ISPRA
Istituto Superiore per la Protezione e la Ricerca Ambientale

Sistema Nazionale per la Protezione dell'Ambiente

Report on Municipal Waste 2023

Summary data

RAPPORTI
394 bis/2023

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This Report was prepared by the National Centre for Waste and Circular Economy of the National Institute for Environmental Protection and Research (ISPRA) with the contribution of the Regional and Provincial Agencies for Environmental Protection (ARPA / APPA).
The Report confirms ISPRA's commitment to ensure that information and knowledge relating to an important sector, such as that of waste, are available to all.

Because of this commitment, ISPRA considered it essential that the process for preparing the Municipal Waste Report, starting from the acquisition of data from specific sources, through to their processing and presentation, is planned and controlled at each stage. The Quality Management System implemented also ensures that all activities are supported by documents (procedures and forms) that guarantee the traceability of the information and processing carried out. In 2021 ISPRA obtained certification of the process of preparing the Municipal Waste Report in accordance with UNI EN ISO 9001:2015 by an internationally recognised independent third-party body.

We would like to thank the regional and provincial environmental protection agencies and all those organisations and institutions that made its publication possible.

The design, coordination and final drafting of this Report was carried out by Andrea Massimiliano LANZ, Head of the National Centre for Waste and Circular Economy.

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MUNICIPAL WASTE IN EUROPE

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CHAPTER 2
MUNICIPAL WASTE GENERATION AND SEPARATE COLLECTION IN ITALY

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CHAPTER 5
ASSESSMENT OF OPERATION COSTS OF THE MUNICIPAL WASTE MANAGEMENT SERVICE, YEAR 2021

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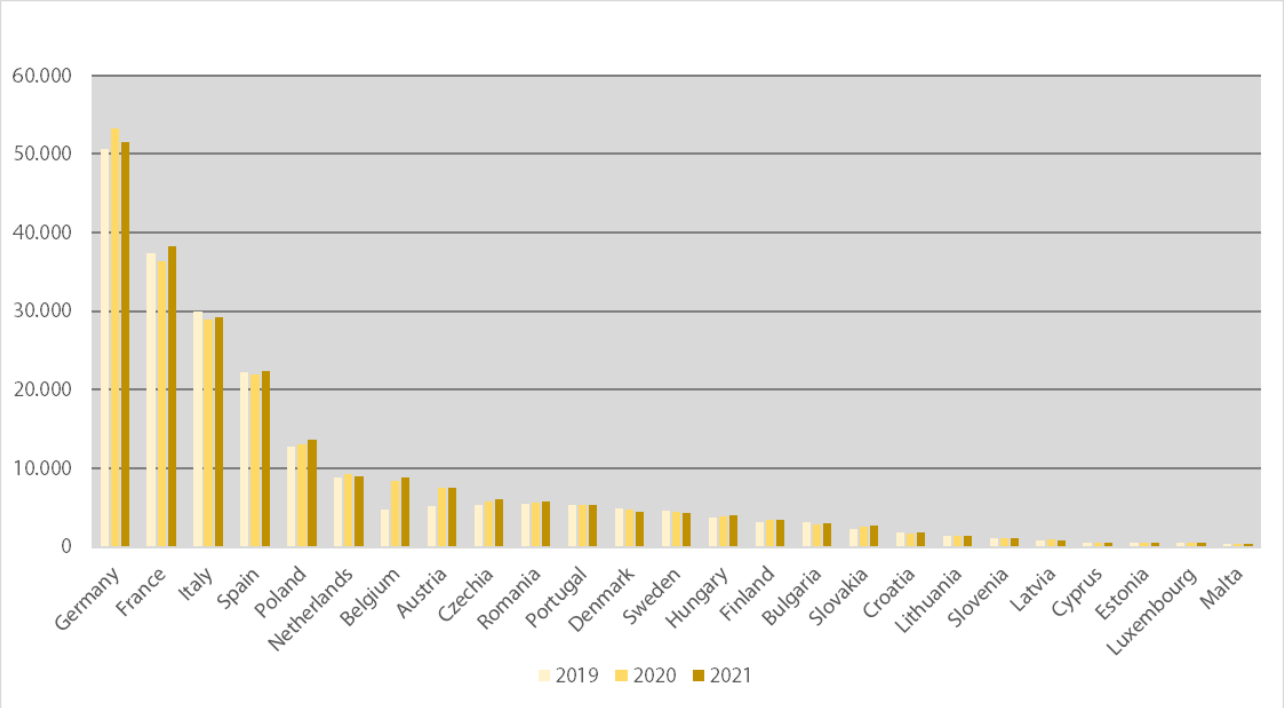
1. Municipal waste in Europe

1.1 Generation of municipal waste in Europe

In 2023, the historical series of Eurostat data on generation of municipal waste (MW) shows data up to 2021. Compared to 2020, total municipal waste generation in the EU27 shows an increase of 1%, from 233.2 million tonnes to approximately 235.4 million tonnes. Compared to 2019, the increase amounts to 4.5% (Figure 1.1). At EU country level, data comparison for the two-year period 2020 - 2021 shows negative decreases in Denmark (-5.1%), Malta (-4.2%) and Sweden (-2.4%), of particular importance because they are also reflected in the three-year period. Countries such as Bulgaria (+8.1%), France and Slovenia (+5.2%) show the largest percentage increases. Italy shows a decrease of 1.1% compared to 2020 and a decrease of 2.6% compared to 2019.

The EU27 trend of the per capita value of generated municipal waste is increasing, from 504 kg/inhabitant per year in 2019, to 521 kg/inhabitant in 2020 and 527kg/inhabitant in 2021. However, per capita generation values are characterised by high variability at country level. The three countries with the highest per capita generation are Austria (835 kg/inhabitant), Luxembourg (793 kg/inhabitant) and Denmark (769 kg/inhabitant), while the three with the lowest per capita generation are Estonia (395 kg/inhabitant), Poland (362 kg/inhabitant) and Romania (302 kg/inhabitant).

Figure 1.1 – Total municipal waste generated in the EU27 (tonnes*1,000), years 2019 - 2021

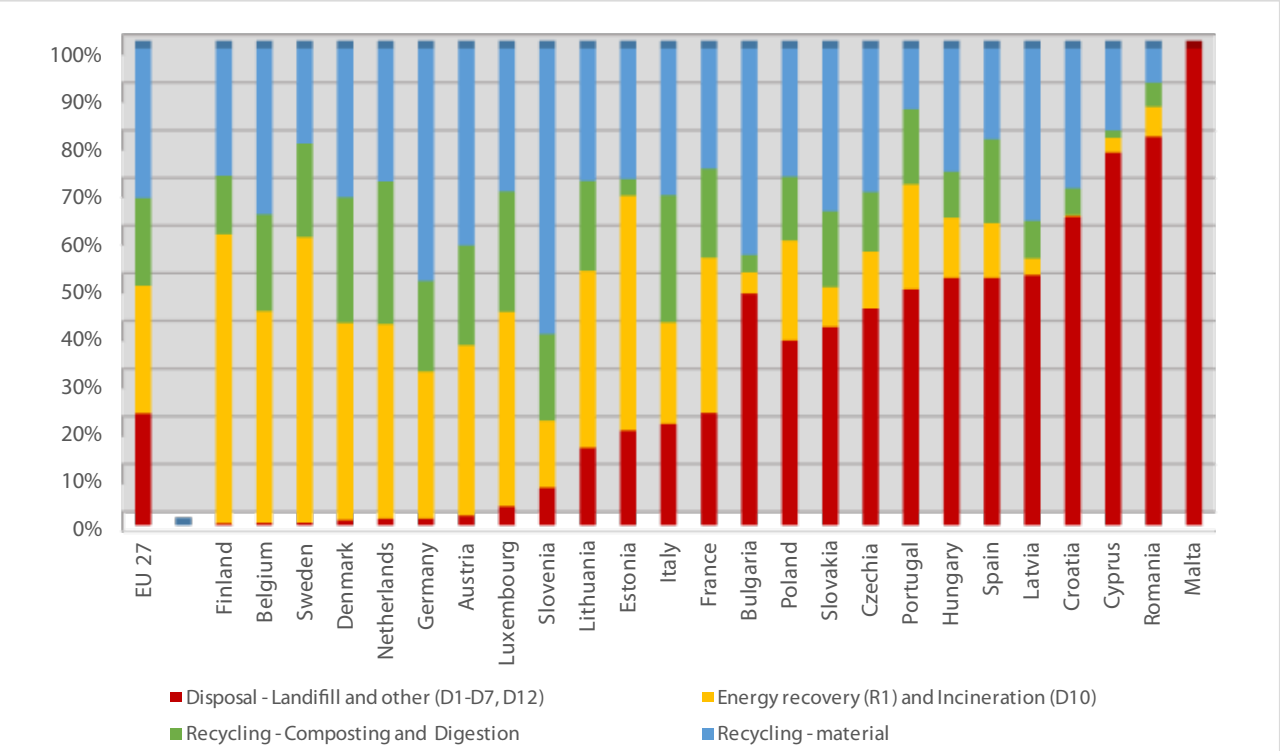


Source: ISPRA elaboration on Eurostat data

1.2 Management of municipal waste in Europe

In the EU27, the total amount of MW treated in 2021 is approximately 232 million tonnes, + 1.2% (+2.8 million tonnes) compared to 2020. For the three-year period 2021-2019, the increase is 11.5 million tonnes (+5.2%).
The largest percentage increases concern Bulgaria (+13.7%, +365 thousand tonnes) and Estonia (+17.7%, + 78 thousand tonnes). However, in terms of quantity, the main increases, excluding those already analysed, were recorded in France (+1.7 million tonnes, +4.8%) and Poland (557 thousand tonnes, +4.2%).
The most significant percentage reductions in the two-year period 2020-2019 concern Denmark, with -5.1% (-241 thousand tonnes), and Germany -10.3%, which with a decrease of 1.7 million tonnes has also the most significant decrease in terms of quantity.
In the EU27, the average per-capita quantities of MW treated increase by 1.4% between 2020 and 2021, while compared to 2019, the growth is 5.3%. Significant rises in per capita treatment values are recorded between 2020 and 2021 for Estonia (+17.5%) and Bulgaria (+14.5%), while the main decreases are observed for Denmark (-5.4%) and the Netherlands (-3.4%). In Italy, per capita values of treated municipal waste increase from 443 kg/inhabitant to 452 kg/inhabitant per year.
Figure 1.2 shows the extreme variability of municipal waste management approaches among different Member States. Finland, Sweden, Estonia, Belgium, Denmark, the Netherlands and Luxembourg dispose of small percentages in landfill, while the percentages of incineration with energy recovery (R1) are higher (ranging from 41% in Luxembourg, the Netherlands and Denmark to 61% in Finland). Other countries such as Malta, Romania, Cyprus, Croatia, Latvia, Spain and Hungary show a significant prevalence of landfilling with percentage values above 50%.

Figure 1.2 – Percentage breakdown of municipal waste management in EU27, year 2021 (data by increasing percentage of landfilling)



Note: Data for Greece and Ireland are not available.
Source: ISPRA elaboration on Eurostat data

1.3 Recycling of municipal waste in Europe

In 2021, the total amount of MW sent to recycling, in the EU27, consist of more than 114 million tonnes, about 1.3 million tonnes more than in 2020 (+1.2%) and 8.3 million tonnes more than in 2019 (+7.8%). Countries with percentages of MW sent to composting and anaerobic digestion above 20% of the total treated are: Austria (21%), Luxembourg (25%) Italy and Denmark (26%) and the Netherlands (30%). Out of 27 countries 9 have percentages above 30% of MW sent to material recycling (recycling of dry fractions), with Slovenia (59%) and Germany (49%) leading the way. Italy sends to material recycling just over 30% of MW, and about 26% to composting and anaerobic digestion, with a total share of waste sent to recycling of about 57%.

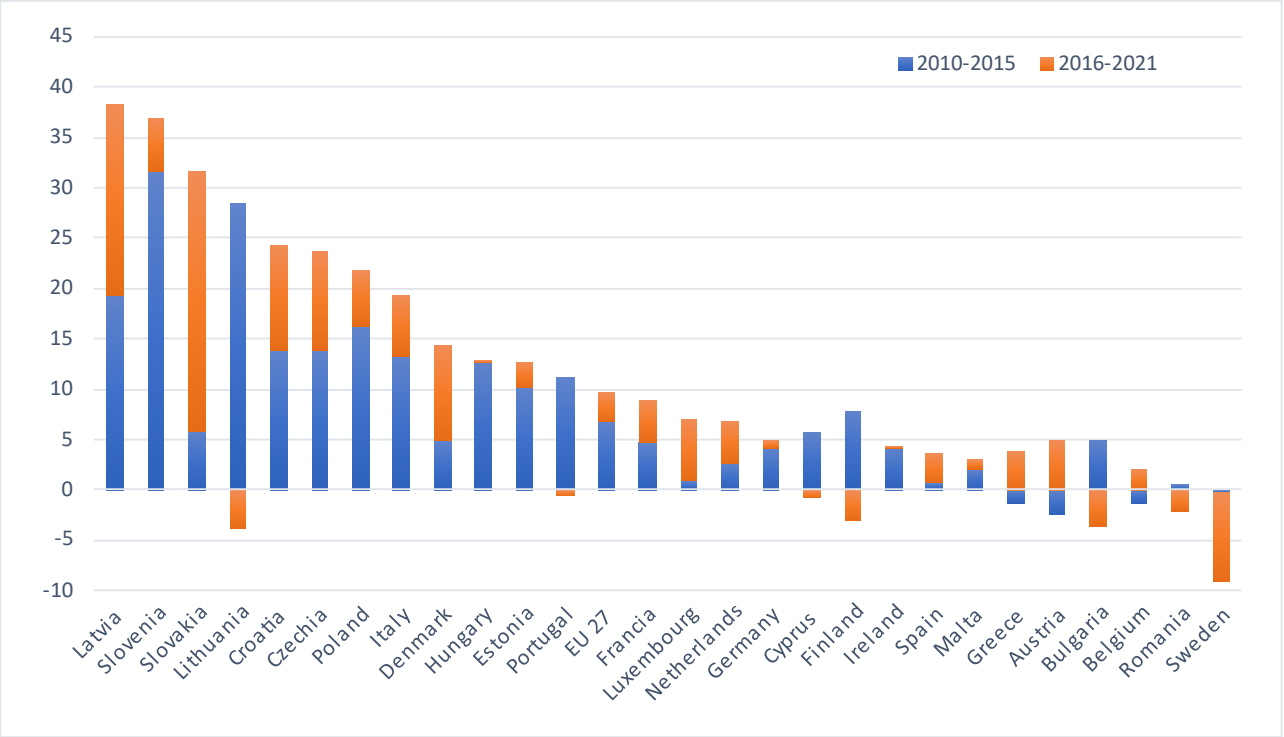
The "recycling rate of municipal waste" is one of Eurostat indicators measuring the progress of circular economy policies. It is part of the set of indicators of the EU Sustainable Development Goals (SDGs) and provides information on the municipal waste management performance of countries, but it is not suitable for monitoring compliance with the recycling target set by Article 11(2) of Directive 2008/98/EC by all Member States, due to the different methodology applied compared to the methodology set out in the WFD and Implementing Decision 2019/1004/EU.

Eurostat calculates the recycling rate as the share of municipal waste sent for recycling in relation to total municipal waste generation.

In 2021 the average recycling rate is 48.7% of the total waste generated in the EU27, showing an increase of 10.7 percentage points (pp) compared to 2010.

The countries with the most significant increases in percentages compared to 2010 are Slovakia (+39.8 pp), Lithuania (+39.4 pp), Slovenia (+38.4 pp). Italy recorded an overall increase of +20.9 pp (Figure 1.3).

Figura 1.3 – Changes in the recycling rate of municipal waste in the EU27, years2010 – 2015 and 2016- 2021



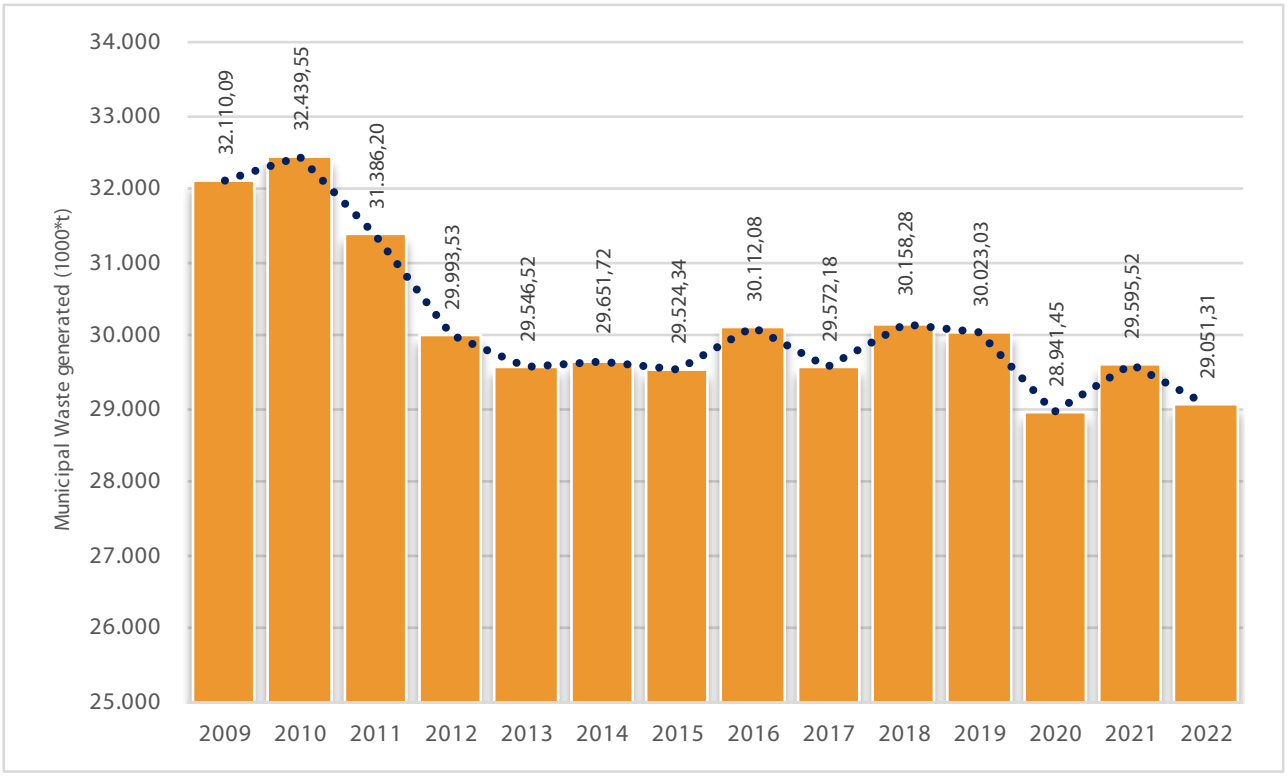
Source: ISPRA elaboration on Eurostat data

2. Municipal waste generation and separate collection in Italy

2.1 Municipal waste generation

In 2022, municipal waste generation in Italy was 29.1 million tonnes, higher than the 2021 value (28.9 million tonnes) (Figure 2.1).
In fact, 2022 has been the year of economic rebound after the health emergency, which influenced the national socio-economic environment due to the restrictive measures taken and trade closures. Data on municipal waste reflect this rebound, but to a lesser extent than other socio-economic indicators such as gross domestic product and household expenditure. The growth of waste generation, which increases by 3.7% by 2020, is lower than the increases in GDP and household consumption of 6.1% and 5.3% respectively.
Waste generated decreases in all geographical macro-areas, with the North recording the largest percentage decrease (-2.2 %), followed by the Centre and the South (-1.5 %). In absolute value, northern Italy produces over 13.8 million tonnes, the Centre 6.2 million tonnes and the South almost 9 million tonnes.In quantitative terms, northern Italy produced almost 14.2 million tonnes, central Italy over 6.3 million tonnes and the southern Italy over 9.1 million tonnes.
Every Italian citizen produced 494 kg/inhabitant, registering a negative percentage change of 1.6%, compared to 2021. It should be noted that the resident population shows a further decline (-0.2%, 132 thousand fewer inhabitants), in line with the trend seen in the 2020-2021, but smaller than that of waste production. In the last five-year period, a per capita value of production below 500 kg per inhabitant was recorded in 2020, a year marked by the pandemic crisis, and in 2022.
The highest values of per capita production are seen, as in previous years, for the Centre with 532 kg/inhabitant. The average value for northern Italy stands at 506 kg/inhabitant, down 10 kg/inhabitant from 2021, while the figure for the South is 454 kg/inhabitant (-6 kg/inhabitant). The per capita production of this macro area is 40 kg/inhabitant lower than the national figure and 78 kg/inhabitant lower than the average value for the Centre.

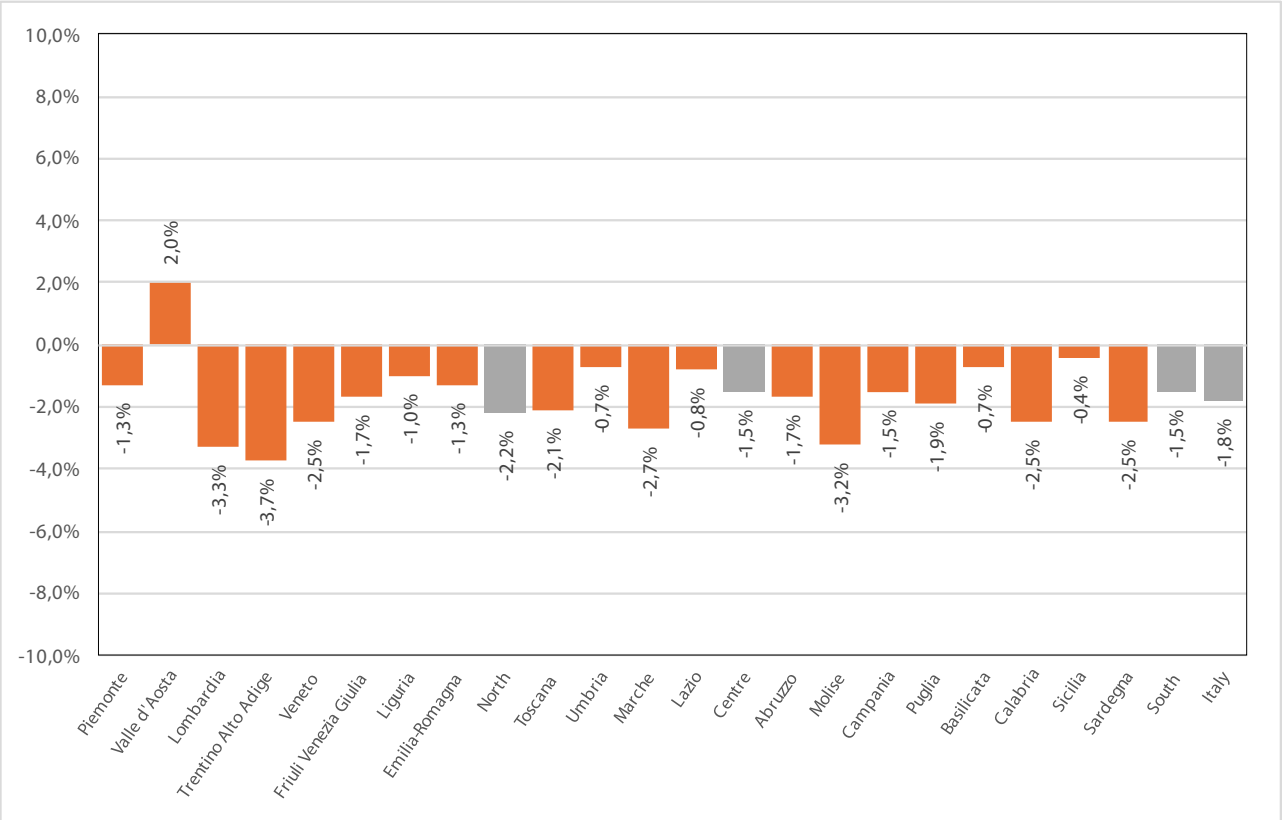
Figure 2.1 – Trends in municipal waste generation, years 2009- 2022



Source: ISPRA

Apart from Valle d'Aosta, whose production slightly increased, all Italian regions showed a decline in waste generated (Figure 2.2). In particular, among the northern regions, the largest contractions were observed for Trentino-Alto Adige (-3.7 %), Lombardy (-3.3 %) and Veneto (-2.5 %); in the Centre, for Marche (-2.7 %) and Tuscany (-2.1 %); and in the south for Molise (-3.2 %), Calabria and Sardinia (-2.5 % for both) and Puglia (-1.9 %). Among the regions, Emilia-Romagna had the highest per capita value with 633 kilograms/inhabitant per year. Next is Valle d'Aosta, with 616 kg/inhabitant, followed by Tuscany with an increase of 14 kilograms, reaching 590 kg/inhabitant. The other regions with per capita values above the national average were Liguria, Marche, Umbria, Lazio and Trentino-Alto Adige. The lowest per capita values were recorded for Basilicata (358 kg per inhabitant), Molise (386 kg per inhabitant) and Calabria 357 kg per inhabitant).

Figure 2.2 - Percentage change, from 2021 to 2022, of municipal waste generation on a regional scale



Source: ISPRA

The three provinces that produce the highest amount of waste are in Emilia-Romagna: Reggio Emilia with 744 kilograms per inhabitant per year, Ravenna with 735 kg/inhabitant per year and Piacenza with 720 kg/inhabitant per year. Provinces with per capita production between 600 and 700 kg/inhabitant per year include three other provinces in Emilia-Romagna (Rimini, Modena and Ferrara), four Tuscan provinces (Livorno, Grosseto, Lucca and Prato) and the province of Aosta.

Lowest per capita values (less than 400 kg/inhabitant per year) were found in several southern Italian provinces and in two provinces in the Centre, Rieti and Frosinone. In particular, Potenza and Enna were below 350 kg/inhabitant per year.

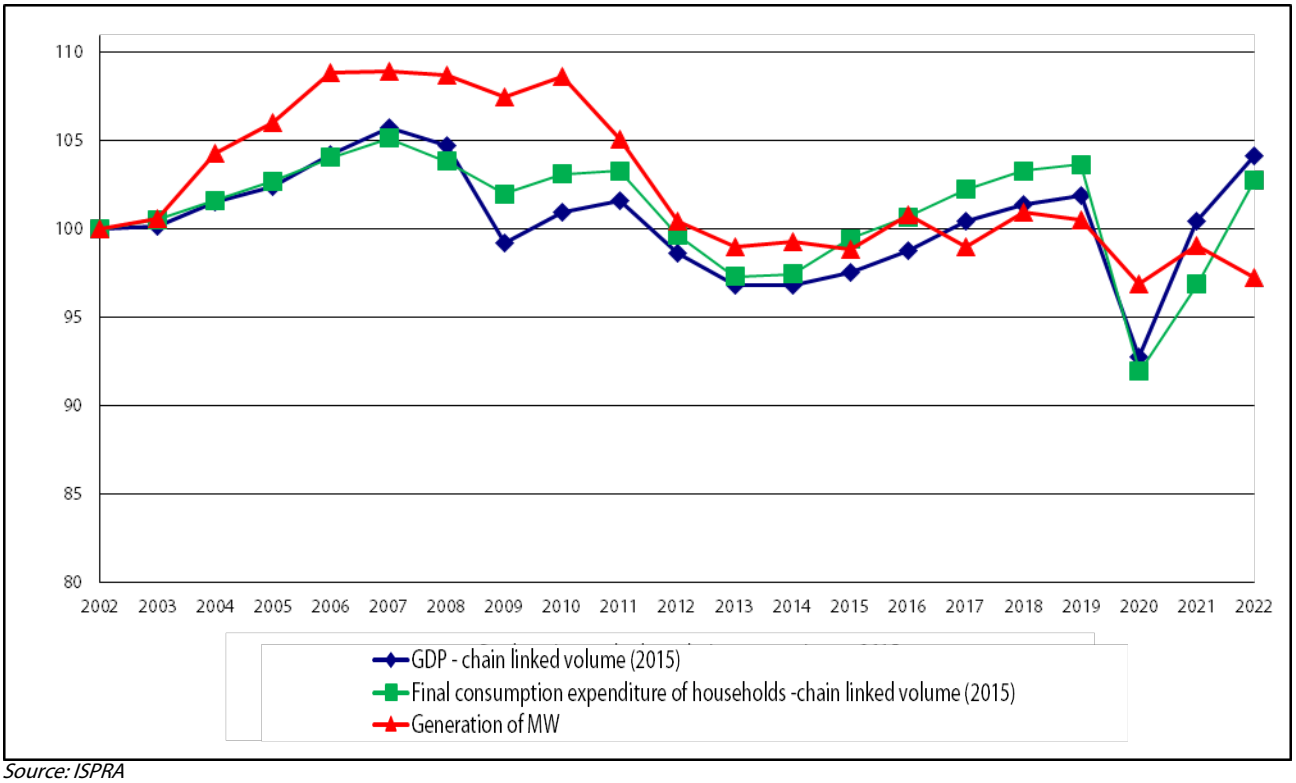
On a **municipal scale**, all 14 municipalities with a resident population above 200,000 (collectively about 16% of the Italian population) show an increase in total output of 0.4% between 2021 and 2022. Venice and Naples show increases of 5.7% and 3.1% followed by Catania and Padua, both with an increase of 2.3%; the increases recorded for Messina and Milano are lower, at 1.5% and 1%, respectively. Below 1% are those of Florence, Bari

and Rome. By contrast, the municipalities of Bologna, Palermo, Turin, Verona and Genoa show a decrease in the production figure.

The fluctuating trend observed in recent years may be linked to various factors, some of which may be combined, including the introduction of new regulatory provisions that have changed the definition and methods of accounting for the collection and management of municipal waste, or health or socio-economic reasons, such as the 2020 pandemic and the international crisis of 2022, which have affected consumption and, consequently, waste generation.

Concerning the impacts of regulatory changes, data may be affected by the introduction of Article 198, paragraph 2-bis, into Legislative Decree 152/2006 by Legislative Decree 116/2020. This amendment allows non-household users to deliver their municipal waste outside the public collection service, if they can prove that they are sending such waste to operators that guarantee its recovery. Waste that falls under these cases may, therefore, not be fully accounted for within the municipal waste data and consequently be included in the accounting of the non-municipal waste data.

Figure 2.3 - Trends in municipal waste generation and socio-economic indicators, years 2002 – 2022

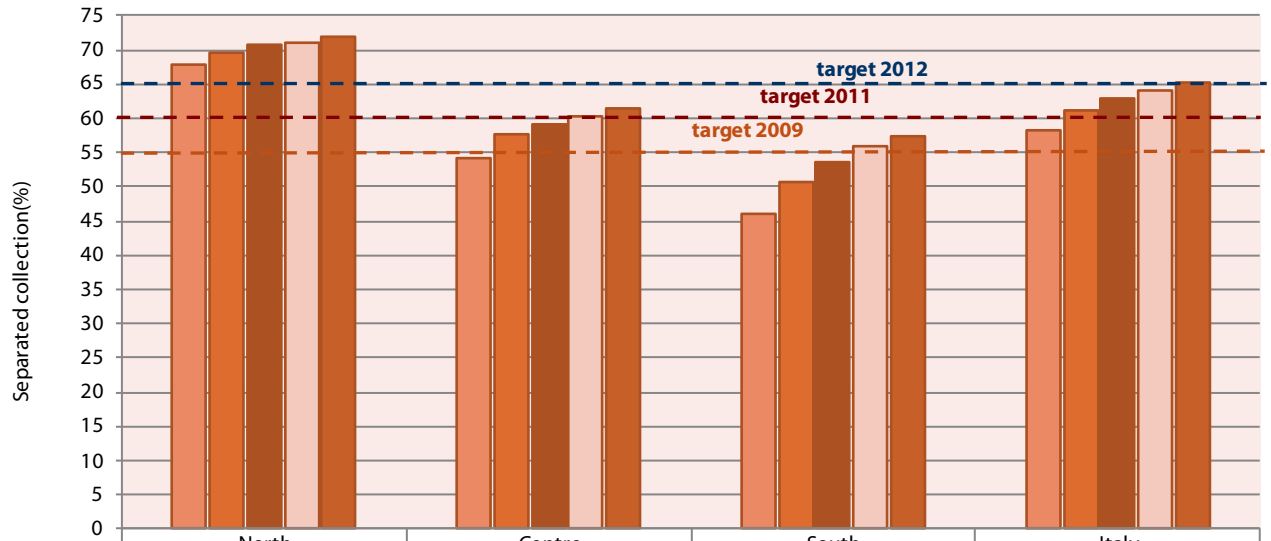


Source: ISPRA

2.2 Separate collection of municipal waste

In 2022 separate collection of municipal waste in Italy reached 65,2% of the national municipal waste generation, 1,2 percentage point higher than 2020 (Figure 2.4). In terms of quantity, after the slight decrease recorded in 2021 (-0.1%), separate collection started to grow again, increasing by 18.9 million tonnes.
In the North, separate collection amounted to 9,9 million tonnes, in the Centre about 3.8 million tonnes and in the South almost 5.2 million tonnes. These quantities correspond in the northern regions to 71,8% of the total production, 61,5% in the Centre and 57,5% in the Southern regions.

Figure 2.4 - Trend in the percentage of separate collection of municipal waste by macroarea, years 2018 - 2022

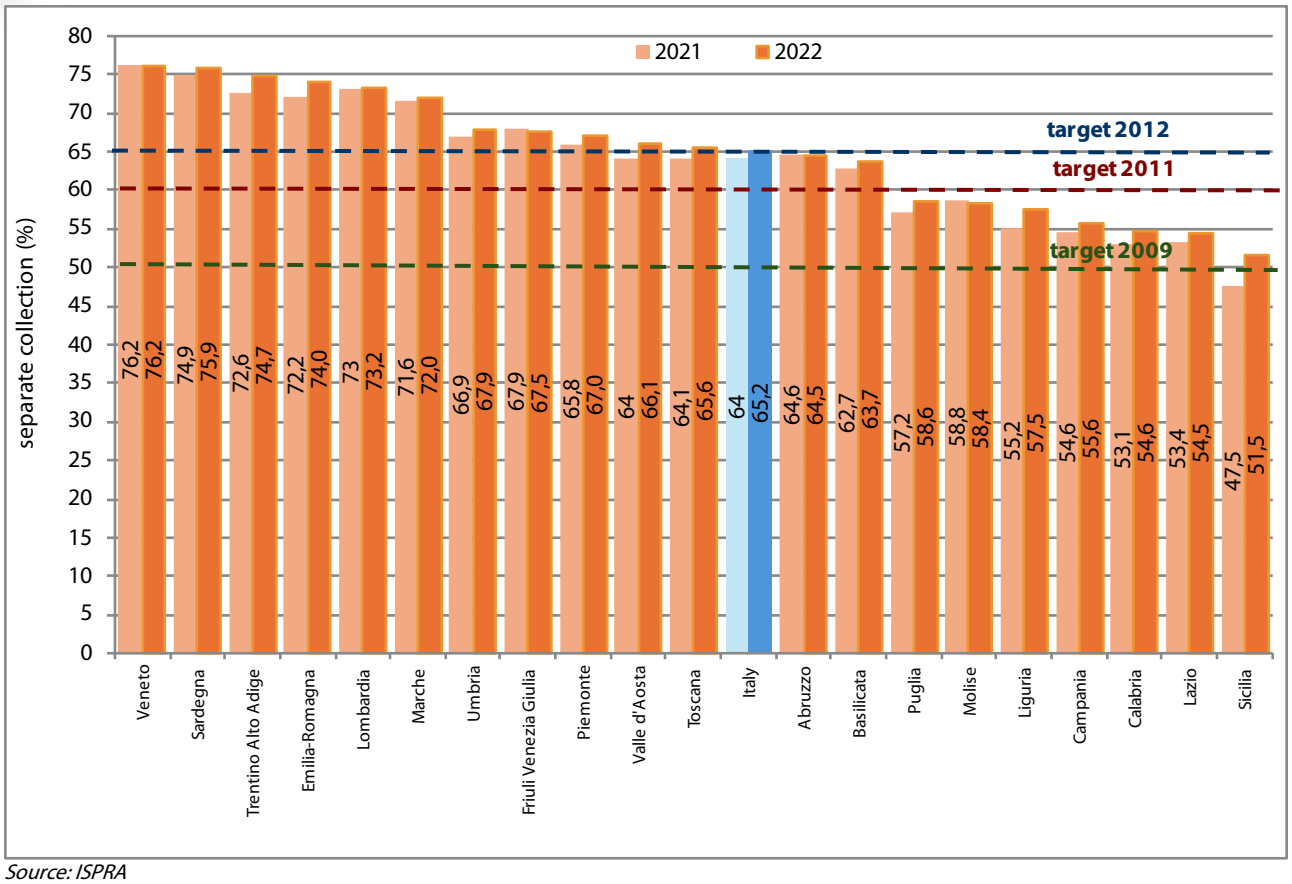


	North	Centre	South	Italy
2018	67,7	54,3	46,1	58,2
2019	69,6	57,8	50,6	61,3
2020	70,8	59,2	53,5	63,0
2021	71,0	60,4	55,8	64,0
2022	71,8	61,5	57,5	65,2

Source: ISPRA

On a regional scale, the highest percentage of separate collection is achieved, similarly to 2021, by the Veneto region, with 76.2 percent, followed by Sardinia (75.9 percent), Trentino-Alto Adige (74.7 percent), Emilia-Romagna (74 %), Lombardy (73.2 percent) and Marche (72 percent) (Figure 2.5). Umbria (67.9 %), Friuli-Venezia Giulia (67.5 %), Piedmont (67 %), Valle d'Aosta (66.1 %) and Tuscany (65.6 %) also exceed the 65% target, set by the legislation for 2012; Abruzzo (64.5 %) and Basilicata (63.7 %) are close to this goal. The number of regions with a collection rate above the national average (65.2 %) is, therefore, 11.
Puglia and Molise stand at 58.6 and 58.4 percent, respectively, while Liguria stands, at 57.5 %, an increase of more than 2 points over 2021. Campania reaches 55.6 %, Calabria 54.6 % and Lazio at 54.5 %. For Puglia and Calabria, percentage increases of 1.4 and 1.5 points, respectively, are recorded.
Exceeding the 50 %threshold for the first time is the region of Sicily (51.5 %) registering an increase of 3.9 points over the 2021 percentage (47.5 percent), more than 9 points over 2020, and 22 points over 2018.

Figure 2.5 - Trend in the percentage of separate collection of municipal waste by region, years 2021 - 2022



Source: ISPRA

On a provincial scale, the highest levels of separate collection are found, similar to previous years, for the province of Treviso, which stands at 88.7 percent, followed by Mantova (86 %), Belluno (84.6 %) and Reggio Emilia (82.3 %). Also close to 80 %are Novara (81.4%), Trento (80.5%), Pordenone (80.2%), Oristano (79.8%) and Parma (79.6%). Separate collection rates below 40% are observed for the provinces of Palermo (34.9%) and Crotone (39%). Provinces or metropolitan cities with separate collection greater than or equal to 65% were 66 and those with collection between 60% and 65% were 16. Provinces with separate collection rates between 50% and 60% were 19. As a result, 94% of the provinces (101 out of 107 compared to 97 in 2021) have separately collected at least half of the amount of municipal waste produced on their territory. Out of the 66 provinces that have reached the 65% target, 40 are located in northern Italy, 13 in central Italy and 13 in the southern Italy. Data at municipal level showed that 69% of the municipalities achieved a separate collection rate higher than 65% in 2022. This value was 66.6% in 2021 and 60.2% in 2020. Two thirds of the Italian municipalities were therefore above the separate collection target of 65%. At the same time, the percentage of municipalities with collection rates below 30 % continues to decline (3.4 % in 2022). Overall, in the past year, 87% of municipalities intercept more than half of their municipal waste separately (85% in 2021).

The highest levels of separate collection for **municipalities with a resident population over 200,000** are observed for Padua, Bologna, Venice and Milan, with rates of 64.3 %, 63.2 %, 62.7 % and 62.1 %, respectively. Also exceeding 50 % are Florence, Turin, Verona and Messina whose rates stand at 55%, 54.4%, 53.7% and 53.5%, respectively. Rome, up slightly from 2021, stands at 45.9%, while Genoa, Naples, and Bari reach or slightly exceed 40%, with 42.8%, 40.4%, and 40%, respectively.

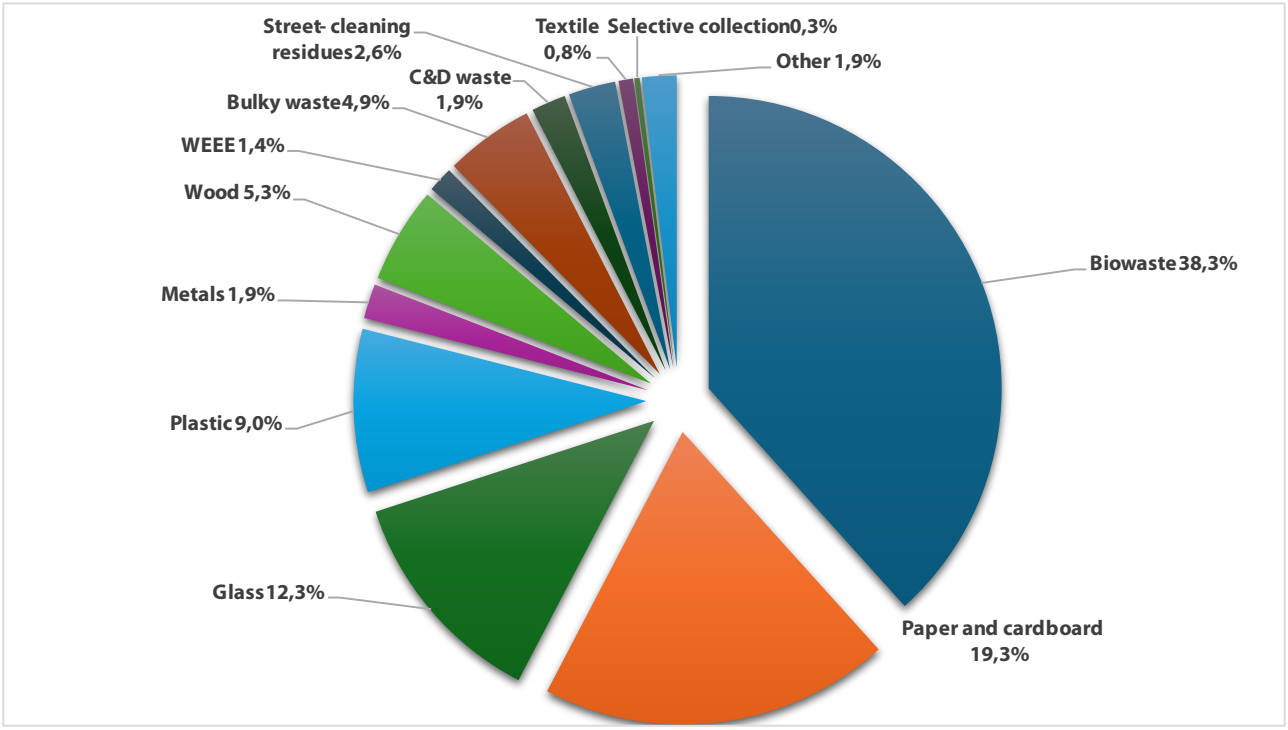
As for Sicily, there is a growth of more than 10 percentage points for the cities of Messina and Catania, with the former rising from 43% to 53.5% and the latter from 11.3% to 22%. Palermo shows the lowest percentage of separate collection among the 14 municipalities surveyed, at 15.2%, with a slight increase from the 13.6% recorded in 2021.

Separately collected waste streams

Among the separately collected waste, organic waste remains the most collected fraction in Italy (38.3% of the total), followed by paper and cardboard with 19.3% of the total, glass (12.3%) and plastic (9%, Figure 2.6).
The collection of organic waste stands at just over 7.2 million tonnes, down 1.8% compared to 2021, after the increase recorded in that year, related to the reopening of commercial, industrial and craft activities and the resumption of travel and tourist flows (Figure 2.7). The decrease, which is also confirmed by a similar trend in the data of waste managed at biological treatment plants, is linked to a reduction in the collection of biodegradable waste from garden and park maintenance, which decreased by 139 thousand tonnes (-7.2%).

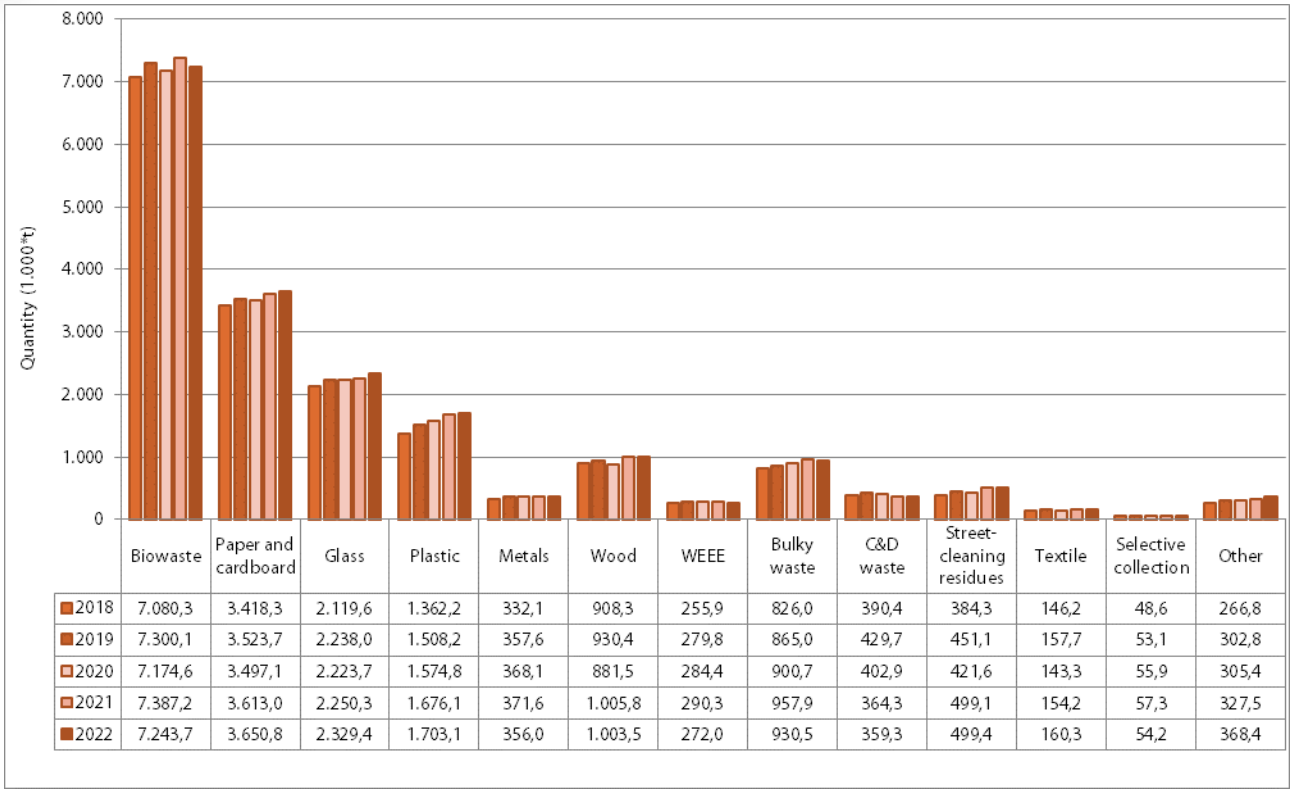
Approximately 70,5% of bio-waste are biodegradable kitchen and canteen waste (LoW 200108 -5.1 million tonnes), 24,7% are biodegradable waste from garden and park maintenance (LoW 200201 - 1.8million tonnes), 4,2% are home composting waste (301 thousand tonnes) and 0.7% waste from markets (LoW 200302 - 48 thousand tonnes).
Paper and cardboard waste is in second place in terms of collected quantity, over 3.6 million tonnes, increased by 1% compared to 2021. Glass waste are next with almost 2.3 million tonnes, also up by 3,4%. About 92% of the glass waste separately collected is packaging. Plastics showed growth in quantities collected, albeit to a more moderate extent than in the previous two-year period, with a total amount intercepted of 1.7 million tonnes (+1.5% compared to 2021). About 95% of the plastic waste separately collected is packaging. After the growth recorded in the previous two years, wood collection shows a slight decrease to just over 1 million tonnes (-0.2%). Approximately 16% is packaging waste.

Figure 2.6 - Percentage breakdown of separate collection, year 2022



Source: ISPRA

Figure 2.7 - Separate collection by product fraction, years 2018 – 2022



	Biowaste	Paper and cardboard	Glass	Plastic	Metals	Wood	WEEE	Bulky waste	C&D waste	Street-cleaning residues	Textile	Selective collection	Other
2018	7.080,3	3.418,3	2.119,6	1.362,2	332,1	908,3	255,9	826,0	390,4	384,3	146,2	48,6	266,8
2019	7.300,1	3.523,7	2.238,0	1.508,2	357,6	930,4	279,8	865,0	429,7	451,1	157,7	53,1	302,8
2020	7.174,6	3.497,1	2.223,7	1.574,8	368,1	881,5	284,4	900,7	402,9	421,6	143,3	55,9	305,4
2021	7.387,2	3.613,0	2.250,3	1.676,1	371,6	1.005,8	290,3	957,9	364,3	499,1	154,2	57,3	327,5
2022	7.243,7	3.650,8	2.329,4	1.703,1	356,0	1.003,5	272,0	930,5	359,3	499,4	160,3	54,2	368,4

Note:
(1) Waste stream included starting from 2016 based on the criteria established by the Ministerial Decree of 26 May 2016.
(2) Starting from 2016, waste collected as multi-material is also included in the "Other" item. Based on the criteria established by the Ministerial Decree of 26 May 2016, the latter must, in fact, be fully calculated (gross of the share of waste) in the amount of Separate Collection. The quotas relating to the paper and cardboard, glass, plastic, metal, and wood fractions are given by the sum of the collected quantities of packaging and other types of waste made up of these materials.
Source: ISPRA

3. Municipal waste management in Italy

In this analysis of data and information on the treated quantities and the forms of municipal waste management, it was decided to also include waste generated from the treatment of municipal waste. These wastes, identified by the LoW[1] codes 191212 (other wastes including mixed materials from mechanical treatment of waste), LoW 191210 (combustible wastes - RDF /SRF), LoW 190501 (non-composted fraction of municipal and similar wastes), LoW 190503 (off-specification compost) and LoW 190599 (wastes from aerobic treatment of waste not otherwise specified), although classified differently, since they are the product of treatment operations that change their nature and chemical composition, are nevertheless of municipal nature.

This choice is also justified by the provisions of Article 182-bis of Legislative Decree No 152/2006, which provides for the achievement of self-sufficiency in the disposal of non-hazardous municipal waste and waste produced by the mechanical treatment of waste, through the creation of an integrated plant network in a defined territory (optimal territorial area). The main critical issue in the analysis of these waste flows is their transport to extra-regional destinations, which makes it particularly complex to follow their path from production to final destination.

Municipal waste (MW) sent to intermediate forms of mechanical biological treatment before a final destination of recovery or disposal represent 30.1% of the municipal waste produced in 2022. It is therefore necessary to account for this waste in order to close the cycle of municipal waste management. Mechanical biological treatment is, as a matter of fact, widely used as a form of pre-treatment to landfilling or incineration. The aim is to guarantee the conditions of biological stability, by reducing the humidity and volume of the waste, but also of increasing its calorific value to make the combustion process more efficient.

As required by law, waste may be landfilled only after treatment[2], and in line with these provisions, 93.7% (91.5% in 2021) of the waste disposed of in landfills, as well as approximately 50% of the waste incinerated, underwent preliminary treatment in 2022.

In many cases, mechanical biological treatment plants (MBT) are located on the same site where there are also landfills or incinerators. In several cases, both the mechanical biological treatment plant and the bio-waste treatment plant are present on the same site.

A total of 654 municipal waste management plants were operational in 2022. The table shows details by geographical macro-area and by type of plant.

Type of plant		Numbers of plants			
		North	Centre	South	Total
Biological treatment	Composting	172	37	76	285
	Integrated treatment	34	8	9	51
	Anaerobic digestion	19	1	2	22
Mechanical or mechanical-biological treatment	MBT	24	26	46	96
	MT	17	14	5	36
Co-incineration		7	1	3	11
Incineration		25	5	6	36
Landfills		50	25	42	117
Total		**348**	**117**	**189**	**654**

Source: ISPRA

[1] European List of Waste

[2] Article 7 of Legislative Decree 36/2003, transposing Directive 99/31/EC as amended.

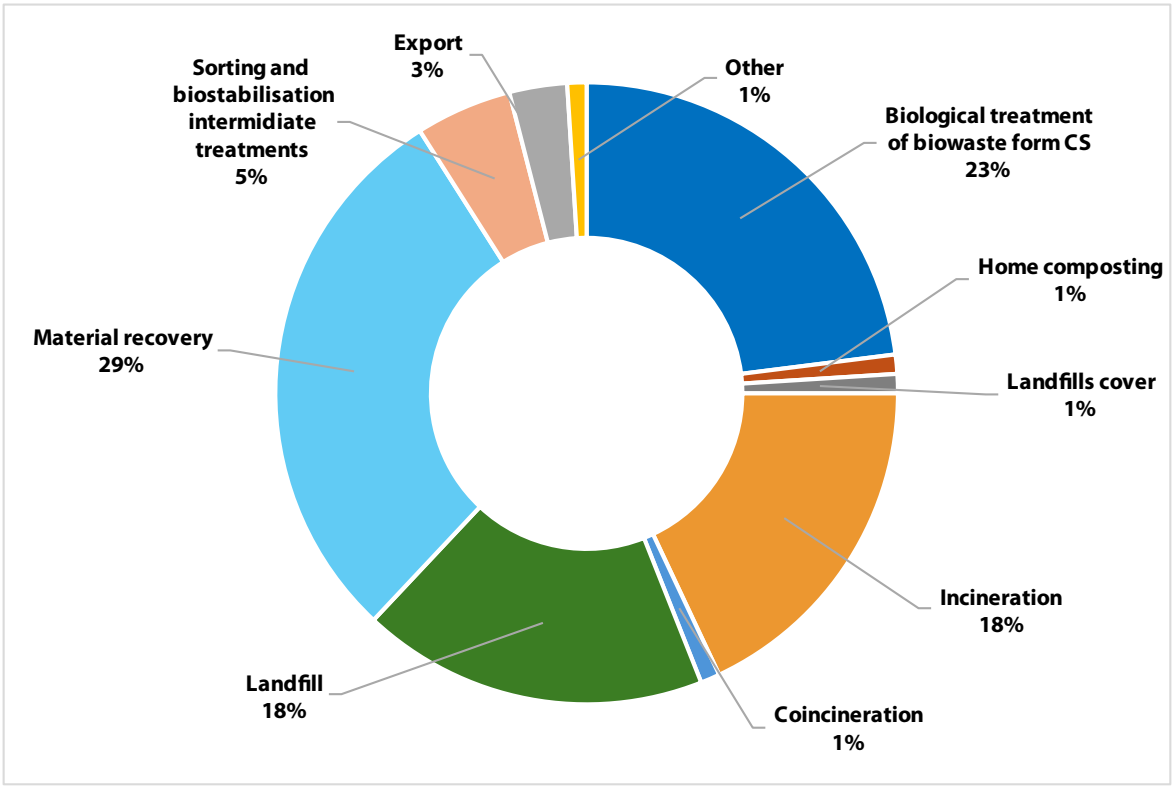
In 2022, waste disposed in landfills without prior treatment was about 324 thousand tonnes, down from 480 thousand tonnes in 2021 with an overall reduction in disposal, including pre-treated MW, of -7.9% in percentage terms.

To avoid data duplication, when accounting for the quantities of waste processed by mechanical biological treatment and subsequently sent to other management operations, Figure 3.1, which represents the percentage breakdown of the different forms of management in 2022, does not show the share of MW treated in this type of plant.

A total of 7.1 million tonnes of mixed municipal waste (identified by LoW code 200301), about 188 thousand tonnes of other fractions of municipal waste, 1.1 million tonnes of waste from the treatment of municipal waste (identified by LoW chapter 19 codes), and 299 thousand tonnes of other types of non-municipal waste were treated by Mechanical biological treatment (MBT) plants in 2022.

Data analysis shows that landfilling affects 18% of municipal waste generated. As a whole, 52% of the waste produced is sent to material recovery plants for the treatment of separated collections: 23% to plants that recover the organic fraction from separate collection (wet + green) and 29% to plants that recover the other product fractions from separated collection. 18% of the municipal waste produced is incinerated, while 1% is sent to production plants, such as cement plants, thermoelectric power plants, etc., for use within the production cycle to produce energy; 1% is used, after adequate treatment, to cover landfills, 5%, consisting of waste from MBT plants, is sent for further treatment such as refining to produce SSF or biostabilization, 3% is exported (about 858 thousand tonnes), and 1% is managed directly by citizens through home composting (301 thousand tonnes). Under "other" (1%), the quantities of waste remaining in storage at the end of the year at treatment plants, process losses, as well as waste produced by MBT plants whose destination cannot be inferred from the MUD database are included. Regarding the figure recorded for exports (3%), it is necessary to point out that it does not include materials exported after recovery operations as a result of which they are qualified as secondary raw materials.

Figure 3.1 – Percentage breakdown of municipal waste management, year 2022

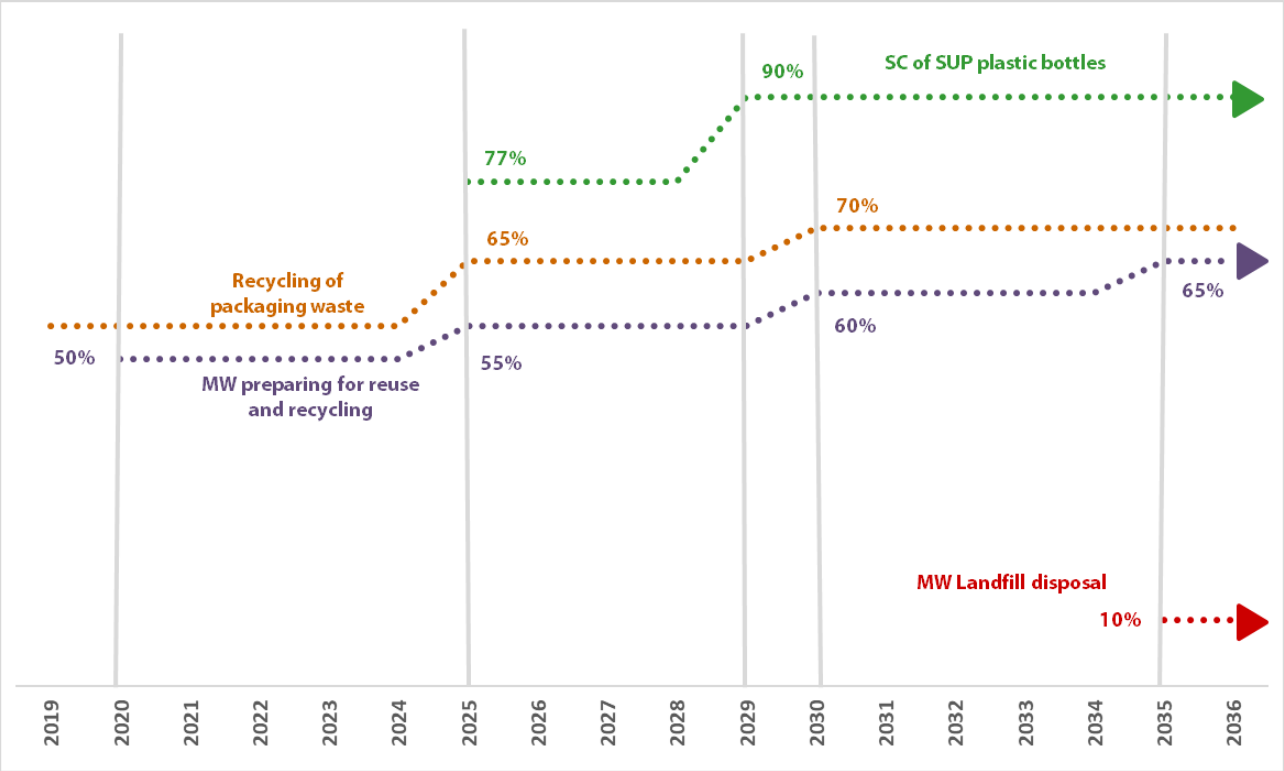


Source: ISPRA

Analysis of the data highlights the need to accelerate the improvement of the management system, especially in some parts of the country, to enable the achievement of the challenging new targets set by European legislation, which are summarized in Figure 3.2. Landfilling in the next 15 years will have to be almost halved (10 % by 2035), the percentage of waste to be sent to material recovery operations will have to be significantly increased to ensure the achievement of 60 % recycling by 2030 and 65 % by 2035. The need for a change of pace appears even more urgent when one considers that with the new targets, new calculation methodologies have also been introduced for both recycling and landfill assessment that appear to be significantly more restrictive than those used to date.

In this regard, it should be noted that the shares of waste sent to incineration without energy recovery destined for landfill will have to be counted in disposal. Analyzing the figure for disposal operations (D1 + D10) in relation to total municipal waste generation shows that, at national level, still almost 18% of municipal waste generated (17.8%) is disposed of in landfills (D1) while 3.6% is sent to incineration (D10).

Figure 3.2 - Main targets under European legislation



Source: ISPRA own elaboration.

Landfilling in 2022 involved 5.2 million tonnes of municipal waste, with a reduction of 7,9% (over 198,000 tonnes) compared to 2021. Data analysis by geographic macro-area show that 26.1% of the total amount (about 1.5 million tonnes) was disposed of in plants located in the north of the country, 30.5% (1.7 million tonnes) was disposed of in plants located in the Centre, while 43.4% of the total (over 2.4 million tonnes) was disposed of in plants located in the South.

In the South, there was a decrease of 5.8% (about 151 thousand tonnes) and in the Centre, a decrease of 2.1% (-37 thousand tonnes) compared to 2021, attributable to improved separate collection in both areas. The reduction in the North was less significant, where there was a decrease of 0.7% (about 11 thousand tonnes) and the separate collection remained stable at 71.8%..

Figure 3.3 shows a decrease of 1.9% between 2021 and 2022 for incineration (about 102 thousand tonnes). 71.5% of this waste is treated in the North, 9.7% in the Centre and 18.8% in the South. Substantial shares of waste produced in central and southern Italy are, however, treated in plants located in the North. Lombardy alone receives almost 375,000 tonnes of waste from outside the region, mainly from Piedmont, Lazio, Campania, Liguria and Puglia.

The treatment of bio-waste from separate collection showed ad decrease of 132,000 tonnes, or -1.9%, from almost 6.8 million tonnes to about 6.7 million tonnes. The recovery of this fraction is mainly carried out in integrated treatment plants (anaerobic/aerobic), which, treating about 3.4 million tonnes, contribute for 50.8% to the treatment of organic waste, showing an increase of 3.2 percentage points compared to 2021. Composting, at approximately 3 million tonnes, contributes 44.4%. The remaining 4.8%, just over 315,000 tonnes, is managed in anaerobic digestion plants.

The national per capita value for biological treatment of bio-waste in 2022 is 113 kg/inhabitant, but values vary according to geographical macro-areas: 159 kg/inhabitant in the North, 65 kg/inhabitant in the Centre and 78 kg/inhabitant in the South.

These data are not fully comparable with those of bio-waste collection at territorial level. Due to the smaller number of plants in the central and southern areas of the country (indeed, 172 composting plants out of 285

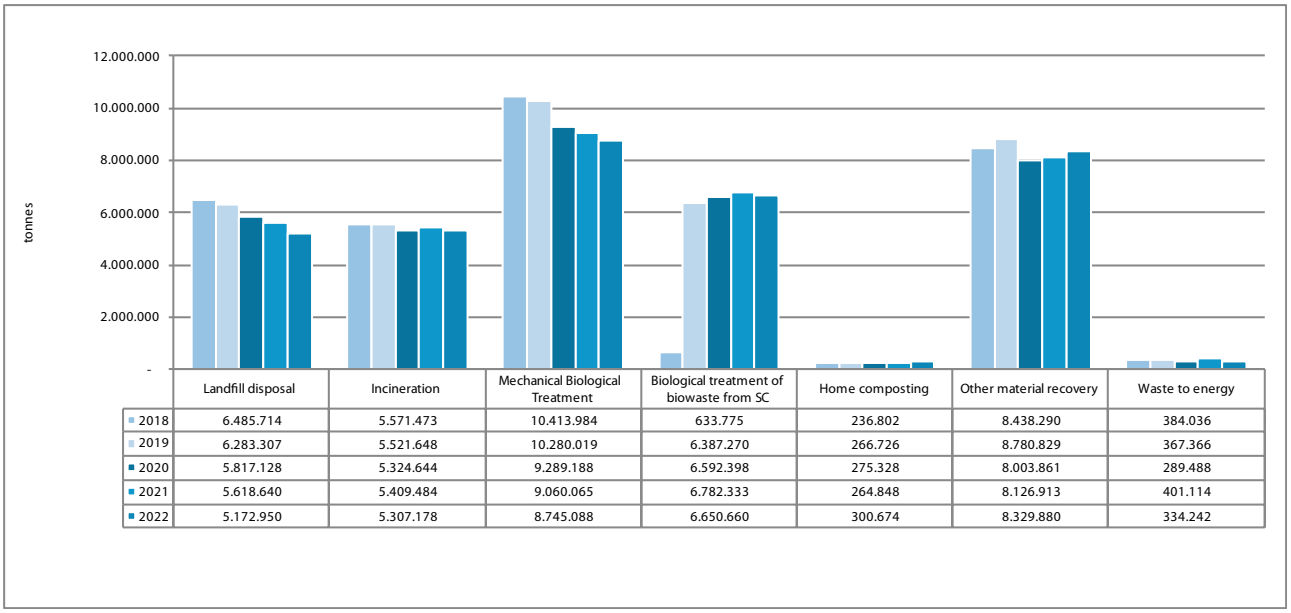
operating nationwide, 34 out of 51 integrated treatment plants and 19 out of 22 anaerobic digestion plants, are located in the North) significant quantities of waste are moved from these areas to plants in the North. The collection of the bio-waste fraction (net of home composting), in fact, at a national level reaches 118 kg/inhabitant, with 124 kg/inhabitant in the North, 117 kg/inhabitant in the Centre and 110 kg/inhabitant in the South.

The valorisation of the organic fraction of municipal waste appears to be a key element in achieving the new and challenging targets set by the European Union. As a matter of fact, this fraction represents 34.7% (about 10.1 million tonnes) of municipal waste. The legislation states that organic waste can be counted towards recycling if treatment produces compost, digestate or another product with a recycled content yield similar to the input, intended to be used as a recycled product, material or substance. Where the output product is used on land, it is only counted as recycled if its use results in agricultural benefits or environmental improvements.

Analysing the data on the different forms of management implemented at regional level, it is evident how, where there is an integrated waste cycle thanks to a developed plant park, the use of landfill is significantly reduced. For example, in Lombardy landfilling is reduced to 3.5% of municipal waste generated, in Friuli-Venezia Giulia to 5%, in Emilia-Romagna to 5.2%, in Trentino-Alto Adige to 5.3%, in Piedmont to 13% and in Veneto to 18.3%. In these regions, separate waste collection stands at 73,2%, 67.5%, 74%, 74.7%, 67% and 76.2% respectively and large shares of waste are treated in incineration plants with energy recovery.

There are regions where the plant framework is inadequate and not very diversified, e.g. Sicily, where municipal waste disposed of in landfills still accounts for 51.5% of the total waste produced, but also Lazio and Campania, which fail to close the cycle within the regional territory.

Figure 3.3 – Forms of municipal waste management at national level, years 2017 - 2021



	Landfill disposal	Incineration	Mechanical Biological Treatment	Biological treatment of biowaste from SC	Home composting	Other material recovery	Waste to energy
2018	6.485.714	5.571.473	10.413.984	633.775	236.802	8.438.290	384.036
2019	6.283.307	5.521.648	10.280.019	6.387.270	266.726	8.780.829	367.366
2020	5.817.128	5.324.644	9.289.188	6.592.398	275.328	8.003.861	289.488
2021	5.618.640	5.409.484	9.060.065	6.782.333	264.848	8.126.913	401.114
2022	5.172.950	5.307.178	8.745.088	6.650.660	300.674	8.329.880	334.242

Source: ISPRA

To limit the analysis of the data to the regional level, in many cases, can be misleading because the waste produced by mechanical-biological treatment plants (codes of Chapter 19 of the European List of Waste) is incinerated, disposed of in landfills or recovered in plants located outside the region. This is the case, for example, of Molise where 60,6% of the combustible waste incinerated comes from other regions.

The same applies, as highlighted, to the treatment of the bio-waste in composting plants. In the case of Campania, for example, the separate collection of this fraction was almost 630 thousand tonnes in 2022, of which only just over 107 thousand tonnes were recovered in regional plants (17% of the total collected). In Lazio, more than 550 thousand tonnes of bio-waste were separately collected, but existing plants in the region were able to treat only 255 thousand tonnes (46.2%).

In 2022 home composting reached about 301 thousand tonnes at national level, showing an increase of almost 36 thousand tonnes in the last year.
The calculation of the recycling rate for municipal waste and the individual forms of management are described in the following paragraphs.

3.1 Calculation of municipal waste recycling rates for targets verification under Article 181 of Legislative Decree No 152/2006

Directive 2008/98/EC introduced targets for preparing for re-use and the recycling of municipal waste. By 2020, the preparing for re-use and the recycling of waste materials should have been increased to a minimum of overall 50% by weight. Further targets for 2025 (55%), 2030 (60%) and 2035 (65%) were set as a result of the amendments introduced by Directive 2018/851/EU. While calculation methods established by Decision 2011/753/EU for the 50% target were more flexible, new targets calculation methods established by Decision 2019/1004/EU are more rigid and have been designed to ensure that the calculated percentages are indeed representative of the actual recycling capacity.
For the 2020 target, it was possible to choose which waste streams to apply the calculation to, as long as they included at least "paper, metal, plastic and glass from households, and possibly from other origins, insofar as these waste streams are similar to households".
The targets presented in previous editions of the Municipal Waste Report referred to the approach of Article 11 of the WFD and the criteria of Decision 2011/753/EU. As of the last edition (2022), however, the new criteria are applied, which no longer provide for the possibility of selecting a calculation option, i.e. choosing which waste types to apply the target measurement to. The new criteria laid down in Article 11a of the Implementing Decision 2019/1004/EU are applied.
The new targets and the related calculation rules were implemented in national legislation by Legislative Decree No. 116/2020.
With regard to the calculation methods, it is worth mentioning that some fractions (e.g. multi-material waste collection, construction and demolition waste), which were previously included in the calculation of separate collection, can no longer contribute to the recycling targets set by Directive 2008/98/EC.

In this section, provisional calculations of the recycling rate on a national basis, conducted through an application-oriented approach to the new calculation methodologies, are reported.
In order to gather more information on the quantities of waste entering final recycling operations, specific changes were made to the Environmental Declaration Form (MUD) through the introduction of a specific 'recycling' section. This information was used in the application of the new calculation method. In addition, in accordance with the provisions of the framework directive, the recycling data for some waste streams were compared with information on the quantities of secondary raw materials produced, again using the MUD databases, starting from the collected waste quotas.
In the case of the bio-waste, the recycled quantities were determined using the input values to the composting and/or anaerobic digestion plants, net of the waste from the treatment processes, as per the guidance provided by the Implementing Decision and the Eurostat implementation guidelines. The quantities of bio-waste recycled included the shares declared by the municipalities as going to domestic composting, in accordance with regulatory requirements.
In addition, the (residual) quantities from the mechanical biological treatment processes of mixed municipal waste subjected to recycling treatments were also counted as recycled.
Taking into account the fact that European legislation excludes construction and demolition waste from the calculation of municipal waste (although national legislation includes some types of such waste in the calculation of separate collection), the recycling percentage has been calculated net of inert waste.
More in detail, the total generation of municipal waste is determined by ISPRA through the 'Guidelines for calculating the percentage of separate collection of municipal waste' contained in the Ministerial Decree of 26 May 2016. The latter, starting from 2016, has included some construction and demolition waste (LoW codes

170107 and 170904) in the separate collection, limited to the portions coming from small demolition works carried out directly by the tenant of the house. This waste amounted to approximately 364,000 tonnes in 2021, 1.9% of the national separate collection and 1.2% of the total generation.
The accounting methods identified by the decree differ, for this type of waste, from the definition of municipal waste given by Directive 2008/98/EC, as amended by Directive 2018/851/EU, and transposed into national law by Legislative Decree No. 116/2020. According to this definition, C&D waste is totally excluded from municipal waste and hence cannot be counted in the recycling targets. Therefore, for the purpose of calculating the recycling rate, this waste was excluded from the count.
According to the estimates made by ISPRA from the databases at its disposal, municipal waste shows the composition displayed in Table 3.1. The percentages in the table represent average values, calculated for the period 2009-2021 by combining data on the composition of mixed municipal waste, from waste analyses available to ISPRA, with data on the separate collection of the various fractions.

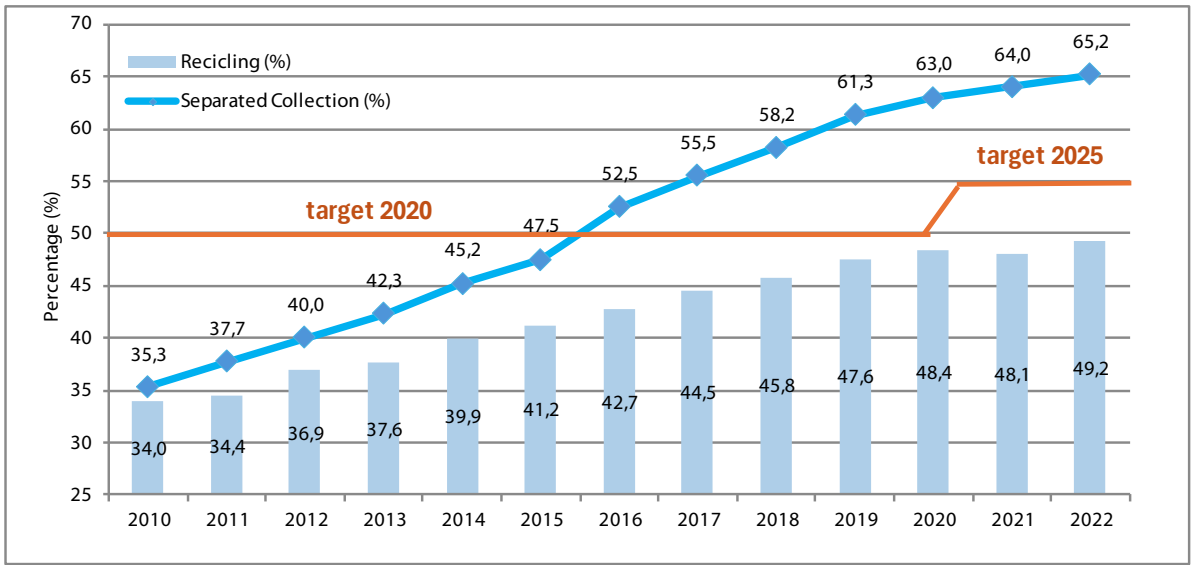
Bio-waste (biodegradable waste from kitchens and canteens and from garden and park maintenance) accounts for almost 35% of the waste produced annually nationwide . Paper and cardboard account for just under 22%, while plastics account for just under 13%.
In 2022, the rate of preparation for re-use and recycling, calculated according to the methodological approach described, stands at 49.2%, 1.1 percentage points higher than 2021. (Figure 3.4).

Table3.1 – Municipal waste composition estimated by ISPRA (average 2009 – 2021*)

Fractions	North	Centre	South	Italy
	(%)			
Bio-waste (biodegradable kitchen and canteen wastes + garden and park wastes)	34,0	30,2	38,8	34,7
Paper and cardboard	21,4	24,3	20,6	21,8
Plastics	11,8	14,5	13,0	12,7
Metals	2,4	2,5	2,3	2,4
Glass	9,5	6,7	7,2	8,2
Wood	4,8	2,8	1,9	3,5
WEEE	-	-	-	1,0
Clothes/Textiles	-	-	-	4,4
C&D materials/street-cleaning residues	-	-	-	0,7
separate collection of selected waste	-	-	-	0,3
Diapers/absorbent materials	-	-	-	4,7
Other	-	-	-	5,6
			Total	**100,0**

**last year for which waste analysis data is available - Source: ISPRA estimates*

Figure 3.4 - Recycling rates of municipal waste (net of C&D waste quantities from separate collection), years 2010 - 2022

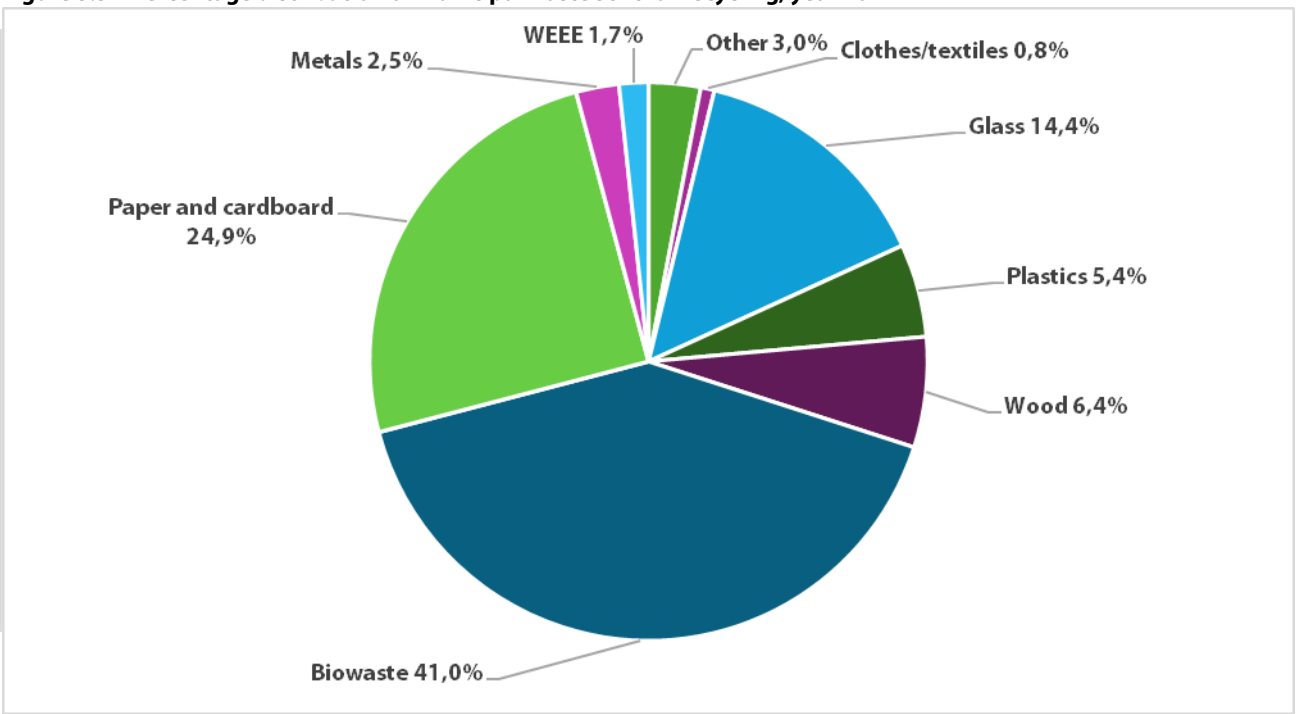


Source: ISPRA

In recent years, there has been a progressive widening of the gap between the percentage of separate collection and the recycling rates, proof of the fact that collection, while being a step of primary importance to ensure that homogeneous flows are obtained, cannot represent the only element to achieve high recycling levels as it is necessary to ensure that the quantities collected are also characterised by a high quality for effective recycling. The development of separate collections must also necessarily be accompanied by the availability of an adequate management plant system.

The percentage breakdown of the quantities sent for recycling by product fraction (Figure 3.5) shows that bio-waste accounted for 41% (slightly down from 42.3% in 2021) and paper and cardboard for 24.9% (24,2% in 2021). Glass represented 14.4% of the total recycled, wood 6,4% and plastic 5.4% (5,5% in 2021 and 4.6% in 2020).

Figure 3.5 – Percentage distribution of municipal waste sent for recycling, year 2022



Source: ISPRA

3.2 Biological treatment of *bio-waste*

Organic waste is a key stream for achieving the municipal waste recovery and recycling targets set by current legislation. It is therefore essential, on the one hand, to intercept increasing quantities through the efficiency of separate waste collection, so as to reduce as far as possible the quantities destined for disposal in landfills and, on the other, to have a plant system adequately distributed in all areas of the country, providing for the installation of new plants or the modernisation, where possible, of pre-existing infrastructures so as to limit their movement and reduce their negative impact on the environment.
The National Recovery and Resilience Programme (PNRR) has introduced specific investments aimed at improving the capacity for efficient and sustainable waste management through an improvement of the network of separate collection of municipal waste, the construction of new treatment/recycling plants for organic waste and other material fractions, and the construction of innovative plants for particular flows. The proposed investments aim to close the waste management gaps in terms of plant capacity and quality standards that exist between the different regions and areas of the country, with the objective of catching up with the objectives set by European and national legislation.
The enabling reforms of the PNRR include the National Waste Management Programme (PNGR) and the National Strategy for the Circular Economy. In particular, the PNGR identifies among the strategic flows precisely the management of organic waste. Intercepting, through separate collection, and sending for recovery as much of the biodegradable organic fraction as possible not only reduces the amount of waste sent for disposal and achieves the best recovery and recycling performance, but also reduces methane emissions from landfills.

The growing demand for the treatment of biodegradable municipal waste, determined by the progressive increase of separate collection over the years, has favoured a considerable development of the biological treatment sector, which has also evolved by adopting innovative plant technologies.
Alongside the traditional aerobic treatment systems, aimed at producing agricultural soil improvers, the national plant system, also through the reconversion of existing plants, has over the years equipped itself with integrated systems that combine aerobic treatment with anaerobic digestion. This type of plants allows for the combination of material and energy recovery, the containment of emissions and the usage of generated and purified biogas for the production of energy and biomethane.
The focus on this type of treatment is particularly relevant in 2022, year characterised by the closure of 8 composting plants, and the commissioning of 9 new integrated treatment plants (of which 4 for reconversion from aerobic treatment and 1 for anaerobic digestion completed with the aerobic treatment section) and 1 plant for anaerobic digestion only. This results in a further increase in the treatment capacity of the entire sector from about 11.2 million tonnes in the year 2021 to about 12 million tonnes.

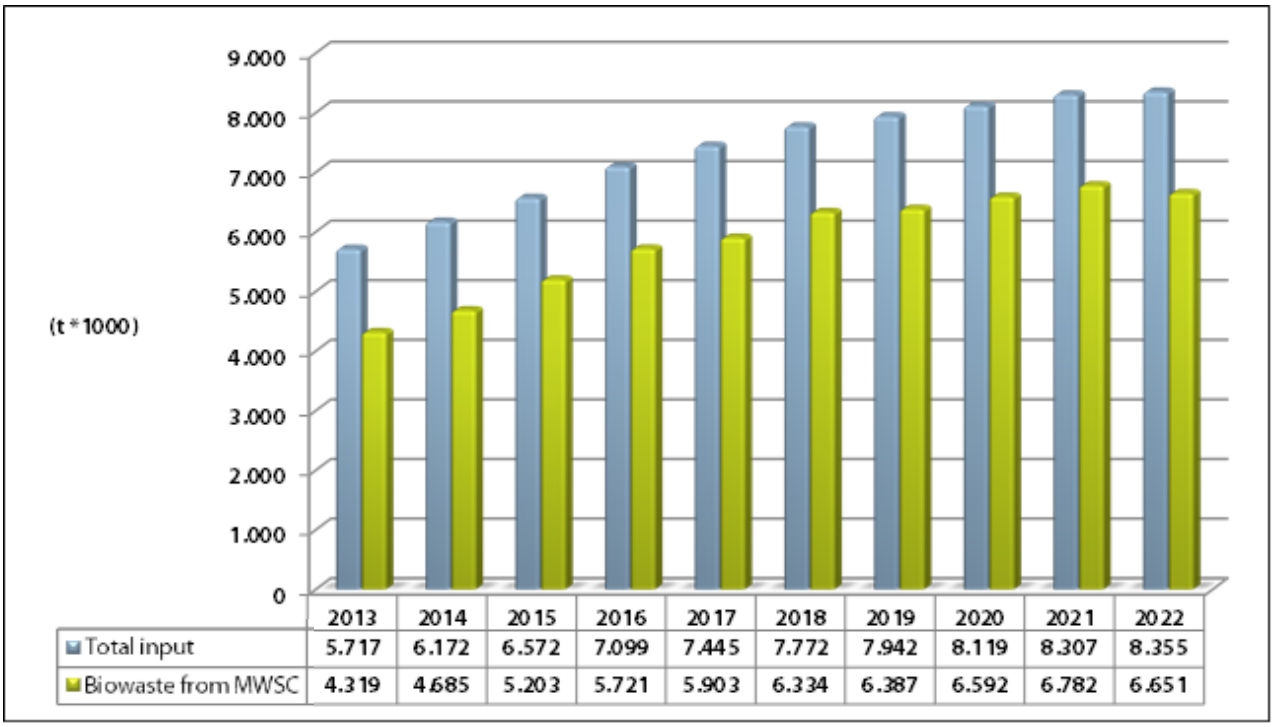
In the year 2022, the whole system consists of 358 operating plants, and, in particular:
- 285 plants dedicated to aerobic treatment only (composting);
- 51anaerobic/aerobic integrated treatment plants;
- 22 anaerobic digestion plants.

Figure 3.2.1 shows the trend in the quantities of waste managed in the period from 2013 to 2022, with details of the bio-waste fraction from separate collection. Data analisys shows a progressive growth in the sector, both in terms of the total quantities treated (+46.1% between 2013 and 2022) and in terms of the quantities of bio-waste, which increased by 54% over the same period.

The total amount of waste recovered through biological treatment processes (8.4 million tonnes) shows an increase of 47,000 tonnes (+ 0,6%) compared to 2021.

The share of bio-waste, in particular, goes from 6.8 million tonnes to about 6.7 million tonnes (79.6% of the total treated), showing a decrease of about 132 thousand tonnes (-1.9%) determined, essentially, by the lower contribution of biodegradable waste from garden and park maintenance (LoW code 200201) which, presumably, is not entirely destined for the production of soil improvers but, in part, is sent to other types of management such as, for example, shredding and reduction to pellets or the production of combustible biomass. Compared to 2021, the quantity of this fraction decreases by more than 138 thousand tonnes (-7.8%). The amount of waste from markets (LoW code 200302) also decreases by more than 4 thousand tonnes (-9.9%), while the trend for biodegradable waste from kitchens and canteens (LoW code 200108) is stable, with a moderate growth of 10 thousand tonnes (+0.2%).

Figura 3.2.1 - Quantities of waste undergoing biological treatment, years 2012 - 2022

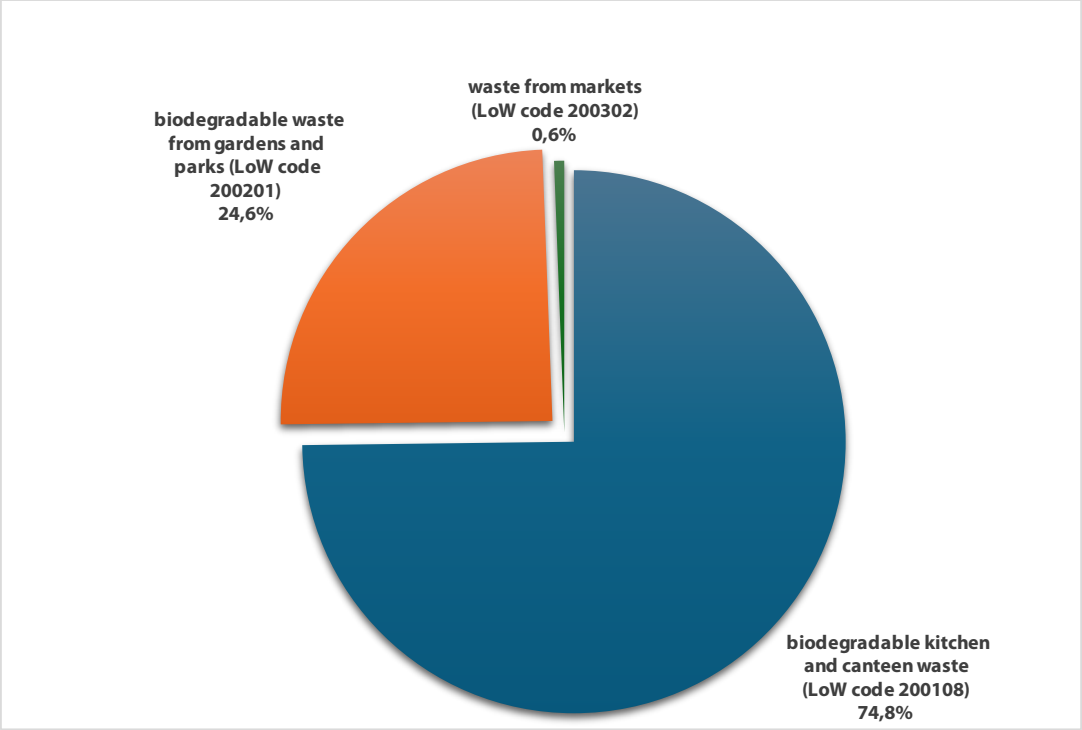


	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total input	5.717	6.172	6.572	7.099	7.445	7.772	7.942	8.119	8.307	8.355
Biowaste from MWSC	4.319	4.685	5.203	5.721	5.903	6.334	6.387	6.592	6.782	6.651

Source: ISPRA

Bio-waste from separate collection, treated in 2022 mainly consisted of 'biodegradable kitchen and canteen waste' (LoW code 200108) with about 5 million tonnes, or 74.8% of the total. The 'biodegradable waste from gardens and parks' (LoW code 200201), with about 1.6 million tonnes, accounted for 24,6% of the total, while 'waste from markets' (LoW code 200302), with more than 38 thousand tonnes, accounts for the residual share of 0.6% (Figure 3.2.2).

Figura 3.2.2 – Composition of the bio-waste fraction from separate collection undergoing biological treatment, year 2022

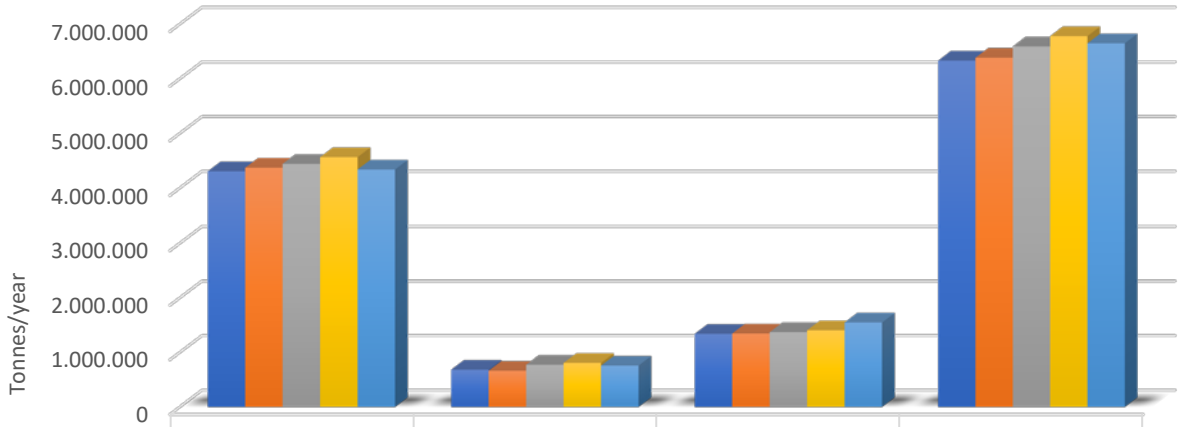


Source: ISPRA

The trend in the quantities of treated organic waste, at the level of geographical macro-area (Figure 3.2.3), confirms a growing pattern in the southern regions.

Between 2021 and 2022, this area of the country shows a further increase of about 144 thousand tonnes, corresponding to 10.2%. The trend in the northern regions is different, with a reduction of about 227 thousand tonnes, (-5%) and a change in the way organic waste is managed, with a reduction in composting and a greater number of integrated treatment and anaerobic digestion plants. More contained, but higher in percentage terms, is the reduction in the central regions (- 49 thousand tonnes, or 6.1%), which are also characterised by a lower number of composting plants and a consequent ncrease in integrated treatment and anaerobic digestion.

Figure 3.2.3 – Treatment of the bio-waste from separate collection, by geographical macro-area, years 2018 - 2022

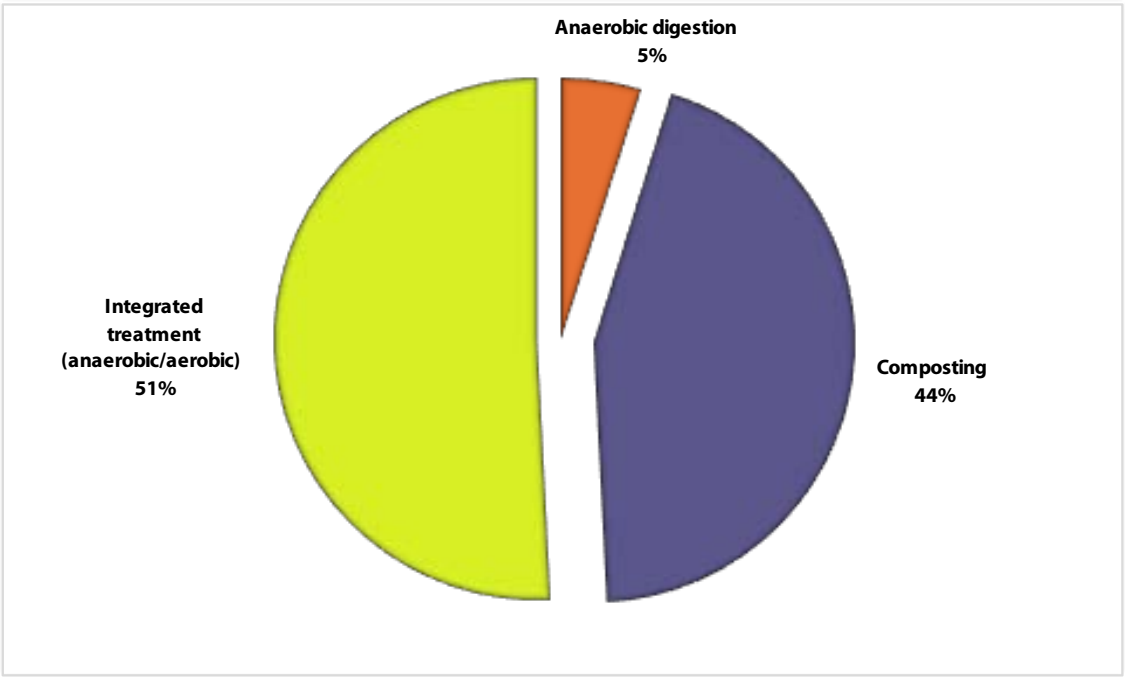


	North	Centre	South	Total
2018	4.307.632	684.698	1.341.445	6.333.775
2019	4.373.568	665.968	1.347.734	6.387.270
2020	4.444.511	775.920	1.371.967	6.592.398
2021	4.567.484	808.722	1.406.127	6.782.333
2022	4.340.765	759.524	1.550.003	6.650.292

Source: ISPRA

Figure 3.2.4 shows the percentage distribution of the different types of biological treatment of bio-waste adopted at national level. Data analysis shows that, in the 2022, the recovery of these fractions is predominantly carried out in integrated treatment plants (anaerobic/aerobic), with a managed quantity of about 3.4 million tonnes. These plants contribute 50.8% to the treatment of organic waste, an increase of 3.2 percentage points compared to 2021, while the composting sector, with a quantity of about 3 million tonnes, contributes 44.4%. The remaining 4.8%, just over 315,000 tonnes, is managed in anaerobic digestion plants.

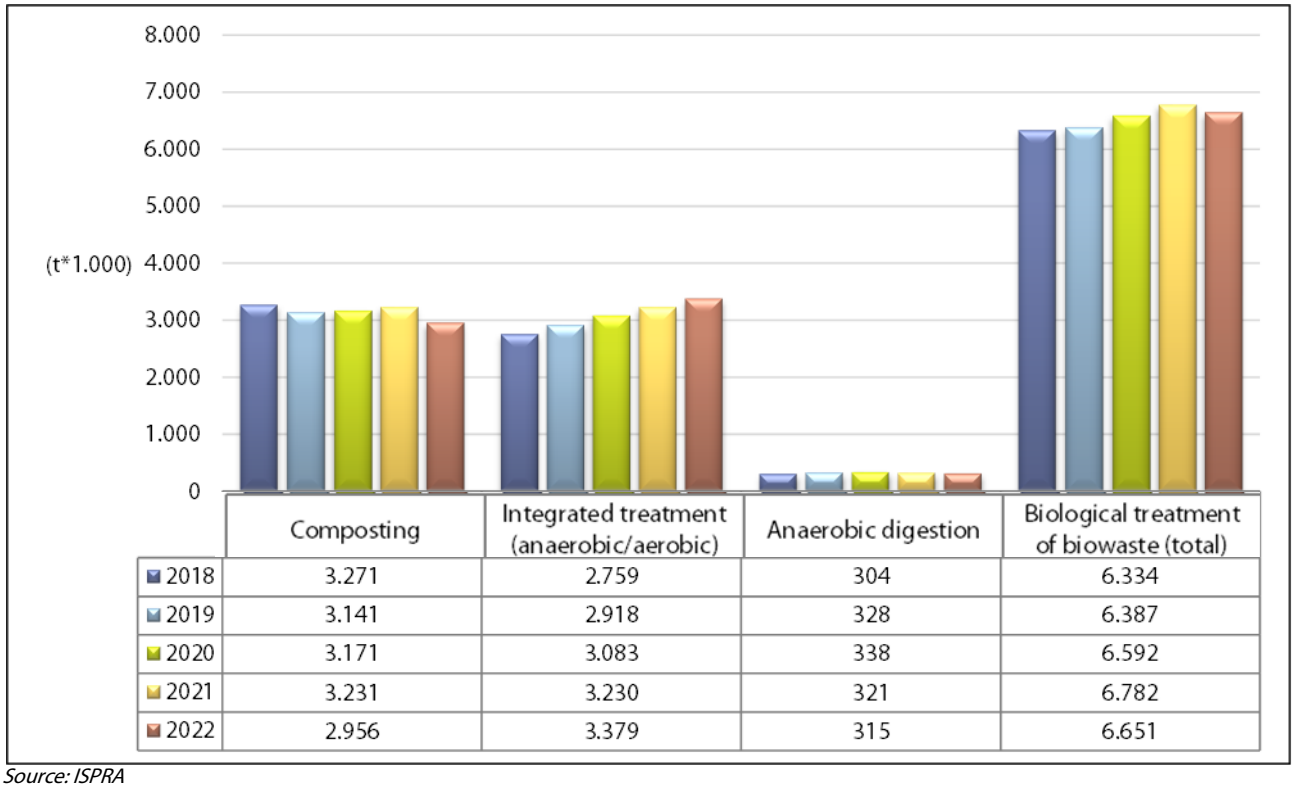
Figure 3.2.4 – Biological treatment of the bio-waste fraction from separate waste collection, year 2022



Source: ISPRA

Figure 3.2.5 shows the trend of the quantities subjected to the different types of management in the period from 2018 to 2022.
It is noticeable how integrated treatment is characterised by a constant growth that, between 2021 and 2022, stands at 149 thousand tonnes, or 4.6% (+ 22.5% compared to 2018). Composting, however, with an decrease of 275 thousand tonnes, corresponding to -8.5% shows a loss of 9.6% in the treatment of bio-waste, compared to 2018.
Anaerobic digestion, on the other hand, shows a decrease of 6 thousand tonnes, (-1.9%), compared to 2021, while the trend compared to 2018 remains positive (+ 3.7%).
The analysis of the data shows how the combination of anaerobic and aerobic processes, proves decisive in increasing the quantities of bio-waste recovered thanks to the possibility of producing, on the one hand, quality soil improvers that comply with the characteristics required by the regulations on fertilisers to be used in agriculture, and, on the other, of using the biogas generated directly for the cogeneration of electricity and heat, and/or further purified, for the production of biomethane for automotive use and other uses instead of natural gas.
In fact, data for the year 2022 showed a growing interest in the biogas purification technology; there are 23 integrated treatment plants dedicated to biomethane production (13 in 2021). In the North of the country, most of the regions have a plant of this type (Piedmont (TO), Lombardy (BG), Trentino-Alto Adige (TN), Veneto (PD), Friuli-Venezia Giulia (PN) and Liguria (SV)); while 3 are located in Emilia-Romagna, in the provinces of Piacenza, Modena and Bologna. In the Centre, there are two operating plants, one in Umbria (PG) and one in Lazio (RM); while in the South, a new plant has been operating in Sicily (CL) since November 2021 and one in Calabria (CS) since 2022.
Other plants are expected to start up, either newly built or from conversion of aerobic treatment to an integrated one.

Figure 3.2.5 – Biological treatment of the bio-waste fraction from separate collection, by type of management, years 2018 – 2022

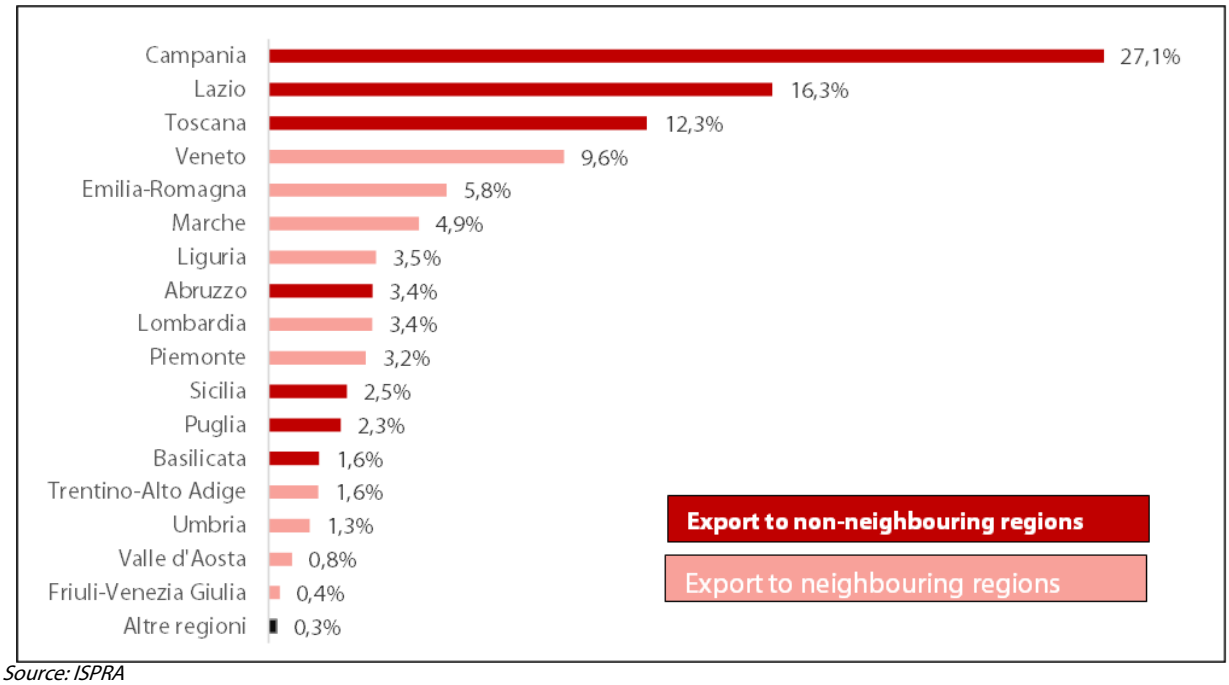


	Composting	Integrated treatment (anaerobic/aerobic)	Anaerobic digestion	Biological treatment of biowaste (total)
2018	3.271	2.759	304	6.334
2019	3.141	2.918	328	6.387
2020	3.171	3.083	338	6.592
2021	3.231	3.230	321	6.782
2022	2.956	3.379	315	6.651

Source: ISPRA

Structural inadequacies in some regions have resulted in waste being moved to plants located outside the territory where it is produced, in regions that are often far away. Analysing the bio-waste flows sent out of the region, it can be seen that the largest quantities come from Campania (480 thousand tonnes. 27.1% of the total), Lazio (290 thousand tonnes, 16.3%) and Tuscany (over 218 thousand tonnes, 12.3%) regions with somewhat obsolete infrastructure and inadequate treatment capacity to handle their organic waste. (Figure 3.2.6).

Figura 3.2.6 - Transfer of the bio-waste from separate collection, in non-regional territories, by region, year 2022

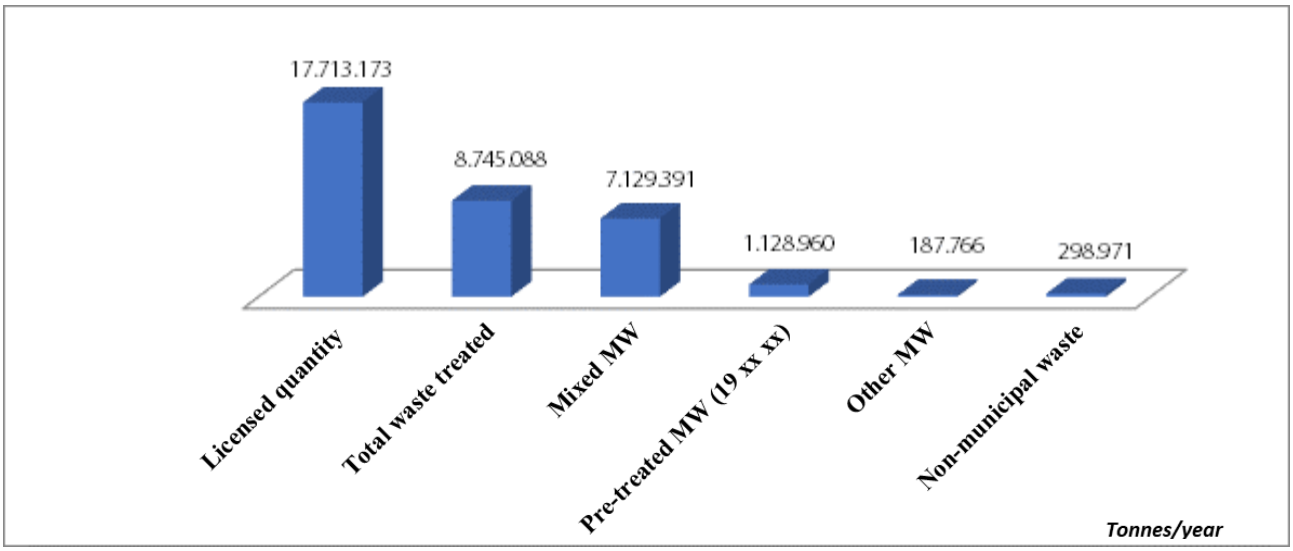


Source: ISPRA

3.3 Aerobic mechanical-biological treatment

In 2022, the amount of waste sent for mechanical biological treatment (MBT) or simply mechanical treatment (MT) were almost 8.7 million tonnes (Figure 3.3.1). Of the waste treated, 81.5% is mixed municipal waste (7.1 million tonnes), 12.1% is waste arising from the treatment of municipal waste (1.3 million tonnes), 2.1% (almost 233 thousand tonnes) are other fractions of municipal waste (paper, plastic, metal, wood, glass and bio-waste fractions from separate collection) and, lastly, 3.4% (300 thousand tonnes) are waste from industrial sectors (agro-industry, wood processing, etc.) and from the treatment of other waste (LoW 1912**).

Figure 3.3.1 - Quantity of waste entering MBT/MT plants (tonnes), year 2022

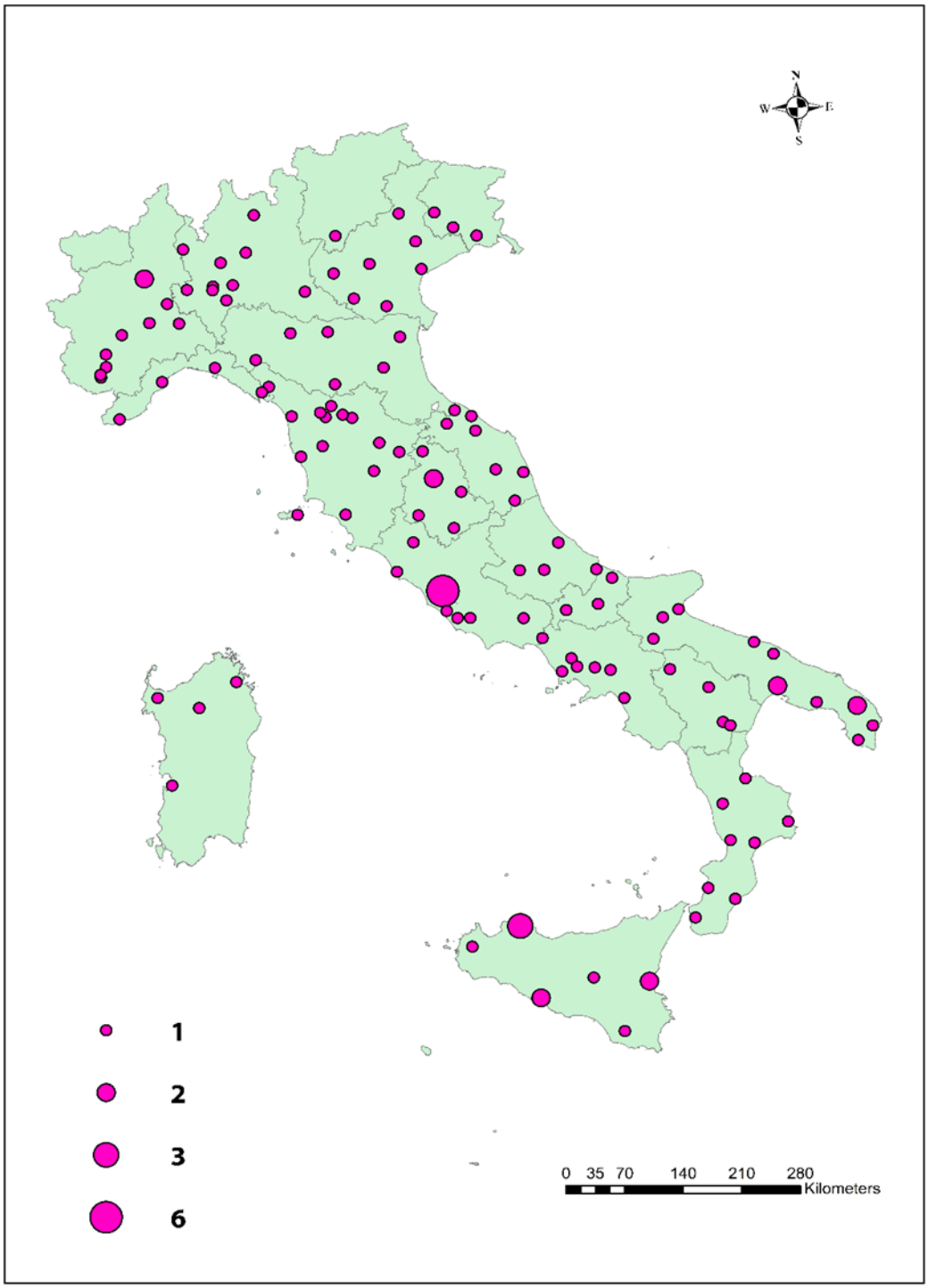


Source: ISPRA

In 2022, there were 132 plants operating in Italy; including 36 plants that only perform mechanical treatment of mixed municipal waste and some MBT plants that did not perform the biostabilisation process of the bio-waste fraction in the year under review. Overall, the Italian plant system is authorised to treat 17.7 million tonnes of waste.

Figure 3.3.2 shows the regional distribution of plants; specifically, there are 41 plants in the North (including 17MTs), 40 plants in the Centre (14 MTs) and 51in the South (5 MTs).

Figure 3.3.2 – Regional distribution of MBT/MT plants, year 2022



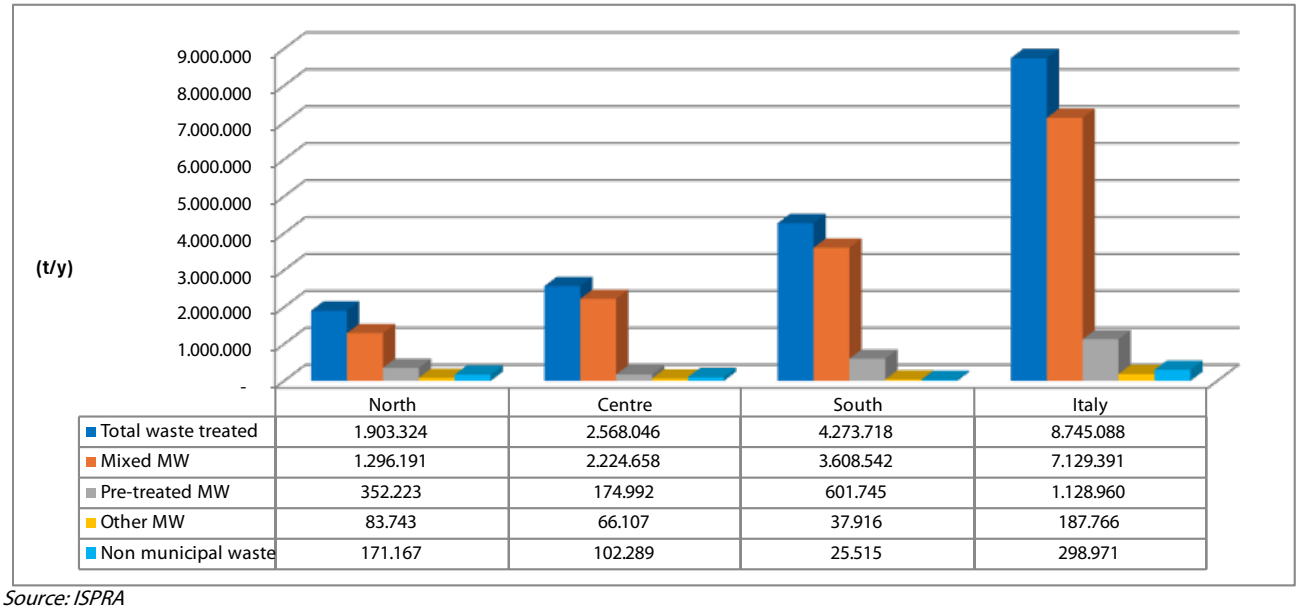
Source: ISPRA

In the North, just over 1.9 million tonnes of municipal waste were treated, of which more than 1.3 million tonnes were mixed municipal waste (68.1% of the total), the rest being pre-treated municipal waste (352 thousand tonnes, 18.5%), fractions from separate collection (almost 84 thousand tonnes, 5.5%) and waste from economic activities (almost 171 thousand tonnes, 9%).

In the Centre, were treated more than 2.6 million tonnes, of which almost 2.2 million tonnes were mixed municipal waste, 86.6% of the total. The remaining part consisted of pre-treated municipal waste (almost 175thousand tonnes, 7.5% of the total), fractions from separate collection (over 66 thousand tonnes, 2.7%) and waste from economic activities (over 102 thousand tonnes, 4%).

The South is the macro-area that sends the largest amount of waste to such intermediate treatment, and the waste treated amounted to almost 4.3 million tonnes, of which 3.8 million tonnes were mixed municipal waste (84.4% of the total). The remaining part consisted of pre-treated municipal waste (almost 601 thousand tonnes, 14% of the total), fractions from separate collection (over 38 thousand tonnes, 0.9%) and waste from economic activities (25 thousand tonnes, 0.6%) (Figure 3.3.3).

Figure 3.3.3 – Types of waste treated in MBT/MT plants, by geographical macro-area (tonnes), year 2022



	North	Centre	South	Italy
Total waste treated	1.903.324	2.568.046	4.273.718	8.745.088
Mixed MW	1.296.191	2.224.658	3.608.542	7.129.391
Pre-treated MW	352.223	174.992	601.745	1.128.960
Other MW	83.743	66.107	37.916	187.766
Non municipal waste	171.167	102.289	25.515	298.971

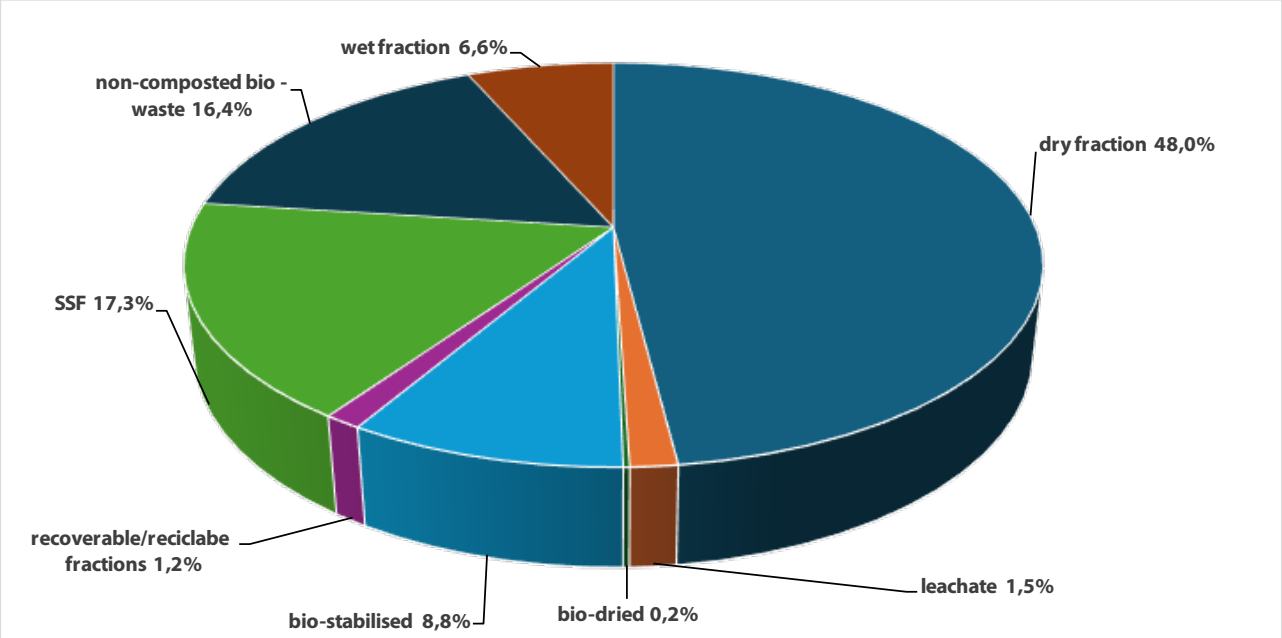
Source: ISPRA

The quantities treated in the examined plants decreased by almost 547 thousand tonnes (-5.9%) compared to 2021, due to a decrease in quantities of both mixed municipal waste and waste resulting from its treatment.

In detail, the quantities of mixed municipal waste subjected to mechanical biological treatment/mechanical treatment decreased by 5.2% (over 388 thousand tonnes). Similarly, pre-treated waste decreased by 14% (almost 180 thousand tonnes), while other municipal waste fractions decrease by 19% (about 45 thousand tonnes). An increase of 22%, or about 67 thousand tonnes, is observed for waste from economic activities. The reduction in the quantities of treated waste involved all geographical areas. The most significant reduction was recorded in the North where treated waste decreased by 7.6% compared to 2021 (over 164 thousand tonnes). The South is second with a decrease of more than 317 thousand tonnes of waste, (-6.9%), and, finally, the Centre with 74 thousand tonnes, (-2.8%).
Figure 3.3.4 shows detailed information on waste generated by MBT and MT plants and destined for other forms of treatment.
With reference to LoW code 191212, it is necessary to specify that plant operators use this code to identify the dry fraction, but also waste from waste treatment and sometimes the wet fraction. Therefore, where plant operators have provided detailed data, through a specific questionnaire prepared and administered by ISPRA, it has been possible to distinguish the different fractions. On the other hand, where no such distinction could be made, LoW code 191212 was identified as the dry fraction.
The waste produced by the mechanical biological and mechanical treatment plants in the year 2022 was approximately 8.1 million tonnes and consisted of:
- dry fraction : over 3.8 million tonnes (48% of the total waste produced);
- combustible waste (RDF/SSF): almost 1.4 million tonnes (17.3%);
- non-composted bio-waste: about 1.3 million tonnes (16.4%);
- bio-stabilised waste: over 696,000 tonnes (8.8%);
- bio-dried waste : almost 14.6 thousand tonnes (0.2%);

- recoverable/recyclable fractions sent to recovery operations, including recycling, such as paper, plastic, metals, wood, glass: almost 97 thousand tonnes (1.2%).
- wet fraction: 520 thousand tonnes (6.6%);
- leachate: 121 thousand tonnes (1.5%).

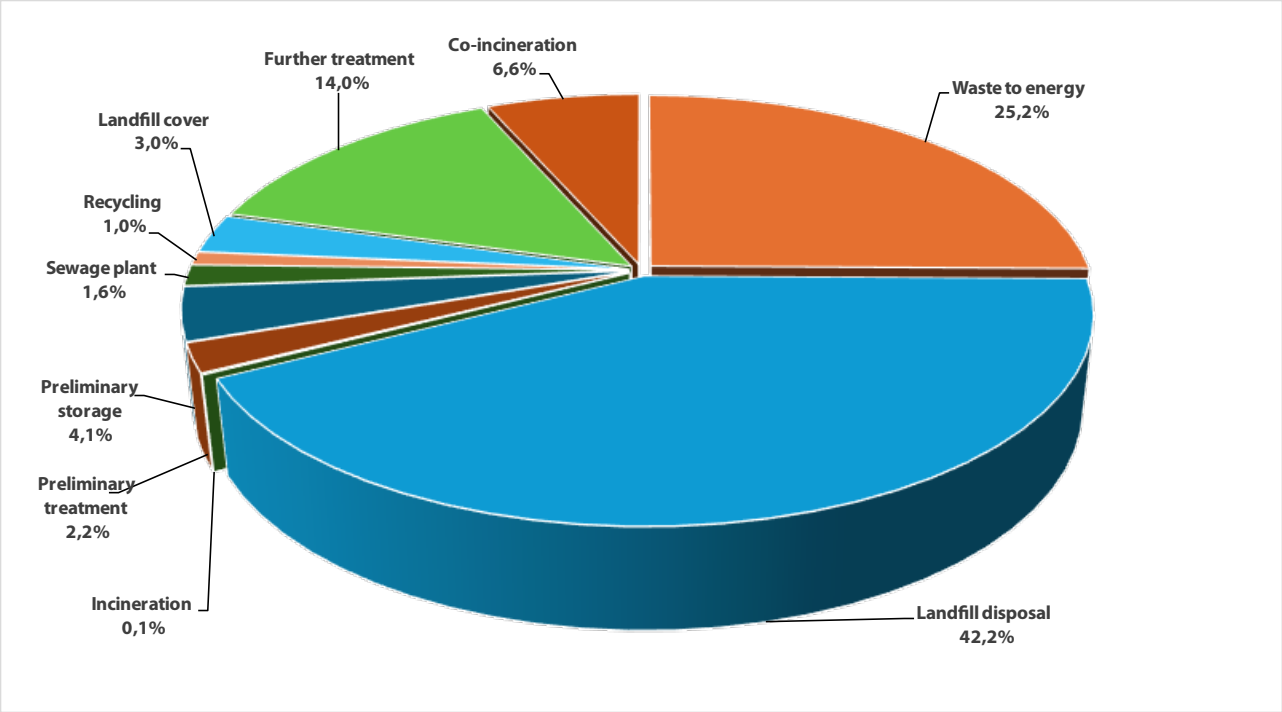
Figure 3.3.4 – Percentage distribution of waste/material produced in MBT/MT plants, year 2022



Source: ISPRA

Figure 3.3.5 shows to which management operations the waste generated by mechanical biological and mechanical treatment is destined for, in the year 2022. The portion destined for "further treatment" includes quantities sent to biostabilisation and RDF production/refining operations carried out at other similar plants. The quantities of waste destined for "preliminary treatment", on the other hand, are those sent to management plants authorised to waste exchange in order to subject them to one of the operations indicated from R1 to R11 (R12).
Similar to the year 2021, fractions such as paper and cardboard, plastic and rubber, metals, glass, wood, etc. were included in the recovery/recycling operations. However, the same fractions destined for the pre-treatment operation (R12) were not included in recycling.

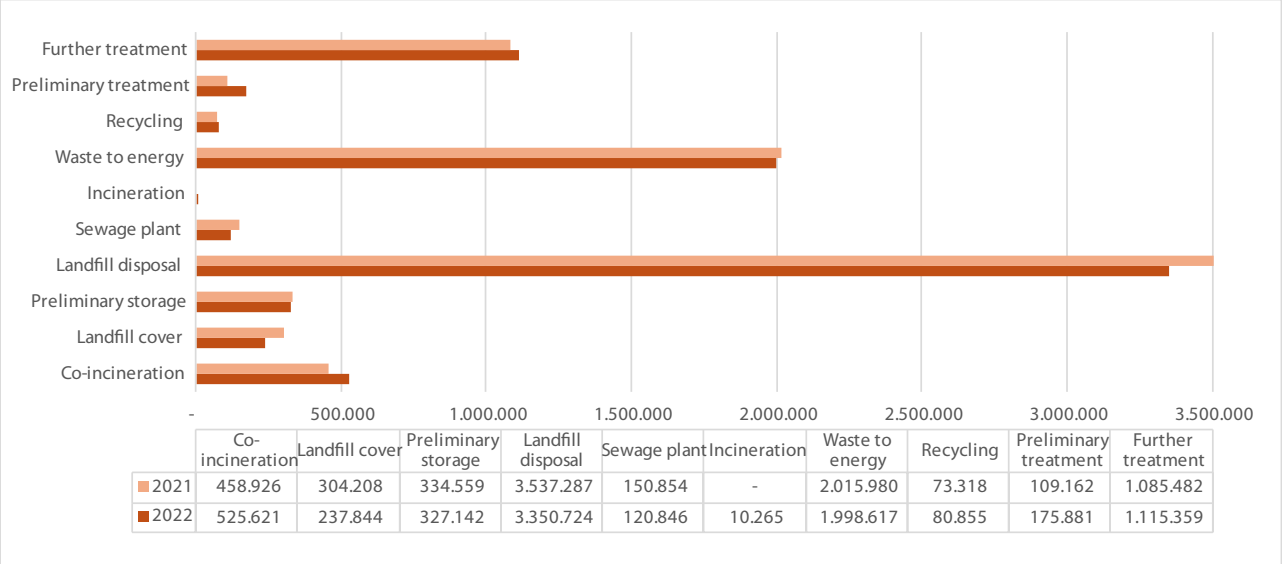
Figura 3.3.5 – Management operations for waste generated by MBT/MT plants, year 2022



Source: ISPRA

Analysis shows that 42.2% of the total waste generated, corresponding to more than 3.3 million tonnes, is disposed of in landfills. These are, mainly, dry fraction (more than 2 million tonnes), non-composted organic fraction (almost 830 thousand tonnes), biostabilized (more than 362 thousand tonnes).
Compared to 2021 (Figure 3.3.6), there is a decrease of more than 186 thousand tonnes in the amount sent to landfill, or -5.3%.
About 2 million tonnes of waste (25.2% of the total amount produced) are sent to incineration plants with energy recovery, consisting, mainly, of dry fraction (1 million tonnes), RDF/SSF (nearly 706 thousand tonnes) and non-composted organic fraction (over 147 thousand tonnes). Compared to 2021, the amount of waste sent to incineration with energy recovery shows a decrease of 17 thousand tonnes or 0.9%.
On the other hand, 14%, more than 1 million tonnes, is destined for further treatment, i.e. biostabilization and RDF/SSF production/refinery processes. Compared to 2021, there is an increase of 2.7% in this form of intermediate treatment.
About 526 thousand tonnes of waste, or 6.6 %of the total produced, are sent to co-incineration at production plants (cement plants, power generation and wood processing). This waste consists of RDF/SSF (about 342 thousand tonnes), dry fraction (116 thousand tonnes) and non-composted organic fraction (over 29 thousand tonnes). Comparison with 2021 shows an increase of 14.5% (about 67 thousand tonnes).
238 thousand tonnes of waste (3% of the total) were destined for landfill coverage and consisted mostly of bio-stabilised (164 thousand tonnes) and non-composted organic fraction (more than 73 thousand tonnes). Compared to 2021 (Figure 3.2.10), the amount of waste destined for landfill coverage shows a reduction of 21.8%.
Lastly, the quantities destined for recycling are about 81 thousand tonnes (1% of the total produced) with an increase of more than 7 thousand tonnes compared to 2021. Nearly 176 thousand tonnes of waste (2.2%) are allocated to pre-treatment operations, and finally, more than 327 thousand tonnes of waste (4.1%) are delivered to storage/preliminary storage.

Figure 3.3.6 – Management operations on waste generated by MBT/MT plants, years 2021 – 2022



	Co-incineration	Landfill cover	Preliminary storage	Landfill disposal	Sewage plant	Incineration	Waste to energy	Recycling	Preliminary treatment	Further treatment
2021	458.926	304.208	334.559	3.537.287	150.854	-	2.015.980	73.318	109.162	1.085.482
2022	525.621	237.844	327.142	3.350.724	120.846	10.265	1.998.617	80.855	175.881	1.115.359

Source: ISPRA

3.4 Municipal waste incineration

There are 36 incineration plants operating in 2022 on the national territory and they treat municipal waste and waste resulting from the treatment of municipal waste such as combustible waste (RDF), dry fraction and bio-dried waste. The number of plants is reduced by one compared to the last survey due to the closure of the plant in Sesto San Giovanni (MI).

The plants are mainly located in the northern regions (25 plants); Lombardy and Emilia-Romagna have 12 and 7 operational plants, respectively, which, in 2022, treated a total of approximately 1.9 million tonnes of municipal waste accounting for 49.4% of the waste incinerated in the North and 35.3% of the national total.

In the Centre and the South are operational, respectively 5 and 6 plants (Figure 3.4.1 and Figure 3.4.2), which treated nearly 504 thousand tonnes and 1 million tonnes of municipal waste.

In 2022, incinerated municipal waste, including RDF, dry fraction and bio-dried waste, is 5.3 million tonnes (-1.9% compared to 2021; -4.7% compared to 2018). 71.4% of this waste is treated in the North, 9.5% in the Centre and 19.1% in the South (Table 3.4.2).

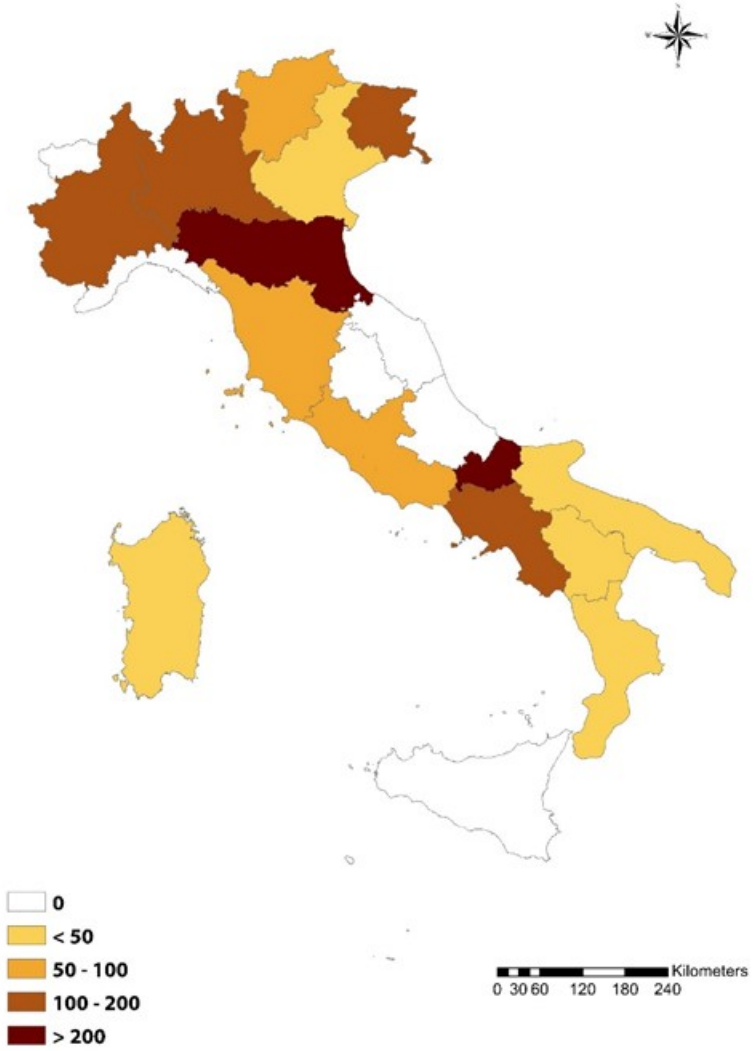
In 2022 a total of almost 102 thousand tonnes less than the previous year was incinerated; decreases are observed in the North (-2.1%) and in the Centre (-4.4%).

Out of the 5.3 million tonnes of waste sent for incineration, slightly more than half (about 2.7 million tonnes) is municipal waste as such (LoW code 20), while the remaining share (more than 2.6 million tonnes) is waste arising from the treatment of municipal waste (combustible waste, dry fraction and, to a lesser extent, bio-dried waste).

With regard to municipal waste, 96.3% (over 2.6 million tonnes) consists of mixed municipal waste (LoW code 200301), mainly incinerated in Lombardy (one million tonnes), Emilia-Romagna (629 thousand tonnes) and Piedmont (almost 452 thousand tonnes). In the same plants, a total of about 711 thousand tonnes of waste from economic activities is incinerated, of which about 65 thousand tonnes is hazardous waste, mainly hazardous medical waste (39 thousand tonnes).

Figure 3.4.1 – Geographical position of municipal waste incinerators, year 2022

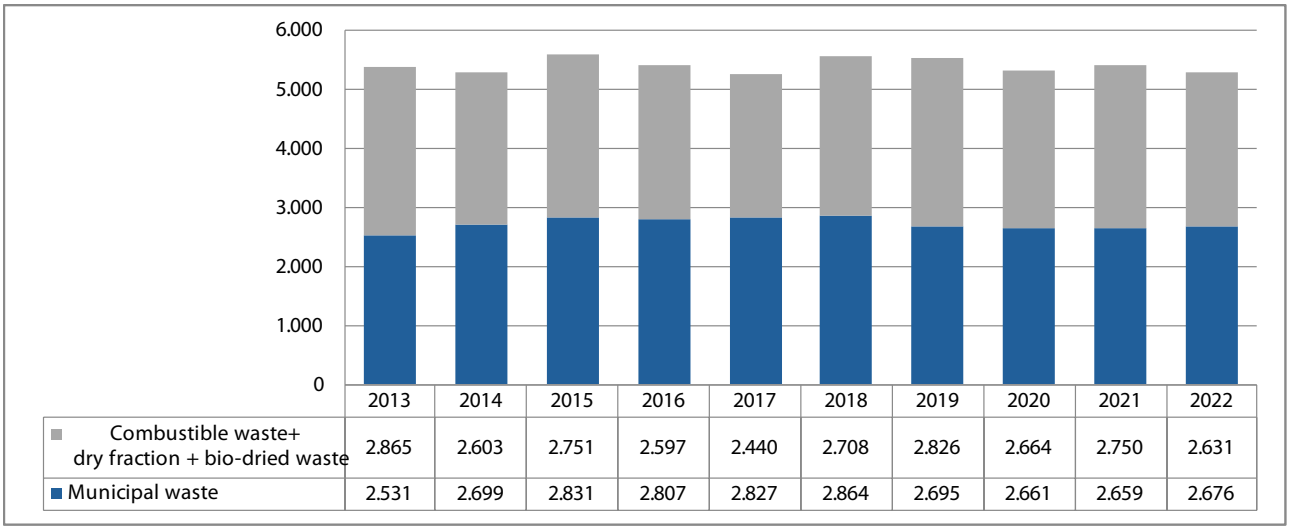
Figure 3.4.2 – Per capita amount of municipal waste incinerated, by region, 2022



Source: ISPRA

The quantities of waste incinerated in the period 2013-2022, shown in figure 3.4.3, are fairly stable over the decade and vary between approximately 5.2 and almost 5.6 million tonnes.

Figure 3.4.3 – Municipal waste incineration in Italy (1,000*tonnes), years 2013 – 2022



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Combustible waste+ dry fraction + bio-dried waste	2.865	2.603	2.751	2.597	2.440	2.708	2.826	2.664	2.750	2.631
Municipal waste	2.531	2.699	2.831	2.807	2.827	2.864	2.695	2.661	2.659	2.676

Source: ISPRA

The per capita incineration of municipal waste shows a decrease of 1.7%, from 91.71 kg/inhabitant in 2021 to 90.18 kg/inhabitant in 2022. Looking at the data for the last five years, a decrease in per capita incineration of 3.2% is similarly observed.

Table 3.4.1 shows 2022 data for electrical and thermal energy recovery, differentiating between plants in which a cogeneration cycle is present.

Table 3.4.1 – Energy recovery in incineration plants treating municipal waste, year 2022

	No. of plants	Total waste treated (t)	Energy recovery		Energy recovery per kg	
			Electrical (MWhe)	Thermal (MWht)	kWhe/kg	kWht/kg
RET&E plants	14	3.230.020	2.317.635	2.290.061	0,72	0,71
REE plants	22	2.788.599	2.187.647	0	0,78	-
Total	**36**	**6.018.619**	**4.505.282**	**2.290.061**	**0,75**	**0,38**

Legend - RET&E= plants with cogeneration cycle**; REE=** plants with electrical energy recovery only**.**

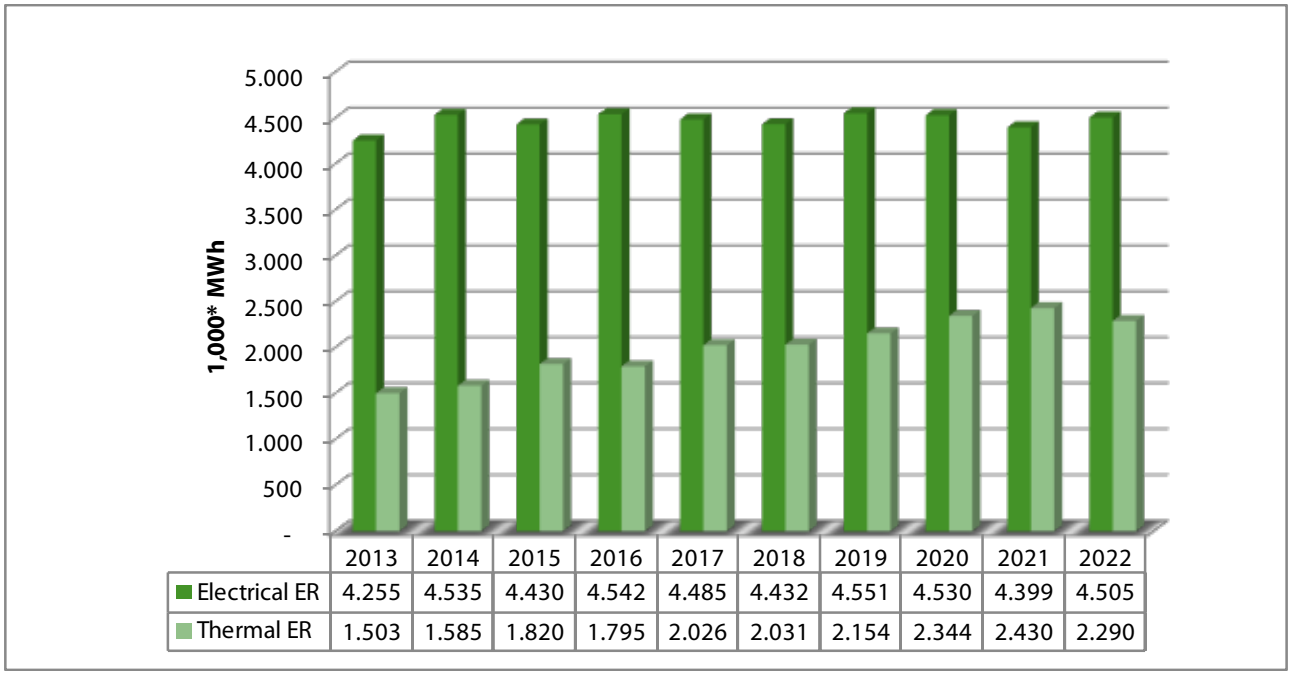
Source: ISPRA

Data analysis shows that all but one of the incineration plants in Italy recover energy. 22 plants treated about 2.8 million tonnes of waste and recovered almost 2.2 million MWh of electrical energy. 13 plants are equipped with cogeneration cycles and have incinerated over 3.2 million tonnes of waste, recovering over 2.3 million MWh of thermal energy and 2.2 million MWh of electrical energy. The recovery of electrical/thermal energy is attributable to the total amount of waste treated by the individual plants and it is not possible to distinguish the share of incineration of municipal waste alone.

Figure 3.4.4 shows the trend, over the 2013-2022 period, of the energy recovery carried out by incineration plants that process mainly municipal waste. In particular, it can be seen that the amount of electrical energy produced shows a progressive increase from about 4.2 million MWh in 2013 to 4.5 million MWh in 2022. Thermal

energy, generated exclusively by plants located in the North, increases from 1.5 million MWh in 2013 to about 2.3 million MWh in 2022.

Figure 3.4.4 – Energy recovery in incineration plants (1,000*MWh), years 2013- 2022



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Electrical ER	4.255	4.535	4.430	4.542	4.485	4.432	4.551	4.530	4.399	4.505
Thermal ER	1.503	1.585	1.820	1.795	2.026	2.031	2.154	2.344	2.430	2.290

Source: ISPRA

Co-incineration of municipal waste

In 2022, 334 thousand tonnes of municipal waste were used as an alternative to traditional fuels in 11 production plants. In particular, these plants are predominantly cement plants and electricity/thermal power plants.
The waste consisted almost exclusively of combustible waste (LoW code 191210) and/or dry fraction (DF - LoW code 191212) mainly produced in mechanical biological treatment plants.
The analysis of data at geographical macro-area shows that in the north of Italy, co-incinerated municipal waste amounted to 220 thousand tonnes (57.9 % of the total), in the South over 133 thousand tonnes (39,9%) and in the Centre about 7 thousand tonnes (2.2%) (Table 3.4.2).

Table 3.4.2 - Co-incineration of municipal waste, year 2022

Region	Province	Municipality	MW	Dry Fraction, RDF/SRF	Total MW	Other Non-hazardous Waste	Other Hazardous Waste	Total
Piemonte	CN	Robilante	-	60.931	60.931	167	-	61.098
Lombardia	BG	Calusco D'Adda	-	13.466	13.466	-	-	13.466
Lombardia	LO	Castiraga Vidardo	-	10.575	10.575	-	-	10.575
Lombardia	VA	Caravate	-	8.319	8.319	-	-	8.319
Lombardia	VA	Comabbio	-	28.708	28.708	33.905	-	62.613
Lombardia	MN	Sustinente	-	15.333	15.333	92.237	-	107.570
Emilia-Romagna	RA	Faenza	13.088	43.214	56.302	3.424	-	59.726
North			**13.088**	**180.546**	**193.634**	**129.733**	**-**	**193.634**
Toscana	AR	Castel Focognano	-	7.364	7.364	-	-	7.364
Centre			**-**	**7.364**	**7.364**	**-**	**-**	**7.364**
Molise	IS	Sesto Campano	-	15.969	15.969	-	-	15.969
Basilicata	PZ	Barile	-	18.548	18.548	1	-	18.549
Puglia	FG	Manfredonia	-	98.727	98.727	-	-	98.727
South			**-**	133.244	133.244	1	-	133.245
Total			**13.088**	**321.154**	**334.242**	**129.734**	**-**	**463.976**

Source: ISPRA

3.5 Landfilling of municipal waste

In 2022, nationwide, 117 landfills for non-hazardous and hazardous waste that received municipal waste were operational. Compared to 2021, the census showed a reduction in the number of facilities. In the North, in fact, the number of landfills decreases from 53 facilities in 2021 to 50 in 2022, in the Centre from 28 to 25, and in the South from 45 to 42. (Table 3.5.1).
Most landfills are located in the North where there are 50 facilities, 25 are located in the Centre and 42 in the South; thus, there is an uneven distribution across the country.

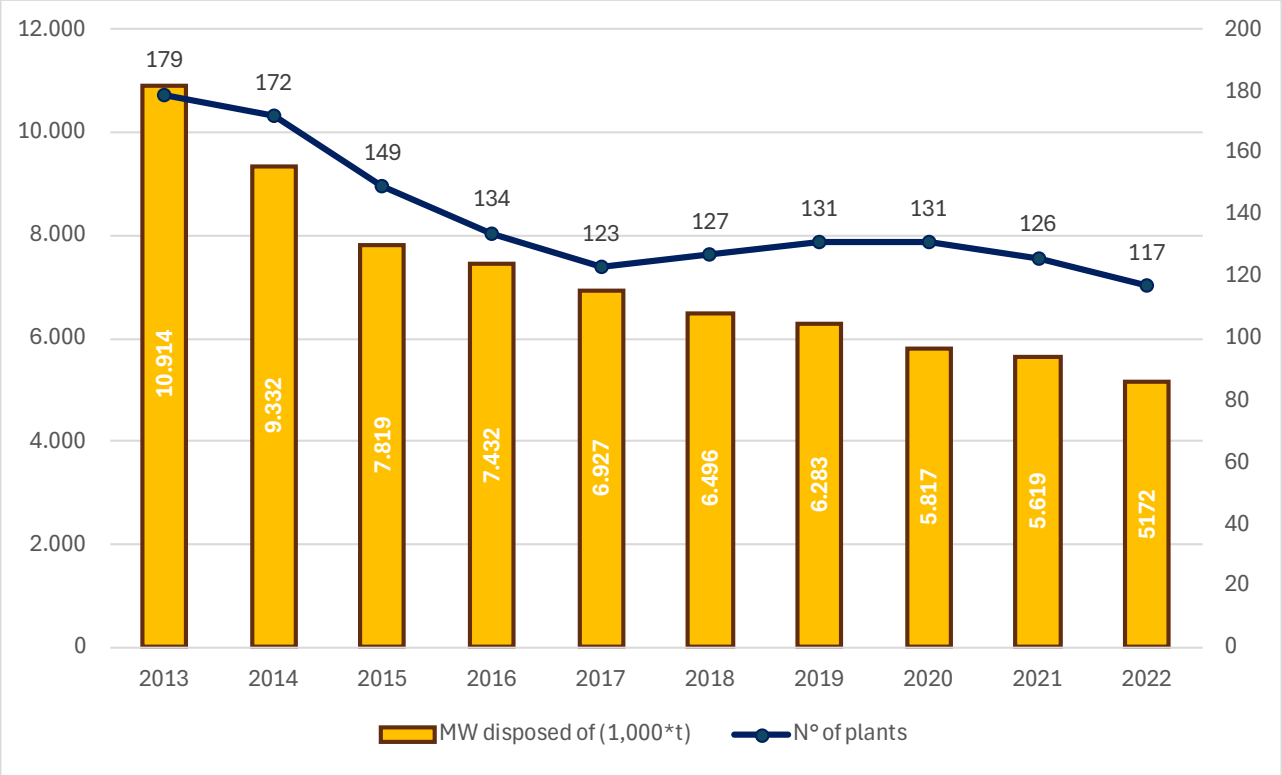
Table 3.5.1 - Landfills for non-hazardous and hazardous waste, disposing of municipal waste, by geographical macro-area (tonnes*1,000), years 2018 - 2022

Macroarea	No. of plants					Quantity of MW disposed of (t/y * 1,000)				
	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022
North	56	54	54	53	50	1.541	1.527	1.479	1.468	1.398
Centre	25	30	26	28	25	1.599	1.910	1.751	1.714	1.755
South	46	47	51	45	42	3.356	2.846	2.587	2.436	2.020
ITALY	**127**	**131**	**131**	**126**	**117**	**6.496**	**6.283**	**5.817**	**5.619**	**5.172**

Source: ISPRA

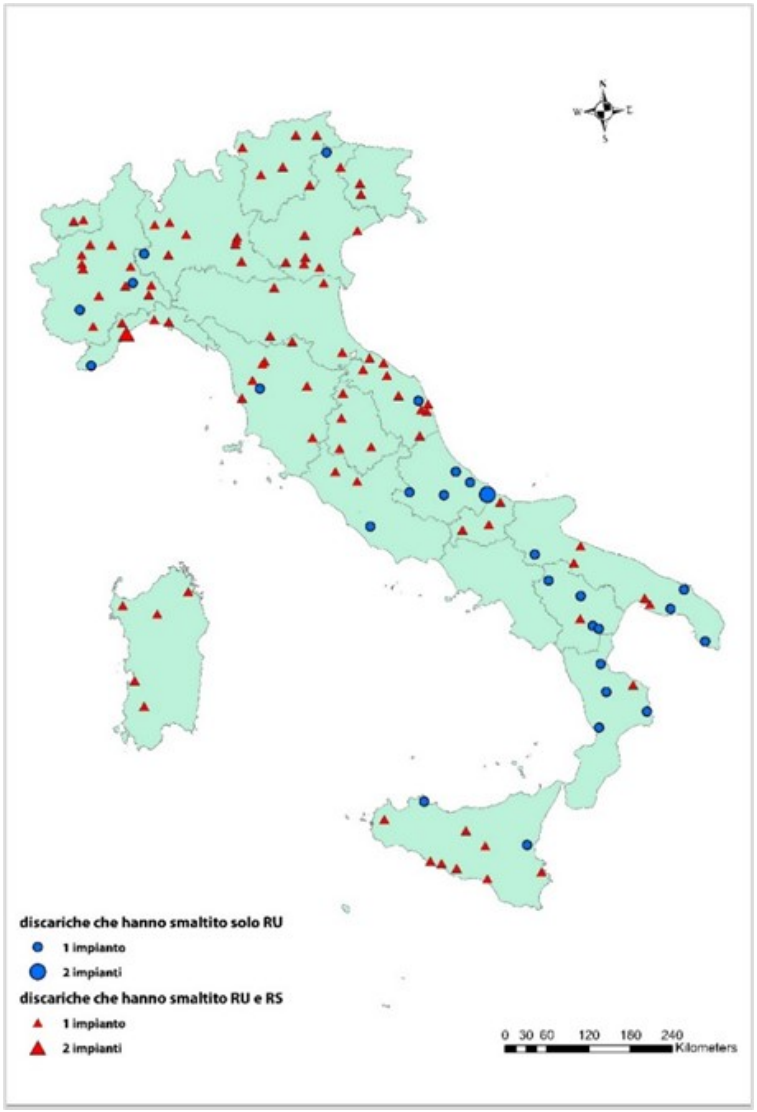
Figure 3.5.1 illustrates the trends in MW disposal and the number of landfill facilities from 2013 to 2022. Figure 3.5.2, on the other hand, shows the distribution and geographic location of operational landfills disposing of municipal waste in the year 2022, by category,and the quantities of municipal waste disposed of in landfills, at regional level.

Figure 3.5.1 – Municipal Waste disposal trends (quantity and number of plants), years 2013 – 2022



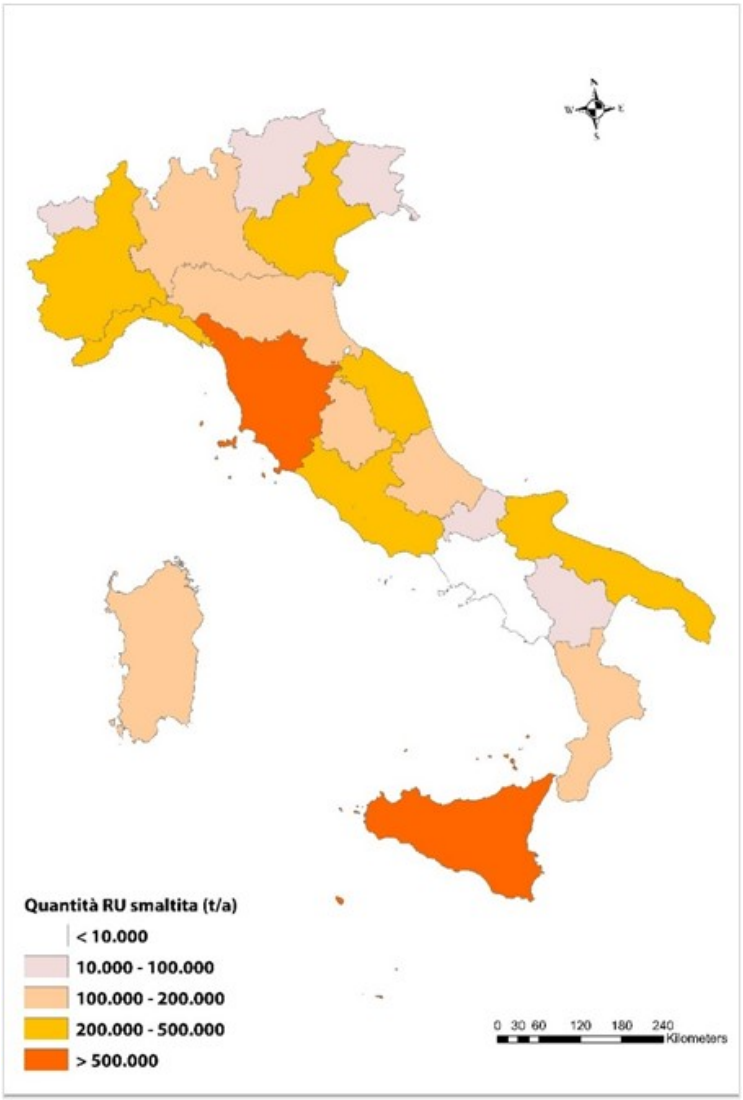
MW = municipal waste - *Source: ISPRA*

Figure 3.5.2 - Distribution and geographical location of landfill plants and quantities of municipal waste (tonnes), year 2022



Legend: Blue dots: Landfill disposing of only municipal waste. Red triangles: Landfill disposing both municipal and non-municipal waste.

Source: ISPRA

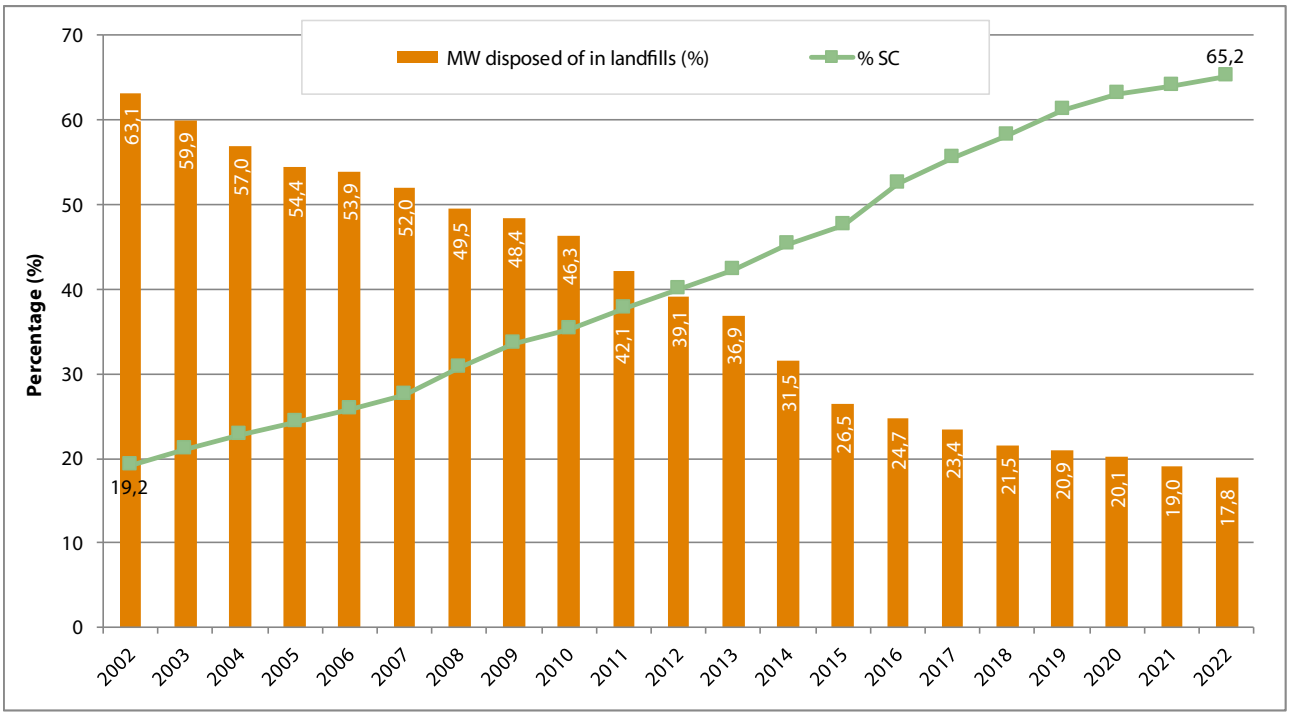


Legend: Quantity of MW disposed of in landfills (tonnes/year)

Source: ISPRA

In the year 2022, the total amount of municipal waste disposed of in landfills amounted to approximately 5.2 million tonnes, or 17.8 % of the amount of municipal waste produced nationwide (approximately 29.1 million tonnes).
Of the total disposed of, 27% (1.4 million tonnes) is managed in plants located in the north of the country, 33.9% (1.8 million tonnes) is managed in the Centre, and 39.1% (2.2 million tonnes) in the South. Compared to the 2021 analysis, a reduction of 7.9 % or 446,000 tonnes of waste was observed.
The reduction in landfilling of municipal waste observed over the last 10 years (-52.6%; from 109 million tonnes in 2013 to approximately 5.2 million tonnes in 2022) is due to the increase and improvement in separate collection, but also to the increased use of pre-treatment, which contributes to reducing the weight and volume of waste disposed of.
The trends of the percentage of MW disposed of in landfill compared to the rates of separate collection over the years shows that as separate collection increases, landfill disposal decreases proportionally (Figure 3.5.3).

Figure 3.5.3- Trends in MW landfill shares compared to separate collection rates (%), years 2002 – 2022



SC = separated collection
Source: ISPRA

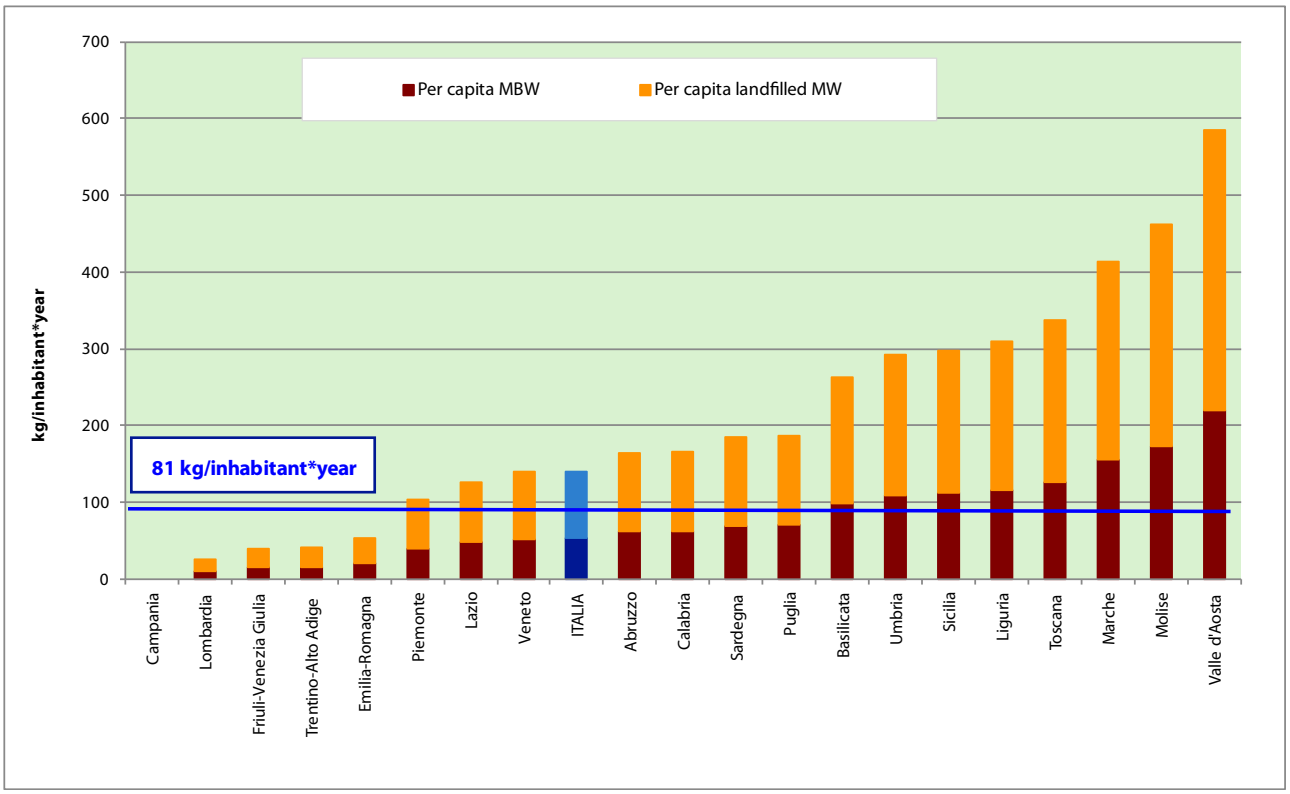
The analysis of data at regional level showed a decrease in the amount of waste disposed of in landfills, between 2021 and 2022, especially in the South where the reduction was -17,1% (about 417 thousand tonnes). In the Centre there is an increase of 40 thousand tonnes (+2.4%) and in the North a decrease of about 70 thousand tonnes (-4.8%).

In 2022, the per capita value of landfill disposal is 88 kg/inhabitant (-7 kg/inhabitant compared to 2021) in Italy, showing a progressive reduction in recent years.
Figure 3.5.4 shows the trend of the per capita value of regional disposal of municipal waste in 2021 and the corresponding share of bio-waste. In fact, National Legislative Decree 36/2003, as amended, had set targets for the progressive reduction of the landfilling of biodegradable municipal waste (MBW), to be achieved by optimal territorial areas. The targets were placed in the short term (173 kg/year per inhabitant by 2008), medium term (115 kg/year per inhabitant by 2011) and long term (81 kg/year per inhabitant by 2018).
As outlined in the National Strategy for the reduction of biowaste in landfills, the content of bio-waste has been quantified by ISPRA through specific waste analysis campaigns on mixed waste allocated to landfills. The results

determined the percentage of MBW in total municipal waste (MW) to be in the range of 58%-65%. ISPRA has set 60% as the average value to be used for the calculation of the biodegradable portion.

In 2022, the total amount of municipal bio-waste disposed of in landfills in Italy was 3.103.497 tonnes, corresponding to 18,5% of the MBW produced (reference year 1995), thus far below the target set for 2016 by the European legislation.
The national per capita value of landfilled bio-waste in 2022 was 53 kg per inhabitant, below the target set by Italian legislation for 2018 (81 kg/year per inhabitant).
An analysis of the data at regional level shows that, in 2022, 12 regions met the 2018 target (Piedmont , Lombardy, Trentino-Alto Adige, Veneto, Friuli-Venezia Giulia, Emilia-Romagna, Lazio, Abruzzo, Campania, Calabria and Sardegna). Puglia is slightly below the target (70 kg/inhabitant) while Basilicata is slightly above (99 kg/inhabitant).
Per capita values below 130 kg/inhabitant were found in Umbria (109 kg/inhabitant), In Sicily (111 kg/inhabitant), Liguria (116 kg/inhabitant), and Tuscany (126 kg/inhabitant).
The regions furthest away from the target are Molise (173kg/inhabitant), Marche (155 kg/inhabitant), and Valle d'Aosta (220 kg/inhabitant). In the case of Molise and Marche that's also due to the incidence of waste from outside the region.

Figure 3.5.4 - Per capita disposal of municipal bio-waste (MBW) and municipal waste (MW) in landfills, by region, year 2022



Source: ISPRA

3.6 Transboundary movement of municipal waste

In 2022, approximately 858 thousand tonnes of municipal waste were exported, and 296 thousand tonnes were imported. The export of waste accounts for 3% of the national municipal waste generation. Compared to 2021, exports increased by 30.2% while imports increased by 35%.

Exports

In 2022, municipal waste exported is 858 thousand tonnes, of which only 2,500 tonnes is hazardous. Compared with 2021, exported waste increases by 30.2%.

As Figure 3.6.1 shows, 32.7% of the exported waste, over 280 thousand tonnes, is "waste generated from the mechanical treatment of municipal waste" (LoW 191212). 60.6% of this waste, over 170 thousand tonnes, comes from mechanical biological treatment plants located in Campania and is mainly destined for the Netherlands (52 thousand tonnes), Germany (over 44 thousand tonnes) and Spain (25 thousand tonnes).

Of the waste generated from the mechanical treatment of municipal waste, 65% is recovered in the form of energy, and the remaining 35% is sent for material recovery.

28.6% of exported waste is "Solid Secondary Fuel" (LoW 191210), over 245 thousand tonnes, produced mainly in the regions: Lazio (about 88 thousand tonnes), Friuli-Venezia Giulia (over 88 thousand tonnes) and Lombardy (about 33 thousand tonnes). SSF is totally recovered in the form of energy and the main destinations are Cyprus (over 80 thousand tonnes), Portugal (about 35 thousand tonnes), Austria (over 28 thousand tonnes) and Greece (over 25 thousand tonnes).

Another 12.8% of exported waste is "non-composted portion of municipal and similar waste" (LoW 190501) produced in Campania and destined mainly for the Netherlands, Austria and Germany. Such waste is recovered for 71% in the form of energy and 29% is sent for material recovery.

Packaging waste accounts for 9.5% of the total exported, over 81 thousand tonnes, consisting mainly of 44 thousand tonnes of "plastic packaging" (LoW 150102), 27 thousand tonnes of "paper and cardboard packaging" (LoW 150101) and 9 thousand tonnes of "wood packaging" (LoW 150103).

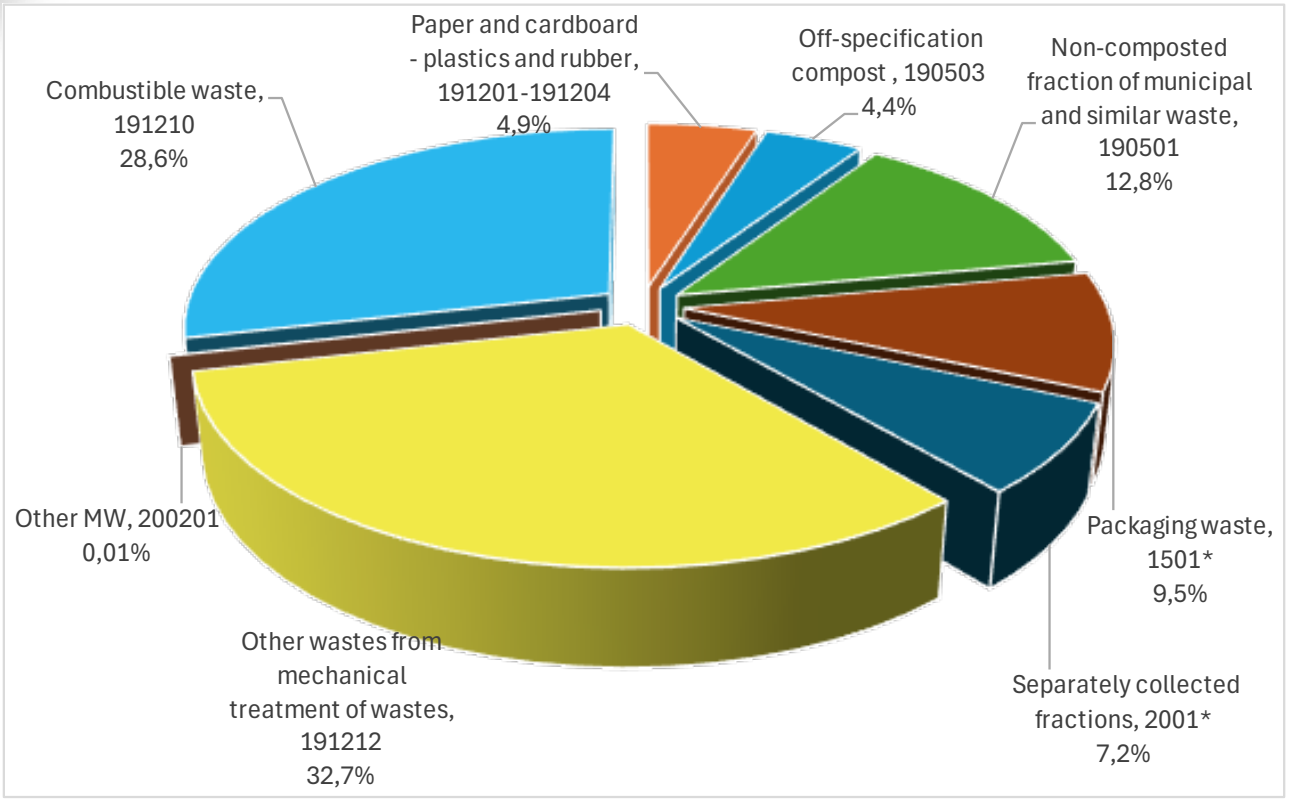
The separate collected fractions of municipal waste, 7.2% of the total exported, amount to about 62 thousand tonnes. They consist mainly of textiles waste, over 47,000 tonnes, produced mainly in Tuscany Lombardy and Piedmont (about 9,000 tonnes each) destined for recovery mainly in Tunisia (about 30,000 tonnes). "Edible oils and fats" (LoW 200125) exported amount to about 8 thousand tonnes, produced mainly in Veneto and Lombardy, are mainly destined to Austria and Slovakia for recovery.

On the other hand, 4.9% of exported waste is "waste produced by mechanical treatment of waste" (LoW 191201, 191202, 191203, 191204) namely paper, cardboard, plastic and rubber (42 thousand tonnes) and are sent for material recovery.

The last 4.4% of exported municipal waste (38 thousand tonnes) is "off-spec compost" (LoW 190503), exported for landfilling to Hungary from Emilia-Romagna and Lazio regions.

It should be noted that the data presented do not include secondary raw materials, regulated by national legislation, which, losing the waste status, are exported as products.

Figure 3.6.1 – Municipal waste exported by type of waste, year 2022



Source: ISPRA

Imports

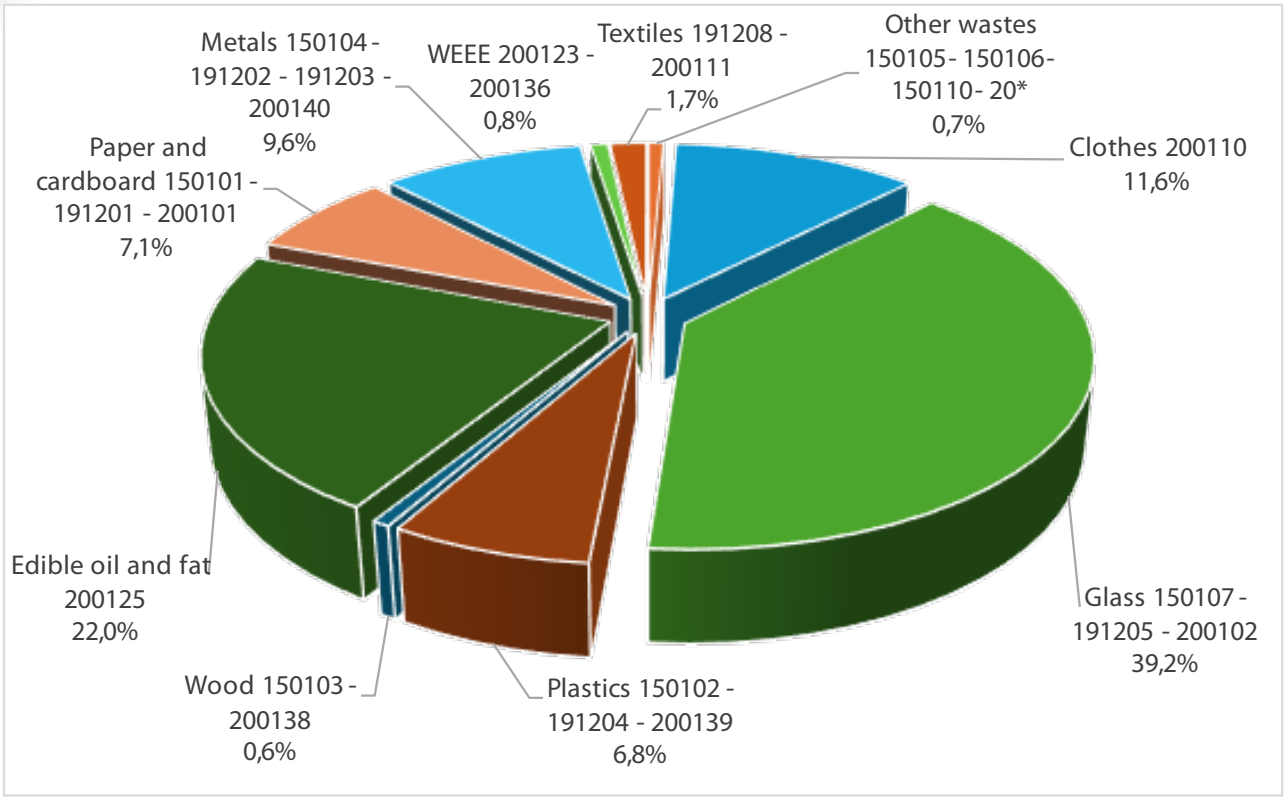
In 2022, 296 thousand tonnes of municipal waste were imported, of which 2 thousand tonnes were hazardous waste (mainly 'end-of-life equipment' - WEEE (LoW 200123*)).

Switzerland is the country from which the largest amount of municipal waste comes, over 72,000 tonnes, corresponding to 24.5% of the total imported; followed by France with 22.5% and Germany with 15.1% of the total.

Plants located in the country imported mainly glass (39.2%), edible oils and fats (22%), clothing (11,6%), metal (9,6%), and plastic (6,8%). Glass mainly is imported from Switzerland and France and is sent for recycling and processing plants located mostly in Lombardy. Campania and Tuscany, import mostly clothes/textiles to be recycled. Piedmont import plastic, mainly from France.

In line with previous assessments, and as shown in figure 3.6.2, the main type of imported waste is “Glass” with 39.2% of the total (over 116 thousand tonnes). Second is “Edible oils and fats” waste (LoW 200125) with 22% (over 65 thousand tonnes) and “Clothes/textiles” waste with 11.6% (over 34 thousand tonnes). “Metal” and “Plastic” waste represent 9.6% (over 28 thousand tonnes) and 6.8% (over 20 thousand tonnes) of the total imported respectively.

Figure 3.6.2 - Municipal waste imported by type of waste, year 2022

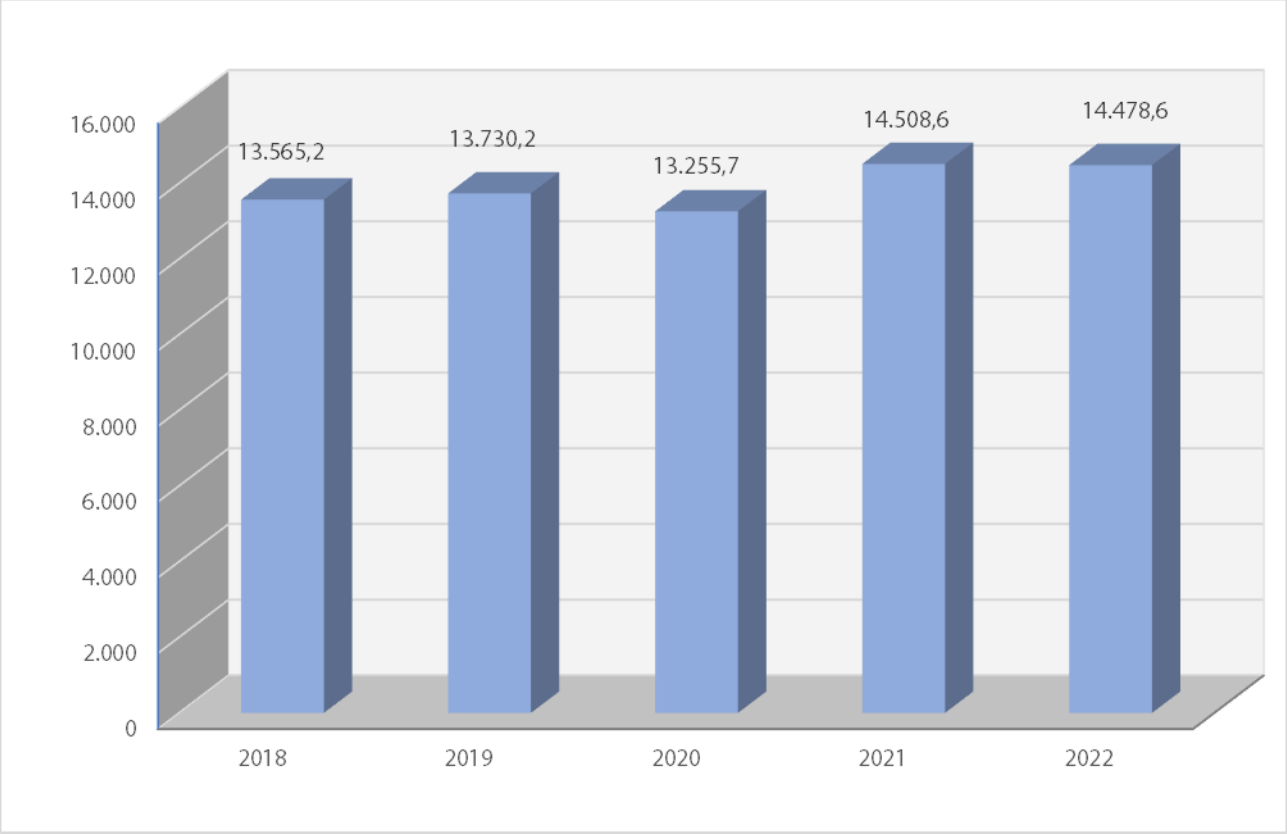


Source: ISPRA

4. Packaging and packaging waste

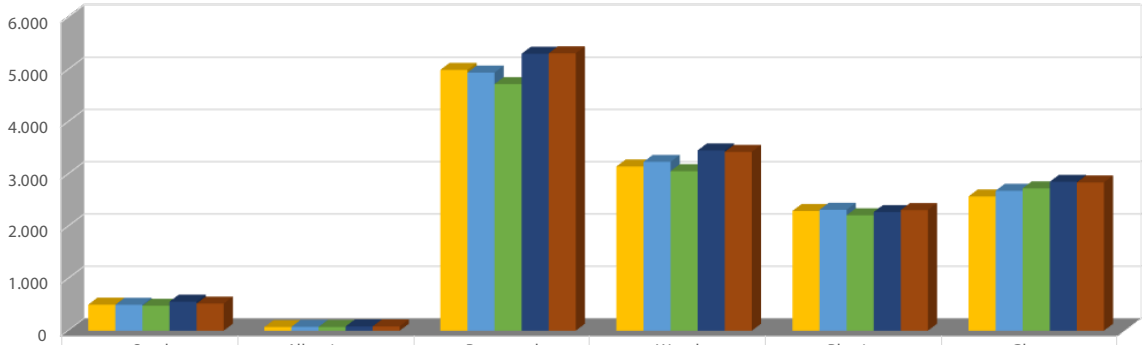
European legislation has set ambitious recycling targets to be reached in 2025 and 2030 for packaging waste, which is one of the main waste streams monitored.
In 2022, the packaging put on the domestic market are about 14.5 million tonnes, essentially stable compared to 2021 (-0.2%, 30 thousand tonnes less, Figure 4.1), in contrast to the upward trend in socio-economic indicators
In fact, 2022 ended with an increase in gross domestic product and final consumption expenditure of households of 3.7% and 6.1% (chain-linked values with reference year 2015), respectively, compared to 2021, year of economic recovery from the Covid-19. health crisis.
The different material fractions show differentiated trends: the steel chain, after the strong increase in 2021, shows the greatest decrease (-6.7%), followed by smaller reductions in wood (-0.8%) and glass (-0.4%); increases, albeit modest, are recorded for plastics and bioplastics (+1.7%), aluminium (+1.0%) and paper (+0.2%).
Paper remains the most sold fraction, accounting for 36.7% of the domestic market, followed by wood, which covers a 23.6 % market share, glass (19.6%) and plastics (15.9%),(Figure 4.2).

Figure 4.1 – Packaging placed on the market (1.000*tonnes), years 2018 – 2022



Source: ISPRA elaborations on CONAI data

Figure 4.2 – Packaging placed on the market by packaging materials (1.000*tonnes), years 2018 – 2022



	Steel	Alluminum	Paper and cardboard	Wood	Plastics	Glass
2018	499,3	69,4	4.992,1	3.142,9	2.292,0	2.569,5
2019	495,1	73,4	4.939,0	3.230,6	2.314,4	2.677,8
2020	477,7	70,4	4.720,5	3.053,3	2.208,6	2.725,3
2021	556,3	81,0	5.300,6	3.450,2	2.270,7	2.849,8
2022	518,9	81,8	5.308,9	3.421,7	2.309,0	2.838,4

Source: ISPRA elaborations on CONAI data

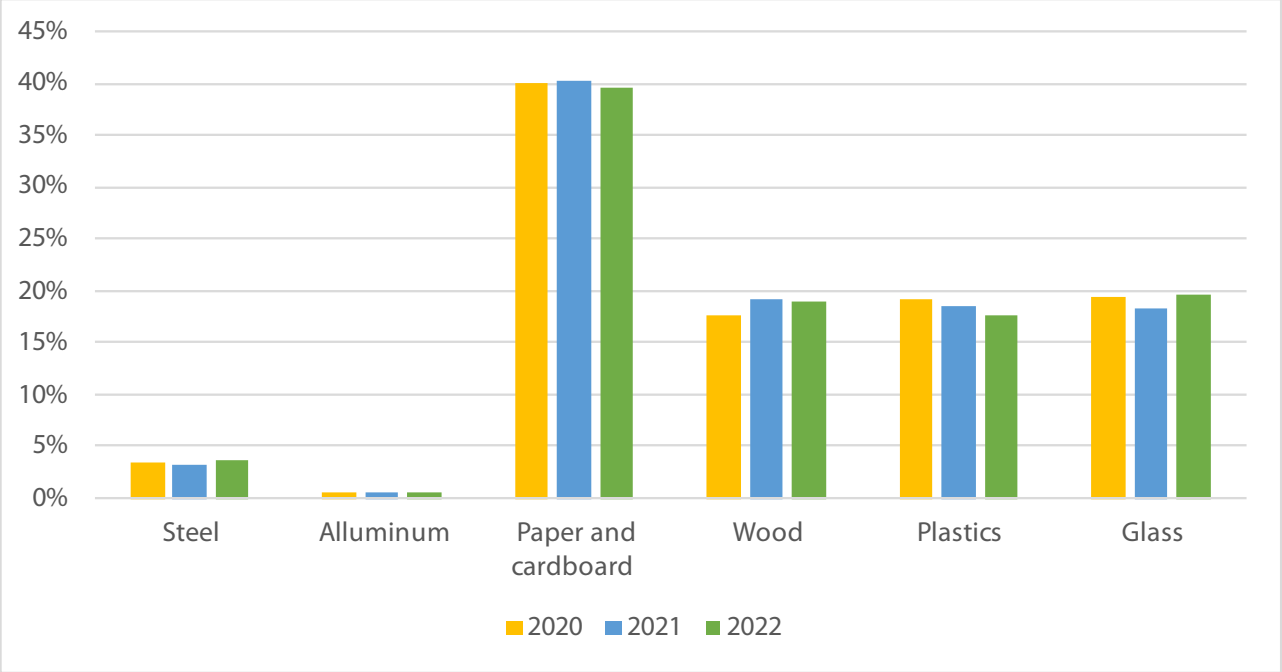
In 2022, packaging waste sent for recovery amounted to almost 11.7 million tonnes, with a little decrease compared to 2021. The amount of recovered packaging waste (plastics, paper, aluminium and glass) also includes the quantities sent for recycling abroad.

The largest share of total recovery is recycling which, for some types of waste, such as glass and steel, represents the only form of recovery. Of the overall recovery, in fact, 88.8% is represented by recycling, corresponding to almost 10.4 million tonnes, also including preparation for reuse through regeneration or repair operations; the remaining 11.2% is energy recovery (equal to 1.3 million tonnes).

All packaging materials show an increase in total recovery, with the exception of paper and wood packaging waste. The most significant percentage increase is for steel (+7.3% corresponding to +28 thousand tonnes compared to 2021), followed by glass (+5.1%, 110 thousand tonnes), plastic (+2.8%, 57 thousand tonnes) and aluminium (+2.8%, almost 2 thousand tonnes). For paper and wood packaging waste, on the other hand, reductions of 202 thousand tonnes (-4.2%) and 67 thousand tonnes (-2.9%), respectively, are observed, in contrast to the trend observed in 2020-2021.

Cellulosic packaging waste remains the most recovered fraction, constituting 39.6% of the total, followed by glass with 19.7%, wood (18.9%) and plastic (17.7%) (Figure 4.3).

Figure 4.3 – Percentage distribution of packaging waste recovered, years 2020 - 2022

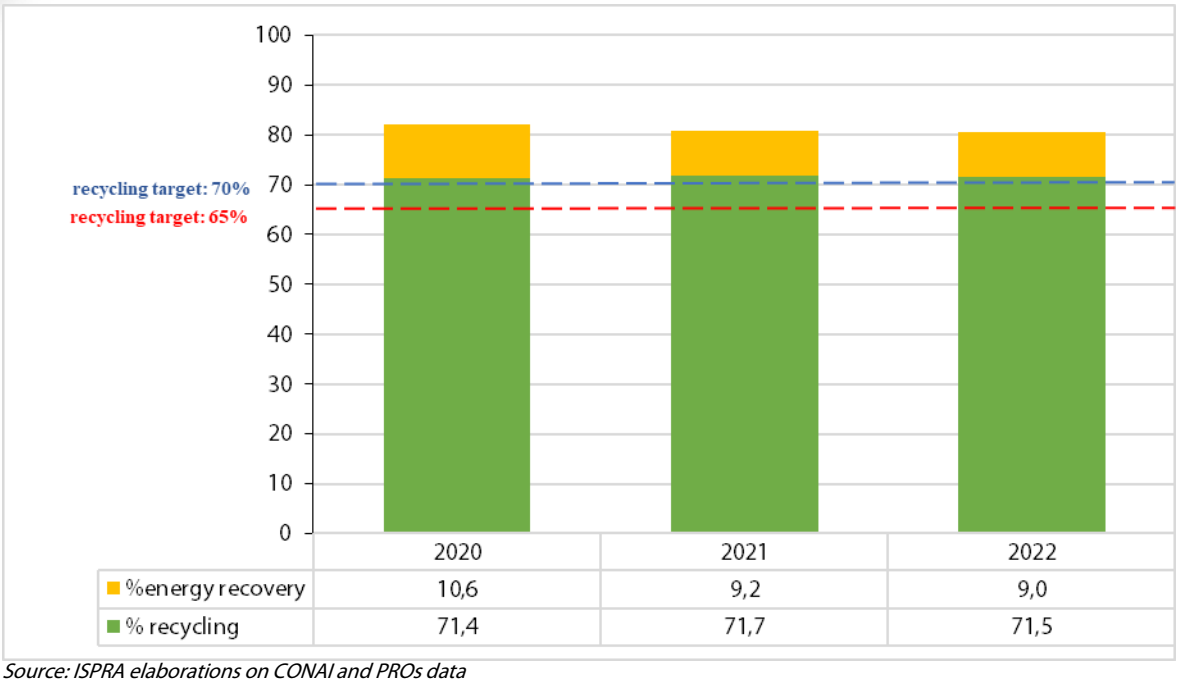


Source: ISPRA elaborations on CONAI and PROs data

Recycled quantities, amounting to almost 10.4 million tonnes, show a slight decrease compared to 2021 (-0.4%, about 41 thousand tonnes) attributable to the decrease recorded for the paper fraction (-3.9%, 174 thousand tonnes less) and the wood fraction (-2.6%, -57 thousand tonnes).
The analysis of data by material fraction shows percentage increases of 7.3% for steel, followed by glass (+5.1%), plastic (+4.5%) and aluminium (+3.5%). The most significant increases in recycled quantities are seen for glass and plastic packaging waste, by 110 thousand tonnes and 48 thousand tonnes respectively.

Recycled packaging waste from "public surface" (municipal waste stream, consisting of waste from households and waste similar in nature and composition generated from other sources) accounts for about 55 % of the total recycled (nearly 5.7 million tonnes); the remainder, about 4.7 million tonnes, comes from the secondary and tertiary packaging waste stream from industrial and commercial sources. The share of packaging waste from public surfaces of recycled shows an increase of 2.8 % over 2021, (+155 thousand tonnes). Glass and paper account for 40% and 38.1% of this amount respectively.
The share of packaging waste from private surfaces decreased by about 196,000 tonnes (-4%). The most relevant fractions are paper with 45.9% and wood with 40.6% of the total.
In 2022, the amount of packaging waste sent for energy recovery (solely from public surface) is 1.3 million tonnes, down 30 thousand tonnes from 2021 (-2.3%), confirming the downward trend observed since the year 2020.
Plastic (with 71.7% of the total) and paper (23.5%) are the fractions most sent for energy recovery. Plastic packaging waste increased slightly from 925,000 tonnes in 2021 to 934,000 tonnes in 2022 (+0.9%), and paper waste from 334,000 tonnes to 306,000 tonnes, down 8.5%. Wood packaging waste, standing at about 60 thousand tonnes, also decreased (-14.7%).
In 2022, the overall recovery of packaging waste is 80.5% of the put on the market, slightly down from 2021 (80.9%). The recycling rate thus decreases from 71.7% to 71.5%, while the energy recovery rate stands at 9% (9.2% in 2021, Figure 4.4).

Figure 4.4 – Recovery and recycling rates of packaging waste, according to the new calculation methodology, years 2020 – 2022



	2020	2021	2022
%energy recovery	10,6	9,2	9,0
% recycling	71,4	71,7	71,5

Source: ISPRA elaborations on CONAI and PROs data

The regulatory framework of recent years requires increasing efforts to ensure timely and accurate monitoring of waste generation and management data. To ensure uniform measurement conditions for the new targets on the amount of packaging waste recycled into new products, materials or substances, stringent calculation methodologies were defined at European level, also for packaging waste.
Comparison of the recycling rates achieved in 2022 with the targets foreseen for 2025 shows that all material fractions have already largely reached the targets set at European level, with the exception of plastics which is nevertheless close to the target (Table 4.1). The trend recorded for this fraction in the three-year period 2020-2022 confirms the improvements achieved in recycling thanks to the measures implemented at national level, with an increase of more than 5 percentage points in the last three years.

For this fraction, it remains a priority to increase recycling, including through the development of new treatment technologies, especially for those types of waste that are currently difficult to recycle through mechanical processes. It is, moreover, necessary to reduce existing gaps at the territorial level, and in this regard important measures are contained in both the National Waste Management Program (PNGR) and the National Recovery and Resilience Program (PNRR). The latter, in fact, has included among its missions the improvement of waste management as a fundamental tool for the implementation of the circular economy, strengthening the infrastructure for separate waste collection, modernizing and developing new waste treatment plants and bridging the gap between the North and the Centre-South, in order to achieve the challenging recycling targets set by European legislation. In particular, it has provided funds for the upgrading of plastic recycling systems through mechanical and chemical recycling in special "Plastic Hubs." As part of the development of a prospective National Plastics Strategy, it will be necessary to provide for the definition of targets, indicators, tools and governance for monitoring.

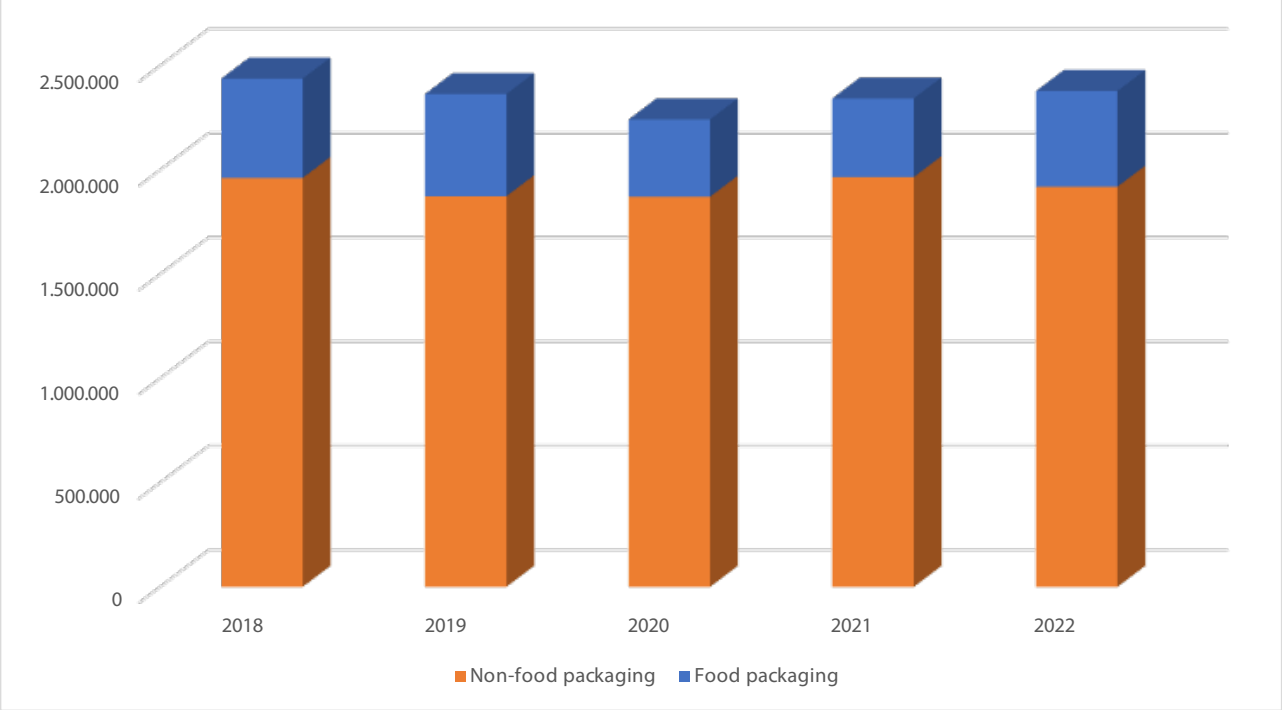
Table 4.1 - Recycling rates of packaging waste by fraction compared with recycling targets at 2025 and 2030, years 2020 – 2022

Fraction	2020	2021	2022	Targets to 2025	Targets to 2030
Steel	74,0%	70,1%	80,6%	70%	80%
Aluminium	67,3%	71,8%	73,6%	50%	60%
Paper	86,1%	84,6%	81,2%	75%	85%
Wood	62,0%	63,9%	62,7%	25%	30%
Plastic	43,8%	47,6%	48,9%	50%	55%
Glass	78,6%	76,6%	80,8%	70%	75%
TOTAL	**71,4%**	**71,7%**	**71,5%**	**65%**	**70%**

Source: ISPRA elaborations on CONAI data

In 2022, the reuse of packaging amounts to more than 2.4 million tonnes, an increase of 1.5% (35 thousand tonnes) compared to 2020, according to CONAI data.
About 460 thousand tonnes of food packaging and almost 2 million tonnes of non-food packaging were reused (Figure 4.5).Data analysis shows that food packaging reused are mainly glass bottles (58,9% of the total) and plastic crates (29,5%), whereas non-food packaging reused are mainly wooden pallets (42,3% of the total) and plastic pallets (19,3%) as well as steel containers and drums (18.1%) and industrial wooden packaging (6,7%).

Figure 4.5 – Total amount of reused packaging in Italy (tonnes), years 2018 - 2022



Source: ISPRA elaborations on CONAI data

5. Assessment of operation costs of the municipal waste management service, year 2022

This chapter analyses the costs faced by municipalities for the management of municipal waste. National Law 205 of 2017, granted the Regulatory Authority for Energy and Networks and Environment (ARERA) powers to regulate and control the cost of municipal waste management service.
The Authority has, among others, the task of:
- "dissemination of knowledge and transparency of the conditions under which services are provided for the benefit of users";
- "protection of users' rights [...]". ;
- "preparation and updating of the method for the determination of tariffs for the integrated waste service and the individual management services, for the coverage of operating and investment costs, including the remuneration of capital, based on the evaluation of efficient costs and the 'polluter pays' principle" ;
- "approval of the tariffs defined, in accordance with the legislation in force, by the governing body of the optimal territorial ambit for the integrated service and by the treatment plant operators";
- "verification of the correct drafting of the territorial ambit management plans by expressing observations and remarks" .
With Resolution 443 of 2019, ARERA adopted the Waste Tariff Methodology (MTR) containing the "criteria for the recognition of efficient operating and investment costs of the integrated waste service, for the period 2018-2021". With Resolution 238 of 2020 ARERA integrated Resolution 443/2019, for the period 2020-2021 in order to take into account the COVID-19 pandemic emergency.
In 2021, ARERA, while confirming the general approach of Resolution 443/2019, with Resolution 363/2021 'Approval of the Waste Tariff Method (MTR-2) for the Second Regulatory Period 2022-2025' introduced some new elements, including a strengthening of incentives for the development of recovered material and/or energy valorisation activities, also in consideration of the potential contribution of recovered output to the achievement of European targets. In addition, it has configured appropriate corrective mechanisms to the cost recognition system, in light of the application of the regulatory changes introduced by Legislative Decree 116/2020, taking into account the economic-financial balance of operations.

ARERA also defined the management scope subject to the new tariff method, so that it is uniform throughout the country. It includes:
(a) street sweeping and street washing
b) collection and transport of municipal waste
c) tariff management and customer relations;
d) treatment and recovery of municipal waste
e) treatment and disposal of municipal waste.
The Resolution MTR-2 also defines, by way of example, activities outside the integrated waste cycle.

In this chapter, taking into account the ARERA Resolutions, the costs related to the municipal waste management cycle have been analysed.
The costs related to the municipal waste management cycle were analysed here, considering the ARERA Resolutions. Specifically, "Operating Costs", "Common Costs" and "Capital Use Costs" were examined.
The analysis of the cost items was carried out by processing the financial data reported in the "Municipal Waste Communication" sheet of the Environmental Mandatory Declaration. The subjects obliged annually, by law, to this communication are municipalities, their consortia, unions of municipalities and other public and private operators.

The economic indicators of the management cycle of the examined municipal services are:
- annual cost per capita for mixed waste collection and transport activities (CRT) and per kg of mixed waste
- annual cost per capita for separate waste collection and transport activities (CRD) and per kg of separated collected waste;

- annual cost per capita for municipal waste treatment and recovery activities (CTR);
- annual cost per capita for municipal waste treatment and disposal activities (CTS);
- total annual cost per capita of the service and per kg of total waste;
- census of Italian municipalities adopting the Pay-As-You-Throw system (TARIP);
- annual costs per capita and per kg of waste, for municipalities adopting the Pay-As-You-Throw system (TARIP).

The following data were used to determine the economic indicators of the municipal waste management cycle:
- data on municipal waste production and separate collection for the year 2022, derived from the elaborations carried out by ISPRA (see chapter 2);
- data on the resident population as of 31 December 2022 at municipal level, derived from the annual ISTAT Demographic Balance Sheet.

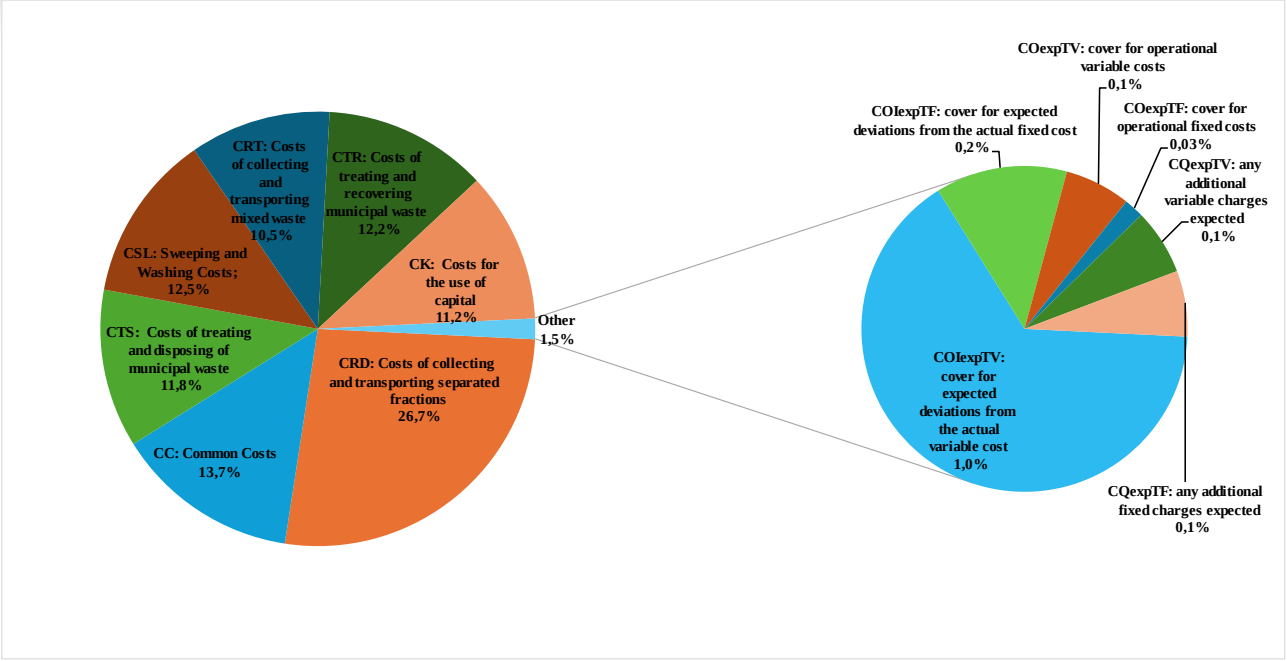
The analysis of the annual per capita costs and revenues from the application of the so-called 'TARI' and/or tariff refers to the resident population. However, It should be noted that urban hygiene services covers both domestic users and non-domestic users (such as commercial, artisan, industrial, offices, etc)., as well as costs due to the presence of non-residents, (such as commuting workers, students and tourists), for which it would be appropriate to introduce the parameter 'number of equivalent inhabitants'.

In the year 2022, the sample consists of 6,090 municipalities, which is 77% of the total (7,904), corresponding to 50,650,154 resident inhabitants, or 86.1% of the Italian population (58,850,717). Compared to 2021, there is a decrease in the sample of 580 municipalities (-8.7%), equivalent to -2,513,969 inhabitants. The ISTAT figure for the national population in 2022 also recorded a decrease of 0.2%, with over 132,000 fewer residents.

In terms of geographic coverage of the population, the sample is distributed as follows: in the North, coverage is 90.5%, in the Centre it reaches 93.7% and, finally, in the South, the lowest coverage is 75.5%.
Compared to 2021, the percentage decrease in coverage is -10.6% in the North, -6% in the Centre and -5.5% in the South.
As a preliminary remark, it is necessary to point out that the analysis of the data showed that in many cases the declarant, instead of assigning values to the individual cost items, provided an aggregate value by attributing it to a single cost item; nevertheless, the sample also includes these cases.

Figure 5.1 shows, with regard to the cost items of variable nature, that the largest cost incurred is related to the collection and transport of separated fractions (CRD), with 26.7% (+0.6% compared to 2021) of the total costs. The cost of treating and disposing of municipal waste (CTS) represented 11.8% (-0.7% compared to 2021) of the total, the cost of collecting and transporting mixed municipal waste (CRT) represented 10.5% (-0.6% compared to 2021) and, lastly, the cost of treating and recovering municipal waste (CTR) corresponded to 12.2% (+2.3% compared to 2021).
Of the total cost, fixed costs, such as common costs (CC) and the cost of sweeping and washing (CSL), represent 13.7% (-0.8% compared to 2021) and 12.5% (+0.3% compared to 2021) while the cost of capital use (CK) represent 11.2% (+1.2% compared to 2021).
And lastly, 1.5% of total costs (-1.1% compared to 2021) consisted of forecast items such as:
- COIexpTV, COIexpTF items intended to cover expected variable and fixed costs related to the achievement of quality improvement targets and/or changes in the management perimeter;
- COexpTV, COexpTF - items of a forecast nature intended to cover expected deviations from the actual cost values of the reference year attributable to regulatory changes introduced by Legislative Decree No. 116/20;
- CQexpTV, CQexpTF - items of a provisional nature intended to cover, respectively, any additional variable and fixed charges expected to be incurred in order to comply with the standards and minimum quality levels to be introduced by the Authority;
In addition, economic reductions in the event of financial equilibrium were also taken into account.

Figure 5.1 – Breakdown of management costs, year 2022



Legend: CRT = Costs of collecting and transporting mixed waste; CTS = Costs of treating and disposing of municipal waste; CTR = Costs of treating and recovering municipal waste; CRD = Costs of collecting and transporting separated fractions; - COIexpTV, COIexpTF items intended to cover expected variable and fixed costs related to the achievement of quality improvement targets and/or changes in the management perimeter; - COexpTV, COexpTF - items of a forecast nature intended to cover expected deviations from the actual cost values of the reference year attributable to regulatory changes introduced by Legislative Decree No. 116/20; - CQexpTV, CQexpTF - items of a provisional nature intended to cover, respectively, any additional variable and fixed charges expected to be incurred in order to comply with the standards and minimum quality levels to be introduced by the Authority;; CSL = Sweeping and Washing Costs; CC = Common Costs; CK = Costs for the use of capital.
Source: ISPRA

The average annual per capita cost for municipal waste management is 192.3 €/inhabitant (in 2021 it was 194.5), a decrease of 2.2 €/inhabitant. The cost is the result of the contribution of several components, such as, in particular: collection and transport of separated fractions (CRD), 51.3 €/inhabitant, treatment and disposal (CTS), 22.7 €/inhabitant, collection and transport of mixed waste (CRT), 20.1 €/inhabitant, treatment and recovery (CTR), 23.4 €/inhabitant, common costs (CC), 26.3 €/inhabitant, sweeping and washing costs (CSL), 24 €/inhabitant, finally, capital use costs (CK), 21.5 €/inhabitant..

In terms of geographical macro-areas, 2022 total annual per capita cost of service is highest in the Centre with 228.3 €/inhabitant (-2.5 €/inhabitant compared to 2021), followed by the South with 202.3 €/inhabitant (unchanged from 2021) and the North with 170.3 €/inhabitant (-4.3 €/inhabitant compared to 2021).

The largest share of the total cost is for the collection and transportation of separated fractions (CRD) with 62.6 €/inhabitant in the Centre (+2.4 compared to 2021), 55.4 €/inhabitant in the South (+1.8 compared to 2021), and 43.7 €/inhabitant in the North (-1.3% compared to 2021).
The cost of treatment and disposal (CTS), was 31.5 €/inhabitant in the Centre (-3.3 compared to 2021), 28.9 €/inhabitant in the South (-2.5 compared to 2021) and 15.1 €/inhabitant in the North (-0.7 compared to 2021).
The cost of collecting and transporting mixed municipal waste (CRT) was 23,8 €/inhabitant in the South (-1.4 compared to 2021), 22,5 €/inhabitant in the Centre (-2.5 compared to 2021) and 16,9 €/inhabitant in the North (-0.2 compared to 2021). Lastly, the cost of treatment and recovery (CTR) was 24,3 €/inhabitant in the North (+1.6 compared to 2021), 22,7 €/inhabitant in the Centre (+2.0 compared to 2021) and 22,6 €/inhabitant in the South (+2.3 compared to 2021).

The cities with the highest costs were Venice with 404,4 €/inhabitant, Cagliari with 296 €/inhabitant and Firenze with 286 €/inhabitant. The lowest costs were registered for Campobasso, 166.5 €/inhabitant and Trento with 172,3 €/inhabitant. In Rome the cost of the service is 270,4 €/inhabitant.

The analysis carried out on the "Pay-As-You-Throw" pricing system of a sample of 1,072 municipalities with a population of about 7.7 million confirmed for 2022 what was found in the previous surveys: the average total cost per capita is lower for these municipalities than for those applying normalized tariff (Tari). The average figure found on the sample stands at 167.5 €/inhabitant per year.
Trento, Cagliari and Potenza are the only regional capitals in the sample that have adopted this pricing system; the per capita cost was 172.3 €/inhabitant for Trento, 296.0 €/inhabitant for Cagliari and 233.1 €/inhabitant for Potenza. For these regional capitals, separate collection of 82.4 %, 74.8 % and 60.7 % was reported.

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