ISPRA
Istituto Superiore per la Protezione e la Ricerca Ambientale

Sistema Nazionale per la Protezione dell'Ambiente

Report on Municipal Waste 2024

Summary data

RAPPORTI
407bis / 2024

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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.

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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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1. Municipal waste in Europe

1.1 Generation of municipal waste in Europe

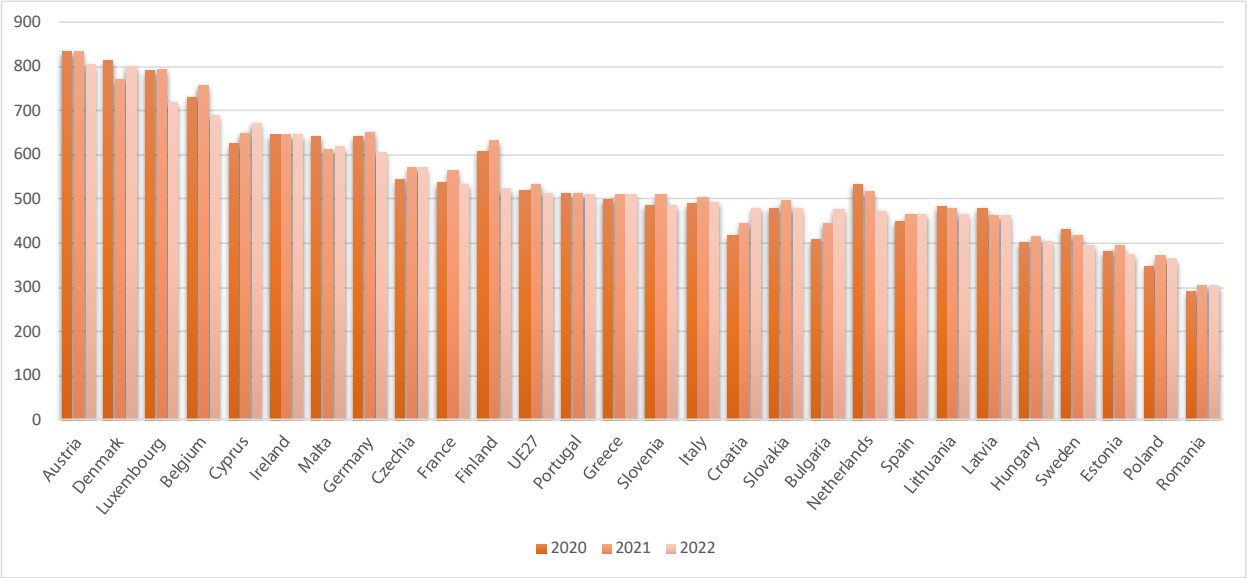
In 2024, the historical series of Eurostat data on generation of municipal waste (MW) shows data up to 2022. Total municipal waste production in the EU27 fell by 3.4% compared to 2021, from 237.5 million tons to 229.4 million tons. Compared to 2020, the reduction was 1.2%.

Comparing the data for the two-year period 2021-2022 at the level of individual EU countries, the largest negative declines are recorded for Finland (-17%), Belgium (-8%), Luxembourg, and the Netherlands (-7.3% and -7.2%). These reductions are also seen over the three-year period, as well as for other countries.

The largest percentage increases in the two-year period are recorded for Cyprus and Denmark (+5.1%), Croatia (+4.4%) and Malta (+3.5%). Cyprus and Croatia have an overall increase of 10.2% and 8.9% respectively.

Between 2020 and 2022, the average European per capita value of municipal waste fluctuates from 520 kg/inhabitant per year in 2020 to 532 kg/inhabitant in 2021 and 513 kg/inhabitant in 2022. However, per capita production values at the individual country level are characterized by considerable variability. The three countries with the highest per capita production, although decreasing compared to 2021, are still Austria (803 kg/inhabitant), Denmark (802 kg/inhabitant), and Luxembourg (721 kg/inhabitant), while the three with the lowest production are, also in the last reference year, Romania (303 kg/capita), Poland (364 kg/capita) and Estonia (373 kg/capita, Figure 1.1).

Figure 1.1 – Total municipal waste generated in the EU27 (tonnes*1,000), years 2020 - 2022



Source: ISPRA elaboration on Eurostat data

1.2 Management of municipal waste in Europe

The total amount of MW treated in 2022 in the EU27 is approximately 224 million tons, down 4.4% (-10.3 million tons) compared to 2021, in line with the decline in production (-3.4%). For the three-year period 2020-2022, the decline is 4.4 million tons (-1.9%).

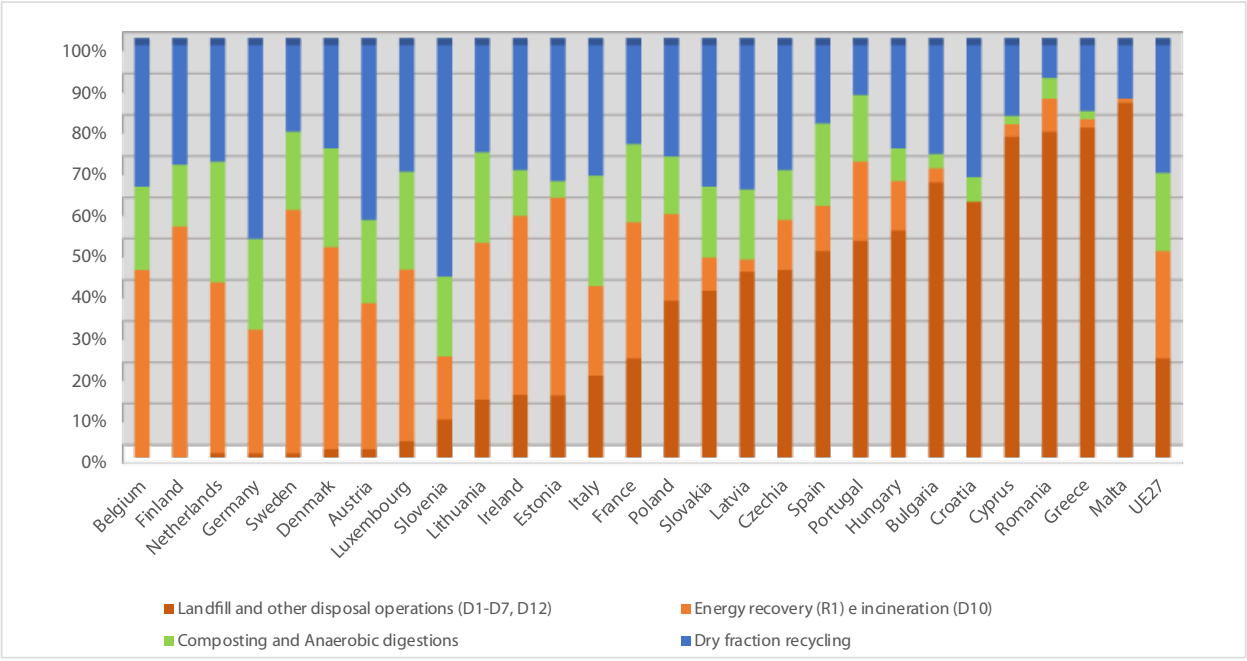
The main percentage increases in the quantities of municipal waste treated concern Croatia (+4.3%, +69 thousand tons) and Cyprus (+4.2%, +19 thousand tons). In terms of quantity, however, the largest increases are recorded in Spain (+153 thousand tons, +0.7%) and Romania (+70 thousand tons, +1.3%).

The most significant percentage reductions in the two-year period were in Finland, with -17% (-593,000 tons), and Estonia, with -14.1%, (-73,000 tons). The most significant decrease in terms of quantities treated was in Germany and France, with -3.3 million tons (-6.2%) and -3.2 million tons (-8.4%) respectively.

Analysing the average per capita quantities of waste treated for the EU27, there was a 4.8% decrease between 2021 and 2022, while compared to 2020, the decrease was 2.2%. With regard to individual Member States, the largest increases in per capita treatment values between 2021 and 2022 were recorded in Croatia (+6.7%) and Cyprus (+2.8%), while the largest decreases were observed in Finland (-17.1%) and Estonia (-15.2%).

Figure 1.2 shows the extreme variability in approaches to municipal waste management among the different Member States. Some countries have a significant prevalence of landfill disposal with percentages above 70% (such as Malta 86%, Romania 79%, Cyprus 77%). Others have higher percentages of energy recovery, such as Sweden (59%), Finland (56%), Denmark (49%), and Estonia (48%). Eight countries report percentages of municipal waste sent for composting and anaerobic digestion equal to or greater than 20% of the total treated, with the Netherlands (29%) and Italy (26%) in the lead, while ten countries have percentages above 30% for dry fraction recycling, with Finland (55%) and Germany (47%) leading the way.

Figure 1.2 – Percentage breakdown of municipal waste management in EU27, year 2022 (data by increasing percentage of landfilling)



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

2. Municipal waste generation and separate collection

2.1 Municipal waste generation

In 2023, national municipal waste (MW) production stood at almost 29.3 million tons, up 0.7% (+218,000 tons) compared to 2022 (Figure 2.1).

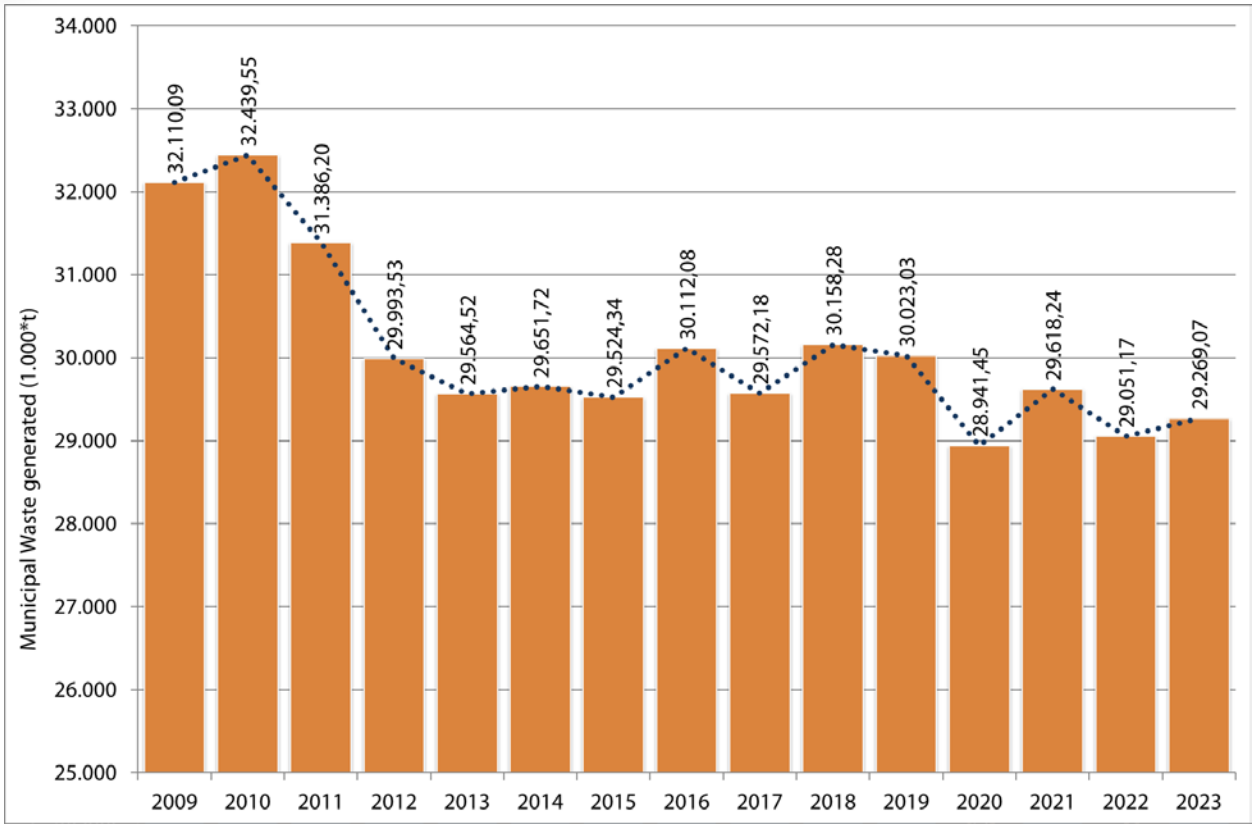
In 2023, the Italian economy slowed down, with lower growth in Gross Domestic Product and final consumption expenditure on the national territory than in the previous year, equal to 0.7% and 1% respectively, compared to 2022.
Overall, the fluctuating trend in waste production observed over the years can be linked to various factors, including the introduction of new regulatory provisions that have, for example, changed the definition or methods of accounting for urban waste collection and management, or health or socio-economic reasons, such as the 2020 pandemic and the 2022 international crisis, which have affected consumption and, consequently, waste production. In relation to the effects of regulatory changes, production figures may be influenced both by the introduction of different methods of accounting for urban waste data and by the possibility for non-domestic users to take advantage of alternative collection methods to the traditional use of public services, based on changes introduced in sector legislation.

Urban waste production increased by 2.3% in the North, remained substantially stable in the Center, and decreased by 1.2% in the South. In absolute terms, northern Italy produced almost 14.2 million tons, the Center about 6.2 million tons, and the South just under 8.9 million tons.

Each Italian citizen produced 496 kilograms of waste, representing a positive percentage change of 0.5% compared to 2022. It should be noted that between 2022 and 2023, the resident population increased by 139,000 inhabitants (+0.2%), bucking the trend observed in the three-year period 2020-2022, but in any case, more modest than the growth in waste production. Over the last five years, per capita production was below 500 kilograms per inhabitant in 2020, a year marked by the pandemic crisis, and in the two-year period 2022-2023.

As in previous years, the highest per capita production values were observed in Central Italy, with 531 kilograms per inhabitant. The average value for northern Italy stands at 515 kilograms per inhabitant, an increase of 9 kilograms per inhabitant compared to 2022, while the figure for the south is 449 kilograms per inhabitant (-5 kilograms per inhabitant). Per capita production in this macro-area is 47 kilograms per inhabitant lower than the national figure and 82 kilograms lower than the average for Central Italy.

Figure 2.1 – Trends in municipal waste generation, years 2009- 2023



Source: ISPRA

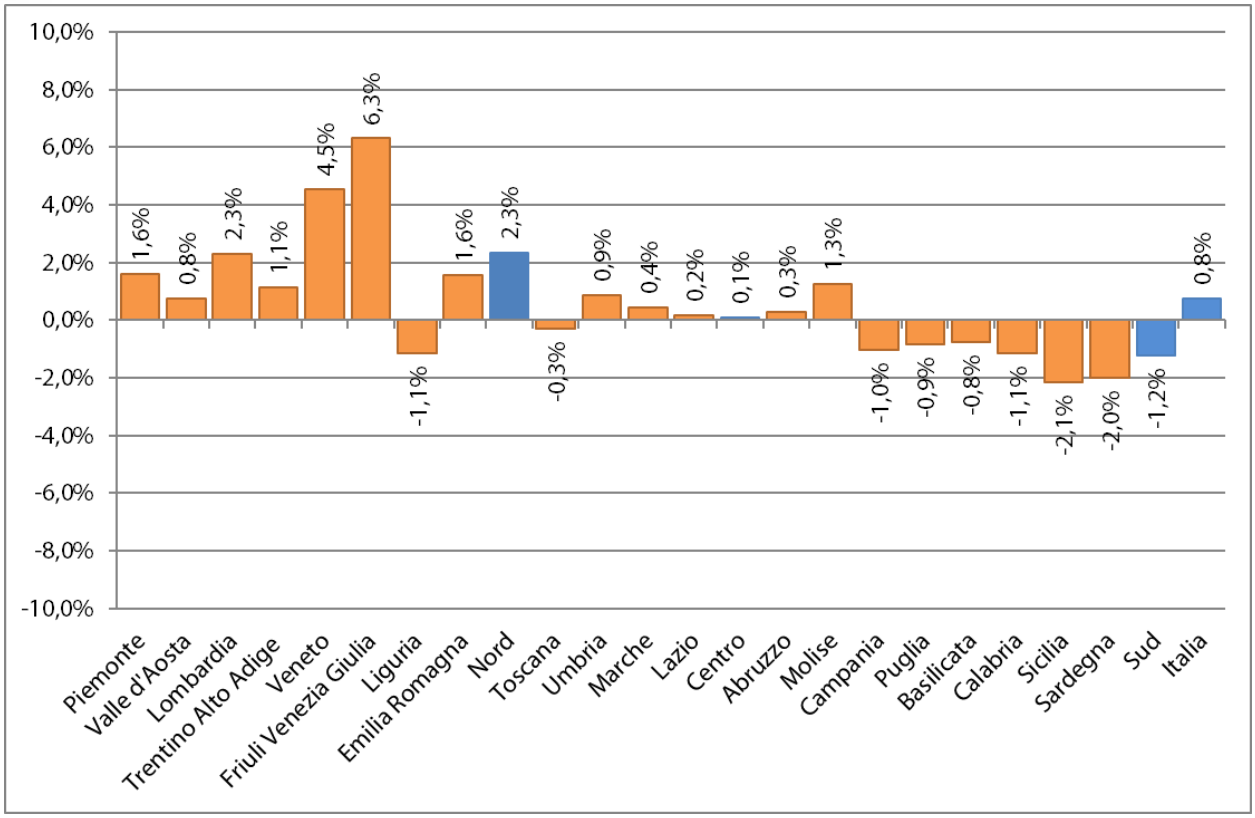
All northern regions, with the exception of Liguria, where production is slightly down, reported an increase in waste produced (Figure 2.2). More specifically, the largest increases were observed in Friuli-Venezia Giulia (+6.3%), Veneto (+4.5%) and Lombardia (+2.3%). Overall, waste production in the central regions remained virtually stable compared to 2022: a slight increase was recorded in Umbria (+0.9%), Marche (+0.4%) and Lazio (+0.2%), while a slight decrease was recorded in Tuscany (-0.3%). In the southern regions, there was a general decrease in waste produced, with the exception of Molise (+1.3%) and Abruzzo (+0.3%).

As in previous years, the highest production was recorded in Emilia-Romagna, with 639 kilograms per inhabitant per year, an increase of 6 kilograms compared to 2022. This was followed by Valle d'Aosta with 620 kilograms, up 4 kilograms compared to 2022, and Tuscany with 586 kilograms, which was nevertheless down 4 kilograms. There is a total of 10 regions with a per capita figure above the national average (496 kilograms per inhabitant): in addition to the three mentioned above, these are Liguria, Friuli-Venezia Giulia, Umbria, Marche, Piedmont, Lazio, and Veneto.

The lowest per capita production values are recorded for Basilicata (357 kilograms per inhabitant), Molise (380 kilograms), and Calabria (398 kilograms).

It should be noted that the per capita production figure is calculated in relation to the number of inhabitants residing in the reference territory and therefore does not take into account the so-called floating population (linked, for example, to tourist flows), which can have a substantial impact on the absolute production of municipal waste and thus increase the per capita production value.

Figure 2.2 - Percentage change, from 2022 to 2023, of municipal waste generation on a regional scale



Source: ISPRA

At the **provincial/metropolitan** city level, the highest per capita production value is found in Reggio Emilia, with 749 kilograms per inhabitant per year, followed by two other provinces in Emilia-Romagna, Ravenna and Rimini, with 726 and 713 kilograms respectively. Three other provinces in Emilia-Romagna (Piacenza, Ferrara, and Modena), three provinces in Tuscany (Livorno, Lucca, and Grosseto), as well as Aosta and Venice, have per capita production values between 600 and 700 kilograms per inhabitant.

The lowest per capita production values (less than 400 kilograms per inhabitant) are found in several provinces in southern Italy and in the province of Frosinone. In particular, Potenza and Enna are below 350 kilograms per inhabitant per year.

In the case of Molise, both provinces, Campobasso and Isernia, are below the threshold of 400 kilograms per inhabitant, with values of 388 and 360 kilograms respectively.

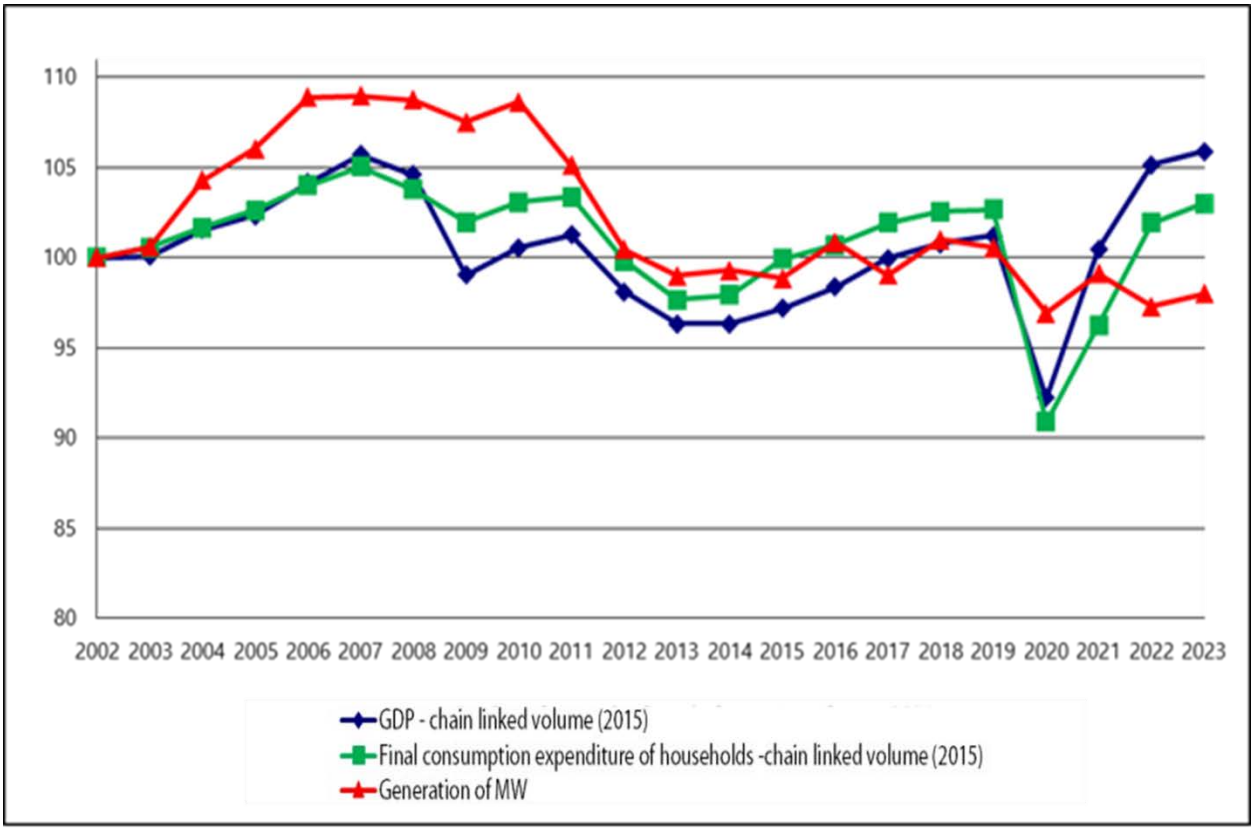
At the **municipal level**, the 14 municipalities with a resident population of over 200,000 inhabitants (approximately 16% of the Italian population) show substantial stability in total urban waste production between 2022 and 2023. Turin and Venice show increases of 4.3% and 3.3%, followed by Milan and Padua, with increases of 2.6% and 1.5% respectively; the increases recorded for Verona and Florence are both 1.2%. The increases recorded for Palermo and Rome are less than 1%, while the municipalities of Catania, Messina, Bari, Naples, and Genoa show a reduction in production. The data for the municipality of Bologna is essentially stable.

The average per capita of the 14 municipalities analysed stands at 545 kilograms per inhabitant, 49 kilograms higher than the Italian average. It should be noted that in the last year, the difference between the national average and the figures for the larger municipalities was lower than that recorded in 2022 (54 kilograms).

In general terms, given the economic recovery already recorded since 2021, with increases in socioeconomic indicators of 0.7% for GDP and 1% for final consumption expenditure, the urban waste production figure for 2023 seems, in any case, to reflect the downward trend observed in the long term, with waste production ranging between 29 and 30 million tons since 2012 (Figure 2.3).

As already highlighted, the fluctuating trend observed in recent years can be linked to a bunch of factors, including new rules that changed how urban waste collection and management are counted, or health and social-economic stuff like the 2020 pandemic and the 2022 international crisis, which affected consumption and, as a result, waste production. Regarding to the effects of regulatory changes, the production data may be influenced by the introduction, in Legislative Decree No. 152/2006, of Article 198, paragraph 2-bis, which took place with Legislative Decree No. 116/2020. This paragraph provides for the possibility, for non-domestic users, to dispose of their urban waste outside the public collection service, if they can demonstrate that they are sending the aforementioned waste to entities that guarantee its recovery. Waste falling within these categories may therefore not be fully accounted for in the data on the production and separate collection of municipal waste and may consequently fall within the scope of non-municipal waste management.

Figure 2.3 - Trends in municipal waste generation and socio-economic indicators, years 2002 – 2023



Source: ISPRA

2.2 Separate collection of municipal waste

In 2023, the percentage of separate waste collection will stand at 66.6% of national production, an increase of 1.4 points compared to 2022 (Figure 2.4). In quantitative terms, separate waste collection will increase by 573,000 tonnes (+3.0%), reaching 19.5 million tonnes.

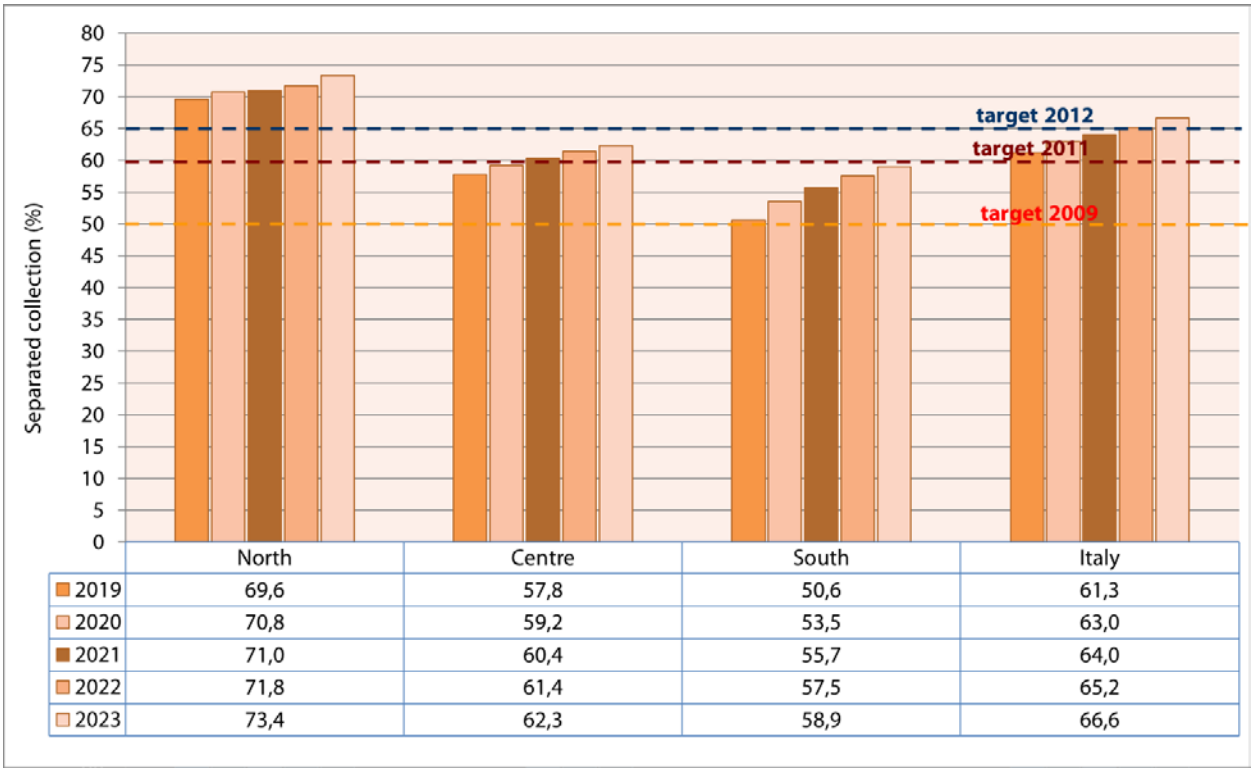
In the North, total collection amounts to almost 10.4 million tonnes, in the Centre to just under 3.9 million tonnes and in the South to around 5.2 million tonnes. These values correspond to percentages, equal to 73.4% for the northern regions, 62.3% for the central regions and 58.9% for the southern regions. Compared to 2022, all macro-geographical areas show increases in the percentage of separate waste collection: in the northern regions, the increase is 1.6 points, in the southern regions 1.4 points, and in the central regions 0.9 points.

An analysis of collection rate trends in the period 2019-2023 shows that the difference between the average rate in the North and the national rate has narrowed by 1.5 points (the gap was 8.3 points in 2019 and is 6.8 points in 2023), the difference between the North and the Centre has narrowed by 0.7 points (from 11.8 to 11.1), while the difference between the North and the South has narrowed by 4.5 points (from 19 to 14.5). Finally, the difference between the Centre and the South has narrowed by 3.8 points (from 7.2 to 3.4), demonstrating that the regions of the South are those that have shown the greatest growth in separate waste collection in recent years.

National per capita collection is 331 kilograms per inhabitant per year, with values of 378 kilograms per inhabitant in the North (15 kilograms per inhabitant more than in 2022), 331 kilograms in the Centre (+4 kilograms) and 265 kilograms in the South (+4 kilograms).

In the three-year period 2021-2023, there was an increase of 11 kilograms per capita in the North, 8 kg in the South and 6 kilograms in Central Italy, while on a national scale, separate waste collection per capita grew by approximately 9 kg/inhabitant.

Figure 2.4 - Trend in the percentage of separate collection of municipal waste by macro-area, years 2019- 2023



	North	Centre	South	Italy
2019	69,6	57,8	50,6	61,3
2020	70,8	59,2	53,5	63,0
2021	71,0	60,4	55,7	64,0
2022	71,8	61,4	57,5	65,2
2023	73,4	62,3	58,9	66,6

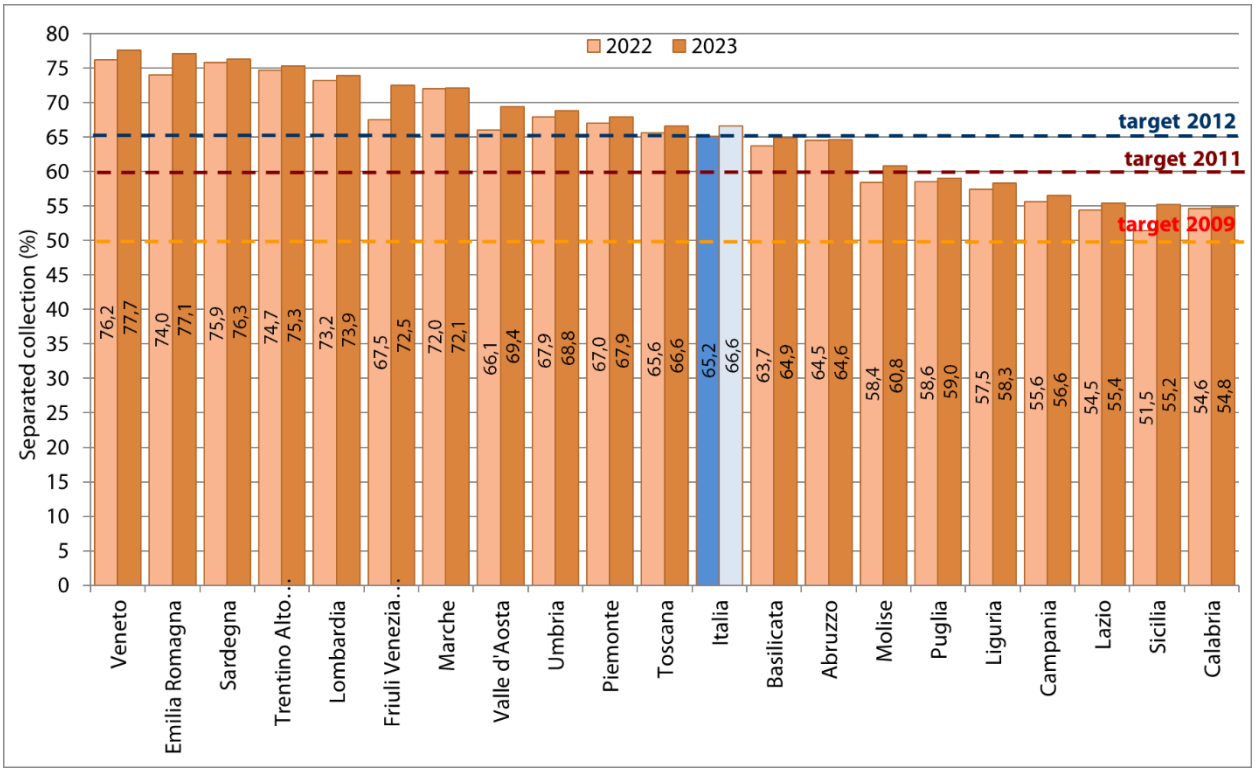
Source: ISPRA

On a **regional** basis, the highest percentage of separate waste collection was achieved, as in 2022, by the Veneto region, with 77.7%, followed by Emilia-Romagna (77.1%), Sardinia (76.3%), Trentino-Alto Adige (75.3%), Lombardy (73.9%) and Friuli-Venezia Giulia (72.5%). Among these regions, Friuli-Venezia Giulia and Emilia-Romagna, which in the last year surpassed Sardinia and Trentino-Alto Adige, approaching the percentage of Veneto, are those that recorded the greatest increase in the percentage of collection, with increases of 5 and 3.1 points respectively compared to the 2022 values (Figure 2.5).

Marche (72.1%), Valle d'Aosta (69.4%), Umbria (68.8%), Piemonte (67.9%) and Tuscany (66.6%) also exceeded the 65% target set by the legislation for 2012, while Basilicata (64.9%) and Abruzzo (64.6%) were close to it. The number of regions with a collection rate above or equal to the national average (66.6%) is therefore 11.

Molise and Puglia stand at 60.8% and 59.0% respectively, while Liguria stands at 58.3%. Campania reaches 56.6%, Lazio 55.4%, Sicily 55.2% and Calabria 54.8%. The region of Sicily recorded an increase of 3.7 points compared to the percentage in 2022 (51.5%), almost 8 points compared to 2021, 13 points compared to 2020 and just under 17 percentage points compared to 2019, exceeding the percentage of Calabria and approaching the value of Lazio.

Figure 2.5 - Trend in the percentage of separate collection of municipal waste by region, years 2022 – 2023



Source: ISPRA

At a provincial level, the highest levels of separate waste collection are found, as in previous years, in the province of Treviso, which stands at 89.1%, followed by Mantua (87%), Belluno (85.8%) and Pordenone (85.4%). Rates above or close to 80% are also found in the provinces of Reggio Emilia (83.3%), Forlì-Cesena (81.7%), Oristano (81.3%), Trento (81.2%), Bergamo (80.5%), Novara (80.4%), Monza and Brianza (79.9%) and Parma (79.7%).

Separate collection rates below 40% are observed for the province of Palermo (36.7%, with an increase of 1.8 points compared to 34.9% in 2022).

Overall, all **provinces/metropolitan cities** achieve separate waste collection rates of over 30%; 68 have rates of 65% or higher (3 more than in 2022) and 17 have rates between 60% and 65% (the same as in 2022). There are 18 provinces with collection rates between 50% and 60% (19 in 2022). As a result, 96% of provinces (103 out of 107 compared to 101 in 2022) have collected at least half of the urban waste produced on their territory separately.

Of the 68 provinces that have achieved the 65% target, 40 are located in northern Italy (10 of the 12 provinces of Lombardy, all 7 provinces of Veneto, both provinces of Trentino-Alto Adige, the 9 provinces of Emilia-Romagna, 3 provinces of Friuli-Venezia Giulia, 7 of the 8 provinces of Piemonte, 1 province of Liguria and the province of Valle d'Aosta), 13 in central Italy (all 5 provinces of Marche, 5 in Tuscany, the 2 provinces of Umbria, 1 in Lazio) and 15 in southern Italy (the 5 provinces of Sardinia, 3 in Sicily, 2 in Abruzzo and Campania, 1 in Basilicata, Calabria and Puglia).

An analysis of the data **at municipal level** shows that almost 71% of municipalities achieved a separate collection rate of over 65% in 2023. In 2022, these municipalities accounted for almost 69% and in 2021 for 66.6%. More than two-thirds of Italian municipalities are therefore above the 65% collection target. At the same time, the percentage of municipalities with collection rates below 30% continues to decline (2.9% in 2023, 3.4% in 2022, 4.1% in 2021). Overall, in the last year, 88.3% of municipalities have collected more than half of their urban waste separately (the percentage was 87% in 2022).

The highest levels of separate waste collection for municipalities with a resident population of over 200,000 inhabitants are observed in Bologna, Padua, Venice and Milan, with percentages of 72.9%, 64.4%, 63% and 62.4% respectively. Bologna, in particular, which has seen an increase of almost 10 percentage points, is the first city to exceed the 65% collection target, not only exceeding the national average but also well above 70%. Turin, Florence, Messina and Verona exceeded or approached 55%, with rates of 57.1%, 55.6%, 55.4% and 53.4% respectively. Rome, showing slight growth compared to 2022, stands at 46.6%, Genoa at 46.1% (+3% compared to 2022), while Bari and Naples exceed 40%, with 43.2% and 41.9% respectively.

As for the cities of Sicily, Catania rose from 22% to 34.7%, showing an increase of almost 13 percentage points (+26.5% in terms of increase in quantities intercepted), and Palermo stood at 16.9%, a slight increase compared to 15.2% in 2022.

Separately collected waste streams

Among sorted waste, organic waste remains the most collected fraction in Italy (38.3% of the total), followed by paper and cardboard with 19.1% of the total, glass (11.9%) and plastic (8.8%, Figure 2.6).

In terms of quantity, organic waste collection stands at almost 7.5 million tonnes, an increase of just under 230,000 tonnes (+3.2%), following the decrease seen between 2021 and 2022 (Figure 2.7). The growth in the last year, also confirmed by a similar trend in the management data at biological treatment plants, is linked to an increase in the collection of biodegradable waste from the maintenance of gardens and parks (+190,000 tonnes, equal to +10.6% in percentage terms).

Of these 68.4% consists of wet waste from kitchens and canteens (5.1 million tonnes), 26.4% of biodegradable waste from the maintenance of gardens and parks (almost 2 million tonnes), 4.5% from waste sent for home composting (just over 333,000 tonnes) and 0.7% (almost 51,000 tonnes) from market waste.

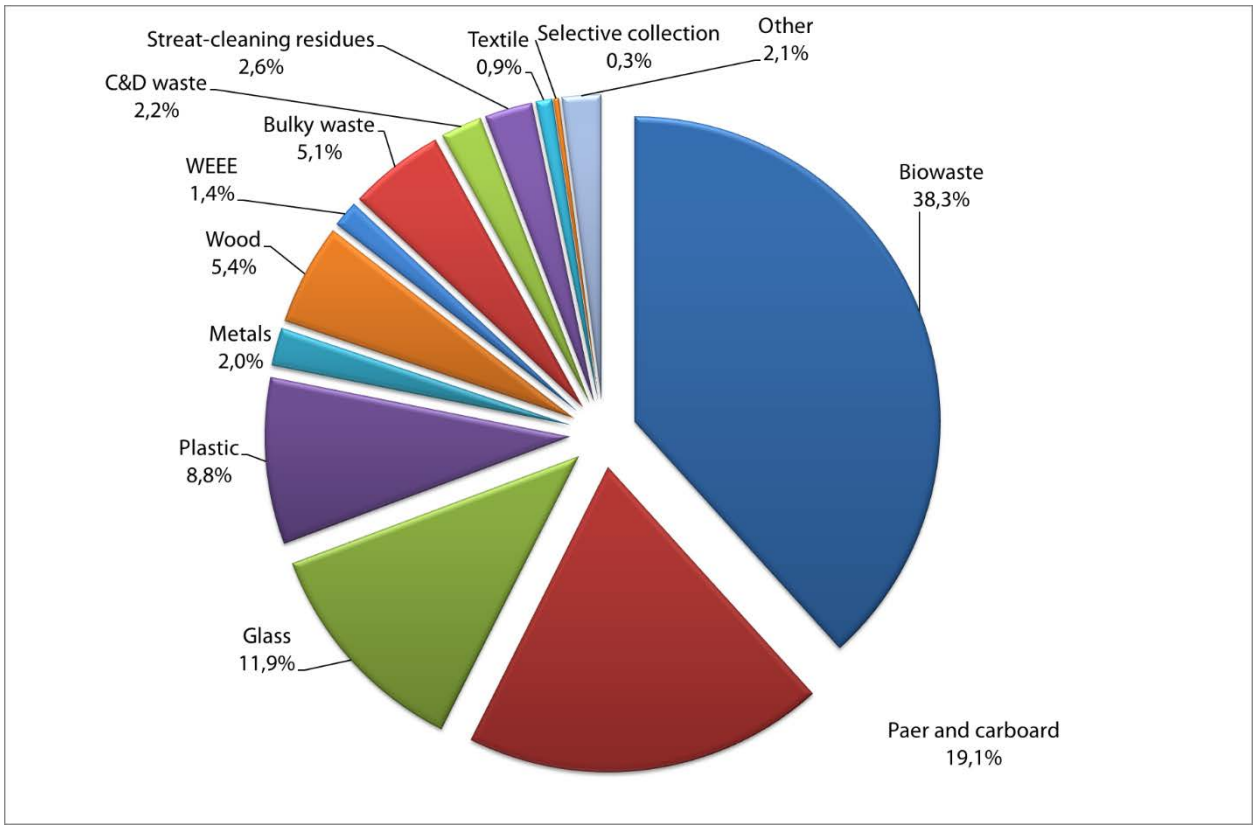
Separate collection of cellulose waste exceeds 3.7 million tonnes, an increase of 2% compared to 2022. The quantity collected in the North is over 1.9 million tonnes, in the Centre 843,000 tonnes and in the South 968,000 tonnes. The northern and southern regions show percentage increases of 3.5% and 2.7% respectively, while the central regions show a decrease of 1.9%. Based on the available data, the share of packaging waste is estimated to be on average 31% of the total cellulose waste collected annually.

Separate glass collection exceeded 2.3 million tonnes, a slight decrease compared to 2022 (-0.5%). In the North, just over 1.2 million tonnes are collected, with a per capita value of over 45 kilograms per inhabitant per year, in the Centre 434,000 tonnes (37 kilograms per inhabitant) and in the South 635,000 tonnes (32 kilograms per inhabitant). Between 2022 and 2023, there was a percentage decrease in the Centre and North, equal to 0.9% and 0.7% respectively, while in the South there were no changes. For glass, packaging is estimated to be the most prevalent type of waste (88% of the total collection of this fraction).

Plastic continues to show growth in the quantities collected, albeit at a more moderate rate than in the previous two years, with a total quantity intercepted of 1.7 million tonnes (+1.2% compared to 2022). In particular, the northern regions (924,000 tonnes) show the highest percentage growth (+3.6%), followed by the southern regions (492,000 tonnes, +1.6%), while the central regions show a decrease in the quantities collected (-307,000 tonnes, -6.0%). Based on the available data, it is estimated that 96% of separately collected plastic waste consists of packaging.

After the decline recorded in 2022, wood collection showed an increase, reaching just over 1 million tonnes (+4.4%). Compared to 2022, all macro-areas recorded an increase in the quantities collected, equal to 11.1% in the South, 5.8% in the Centre and 3% in the North. Overall, it is estimated that approximately 17% is represented by packaging waste.

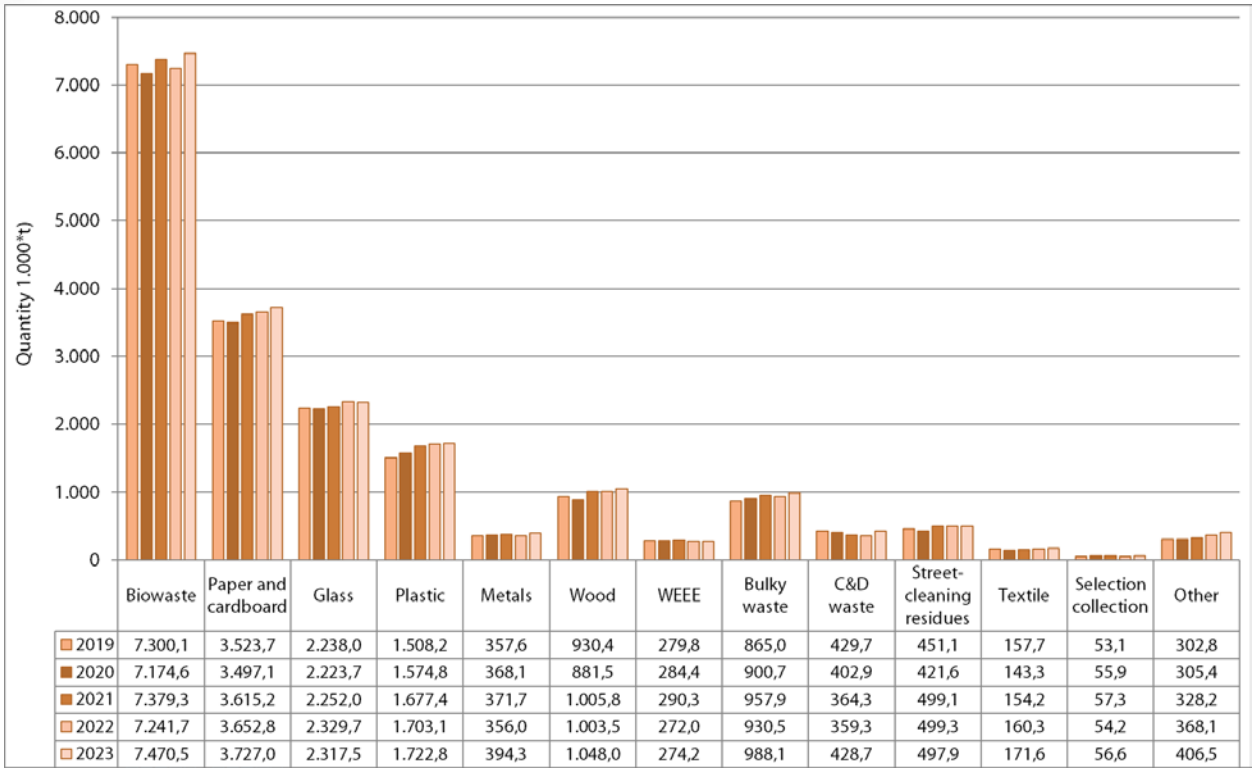
Figure 2.6 - Percentage breakdown of separate collection, year 2023



Notes: Since 2016, the item 'Other' also includes waste from multi-material collection. According to the criteria established by the Ministerial Decree of 26 May 2016, the latter must, in fact, be fully included (gross of the waste share) in the RD data.

Source: ISPRA

Figure 2.7 - Separate collection by product fraction, years 2019 – 2023



	Biowaste	Paper and cardboard	Glass	Plastic	Metals	Wood	WEEE	Bulky waste	C&D waste	Street-cleaning residues	Textile	Selection collection	Other
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	7.379,3	3.615,2	2.252,0	1.677,4	371,7	1.005,8	290,3	957,9	364,3	499,1	154,2	57,3	328,2
2022	7.241,7	3.652,8	2.329,7	1.703,1	356,0	1.003,5	272,0	930,5	359,3	499,3	160,3	54,2	368,1
2023	7.470,5	3.727,0	2.317,5	1.722,8	394,3	1.048,0	274,2	988,1	428,7	497,9	171,6	56,6	406,5

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

This chapter analyses data on municipal waste management, including waste identified with the European list codes 191212 (other waste including mixed materials produced by mechanical waste treatment), 191210 (secondary solid fuel - CSS), 190501 (part of municipal and similar waste not composted), 190503 (off-specification compost) and 190599 (waste from aerobic treatment of waste not otherwise specified) which, although classified as non-municipal waste following treatment operations that alter its nature and chemical composition, are in any case of urban origin. This choice is 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 from its treatment through the creation of an integrated network of plants within the optimal territorial area. The main critical issue in the analysis of these waste streams is their transport to destinations outside the region and, in some cases, to other countries, which makes it particularly difficult to track their path from production to final destination.

The types of plants analysed are biological treatment plants for organic waste from separate collection, incineration and co-incineration plants for municipal waste and waste from its treatment, mechanical or mechanical/biological treatment plants, and landfills.

It should be noted that municipal waste sent for intermediate mechanical/biological treatment prior to final recovery or disposal will account for 29.5% of municipal waste produced in 2023 (30.1% in 2022). It is therefore necessary to take this waste into account when analysing and closing the overall municipal waste management cycle. Mechanical-biological treatment is widely used as a form of pre-treatment prior to landfill or incineration with the aim, for both ensuring biological stability by reducing the moisture content and volume of the waste and increasing its calorific value to make the combustion process more efficient.

Article 7 of Legislative Decree 36/2003, implementing Directive 99/31/EC and subsequent amendments, stipulates that waste may only be landfilled after treatment and, in line with these provisions, in 2023, 93.5% of waste disposed of in landfills (similar to the 2022 figure of 93.7%) and approximately 51% of waste incinerated (up from 50% in 2022) underwent preliminary treatment.

In many cases, mechanical biological treatment plants are located on the same site as landfills or incinerators, constituting veritable treatment platforms. Furthermore, in several cases, both mechanical biological treatment plants and treatment plants for the organic fraction of separate waste collection are located on the same site.

There is a total of 656 municipal waste management plants of the types examined that will be operational in 2023. Details by geographical macro-area and type of plant are provided below.

Type of plant		Numbers of plants			
		North	Centre	South	Total
Biological treatment	Composting	166	33	76	**275**
	Integrated treatment	38	10	13	**61**
	Anaerobic digestion	23	2	2	**27**
Mechanical or mechanical-biological treatment	MBT	27	24	50	**101**
	MT	14	16	3	**33**
Co-incineration		7	1	3	**11**
Incineration		25	5	6	**36**
Landfills		49	24	39	**112**
Total		**349**	**115**	**192**	**656**

Source: ISPRA

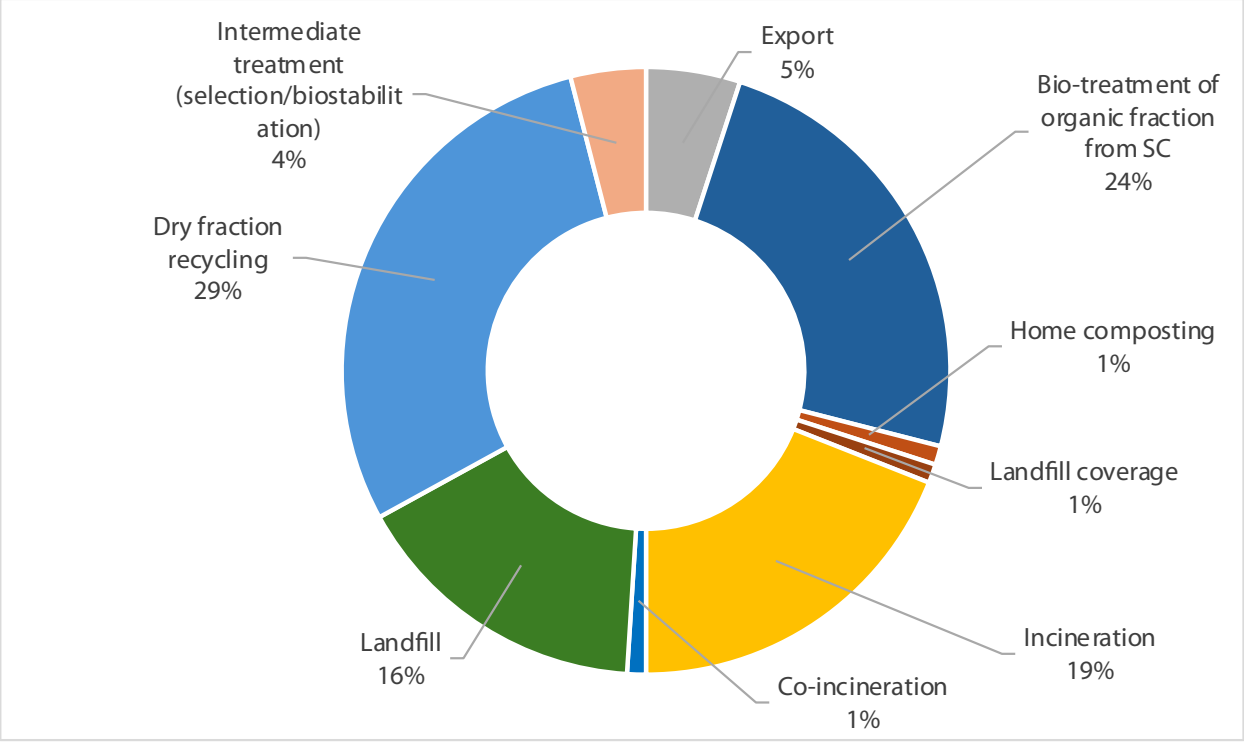
In 2023, the amount of waste disposed of in landfills without prior treatment was approximately 302,000 tonnes, down from 324,000 tonnes in 2022 and 480,000 tonnes in 2021, with overall reductions of 6.8% and 37.1% respectively. Including pre-treated municipal waste, there were decreases of 10.8% compared to 2022 and 19.4% compared to 2021.

In order to avoid duplication of data, when accounting for the quantities of waste subjected to mechanical biological treatment and subsequently sent for other management operations, Figure 3.1, which shows the percentage breakdown of the different forms of management in 2023, does not show the share of municipal waste treated in this type of plant.

Overall, in 2023, MBT plants treated 7 million tonnes of unsorted municipal waste (identified with the LoW code 200301), approximately 167,000 tonnes of other types of municipal waste, 1.5 million tonnes of waste from municipal waste treatment (identified with the LoW codes 19) and 292,000 tonnes of other types of non-municipal waste.

Analysis of the data shows that landfill disposal accounts for 16% of municipal waste produced (in 2022, the percentage was 18%). A total of 53% of the waste produced is sent to material recovery plants for the treatment of separate collections (52% in 2022): 24% to plants that recover the organic fraction from separate collections (wet + green) and 29% to plants that recover other types of waste from separate collections. 19% of municipal waste produced is incinerated, while 1% is sent to production plants (such as cement factories, thermoelectric power stations, etc.) to be used to produce energy within the production cycle; 1% is used, after appropriate treatment, for landfill covering; 4%, consisting of waste from MBT plants, is sent for further treatment such as refining for the production of CSS or biostabilisation; 5% is exported (approximately 1.4 million tonnes) and 1% is managed directly by citizens through home composting (333,000 tonnes). With regard to the data collected for exports, it should be noted that it does not include materials exported after recovery operations, following which they are classified as products or secondary raw materials.

Figure 3.1 – Percentage breakdown of municipal waste management, year 2023

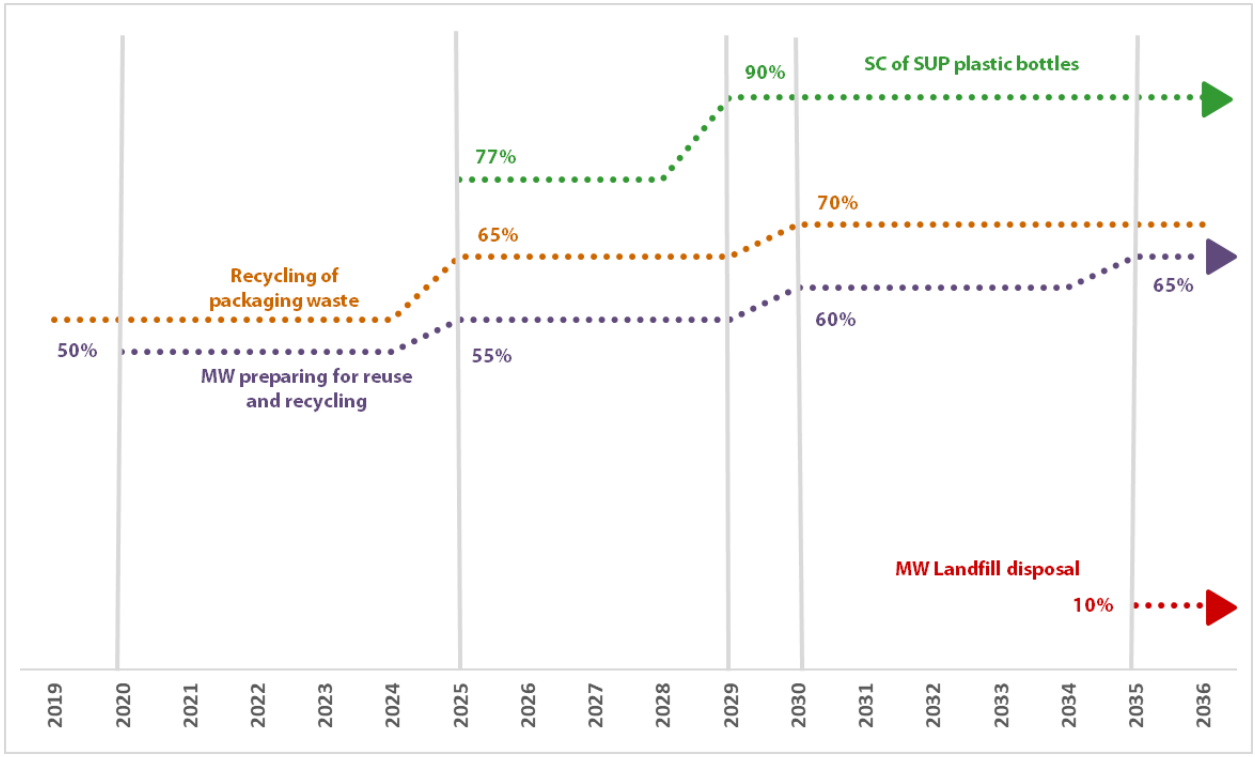


Source: ISPRA

The analysis of the data highlights the need to ensure further improvement of the management system, especially in certain areas of the country, in order to achieve the new challenging targets, set by European legislation, which are summarised in Figure 3.2. Landfill disposal, currently at 15.8%, will have to be further reduced over the next 14 years in order to ensure that the maximum target of 10% is achieved by 2035. However, pursuant to Article 5 bis of the Landfill Directive, also includes the share of municipal waste subjected to incineration operations and subsequently sent to landfill. In 2023, these amounts will total 458,000 tonnes, which, when added to the quantities of municipal waste sent for disposal without treatment or after pre-treatment, will result in an overall percentage of 17.3%.

At the same time, the percentage of recycled waste will have to be increased to ensure that 60% is achieved by 2030 and 65% by 2035. In this regard, it should be noted that the new targets have also introduced new calculation methods for both recycling and landfill disposal, which appear to be significantly more restrictive than those previously provided for in European legislation.

Figure 3.2 - Main targets under European legislation



Source: ISPRA own elaboration.

In 2023, landfill disposal involved 4.6 million tonnes of municipal waste, representing a reduction of almost 560,000 tonnes compared to 2022, corresponding, as already noted, to a percentage decrease of 10.8%. The reduction is more than one million tonnes compared to 2021. The data by geographical macro-area shows that 28.4% of the total (1.3 million tonnes) is managed in plants located in the north of the country, 32.9% (equal to 1.5 million tonnes) is sent for disposal in plants in the centre and 38.7% (equal to almost 1.8 million tonnes) is managed in the south.

Compared to 2022, there has been a decrease of 13.6% in the centre, equal in absolute terms to a reduction of approximately 238,000 tonnes, and 11.7% in the south (-236,000 tonnes), linked in both areas to an improvement in separate waste collection. In the North, there was a decrease of 6.1%, corresponding to a reduction of 86,000 tonnes. In the same year, at national level, separate waste collection reached 66.6% of total municipal waste production, an increase of 1.4 points compared to 2022, while total municipal waste production stood at just under 29.3 million tonnes, an increase of 0.7% (+211,000 tonnes).

Figure 3.3 shows the quantities of municipal waste sent for various forms of treatment. It shows a 4% increase in incineration between 2022 and 2023, equal to over 210,000 tonnes. 72.7% of this waste is treated in the north, 9.1% in the centre and 18.2% in the south. It should be noted that a considerable proportion of the waste produced in central and southern Italy is treated in plants located in the north. Lombardy alone receives over 450,000 tonnes of waste from outside the region (in 2022, the quantities amounted to 375,000 tonnes), almost 75% of which comes from Campania and Lazio. At the same time, Emilia Romagna receives almost 112,000 tonnes from other regions, with the majority (approximately 58%) coming from Lazio and Campania.

The treatment of the organic fraction of separate waste collection (wet + green), rising from almost 6.7 million tonnes to 6.9 million tonnes, recorded growth of over 250,000 tonnes (+3.8%) after the decline of the previous year (-132,000 tonnes). This fraction is mainly recovered in integrated anaerobic/aerobic treatment plants which, with a managed quantity of approximately 3.9 million tonnes, contribute to the treatment of organic waste by 56.8%, showing an increase of 6 percentage points in the last reference year (the incidence was in fact 50.8% in 2022). The aerobic composting sector, with a quantity of 2.5 million tonnes, down by more than 410,000 tonnes compared to 2022, contributes 36.9% (44.4% in 2022). The remaining 6.3%, equal to almost 433,000 tonnes, is managed in anaerobic digestion plants. Integrated treatment also shows an increase in the number of operating units from 51 to 61, while composting shows a decrease from 285 in 2022 to 275 in 2023. For anaerobic digestion, the plant system has increased by 5 units, from 22 to 27.

In 2023, the national per capita figure for the biological treatment of organic waste from separate collection is 117 kg/inhabitant, with very different values in individual geographical areas: 171 kg/inhabitant in the North, 65 kg/inhabitant in the Centre and 73 kg/inhabitant in the South.

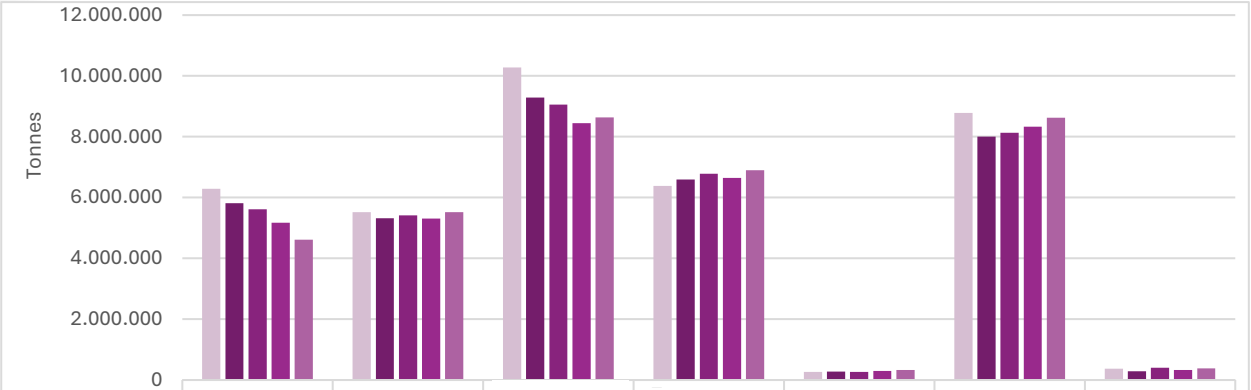
These data are not entirely comparable with those for organic waste collection at the local level. The lower number of plants in some areas of central and southern Italy means that large quantities of waste have to be transported from these areas to plants in the north. It should be noted that of the 275 composting plants in operation, 166 are located in the north, as are 38 of the 61 integrated treatment plants and 23 of the 27 anaerobic digestion plants. The collection of organic waste (wet + green), excluding home composting, stands at 120 kg/inhabitant nationwide, with 130 kg/inhabitant in the north, 119 kg/inhabitant in the centre and 110 kg/inhabitant in the south.

The enhancement of the organic fraction of municipal waste is a key element in achieving the new and challenging recycling targets set by the European Union. This fraction represents a total of around 34.7% (approximately 10.1 million tonnes) of municipal waste, considering both the portion from separate collection and that contained in unsorted waste. The legislation stipulates that organic waste can be counted as recycled if the treatment produces compost, digested material or other output with a similar recycled content yield to the input, intended for use as a recycled product, material or substance. If the output is used on land, it is only counted as recycled if its use benefits agriculture or improves the environment.

Analysing data relating to the various forms of management implemented at regional level shows that, where an integrated waste cycle exists, thanks to a developed plant infrastructure, landfill use is significantly reduced. The overall data are obviously affected by extra-regional waste flows, which may involve the treatment and/or disposal of higher or lower quantities than those actually produced in the region, as mentioned above in the case of waste sent to incineration plants. These aspects are examined in the following paragraphs, as part of the analysis of the various forms of management.

In general, a representation of data limited to the regional level alone could therefore be misleading. This is the case, for example, in Molise, where approximately 28% of CSS, dry fraction and biostabilised waste incinerated (down from 60.6% in 2022) comes from other regions, or even more so in Lombardy and Emilia-Romagna, where extra-regional shares of these flows account for 48.9% and 34.1% respectively of the total sent for incineration.

Figure 3.3 – Forms of municipal waste management at national level, years 2019 - 2023



	Landfilling	Incineration	Mechanical/ mechanical-biological treatment	Biotratment of organic fraction from SC	Home composting	Other material recovery	Energy recovery use
2019	6.283.307	5.521.648	10.280.019	6.387.270	266.762	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	8.446.117	6.650.660	300.674	8.330.134	334.242
2023	4.612.726	5.520.261	8.638.452	6.900.912	333.256	8.622.421	378.521

Source: ISPRA

With regard to the management of organic waste, it can be seen, for example, in the case of Campania, that out of a total of just under 630,000 tonnes of separate waste collection in 2023, only around 65,000 tonnes are recovered in plants in the region (10% of the total collected). In Lazio, with almost 565,000 tonnes of organic waste collected, excluding the portion sent for home composting, existing plants in the region treat just under 290,000 tonnes, corresponding to 51.8%, which is still an increase compared to 46.2% in 2022. Furthermore, Tuscany, which collects almost 505,000 tonnes of organic waste, excluding the portion destined for home composting, sees 52.1% of this waste managed in regional plants.

In 2023, domestic composting amounted to approximately 333,000 tonnes nationwide, showing an increase of almost 33,000 tonnes over the previous year.

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

The targets for preparing municipal waste for reuse and recycling were introduced by Directive 2008/98/EC, which initially set a target of 50% by weight to be achieved by 2020 (Article 11) and further targets for 2025 (55%), 2030 (60%) and 2035 (65%) established as a result of the amendments introduced by Directive 2018/851/EU (Article 11a). While more flexible calculation methods were identified for the 50% target, established by Decision 2011/753/EU, the accounting methods for the new targets are undoubtedly more rigid and were designed, through the enactment of Implementing Decision 2019/1004/EU, to ensure that the percentages calculated are truly representative of actual recycling capacity.

For the 2020 target, it was possible to select the types of waste to which the calculation would apply, provided that these types included at least "paper, metal, plastic and glass from households, and possibly from other sources, insofar as these waste streams are similar to household waste". Among the methodologies identified in Decision 2011/753/EU, Italy had chosen methodology 2 ("percentage of recycling of household and similar waste consisting of paper, metals, plastics and glass and other individual streams of household and similar

waste"), adding organic waste and wood to the mandatory streams and communicating this choice in the first monitoring report submitted in 2013.

In this section, are illustrated the monitoring data based on the methodology mentioned in Decision 2001/753/EU for the flows listed above, and monitoring data for the indicator relating to the recycling of municipal waste according to the criteria established in Article 11bis and Implementing Decision 2019/1004/EU, which, in addition to requiring a more rigorous methodological approach, no longer allow for the possibility of choosing which types of waste to apply the target measurement to, but require the assessment to be reported for the entire municipal waste stream.

More specifically, the above-mentioned Article 11bis states the following:

(a) Member States shall calculate the weight of municipal waste produced and prepared for reuse or recycled in a given calendar year;

b) the weight of municipal waste prepared for reuse shall be calculated as the weight of products and product components that have become municipal waste and have undergone all necessary control, cleaning or repair operations to enable their reuse without further sorting or pre-treatment;

c) the weight of recycled municipal waste shall be calculated as the weight of waste which, after undergoing all necessary control, sorting and other preliminary operations to remove waste materials that are not affected by subsequent reprocessing and to ensure high-quality recycling, is fed into the recycling operation where the waste materials are effectively reprocessed to obtain products, materials or substances.

2. For the purposes of paragraph 1(c), the weight of recycled municipal waste shall be measured at the point of entry into the recycling operation.

By way of derogation from the first subparagraph, the weight of recycled municipal waste may be measured at the output after any sorting operation, provided that:

(a) such output waste is subsequently recycled;

(b) the weight of materials or substances that are removed by further operations prior to the recycling operation and are not subsequently recycled is not included in the weight of waste reported as recycled.

Furthermore, based on the provisions of Article 11bis, paragraphs 4, 5 and 6:

- In order to calculate whether the targets have been achieved, the quantity of biodegradable municipal waste entering aerobic or anaerobic treatment may be counted as recycled if the treatment produces compost, digestate or other output with a similar amount of recycled content compared to the input, intended to be used as a recycled product, material or substance. Where the output product is used on land, Member States may only count it as recycled if its use results in benefits for agriculture or an improvement in the environment [...]";
- to calculate whether the targets set out in Article 11(2)(c), (d) and (e), and Article 11(3) have been achieved, the quantity of waste materials that have ceased to be waste as a result of a preparatory operation prior to reprocessing may be counted as recycled, provided that those materials are destined for subsequent reprocessing to obtain products, materials or substances to be used for their original purpose or for other purposes. However, materials that have ceased to be waste and are to be used as fuel or other means of energy production, or to be incinerated, used in backfilling or disposed of in landfills, shall not be counted towards the achievement of the recycling targets;
- in order to calculate whether the targets set out in Article 11(2)(c), d) and e), and Article 11(3) have been achieved, Member States may take into account the recycling of metals separated after the incineration of municipal waste, provided that the recycled metals meet certain quality criteria laid down in the implementing act adopted pursuant to paragraph 9 of this Article.

The new targets and the related calculation rules have been transposed into national law by Legislative Decree No 116/2020 and, in particular, the former by Article 181 of Legislative Decree No 152/2006, which already contained the 2020 target, and the latter by Article 205-bis.

Regarding the processing methods, it should be noted that some fractions included in the calculation of separate collection using the methodology set out in the Ministerial Decree of 26 May 2016 (see, in particular, multi-material collection waste and construction and demolition waste) cannot contribute to the achievement of the recycling targets set out in Directive 2008/98/EC.

In general, as specified in the text of Implementing Decision 2019/1004/EU, but also stated in the recitals of that decision, the calculation of the targets for 2025, 2030 and 2035, waste that is sent for recycling or waste that is no longer classified as such is counted, and, as a rule, recycled waste must be measured at the point of entry into the final recycling operation. Member States may, however, benefit from a derogation and measure municipal waste output after a sorting operation, provided that they deduct any additional waste resulting from treatment prior to the recycling operation and that the waste output is actually recycled.

As can be seen from the directive and the implementing decision, the method for determining the quantities sent for recycling is more complex than the previous provisions, as in this case it is necessary to apply the concept of "calculation point", according to the definitions identified for the various product categories in Annex I to the implementing decision.

In order to apply the procedures for determining recycled quantities, Eurostat has prepared specific guidelines ('Guidance for the compilation and reporting of data on municipal waste according to Commission Implementing Decisions 2019/1004/EC and 2019/1885/EC, and the Joint Questionnaire of Eurostat and OECD') in which it is clearly stated that the total weight of recycled waste must correspond to the weight of waste at the calculation points. The guidelines also include some considerations on best practices for identifying calculation points, as well as associated measurement methods and some options for obtaining data at each of the measurement points.

It should be noted that EU regulations distinguish between the concepts of "calculation point" and "measurement point", the latter being understood as the point at which the measurement is physically carried out in order to determine the proportion of waste recycled at the calculation point. The Eurostat guidelines also provide specific details on this aspect.

However, municipal waste entering the recycling process may still contain a certain amount of materials that are not subject to subsequent reprocessing but could not have been removed by reasonable effort through operations prior to final recycling. Member States should not be required to deduct such materials from the calculation of recycled municipal waste, provided that the recycling operation tolerates them and does not prevent high-quality recycling. However, it remains understood that, in accordance with Article 3(5) of the Implementing Decision, if a facility carries out preliminary treatment before the calculation point in that facility, the waste eliminated during the preliminary treatment is not included in the quantity of municipal waste recycled. Furthermore, if municipal waste fractions are sent for recovery operations where they are mainly used as fuel or other means of energy production, the quantity produced by the operations generating such combustible material cannot be counted as recycled, with the exception of metals separated and recycled after the incineration of municipal waste. Specific calculation methods for these are set out in Annex III to the implementing decision.

From the above, it is clear that the full application of the methodology established by the new European provisions requires particularly complex processing.

In order to acquire information on the quantities of waste entering final recycling operations, specific updates were made to the Environmental Mandatory Declaration (MUD) in 2021 through the introduction of a specific form for recycling data and information. This information was used as the basis for the calculations. Furthermore, in accordance with the provisions of the framework directive, the recycling data for certain product categories was verified using information on the quantities of secondary raw materials produced, again

using the MUD databases, starting from the quantities of waste collected.

In the case of organic waste, the quantities recycled were determined using the values relating to the input to composting and/or anaerobic digestion plants, net of waste from treatment processes, based on the guidelines provided by the implementing decision and Eurostat's application guidelines. In accordance with regulatory provisions, the quantities of organic fraction recycled included the amounts declared by municipalities as sent for domestic composting.

In addition, quantities (however residual) from the mechanical biological treatment of unsorted municipal waste subjected to recycling processes were also counted as recycled.

Given that European legislation excludes construction and demolition waste from the calculation of municipal waste, although national legislation includes certain types of such waste in the calculation of separate collection, the data presented below show the recycling rate calculated net of inert waste. More specifically, the total production of municipal waste is determined by ISPRA on the basis of the provisions contained in the Ministerial Decree of 26 May 2016 containing the "Guidelines for calculating the percentage of separate collection of municipal waste" which, starting from 2016, leads to the inclusion of construction and demolition waste in separate collection (only codes 170107 and 170904) limited to the quantities resulting from small removal operations carried out directly by the occupant of the residential building. In 2022, this waste amounts to 422,000 tonnes, corresponding to 1.4% of total municipal waste production. The accounting methods identified by the decree differ, for this type of waste, from the definition of municipal waste given in 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 cannot, therefore, be counted towards the recycling targets for this type of waste. For this reason, such waste has been excluded from the calculation of the recycling rate.

It should be noted that this measurement procedure, in line with the provisions of Implementing Decision 2019/1004/EU, has also been applied to determine the recycled quotas for the purposes of monitoring the 2020 target through the application of methodology 2 referred to in Decision 2011/753/EU, thus adopting a more restrictive approach than that established by the latter decision.

Based on estimates made by ISPRA using the databases at its disposal, municipal waste shows the product composition reported in Table 3.1. The percentages shown in this table represent average values, calculated for the period between 2009 and 2022 (the last year for which product analysis data is available) by combining data on the product composition of unsorted municipal waste, derived from product analyses available to ISPRA, with data on the separate collection of the various fractions.

At national level, almost 35% of the waste produced annually is organic waste, consisting of biodegradable waste from kitchens and canteens, waste from markets, and waste from the maintenance of gardens and parks. Just under 22% is paper and cardboard, just under 13% is plastic and 8.3% is glass.

Table 3.1 – Municipal waste composition estimated by ISPRA (average 2009 – 2022*)

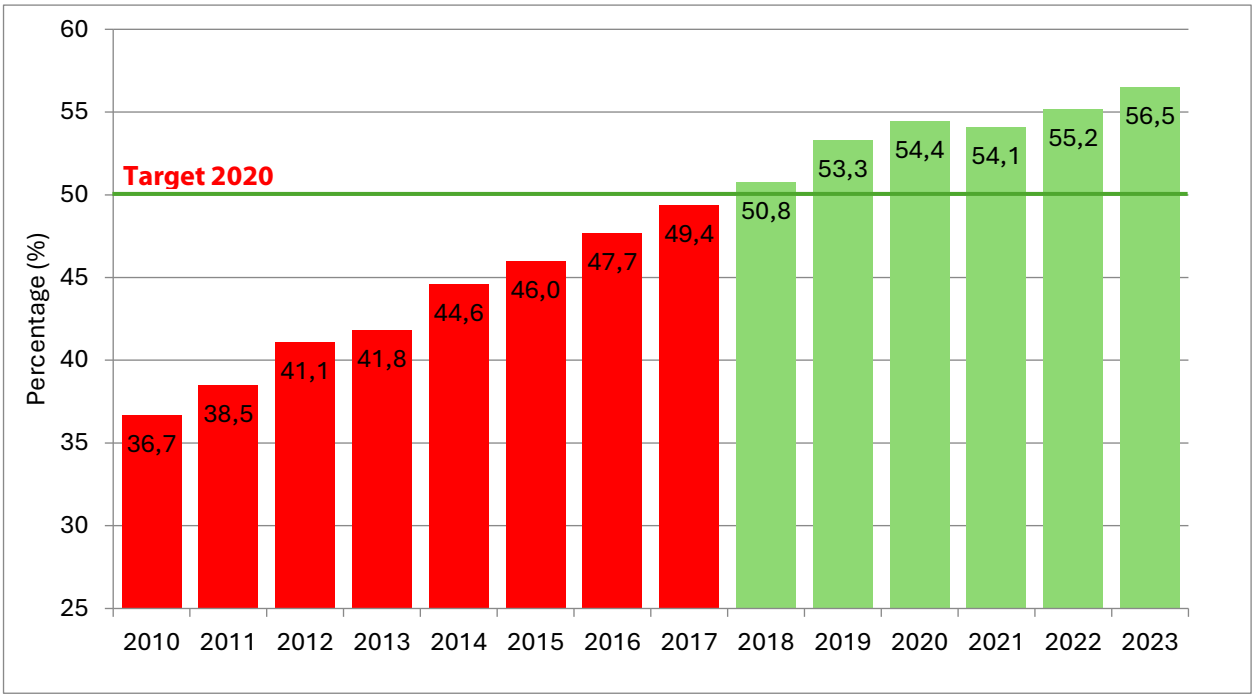
Fractions	North	Centre	South	Italy
	(%)			
Bio-waste (biodegradable kitchen and canteen wastes + garden and park wastes)	34,0	30,5	38,9	34,7
Paper and cardboard	21,4	24,3	20,6	21,8
Plastics	11,9	14,5	13,0	12,8
Metals	2,4	2,5	2,3	2,4
Glass	9,6	6,9	7,4	8,3
Wood	4,9	2,8	1,9	3,5
WEEE	-	-	-	1,0
Clothes/Textiles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

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

Regarding the monitoring of target set for 2020 in Article 11, paragraph 2, letter a) of the Framework Directive, applying methodology 2 of Decision 2011/753/EU, the data processing reveals a total recycling rate for paper and cardboard, plastic, metal, glass, wood and organic waste of 56.5% in 2023, which is more than 6 percentage points above the target. It should be noted that this target has been achieved since 2018, when the recycling rate stood at 50.8%. The organic fraction contributes 43.7% to this target, paper and cardboard 25.9%, glass 14.8%, wood 7%, plastic 5.7% and metals 3%.

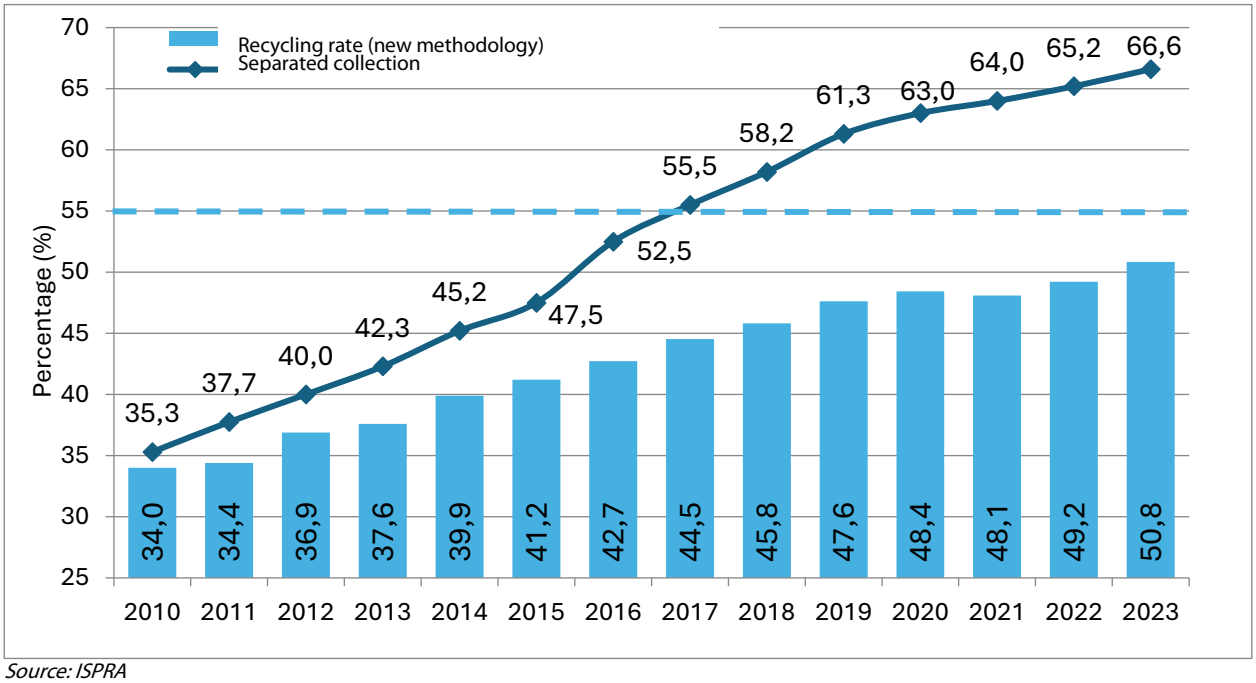
Regarding the monitoring of targets referred to in Article 11(2)(c) to (e) of the Framework Directive, in accordance with the criteria set out in Article 11a of that Directive and the methodology set out in Implementing Decision 2019/ 1004/EU, which take into account the entire municipal waste stream, the percentage of preparation for reuse and recycling in 2023 is 50.8% (Figure 3.5), an increase of 1.6 percentage points compared to the value recorded in 2022. For the first time, the calculation made by applying the procedure in line with the new provisions leads to a percentage higher than the target set for 2020.

Figure 3.4 – Trend in the recycling rate of the following fractions of municipal waste: paper and cardboard, plastics, metals, glass, wood and organic waste (methodology 2 of Decision 2011/753/EU)



Source: ISPRA

Figure 3.5 - Recycling rates calculated in accordance with Article 11-bis of Directive 2008/98/EC (net of quantities of C&D waste from separate collection), years 2010–2023

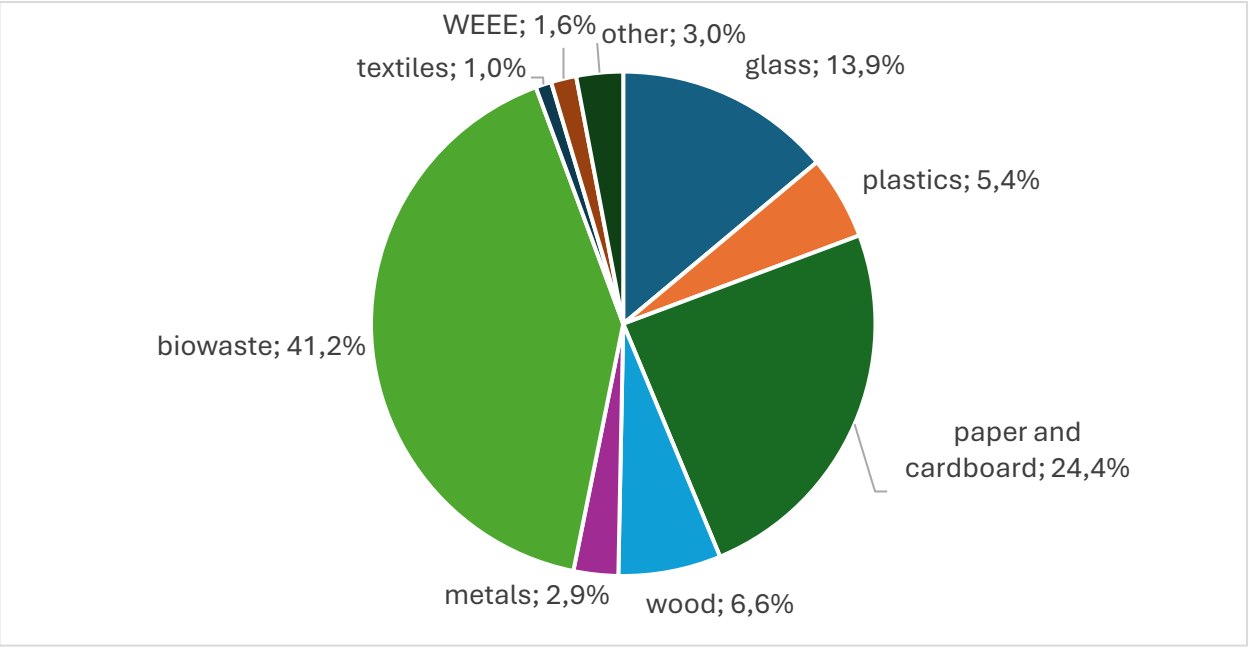


Source: ISPRA

When it comes to separate waste collection rates, there's a difference of 15.8 percentage points, which shows that even though collection is a key step in making sure we get consistent, recyclable waste streams, it can't just be about getting high rates. It's also important that the different types of waste collected are of high quality so they can actually be recycled. The development of collection must also be accompanied by the availability of an adequate plant management system.

The breakdown of the quantity sent for recycling by product fraction (Figure 3.6) shows that 41.2% (slightly higher than 41% in 2022) consists of organic waste and 24.4% of paper and cardboard (24.9% in 2022). Glass accounts for 13.9% (down from 14.4% in 2022), wood for 6.6% (6.4% in 2022) and plastic for 5.4% (the same percentage as in 2022, 5.5% in 2021 and 4.6% in 2020).

Figure 3.6 – Percentage breakdown of the quantity of municipal waste sent for recycling, year 2023



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.

In recent years, there has been a significant increase in the separate collection of organic waste, although some areas have not yet reached optimal levels. This trend has led to significant development in the biological treatment sector, which has evolved through the adoption of innovative plant technologies. Alongside traditional aerobic treatment systems aimed at producing soil improvers for use in agriculture, the national plant system, also through the conversion of existing plants, has been equipped over the years with integrated systems that combine this treatment method with anaerobic digestion, thus combining material recovery with energy recovery, limiting emissions and, finally, using the biogas generated and purified for the production of energy and biomethane.

In 2023, the entire sector will continue to be characterised by the modernisation of the national plant network, with a reduction of 10 composting units, offset by the entry into operation of 10 integrated treatment plants (7 of which are being converted from aerobic treatment and 3 are newly built) and 5 new anaerobic digestion-only plants. This will result in a further increase in overall treatment capacity from approximately 12 million tonnes to 12.3 million tonnes.

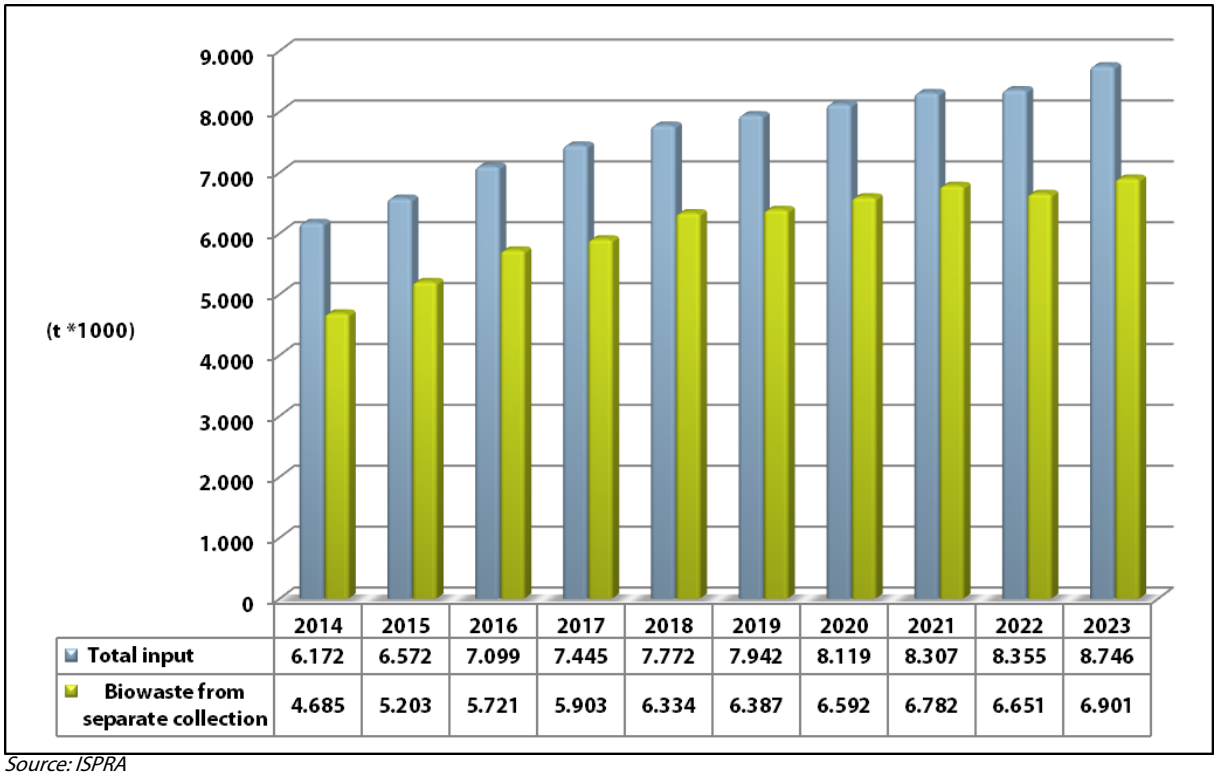
In 2023, the entire system will consist of 363 operating units, specifically:

- 275 plants dedicated solely to aerobic treatment (composting);
- 61 integrated anaerobic/aerobic treatment plants;
- 27 anaerobic digestion plants.

Figure 3.2.1 shows the trend in the quantities of waste managed in the period from 2014 to 2023, with details referring to the organic fraction from separate collection (wet + green). Analysis of the data shows a progressive growth in the sector, both in terms of the total quantities treated (+41.7% between 2014 and 2023) and in terms of the organic fraction alone, whose quantities increased by 47.3% over the same period.

In 2023, the total quantity of waste recovered through biological treatment processes (8.7 million tonnes) will increase by approximately 392,000 tonnes compared to 2022, corresponding to 4.7%. A similar trend can also be seen in the share of organic waste from separate collection, which rose from approximately 6.7 million tonnes to 6.9 million tonnes, an increase of 250,000 tonnes (+3.8%). The latter shows a greater contribution from biodegradable waste from the maintenance of gardens and parks (LoW code 200201) which, in line with the increase in separate collection, shows an increase of 258,000 tonnes, equal to 15.8%, in contrast to the two-year period 2021 – 2022, when there was a loss of 138,000 tonnes. A slight increase of 2,000 tonnes (+5.4%) was also recorded in the share of market waste (LoW code 200302), while the figure for biodegradable waste from kitchens and canteens (LoW code 200108) remained stable, with a moderate reduction of approximately 10,000 tonnes (-0.2%), is back in line with the 2021 figure.

Figure 3.2.1 – Quantities of waste subjected to biological treatment, 2014–2023

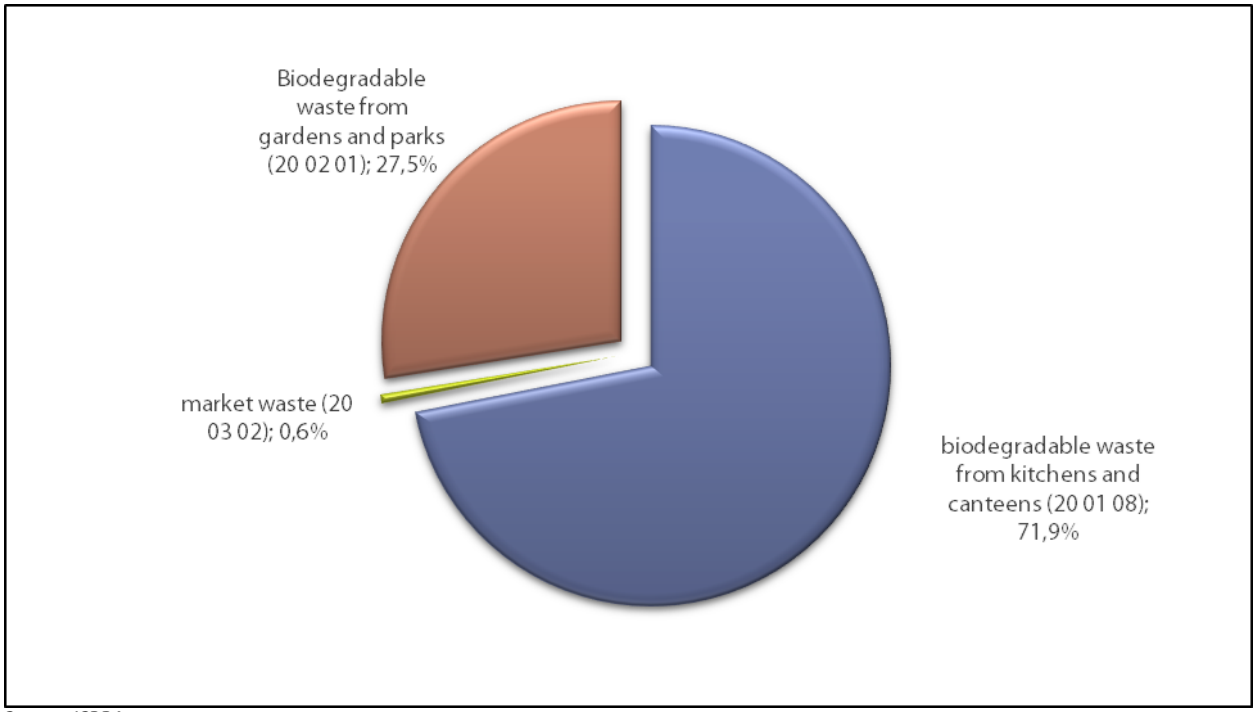


	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Total input	6.172	6.572	7.099	7.445	7.772	7.942	8.119	8.307	8.355	8.746
Biowaste from separate collection	4.685	5.203	5.721	5.903	6.334	6.387	6.592	6.782	6.651	6.901

Source: ISPRA

The organic fraction from separate collection managed in 2023 consists mainly of "biodegradable waste from kitchens and canteens" (LoW code 200108), with a quantity of approximately 5 million tonnes, equal to 71.9% of the total. 'Biodegradable waste' from gardens and parks (LoW code 200201), with approximately 1.9 million tonnes, represents 27.5%, while 'market waste' (LoW code 200302), with over 40,000 tonnes, accounts for 0.6% (Figure 3.2.2).

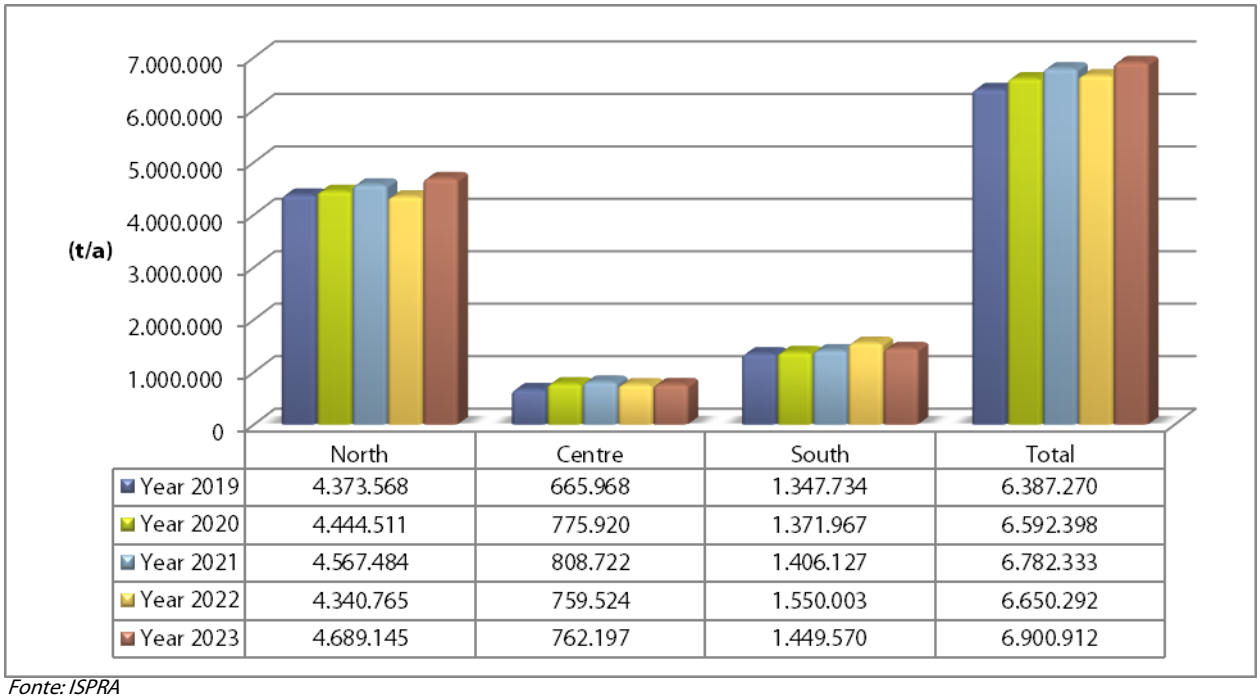
Figure 3.2.2 – Composition of organic waste from separate collection undergoing biological treatment, year 2023



Source: ISPRA

The trend in the quantities of organic waste treated at the macro-geographical area level (Figure 3.2.3) shows a reversal of the trend compared to 2022, with the northern regions, after the reduction that characterised the two-year period 2021-2022, seeing an increase of over 348,000 tonnes, corresponding to 8%. The evolution in the methods of treating organic fractions of RD in this area of the country is characterised by a reduction of 6 units in the composting sector, which contrasts with the entry into operation of 4 integrated treatment plants, 3 of which have been converted from aerobic treatment, and 4 new anaerobic digestion plants. Even in the central regions, where organic waste treatment remains stable (+3,000 tonnes, +0.4%), the plant infrastructure has changed with the reduction of 4 composting units and the simultaneous increase in integrated treatment plants (+2 units compared to 2022, one of which has been converted from aerobic treatment) and anaerobic digestion plants, the number of which has increased by a further unit. The trend appears to be different in the southern regions, which have seen a reduction of over 100,000 tonnes in the organic fractions treated in the plants, corresponding to a 6.5% decrease, compared to the separate collection data, which is substantially stable compared to 2022 (a reduction of approximately 5,000 tonnes, -0.2%); the plant network, which remains unchanged in terms of composting and anaerobic digestion, has seen an increase of four units in the integrated treatment sector, three of which are newly built and one resulting from the conversion from aerobic treatment.

Figure 3.2.3 – Biological treatment of the bio-waste fraction from separate waste collection, year 2023, by geographic area, years 2019 – 2023

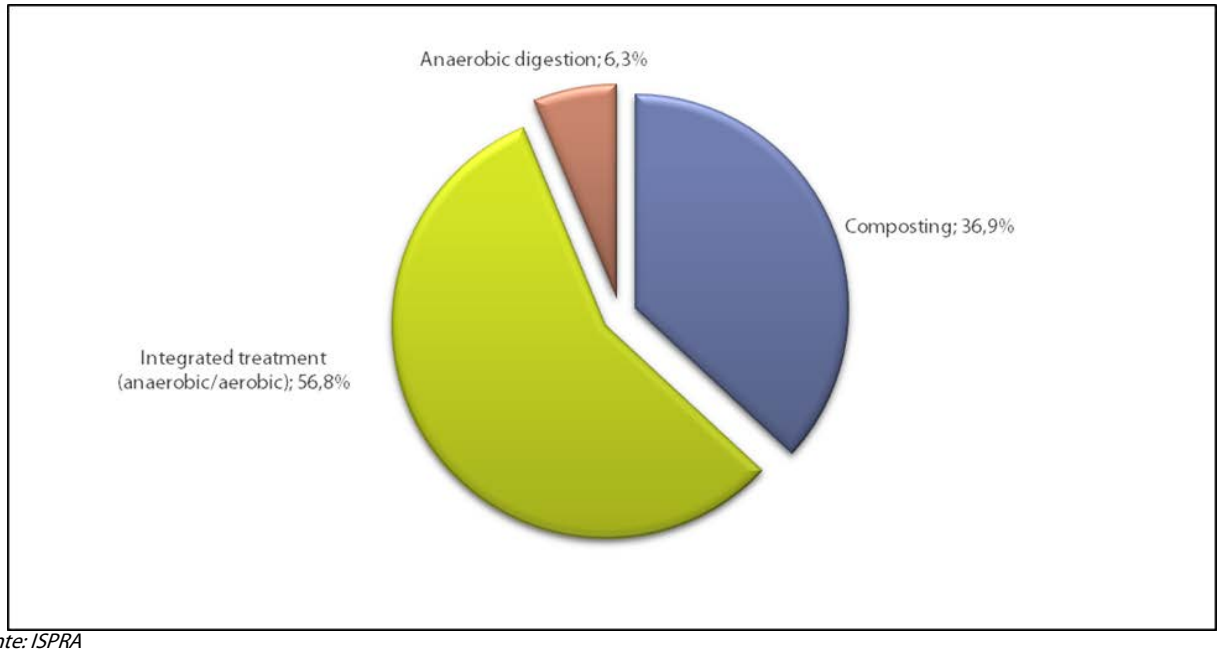


	North	Centre	South	Total
Year 2019	4.373.568	665.968	1.347.734	6.387.270
Year 2020	4.444.511	775.920	1.371.967	6.592.398
Year 2021	4.567.484	808.722	1.406.127	6.782.333
Year 2022	4.340.765	759.524	1.550.003	6.650.292
Year 2023	4.689.145	762.197	1.449.570	6.900.912

Fonte: ISPRA

Figure 3.2.4 shows the percentage breakdown of the different types of biological treatment of organic waste adopted at national level. The analysis of the data confirms the trend already noted in the previous edition of the Waste Report, highlighting the now predominant role of integrated (anaerobic/aerobic) treatment, which, with a quantity of 3.9 million tonnes, contributes to the recovery of these fractions by 56.8%, an increase of 6 percentage points compared to 2022. The composting sector, with a quantity of over 2.5 million tonnes, contributes 36.9% (44.4% in 2022). The remaining 6.3% (+1.5 percentage points compared to 2022), equal to approximately 433,000 tonnes, is managed in anaerobic digestion plants.

Figure 3.2.4 – Biological treatment of the bio-waste fraction from separate waste collection, year 2023



Fonte: ISPRA

The graph in Figure 3.2.5, which analyses the evolution of the quantities subjected to different types of management in the period from 2019 to 2023, shows that the composting sector, with a reduction of 10 operational plants, seven of which have been converted to integrated treatment (anaerobic/aerobic), is experiencing a progressive decline, which in the last year stood at 410,000 tonnes, equal to 13.9% less than in 2022 (compared to 2019, the decline is equal to -595,000 tonnes, -19%).

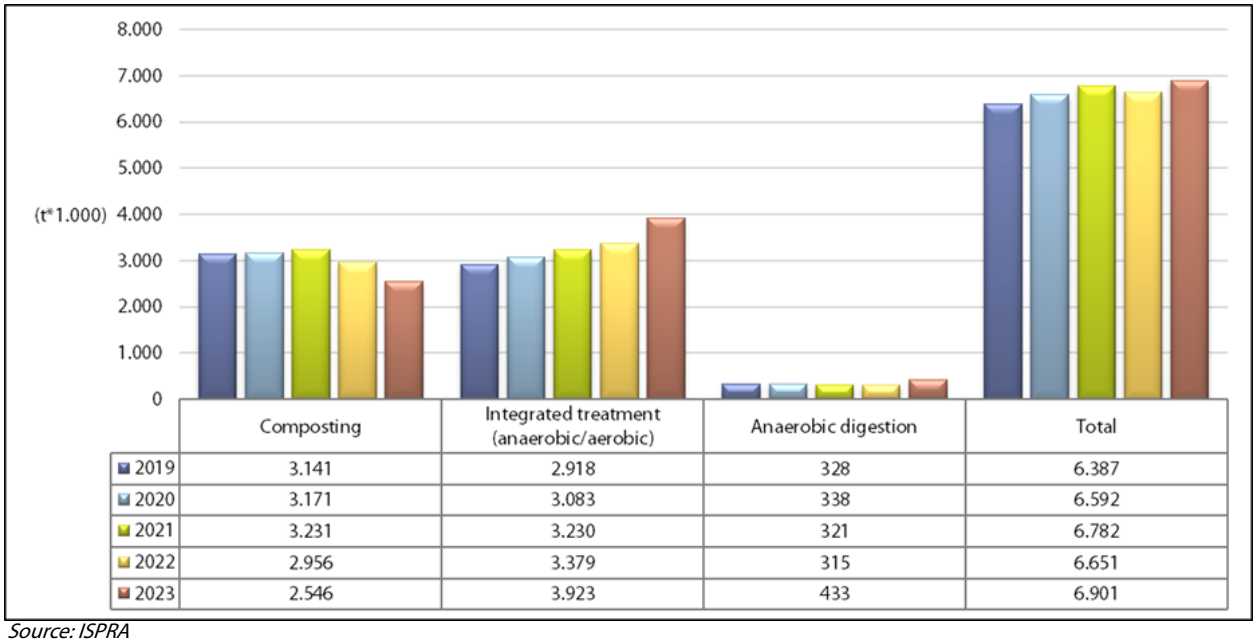
On the other hand, there has been steady growth in integrated treatment which, thanks in part to the increase in the number of operational units (+10 plants between 2022 and 2023), has seen a further increase of 543,000 tonnes, corresponding to 16.1% (+34.4% compared to 2019). Anaerobic digestion also shows a similar trend, with the entry into operation of five new plants, recording growth of 118,000 tonnes between 2022 and 2023, corresponding to 37.3% (+32% compared to 2019).

The analysis of the data therefore confirms the growing interest in dedicated anaerobic processes, especially when combined with aerobic treatment, in the treatment of organic fractions from separate waste collection. Integrated (anaerobic/aerobic) treatment plants, the number of which increased by 20 between 2019 and 2023, have proved to be decisive in the increase in the quantities of organic waste recovered, precisely because of the possibility of producing, on the one hand, quality soil improvers that comply with the characteristics required by the regulations on fertilisers for use in agriculture, and, on the other hand, to use the biogas generated directly for the cogeneration of electricity and heat and/or, after further purification, for the production of biomethane for transport and other uses in place of natural gas. In fact, interest in biogas upgrading technology for the production of biomethane is also growing. Between 2022 and 2023, the number of integrated (anaerobic/aerobic) treatment plants equipped with this biogas purification technology will increase from 23 to 36, some of which are already operational, and others started up in the last year. In the north of the country, Lombardy has 9 operational units of this type, followed by Piemonte (5 plants), Emilia-Romagna (4 plants) and Veneto (3 plants), while Trentino-Alto Adige (TN), Friuli-Venezia Giulia (PN) and Liguria (SV) each have one unit. In central Italy, there are four plants in operation, two in Tuscany (AR and GR) which began operating in 2023, one in Umbria (PG) and one in Lazio (RM), while there are eight in southern Italy, located in Abruzzo, Puglia, Calabria and Sicily. Each of these regions has two units; the recently built ones, located in the provinces of L'Aquila, Teramo, Catanzaro and Trapani, have been operating on a trial basis and began producing biomethane in the last months of 2023.

There are also 13 plants dedicated to anaerobic digestion (6 in 2022). Again, Lombardy (4 units) has the largest number of plants; those that came into operation in 2023 are located in the provinces of Milan and Mantua, while those already operational in previous years are located in Lodi and Cremona. The other 5 plants in the North are distributed in Veneto (3 plants), in the provinces of Padua and Verona, the latter with a new plant, and in Emilia-Romagna (RA and MO). In the Centre, there are two plants in operation, one of which started operating in 2023, both located in the province of Latina. Finally, in the South, Molise has two plants in the province of Campobasso, one of which, already in operation, began producing biomethane in 2023.

Finally, other plants are expected to start up, either newly built or converted from aerobic to integrated treatment, most of which are equipped with biomethane production technology, located in Piemonte, Veneto, Friuli-Venezia Giulia, Liguria, Emilia-Romagna, Abruzzo, Campania, Puglia, Calabria and Sardinia.

Figure 3.2.5 – Biological treatment of the bio-waste fraction from separate collection, by type of management, years 2019 – 2023



	Composting	Integrated treatment (anaerobic/aerobic)	Anaerobic digestion	Total
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
2023	2.546	3.923	433	6.901

Source: ISPRA

The analysis of the data reported so far highlights how the biological treatment sector, which must respond adequately to the growing demand for the treatment of organic fractions from separate waste collection, is characterised by constant evolution, both in terms of quantity and treatment methods. The recovery and recycling targets for organic waste set by sector regulations and the strategies outlined for this purpose by the PNRR and then by the PNGR, together with the National Strategy for the Circular Economy, provide precise indications on the recovery performance of this important waste stream, which can be achieved through a modern network of plants adapted to the treatment needs of each region. As we have seen, much progress has been made in recent years in the recovery of organic fractions, but the data still show a significant gap between the northern regions and those in the centre and south, which are affected by the considerable delays in the process of renewing the plant network and still have many obsolete plants with treatment capacities that are inadequate for internal needs. It should be noted, however, that adequate plant equipment may not effectively meet the objectives set by the legislation if it is not combined with separate collection of sufficient quality, which is a necessary condition for achieving the best recovery performance of this important waste stream in order to obtain, on the one hand, the production of soil improvers that meet the specifications of the legislation on fertilisers and/or biogas for the production of energy and biomethane and, on the other hand, the consequent reduction of waste destined for final disposal in landfills.

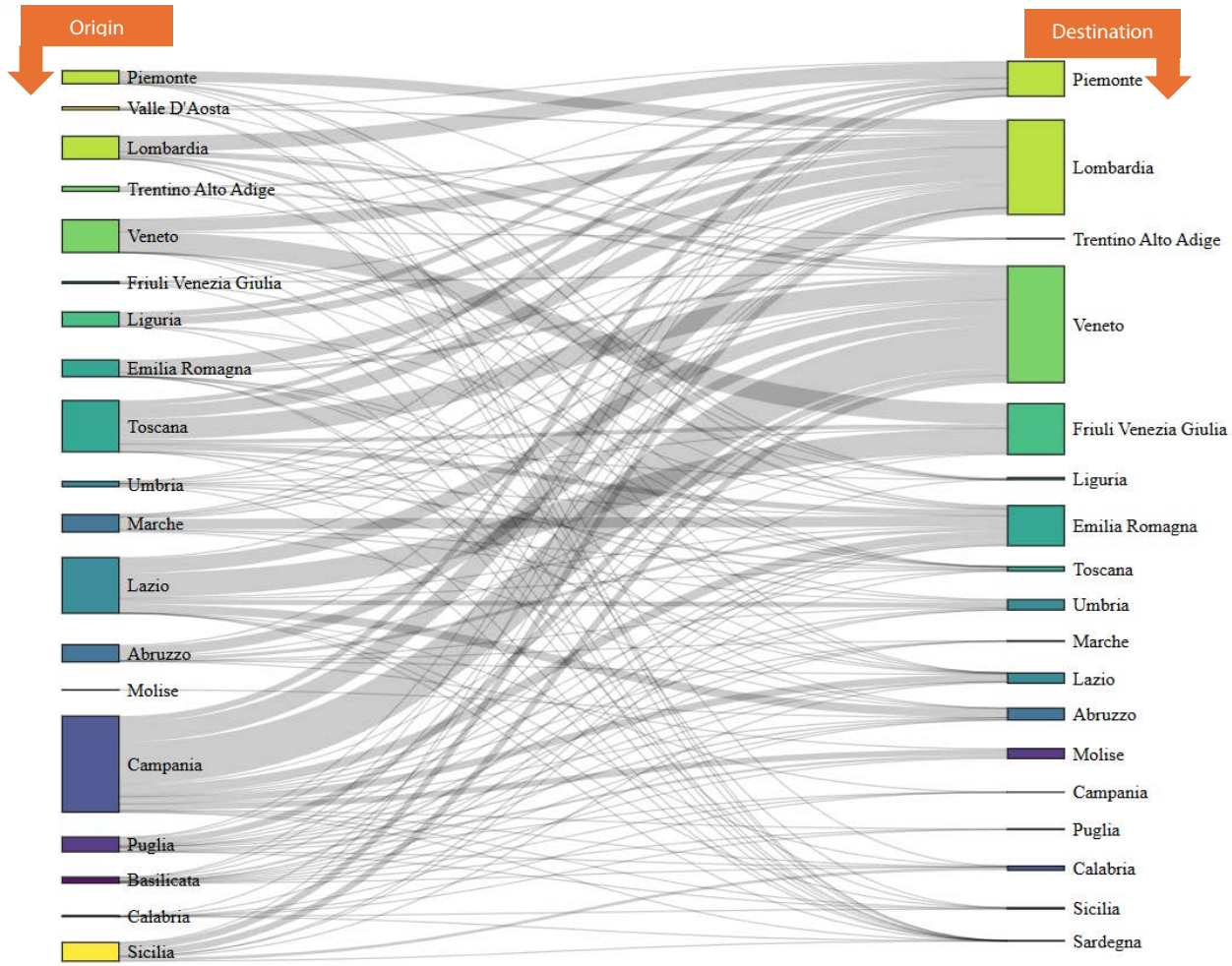
Studies conducted by the Italian Composters Consortium (CIC), through numerous product analyses of organic waste samples from separate collection, show that the organic waste collected in our country is generally characterised by good quality. However, in recent years there has been an increase in the non-compostable fractions contained in such waste, mainly represented by plastics (non-compostable bags that do not meet the characteristics set by the technical standards of the sector) but also by other fractions such as nappies and glass.

In the three-year period 2020 - 2022, there was a reduction in the recycling percentage of organic waste from 81.2% in the year 2020, to 80.7% in 2021 and 79.9% in 2022, a decrease of 1.3 percentage points over the three-year period. In the year 2023, where there is an increase of 3.1% in the separate collection of organic waste (+227 thousand tonnes compared to 2022) combined, as we have seen, with a significant increase in the quantities managed through biological treatment, there is instead a reversal of the trend, with the recycling percentage increasing again to 80.9%, a value that is still below that recorded in 2020 but which seems to show an improvement in treatment performance.

The percentage of waste in relation to the total sent to biological treatment also shows a similar trend. In fact, unlike what was recorded in the three-year period 2020 - 2022, which had seen this percentage gradually increase (from 12.9% in 2020, to 13.1% in 2021 and 13.9% in 2022), the last year is instead characterised by a reduction that brings this percentage to 13.6% of the total sent to biological treatment. However, the trend at the level of the geographical macro-area does not entirely reflect the national one. In Northern Italy, which is characterised, however, by a lower rate of waste than in the Centre-South areas, there is a constant growth that brings this percentage from 10.9% in 2020, to 11% in 2021, 11.9% in 2022 and 12.4% in 2023. On the other hand, the trend improves in the central regions whose plants see the percentage of waste produced fall by a good 5 percentage points compared to 2022 (from 19.8% to 14.8%). In the South, the trend appears to be stable, with the percentage standing at 17.3% of the total sent to biological treatment in 2022.

Figure 3.2.6 shows data on organic waste streams sent outside the region. In this regard, a similar trend to that found in previous editions of the Report is outlined, with the largest flows of sorted organic matrices coming from Campania (over 476 thousand tonnes, or 24.4% of the total), Lazio (276 thousand tonnes, or 14.2% of the total) and Tuscany (over 254 thousand tonnes, or 13.1% of the total), some of which have obsolete infrastructures and inadequate treatment capacity to handle their organic waste.

Figure 3.2.6 - Transfer of the bio-waste from separate collection, in non-regional territories, by region, year 2023

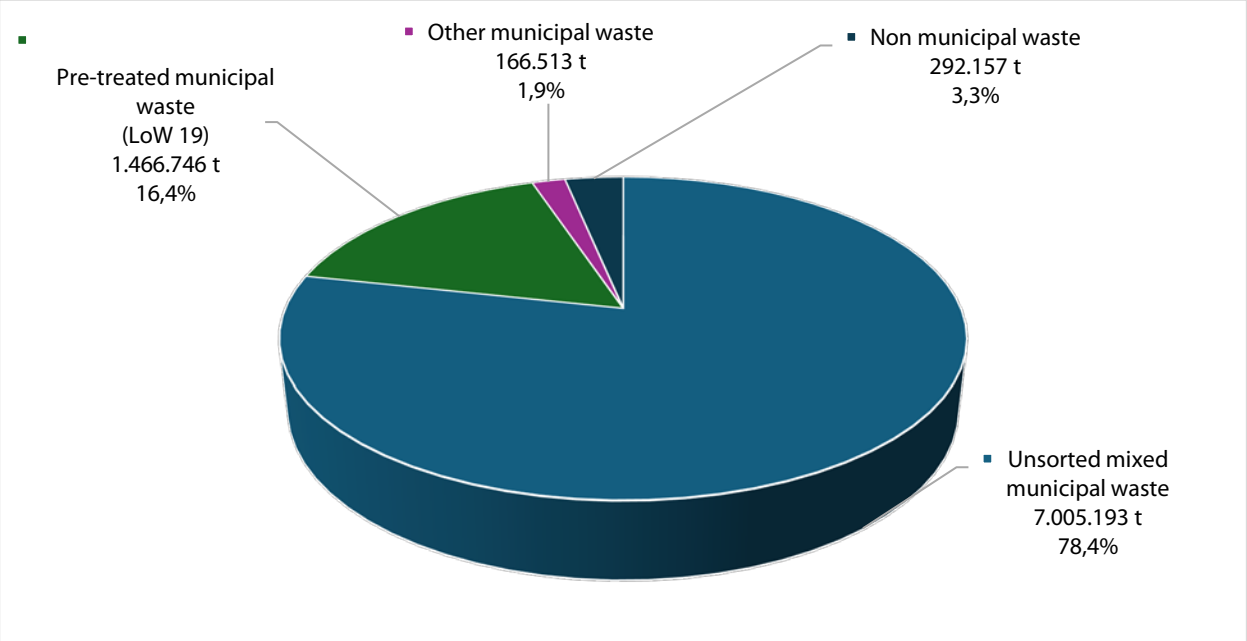


Source: ISPRA

3.3 Aerobic mechanical-biological treatment

In 2023, the waste sent for mechanical biological treatment or mechanical treatment alone will amount to almost 9 million tonnes, 78.4% of which will consist of undifferentiated municipal waste (7 million tonnes), 16.4% of waste from the treatment of municipal waste and the treatment of other waste from Chapter 19 of the European list (over 1, 4 million tonnes), 1.9 % (more than 166,000 tonnes) from other product fractions of municipal waste (paper, plastic, metals, wood, glass and organic fractions from separate collection) and, finally, 3.3 % from non-municipal waste from industrial sectors (agro-industry, wood processing, etc.), with an amount of), amounting to 292 thousand tonnes (Figure 3.3.1).

Figure 3.3.1 - Quantity of waste entering MBT/MT plants (tonnes), year 2023

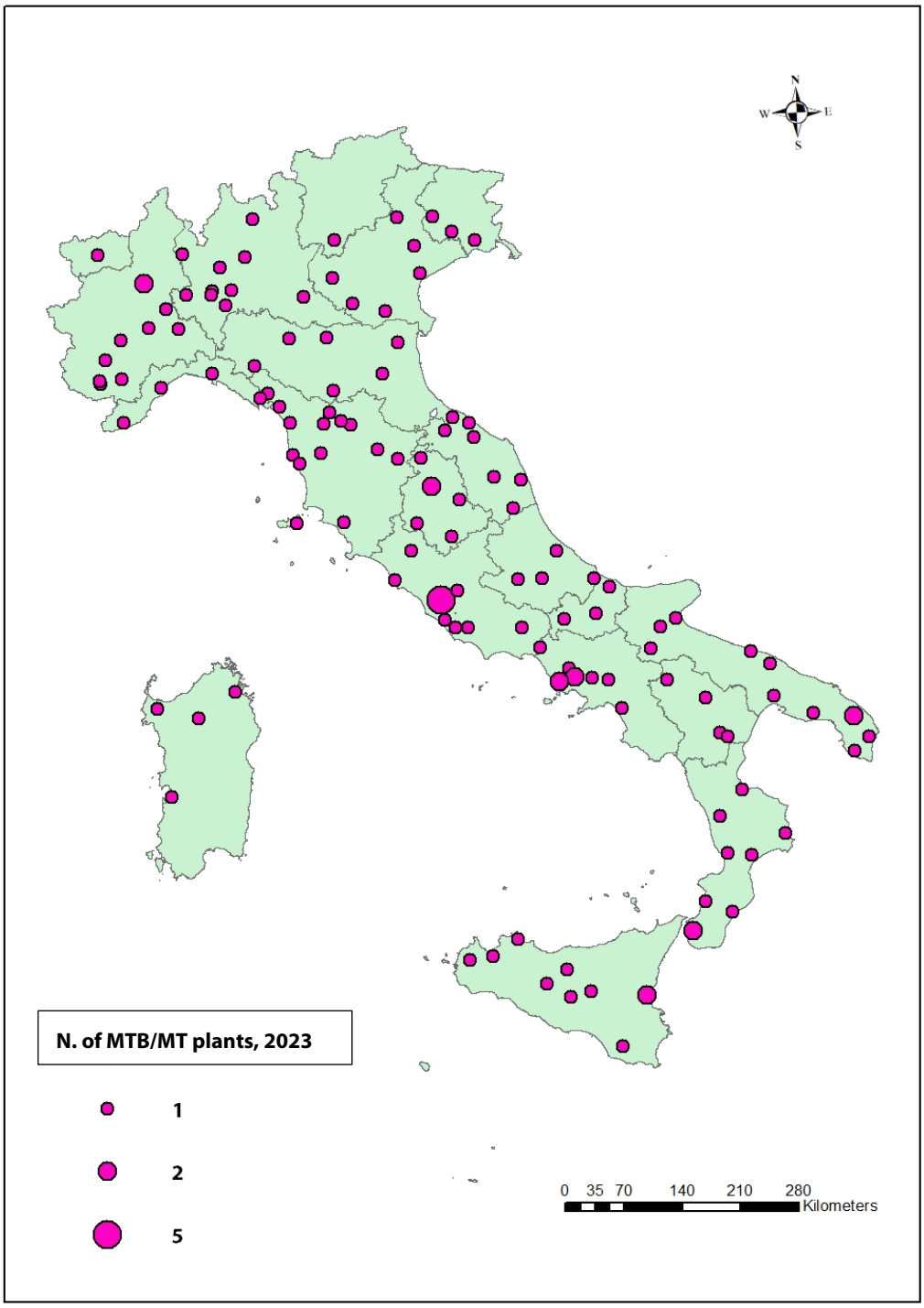


Source: ISPRA

The operating plants surveyed in the country (134) include 34 plants that only perform mechanical treatment (MB) of undifferentiated municipal waste. The latter also includes some MBT plants that did not perform the biostabilisation process of the organic fraction in the year under review.

The regional distribution of plants is shown in Figure 3.3.2; in particular, in the North there are 41 plants (including 14 TM plants), in the Centre 40 (16 MT) and in the South 53 (4 MT).

Figure 3.3.2 – Regional distribution of MBT/MT plants, year 2023



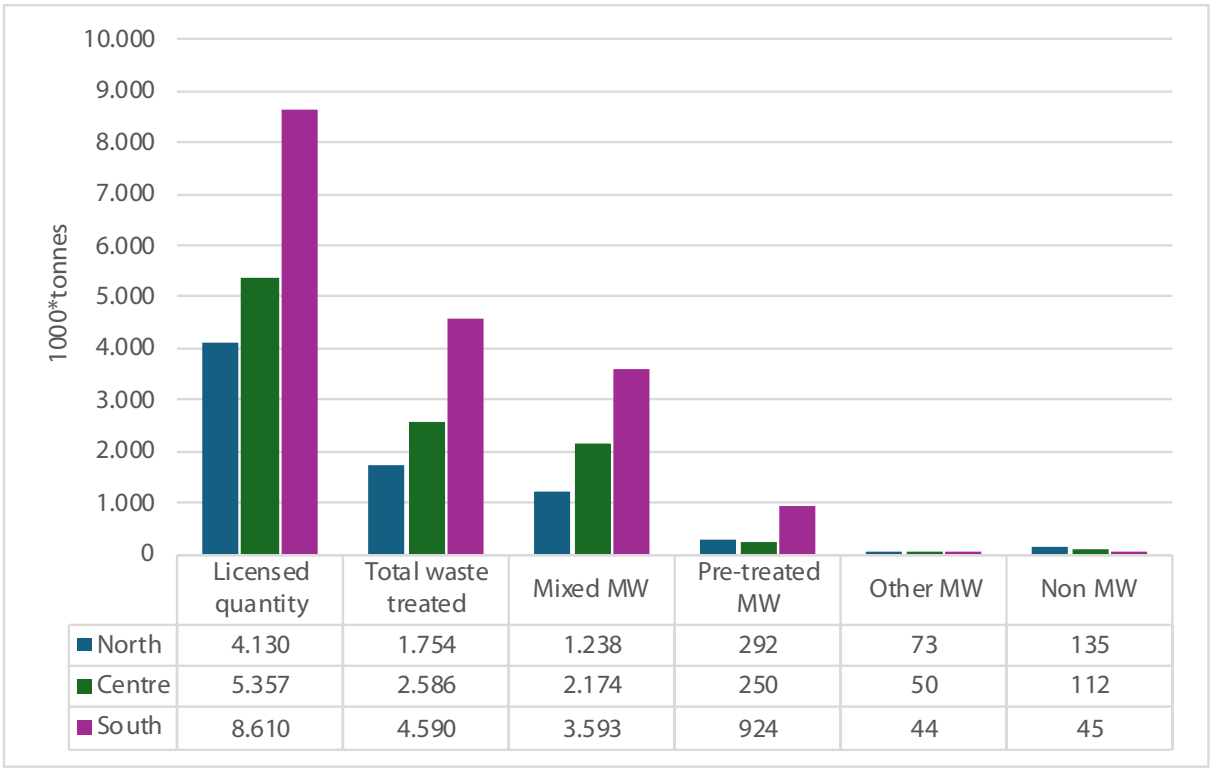
Source: ISPRA

In the North, just over 1.7 million tonnes of municipal waste were treated, of which more than 1.2 million tonnes were mixed municipal waste (70,6% of the total), the rest being pre-treated municipal waste (292 thousand tonnes, 16,6%), fractions from separate collection (almost 73 thousand tonnes, 4,1%) and waste from economic activities (almost 135 thousand tonnes, 7,7%).

In the Centre, were treated more than 2.6 million tonnes, of which almost 2.2 million tonnes were mixed municipal waste, 84,1% of the total. The remaining part consisted of pre-treated municipal waste (almost 250thousand tonnes, 9,7% of the total), fractions from separate collection (over 50 thousand tonnes, 1,9%) and waste from economic activities (over 112 thousand tonnes, 4,3%).

In the South, treated waste amounts to almost 4.6 million tonnes, of which approximately 3.6 million tonnes is undifferentiated municipal waste (78.2% of the total treated). The remaining types of waste consist of pre-treated RU (over 924 thousand tonnes, 20% of the total), RU fractions (over 43 thousand tonnes, 0.9%) and non-municipal waste (45 thousand tonnes, 0.9%). The South is the macro-area that sends the largest amount of municipal waste to intermediate mechanical biological treatment before a final destination of recovery or disposal. Figure 3.3.3 provides details by macro-area of the authorised quantities, as well as the types and quantities of waste treated by the plants under consideration.

Figure 3.3.3 – Types of waste treated in MBT/MT plants, by geographical macro-area (tonnes), year 2023

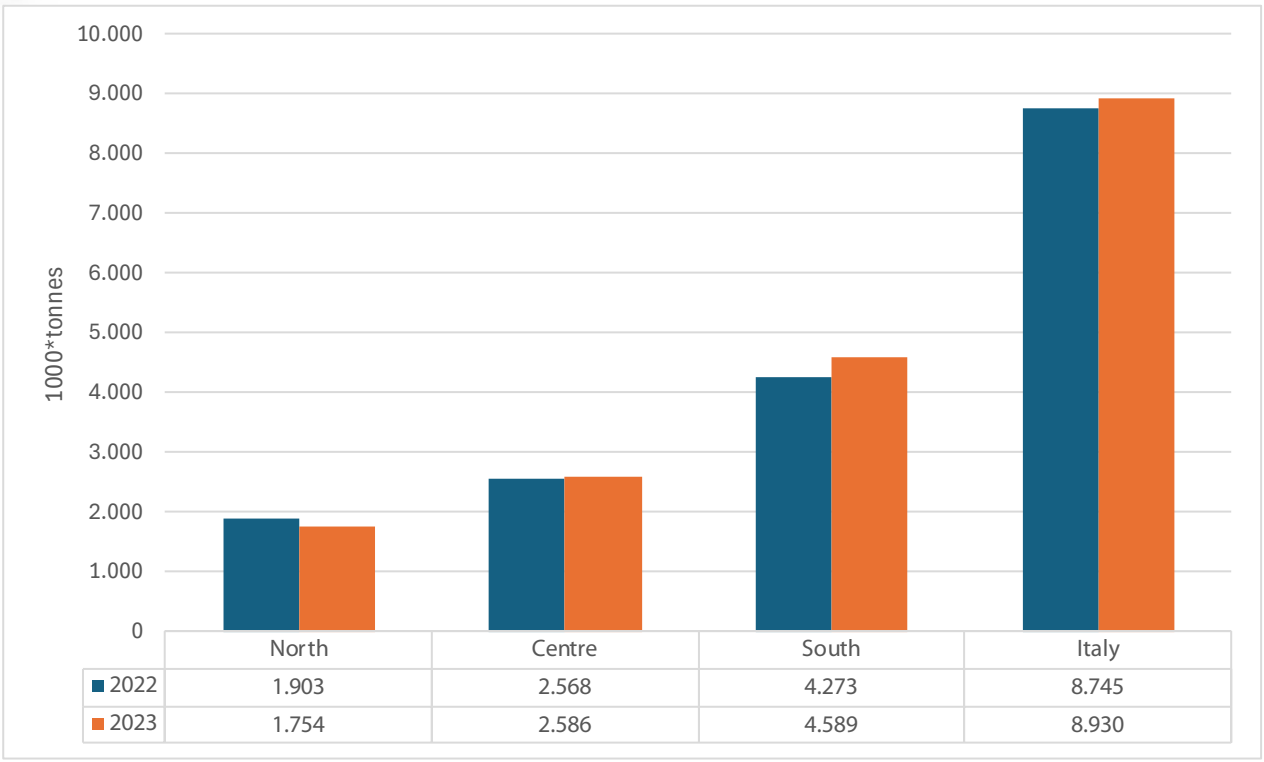


	Licensed quantity	Total waste treated	Mixed MW	Pre-treated MW	Other MW	Non MW
North	4.130	1.754	1.238	292	73	135
Centre	5.357	2.586	2.174	250	50	112
South	8.610	4.590	3.593	924	44	45

Source: ISPRA

Compared to 2022, there is an increase in the quantities treated of more than 185 thousand tonnes (+2.1%), which can be attributed exclusively to an increase in the quantities of LoW Chapter 19 waste, resulting from the treatment of municipal waste, while the quantity of undifferentiated waste decreases by 1.7% (124 thousand tonnes). The quantity of pretreated waste increased by 29.9% (approximately 338 thousand tonnes), other municipal waste fractions decreased by 11.3% (21 thousand tonnes) and non-municipal waste decreased by 2.3% (approximately 7 thousand tonnes). This increase can be seen, in particular, in the macro-areas of the Centre and the South where the quantities of waste treated increased by over 18 thousand tonnes (+0.7%) and over 316 thousand tonnes (+7.4%) respectively. On the other hand, the Northern macro area records a reduction of 7.8% (about 149 thousand tonnes) (Figure 3.3.4).

Figure 3.3.4 - Waste treated in MBT/MT plants (1000*t), years 2022 – 2023

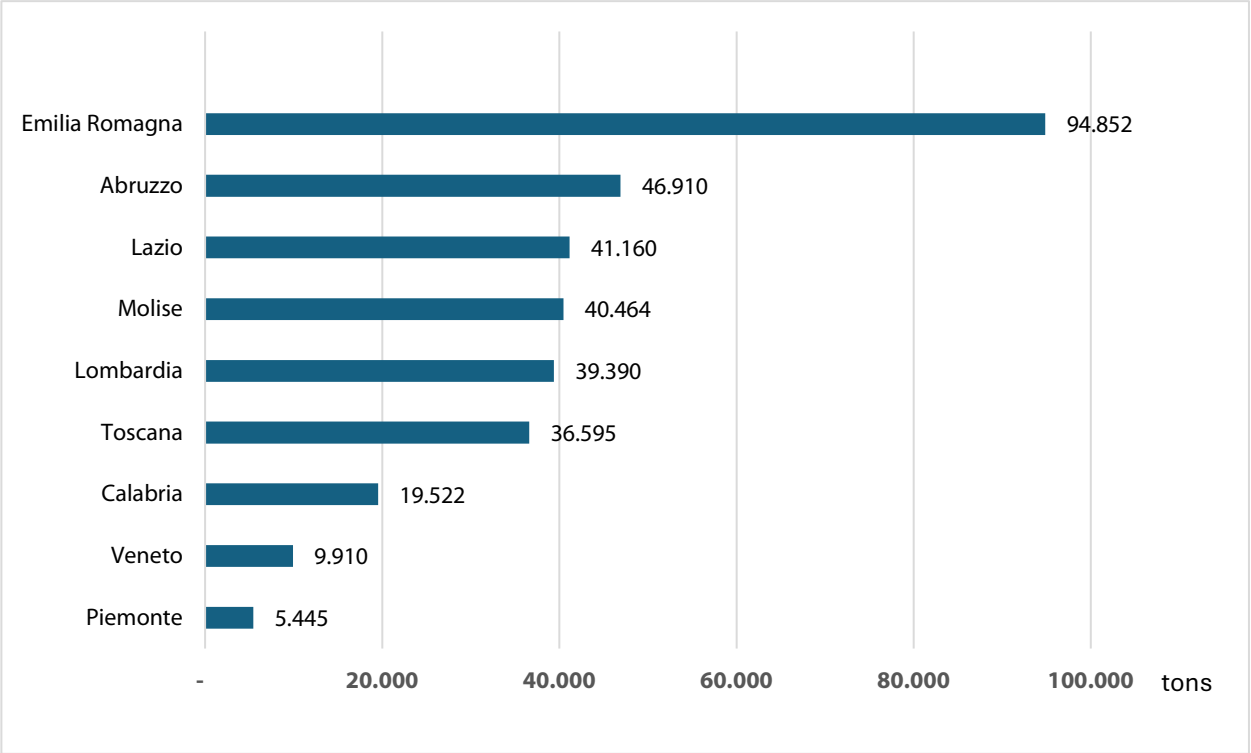


	North	Centre	South	Italy
2022	1.903	2.568	4.273	8.745
2023	1.754	2.586	4.589	8.930

Source ISPRA

The unsorted municipal waste treated by the intermediate MBT/MT plants comes mainly from the same region where it is produced; exceptions are Piedmont, which receives over 103,000 tonnes from Liguria, and Abruzzo, which receives 58,000 tonnes from Lazio. With reference, on the other hand, to waste belonging to LoW Chapter 19, it is noted that the regions receiving the largest quantities from outside the region are Emilia Romagna with about 95 thousand tonnes, Abruzzo with almost 47 thousand tonnes, Lazio with 41 thousand tonnes and Lombardy with 39 thousand tonnes (Figure 3.3.5).

Figure 3.3.5 - Quantities of waste of LoW chapter 19 resulting from the treatment of waste treated in MBT/MT plants from outside the region (tonnes), year 2023



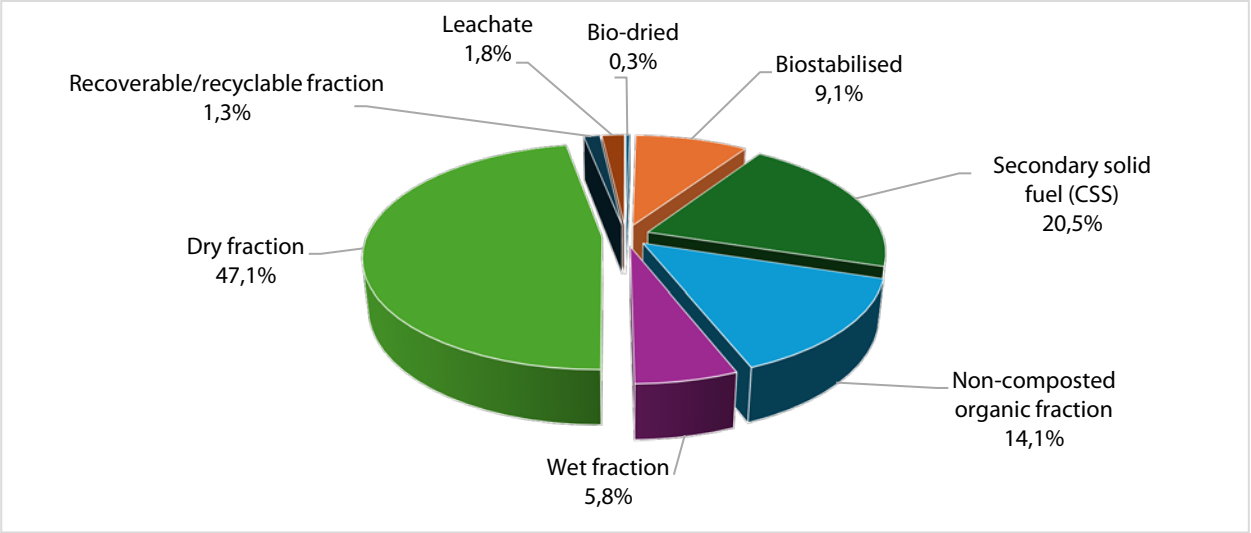
Source: ISPRA

The waste produced by the TMB and TM plants (Figure 3.3.6) and destined for other forms of treatment amount to more than 8.1 million tonnes in 2023 and consists of

- dry fraction (FS): over 3.8 million tonnes (47.1 % of total waste produced)
- secondary solid fuel (CSS): over 1.6 million tonnes (20.5 %);
- non-composted organic fraction: over 1.1 million tonnes (14.1 %);
- biostabilised (BS): just over 740 thousand tonnes (9.1%);
- wet fraction: over 474 thousand tonnes (5.8%);
- leachate: over 148 thousand tonnes (1.8%)
- recoverable/recyclable fractions sent to recovery operations, including recycling, such as paper, plastic, metals, wood, glass, textiles: about 106 thousand tonnes (1.3%)
- bio-dried (BE): 27 thousand tonnes (0.3%).

The LoW code 191212 is usually used to identify both the dry fraction and the treatment waste and sometimes also to indicate the wet fraction. Therefore, only where detailed data was provided, through the completion of an annual questionnaire prepared and administered by ISPRA, was it possible to distinguish the different product fractions. Where it was not possible to make such a distinction, the LoW code 191212, indicated in the MUD declarations, was classified as the dry fraction.

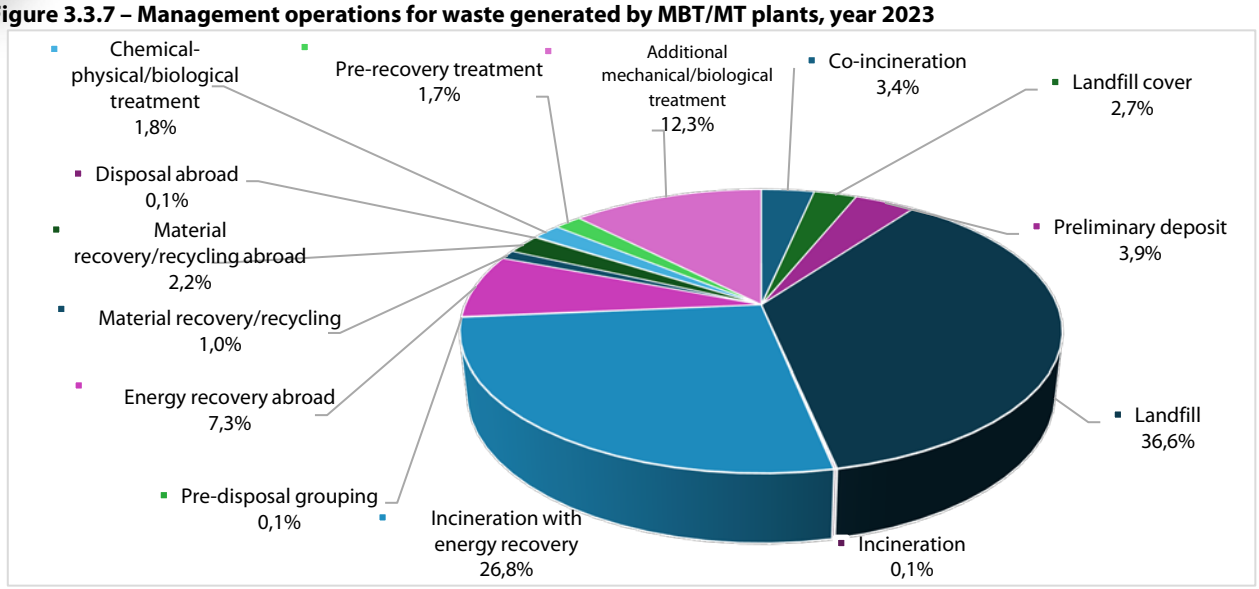
Figure 3.3.6 - Percentage distribution of waste/materials produced in MBT/MT plants, year 2023



Source: ISPRA

Figure 3.3.7 shows the management operations to which waste produced by mechanical and mechanical biological treatment is allocated in the year 2023. The portion destined for 'further mechanical and/or biological treatment' includes the quantities sent to biostabilisation and CSS production/refining operations carried out at other plants. The quantities of waste destined for 'treatment prior to recovery' (R12), on the other hand, are those sent to management plants authorised to exchange waste in order to subject it to one of the operations indicated in R1 to R11. Similarly to 2022, product fractions such as paper and cardboard, plastic and rubber, metals, glass, wood, etc. were included in the material recovery/recycling operations. However, the same fractions destined for the pre-treatment operation (R12) were not included in recycling.

Figure 3.3.7 – Management operations for waste generated by MBT/MT plants, year 2023



Source: ISPRA

The analysis shows that 36.6% of the total waste produced, approximately 3 million tonnes, is disposed of in landfills. This is mainly dry fraction (more than 1.8 million tonnes), non-composted organic fraction (almost 636 thousand tonnes) and biostabilised waste (more than 377 thousand tonnes). Compared to 2022, there is a decrease of more than 374 thousand tonnes (-11.2%) in the amount sent to landfill (Figure 3.3.8).

Almost 2.2 million tonnes of waste are sent to incineration plants with energy recovery (26.8% of the total produced), mainly consisting of dry fraction (1 million tonnes), CSS (more than 845 thousand tonnes) and non-composted organic fraction (more than 240 thousand tonnes). Compared to 2022, the amount of waste sent to incineration with energy recovery increased by more than 224 thousand tonnes (+11.5%) (Figure 3.3.8).

More than 867 thousand tonnes of waste are sent to co-incineration at production plants (cement, electricity production and wood processing), i.e. 10.7% of the total produced. The value also includes the quantities of waste sent abroad for energy recovery, amounting to almost 592 thousand tonnes. This waste consists of CSS-secondary solid fuel (503 thousand tonnes), dry fraction (over 251 thousand tonnes), wet fraction (over 44 thousand tonnes) and non-composted organic fraction (over 62 thousand tonnes). A comparison with 2022 shows an increase of 6% (over 15 thousand tonnes) (Figure 3.3.8).

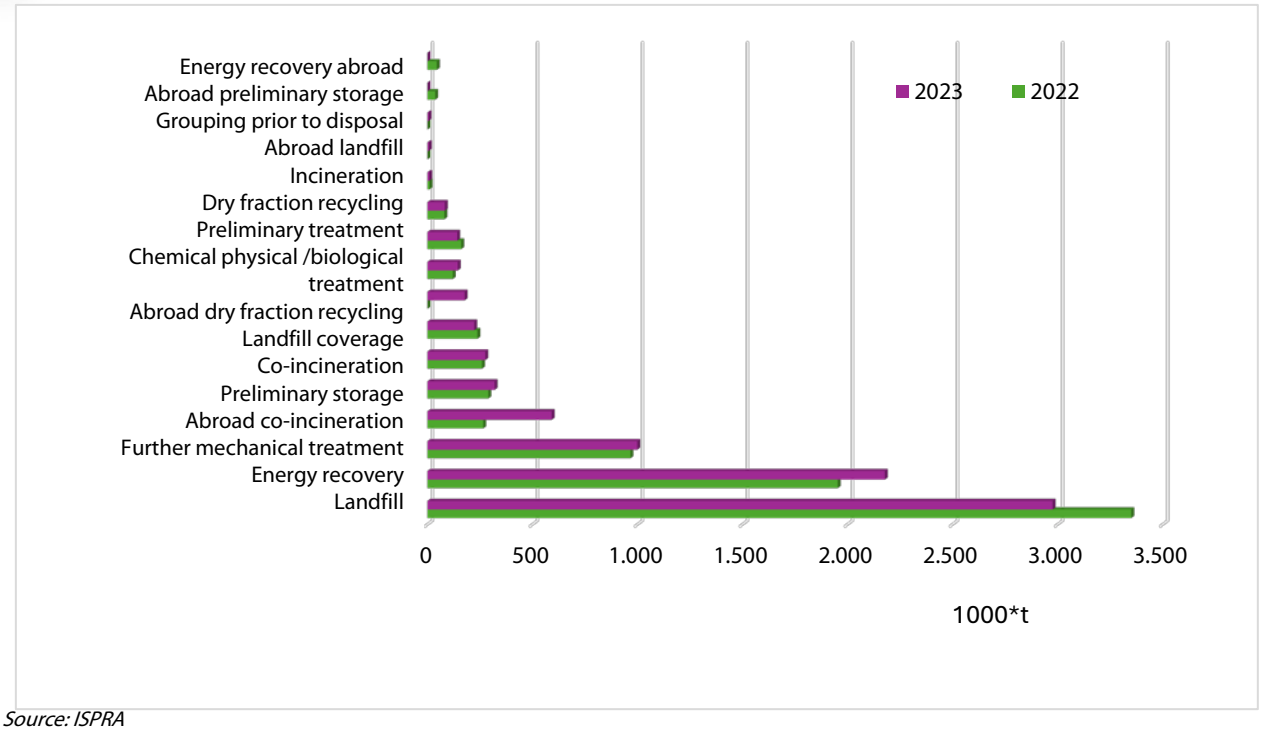
On the other hand, 12.3%, almost 1 million tonnes, is destined for further mechanical and/or biological treatment, which mainly involved the dry fraction (over 455 thousand tonnes), the wet fraction (about 335 thousand tonnes), the non-composted organic fraction (almost 86 thousand tonnes), BS (over 107 thousand tonnes) and CSS (15 thousand tonnes). Compared to 2022, there is a 3.4 per cent increase in this form of intermediate treatment (over 32 thousand tonnes) (Figure 3.3.8).

A total of 223 thousand tonnes of waste produced (2.7% of the total) are destined for landfill, consisting mostly of biostabilised (almost 123 thousand tonnes) and non-composted organic fraction (100 thousand tonnes). This amount shows a reduction of almost 15 thousand tonnes (-6.2%) compared to 2022 (Figure 3.3.8).

Quantities destined to be recycled in Italy are almost 83 thousand tonnes (about 1% of the total produced) increasing of about 2 thousand tonnes compared to 2022, while the quantities sent for material recovery abroad are over 177 thousand tonnes (2.2%).

Almost 142 thousand tonnes of waste are sent to preliminary treatment operations (1.7%) and about 320 thousand tonnes of waste (3.9%) are sent to preliminary storage.

Figure 3.3.8– Management operations for waste generated by MBT/MT plants, years 2022 – 2023



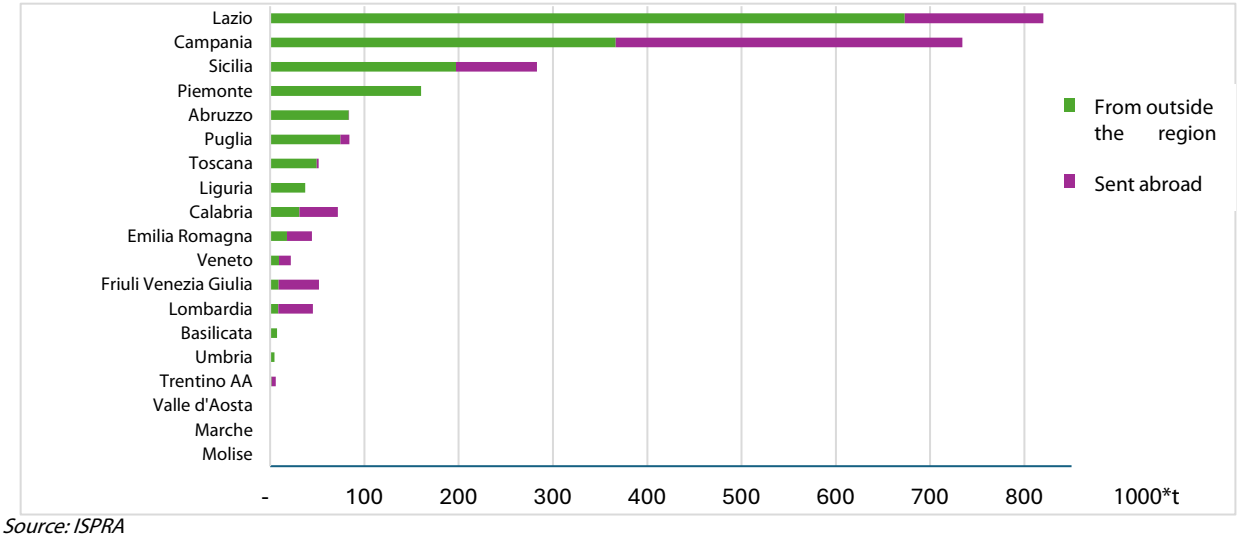
Source: ISPRA

Of the waste produced by mechanical/mechanical/biological treatment plants, 69.2 % (5.6 million tonnes) is destined for plants located in the same region, 21.3 % (1.7 million tonnes) to plants outside the region and 9.5 % (almost 776 thousand tonnes) to plants abroad.

In Figure 3.3.9 are shown the quantities of waste produced by the mechanical and mechanical/biological treatment plants that, in 2023, and sent outside the region and abroad in regional detail. Lazio is the region that sends the largest quantities outside its territory with 673 thousand tonnes (50.3% of the waste produced by TMB/TM in the region). In the case of Sicily, 197,000 tonnes (17.9% of the waste produced by TMB/TM in the region) are destined outside the region, while Piedmont destines 160,000 tonnes (42% of the waste produced by TMB/TM in the region) outside the region,

About 776,000 tonnes of the waste produced by TMB/TM are sent abroad, in particular, from Campania (more than 367,000 tonnes), Lazio (almost 147,000 tonnes) and Sicily (about 86,000 tonnes). Sardinia is the only region which manages such waste exclusively at regional level.

Figure 3.3.9 - Quantities of waste produced by the MTB/MT plants and sent outside the region or abroad (1000*t), year 2023



Source: ISPRA

3.4 Municipal waste incineration

The number of incineration plants operating in 2023 on the national territory is 36 and they treat municipal waste and waste resulting from the treatment of municipal waste such as secondary solid fuel (CSS), dry fraction (FS) and bio-dried/bio-stabilised waste (BE/BS).

Most of the plants are located in the Northern regions (25 plants); in Lombardy and Emilia-Romagna there are, respectively, 12 and 7 operational plants that, in 2023, treated a total of approximately 3 million tonnes of municipal waste (73.6% of those incinerated in the North and 53.5% of the national total). In the Centre and South, 5 and 6 plants are operational respectively (Figure 3.4.1 and Figure 3.4.2), which treated almost 504 thousand tonnes and one million tonnes of municipal waste.

In 2023, the amount of municipal waste incinerated, including waste resulting from its treatment (LoW codes 190501, 190503, 191210 and 191212) is 5.5 million tonnes (+4% compared to 2022). 72.7% of this waste is treated in the North, 9.1% in the Centre and 18.2% in the South (Table 3.4.2). It is noted that the Acerra (NA) plant alone treats 70.4% of the total waste incinerated in the South.

A comparison with the previous year shows that in 2023, incinerated municipal waste increased by 213 thousand tonnes; this increase affected only the North macro-area (+5.9%), while in the Centre the quantities treated remained stable and, in the South, a 1% decrease was observed, which corresponds to a decrease, in quantitative terms, of 100 tonnes.

Of the 5.5 million tonnes of waste sent for incineration, 48.7% (about 2.7 million tonnes) is municipal waste as such (LoW chapter 20 codes) while the remainder (more than 2.8 million tonnes) is pre-treated municipal waste (secondary solid fuel, dry fraction and, to a lesser extent, bio-dried waste).

As regards municipal waste as such, 96% (about 2.6 million tonnes) consists of unsorted municipal waste (LoW code 200301), which is incinerated mainly in Lombardy (one million tonnes), in Emilia-Romagna (576 thousand tonnes) and in Piedmont (almost 455 thousand tonnes). In addition, in the same plants, non-municipal waste is also incinerated for a total of 713 thousand tonnes, of which approximately 66 thousand tonnes is hazardous waste; the latter is mainly healthcare originated (approximately 36 thousand tonnes).

Regarding secondary solid fuel (identified by LoW code 191210), waste produced by mechanical treatment of municipal waste (LoW code 191212), the non-composted part of municipal and similar waste (LoW code 190501) and off-specification compost (LoW code 190503) treated in incineration plants, an analysis of the origin was carried out, which made it possible to distinguish, with a good approximation, between waste of municipal origin and waste produced by the treatment of non-municipal waste. This information was taken from the waste received from third parties' forms of the MUD declaration, where the declarant is required to specify whether such waste is of municipal origin, and from further specific additions where the waste source plants treated mainly municipal waste (e.g. mechanical biological treatment and composting plants).

Figure 3.4.1 – Per capita amount of municipal waste incinerated, by region, 2023

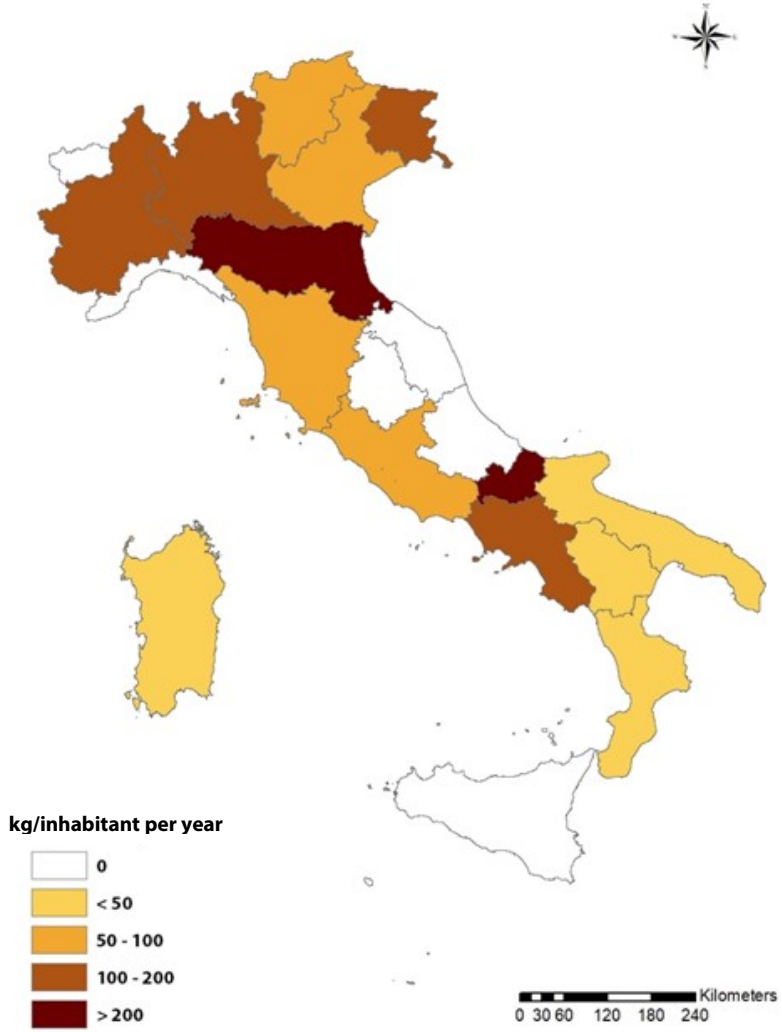
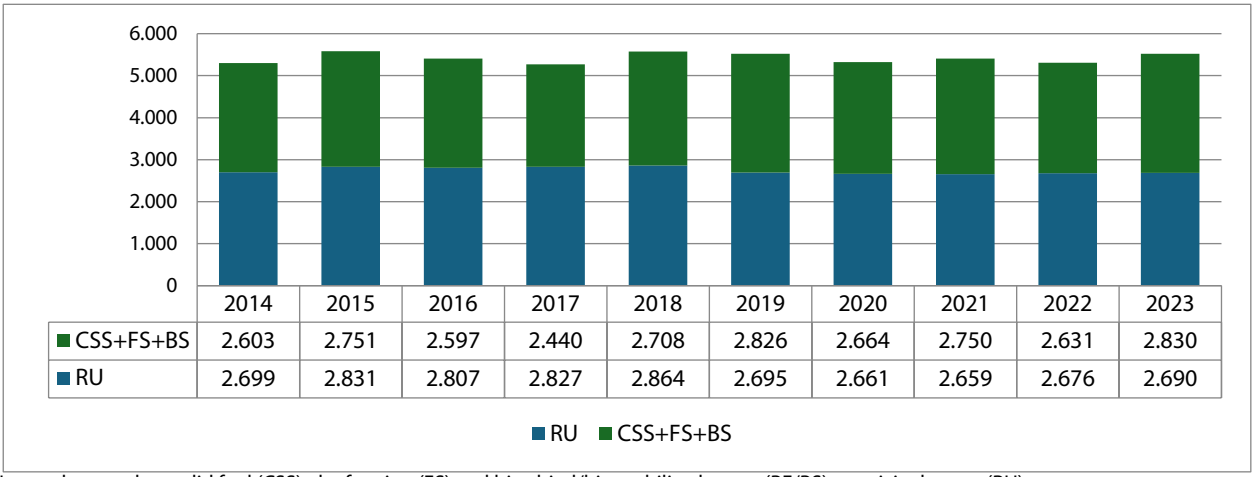


Figure 3.4.2 – Geographical position of municipal waste incinerators, year 2023

Source: ISPRA

The quantities of waste incinerated in the period 2014-2023, shown in figure 3.4.3, are fairly stable over the decade and vary between approximately 5.3 and almost 5.6 million tonnes.

Figure 3.4.3 – Municipal waste incineration in Italy (1,000*tonnes), years 2014 – 2023



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
CSS+FS+BS	2.603	2.751	2.597	2.440	2.708	2.826	2.664	2.750	2.631	2.830
RU	2.699	2.831	2.807	2.827	2.864	2.695	2.661	2.659	2.676	2.690

Legend: secondary solid fuel (CSS), dry fraction (FS) and bio-dried/bio-stabilised waste (BE/BS), municipal waste (RU)
Source: ISPRA

The per capita incineration of municipal waste shows an increase from 90.2 kg/inhabitant in the year 2022 to 93.6 kg/inhabitant in 2023, an increase of 3.4%. Looking at the data for the last five years, an increase in per capita incineration of 1% is similarly observed.

Table 3.4.1 shows 2023 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 2023

	No. of plants	Total waste treated (t)	Energy recovery		Energy recovery per kg	
			Electrical (MWhe)	Thermal (MWht)	kWhe/kg	kWht/kg
RET&E plants	13	3.245.289	2.246.611	2.245.642	0,69	0,69
REE plants	23	2.988.194	2.205.737	0	0,74	-
Total	**36**	**6.233.483**	**4.452.349**	**2.245.642**	**0,71**	**0,36**

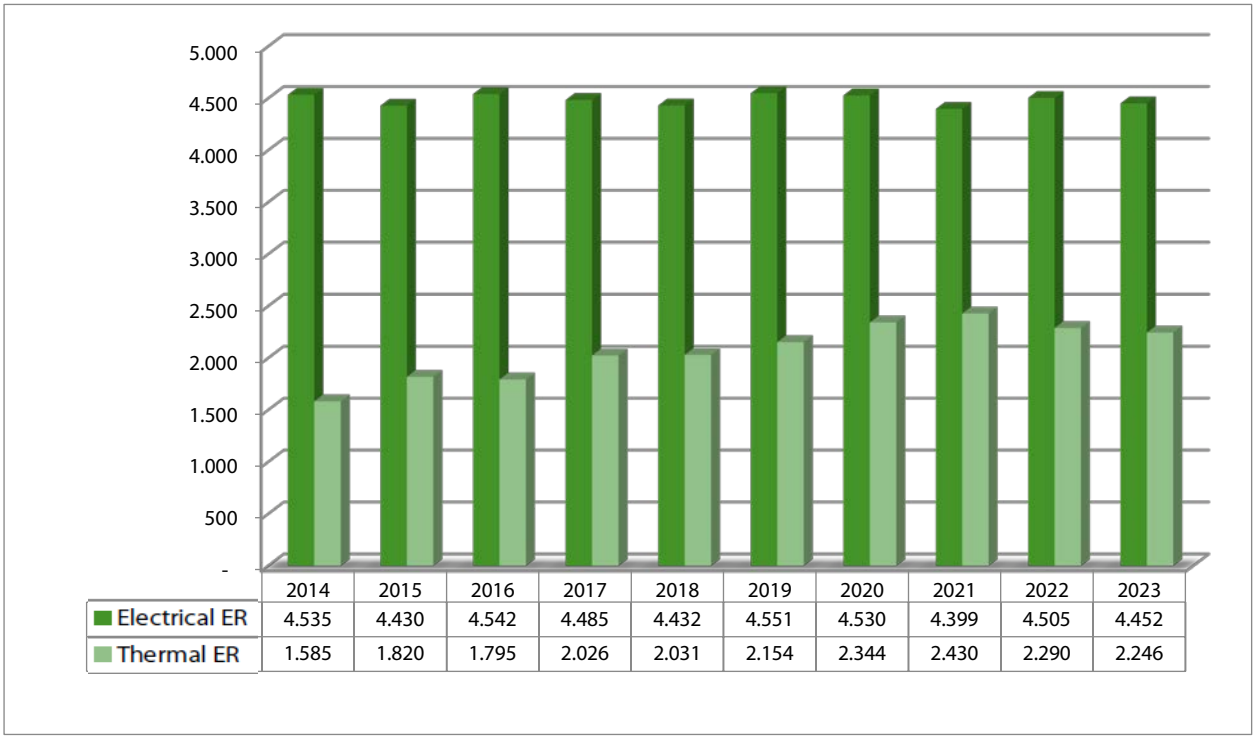
Legend - RET&E= plants with cogeneration cycle**; REE=** plants with electrical energy recovery only**.**

Source: ISPRA

Data analysis shows that all plants in the country recover energy; 23 plants treated almost 3 million tonnes of waste and recovered 2.2 million MWh of electrical energy. 13 plants are equipped with cogeneration cycles and have incinerated almost 3 million tonnes of waste, with recovery equally divided between thermal and electrical energy (2.2 million MWh each). It should be noted that the recovery of electrical/thermal energy can be attributed to the total waste treated by the individual plants, as it is not possible to distinguish the share relating to the incineration of municipal waste only.

Figure 3.4.4 shows the trend, over the period 2014-2023, of energy recovery carried out by incineration plants treating mainly municipal waste. In particular, it can be seen that the amount of electrical energy produced remains substantially stable over the period examined while thermal energy, generated exclusively by plants located in the North, increases from about 1.6 million MWh in 2014 to over 2.2 million MWh in 2023.

Figure 3.4.4 – Energy recovery in incineration plants (1,000*MWh), years 2014 - 2023



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Electrical ER	4.535	4.430	4.542	4.485	4.432	4.551	4.530	4.399	4.505	4.452
Thermal ER	1.585	1.820	1.795	2.026	2.031	2.154	2.344	2.430	2.290	2.246

Source: ISPRA

Co-incineration of municipal waste

In 2023, more than 378,000 tonnes of waste from the urban circuit were used as an alternative to traditional fuels in 11 production plants. In particular, these plants are cement plants, predominantly, and electricity/thermal power plants.

The waste consists almost exclusively of secondary solid fuel (CSS) produced, mainly, in mechanical biological treatment plants.

The analysis of the data at the level of geographical macro-area shows that, in the North, the quantities of municipal waste co-incinerated are about 219 thousand tonnes (57.8% of the total), in the South about 158 thousand tonnes (41.7%) and in the Centre 2 thousand tonnes (0.5%) (Table 3.4.2).

Table 3.4.2 - Co-incineration of municipal waste, year 2023

Region	Province	Municipality	MW	Dry Fraction, RDF/SRF	Total MW	Other Non-hazardous Waste	Other Hazardous Waste	Total
Piemonte	CN	Robilante	-	68.461	68.461	295	-	68.756
Lombardia	BG	Calusco D'Adda	-	26.058	26.058	-	-	26.058
Lombardia	LO	Castiraga Vidardo	-	32.563	32.563	-	-	32.563
Lombardia	VA	Caravate	-	4.936	4.936	-	-	4.936
Lombardia	VA	Comabbio	-	24.693	24.693	50.142	13466	88.301
Lombardia	MN	Sustinente	-	10.980	10.980	93.396	-	104.376
Emilia-Romagna	RA	Faenza	-	51.021	51.021	32.967	-	83.988
North			**-**	**218.712**	**218.712**	**193.955**	**13.466**	**426.133**
Toscana	AR	Castel Focognano	-	2.030	2.030	29.345	-	31.375
Centre			**-**	**2.030**	**2.030**	**29.345**	**-**	**31.375**
Molise	IS	Sesto Campano	-	18.521	18.521	6185	-	24.706
Basilicata	PZ	Barile	-	10.251	10.251	1	-	10.252
Puglia	FG	Manfredonia	-	129.007	129.007	2	-	129.009
South			**-**	**157.779**	**157.779**	**6.188**	**-**	**163.967**
Total			**0**	**378.521**	**378.521**	**229.488**	**13.466**	**621.475**

Source: ISPRA

3.5 Landfilling of municipal waste

In 2023, there were 112 landfills for non-hazardous waste operating nationwide. Compared to 2022, the census showed a reduction in the total number of facilities by 5, from 50 facilities in 2022 to 49 in 2023 in the North, from 25 to 24 in the Centre and from 42 to 39 in the South (Table 3.5.1). Of the 112 landfills for non-hazardous waste, 24 receive only municipal waste (4 plants in the North, 4 in the Centre, and 16 in the South), the remaining 88 both municipal and non-municipal waste.

The majority of the landfills are located in the North where there are 49 plants, 25 are located in the Centre and 39 in the South; an uneven distribution over the national territory is therefore evident.

Table 3.5.1 - Landfills for non-hazardous and hazardous waste, disposing of municipal waste, by geographical macro-area (tonnes*1,000), years 2019 - 2023

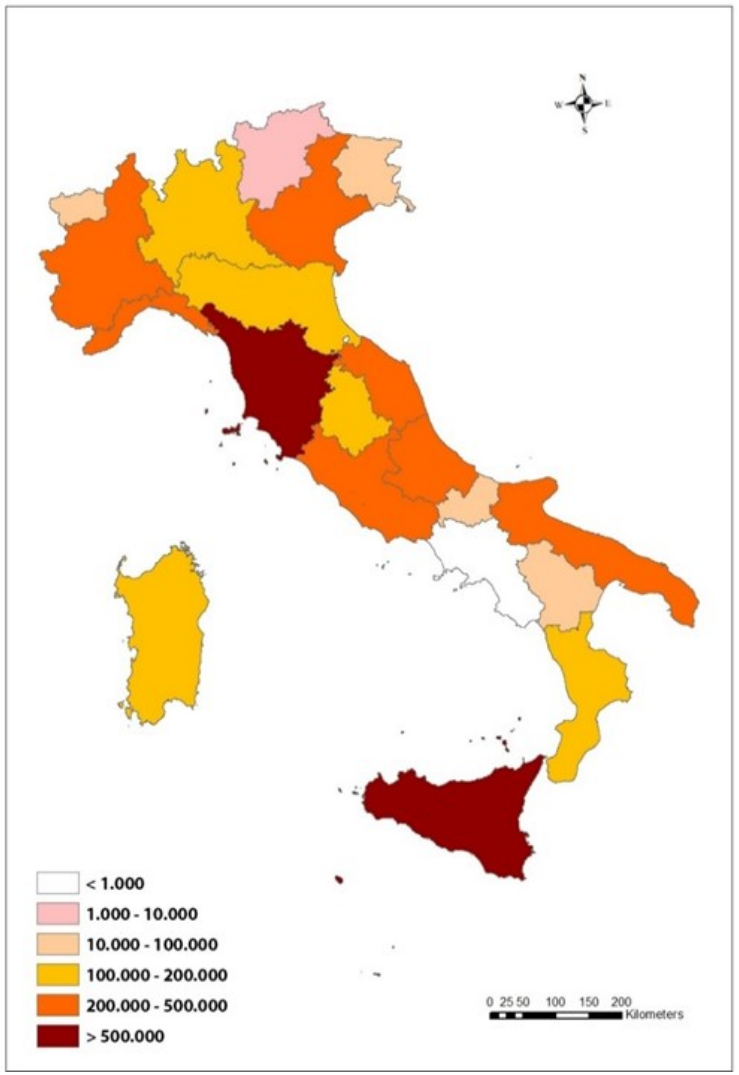
Macro-area	No. of plants					Quantity of MW disposed of (t/y * 1,000)				
	2019	2020	2021	2022	2023	2019	2020	2021	2022	2023
North	54	54	53	50	49	1.527	1.479	1.468	1.468	1.312
Centre	30	26	28	25	24	1.910	1.751	1.714	1.714	1.516
South	47	51	45	42	39	2.846	2.587	2.436	2.436	1.784
ITALY	**131**	**131**	**131**	**117**	**112**	**6.283**	**5.817**	**5.619**	**5.619**	**4.613**

Source: ISPRA

Figure 3.5.1 shows the distribution and geographic location of operational landfills disposing of municipal waste in the year 2023, by category, and the quantities of municipal waste disposed of in landfills, at regional level. Figure 3.5.2 shows the trend in waste disposal and the number of landfill plants from 2013 to 2023.

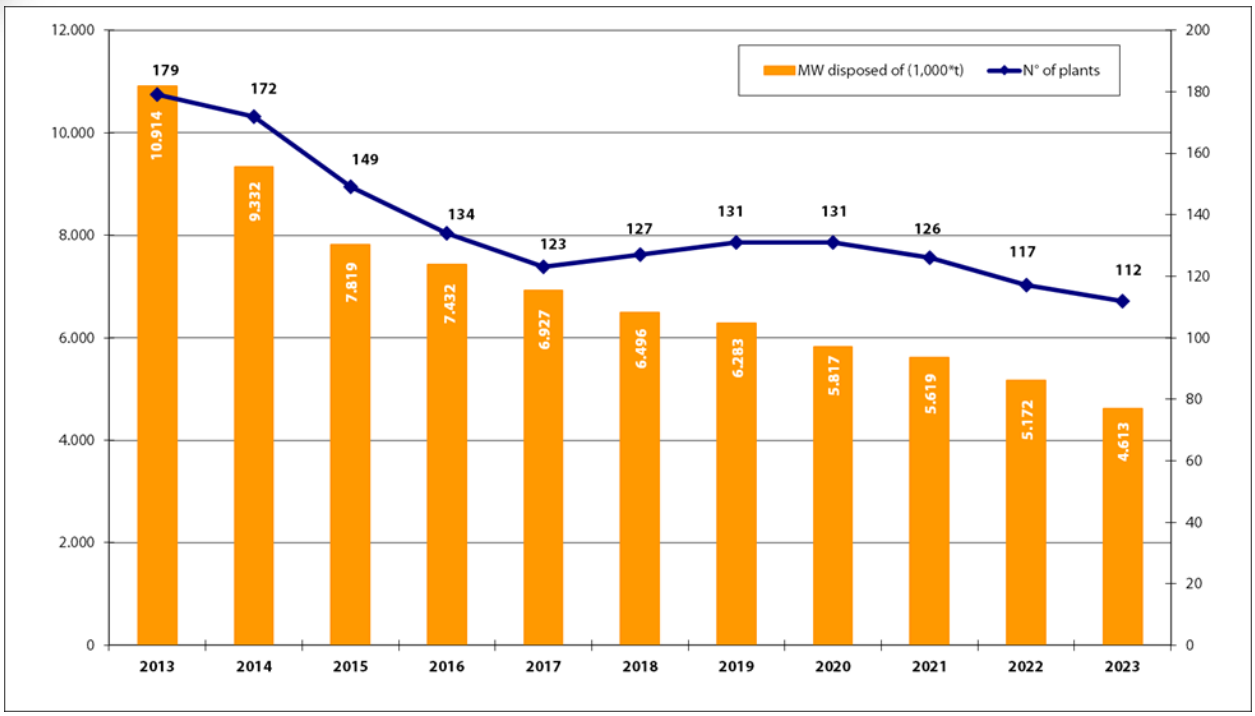
Figure 3.5.1 - Distribution and geographical location of landfill plants and quantities of municipal waste (tonnes), year 2023

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

Figura 3.5.2 – Trend of MW disposed of in landfill and number of plants, years 2013 – 2023



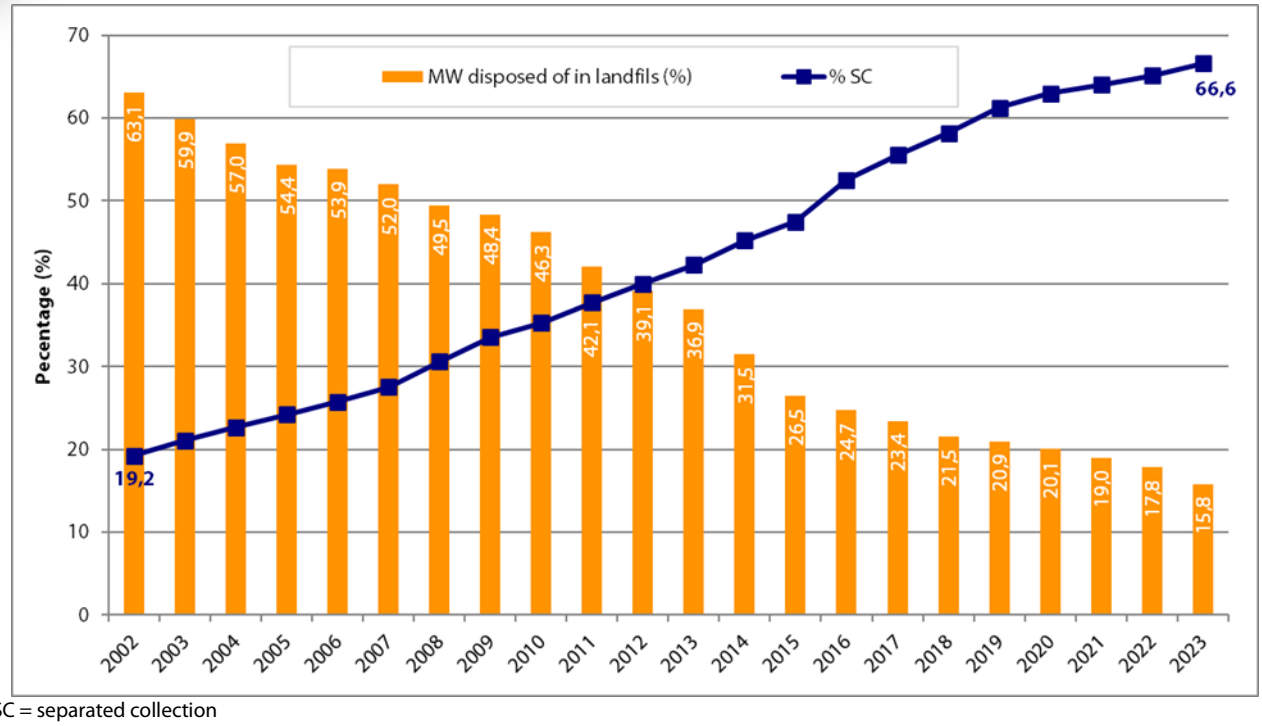
Source: ISPRA

In 2023, the total amount of municipal waste disposed of in landfills amounted to over 4.6 million tonnes, equal to 15.8% of the total amount of municipal waste produced nationally (approximately 29.3 million tonnes).

28.4% of the total disposed of (1.3 million tonnes) is managed in plants located in the north of the country, 32.9% (approximately 1.6 million tonnes) is sent for disposal in plants in the centre and 38.7% (approximately 1.8 million tonnes) in plants in the south. Compared to the 2022 survey, there has been a 10.8% reduction in the quantities sent for disposal, equal to a decrease of approximately 560,000 tonnes.

The reduction in landfill disposal observed over the last 10 years (-50.6%; from 9.3 million tonnes in 2014 to 4.6 million tonnes in 2023) is due not only to the increase in separate collection but also to the greater use of preliminary treatment of unsorted municipal waste, which contributes to reducing the weight and volume of waste sent for disposal.
An analysis of the trend in the percentage of waste sent to landfill compared to the percentage of separate waste collection shows that, as the collection rate has gradually increased from 19.2% in 2002 to 66.6% in 2023, disposal has decreased proportionally from 63.1% to 15.8% (Figure 3.5.3).

Figure 3.5.3- Trends in MW landfill shares compared to separate collection rates (%), years 2002 – 2023



SC = separated collection
Source: ISPRA

Analysis of regional data shows reductions of 238,000 tonnes (-13.6%) in Central Italy, 236,000 tonnes (-11.7%) in Southern Italy and 86,000 tonnes (-6.1%) in Northern Italy between 2022 and 2023.

The decrease observed in the central regions is attributable, in particular, to the quantities disposed of in Lazio, where there was a 52.5% decrease compared to 2022 (approximately -236,000 tonnes); at the same time, there was a slight increase in separate collection, which rose from 54.5% in 2022 to 55.4% in 2023 (+30,000 tonnes). As in previous years, however, plant capacity is insufficient to guarantee complete management within the region, resulting in the transfer of waste to plants located in other regions. The quantity of this waste, approximately 192,000 tonnes of pre-treated urban waste, shows an increase of almost 110,000 tonnes compared to 2022. In addition, for this region, there is a concomitant increase of just under 50,000 tonnes in the amount of waste sent for incineration outside the region.

The Marche region (-13.4%) also recorded a reduction in the amount of municipal waste disposed of in regional landfills, as did Umbria (-3.4%). In Tuscany, on the other hand, there was an increase of 7% (approximately +54,000 tonnes).

In the south, the largest reductions in terms of quantity were seen in Sicily (-149,000 tonnes, -16.8%). In this region, the decrease in the amount of municipal waste disposed of in landfills appears to be related to the increase in separate waste collection, which rose from 51.5% in 2022 to 55.2% in 2023, with an increase in terms of quantity of over 56,000 tonnes. Decreases were also recorded in Calabria (-59,000 tonnes, -30.7%), Puglia (-58,000 tonnes, -12.8%), Basilicata (-46,000 tonnes, -51.9%) and Molise (-11,000 tonnes, -12.8%). The quantities disposed of in the latter region include approximately 25,000 tonnes imported from outside the region.

In Campania, where there have been no operational landfill sites since 2021, there has been a decrease in the amount of waste sent for disposal outside the region. Exported waste will fall from around 36,000 tonnes in 2022 to around 29,000 tonnes in 2023, and almost all of it is identified with code 191212 in the European List of Waste, relating to “mixed materials from mechanical waste treatment”, originating from the treatment of municipal waste.

Figure 3.5.4 shows the regional per capita trend in municipal waste disposal in the reference year, with an indication of the proportion corresponding to biodegradable waste. Legislative Decree 36/2003 and subsequent amendments set targets for the progressive reduction of biodegradable municipal waste (BMW) disposal in landfills, to be achieved at the optimal territorial level. The targets are set as follows: short term (173 kg/year per inhabitant by 2008); medium term (115 kg/year per inhabitant by 2011); long term (81 kg/year per inhabitant by 2018).

Based on the National Strategy on the reduction of biodegradable municipal waste sent to landfill, the biodegradable fraction content is quantified by ISPRA on the basis of the values relating to the different product categories present in unsorted waste sent to landfill, ascertained through specific product category campaigns. The available information indicates that the percentage of RUB present in total municipal waste can be quantified between 58% and 65%. ISPRA has set 60% as the average value to be used for calculating the biodegradable fraction. The graph shows the target for 2018.

The progressive reduction of biodegradable municipal waste disposal in landfills is one of the priorities of waste management indicated by European legislation and has also been confirmed by the so-called 'waste package'. Legislative Decree No. 36/2003 and subsequent amendments define "biodegradable" as any waste that undergoes aerobic or anaerobic decomposition processes, such as food waste, garden waste, paper and cardboard waste, biodegradable plastic waste and compostable waste certified to EN 13432 or EN 14995. This decree, in transposing Directive 1999/31/EC, has modified the target for reducing the disposal of biodegradable municipal waste in landfills. in fact, the directive sets a national target based on the percentage reduction in disposal compared to biodegradable waste produced in 1995, set as the reference year, while the national standard, as mentioned above, sets a reduction target calculated on a per capita basis. Applying the provisions of Directive 1999/31/EC (Article 5, paragraph 2), the reduction target for 2016 stipulates that biodegradable municipal waste disposed of in landfills must be less than 5,864,950 tonnes (equal to 35% of the biodegradable municipal waste produced in 1995).

In 2023, the total amount of biodegradable municipal waste disposed of in landfills in Italy was 2,767,635 tonnes, corresponding to 16.5% of the BMW produced in 1995, well below the target set for 2016 by European legislation.
Italian legislation is much more restrictive, not only in terms of quantity, but above all because it requires the targets to be achieved at the optimal territorial level.

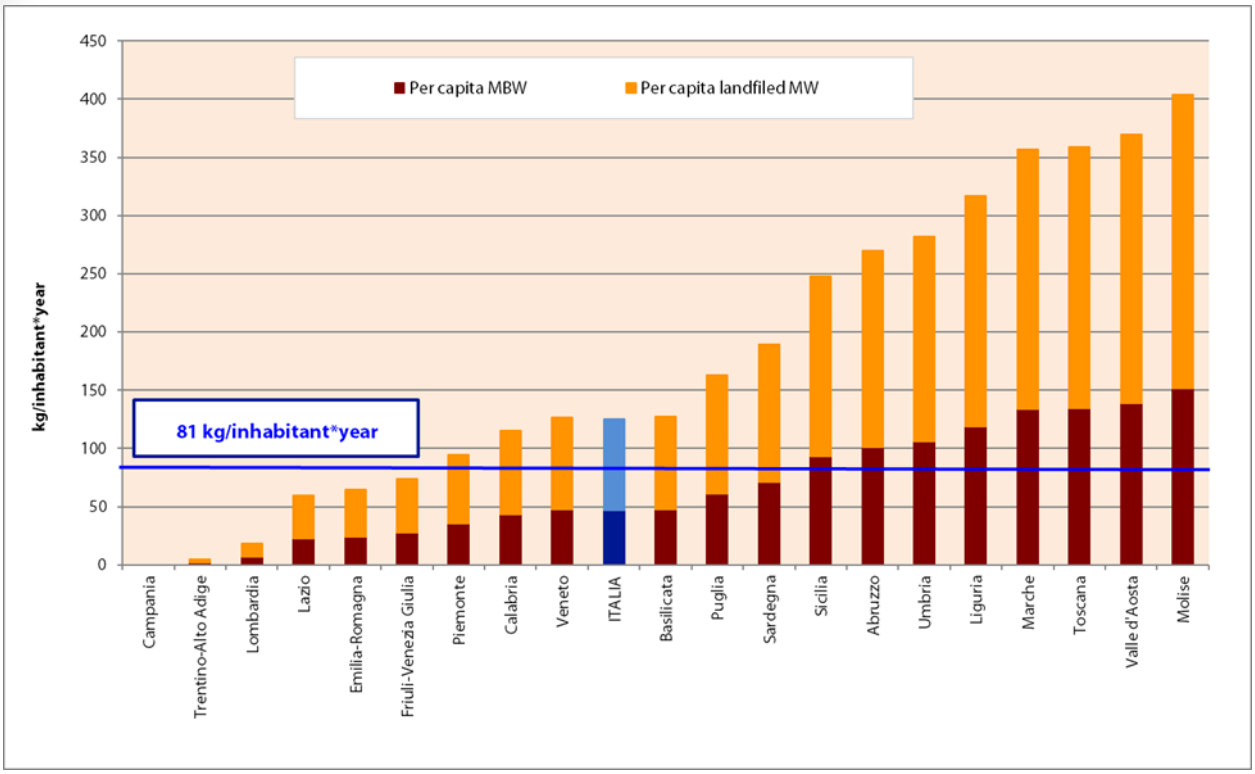
The national per capita amount of biodegradable waste in landfills in 2023 is 47 kg per inhabitant, below the target set by Italian legislation for 2018 (81 kg/year per inhabitant).

Analysis of regional data shows that, in 2023, 12 regions will have achieved the target set for 2018 (Campania, Trentino-Alto Adige, Lombardy, Lazio, Emilia-Romagna, Friuli-Venezia Giulia, Piemonte, Calabria, Veneto, Basilicata and Puglia). Sardinia (71 kg/inhabitant) is slightly below the target, while Sicily (93 kg/inhabitant) is still above the target.

Per capita values below 120 kg/inhabitant are found in Abruzzo (101 kg/inhabitant), Umbria (106 kg/inhabitant) and Liguria (119 kg/inhabitant).

The regions furthest from the target are Molise (151 kg/inhabitant), Valle d'Aosta (139 kg/inhabitant), Tuscany (135 kg/inhabitant) and Marche (134 kg/inhabitant). The values recorded in the latter region, as in Molise, are affected by the incidence of waste coming 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 2023



Source: ISPRA

3.6 Transboundary movement of municipal waste

In 2023, exports amounted to 1.4 million tonnes, while imports amounted to 319,000 tonnes. Exports accounted for 4.6% of municipal waste produced nationally.

Exports

In 2023, 1.4 million tonnes of municipal waste were exported, of which 4,586 tonnes were hazardous. Compared to 2022, exported waste increased by 419,000 tonnes.

As shown in Figure 3.6.1, 39.7% of exported waste, approximately 537,000 tonnes, consists of waste produced by the mechanical treatment of municipal waste, classified under code LoW 191212. Thirty-nine per cent of this waste, equal to over 162,000 tonnes, comes from mechanical biological treatment plants located in Campania.

At national level, 58.2% of waste produced by the mechanical treatment of municipal waste is recovered in the form of energy and 36.7% is sent for material recovery.

27.4% of exported waste consists of secondary solid fuel (LoW 191210), over 370,000 tonnes produced mainly in the regions of Campania (over 130,000 tonnes), Lazio (over 67,000 tonnes) and Abruzzo (around 48,000 tonnes). CSS is fully recovered in the form of energy, with the main destinations being Sweden (82,000 tonnes), Cyprus (over 63,000 tonnes), the Netherlands (over 33,000 tonnes) and Hungary (around 32,000 tonnes).

8.8% of exported waste (approximately 119,000 tonnes) consists of LoW code 190501 (non-composted municipal and similar waste produced by aerobic treatment), mainly originating from Campania (approximately 81,000 tonnes) and destined mainly for Germany, Austria and the Netherlands. Of this waste, 58.7% is recovered in the form of energy and 41.3% in the form of material.

On the other hand, 7.5% of exported waste, approximately 101,000 tonnes, consists of paper, cardboard, plastic and rubber from mechanical treatment (LoW 191201, 191202, 191203, 191204) and is destined for material recovery.
Packaging waste accounts for 6.2% of total exports, over 84,000 tonnes sent for material recovery, and consists mainly of plastic (33,000 tonnes), wood (approximately 25,000 tonnes) and cellulose packaging (approximately 20,000 tonnes).

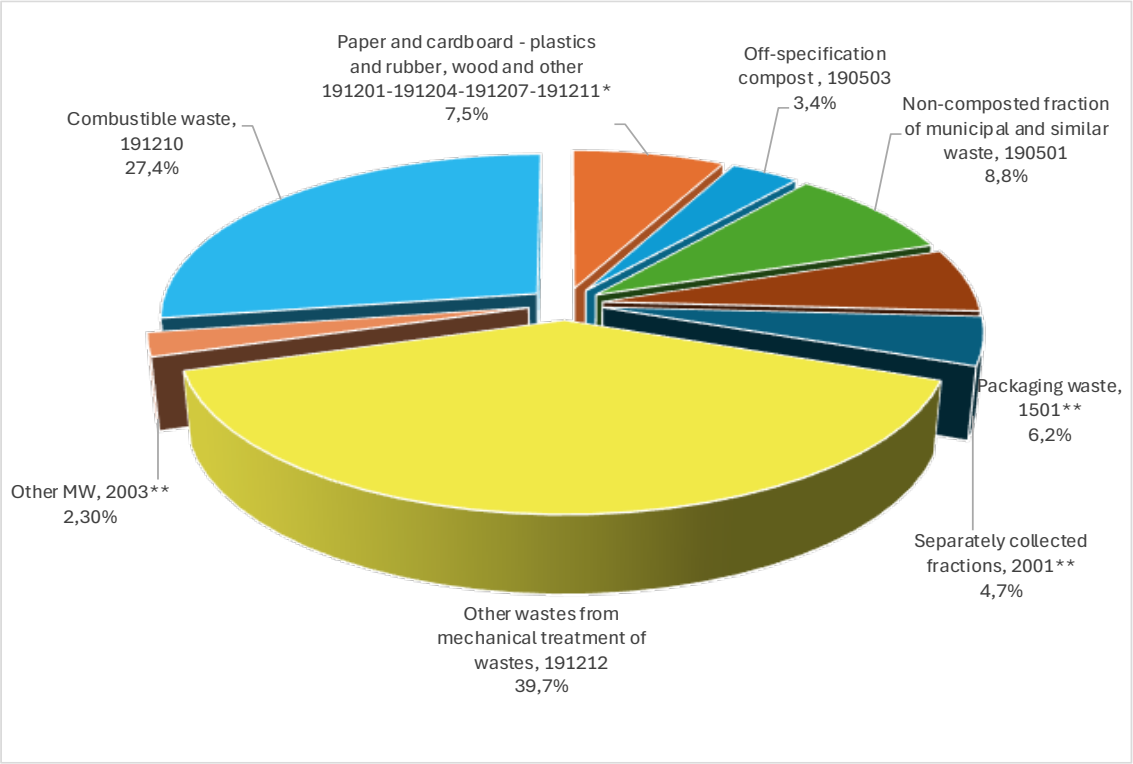
The product categories of municipal waste from separate collection, amounting to approximately 64,000 tonnes, account for 4.7% of the total exported. This waste consists mainly of clothing waste (LoW 200110), over 47,000 tonnes, and edible oils and fats (LoW 200125), amounting to approximately 8,000 tonnes.

Finally, 3.4% of exported municipal waste (approximately 47,000 tonnes) consists of off-specification compost (LoW 190503), exported to Hungary and Denmark, mainly from the Emilia-Romagna and Lazio regions, for disposal in landfills.

Compared to 2022, there was an increase in the quantities exported of waste produced by the mechanical treatment of municipal waste (LOW 191212) equal to 256,000 tonnes and secondary solid fuel (LoW 191210) equal to 125,000 tonnes.

It should be noted that the data presented, derived from the processing of MUD declarations, does not include secondary raw materials, which are governed by national legislation and, having lost their status as waste, are exported as products.

Figure 3.6.1 – Municipal waste exported by type of waste, year 2023



Source: ISPRA

Imports

In 2023, the quantity of imported municipal waste amounted to approximately 319,000 tonnes, of which over 2,000 tonnes were hazardous, consisting mainly of waste electrical and electronic equipment classified under code LoW 200123*.

Compared to 2022, there will be a 7.6% increase in the quantities imported (+23,000 tonnes).

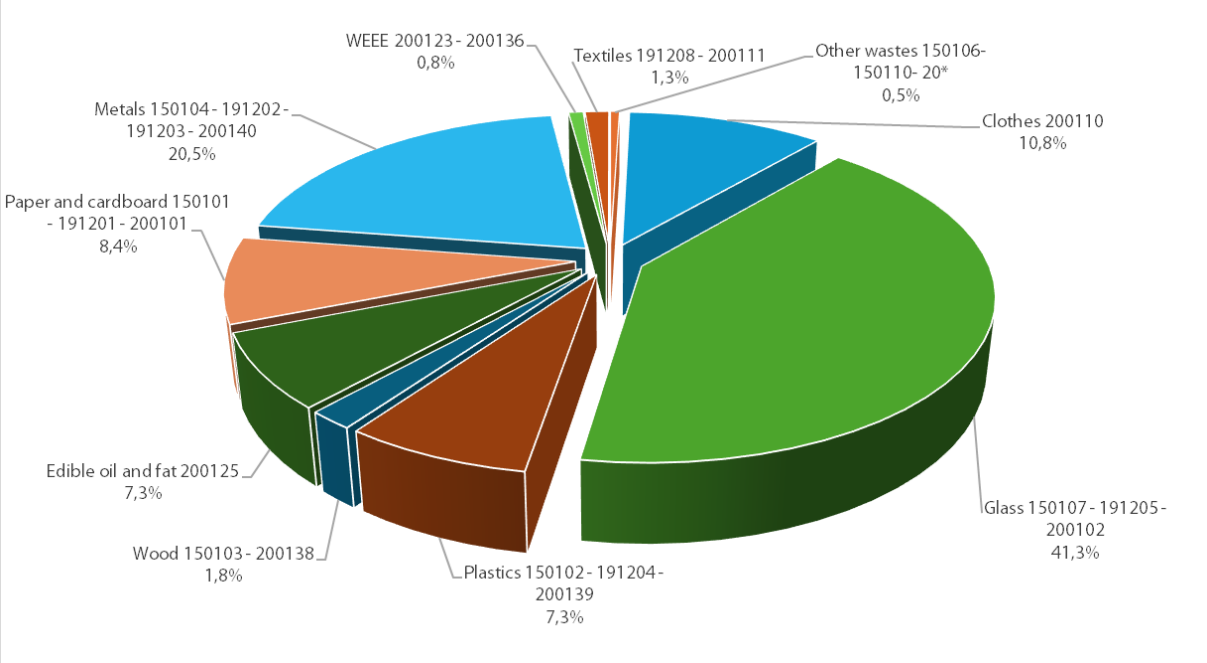
France is the country from which the largest quantity of municipal waste comes, 101,000 tonnes, corresponding to 31.7% of the total imported; followed by Switzerland with 27.4% and Germany with 17.1% of the total.

In line with previous surveys and as shown in Figure 3.6.2, plants located in Italy mainly import glass waste, which accounts for 41.3% of the total (approximately 132,000 tonnes), followed by metal waste with 20.5% (over 65,000 tonnes), clothing waste with 10.8% (over 34,000 tonnes), and paper and cardboard waste with 8.4% (approximately 27,000 tonnes). Plastic waste and edible oils and fats both account for 7.3% of total imports (over 23,000 tonnes each).

Glass comes mainly from Switzerland and France and is mainly destined for recovery and processing plants located in Lombardy and Liguria.

Clothing, on the other hand, is mostly imported from Campania and Tuscany and managed by companies that recover it. Plastic, mainly from France, is mostly imported into Piemonte.

Figure 3.6.2 - Municipal waste imported by type of waste, year 2023



Source: ISPRA

4. Packaging and packaging waste

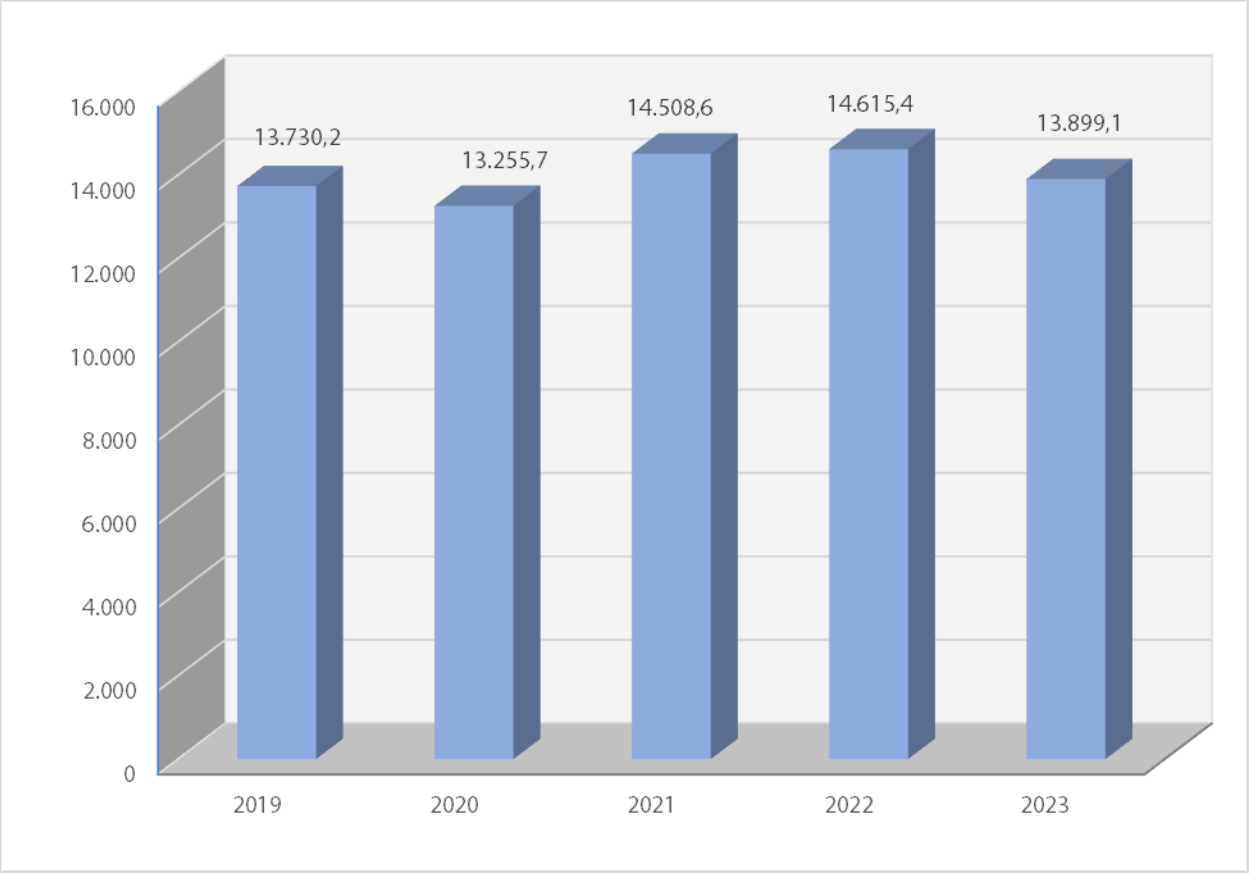
European legislation sets ambitious recycling targets for 2025 and 2030 for packaging waste, which is one of the main waste streams monitored. To address the problem of the continuous increase in such waste, harmonise internal market laws and promote the circular economy, the new Regulation on packaging and packaging waste has been adopted, reforming the relevant regulations with significant repercussions on the waste management system.

In 2023, the amount of packaging placed on the domestic market stood at 13.9 million tonnes, down compared to 2022 (-4.9%, corresponding to 716,000 tonnes less, Figure 4.1), against a backdrop of growing socio-economic indicators. In fact, 2023 ended with an increase in gross domestic product and final consumption expenditure in Italy, up 0.7% and 1% respectively compared to 2022 (chained values with reference year 2020).

The contraction recorded affects all packaging supply chains placed on the market, with the exception of aluminium, which instead shows an increase (+3.1%). For other materials, the trends varied: steel, as in 2022, showed the largest decline (-8.3%), followed by glass (-6.9%) and paper (-6.5%), while more modest reductions were recorded for wood (-2.6%) and plastic and bioplastic (-1.6%).

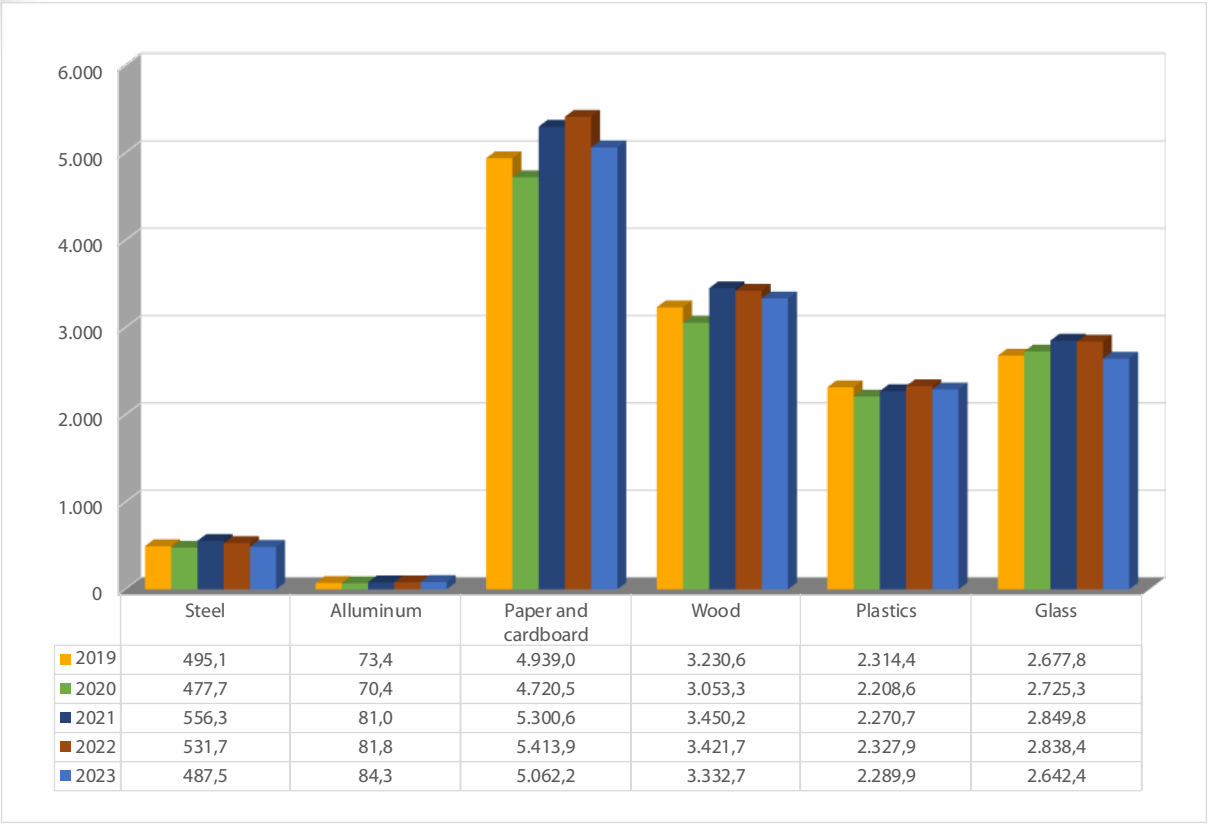
Paper remains the most traded fraction, with 36.4% of the domestic market, followed by wood, which covers a market share of 24%, glass (19%) and plastic (16.5%, Figure 4.2).

Figure 4.1 – Packaging placed on the market (1.000*tonnes), years 2019 – 2023



Source: ISPRA elaborations on CONAI data

Figure 4.2 – Packaging placed on the market by packaging materials (1.000*tonnes), years 2019 – 2023



	Steel	Alluminum	Paper and cardboard	Wood	Plastics	Glass
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	531,7	81,8	5.413,9	3.421,7	2.327,9	2.838,4
2023	487,5	84,3	5.062,2	3.332,7	2.289,9	2.642,4

Source: ISPRA elaborations on CONAI data

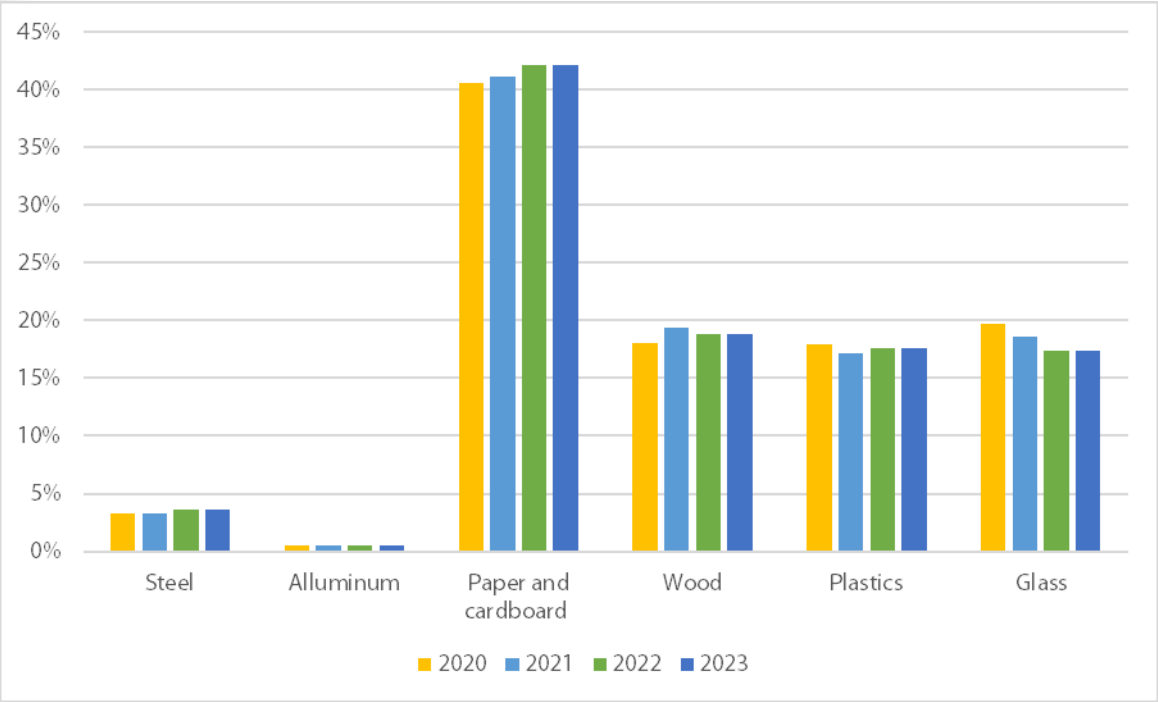
In 2023, the total amount of packaging waste recovered amounted to 11.8 million tonnes, a slight increase compared to 2022 (+0.9%, corresponding to 103,000 tonnes in quantitative terms). The recovered share of plastic, paper, aluminium and glass fractions also includes quantities of waste recycled abroad.

The overall recovery trend varies by product category. The most significant percentage increase was recorded for paper (+7.1%, corresponding to 328,000 tonnes more than in 2022), bucking the trend observed in the two-year period 2021-2022, followed by steel (+2.4%, 10,000 tonnes) and wood (+0.8%, 17,000 tonnes). On the other hand, there was a significant reduction in glass, with 248,000 tonnes less (-10.8%), while aluminium and plastic remained virtually stable.

Cellulose packaging waste remains the most recovered fraction in 2023, accounting for 42.1% of the total, followed by wood (18.8%), plastic (17.6%) and glass with 17.3% (Figure 4.3).

The largest share of total recovery is recycling, which is the only form of recovery for some types of waste, such as glass and steel. In detail, 88.7% of total recovery is represented by recycling, corresponding to almost 10.5 million tonnes, including preparation for reuse through regeneration or repair operations; the remaining 11.3% consists of energy recovery (just over 1.3 million tonnes).

Figure 4.3 – Percentage distribution of packaging waste recovered, years 2020 - 2023



Source: ISPRA elaborations on CONAI and PROs data

Recycled quantities show an increase compared to 2022 (+1.3%, corresponding to approximately 135,000 tonnes), mainly attributable to paper, which recorded a percentage increase of 7.9%. This fraction also shows the most significant increase in absolute terms, equal to 341,000 tonnes. Glass, on the other hand, saw a significant decline (-10.8%, 248,000 tonnes less). Continuing the analysis of the data by product category, there were also percentage and quantitative increases, albeit less marked, for steel (+2.4%, 10,000 tonnes), plastic (+1.4%, approximately 15,000 tonnes), and wood (+0.8%, almost 18,000 tonnes), while aluminium saw a slight decrease (-1.5%).

Recycled packaging waste from "public areas" (urban waste streams, consisting of household waste and waste of a similar nature and composition generated by other sources) accounts for approximately 52% of the total recycled (over 5.4 million tonnes); the remaining 5 million tonnes comes from secondary and tertiary packaging waste from industrial and commercial sources.

In detail, the share of recycling from public areas fell by 4.1% compared to 2022, equal to 233,000 tonnes. Paper and glass accounted for 39.8% and 37.3% respectively of the total recycled from public areas in 2023.

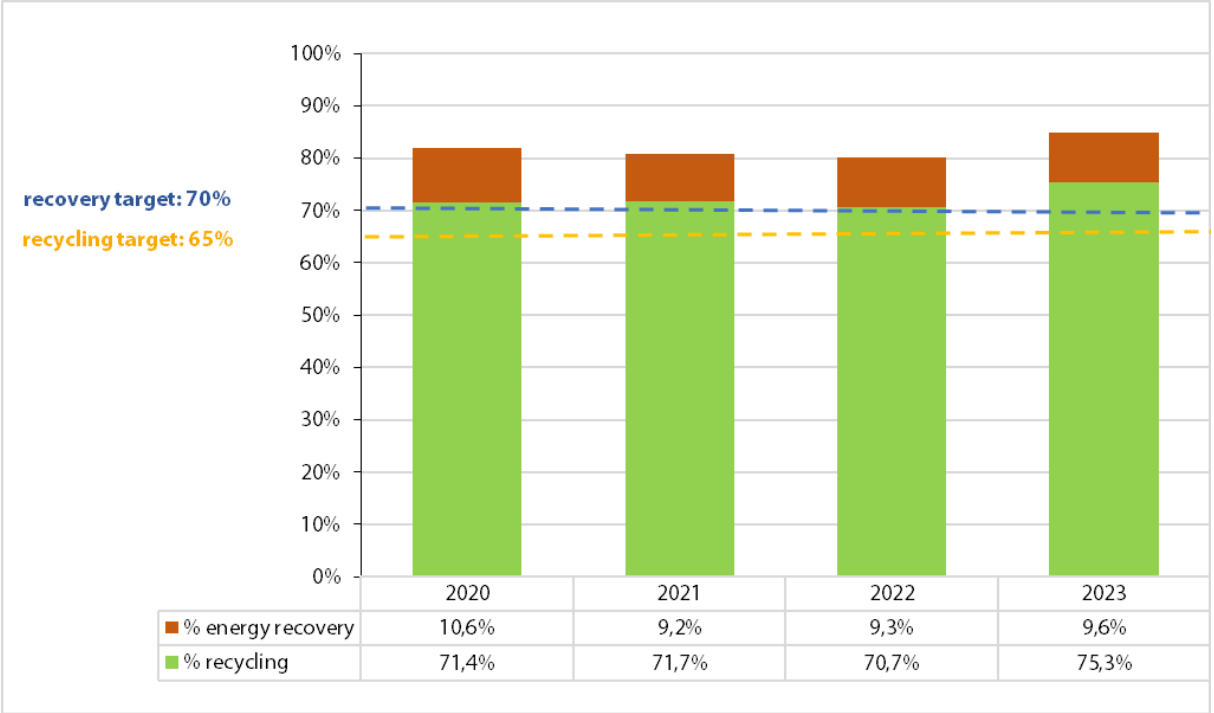
On the other hand, the amount of packaging waste from private areas will increase by approximately 368,000 tonnes (+7.9%) in 2023. The fractions that have the greatest impact on the total recycled from private areas are paper with 49.9% and wood with 38%.

In 2023, the amount of packaging waste sent for energy recovery from public areas alone will be over 1.3 million tonnes, down 32,000 tonnes compared to 2022 (-2.3%). This trend appears to be in contrast to the previous two-year period 2021-2022, which saw an increase in the quantities recovered for energy.

The fractions most commonly sent for energy recovery are plastic (73.5% of the total) and paper (21.9%). Plastic packaging waste, which is slightly down, goes from 997,000 tonnes in 2022 to 980,000 tonnes in 2023 (-1.8%), while paper packaging waste goes from 306,000 tonnes to 292,000 tonnes, down 4.4%. Aluminium packaging waste, at just over 3,000 tonnes, also recorded a decline (-5.9%), while wood packaging waste, at around 58,000 tonnes, fell by 1.4%.

In 2023, the total recovery of packaging waste was 84.9% of that placed on the market, an increase compared to 2022 (80.1%, Table 4.7, Figure 4.10). The overall recycling rate rose from 70.7% to 75.3%, while energy recovery stood at 9.6% (9.3% in 2022, Figure 4.4).

Figure 4.4 – Recovery and recycling rates of packaging waste, according to the new calculation methodology, years 2020 – 2023



	2020	2021	2022	2023
% energy recovery	10,6%	9,2%	9,3%	9,6%
% recycling	71,4%	71,7%	70,7%	75,3%

Source: ISPRA elaborations on CONAI and PROs data

The regulatory framework that has been developing in recent years requires ever greater efforts to ensure accurate and timely monitoring of data on waste production and management. With a view to ensuring uniform conditions for measuring the new targets on the actual quantity of packaging waste reprocessed to obtain new products, materials or substances, stringent calculation methods have been defined at European level and must now be applied.

A comparison of the recycling rates achieved in 2023 with the targets set for 2025 shows that all product categories have already largely achieved the targets set at European level, with the exception of plastics, which are nevertheless close to the target (48% compared to a target of 50% by 2025, Table 4.1). Thanks to the measures implemented at national level, there has been an increase of more than 4 percentage points for this fraction compared to 2020.

For plastics, increasing recycling remains a priority, including through the development of new treatment technologies, especially for those types of waste that are currently difficult to recover through mechanical processes. It is also necessary to reduce existing gaps at the territorial level, and important measures in this area are contained in both the National Waste Management Programme (PNGR) and the National Recovery and Resilience Programme (PNRR). The latter 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 collection, modernising 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 allocated funds for the upgrading of plastic recycling systems through mechanical and chemical recycling in special "Plastic Hubs". The preparation of a national strategy on plastics will also require the definition of objectives, indicators, tools and governance for monitoring.

Table 4.1 - Recycling rates of packaging waste by fraction compared with 2025 and 2030 recycling targets, years 2020 – 2023

Fraction	2020	2021	2022	2023	Targets to 2025	Targets to 2030
Steel	74,0%	70,1%	78,6%	87,7%	*70%*	*80%*
Aluminium	67,3%	71,8%	73,6%	70,3%	*50%*	*60%*
Paper and Cardboard	86,1%	84,6%	80,0%	92,3%	*75%*	*85%*
Wood	62,0%	63,9%	62,7%	64,9%	*25%*	*30%*
Plastic	43,8%	47,6%	46,6%	48,0%	*50%*	*55%*
Glass	78,6%	76,6%	80,8%	77,4%	*70%*	*75%*
TOTAL	**71,4%**	**71,7%**	**70,7%**	**75,3%**	***65%***	***70%***

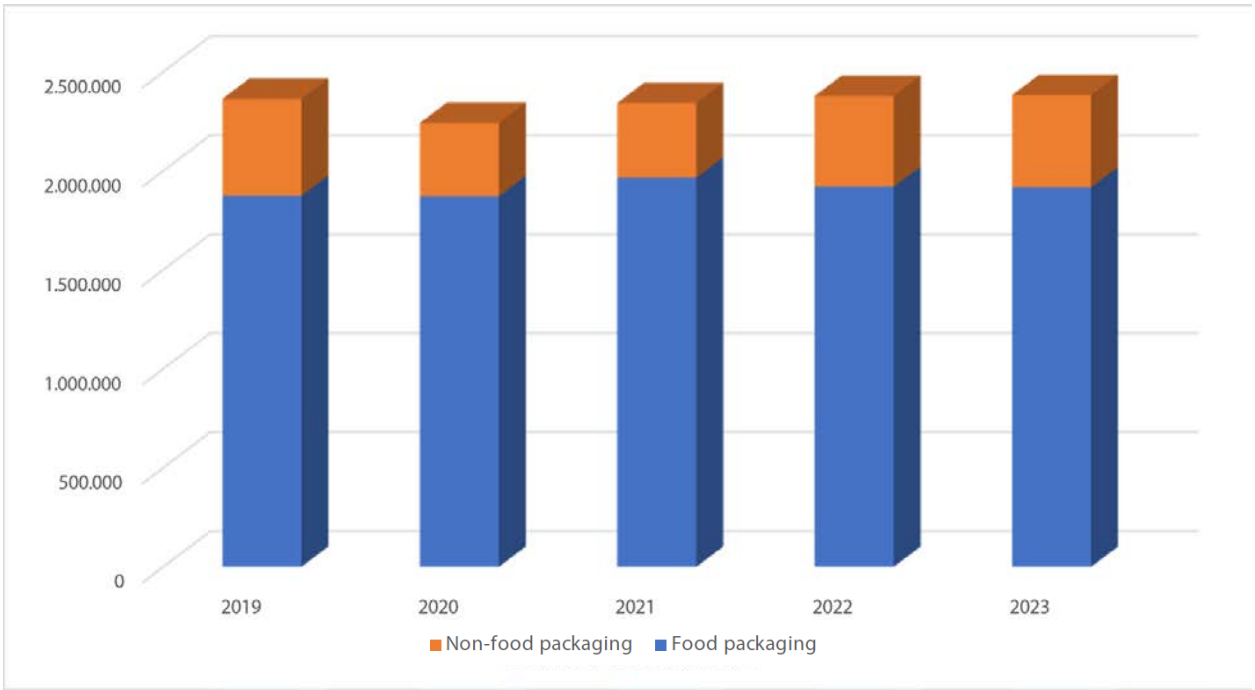
Source: ISPRA elaborations on CONAI data

The reuse of packaging reported by CONAI in 2023 totalled almost 2.4 million tonnes, essentially stable compared to 2022 (+0.2%, corresponding to 4,500 tonnes).

In detail, 466,000 tonnes of packaging were reused for food purposes (+1.6%, approximately 7,000 tonnes more than in 2022) and just over 1.9 million tonnes for other uses (-0.1%, almost 3,000 tonnes less, Figure 4.4). Most of these quantities consist of wooden and plastic pallets, steel containers and glass bottles.

Analysis of the data shows that packaging reused for food use mainly consists of glass bottles (57.6% of the total) and plastic crates (29.8%), while packaging reused for non-food uses mainly consists of wooden and plastic pallets (49.2% of the total and 20.2% of the total, respectively). There is also evidence of reuse for other purposes of steel containers and drums (18.3% overall) and industrial wooden packaging (6.5%).

Figure 4.5 – Total amount of reused packaging in Italy (tonnes), years 2019 - 2023



Source: ISPRA elaborations on CONAI data

5. Assessment of operation costs of the municipal waste management service, year 2023

This chapter analyses the management costs incurred by Italian municipalities for urban sanitation services.

Law 205 of 2017, in Article 1, paragraph 527, assigned the Regulatory Authority for Energy, Networks and Environment (ARERA) regulatory and control functions in the field of urban and similar waste.

The provision assigns the Authority, among other things, the functions of:

- "prepare and update the tariff method for determining the fees for the integrated waste service and the individual services that constitute management activities, to cover operating and investment costs, including the remuneration of capital, on the basis of the assessment of efficient costs and the 'polluter pays" principle'';
- "approve the tariffs defined, in accordance with current legislation, by the governing body of the optimal territorial area for the integrated service and by the operators of the treatment plants";
- "verify the correct drafting of the area plans, expressing observations and comments".

With Resolution 443 of 2019, the Authority adopted the Waste Tariff Method (MTR), introducing a regulation for updating reference tariff revenues based on criteria for recognising efficient costs for the period 2018-2021. Title II of the Resolution defines the reference tariff revenues for the integrated management service, expressing them as the sum of the tariff revenues relating to variable cost components and the tariff revenues of fixed cost components. Title III defines the operating cost items, while Title IV defines the capital cost items. With Resolution 238/2020, ARERA supplemented Resolution 443/2019 for the period 2020-2021 in order to consider the COVID-19 epidemiological emergency.

In 2021, ARERA confirmed 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', it introduced some new elements, including a strengthening of incentives for the development of activities for the recovery of materials and/or energy, also in consideration of the potential contribution of the recovered output to the achievement of European targets. In addition, it has established appropriate corrective mechanisms for the cost recognition system, in light of the application of the new regulations introduced by Legislative Decree 116/2020, considering the economic and financial balance of operations.

Article 1, point 1 of Resolution 363, like the previous 443, defines the management perimeter subject to the tariff method, in order to make it uniform throughout the country. The management perimeter includes:

a) street sweeping and washing;
b) collection and transport of municipal waste;
c) tariff management and relations with users;
d) treatment and recovery of municipal waste
e) treatment and disposal of urban waste.

Furthermore, the annex to Resolution MTR-2 also goes on to define activities outside the integrated waste cycle (Art.1, point 1.1), albeit by way of example but not exhaustively.

The costs related to the municipal waste management cycle were analysed here, taking into consideration 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 (MUD). 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 2023, derived from the elaborations carried out by ISPRA (see chapter 2);
- data on the resident population as of 31 December 2023 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 cover 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 2023, the sample consists of 6,592 municipalities, which is 83,4% of the total (7,901), corresponding to 53.715.812 resident inhabitants, or 91.1% of the Italian population (58.989.749). Compared to 2022, there is an increase in the sample of 502 municipalities (+8.2%), equivalent to +3.065.658 inhabitants. The ISTAT figure for the national population in 2022 also recorded a decrease of 0.2%, with over 139,000 fewer residents.

In terms of geographic coverage of the population, the sample is distributed as follows: in the North, coverage is 96.8%, 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.

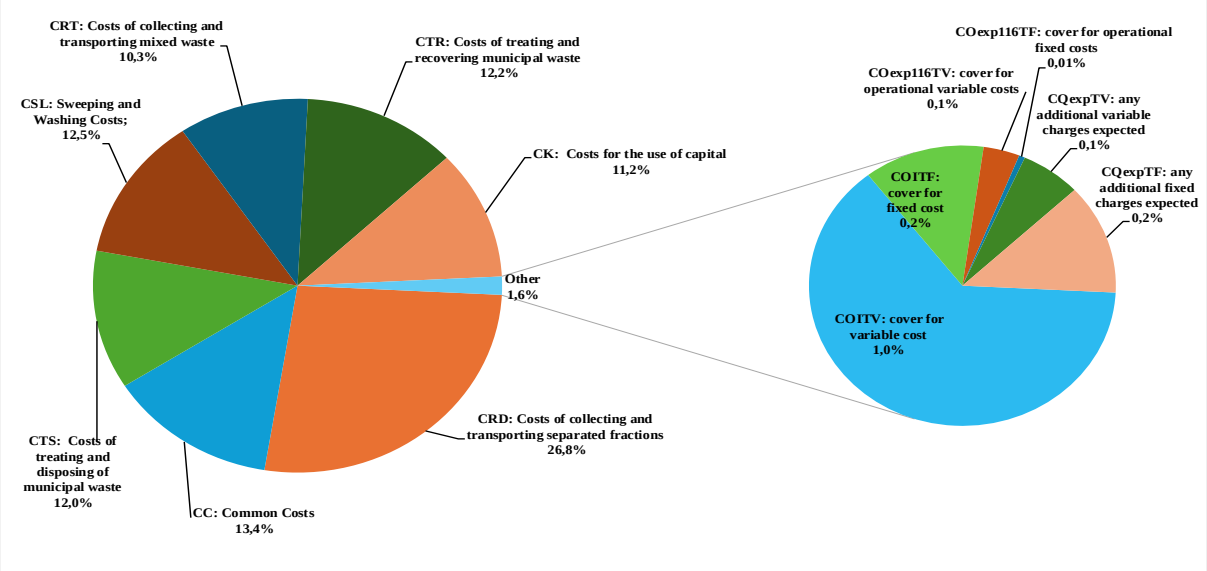
As a preliminary remark, it is necessary to point out that the analysis of the MUD data showed that in many cases the declarant, instead of assigning values to the individual cost items, provided an aggregate value by attributing it to a single cost item; nevertheless, the sample also includes these cases.

Figure 5.1 shows that, in terms of variable items, the highest cost incurred is that relating to the collection and transport of separated waste fractions (CRD), accounting for 26.8% (+0.2% compared to 2022) of the total. The cost of treating and recovering municipal waste (CTR) is 12.3% (+0.1% compared to 2022), the cost of treating and disposing of municipal waste (CTS) represents 12% of the total (+0.2% compared to 2022) and, finally, the cost of collecting and transporting unsorted municipal waste (CRT) is 10.1% (-0.4% compared to 2022).

The same figure shows that fixed items, such as common costs (CC) and the cost of sweeping and washing (CSL), account for 13.4% (-0.3% compared to 2022) and 12.5% of the total (unchanged compared to 2022), while capital use costs (CK) stand at 11.2% (unchanged compared to 2022). Finally, 1.6% of total costs (+0.1% compared to 2022) consists of provisional items such as:

- items intended to cover expected variable and fixed costs relating to the achievement of quality improvement targets and/or changes in the scope of operations (COIexpTV, COIexpTF),
- items of a provisional nature intended to cover expected deviations from the actual cost values for the reference year attributable to the new regulations introduced by Legislative Decree No. 116/20 (CO116expTV, CO116expTF);
- provisional items intended to cover, respectively, any additional variable and fixed costs expected to be incurred in order to comply with the standards and minimum quality levels to be introduced by the Authority (CQexpTV, CQexpTF).

Figure 5.1 – Breakdown of management costs, year 2023



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 national cost per capita for urban waste management is €197 per inhabitant (in 2022 it was €192.3), an increase of €4.8 per inhabitant.

The variable cost items that have the greatest impact on this cost are the collection and transport of separated waste (CRD), €52.9 per inhabitant, treatment and recovery (CTR), €24.2 per inhabitant, treatment and disposal (CTS), €23.6 per inhabitant, and the collection and transport of unsorted municipal waste (CRT), €20 per inhabitant. The fixed items that have the greatest impact are common costs (CC), €26.5 per inhabitant, the cost of street sweeping and washing (CSL), €24.5 per inhabitant, and, finally, capital use costs (CK), €22.1 per inhabitant.

In 2023, the total annual cost per capita of the service by geographical macro-area is highest in the Centre at 233.6 euros/inhabitant (+5.3 euros/inhabitant compared to 2022), followed by the South with €211.4 per

inhabitant (+€9.1 compared to 2022) and the North with €173.3 per inhabitant (+€3 per inhabitant compared to 2022). In all macro-areas, the item that has the greatest impact on the total cost is that relating to the collection and transport of separated waste (CRD), with €64.6 per inhabitant in Central Italy (+2 compared to 2022), €57.5 per inhabitant in the South (+2.1 compared to 2022) and €45.3 per inhabitant in the North (+1.6 compared to 2022).

With regard to the cost of treatment and disposal (CTS), the figure is €32.6 per inhabitant in Central Italy (+1.1 compared to 2022), €31.8 per inhabitant in Southern Italy (+2.9 compared to 2022) and €14.9 per inhabitant in Northern Italy (-0.2 compared to 2022).

Compared to 2022, the cost of collecting and transporting unsorted municipal waste (CRT) remains virtually unchanged (+0.1) for the South and the Centre, with values of €23.9 per inhabitant and €22.6 per inhabitant respectively, while in the North it decreases by €0.3 per inhabitant, amounting to €16.6 per inhabitant in the last year.
Finally, the cost of treatment and recovery (CTR) stands at €24.7 per inhabitant in the North (+0.4 compared to 2022), €24 per inhabitant in the Centre (+1.3 compared to 2022) and €23.4 per inhabitant in the South (+0.8 compared to 2022).

Among the cities with the highest costs are Venice, with €411 per inhabitant (+6.6 compared to 2022), followed by Cagliari with €296.7 per inhabitant (+0.7) and Perugia with €291 per inhabitant (+5). The lowest values are observed in Campobasso and Trento, with €166.8 per inhabitant (+0.3) and €170.9 per inhabitant (-1.4). In Rome, the cost of the service is €272.9 per inhabitant (+2.5).

The analysis carried out on the pay-as-you-throw system in a sample of 1,352 municipalities, with a population of over 9.7 million inhabitants, confirmed for 2023 what had been found in previous surveys on pay-as-you-throw, finding that the average total cost per capita for these municipalities is lower than for those that apply the presumptive Tari. The average figure for the sample is €166.6 per inhabitant per year. For the cities of Trento and Cagliari, the per capita cost was €170.9 and €296.7 per inhabitant, respectively. For these cities, the percentage of separate waste collection was 82.4% and 76.8%, respectively.

6. National and Regional Planning

The Waste Framework Directive 2008/98/EC, as amended by Directive 2018/851/EU, stipulates in Article 28 that EU Member States are required to draw up waste management plans. These plans cover, individually or in combination, the entire geographical territory of a Member State and must comply with the principles laid down in Articles 1, 4, 13 and 16 of the Directive: the protection of the environment and human health, the reduction of the negative effects of waste production and management, the reduction of the overall impact of resource use, the waste management hierarchy and the application of the principles of self-sufficiency and proximity.

Member States shall communicate their waste management plans to the Commission once they have been adopted, as well as any substantial revisions to those plans.

The National Recovery and Resilience Plan (PNRR) outline a package of reforms and investments in order to access the financial resources made available by the European Union and is divided into 16 components, grouped into 6 missions.

Among its missions, the Plan includes improving waste management as a fundamental tool for implementing the circular economy, strengthening infrastructure for separate collection, modernising and developing new waste treatment plants, and bridging the gap between the North and the Centre-South in order to achieve the recycling targets set by European legislation.

As part of the implementation of the PNRR, a series of investments and reforms have also been identified to achieve the European targets for the transition to a circular economy. The reforms include the National Waste Management Programme and the National Strategy for the Circular Economy, while the investments are aimed at selecting and financing projects related to separate waste collection, recycling plants and flagship initiatives for the paper and cardboard, plastics, WEEE and textiles supply chains.

The PNRR allocates €2.1 billion to two investment lines: 1.1 (Intervention Lines A, B and C) and 1.2 (Intervention Lines A, B, C and D).

The first (Investment 1.1) provides for the improvement and mechanisation of the separate urban waste collection network, the construction of new treatment/recycling plants (for organic waste, multi-material waste, glass and paper packaging) and the construction of innovative treatment/recycling plants for absorbent materials for personal use (PAD), wastewater sludge, leather goods waste and textile waste. With particular reference to Action Lines B and C of investment line 1.1 (Action Line A concerns the improvement and mechanisation of the separate collection network for urban waste and does not provide for the construction of new plants), below is a summary of the data, updated to November 2024, relating to applications eligible for funding.

Macro-area	N°. of applications accepted for financial aid under line MTE 1.1 B	N°. of applications accepted for financial aid under line a MTE 1.1 C
North	13	30
Centre	2	13
South	11	20
Italy	**26**	**63**

With reference to Investment 1.2, aimed at financing flagship circular economy projects relating to waste electrical and electronic equipment, including wind turbine blades and photovoltaic panels (Line A), paper and cardboard waste (Line B), plastic waste, including marine litter (Line C), and textile waste (Line D), the number of applications eligible for funding is shown below.

Macro-area	N°. of applications accepted for financial aid under line MTE 1.2 A	N°. of applications accepted for financial aid under line MTE 1.2 B	N°. of applications accepted for financial aid under line MTE 1.2 C	N°. of applications accepted for financial aid under line MTE 1.2 D
North	19	19	28	10
Centre	13	12	8	1
South	22	28	20	3
Italy	**54**	**59**	**56**	**14**

The National Waste Management Programme (PNGR) is the national planning tool for the sector and is a structural reform provided for by the PNRR in Mission 2 - Green Revolution and Ecological Transition, Component 1 - Circular Economy and Sustainable Agriculture. The Programme was adopted by Ministerial Decree No. 257 of 24 June 2022, in compliance with the European target, and may be updated at least every six years, considering, among other things, regulatory, organisational and technological changes that have taken place at national and supranational level. ISPRA supported the Ministry in the development of the PNGR, providing the reference framework for waste production on a national scale, as well as a national survey of plants by type and region. It also prepared a study on the analysis of urban waste flows for Life Cycle Assessment, which identifies the technical assessment tools and general management criteria for the definition of regional planning. The application of the LCA method to waste management makes it possible to quantify the exchanges between the waste management system and the socio-economic world in terms of materials, energy and atmospheric emissions. The conclusions of the study made it possible to ensure consistency between the choices made by the National Programme and the financing objectives of the PNRR.

The PNGR is a policy tool for regions and autonomous provinces, as it contains the strategic guidelines they must follow when drawing up their waste management plans, as required by Article 199 of Legislative Decree 152/2006.
The Programme, designed to guide public policies and encourage private initiatives for the development of a sustainable and circular economy, has as its main objective to bridge the gap in infrastructure and increase the rate of separate collection and recycling, also with a view to developing new supply chains for secondary raw materials from the waste cycle, replacing traditional ones.
The targets, linked to the National Recovery and Resilience Plan (PNRR) and European objectives, are as follows:

- by 31 December 2023, the difference between the national average and the region with the worst results in separate waste collection will be reduced to 20 percentage points, considering a starting point of 22.8%;
- by 31 December 2024, the difference between the average separate waste collection rate of the three most virtuous regions and the same average of the three least virtuous regions will be reduced by 20%, considering a starting point of 27.6%;
- by 31 December 2023, the number of illegal landfills subject to infringement procedure NIF 2003/2007 is reduced from 33 to 7;
- by 31 December 2023, the number of illegal landfills subject to infringement procedure NIF 2011/2215 is reduced from 34 to 14.

Chapter 12 of the National Programme is dedicated to monitoring the programme itself in order to provide an information base that allows it to be adapted to the evolving dynamics of the national and regional system. The purpose of monitoring is to verify the status of implementation of the programme's guidelines, i.e. to assess the effectiveness of the objectives, including proposing any corrective actions. Other purposes are related to environmental communication, transparency of administrative action and stakeholder involvement. Among the

monitoring tools, reference is made to a dedicated national information system based on “Monitor Piani” and ISPRA's Waste Register. Tables 34 and 35 of the PNGR provide a summary of the logical framework of the monitoring indicators for the macro objectives and macro activities of the Programme. ISPRA is indicated as the source of much of the data needed to populate the indicators for the implementation of the plan's macro-objectives, as, in many cases, these are indicators already monitored to comply with the waste reporting obligations imposed by EU directives in this sector, or are data that can be monitored thanks to the institute's databases, in particular the Waste Register database (available on the website www.catasto-rifiuti.isprambiente.it).

Thus, for example, the indicators relating to separate waste collection at municipal level, in relation to the objectives imposed by Article 205 of Legislative Decree 152/2006, separate collection of organic waste at municipal level, and preparation for reuse and recycling of urban waste at national level. Furthermore, with reference to the macro-objective of reducing the gap in planning and plant equipment between different areas of the country, data prepared by ISPRA will be used to monitor the achievement of the targets set out in the National Programme. The Programme does not alter regional/provincial competences in the field of waste management, so it will be the regional waste management plans that identify the types of facilities to be built and the criteria for their location, as established by Article 199 of Legislative Decree 152/2006.

The management plans represent the unified reference framework for all levels of planning and programming of waste management interventions, at regional and optimal territorial level, and constitute the reference basis for other territorial planning instruments. However, the Regions must update their regional waste management plans.

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