasticsEurope, 2022). According to PlasticsEurope, the generation of pre-consumer wastes amounted in 2018 to 3.9 Mt. Considering the closeness of this figure to the estimate under task 1, no correction was made to our estimate and the figure from task 1 was used for the flow diagram

9. Plastic flows (Sankey-diagram)

Figure 10 shows the (Sankey) flow diagram that is based on the considerations and the data presented in the previous chapters. The quantities for the nodes are visible in the diagram. The volumes of the flows are not shown in the diagram but presented in Table 18.

9.1. Nodes in the Sankey-diagram

The nodes basically reflect the stages of the life cycle of plastics as described in chapter 4. In addition, a node for the converters demand of primary plastics was introduced.

Node ‘Primary plastics production (NACE 20.16)’: The starting point of the diagram is the production of primary plastics in NACE class 20.16 of 67.2 Mt which is determined based on production statistics (see chapter 5.1 Table 1). The main outflow from NACE 20.16 is the quantity of primary plastics used by plastic converters (NACE 22.2) in the EU (37.2 Mt). Exports of primary plastics (14.9 Mt) and primary plastics used for products outside the scope of task 3 (15 Mt) are not further followed.

Primary plastics imported (11 Mt) and those produced for use in the EU (52.3 Mt) were equally split concerning their application (71% demand of plastic converters / 29% production of other for products outside the scope of task 3, so that 18.2 Mt used in other applications result.

Node ‘Demand of primary plastics’: This node does not constitute a stage in the life cycle but is a measurement point at which the input of primary plastics into NACE 22.2 is determined, based on data from PlasticsEurope, which include primary plastic imports (see chapter 5.3, Table 3 and Table 1). The total quantity is 45.2Mt (37.2 Mt from production in Europe and 7.9 Mt from imports) and the measurement point allows to specify the input to plastic converters by application segment.

Node ‘Manufacture of plastics products (NACE 22.2): This node is calculated as sum of the input flows, i.e., the demand of primary plastics and the use of recyclates (9.1 Mt) and by-products (2.25 Mt). The quantity (56.5 Mt) is by 7.7 Mt higher than the value from production statistics for NACE 22.2 (48.8 Mt). Assumed reasons are:

- Missing quantities for products which are not reported in mass-units but in pieces or other units;
- Quantities of plastic products that not covered by NACE 22.2 but by other NACE groups/classes; and
- Production wastes that are not reflected by the output of products in production statistics. Only 52 Mt of plastics used for production actually end up in products, while 4.5 Mt are pre-consumer wastes / by-products not covered by the statistic.

Node ‘Consumption’: The node (50.5 Mt) is calculated on the basis of the inflows of domestically produced and consumed plastic products (45.5 Mt) and imported plastic products (5.0 Mt). The domestically produced and consumed plastic products refer to the total production (56.5 kt) minus pre-consumer waste (4.5 Mt) and minus Export of plastic products (6.5 Mt).

Node ‘Waste treatment’: This node (38.2 Mt) is completely based on the waste accounts data from task 1 (see chapter 7.1, Table 6) and covers the materials by EWC-Stat of column “Total (Tot_HH)”, the imports of primary and secondary waste (1.5 Mt) and the pre-consumer waste (2.2 Mt). The breakdown by residuals deviates slightly from Table 6, because pre-consumer waste was included in EWC-Stat-category W074. Thus, the 10.3 Mt of plastic wastes shown in Table 6 was split into pre-consumer waste and post-consumer waste in the Sankey (8.1Mt).

Nodes for final waste treatment: The final destination of plastic waste, including the return of recyclates into the economy (9.1 Mt) is completely based on waste accounts data from task 1 (see chapter 7.2, Table 6 Table 7 Table 1).

Nodes for imports and exports:

- ITG statistics were used to determine the Imports/exports of primary plastics (CPA 20.16) (see chapter 5.1 Table 1) and plastic products (CPA 22.2) (see chapter 5.2, Table 2 Table 1);
- Imports/exports of waste are determined under task 1, mostly based on trade statistics and partly on data on the transfrontier shipment of waste acc. to the Waste Shipment Regulation (see chapter 7, Table 6 and Table 7 Table 1).
- Please note: Not shown in the flow chart are the im- and exports broken down by plastic segments (e.g. vehicles, electrical and electronic equipment, machinery, ..). The respective amounts are difficult to estimate.

9.2. Flows in the Sankey-diagram

As can be seen from the colouring, the classification of plastic flows changes several times between the nodes as follows:

- Outflows from NACE 20.16 are classified by their further use as follows:
 - Demand of primary plastics (yellow)
 - NACE other than 22.2, i.e., other applications (light blue)
 - Export (red).
- Starting with the node ‘Demand of primary plastics’ and ending with the node ‘consumption’ the flows are classified by application segment (packaging, building and construction, automotive, ...) (orange flows in different brightness, see Table 15 for details on the data).
- The outflows from ‘consumption’ are classified by waste categories (blue colours in different brightness, see Table 15 for details on the data).
- The final destination of plastics (outflows from ‘waste treatment’) and their colouring is classified by treatment categories.
- The flows of all imports are orange-brown and those of all exports are red

The volume of the flows is determined as follows:

- Outflows from NACE 20.16 are determined by combining data from production and trade statistics (total production, imports, exports) with data on the converters demand.
- Outflows of the converters demand are completely based on data from PlasticsEurope (see chapter 5.3).
- Outflows from NACE 22.2 are based on the data analysis by segment (see chapter 8) using different data sources (production and trade statistics, monitoring data, data from CPA and PlasticsEurope, ..).

Outflows from ‘consumption’ and ‘waste treatment’ are taken completely from the waste accounts data, without changes. Table 15 shows the flows the figures of flows by segments and waste categories used in the Sankey-diagram that are partly not visible due to the low amounts.

Table 15: Detailed data for flows of plastic segments or waste categories in the Sankey-diagram, EU27, 2016 (Mt)

Outflows of converters demand		Outflows of NACE 22.2		Outflows of consumption	
Segment	Quantity	Segment	Quantity	Waste category	Quantity*
Packaging	18.0	Packaging	18.2	W05 Health care waste	0.5
Construction	8.9	Construction	8.9	W074	8.1
Automotive	4.5	Automotive	3.0	W08A	1.0
Electro-, electrical	2.8	Electro-, electrical	2.3	W081	0.7
Households, leisure	1.9	Households, leisure	2.3	W0841	0.1
Agriculture	1.5	Agriculture	0.7	W101	17.6
Other	7.5	Other	10.1	W102 packaging	5.8
				W102 paper rejects	0.5
				W121 mixed C&D waste	0.3
Total	45.2		45.5		34.5

* The total figure is lower than the total amount of waste treated of 38.2 t due to imports (1.5 Mt) and pre-consumer plastic waste (2.25 Mt), which is shown in the Sankey diagram as separate flow. Part of the import 0.7 Mt and the pre-consumer waste is shown in under the category W074, so that the amount of W074 is also lower than in Table 6.

9.3. Description of results

The total domestic production of primary plastics amounts to 67.2 Mt of which 37.2 Mt are used by converters (NACE 22.2) in the EU27, 18.2 Mt are used for other plastic-based products and 14.9 Mt are exported.

56.5 Mt of plastics material is used for the production of plastic products in NACE 22.2 of which 45.2 Mt are virgin primary plastics and 11.3 Mt are recyclates (9.1 Mt) or pre-consumer by-products (2.25 Mt).

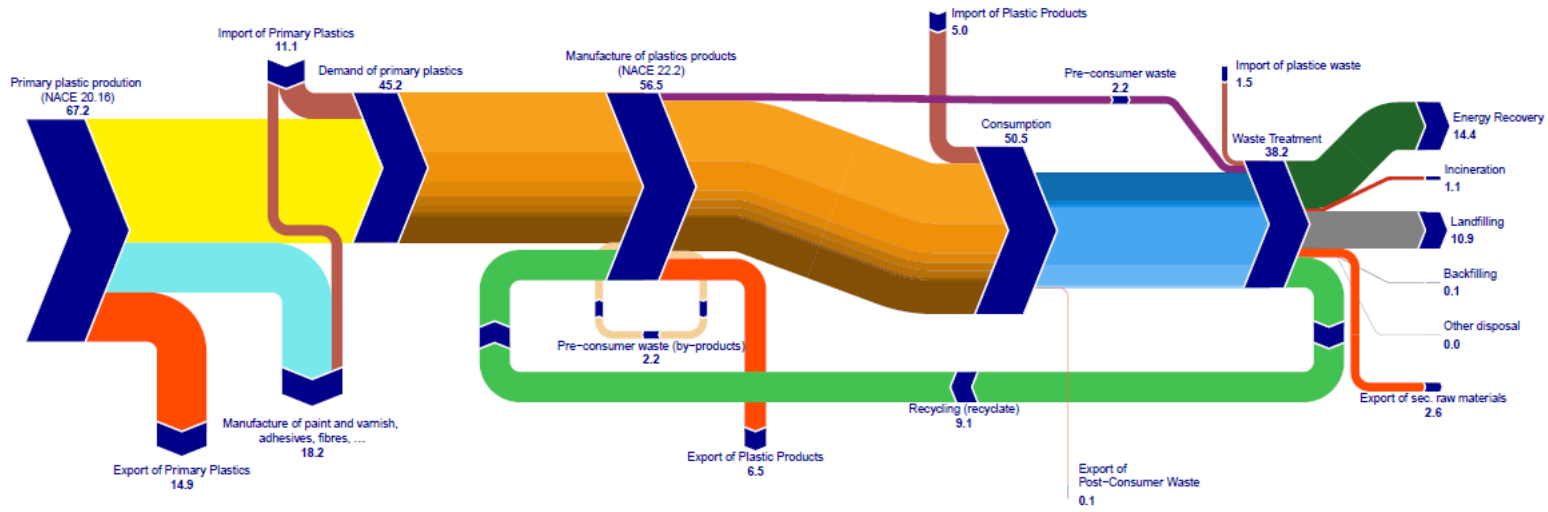
From 56.5 Mt plastics material used for production, 4.5 Mt end up as pre-consumer waste / by-products. This results in 52 Mt of plastic products is estimated to be produced in the EU27, of which 45.5 Mt are used in the EU and 6.5 Mt are exported. Together with 5.0 Mt of imported plastic production, the total consumption of plastic products is estimated at 50.5 Mt.

Based on the waste accounts, the total amount of plastic waste treated is estimated at 38.2 Mt, of which 36 Mt are assumed to be post-consumer waste and 2.25 Mt pre-consumer waste. Recyclates produced are determined at 9.1 Mt of which 2.25 Mt are produced from pre-consumer wastes and 6.9 Mt from post-consumer waste. Energy recovery of plastics waste is determined at 14.4 Mt, landfilling at 10.9 Mt and exports at 2.6 Mt. Minor amounts go to incineration, backfilling or other disposal.

The difference between consumption and domestic waste treatment is 14.5 Mt. Possible reasons for this discrepancy are:

- Time lag between consumption and waste generation for products with a long use phase (-> addition to stock)
- Net exports of used products (e.g. used vehicles)
- Products used in civil engineering, such as pipes, may remain in the ground after use.
- Littering

Figure 10: Sankey diagram with plastics flows from production to treatment and recycling through the EU27 - 2016.



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10. Summary and Conclusions

10.1. Data quality and availability

- Published data mostly refer to post-consumer waste. Data on pre-consumer waste are scarce.
- Main data source for most publications on the topic are the data from PlasticsEurope on the converters. This data also play a central role in our flow model. Problem of the data: they reflect the amount of primary plastics used for plastic products but not the consumption of plastic products (although in other publications it is often used as equivalent or estimate for the consumption). Furthermore, the demand for secondary plastics is not covered and the data include imported primary plastic.
- Production and trade statistics are considered reliable for primary plastics but less reliable for plastic products because not all products are covered -> probably underestimation. On the other hand, double counts cannot be excluded as NACE 22.2 covers intermediate and final products. As explained in chapter 4.1.2, the manufacture of several specific final products made of plastics like luggage, footwear, furniture, mattresses, sports requisites, games and toys, medical appliances and safety equipment are not included in NACE 22.2 but in other NACE classes which are not considered in the analysis. Furthermore, it is explained in chapter 5.2 that for the products of CPA sub-category 22.29.91, which includes for instance plastic parts for machinery and mechanical appliances, for electrical machinery and equipment and for railway, land vehicles and aircraft, only the monetary value has to be reported. The corresponding amounts could not be determined and are therefore not considered in this study. For details on the covered plastic products, see Table 17.
- Import and exports of plastic products: Statistics cover pure plastic products acc. to CN codes but not plastics contained in products and the plastic packaging of packed products.
- Imports and exports of used goods (vehicles, EEE, ..) -> not considered in the flow diagram; difficult to estimate, in particular if unrecorded (see ELV).

10.2. Waste Accounts

Assessment of the waste accounts results in the light of the in-depth analysis for plastics:

- The results of the waste accounts with regard to plastic waste generation and recycling were compared as far as possible to data from other sources (CPA SoP reports, PlasticsEurope data, monitoring data, literature). Data used for comparison mostly refer to application segments and not waste categories'. Therefore, the possibilities are limited depending on the segments (possible for ELV, WEEE; difficult for packaging, building and construction, agriculture, households). Generally, the results of the waste accounts were in a reasonable range and the comparison confirms the assumptions made.
- The amount of plastic packaging waste that is finally recycled / processed to recycle is overestimated in our waste accounts model probably mainly because the losses during plastic waste treatment are underestimated.
- The same is true for the recycling rates determined based on the PPWD-data. Output from sorting is measured, not the final amount that is processed into recyclates.
- Composition data are of great importance for the waste flow model, as large amounts of plastic waste is contained in mixed waste categories, either in household and similar waste (W101) or for separately collected lightweight packing (W102 – packaging). These streams can be well covered by waste analyses. However, for streams where plastic is part of a composite

mix of materials like WEEE or ELV, the ways to estimate the plastic content are more challenging.

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Annex

Table 16: Production, export, import and apparent consumption of primary plastics in NACE 20.16 "Manufacture of plastics in primary forms" in the EU27 in 2016 according to CPA (in tons)

PRODCOM code	PRODCOM label	Production	Export	Import	Apparent consumption
201610	Polymers of ethylene, in primary forms				
20161035	Linear polyethylene having a specific gravity < 0,94, in primary forms	2,179,807	363,471	1,328,108	3,144,444
20161039	Polyethylene having a specific gravity < 0,94, in primary forms (excluding linear)	4,145,467	1,043,945	896,971	3,998,492
20161050	Polyethylene having a specific gravity of >= 0,94, in primary forms	5,681,988	1,277,446	1,652,149	6,056,691
20161070	Ethylene-vinyl acetate copolymers, in primary forms	496,736	215,792	95,473	376,417
20161090	Polymers of ethylene, in primary forms (excluding polyethylene, ethylene-vinyl acetate copolymers)	1,159,131	828,819	540,070	870,382
201610	Polymers of ethylene, in primary forms	13,663,129	3,729,473	4,512,771	14,446,427
201620	Polymers of styrene, in primary forms				
20162035	Expansible polystyrene, in primary forms	1,225,193	112,073	40,743	1,153,863
20162039	Polystyrene, in primary forms (excluding expansible polystyrene)	2,239,342	298,614	158,238	2,098,966
20162050	Styrene-acrylonitrile (SAN) copolymers, in primary forms	178,653	11,096	33,933	201,490
20162070	Acrylonitrile-butadiene-styrene (ABS) copolymers, in primary forms	736,369	162,577	242,755	816,547
20162090	Polymers of styrene, in primary forms (excluding polystyrene, styrene-acrylonitrile (SAN) copolymers, acrylonitrile-butadiene-styrene (ABS) copolymers)	664,155	307,302	102,172	459,025
201620	Polymers of styrene, in primary forms	5,043,712	891,663	577,842	4,729,891
201630	Polymers of vinyl chloride or of other halogenated olefins, in primary forms				
20163010	Polyvinyl chloride, not mixed with any other substances, in primary forms	5,288,754	1,399,864	466,284	4,355,174
20163023	Non-plasticised polyvinyl chloride mixed with any other substance, in primary forms	320,528	72,366	28,651	276,814
20163025	Plasticised polyvinyl chloride mixed with any other substance, in primary forms	990,148	171,283	55,780	874,645

20163040	Vinyl chloride-vinyl acetate copolymers and other vinyl chloride copolymers, in primary forms	336,778	99,705	3,723	240,797
20163060	Fluoropolymers	59,979	26,108	33,072	66,943
20163090	Polymers of halogenated olefins, in primary forms, n.e.c.	94,485	47,642	5,887	52,729
201630	Polymers of vinyl chloride or of other halogenated olefins, in primary forms	7,090,672	1,816,967	593,397	5,867,102
201640	Polyacetals, other polyethers and epoxide resins, in primary forms; polycarbonates, alkyd resins, polyallyl esters and other polyesters, in primary forms				
20164013	Polyacetals, in primary forms	339,523	78,298	66,189	327,415
20164015	Polyethylene glycols and other polyether alcohols, in primary forms	2,078,772	874,665	112,907	1,317,013
20164020	Polyethers, in primary forms (excluding polyacetals, polyether alcohols)	233,560	69,755	60,580	224,385
20164030	Epoxide resins, in primary forms	1,187,089	226,393	164,664	1,125,360
20164040	Polycarbonates, in primary forms	1,134,645	233,231	91,906	993,320
20164050	Alkyd resins, in primary forms	542,335	58,469	7,985	491,851
20164062	Polyethylene terephthalate in primary forms having a viscosity number of ≥ 78 ml/g	2,513,416	255,667	750,406	3,008,155
20164064	Other polyethylene terephthalate in primary forms	417,398	69,690	237,745	585,453
20164070	Unsaturated liquid polyesters, in primary forms (excluding polyacetals, polyethers, epoxide resins, polycarbonates, alkyd resins, polyethylene terephthalate)	476,256	136,176	49,080	389,160
20164080	Unsaturated polyesters, in primary forms (excluding liquid polyesters, polyacetals, polyethers, epoxide resins, polycarbonates, alkyd resins, polyethylene terephthalate)	560,000	34,470	9,066	534,597
20164090	Polyesters, in primary forms (excluding polyacetals, polyethers, epoxide resins, polycarbonates, alkyd resins, polyethylene terephthalate, other unsaturated polyesters)	1,184,427	338,531	283,359	1,129,255
201640	Polyacetals, other polyethers and epoxide resins, in primary forms; polycarbonates, alkyd resins, polyallyl esters and other polyesters, in primary forms	10,667,423	2,375,345	1,833,886	10,125,964
201651	Polymers of propylene or of other olefins, in primary forms				
20165130	Polypropylene, in primary forms	9,780,319	993,689	1,293,270	10,079,900
20165150	Polymers of propylene or of other olefins, in primary forms (excluding polypropylene)	2,413,558	1,247,366	491,464	1,657,657
201651	Polymers of propylene or of other olefins, in primary forms	12,193,877	2,241,055	1,784,734	11,737,556

201652	Polymers of vinyl acetate or of other vinyl esters and other vinyl polymers, in primary forms				
20165230	Polymers of vinyl acetate, in aqueous dispersion, in primary forms	1,063,007	145,527	19,166	936,645
20165250	Polymers of vinyl acetate, in primary forms (excluding in aqueous dispersion)	400,000	49,811	36,890	387,079
20165270	Polymers of vinyl esters or other vinyl polymers, in primary forms (excluding vinyl acetate)	228,777	82,575	172,984	319,186
201652	Polymers of vinyl acetate or of other vinyl esters and other vinyl polymers, in primary forms	1,691,785	277,914	229,040	1,642,910
201653	Acrylic polymers, in primary forms				
20165350	Polymethyl methacrylate, in primary forms	176,705	5,874	38,453	209,284
20165390	Acrylic polymers, in primary forms (excluding polymethyl methacrylate)	3,082,491	955,212	375,960	2,503,239
201653	Acrylic polymers, in primary forms	3,259,195	961,085	414,414	2,712,524
201654	Polyamides, in primary forms				
20165450	Polyamide -6, -11, -12, -6,6, -6,9, -6,10 or -6,12, in primary forms	2,158,017	489,603	232,871	1,901,285
20165490	Polyamides, in primary forms (excluding polyamide -6, -11, -12, -6,6, -6,9, -6,10 or -6,12)	281,759	139,847	73,944	215,856
201654	Polyamides, in primary forms	2,439,776	629,451	306,815	2,117,140
201655	Urea resins, thiourea resins and melamine resins, in primary forms				
20165550	Urea resins and thiourea resins, in primary forms	3,078,471	162,436	90,108	3,006,143
20165570	Melamine resins, in primary forms	788,725	44,901	24,766	768,590
201655	Urea resins, thiourea resins and melamine resins, in primary forms	3,867,196	207,337	114,874	3,774,733
201656	Other amino-resins, phenolic resins and polyurethanes, in primary forms				
20165630	Amino resins, in primary forms (excluding urea and thiourea resins, melamine resins)	974,895	576,260	31,209	429,844
20165650	Phenolic resins, in primary forms	844,122	97,584	51,546	798,084
20165670	Polyurethanes, in primary forms	3,362,814	473,070	65,300	2,955,045
201656	Other amino-resins, phenolic resins and polyurethanes, in primary forms	5,181,830	1,146,914	148,055	4,182,972
201657	Silicones, in primary forms				

20165700	Silicones, in primary forms	737,518	81,701	149,367	805,184
201657	Silicones, in primary forms	737,518	81,701	149,367	805,184
201659	Other plastics, in primary forms, n.e.c.				
20165920	Petroleum resins, coumarone-indene resins, polyterpenes, polysulphides, polysulphones, etc., n.e.c., in primary forms	555,183	231,856	196,162	519,490
20165940	Cellulose and its chemical derivatives, n.e.c., in primary forms	407,900	272,067	125,720	261,553
20165960	Natural and modified natural polymers, in primary forms (including alginic acid, hardened proteins, chemical derivatives of natural rubber)	289,400	21,761	23,787	291,425
20165970	Ion-exchangers based on synthetic or natural polymers, in primary forms	141,208	13,664	24,173	151,717
201659	Other plastics, in primary forms, n.e.c.	1,393,691	539,347	369,842	1,224,186

Table 17: Production, export, import and apparent consumption of plastic products in NACE 22.2 "Manufacture of plastics products" in the EU27 in 2016 (t)

PRODCOM code	PRODCOM label	Production	Export	Import	Apparent consumption
222110	Monofilament > 1 mm, rods, sticks and profile shapes, of plastics				
22211050	Monofilament with any cross-sectional dimension > 1 mm, rods, sticks, profile shapes, of polymers of ethylene (including surface worked but not otherwise worked)	166,767	10,785	5,004	160,986
22211070	Monofilament with any cross-sectional dimension > 1 mm, rods, sticks, profile shapes, of polymers of vinyl chloride (including surface worked but not otherwise worked)	1,080,808	152,584	38,257	966,481
22211090	Monofilament with any cross-sectional dimension > 1 mm; rods; sticks and profile shapes of plastics (excluding of polymers of ethylene, of polymers of vinyl chloride)	229,017	45,968	22,801	205,850
222110	Monofilament > 1 mm, rods, sticks and profile shapes, of plastics	1,476,592	209,337	66,062	1,333,317
222121	Artificial guts, of hardened proteins or of cellulosic materials; tubes, pipes and hoses, rigid, of plastics				
22212130	Artificial guts (sausage skins) of hardened protein or cellulosic materials	77,345	31,627	4,768	50,486
22212153	Rigid tubes, pipes and hoses of polymers of ethylene	965,097	93,394	32,726	904,429
22212155	Rigid tubes, pipes and hoses of polymers of propylene	305,445	65,943	16,276	255,779
22212157	Rigid tubes, pipes and hoses of polymers of vinyl chloride	1,030,566	56,580	19,229	993,216
22212170	Rigid tubes, pipes and hoses of plastics (excluding of polymers of ethylene, of polymers of propylene, of polymers of vinyl chloride)	242,692	43,801	17,296	216,187
222121	Artificial guts, of hardened proteins or of cellulosic materials; tubes, pipes and hoses, rigid, of plastics	2,621,145	291,343	90,295	2,420,096
222129	Other tubes, pipes, hoses and fittings thereof, of plastics				
22212920	Flexible tubes, pipes and hoses of plastics, with a burst pressure \geq 27,6 MPa	111,961	14,744	11,631	108,847
22212935	Flexible tubes, pipes and hoses of plastics, not reinforced or otherwise combined with other materials, without fittings	554,167	80,511	32,103	505,758
22212937	Flexible tubes, pipes and hoses of plastics, not reinforced or otherwise combined with other materials, with fittings, seals or connectors	46,312	16,069	10,834	41,076
22212950	Plastic tubes, pipes and hoses (excluding artificial guts, sausage skins, rigid, flexible tubes and pipes having a minimum burst pressure of 27,6 MPa)	414,820	76,494	44,525	382,850

22212970	Fittings, e.g. joints, elbows, flanges, of plastics, for tubes, pipes and hoses	355,882	95,554	52,121	312,449
222129	Other tubes, pipes, hoses and fittings thereof, of plastics	1,483,141	283,373	151,213	1,350,980
222130	Plates, sheets, film, foil and strip, of plastics, not supported or similarly combined with other materials				
22213010	Other plates..., of polymers of ethylene, not reinforced, thickness <= 0,125 mm	3,938,326	496,650	329,892	3,771,568
22213017	Other plates..., of polymers of ethylene, not reinforced, etc., thickness > 0,125 mm	1,101,975	189,391	113,777	1,026,361
22213021	Other plates..., of biaxially orientated polymers of propylene, thickness <= 0,10 mm	646,144	234,731	222,138	633,551
22213023	Other plates..., of polymers of propylene, thickness <= 0,10 mm, others	407,463	48,307	24,155	383,311
22213026	Other plates..., of non-cellular polymers of propylene, thickness > 0,10 mm, n.e.c.	272,417	79,211	38,295	231,501
22213030	Other plates..., of polymers of styrene, not reinforced, etc.	765,776	94,918	42,994	713,852
22213035	Other plates, sheets, film, foil and strip, of polymers of vinyl chloride, containing >= 6 % of plasticisers, thickness <= 1 mm	404,573	76,712	25,132	352,993
22213036	Other plates, sheets, film, foil and strip, of polymers of vinyl chloride, containing >= 6 % of plasticisers, thickness > 1 mm	135,431	20,818	20,990	135,603
22213037	Other plates, sheets, film, foil and strip, of polymers of vinyl chloride, containing < 6 % of plasticisers, thickness <= 1 mm	387,048	114,731	29,506	301,823
22213038	Other plates, sheets, film, foil and strip, of polymers of vinyl chloride, containing < 6 % of plasticisers, thickness > 1 mm	80,944	38,750	21,476	63,670
22213053	Plates..., of polymethyl methacrylate, not reinforced, etc.	177,500	24,579	62,636	215,557
22213059	Plates..., of other acrylic polymers, not reinforced, etc., n.e.c.	19,663	2,415	3,017	20,264
22213061	Plates, sheets, film, foil, strip of polycarbonates, non-cellular excluding floor, wall, ceiling coverings - self-adhesive, reinforced, laminated, supported/similarly combined with other materials	137,945	17,275	32,081	152,751
22213063	Plates..., of unsaturated polyesters, not reinforced, etc.	40,000	1,037	771	39,734
22213065	Plates, sheets, film, foil, strip, of polyethylene terephthalate, not reinforced, etc., of a thickness <= 0,35 mm	402,685	77,686	205,145	530,144
22213067	Plates, sheets, film, foil, strip, of polyethylene terephthalate, not reinforced, etc., of a thickness > 0,35 mm	168,927	50,319	38,948	157,556
22213069	Plates, sheets, film, foil, strip of polyesters, non-cellular excluding floor, wall, ceiling coverings, self-adhesive - of polycarbonates, polyethylene terephthalate, unsaturated polyesters	43,682	21,378	29,652	51,956

22213070	Plates, sheets, film, foil and strip, of non-cellular cellulose or its chemical derivatives, not reinforced, laminated, supported or similarly combined with other materials (excluding self-adhesive products as well as and floor, wall and ceiling coverings of HS 3918)	17,329	8,698	8,526	17,157
22213082	Plates, sheets, film, foil, strip of polyamides, non-cellular (excluding floor, wall, ceiling coverings, self-adhesive, reinforced, laminated, supported/similarly combined with other materials)	94,556	15,577	17,421	96,400
22213086	Plates, sheets, film, foil and strip, of non-cellular poly(vinyl butyral), amino-resins, phenolic resins or polymerisation products, not reinforced, laminated, supported or similarly combined with other materials (excluding self-adhesive products as well as and floor, wall and ceiling coverings of H	238,445	41,731	42,265	238,980
22213090	Plates, sheets, film, foil and strip, of non-cellular plastics, n.e.c., not reinforced, laminated, supported or similarly combined with other materials (excluding self-adhesive products, floor, wall and ceiling coverings of HS 3918 and sterile surgical or dental adhesion barriers of CN 3006 10 30)	389,799	34,981	26,953	381,771
222130	Plates, sheets, film, foil and strip, of plastics, not supported or similarly combined with other materials	9,870,630	1,689,896	1,335,768	9,516,502
222141	Other plates, sheets, film, foil and strip, of plastics, cellular				
22214120	Plates, sheet, film, foil and strip of cellular polymers of styrene	967,716	43,809	26,401	950,308
22214130	Plates, sheets, film, foil and strip of cellular polymers of vinyl chloride	99,037	51,290	47,136	94,884
22214150	Plates, sheets, film, foil and strip of cellular polyurethanes	1,159,639	125,168	25,551	1,060,022
22214170	Plates, sheets, film, foil and strip of regenerated cellular cellulose	20,311	6,049	3,375	17,637
22214180	Plates, sheets, film, foil and strip of cellular plastics (excluding of polymers of styrene, of polymers of vinyl chloride, of polyurethanes, of regenerated cellulose)	193,599	57,779	56,514	192,335
222141	Other plates, sheets, film, foil and strip, of plastics, cellular	2,440,302	284,093	158,977	2,315,186
222142	Other plates, sheets, film, foil and strip, of plastics, non-cellular				
22214230	Non-cellular plates, sheets, film, foil, strip of condensation or rearrangement polymerisation products, polyesters, reinforced, laminated, supported/similarly comb. with other materials)	193,903	53,472	24,811	165,241
22214250	Non-cellular plates, strips..., of phenolic resins	87,198	26,881	3,244	63,561
22214275	Non-cellular plates, sheets, film, foil, strip of condensation or rearrangement polymerisation products, amino-resins (high pressure laminates, decorative surface one/both sides)	281,481	72,037	27,974	237,419
22214279	Other plates, sheets, films, foil and strip, of polymerisation products	697,469	141,489	64,699	620,680

22214280	Other plates..., non-cellular of plastics other than made by polymerisation	455,924	149,975	147,142	453,091
222142	Other plates, sheets, film, foil and strip, of plastics, non-cellular	1,715,975	443,853	267,870	1,539,992
222211	Sacks and bags (including cones), of polymers of ethylene				
22221100	Sacks and bags of polymers of ethylene (including cones)	2,830,254	235,081	475,442	3,070,615
222211	Sacks and bags (including cones), of polymers of ethylene	2,830,254	235,081	475,442	3,070,615
222212	Sacks and bags (including cones), of other plastics than polymers of ethylene				
22221200	Plastic sacks and bags (including cones) (excluding of polymers of ethylene)	442,170	78,200	84,668	448,638
222212	Sacks and bags (including cones), of other plastics than polymers of ethylene	442,170	78,200	84,668	448,638
222213	Boxes, cases, crates and similar articles of plastics				
22221300	Plastic boxes, cases, crates and similar articles for the conveyance or packing of goods	2,392,243	351,533	248,172	2,288,883
222213	Boxes, cases, crates and similar articles of plastics	2,392,243	351,533	248,172	2,288,883
222214	Carboys, bottles, flasks and similar articles of plastics				
22221450	Plastic carboys, bottles, flasks and similar articles for the conveyance or packing of goods, of a capacity <= 2 litres	3,895,499	207,281	120,487	3,808,705
22221470	Plastic carboys, bottles, flasks and similar articles for the conveyance or packing of goods, of a capacity > 2 litres	3,588,782	364,796	91,508	3,315,493
222214	Carboys, bottles, flasks and similar articles of plastics	7,484,281	572,077	211,995	7,124,198
222219	Other plastic packing goods				
22221910	Spools, cops, bobbins and similar supports, of plastics	293,010	24,231	11,280	280,059
22221925	Plastic stoppers, lids, caps, capsules and other closures	2,057,568	193,550	114,705	1,978,723
22221950	Articles for the conveyance or packaging of goods, of plastics (excluding boxes, cases, crates and similar articles; sacks and bags, including cones; carboys, bottles, flasks and similar articles; spools, spindles, bobbins and similar supports; stoppers, lids, caps and other closures)	3,657,392	183,424	133,820	3,607,787
222219	Other plastic packing goods	6,007,970	401,205	259,805	5,866,570
222311	Floor, wall or ceiling coverings of plastics, in rolls or in the form of tiles				
22231155	Floor coverings in rolls or in tiles and wall or ceiling coverings consisting of a support impregnated, coated or covered with polyvinyl chloride	548,257	237,984	126,198	436,470

22231159	Other floor, wall, ceiling... coverings of polymers of vinyl chloride	287,551	105,281	188,886	371,157
22231190	Floor coverings in rolls or in tiles; and wall or ceiling coverings of plastics (excluding of polymers of vinyl chloride)	450,288	39,171	81,923	493,040
222311	Floor, wall or ceiling coverings of plastics, in rolls or in the form of tiles	1,286,096	382,437	397,007	1,300,667
222312	Baths, wash-basins, lavatory pans and covers, flushing cisterns and similar sanitary ware, of plastics				
22231250	Plastic baths, shower-baths, sinks and wash-basins	213,715	-	-	213,715
22231270	Plastic lavatory seats and covers	64,913	-	-	64,913
22231290	Plastic bidets, lavatory pans, flushing cisterns and similar sanitary ware (excluding baths, showers-baths, sinks and wash-basins, lavatory seats and covers)	587,285	-	-	587,285
222312	Baths, wash-basins, lavatory pans and covers, flushing cisterns and similar sanitary ware, of plastics	865,913	-	-	865,913
222313	Reservoirs, tanks, vats and similar containers, capacity > 300 l, of plastics				
22231300	Plastic reservoirs, tanks, vats, intermediate bulk and similar containers, of a capacity > 300 litres	202,615	30,683	13,262	185,194
222313	Reservoirs, tanks, vats and similar containers, capacity > 300 l, of plastics	202,615	30,683	13,262	185,194
222314	Doors, windows and frames and thresholds for doors; shutters, blinds and similar articles and parts thereof, of plastics				
22231450	Plastic doors, windows and their frames and thresholds for doors	2,484,235	472,508	102,963	2,114,691
22231470	Plastic shutters, blinds and similar articles and parts thereof	290,829	8,138	10,882	293,573
222314	Doors, windows and frames and thresholds for doors; shutters, blinds and similar articles and parts thereof, of plastics	2,775,064	480,646	113,845	2,408,263
222315	Linoleum and hard non-plastic surface floor coverings, i.e. resilient floor coverings, such as vinyl, linoleum etc.				
22231500	Linoleum, floor coverings consisting of a coating or covering applied on a textile backing (excluding sheets and plates of linoleum compounds)	88,001	24,915	11,856	74,942
222315	Linoleum and hard non-plastic surface floor coverings, i.e. resilient floor coverings, such as vinyl, linoleum etc.	88,001	24,915	11,856	74,942
222319	Builders' ware of plastics n.e.c.				
22231950	Builder's fittings and mountings intended for permanent installation of plastics	534,981	28,803	21,165	527,344
22231990	Builders' ware for the manufacture of flooring, walls, partition walls, ceilings, roofing, etc., guttering and accessories, banisters, fences	617,029	101,677	78,029	593,381

	and the like, fitted shelving for shops, factories, warehouses, storerooms, etc., architectural ornaments such as fluting, vaulting and friezes, of plastics,				
222319	Builders' ware of plastics n.e.c.	1,152,011	130,480	99,194	1,120,725
222320	Prefabricated buildings of plastics				
22232000	Prefabricated buildings, of plastics	-	-	-	-
222320	Prefabricated buildings of plastics	-	-	-	-
222910	Apparel and clothing accessories (including gloves), of plastics				
22291000	Plastic articles of apparel and clothing accessories (including gloves, raincoats, aprons, belts and babies' bibs) (excluding headgear)	23,456	7,065	114,083	130,474
222910	Apparel and clothing accessories (including gloves), of plastics	23,456	7,065	114,083	130,474
222921	Self-adhesive plates, sheets, film, foil, tapes, strip and other flat shapes of plastics, in rolls of width ≤ 20 cm				
22292130	Self-adhesive strips of plastic with a coating consisting of unvulcanised natural or synthetic rubber, in rolls of a width ≤ 20 cm	299,449	56,886	40,682	283,245
22292140	Self-adhesive plates, sheets, film, foil, tape, strip and other flat shapes, of plastics, in rolls ≤ 20 cm wide (excluding plastic strips coated with unvulcanised natural or synthetic rubber)	217,684	22,190	48,344	243,839
222921	Self-adhesive plates, sheets, film, foil, tapes, strip and other flat shapes of plastics, in rolls of width ≤ 20 cm	517,133	79,075	89,027	527,084
222922	Other self-adhesive plates, sheets, film, foil, tapes, strip and other flat shapes of plastics				
22292240	Self-adhesive plates, sheets, film, foil, tape, strip and other flat shapes, of plastics, whether or not in rolls > 20 cm wide (excluding floor, wall and ceiling coverings of HS 3918)	405,464	257,169	111,411	259,706
222922	Other self-adhesive plates, sheets, film, foil, tapes, strip and other flat shapes of plastics	405,464	257,169	111,411	259,706
222923	Tableware, kitchenware, other household articles and toilet articles, of plastics				
22292320	Tableware and kitchenware of plastic	1,355,810	90,669	216,470	1,481,612
22292340	Household articles and toilet articles, of plastics (excluding tableware, kitchenware, baths, shower-baths, washbasins, bidets, lavatory pans, seats and covers, flushing cisterns and similar sanitary ware)	588,425	78,631	120,245	630,040
222923	Tableware, kitchenware, other household articles and toilet articles, of plastics	1,944,235	169,300	336,716	2,111,651
222924	Parts n.e.c. for lamps and lighting fitting, illuminated name-plates and the like, of plastics				

22292400	Plastic parts for lamps, lighting fittings and illuminated signs and name-plates	-	-	-	-
222924	Parts n.e.c. for lamps and lighting fitting, illuminated name-plates and the like, of plastics	-	-	-	-
222925	Office or school supplies of plastics				
22292500	Office or school supplies of plastic (including paperweights, paper-knives, blotting pads, pen-rests and book marks)	153,120	19,711	69,423	202,832
222925	Office or school supplies of plastics	153,120	19,711	69,423	202,832
222926	Fittings for furniture, coachwork or the like, of plastics; statuettes and other ornamental articles, of plastics				
22292610	Plastic fittings for furniture, coachwork or the like	200,947	36,072	28,485	193,359
22292620	Statuettes and other ornamental articles of plastic (including photograph, picture and similar frames)	180,000	6,699	82,923	256,224
22292630	Perforated buckets and similar articles used to filter water at the entrance to drains, of plastic	16,735	2,179	1,599	16,155
222926	Fittings for furniture, coachwork or the like, of plastics; statuettes and other ornamental articles, of plastics	397,681	44,950	113,007	465,737
222929	Other articles of plastics				
22292910	Hard rubber or plastic combs, hair-slides and the like (excluding electro-thermic hairdressing apparatus)	655	688	5,673	5,640
22292915	Hairpins, curling pins, curling grips, hair-curlers and the like, and parts thereof, of plastic (excluding electro-thermic hairdressing apparatus)	80	-	-	80
22292920	Outer soles and heels of plastics	85,827	-	-	85,827
22292950	Other articles made from sheet	166,940	34,192	126,218	258,966
22292995	Other articles of plastic n.e.c (excluding appliances identifiable for ostomy use)	-	-	-	-
222929	Other articles of plastics	253,501	34,880	131,892	350,513
222991	Manufacturing services of other plastic products				
22299110	Plastic parts for machinery and mechanical appliances, excluding internal combustion piston engines, gas turbines	-	-	-	-
22299125	Plastic parts for apparatus of HS 8509 and 8516	-	-	-	-
22299127	Plastic parts for turntables, record players, cassette-players, magnetic tape recorders, other sound or video recording/reproducing apparatus excluding pick-up cartridges	-	-	-	-
22299130	Plastic parts for apparatus of HS 8525 to 8528	-	-	-	-

22299140	Plastic products, parts of apparatus of HS 8535 to 8537, and 8542	-	-	-	-
22299150	Plastic parts for locomotives or rolling stock, railway or tramway track fixtures and fittings, mechanical signalling, safety or traffic control equipment	-	-	-	-
22299160	Plastic parts and accessories for all land vehicles (excluding for locomotives or rolling stock)	-	-	-	-
22299180	Plastic parts for aircraft and spacecraft	-	-	-	-
22299193	Plastic parts for electrical machinery and equipment, sound recorders and reproducers, television image and sound recorders and reproducers	-	-	-	-
22299197	Plastic parts for optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus	-	-	-	-
222991	Manufacturing services of other plastic products	-	-	-	-

Table 18: Demand of primary plastics by plastic converters in the EU27+3 from 2016 to 2020, broken down by application segment (in Mt)

Application segment	2016	2017	2018	2018	2020
Packaging	19.9	20.3	20.4	20.1	19.9
Building & construction	9.8	10.1	10.1	10.3	10.1
Automotive	5.0	5.2	5.1	4.9	4.3
Electrical & electronic	3.1	3.2	3.2	3.1	3.1
Household, leisure & sports	2.1	2.1	2.1	2.1	1.6
Agriculture	1.6	1.7	1.7	1.7	2.1
Others	8.3	8.6	8.6	8.5	8.2
27 + UK, NO, CH	49.9	51.2	51.2	50.7	49.1

Table 19: Total demand of primary plastics by plastic converters in the EU27+3 according to PlasticsEurope and estimate for the EU 27 from 2016 to 2020 (in Mt)

Application segment	2016	2017	2018	2018	2020
EU27 + UK, NO, CH	49.9	51.2	51.2	50.7	49,1
UK, NO, CH*	4.7	4.8	4.8	4.6	4,5
EU27	45.2	46.4	46.4	46.1	44,7

* Share of UK is available from the publications of PlasticsEurope. The share of NO and CH is set at 2% for the whole period (PlasticsEurope 2022)

Table 20 shows the available data for the EU27 downloaded from Eurobase on 26 October 2021. The represent the sums of all individual country data of the EU27. The figures not in Italics are complete and correspond to the aggregates available in Eurobase. Table 21 to Table 24 show the data used to fill gaps for the EU27 and to calculate the aggregate EU27 plus UK, CH, and NO.

Table 20: Packaging waste generated, recovered, and recycled according to the monitoring data pursuant to the Packaging-Directive, sum of Member States' reporting for EU27 (in tons)

Eurostat label	2014	2015	2016	2017	2018
Waste generated	13,187,608	13,663,999	14,037,118	14,550,476	14,817,435
Recovery total, of which	9,768,454	10,272,462	10,788,911	11,218,168	11,616,632
Recovery - energy recovery from packaging waste	4,510,722	4,732,887	4,831,342	5,147,595	5,468,909
Recovery - other	8,729	10,645	9,834	7,131	8,781
Recycling, of which	5,249,004	5,528,930	5,947,735	6,063,442	6,138,943
<i>Recycling in other Member States of the EU</i>	:	8,725	8,558	35,428	831,642
<i>Recycling in the Member State</i>	:	:	:	24,862	4,333,570
<i>Recycling outside the EU</i>	:	:	:	324	54,570

Data in Italics are incomplete in two aspects

- Four countries did not report any figures for the breakdown of recycling (BE, CZ, NL, PT), and

- Two countries (BG, DE) report only 'Recycling in other Member States of the EU' for 2018, but more detailed data for 2019.

Thus, the gaps were filled in two steps:

- In the 1st step, the missing figures for BG and DE were estimated based on the breakdown of the complete figures for 2019, and
- In the second step, the breakdown of the completed data was determined and applied to the complete recycling figure for all years.

The stepwise estimation process is shown in Table 21.

Table 21: *Development of estimates for the breakdown of recycling 2018 as basis for estimates of the breakdown of earlier years 2014 to 2017 for EU27 (in tons)*

Eurostat label	Sum of countries with figures, (incomplete)	Sum of countries with figures, (step 1)	Split of completed data	Estimates for all countries (step 2)
Recycling, of which	5,426,690	5,426,690		6,138,942
Recycling in other Member States of the EU	831,642	1,007,850	18.6%	1,140,130
Recycling in the Member State	4,333,570	4,333,570	79.9%	4,902,351
Recycling outside the EU	54,570	85,269	1.6%	96,461
Sum of breakdown	5,219,782	5,426,690		
Share of total recycling represented	85 %	87 %		100 %

Table 22: *Packaging waste generated, recovered, and recycled according to the monitoring data pursuant to the Packaging-Directive, UK (in tons)*

Eurostat label	2014	2015	2016	2017	2018
Waste generated	2,220,040	2,260,000	2,260,000	2,260,000	2,361,000
Recovery total, of which	1,068,462	1,081,636	1,321,994	1,324,405	1,325,767
Recovery - energy recovery from packaging waste	226,273	190,495	306,768	280,042	291,357
Recovery - other	0	0	0	0	0
Recycling, of which	842,189	891,141	1,015,226	1,044,363	1,034,410
Recycling in other Member States of the EU	<i>239,313</i>	<i>253,223</i>	<i>288,483</i>	<i>296,762</i>	<i>293,934</i>
Recycling in the Member State	<i>313,333</i>	<i>331,545</i>	<i>377,711</i>	<i>388,551</i>	<i>384,848</i>
Recycling outside the EU	<i>289,543</i>	<i>306,372</i>	<i>349,033</i>	<i>359,050</i>	<i>355,628</i>

Figures in Italics estimated based on the breakdown 2018

Table 23: Packaging waste generated, recovered, and recycled according to the monitoring data pursuant to the Packaging-Directive, NO (in tons)

Eurostat label	2014	2015	2016	2017	2018
Waste generated	165,185	184,132	193,200	220,614	221,693
Recovery total, of which	164,999	181,507	188,937	217,302	221,692
Recovery - energy recovery from packaging waste	105,304	113,157	113,103	135,886	141,305
Recovery - other	0	0	0	0	0
Recycling, of which	59,695	68,350	75,834	81,416	80,387
Recycling in other Member States of the EU	49,265	56,408	61,606	68,241	<u>68,960</u>
Recycling in the Member State	10,430	11,942	14,228	13,175	11,427
Recycling outside the EU	0	0	0	0	0

Figures in Italics estimated based on the average breakdown 2016 and 2017, underlined figure calculated as difference of the existing two figures.

Table 24: Packaging waste generated, recovered, and recycled according to the monitoring data pursuant to the Packaging-Directive, CH (in tons)

Eurostat label	2014	2015	2016	2017	2018
Waste generated	277,890	288,810	297,276	311,354	316,973
Recovery total, of which	233,216	245,173	253,862	268,094	277,681
Recovery - energy recovery from packaging waste	124,529	131,005	133,988	142,933	151,545
Recovery - other	0	0	0	0	0
Recycling, of which	108,687	114,168	119,874	125,161	126,136
Recycling in other Member States of the EU	21,230	22,300	23,415	24,448	24,638
Recycling in the Member State	85,405	89,712	94,195	98,350	99,116
Recycling outside the EU	2,052	2,156	2,264	2,363	2,382
Population CH	8,139,631	8,237,666	8,327,126	8,419,550	8,484,130
Population DE, AT, FR, IT	216,223,897	217,036,228	218,180,097	218,693,779	219,124,815

All figures for CH are estimated since CH has never reported packaging data. The data were created from the data of DE, AT, FR, and IT (neighbour-countries) by dividing the sums of these four countries for all fields by their combined population and multiply the results with the population of CH.

Table 25: Estimated Market Demand 2020 for the EU27 plus UK, CH, and NO in kt (PlasticsEurope, 2022)

Plastics Total	Estimated Market Demand 2020 for the EU27 plus UK, CH, and NO in kt (best expert estimation based on external sources, studies, publications)							
	Packaging kt	Construction kt	Automotive kt	E/E kt	Agriculture kt	Household, Leisure, Sports kt	Others kt	Total kt
PE-LD, -LLD	5,920	460	170	280	530	60	1,160	8,570
PE-HD, -MD	3,570	1,390	330	170	40	250	560	6,320
PP	4,660	810	940	490	530	780	1,480	9,700
PS	580	250	60	170	20	150	200	1,430
PS-E	280	1,260	10	0	0	10	0	1,550
PVC	400	3,420	150	130	140	190	270	4,700
PET	4,100	0	0	10	10	10	10	4,140
ABS, SAN	20	120	260	230	0	120	80	830
PMMA	0	80	50	10	0	20	90	260
PA (PA6, PA66)	60	50	260	220	0	20	240	850
PC	20	160	190	190	10	30	140	730
Other Thermoplastics	50	330	1,000	610	100	90	430	2,610
PUR	50	1,000	610	320	0	40	1,790	3,810
Other Plastics	190	700	310	200	190	330	1,730	3,650
Total	19,880	10,050	4,330	3,030	1,560	2,090	8,200	49,140

Source: PlasticsEurope Market Research Group, PlasticsEurope (2022)

Above data are rounded (therefore deviations in total sums are possible)