“THE 3RS FOR A SUSTAINABLE USE OF NATURAL RESOURCES IN ULAANBAATAR-3R4UB” PROJECT

Masterplan for separate waste collection in Ulaanbaatar

ENGLISH VERSION

Credit

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3R4UB
Reduce - Reuse - Recycle

switchasia GRANTS PROGRAMME

Funded by the European Union

Summary

1 PART ONE: GENERAL FRAMEWORK

1.1 Preface

In the framework of the activities foreseen by the project ‘The 3Rs for a sustainable use of natural resources in Ulaan Bator - 3R4UB’ - financed by the European Commission within the ASIA SWITCH Programme - it is essential to carry out a synthetic, but exhaustive, analysis of some data and factors of a socio-economic nature, both relative to the entire national context and, more specifically, to the capital area, Ulan Bator, which constitutes the territorial scope of the project.
The analysis aims to provide an initial evaluation framework of certain phenomena and trends, of a socio-demographic nature or, rather, connected to economic sectors, which are of great interest for the correct determination of intervention strategies and policies aimed at the definition of a pilot programme for the collection, management and recycling of urban waste.

1.2 The National Territory

Mongolia is a landlocked East Asian state, bordering Russia to the north and China to the south, and although it does not share a border with Kazakhstan, its westernmost point is only 39.45 km from the latter's eastern tip. Much of its territory is covered by steppes, with mountains to the north and west and the Gobi Desert to the south. The cultivable area is very limited due to the cold climate.
With its 1 566 000 km² and a population of about 3.2 million people (mostly concentrated in the capital and largest city Ulan Bator where about 45.9 % of the population reside), it is the state with the lowest population density in the world: about 30% of the population is nomadic, mainly engaged in animal husbandry; the majority of the state's citizens are ethnic Mongolians, however, minority ethnic groups, including Kazakhs and Tuvans, are present, especially in the western part of the country; the predominant religion is Tibetan Buddhism; about 20% of the population lives on less than a dollar a day[8]. The political system is a semi-presidential republic: the president is elected by the citizens and appoints the prime minister, but cannot appoint ministers or dissolve parliament; he can, however, veto laws being passed. Mongolia joined the World Trade Organisation in 1997 and seeks to expand its regional participation in trade and economics.
Present-day Mongolia was preceded by several nomadic empires, including Xiongnu, Xianbei, Rouran, Göktürk and others. The Mongolian Empire was founded by Genghis Khan in 1206. Around the 17th century, Mongolia came under the influence of Tibetan Buddhism. At the end of the 17th century, most of Mongolia was incorporated into the area ruled by the Qing dynasty. During the collapse of the Qing dynasty in 1911, it declared independence, but had to struggle until 1921 to become de facto independent from the Republic of China. It was greatly influenced by the Soviets: in 1924, the Mongolian People's Republic was established, a classic Soviet-style, loyal ally of the Soviet Union throughout its history. In 1945 it gained full international recognition as a state. After the collapse of the communist regimes in Eastern Europe at the end of 1989 and the peaceful democratic revolution of 1990, Mongolia embarked on a slow transition to democracy, through the approval of a new

constitution in 1992, the introduction of multi-party rule and the transition to a market economy. Ulan Bator (or Ulaanbaatar) is the capital and most populous city of Mongolia, located in the north-central part of the country. The city's name, given since 1924, means 'Red Hero'.

Mongolia, with a total area of 1,564,000 km², is among the last countries in the world in terms of population density - 2 inhabitants per km² in 2020 - followed only by the Falkland Islands, Svalbard and Jan Mayen Islands and Greenland.

Its territory from a morphological point of view has three main areas: the northern and western regions dominated by mountain ranges, vast basins located around and between the mountain ranges, the southern and eastern regions characterised by a very wide band of highlands consisting of steppes and desert areas.

Figure 1: City map Mongolia

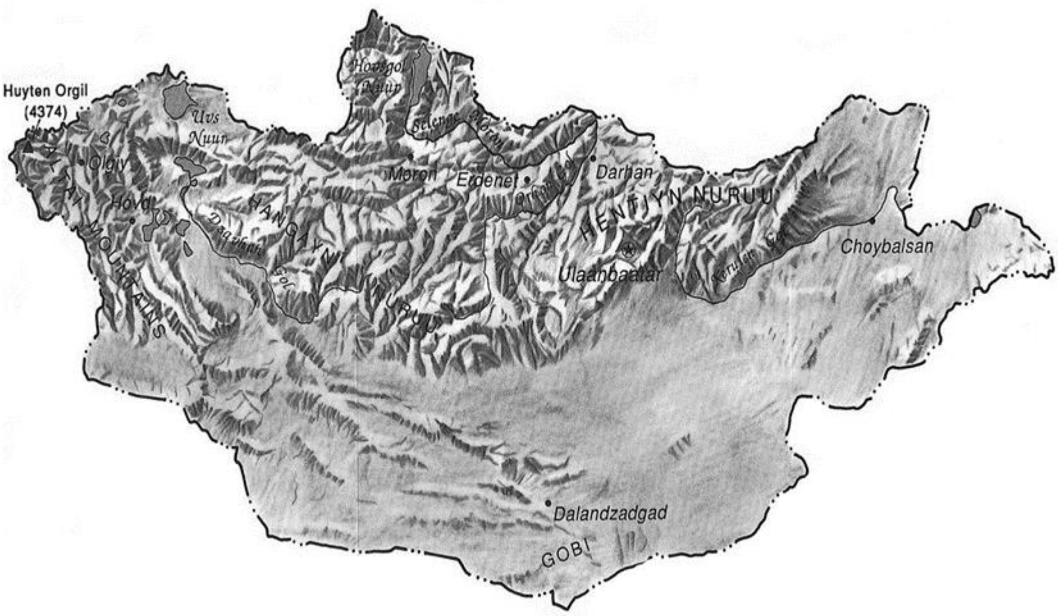

Figure 2: City map Mongolia

From an administrative-political point of view, the territory is divided into 21 provinces (further subdivided into districts), to which is added the capital area of Ulan Bator, which has the status of a province.

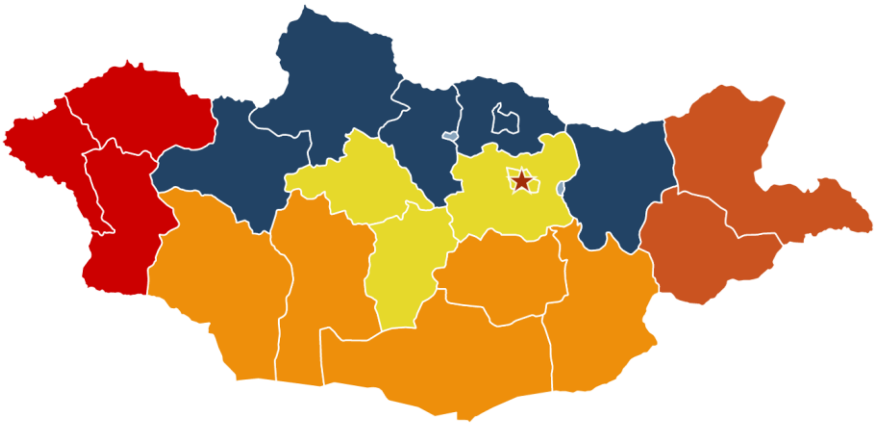

Figure 3: Subdivision of provinces in Mongolia

Figure 4: Administrative subdivision by province (Source: www.worldatlas.com/upload/af/ac/cf/provinces-of-mongolia-map.png)

For the purposes of the following brief socio-economic analysis, where appropriate, below - following the same logic of territorial aggregation adopted by the National Statistical Office of Mongolia - reference will be made to the territorial spheres by grouping the provinces into five macro-areas, including that of the capital, which, as mentioned, has the status of a province, due to its relevance within the national context.

1.3 The State Macroeconomic Context

Mongolia is the second largest landlocked country in the world and the one with the lowest population density, part of which, around 30 %, continues to maintain nomadic and agro-pastoral traditions. Until the late 1980s, Mongolia had adopted a one-party form of government, cultivating close ties with the Soviet Union from which it received technical, economic and military assistance as well as political control, with an emphasis on building a socialist society. In the 1990s, the country abandoned the Communist Party's political monopoly, reforming the constitution, introducing free elections and initiating a process of transition to a market economy through an extensive programme of privatization of public enterprises, price and wage liberalization and currency reforms.

Instability is one of the main features of the Mongolian political system, characterized by frequent sectarian conflicts, endemic governance problems and widespread popular discontent. The Mongolian People's Party (MPP) won a landslide victory in the June 2020 unicameral (State Great Khural) parliamentary elections where it controlled 62 of the 76 seats. In June 2021, the MPP's candidate, Ukhnaa Kurelsukh, won another irrefutable victory in the presidential election, registering 72% of the vote. The government is thus free to implement its political agenda, in the absence of significant internal opposition, at least until 2024, when the next general elections will be held, although the unchallenged dominance of a single party is likely to generate governance issues. The weakness of the opposition and the absence of other instruments of political influence and control over the actions of public officials make popular protests increasingly widespread. The government, which had been harshly criticized for its handling of the initial phase of the pandemic, is systematically the target of mass protests by the population, as was the case in April 2022, due to frustration over rising food prices and energy costs as well as the lack of economic opportunities for young people and small businesses. In December 2022, further waves of protest were directed against a corruption scandal that broke out in a large state-owned mining company, Erdenes Tavan Tolgoi.

1.3.1 Type Of Business

Mongolia's economy is traditionally based on agriculture and pastoralism, and above all on the mining sector on which it is heavily dependent, especially for coal and copper exports to China. The country is, in fact, endowed with considerable deposits of minerals, such as copper, coal, molybdenum, tin, tungsten and gold, largely exploited during the period of Soviet influence, which feed a conspicuous industrial production.

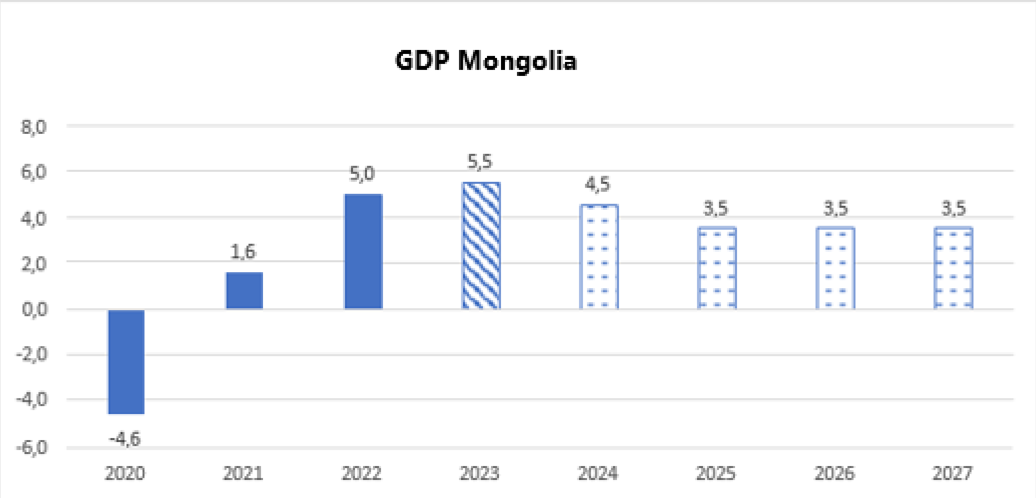

Figure 5: Mongolian GDP

MONGOLIA: Macro-Economic Indicators	2022	2023 (1)	2024 (2)	2125 (2)
GDP Nominal (mln US$) (current price)	17,1	18,8	19,6	19,6
GDP real (Var. %)	5,0	5,5	4,5	3,5
Population (mln)	3,5	3,5	3,6	3,6
GDP pro-capite (current price) ($)	4.954	5.348	5.490	5.443
Financial Statements (% GDP)	0,7	-0,7	-2,8	-2,5
Public Debt (% GDP)	64,5	59,1	61,5	63,3
Inflation (%)	15,2	12,3	12,3	12,0
Unemployment rate (%)	7,3	6,6	5,9	5,3
Export Rate (Var. %)	23,8	24,7	9,6	9,2
Import Rate (Var. %)	12,5	13,9	2,3	-0,6
Current Account Balance (% GDP)	-13,4	-10,9	-12,6	-10,3
(1) extimation (2) prevision				
Fonts: FMI data – 2023 Article IV & World Economic Outlook (october 2023)				

Table 1: Macro-Economic Indicators

Since the second half of 2022, growth has experienced a robust recovery, with GDP rising by 5% for the year 2022, as a result of the reopening of borders and trade with China, the resulting rapid expansion of exports, especially coal, and the strong tone of domestic consumption. The expansion was also supported by the new pro-cyclical fiscal stimulus measures passed in June 2023, which introduced large and permanent increases in wage, benefit and pension levels. On the other hand, private investment experienced a slowdown, due to high commodity costs and the risk-averse attitude of banks. In line with the economic recovery and large public investment projects, demand for imports was relatively robust, despite the dampening effect of high import prices and transport costs.

On the supply side, growth is explained by the increase in livestock numbers and the recovery of services, associated with the end of pandemic restrictions.

Mining production appears to be expanding, thanks to the rapid resumption of operations at the Oyu Tolgoi mine coupled with the removal of export restrictions.

Economic growth has helped increase employment and reduce the unemployment rate to its lowest level since the mid-2000s. On the other hand, supply bottlenecks, buoyant household consumption and price pressures on imported products, together with the significant depreciation of the exchange rate, pushed up the inflation rate.

Despite the expansion of government spending, solid growth in mining revenues is containing domestic financial imbalances, while balance of payments pressures remain significant, due to sustained growth in imports and payments associated with foreign bonds.

The medium-term outlook remains cautiously optimistic, with the real GDP growth rate estimated at 5.5% in 2023, with a moderate deceleration to 4.5% in 2024, according to the IMF, driven mainly by production improvements at the Oyu Tolgoi copper mine and continued investment in its operations, as well as gradually improving labour market conditions and rising private consumption, driven by strengthening consumer expectations and accelerating demand.

The expected increase in mining production is expected to boost government revenues and reduce balance of payments pressures, increasing the level of foreign exchange reserves. On the other hand, the persistent concentration on the mining sector is generating a general loss of competitiveness in sectors not associated with resource exploitation and an increase in the country's vulnerability to fluctuations in commodity prices, necessitating progress in economic diversification processes.

In recent years, Mongolia has recorded systematic trade surpluses, thanks to the positive development of exports, mainly in the mining sector, to China.

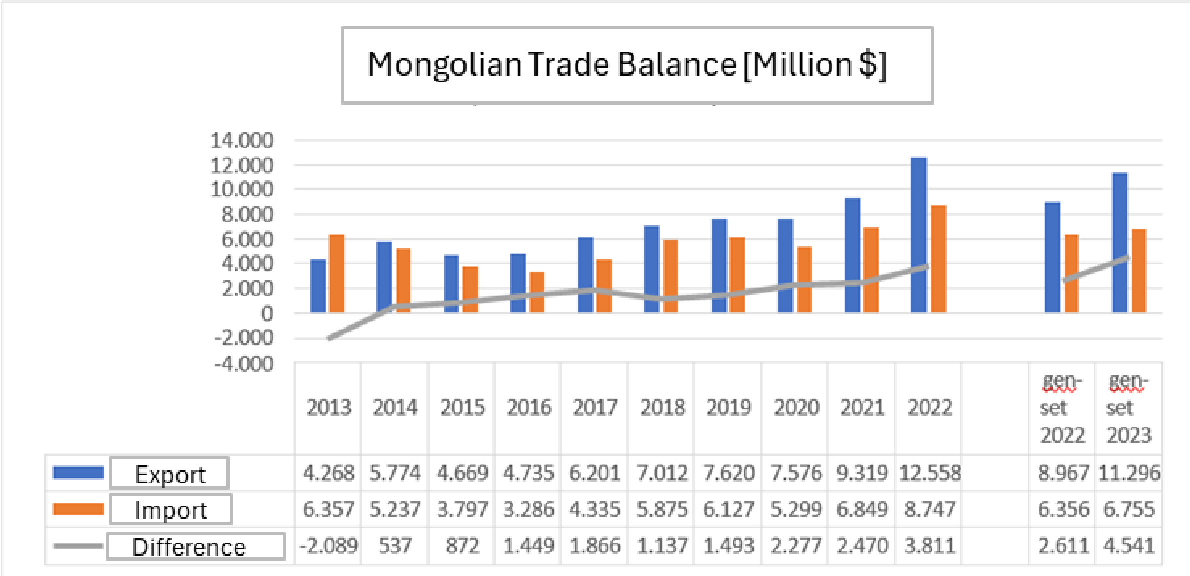

Figure 6: Mongolian Trade Balance

According to data from the National Statistics Office of Mongolia, in 2022, exports amounted to about $ 12.6 billion, up 34.8 % from 2021, their highest level historically, while total imports reached $ 8.7 billion, registering an annual increase of 27.7 %, also at their highest level. The trade balance amounted to a record high of over USD 3.8 billion.

In the first nine months of 2023, exports increased by a further 26% compared to the first nine months of 2022, while imports grew at a more moderate pace of 6.3%. As a result of these dynamics, there was a further expansion of the trade balance to a new peak level of over USD 4.5 billion.

China dominates the ranking of Mongolia's outlet countries, representing, by far, its main destination country for exported goods, with a share that, in the first nine months of 2023, reached 91%, thanks to the 36% increase recorded by Mongolian sales compared to the first nine months of 2022, followed, by much lower values, by Switzerland, which, however, recorded a 30.2% decline for a share that dropped to 4.3% of the total. Italy ranked fifth in the ranking of outlet countries, recording Mongolian exports increasing by 26.2%, compared to the first nine months of 2022, accounting for 0.6% of the total.

Ord.	Partner Country	January - September (Value: Mil USD)		Market share (%)		Var, 2023/2022	
		2022	2023	2022	2023	Value	%
	World	**8.967**	**11.296**	**100,0**	**100,0**	**2.330**	**26,0**
1	China	7.563	10.284	84,4	91,0	2.721	36,0
2	Switzerland	700	488	7,8	4,3	-211	-30,2
3	Sud Corea	158	134	1,8	1,2	-24	-15,1

4	Russia	76	80	0,8	0,7	4	5,7
5	Italy	56	71	0,6	0,6	15	26,3
6	Singapore	321	40	3,6	0,4	-281	-87,6
7	USA	6	33	0,1	0,3	27	449,1
8	Taiwan	0	26	0	0,2	26	15577,7
9	Egipt	0	18	0,0	0,2	18	3594,5
10	Kazakhstan	5	17	0,1	0,2	13	272,1

Table 2: Commodity exports by country - January-September 2022-23 (USD million) - National Statistics Office of Mongolia

Ord.	**Partner Country**	**January -September (Value: Mil USD)**		**Market share (%)**		**Var. 2023/2022**	
		2022	**2023**	**2022**	**2023**	**Valore**	**%**
	World	**6.356**	**6.755**	**100,0**	**100,0**	**400**	**6,3**
1	China	2.206	2.718	34,7	40,2	511	23,2
2	Russia	1.901	1.780	29,9	26,4	-120	-6,3
3	Japan	530	521	8,3	7,7	-9	-1,7
4	Sud Corea	324	292	5,1	4,3	-32	-9,8
5	USA	196	223	3,1	3,3	28	14,2
6	Germany	133	159	2,1	2,4	26	19,4
7	Vietnam	62	87	1,0	1,3	25	40,7
8	Turchia	85	70	1,4	1,0	-15	-18,1
9	Polonia	71	66	1,1	1,0	-4	-6,3
10	Italy	52	57	0,8	0,8	4	8,3

Table 3: Commodity imports by country - January-September 2022-23 (USD million) - National Statistics Office of Mongolia

On the import side, China accounted for 40.2% of the total in the first nine months of 2023, up 23.2% year-on-year, followed by Russia with 26.4%, which, however, showed sales down 6.3%, similarly to Japan (8.1%, slightly down 1.7%) and South Korea (5%, down 9.8%). In fifth position was the United States (3.3% of the total and a trend increase of 14.2% compared to the first nine months of 2022) followed by Germany (2.4%, up 19.4%). Italy ranked tenth among Mongolia's supplier countries in the first three quarters of 2023, with a market share of 0.8% and sales up 8.3% in dollar values.
The main products exported by Mongolia in January-September 2023 were coal, accounting for 56.8% of the total, copper ores (17.7%), gold (5%), iron ore (2.9%), crude oil (2.4%), crude cashmere hair (3.3%), and other minerals (zinc, feldspar, etc.). The positive change in foreign sales of minerals (coal +41.9%; crude oil +92%; feldspar +167.9%), as well as nuts (pine nuts) and canned meat was remarkable.

1.4 The Regional Reference Territory

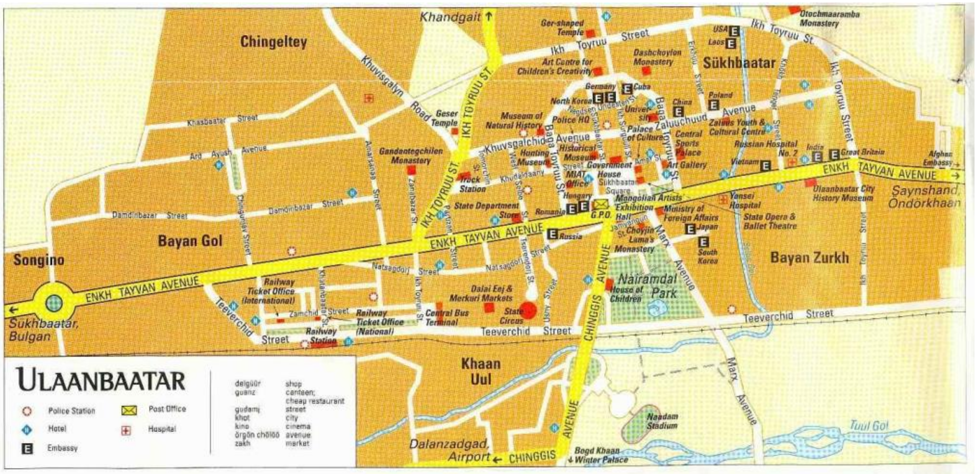

Figure 7

From an administrative point of view, the Ulaanbaatar area - located within the Tôv Province - enjoys the status of a Province (Haimag). It is made up of 9 districts: Baganuur, Bagahangaj, Bajangol, Bajanzurh, Cingeltej, Han Uul, Nalajh, Songinohajrhan, and Suhbaatar (of which the first two are not geographically contiguous, neither with each other nor with the capital area) - in turn divided into sub-districts (Horoo).

The sizing was conducted taking into consideration each of the districts thus identified, and led to the definition of a schedule for domestic users and the determination of the number and type of vehicles and operators needed to carry out the service.

The following table shows the number of inhabitants in each district

District	Population
Baganuur	27.449
Bagahangaj	4.334
Bajangol	222.479
Bajanzhurh	356.833
Cingeltej	147.356
Han Uul	184.918
Nalajh	37.561
Songinohajrhan	322.161
Suhbaatar	141.578
TOTAL	1.444.669

Table 4: Districts Population

Figure 8 Districts Map

The capital is the administrative, economic, cultural and demographic center of the country. At the end of 2020, the population living in the area constituted 47.6% of Mongolia's total population and 69% of the total population living in urbanised areas.
Population growth in the area has been progressively accelerating since the 1980s. Between 1990 and 2020, the number of residents (understood as the net balance between immigrants/emigrants and births/deaths) almost tripled, from 586,228 to 1,597,290, a rate far higher than the average rate of increase of the national population (precisely because of the significant immigration flows).

During the implementation phase, by means of territorial surveys, it will be possible to carry out a precise census also of non-domestic users, allowing the correct sizing of waste flows and of the necessary equipment and means (of the volumes of containers/kits needed).

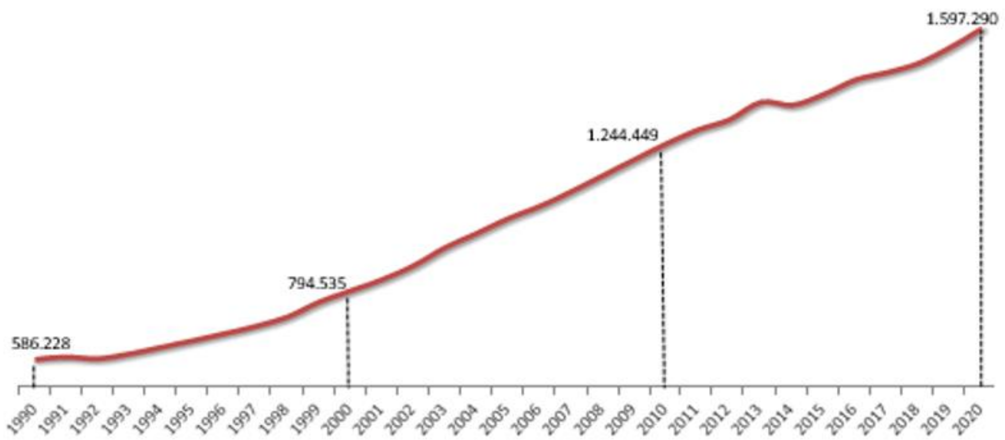

Figure 9: UB Demographic Trend

The 2020 Annual Census of Population and Housing (whose data in many cases is updated to 2019 and to which, due to the timeliness of the survey, reference will be made for the analysis of numerous factors relating to the capital area), recorded 1,539,810 citizens in the area in 2019, of whom 91,168 were Mongolian citizens residing abroad for 6 months or more, thus the actual residents were 1,466,125, of whom 17,483 were foreigners or stateless persons. The spatial distribution of residents in the districts shows that more than 62% of the inhabitants are concentrated in the districts of Bajanzurh, Songinohajrhan and Bajangol.

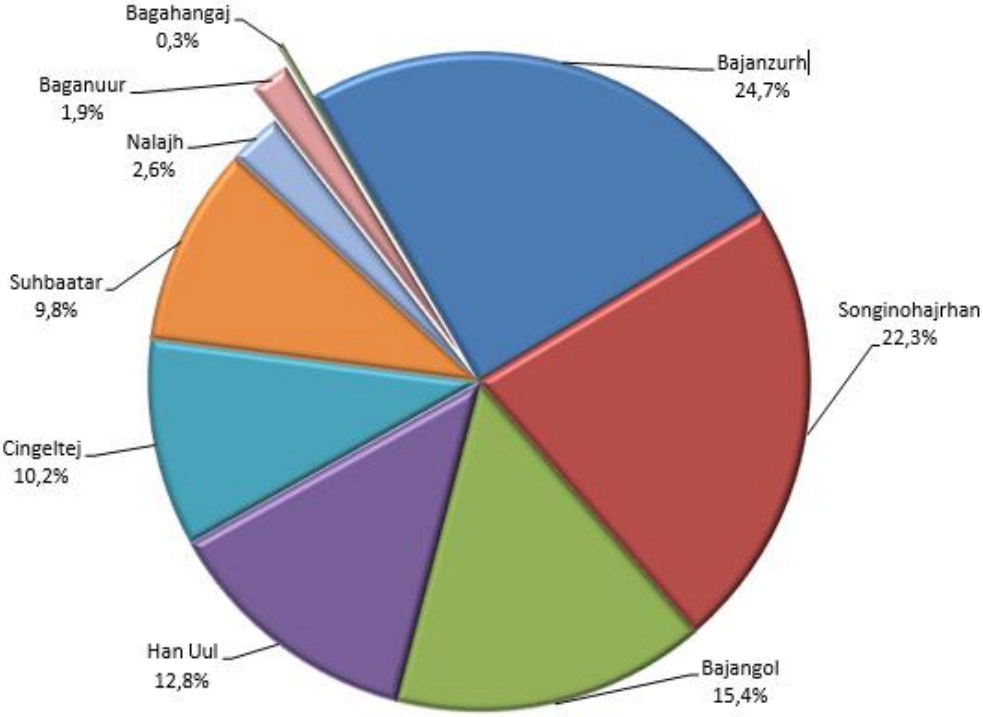

Figure 10: UB Demographic Distribution

Compared to 2010, the percentage distribution of the population in the different districts remained almost unchanged, however, when considering the inhabitants in the individual districts, there were variations. For example, the population of Han-Uul district increased by 3.2 points, while it decreased by 1.3-2.5 points in Sukhbaatar and Chingeltei districts. This can be explained by the fact that in recent years, Khan-Uul district has seen an increase in housing construction (especially apartment blocks) and increased migration between the districts. Furthermore, it should not be underestimated that the population capacity of some districts may be limited due to expansion potential, location and environmental conditions.

Population growth in the capital area, however, slowed down in the period 2010-2020, with an average annual growth rate of 2.5%, compared to an average of 4.6% in the previous decade. It should be noted, however, that from 2019 onwards, the annual growth rate has started to be above 3% again, a sign that the political will to limit the inflow from rural areas in particular is not having the desired effects.

Projections in the World Population Prospects 2019, produced by the UN Department of Economic and Social Affairs, indicate that the population of the area is expected to reach almost 2 million in 2030.

The average population density figure referring to the entire area of the Province (312 inhabitants/km2) is absolutely misleading. In reality - not taking into consideration the Districts of Baganuur, Bagahangaj and Nalajh, and although the population density is influenced by the urban structure of the individual areas to be considered, which may see the presence of, e.g, of large, multifamily, multi-storey dwellings (apartment blocks) or rather of detached houses or jurts since the majority of the population is concentrated in the central urbanized area, it is most likely that, making an accurate calculation of its actual land area, the population density would not be particularly distant from that recorded in Bajangol District (9. 254 inhabitants/km2).

The area's population growth is naturally the result of two phenomena: migration flows and the birth/death balance.

As already mentioned, migration flows to the capital have been very substantial since the 1990s, accelerating further in the first decade of the 2000s and then slowing down, due to policies aimed at discouraging immigration, since 2017.

At the end of 2019, 64.6 % of Ulan Bator's urban population had been living in the capital since birth, while 35.4 % were immigrants, of whom 34.9 % were from other provinces or cities and 0.5 % from abroad. Compared to the 2010 Census, the percentage of people living in Ulan Bator from birth increased by 17.4 %, while the share of immigrants in the total population decreased by the same amount (among them, those from other localities or rural areas decreased by 15.7 % and those from abroad by 1.7 %).

The main provinces of origin of the resident immigrant population are Tov (9.3%), Zavkhan (9.0%), Arkhangay (8.1%), Uvs (7.7%) and Ovorkhangai (7.2%) those from which fewer immigrants come are Omnogovi (1.7%)), Bayan Olgiy (1.0%) and Govisumber (0.5%). In general, with the exception of the Eastern Region - which accounts for only 11.8% of total immigration - inflows from the other three macro-areas are distributed substantially evenly.

Outflows from the capital area are concentrated in the provinces of Orkhon (15.3%), Darkhan-Uul (14.4%), Tuv, (13.0%), Selenge (11.2%) and Dornogovi (8.6%). Whereas the provinces of Bayan-Ulgii, Gobi-Altai and Uvs recorded the lowest emigration flows. In addition to a lower propensity of both natives and immigrants to leave the capital area, it would seem to emerge that those who decide to leave the capital area tend towards larger cities or at least areas with well-developed infrastructure and along the railways.

In terms of the age and gender structure of migrants, the number of migrants aged between 15 and 20 is growing rapidly. In general, young people come to the capital to study (most of the country's universities and colleges are in Ulan Bator), to improve their living conditions, work and incom
Data highlighting the strong impact of births in the last 10 years, but also the improvement in living conditions, with a growing number of residents belonging to the third age group.

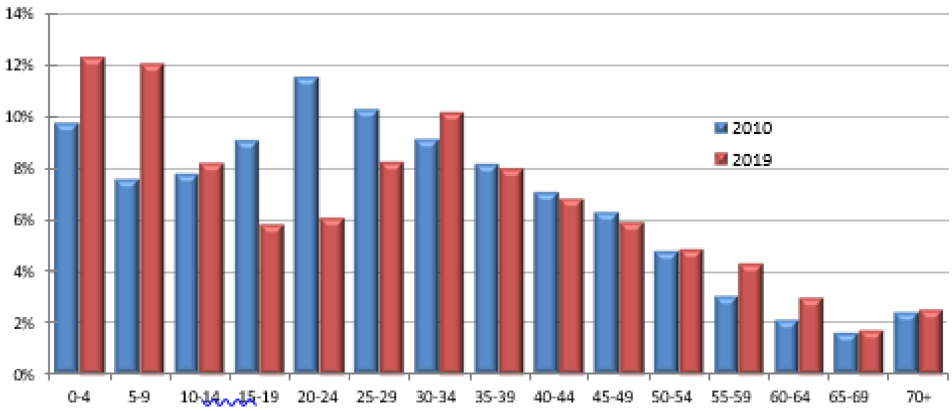

Figure 11: UB Distribution by Age

The total population of the area is 411,420 households composed of a total of 1,426,085 people (with an average of 3.5 members per household), while 40,040 inhabitants do not belong to multi-member households (single or widowed).
The distribution on a territorial basis - by districts - is almost equivalent to that of the resident population as a whole. However, it is interesting to note that compared to the 2010 census, the largest increase in the number of households was in the districts of Khan-Uul (78.0%), Bayanzurkh (42.8%) and Songinokhairkhan (42.0%). This is partly due to the fact that most rural migrants live in the districts of Bayanzurkh and Songinokhairkhan, and partly because there is more housing available in these areas. The districts of Sukhbaatar and Chingeltei, on the other hand, have a growth rate lower than the average for the whole area, most probably due to the conformation of the territory and the consequent reduced availability of space for settlements.

The level of education of the population has increased compared to the picture that the country presented in the last decades of the twentieth century. At the end of 2019, among the population resident in the capital area aged 10 years and over, 9.2% have a primary education, 9.4% have a basic education and 9.4% have completed secondary education. Only 0.5% of the population aged 15 and over are illiterate.
There are still differences in the level of education according to gender, with a substantial prevalence of women and a further increase in the gap men/women between the two censuses of 2010 and 2020. For example, among the population aged 10 and over, in 2010 23.8% of men and 30.2% of women

had a higher education, at the time of the census the incidence had risen to 31.3% and 40.9%, respectively.
The highest percentages of population with higher education are recorded, as in the 2010 Census, in the districts of Bayangol, Sukhbaatar and Khan-Uul.
In proportion to the degree of population concentration, in 2019 of the 2,259 pre-primary and general education institutions operating in Mongolia 41.7% (943) were located in the Ulaanbaatar area, 47.6% of all kindergartens and 31,5% of secondary schools.
As regards employment, at the date of the last census, the population aged 15 and over was 989,404 (64.25% of the total population in the area), of which 587,159 (59.34% of the working age population) constituted the labour force (i.e., employed and unemployed job seekers), while 402,245 are the subjects outside the labour market.

The total number of companies in the period 2015-2020 has grown considerably (+59.3%), from 40,388 to 64,351 units. The sectors that recorded above-average growth rates were: Other service activities (+78.1%); Wholesale and retail trade, car and motorcycle maintenance (+76.6%); Education (+63.3%); Entertainment and games (+63.0%).
The lowest growth rates were: electricity, gas, steam and ventilation supply (+28.6%); mines and quarries (26.3%); administrative and support activities (22.5%).
In recent years, all aspects of the economy and society have been affected by urban development, planning, environment and ecological security, unplanned settlements, increased crime and conflict, from traffic congestion and the public health, social welfare and services sectors. in bilateral relations. Therefore, the Mayor of Ulaanbaatar and the Mayor of Ulaanbaatar 2017
On 9 January 2018, a decree was issued temporarily suspending the movement of people from rural areas to Ulaanbaatar for permanent residence until 1 January 2018 and the decision was extended until 1 January 2020. The number of visitors should decrease. However, it should be noted that the number of unregistered "temporary residents" is increasing despite the enactment of the ordinance.

The rapid growth of the resident population has obviously had a major impact on its urban structure. Around the central area, there are rapidly created increasingly large peripheral areas (some of which extend over 20 km. from the city center), characterized by settlements where, next to small independent houses, jurtes represent the most widespread type of dwelling, so much so that they are defined as "Ger Areas".

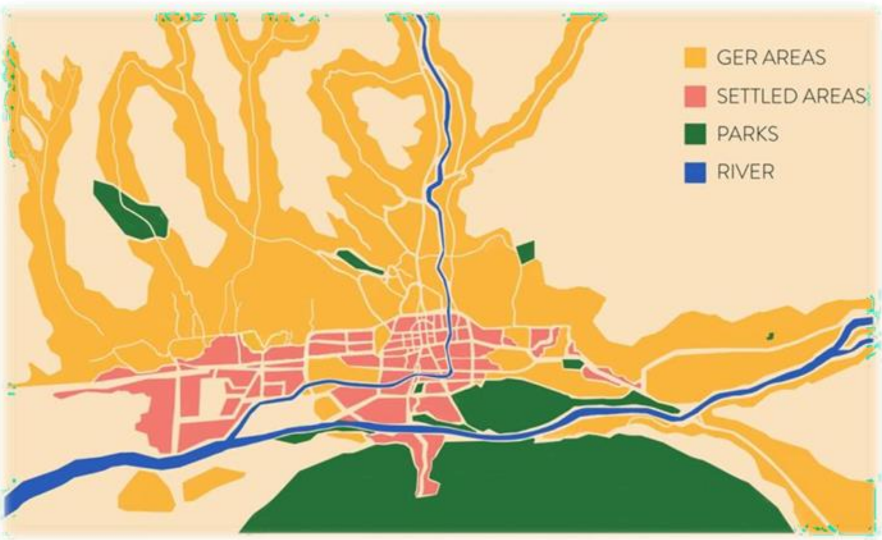

Figure 12: UB Map

According to the census of population and housing, in 2020 22.2% of the 411,420 families in the area lived in traditional ger mongs, 77.3% in houses (independent or condominium) and 0.5% in other types of housing (these are generally public facilities and/or dormitories). The percentage of households living in ger is 16 percentage points lower than the national average, while the percentage of households living in houses is 16.3 percentage points higher.

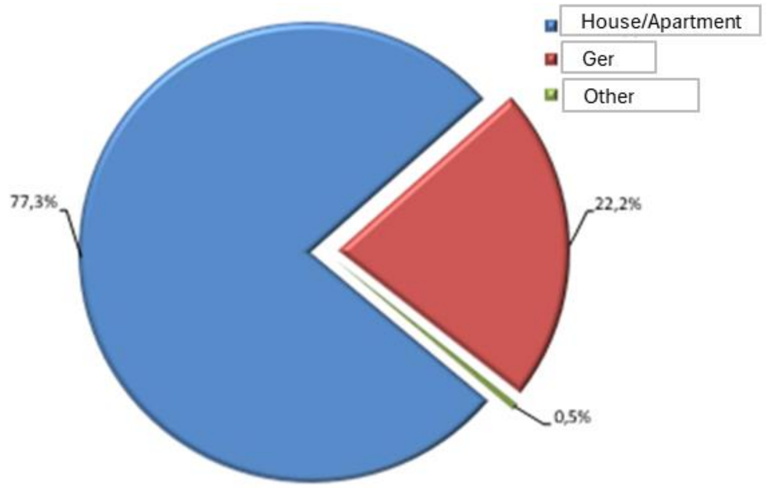

Figure 13: Distribution Urban Settlements

The share of households living in GERS decreased by 6.8 points compared to the previous census, while the share of households living in houses increased by 7.7 points. This is due to the redevelopment work carried out in the Gear Areas and the construction of many new residential complexes, especially in the last ten years. Among the possible causes of the reduction of families living in the Ger Areas is reported the decision of the Governor of the Capital - taken in January 2017 and still in force - to limit the influx of new residents from the countryside to Ulan Bator, which however does not apply to persons buying apartments. Further confirmation is given by the fact that, between the two censuses, the number of families living in apartments increased by 84%. In contrast, the number of families living in dormitories has decreased by 2.6 times.
In addition, when comparing the two censuses, there is a significant increase in single-family homes, which indicates that people are starting to build their own houses and are gradually abandoning ger.
The analysis of household housing typology by district shows that the percentage of households living in gers in the capital's remote districts (Ba ganuur, Bagahangaj and Nalajh) and in the Songinohajran district is higher; one family in three lives in gers. In the more central districts, however, this percentage falls considerably to reach the lowest levels in the districts of Bajangol and Han Uul where families living in houses and apartments reach 93.6% and 85.0%, respectively.
Between the two censuses, in absolute value, the number of families living in houses has increased by 50.9%; among these, the increase of those living in apartments was equal to 84%, currently there are almost 200,000 families living in apartments, in medium and large buildings. The number of families living in dormitories has decreased by 2.6 times. The increase in the number of single-family homes is also a sign that people are starting to build their own houses, and

If. However, the number of families living in gers has increased by 3.8 thousand (4.3%), but overall and the number of ger has decreased by 6.8
In terms of access to primary services, the latest census shows that 99.5% of households have access to the public electricity network, As regards the availability of drinking water, it would appear that this

is available to 99.8% of households. In relation to this last figure it should be pointed out that the availability of drinking water does not mean direct connection to the public water network, which is available only to 62.2% of households (among the sources of availability of drinking water are also considered public kiosks - connected and not to the water network - protected wells, springs and streams).

The sanitary discharges in the Ger Areas are very poor. 96.6% of the families living in these areas have no sewerage and use pit latrines. For sewage discharge the condition is similar, 86.5% of households discharge into designated wells, while 13.5% discharge to open air. In these conditions, the risks of soil pollution and also for the health of the population are obvious. The situation is better for families living in apartments where 61.7% have direct drainage into public sewerage.

Finally, as regards the solid waste disposal system, during the census it was found that 96.6% of households (98% for families living in houses and apartments) has access to a collection system run by specialised organisations, an increase of 8.9 percentage points compared to the previous census. Just under 2% of households, however, do not yet have a disposal site for solid waste and a residual amount of subjects continues to burn or bury them.

The theme of urban development and new construction is extremely relevant. The urban regeneration and housing policies, which were launched at the end of the 1980s but over the last twenty years, despite the technical difficulties associated with the construction of mid-rise buildings on permafrost, have had a considerable acceleration.

To give an example of the types of operations, among those in progress it is possible to mention 9 interventions carried out by the Capital City Housing Corporation (MUB), aimed at the realization of a very large number of cheap housing, Targeted at low/middle income households, including long-term rental. The following is a graphical summary of the current interventions.

GER areas

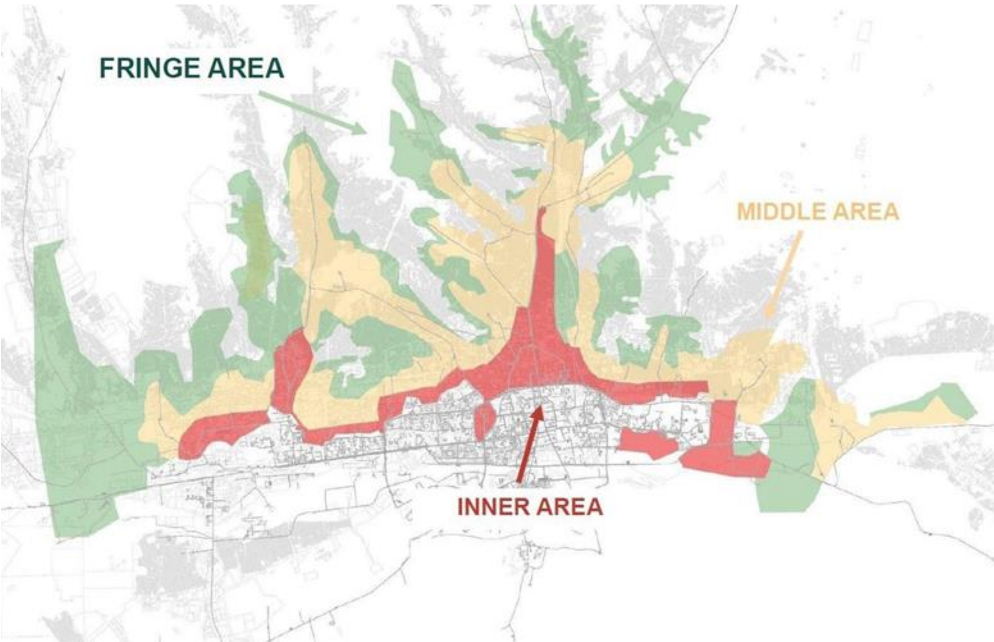

Figure 14: Macrozonisation of Ger Areas

The Inner Areas will see the development of better connections and connections to public utilities (including water and sewerage networks) and the construction of new apartment complexes, with medium and high density housing.
The Middle Areas will be redeveloped as residential areas with medium or low density, with users partly interconnected to the central networks and partly with utilities infrastructures and services of a local nature.
Fringe Areas will be developed as low-density residential districts with independent utilities and services infrastructure.

All the measures envisaged are aimed, as mentioned above, at improving the quality of the urban system as a whole and, above all, at improving the living conditions of residents. It should be stressed that, although it is strongly emphasized that "the new residential areas will be adapted to the Mongolian culture and traditions", there is no doubt that the new housing model of large condominiums will not affect the structure and social relations, as well as the ways of access and provision of public services, which will have to be redesigned in a new perspective and based on scalability, due to the progressive expansion of the new urban model.

1.5 Socio-Economic Analysis

Over the last twenty years, the country has recorded a constant growth of the resident population, with an average rate between 2000 and 2020 of 1.7%.
In the period under review, the overall population increase was 39.7%, from 2,403,105 inhabitants in 2000 to 3,357,542 at the end of 2020.
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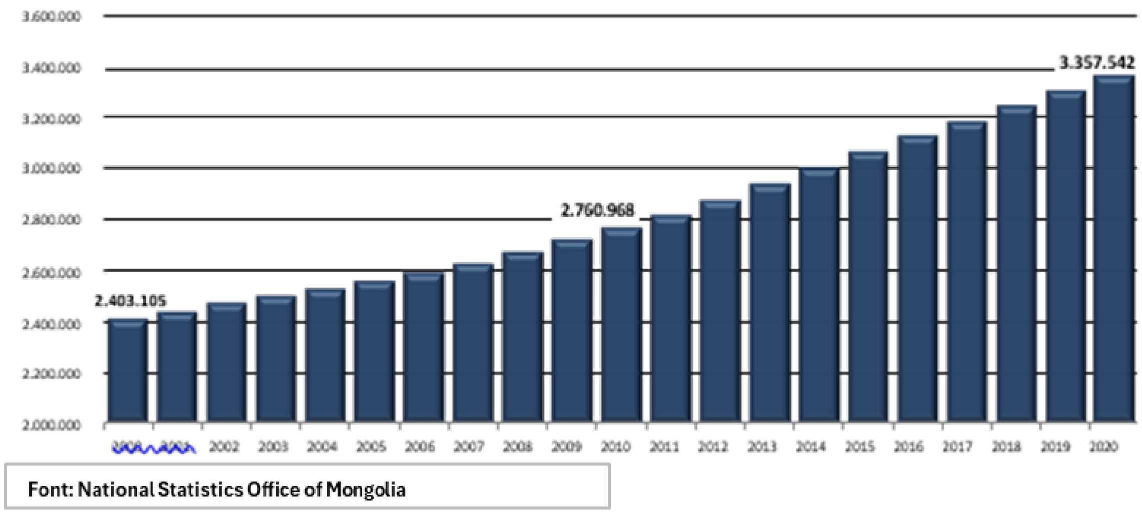


Figure 15: Resident population growth

The distribution on a territorial basis shows the clear predominance of the capital area, in which resides just under 47.6% of the total population.

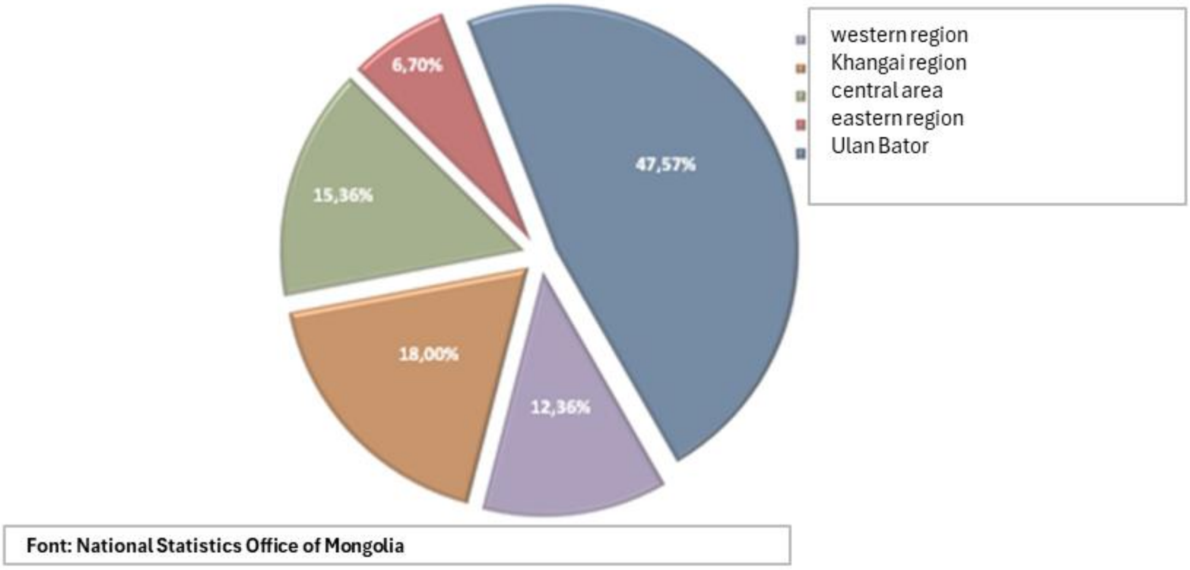


Figure 16: Resident population by macro-areas (2020)

The average age of the population in 2020 was 28 years, in line with most countries in the area.

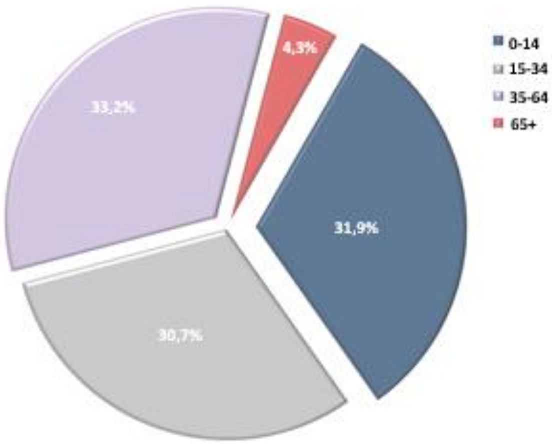


Figure 17: Resident population by age groups (2020)

The incidence of the population over 65 years old is substantially low, although tending to increase, due to the progressive extension of average life expectancy, which has increased significantly in the last twenty years, From 64.2 years of age in 2000 to 70.8 years in 2020, a significant improvement in the general living conditions of the country.

From the gender perspective, there is a substantial balance between men and women, 49.1% and 50.9% respectively of the total population in 2020. It is interesting to note that the incidence of women is prevalent in the higher age groups, 61% among the population aged over 65, a fact which highlights, as it does elsewhere in the world, an average life expectancy of women (74.7 years) higher than that of men.

The total number of households in 2020 was 908,712, of which as will be seen in more detail later on 45.6% living in the area of Ulan Bator.

Like most of the world's countries, Mongolia has been affected by a process of progressive concentration of population in urbanized areas, which has also led to substantial changes in social structures and economic structure. This phenomenon has seen a strong acceleration since the early 1980s, when the population living in urban areas represented 55.3% of the total, reaching 69% in 2020. In this context, the impact of the capital area is extremely important. The population in the area of Ulan Bator, in fact, represents just under 69% of the total population living in urbanized areas.

Obviously the prevalence of the urban area of the capital is also found in the analysis of migratory balances (as a result of arrivals and departures in the individual macro-areas considered). The area of Ulan Bator, unlike the remaining provinces which - except for rare and specific cases relating to specific years - have consistently negative balances since 1993, has consistently positive balances, with an overall increase in the resident population between 2000 and 2019 (as data on outflows for 2020 is not yet available) attributable to migration flows, of just under 377,500 units.

As for the housing types, it is still very widespread residence in traditional jurte (otherwise called ger), even in urbanized areas (including that of Ulan Bator), especially in the suburbs, In which entire residential areas have been created with this type of housing. In a general process of urbanization and

settlement, the use of jurtes as permanent housing is also decreasing, obviously especially in major urban areas.
In 2010 jurtes represented 45.23% of the total number of dwellings used and the incidence of other types of housing (often semi-temporary, such as shacks) was 1.14%. In 2020 jurtes make up 33.47% of the total number of dwellings used and the incidence of "other types" is less than 1%.
In the capital area, with substantial differences for the different districts that make up it and despite the significant and growing size of the so-called "Ger areas", in 2020 permanent housing represents 77.3% of the total.
The level of education of the population has gradually increased since the second half of the 20th century and illiteracy has almost disappeared. In 2020, the incidence of literacy among the population aged 15 and over reached 99.2%.
The total number of students (including those in preschool age attending kindergartens or similar facilities) in 2020 was 1,115,335.

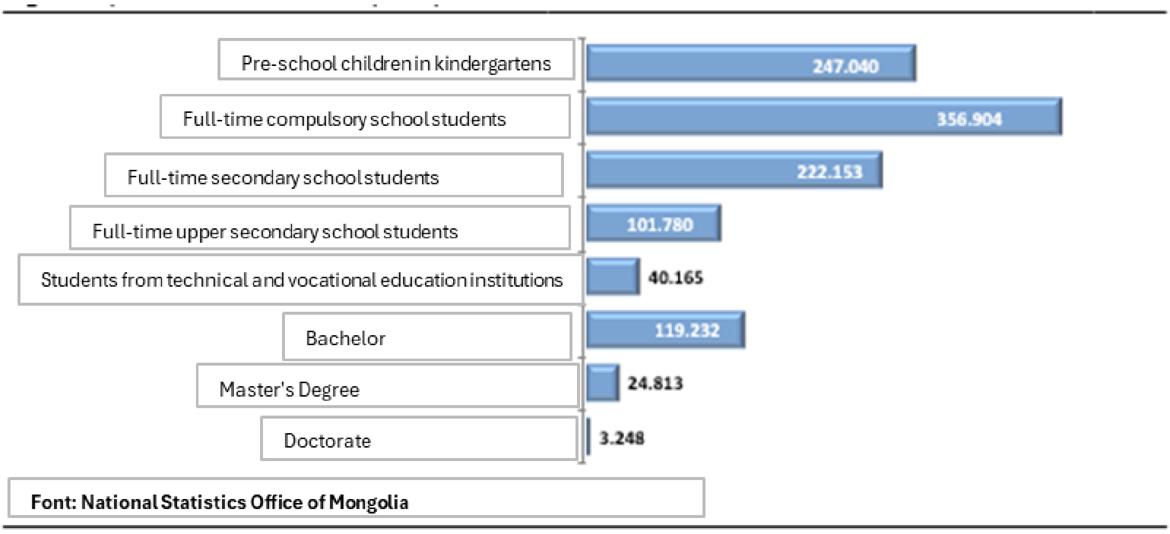


Figure 18: Student population (2020)

The level of participation in compulsory education is quite high, just over 98%, and the same applies to the two levels of secondary education, with a participation rate of 91.86%, with a slight prevalence of women. The latter are more prevalent among the university population, where they represent almost 61% of the total. 93.85% of university students, also due to the location of the universities, are located in the capital area.
Despite the significant economic growth since 2000, in absolute terms up by 47.6% (from 847560 in 2000 to 1250608 in 2020), the labour force participation rate of the population of working age (> 15 years) is has been steadily declining, from 62.9% in 2000 to 58.8% in 2020. The absolute increase in the population outside the labour market (that is, those who for different reasons are not actively seeking a job opportunity) was significant, from 499,854 in 2000 to 877,503 in 2020 (+75.5%), whose circumstances are probably to be found in a progressive change in the social and economic structure of the country.
The labour market participation rate is at different levels, depending on age and gender. In 2020, the highest labour force participation rate among men is between 20 and 59 years (from 60.9% in the 20-24 age group to 88.1% in the 35-39 age group), whereas for women the age range is narrower, from 25 to 54 (from 68.9% in the 25-29 age group to 78.4% in the 45-49

age group), with a significant fall in participation after 55 years. As shown in the figure below, over the last twenty years, the employment rate, with obvious fluctuations over time, has also decreased from 60% in 2000 to 54.6% in 2020. In terms of percentage change, the increase in the average level of unemployment appears to be much more significant (from 4.6% in 2000 to 7% in 2020). In particular, the youth unemployment rate (15-24), after a phase of reduction that began at the beginning of 2000 (from over 20% to 11.9% in 2011) has gradually increased, reaching around 18% as of 2018.

The distribution of workers in the different economic sectors, despite a still important presence in the primary sector, now sees the clear predominance of services.

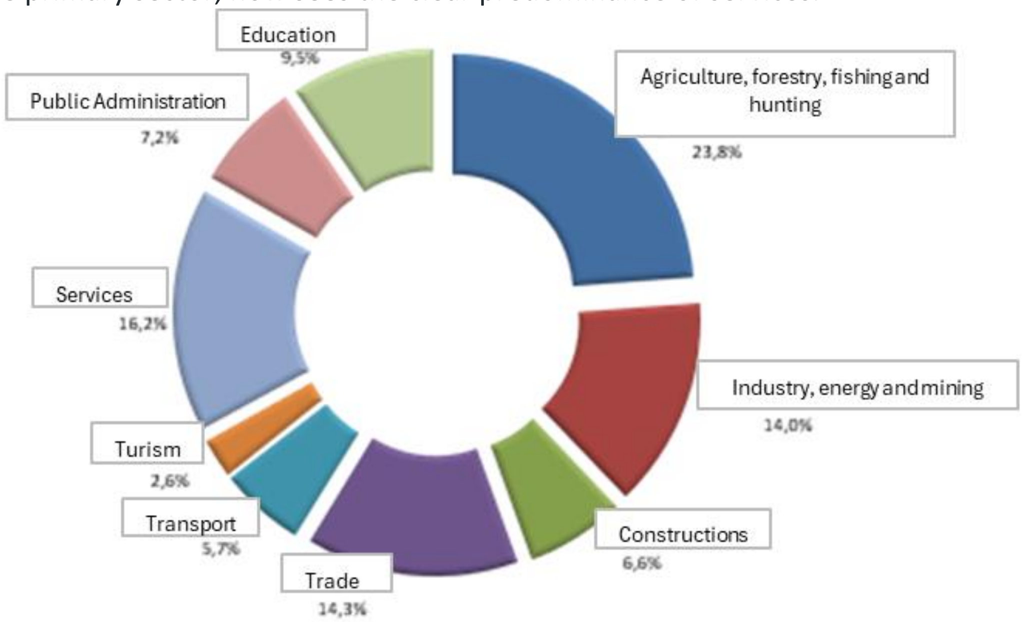


Figure 19: Distribution of workers by economic sectors (2020)

The changes in the country's economic performance and structure over the last ten years have also had a significant impact on the distribution of employees across the various economic sectors, with a significant reduction in the number of employees in the primary sector and a corresponding growth in other economic sectors, among which it is worth mentioning the increase - as well as in the industrial sectors, of construction and services - employees in the Public Administration of education.

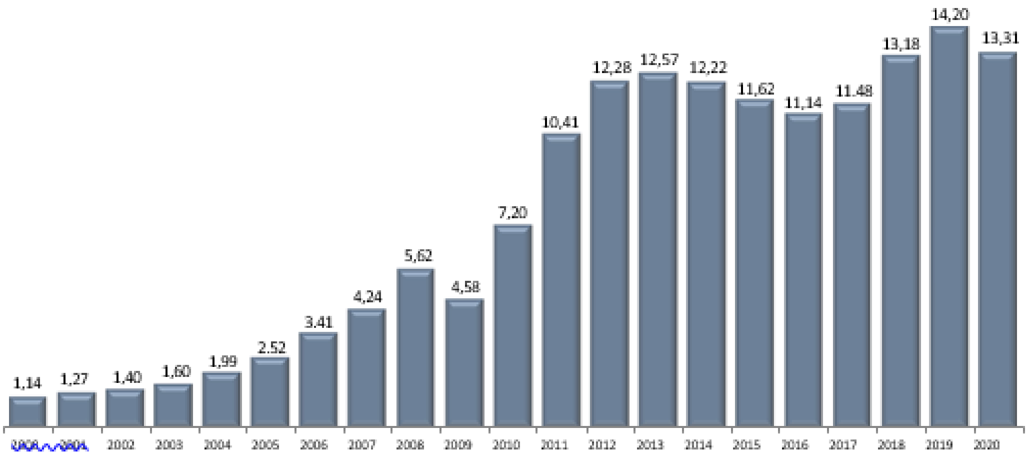
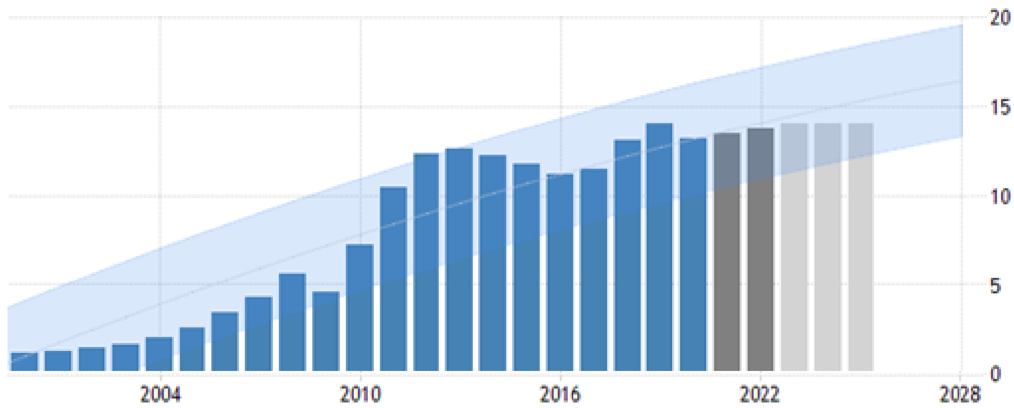


Figure 20: Gross Domestic Product at Current Prices (2000-2020) - US$ Billions

The analysis of the changes in the participation of the various economic sectors in gross domestic product clearly shows the progressive reduction in the importance of the primary sector, the steady growth of the manufacturing and construction sectors and the clear predominance of the tertiary sector in the country's economic structure.
In the period 2015-2020 alone, enterprises grew by almost 47%, from 64,309 to 94,527 units. The growth of enterprises located in the Ulaanbaatar area was just under 60%, and in 2020 they represented 68.1% of all national enterprises.
Exports - mainly of mineral products (coal, copper, iron and oil) - between 2000 and 2020 represented on average 44.4% of the GDP and from 2017 no less than 53%. The progressive growth of exports and, at the same time, of domestic production capacity has had a positive impact on the trade balance which has been consistently positive since 2014.
The country's economic projections appear to be broadly positive. World Bank analysis shows a substantial stabilization of GDP around 14 billion. US$ at least until 2025 and a prospect of further growth.



Fonte: Tradingeconomics.com e World Bank

Figure 21: Gross Domestic Product projection to 2028 (US$ billion)

Economic growth has of course had an immediate impact on the total income, which has been increasing progressively, at least in absolute terms. Per capita GDP at current values from just over 448 US$ in 2000, in 2020 reached 3,688 US$. Of course this did not lead to a corresponding increase in household disposable income, which nevertheless increased from about US$1,166 in 2000 to US$7,242 in 2020 (values calculated at the average MTN/US$ exchange rate for the years considered). In general, the average income of households living in non-urbanized areas was on average 16% lower than that of those living in urbanized areas over the period.

As is often the case, general data do not give a true picture of the economic status of the population. In 2018, 28.4% of the population was below the poverty line due to significant economic growth and "average" household income growth, with some differences on a territorial basis (from 37.4% of the eastern region to 25.9% of Ulan Bator Province) which, although they highlight the economic differences between the different macro-areas, do not make the figure less heavy, which is also high in the capital area, the most productive and rich of the country.

There is no doubt that the general living conditions in Mongolia have improved. Consider, for example, that the infant mortality rate (albeit with some fluctuations in different years) between 2010 and 2020 has almost halved, from 1.95% to 1.12%. The same applies to child mortality (under 5 years) for every 1,000 live births, which rose from 2.38% in 2000 to 1.35% in 2020.
The number of existing health facilities is particularly significant, which between 2015 and 2020 increased by almost 48%, from 3,100 to 4,575. The majority of structures, as expected, is concentrated

in the capital area, 2,773 in 2020 (representing more than 60% of the total on a national basis), which also presented the highest growth rate (+ 72%).
Social security spending has also grown significantly, from US$ 447.7 million in 2000 to over US$ 980.7 million in 2020 (+ 119%).

After a brief overview of the main social and economic data of the country, it is appropriate to focus on the area covered by this intervention, that of Ulan Bator. Located at 1,350 m.a.s.l. - right next to the Bogd Khan Uul National Park, in the valley of the Tuul Gol River - Ulaanbaatar is the coldest capital city in the world with an annual average temperature of -1.3°C.

2 PART TWO: URBAN WASTE KNOWLEDGE FRAMEWORK

2.1 Data Sources, Data Processing And Validation Methodology

For the purposes of dimensioning, data relating to production in 2019 were taken into account from the study "Ulaanbaatar Household Waste Composition Study - Report 2019". This study was carried out by analysing the waste production in 132 housing units taken as a representative sample in 6 of the 9 districts in which the municipal territory is administratively divided. The production values have been updated in relation to population growth data with a projection for 2026 and per capita of 0.640 kg/day (without ash). The analysis allowed the determination of the product composition of the waste used as a starting point for the dimensioning of the service.
The main findings and conclusions of the study are:

- The rate of waste generation per capita is increasing, and its composition is changing. Whereas the results of previous compositional studies cannot be directly compared to this study because of differences in methodology. (Overall, the study results show that waste composition is changing and per capita waste production has changed in an increasing way, relating it to population growth and income).
- The amount of waste in residential areas is seasonally stable. The difference in waste production per person per day in residential areas in summer and winter is approx. 13 g, indicating a very low seasonal variation. In terms of composition, there is also very little difference regardless of the season.
- Ash plays an important role in the definition of total waste composition and waste generation per person in the GER area. In the GER district, households produce 26-75% of the weight of waste in summer and winter. Further studies should be carried out to understand the characteristics of ash generated in GER districts, and to identify appropriate ways of separating, transporting, disposing of and recycling ash. Only by finding viable solutions for ash will it be possible to solve the waste problem in GER areas, especially during the winter period when ash prevails in the composition of household waste.
- Over 60% of household waste produced can potentially be recycled or pre-treated for recycling. Even though recycling is limited in the country, there is the possibility of exporting some recyclable materials to China. There are also upcoming plans to support and expand recycling in the country in line with the government's green development plans, which aim to recycle 40% of total waste by 2030. This is a strong argument for developing waste recycling and processing facilities in the country and creating a legal framework for integrating waste

into the economy. This would also be a crucial step towards the actualisation of the circular economy.

2.2 Municipal Waste Generation And Product Composition

The composition of the waste in percentage by weight for the samples collected in the above mentioned study are summarised in the following table.

Area	Dwelling type	Season	Number of samples	Paper	PET bottles	Hard plastic (HDPE, LDPE, PVC etc.,)	Tetra pak cartons	Plastic bags & packaging	Glass	Metal	Food waste	Fabric & woven products	E-waste	Batteries	Bathroom waste	Ash	Other
Ger areas	Gers	Winter	174	3%	2%	1%	0%	2%	5%	0%	7%	1%	0%	0%	4%	71%	4%
		Summer	169	5%	7%	2%	1%	5%	9%	1%	11%	2%	1%	0%	9%	39%	7%
	Detached houses	Winter	287	2%	2%	1%	0%	1%	5%	1%	7%	1%	0%	0%	2%	77%	3%
		Summer	280	6%	7%	3%	1%	4%	19%	1%	19%	3%	0%	0%	11%	20%	7%
	Average	Winter	461	2%	2%	1%	0%	1%	5%	1%	7%	1%	0%	0%	3%	75%	3%
		Summer	449	5%	7%	3%	1%	4%	16%	1%	16%	3%	0%	0%	10%	27%	7%
		Annual	910	3%	3%	1%	1%	2%	8%	1%	10%	1%	0%	0%	5%	61%	4%
Apartment areas	Apartments	Winter	263	14%	5%	4%	2%	7%	18%	1%	36%	1%	0%	0%	9%	n/a	2%
		Summer	286	14%	5%	4%	1%	4%	14%	2%	41%	1%	0%	0%	10%	n/a	3%
	Town houses	Winter	24	16%	7%	3%	4%	3%	19%	3%	35%	1%	0%	0%	7%	n/a	3%
		Summer	4	16%	6%	7%	1%	5%	3%	1%	48%	0%	0%	0%	10%	n/a	2%
	Average	Winter	287	14%	5%	4%	2%	6%	18%	2%	36%	1%	0%	0%	8%	n/a	2%
		Summer	290	14%	5%	4%	1%	4%	13%	2%	41%	1%	0%	0%	10%	n/a	3%
		Annual	557	14%	5%	4%	2%	5%	16%	2%	38%	1%	0%	0%	9%	n/a	3%
All areas Summer Annual		Winter	748	4%	2%	1%	1%	2%	7%	1%	12%	1%	0%	0%	4%	63%	3%
		Summer	739	8%	6%	3%	1%	4%	15%	1%	24%	2%	0%	0%	10%	18%	6%
		Annual	1,487	5%	4%	2%	1%	3%	10%	1%	16%	1%	0%	0%	6%	48%	4%

Table 5: Composition of waste by type of dwelling

On average across all samples, the first three components of waste measured by weight were ash (48.2%), food waste (15.7%) and glass (9.6%).

There is a significant seasonal variation in the composition of waste from households in the GER area due to the significant amount of ash generated during the winter. When ash was excluded from the waste composition of the GER area to observe seasonal variations in other types of waste, it was found that the composition of waste in the extended area did not change significantly, as shown in the next Figure.

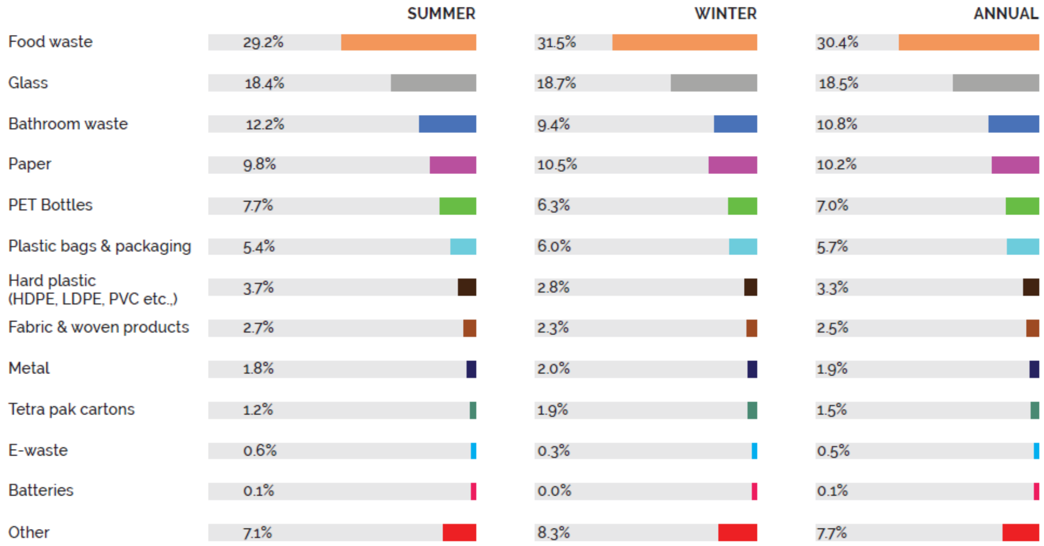


Figure 22: Seasonal composition of waste (excluding ash, percentage by weight)

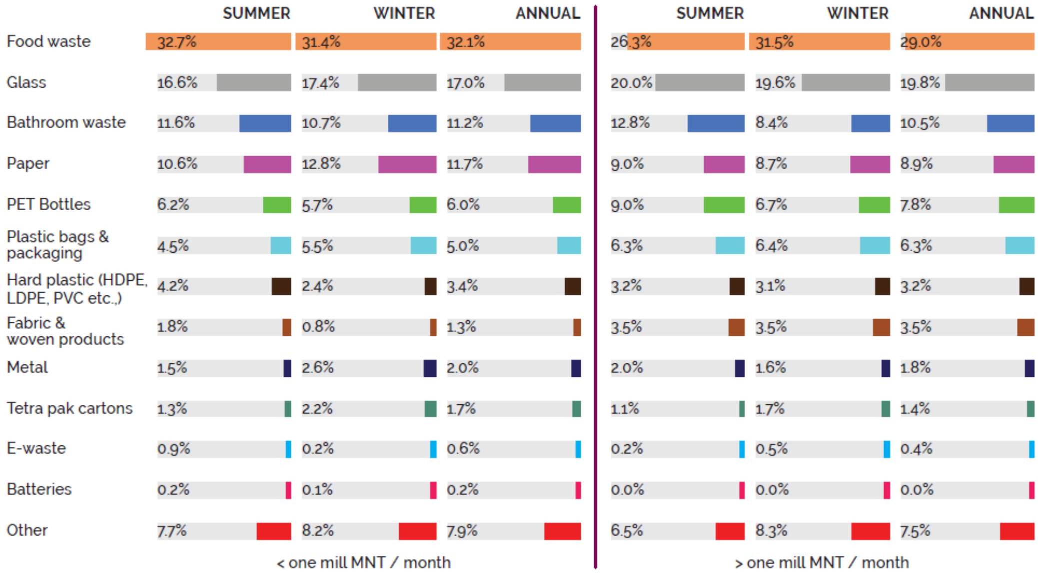


Figure 23: Composition of waste by income level (excluding ash)

As regards the different composition of waste based on monthly income, of the total households surveyed, 46% of households had a combined monthly income above MNT 1 million and 54% had less than MNT 1 million. However, the composition of waste among households with an income above or below MNT 1 million has not changed significantly. The composition of waste by income level is shown in the figure above (excluding ash).

3 PART THREE: PLAN OBJECTIVES AND SCENARIOS

3.1 Definition Of The Area Of Study And Estimation Of Municipal Waste Production

The Plan hypothesis was carried out by combining the neighbouring districts as shown in the table to obtain homogeneous territorial areas for population and production and optimize the use of means and operators.

ZONE	DISTRICT	Population	Waste production t/year
1	Baganuur + Bagahangaj + Bajanzhurh + Nalajh	462.560	99.554,95
2	Bajangol + Han Uul + Suhbaatar	595.841	128.240,56
3	Cingeltej + Songinohajrhan	509.600	109.679,17
			337.474,68

Table 6: Waste production by zones

The data presented have been aggregated from the individual territorial realities considered, as illustrated below.

	%	n. inhabitants	t/year
Baganuur	1,9	29.792	6.959,41
Bagahangaj	0,3	4.704	1.098,85
Bajangol	15,4	241.472	56.407,86
Bajanzhurh	24,7	387.296	90.472,35
Cingeltej	10,2	159.936	37.361,05
Han Uul	12,8	200.704	46.884,45
Nalajh	2,6	40.768	9.523,40
Songinohajrhan	22,3	349.664	81.681,51
Suhbaatar	9,8	153.664	35.895,91
		1.568.000	**337.474,68**

Table 7 Waste Districts Distribution

The following is a summary chart showing the estimated amounts of waste for each fraction.

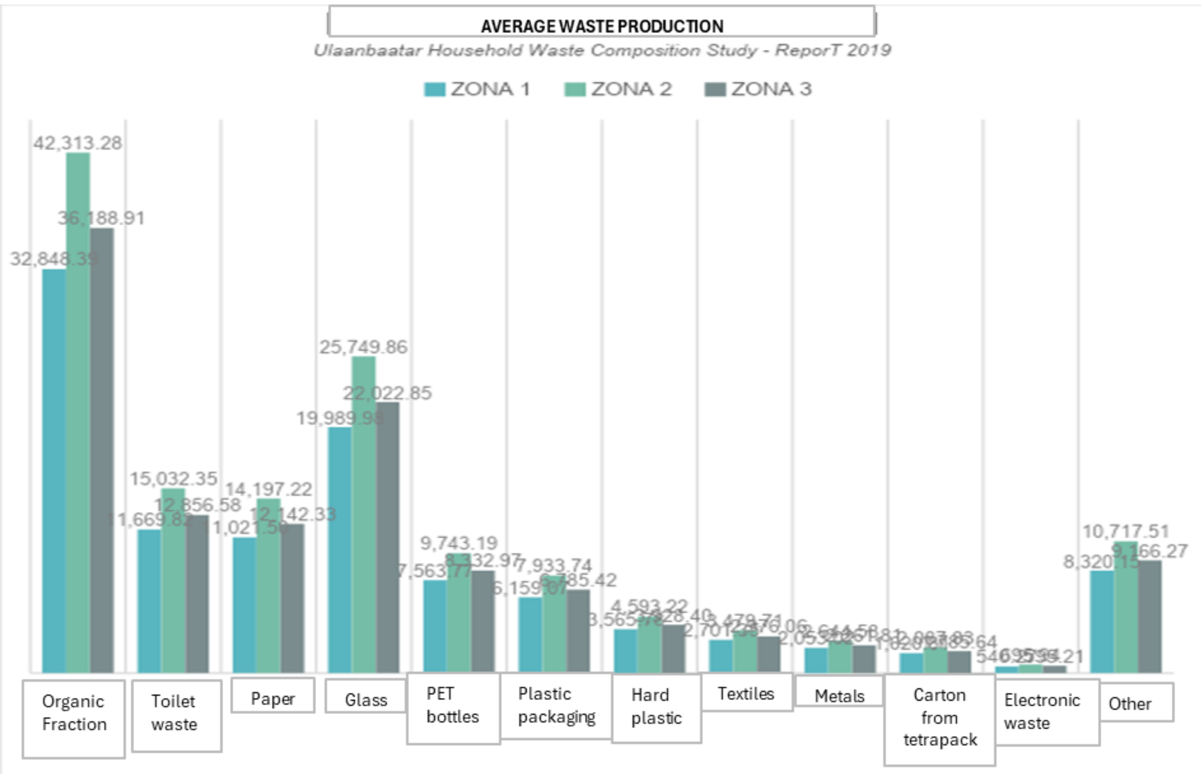


Figure 24: Average waste production

The following quantities of waste in the three identified areas were considered for dimensioning in the various scenarios.

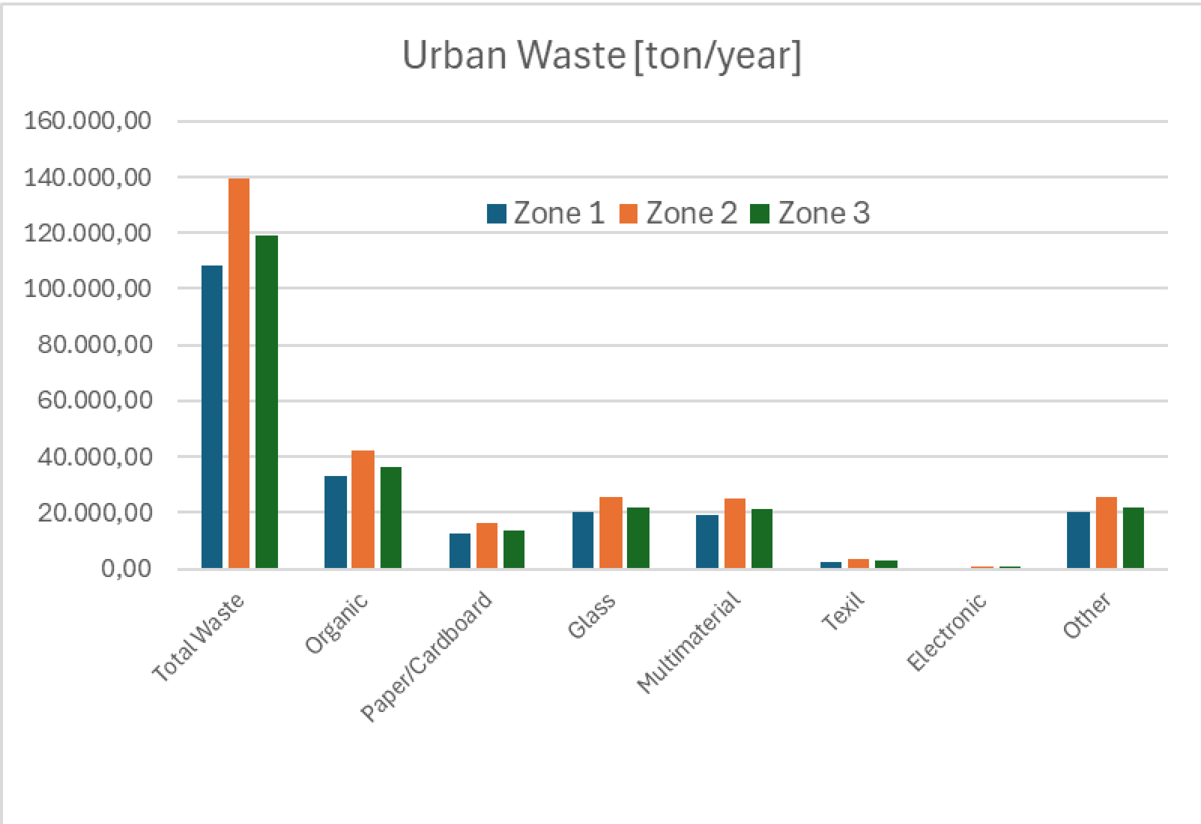


Figure 25: Average waste production

The analytical data are given in the following table:

ZONE	DISTRICT	Population	WASTE PRODUCTION t/year	Organic Fraction (t)	Paper (t)	Glass (t)	Multimaterial (t)	Textiles (t)	Electronic waste (t)	Other(t)
				30,40%	11,70%	18,50%	17,90%	2,50%	0,50%	18,50%
1	Baganuur + Bagahangaj + Bajanzhurh + Nalajh	462.560	108.053,93	32.848,39	12.642,31	19.989,98	19.341,65	2.701,35	540,27	19.989,98
2	Bajangol + Han Uul + Suhbaatar	595.841	139.188,42	42.313,28	16.285,05	25.749,86	24.914,73	3.479,71	695,94	25.749,86
3	Cingeltej + Songinohajrhan	509.600	119.042,45	36.188,91	13.927,97	22.022,85	21.308,60	2.976,06	595,21	22.022,85
			366.284,80	**111.350,58**	**42.855,32**	**67.762,69**	**65.564,98**	**9.157,12**	**1.831,42**	**67.762,69**

Table 8: Basic data for dimensioning collection and treatment services

The scenarios were conducted on the 3 areas being analysed and planned. In particular, data on waste generation by area are reported, calculated from historical population growth series and per capita waste production.

ZONE	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
1	462.559,61	473.092,10	483.864,40	494.882,00	506.150,46	517.675,51	529.462,98	541.518,85	553.849,23	563.735,44	573.798,12	584.040,42	594.465,54	605.076,75
2	595.840,85	609.408,14	623.284,37	637.476,55	651.991,89	666.837,75	682.021,64	697.551,28	713.434,52	726.169,32	739.131,45	752.324,94	765.753,94	779.422,65
3	509.599,54	521.203,12	533.070,92	545.208,94	557.623,35	570.320,43	583.306,63	596.588,52	610.172,84	621.064,43	632.150,43	643.434,31	654.919,61	666.609,93
Ulaan Bator Population	**1.568.000,00**	**1.603.703,36**	**1.640.219,69**	**1.677.567,49**	**1.715.765,70**	**1.754.833,68**	**1.794.791,25**	**1.835.658,64**	**1.877.456,59**	**1.910.969,19**	**1.945.079,99**	**1.979.799,67**	**2.015.139,09**	**2.051.109,33**

Table 9: Demographic trends in Ulaan Bator city

3.1.1 Current collection system

To date, the service provides as the only mode of waste treatment the disposal in landfills and often uncontrolled combustion of the same without any source separation operation and/ or separate collection. There are also phenomena of parallel collection of recyclable materials (informal collection) which is therefore subtracted from the official collection and treatment channels and which must be taken into account in the design of the new service.

3.2 Plan Scenarios And Targets

The hypothesis of the collection and transport service to the installations was carried out by combining the neighbouring districts as shown in the table to obtain homogeneous territorial areas for population and production and optimize the use of means and operators.

ZONE		n. inhabitants	t/year
1	Baganuur + Bagahangaj + Bajanzhurh + Nalajh	462.560	99.555
2	Bajangol + Han Uul + Suhbaatar	595.841	128.241
3	Cingeltej + Songinohajrhan	509.600	109.679
TOTAL		**1.568.000**	**337.475**

Table 10: References Districts

The annual waste generation was calculated on the basis of two considerations:

- the increase in GDP is closely related to an increase in waste production, as there is a greater availability of products that can be used for waste
- new environmental policies (regulations, communication campaigns and user awareness) guarantee a reduction in the waste produced, raising awareness among users about the optimal use of products, and avoiding becoming waste

These two aspects, when combined, give an indicative value on which the whole planning can be based, that is a percentage able to take account of these two aspects. In particular, referring to the IMF Data Calculations (2023 Article IV & World Economic Outlook - October 2023) the growth of GDP in Mongolia is estimated at + 3.5% in the coming years.
At the same time, implementation of green policies will lead to a reduction which, on average, can be attested to around -0.5% on an annual basis.
Therefore, the basis of the considerations made, for the purpose of sizing the scenarios, it was taken into account an increase in waste produced by users of +3% on an annual basis.
This Plan identifies three scenarios with a time horizon of 2035:

- Base scenario - BAU - business as usual, that is to say the scenario assumed in the absence of planning with a differentiated collection rate equal to 50%
- Intermediate scenario with a differentiated collection rate of 60%
- Advanced scenario with 70% separate collection rate

In the definition of scenarios, in order to conduct precautionary assessments on plant requirements, it is considered that the achievement of DR objectives will be pursued progressively from today until 2035, with a constant trend.
The assessment of plant requirements is made with reference to the year 2035, in which the target results for separate collection are considered to have been achieved for the plan scenarios. In the period under review, there is also a trend towards a reduction of the total amount of RU due to a hypothesis of population contraction and improvement of collection.

The needs assessment is also applied to the base scenario (BAU - business as usual, that is to the scenario assumed in the absence of planning).
The assessment of plant requirements shall take into account foreseeable developments in the current plant framework in terms of:

- Reduce waste generation (PREVENTION AND REDUCTION OBJECTIVE);
- Minimising landfill disposal;
- Increase the amount of separate collection in order to achieve recycling and waste recovery targets (RECYCLING TARGETS);

rationalise and optimise the plant system in accordance with the proximity principle and in order to reduce costs.

3.2.1 State scenario at 50% of RD

- Plan RD target 2035: 50%;
- Waste production rate: annual growth of 3.0%;
- Organic waste fraction: average 22% by 10 years (2035)

Urban waste fractions	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Organic fraction (t)	18.795,23	19.817,73	20.877,05	21.992,99	23.168,58	24.407,01	25.587,96	26.826,05	28.124,04	29.484,83	30.911,47
Paper (t)	4.271,64	4.504,03	4.744,78	4.998,41	5.265,59	5.547,05	5.815,45	6.096,83	6.391,83	6.701,10	7.025,33
Glass (t)	5.980,30	6.305,64	6.642,70	6.997,77	7.371,82	7.765,87	8.141,62	8.535,56	8.948,56	9.381,54	9.835,47
Multimaterial (t)	6.834,63	7.206,45	7.591,65	7.997,45	8.424,94	8.875,28	9.304,71	9.754,93	10.226,92	10.721,76	11.240,53
Textiles (t)	1.281,49	1.351,21	1.423,43	1.499,52	1.579,68	1.664,11	1.744,63	1.829,05	1.917,55	2.010,33	2.107,60
Electronic waste (t)	427,16	450,40	474,48	499,84	526,56	554,70	581,54	609,68	639,18	670,11	702,53
Other (t)	5.125,97	5.404,83	5.693,74	5.998,09	6.318,70	6.656,46	6.978,53	7.316,19	7.670,19	8.041,32	8.430,40
TOTAL RD	**42.716,43**	**45.040,29**	**47.447,83**	**49.984,06**	**52.655,87**	**55.470,49**	**58.154,45**	**60.968,29**	**63.918,27**	**67.010,98**	**70.253,34**
UNDIFFERENTIATED (t)	**42.716,43**	**45.040,29**	**47.447,83**	**49.984,06**	**52.655,87**	**55.470,49**	**58.154,45**	**60.968,29**	**63.918,27**	**67.010,98**	**70.253,34**
TOTALE RU	**85.432,85**	**90.080,57**	**94.895,66**	**99.968,13**	**105.311,73**	**110.940,97**	**116.308,91**	**121.936,57**	**127.836,53**	**134.021,97**	**140.506,69**
POPULATION	**494.882,00**	**506.150,46**	**517.675,51**	**529.462,98**	**541.518,85**	**553.849,23**	**563.735,44**	**573.798,12**	**584.040,42**	**594.465,54**	**605.076,75**
Waste output per capita (kg/year)	172,63	177,97	183,31	188,81	194,47	200,31	206,32	212,51	218,88	225,45	232,21
Waste output per capita (kg/day)	0,473	0,488	0,502	0,517	0,533	0,549	0,565	0,582	0,600	0,618	0,636

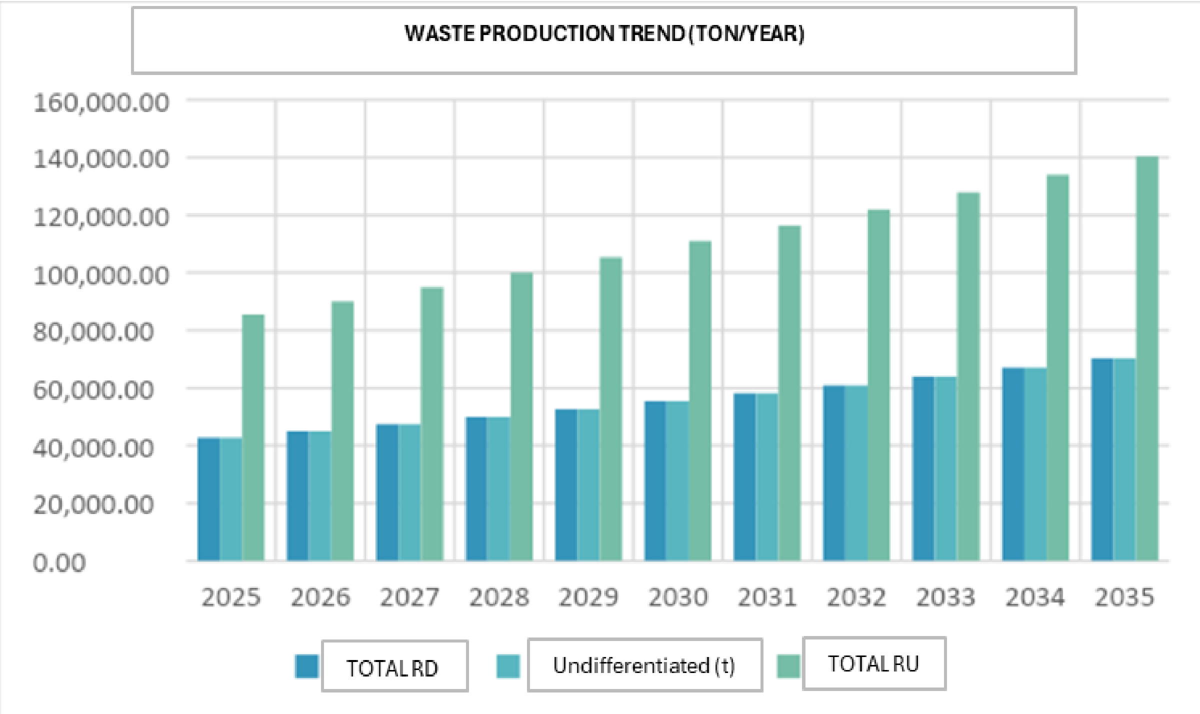


Table 11: Scenario di BASE - zona 1

Urban waste fractions	**2025 (ton/year)**	**2026 (ton/year)**	**2027 (ton/year)**	**2028 (ton/year)**	**2029 (ton/year)**	**2030 (ton/year)**	**2031 (ton/year)**	**2032 (ton/year)**	**2033 (ton/year)**	**2034 (ton/year)**	**2035 (ton/year)**
Organic fraction (t)	24.210,86	25.527,98	26.892,53	28.330,01	29.844,34	31.439,61	32.960,84	34.555,66	36.227,65	37.980,55	39.818,26
Paper (t)	5.502,47	5.801,81	6.111,94	6.438,64	6.782,80	7.145,37	7.491,10	7.853,56	8.233,56	8.631,94	9.049,60
Glass (t)	7.703,45	8.122,54	8.556,71	9.014,10	9.495,93	10.003,51	10.487,54	10.994,98	11.526,98	12.084,72	12.669,45
Multimaterial (t)	8.803,95	9.282,90	9.779,10	10.301,82	10.852,49	11.432,59	11.985,76	12.565,70	13.173,69	13.811,11	14.479,37
Textiles (t)	1.650,74	1.740,54	1.833,58	1.931,59	2.034,84	2.143,61	2.247,33	2.356,07	2.470,07	2.589,58	2.714,88
Electronic waste (t)	550,25	580,18	611,19	643,86	678,28	714,54	749,11	785,36	823,36	863,19	904,96
Other (t)	6.602,96	6.962,18	7.334,33	7.726,37	8.139,37	8.574,44	8.989,32	9.424,27	9.880,27	10.358,33	10.859,52
TOTAL RD	**55.024,67**	**58.018,13**	**61.119,38**	**64.386,40**	**67.828,05**	**71.453,67**	**74.910,99**	**78.535,60**	**82.335,58**	**86.319,43**	**90.496,04**
UNDIFFERENTIATED (t)	**55.024,67**	**58.018,13**	**61.119,38**	**64.386,40**	**67.828,05**	**71.453,67**	**74.910,99**	**78.535,60**	**82.335,58**	**86.319,43**	**90.496,04**
TOTALE RU	**110.049,34**	**116.036,25**	**122.238,75**	**128.772,79**	**135.656,10**	**142.907,34**	**149.821,98**	**157.071,19**	**164.671,16**	**172.638,85**	**180.992,07**
POPULATION	**637.476,55**	**651.991,89**	**666.837,75**	**682.021,64**	**697.551,28**	**713.434,52**	**726.169,32**	**739.131,45**	**752.324,94**	**765.753,94**	**779.422,65**
Waste output per capita (kg/year)	172,63	177,97	183,31	188,81	194,47	200,31	206,32	212,51	218,88	225,45	232,21
Waste output per capita (kg/day)	0,473	0,488	0,502	0,517	0,533	0,549	0,565	0,582	0,600	0,618	0,636

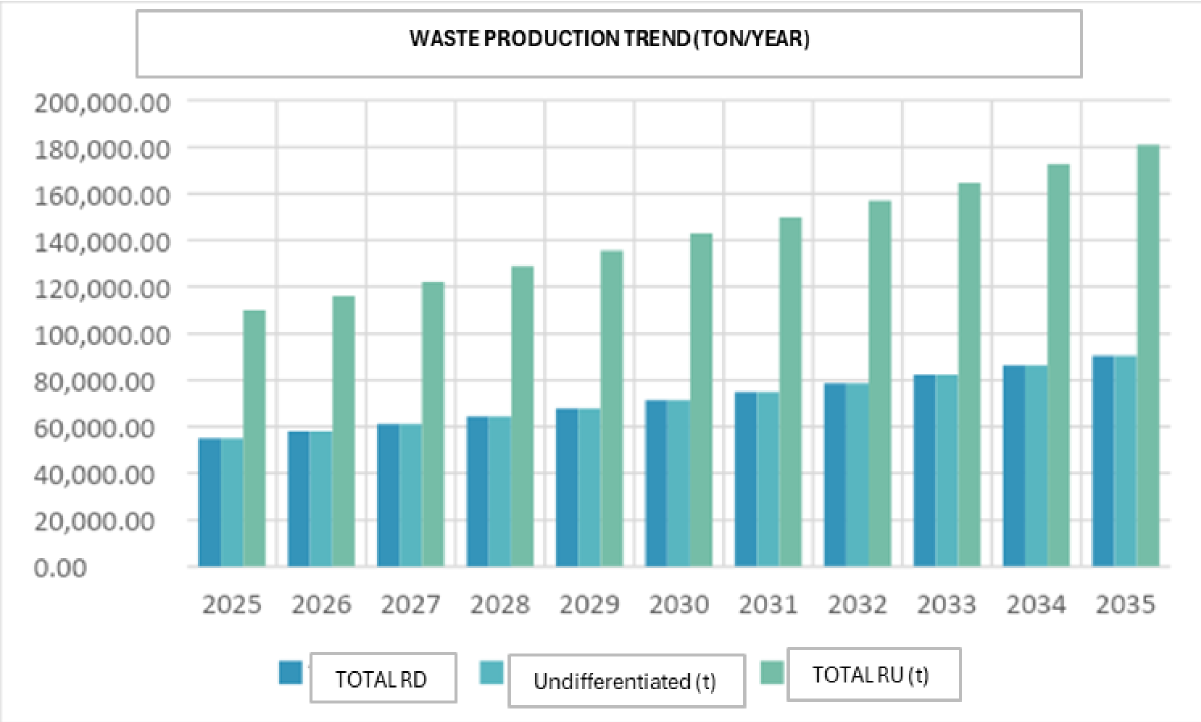


Table 12: Scenario di BASE - zona 2

Urban waste fractions	2025 (ton/year)	2026 (ton/year)	2027 (ton/year)	2028 (ton/year)	2029 (ton/year)	2030 (ton/year)	2031 (ton/year)	2032 (ton/year)	2033 (ton/year)	2034 (ton/year)	2035 (ton/year)
Organic fraction (t)	20.706,60	21.833,09	23.000,13	24.229,56	25.524,71	26.889,08	28.190,12	29.554,12	30.984,11	32.483,29	34.055,01
Paper (t)	4.706,05	4.962,07	5.227,30	5.506,72	5.801,07	6.111,15	6.406,85	6.716,84	7.041,84	7.382,57	7.739,77
Glass (t)	6.588,47	6.946,89	7.318,22	7.709,41	8.121,50	8.555,62	8.969,58	9.403,58	9.858,58	10.335,59	10.835,68
Multimaterial (t)	7.529,67	7.939,30	8.363,68	8.810,75	9.281,71	9.777,85	10.250,95	10.746,95	11.266,95	11.812,10	12.383,64
Textiles (t)	1.411,81	1.488,62	1.568,19	1.652,02	1.740,32	1.833,35	1.922,05	2.015,05	2.112,55	2.214,77	2.321,93
Electronic waste (t)	470,60	496,21	522,73	550,67	580,11	611,12	640,68	671,68	704,18	738,26	773,98
Other (t)	5.647,26	5.954,48	6.272,76	6.608,06	6.961,28	7.333,39	7.688,22	8.060,21	8.450,21	8.859,08	9.287,73
TOTAL RD	**47.060,46**	**49.620,65**	**52.273,03**	**55.067,18**	**58.010,70**	**61.111,55**	**64.068,46**	**67.168,44**	**70.418,42**	**73.825,65**	**77.397,75**
UNDIFFERENTIATED (t)	**47.060,46**	**49.620,65**	**52.273,03**	**55.067,18**	**58.010,70**	**61.111,55**	**64.068,46**	**67.168,44**	**70.418,42**	**73.825,65**	**77.397,75**
TOTALE RU	**94.120,93**	**99.241,30**	**104.546,06**	**110.134,37**	**116.021,39**	**122.223,10**	**128.136,92**	**134.336,89**	**140.836,85**	**147.651,31**	**154.795,49**
POPULATION	**545.208,94**	**557.623,35**	**570.320,43**	**583.306,63**	**596.588,52**	**610.172,84**	**621.064,43**	**632.150,43**	**643.434,31**	**654.919,61**	**666.609,93**
Waste output per capita (kg/year)	172,63	177,97	183,31	188,81	194,47	200,31	206,32	212,51	218,88	225,45	232,21
Waste output per capita (kg/day)	0,473	0,488	0,502	0,517	0,533	0,549	0,565	0,582	0,600	0,618	0,636

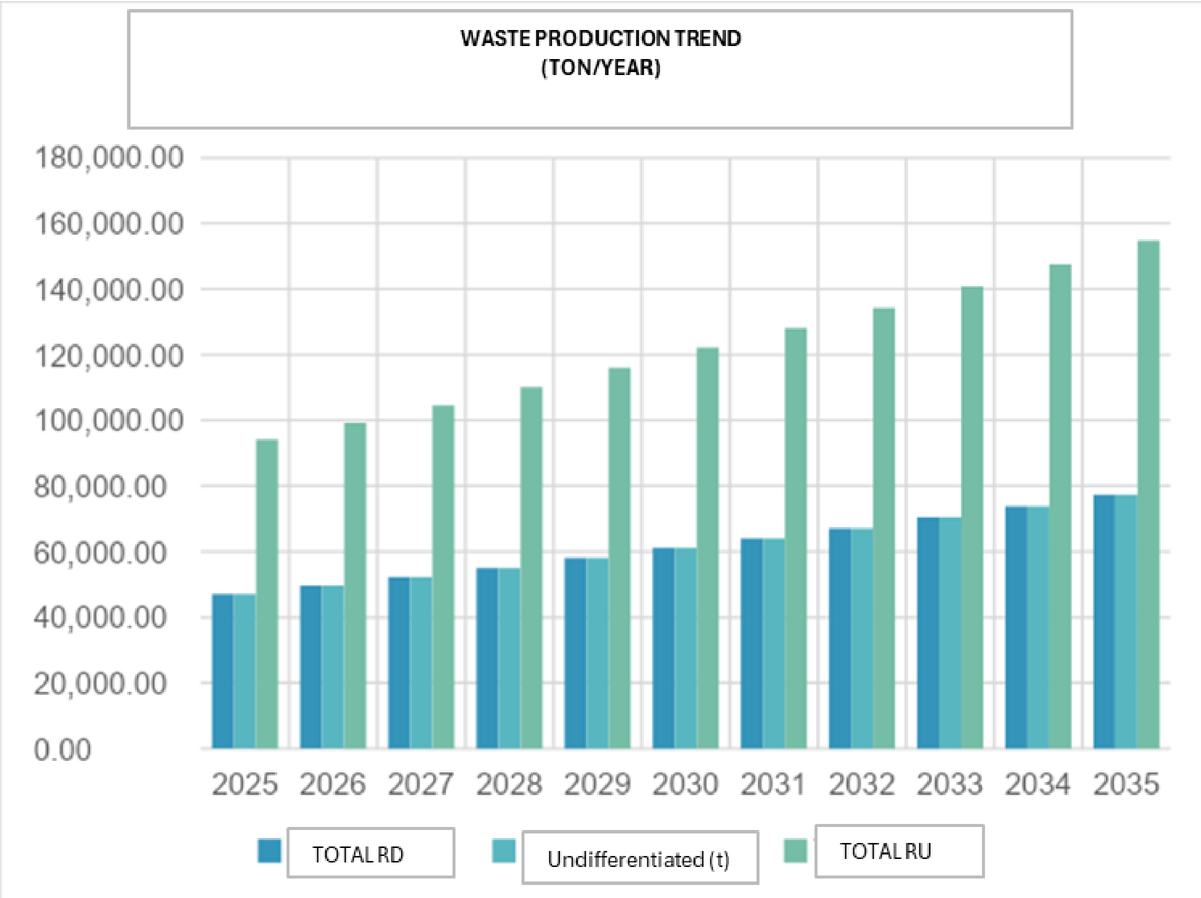


Table 13: Scenario di BASE - zona 3

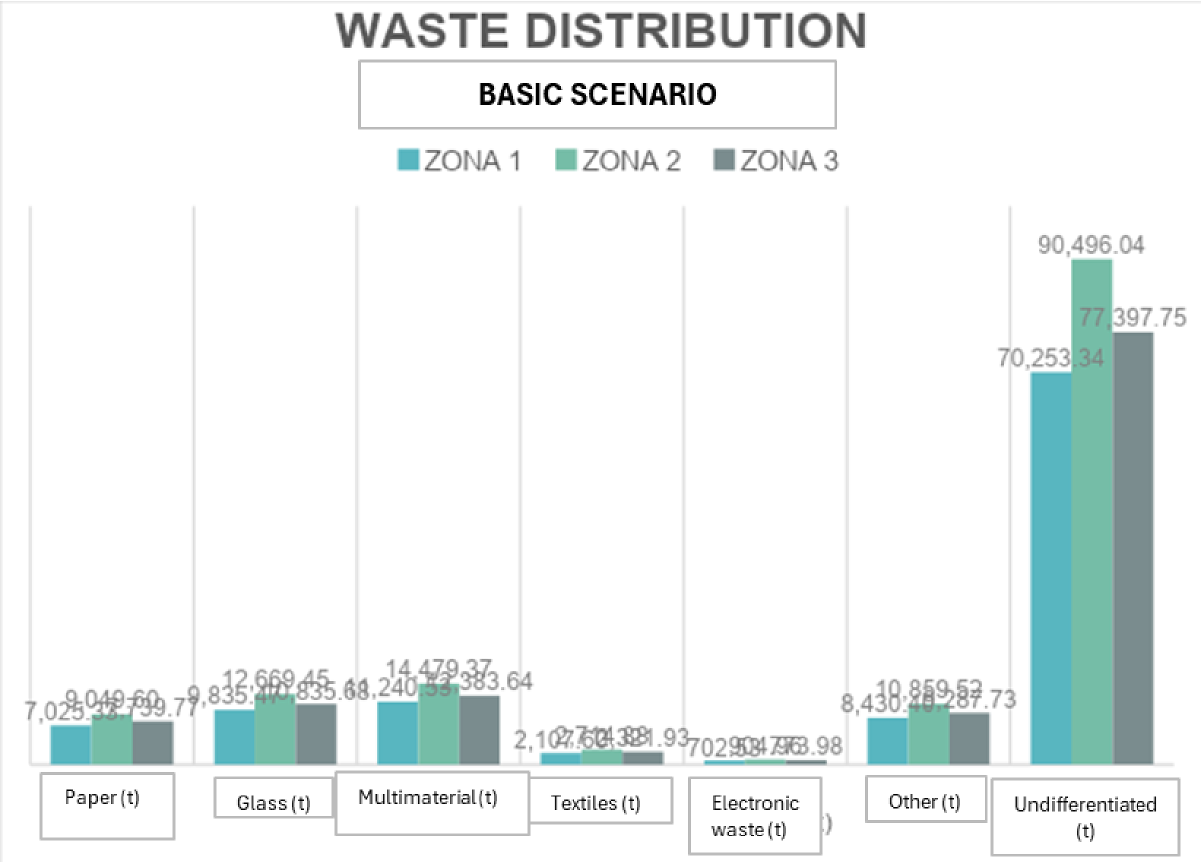


Figure 26: Waste collection - Basic scenario

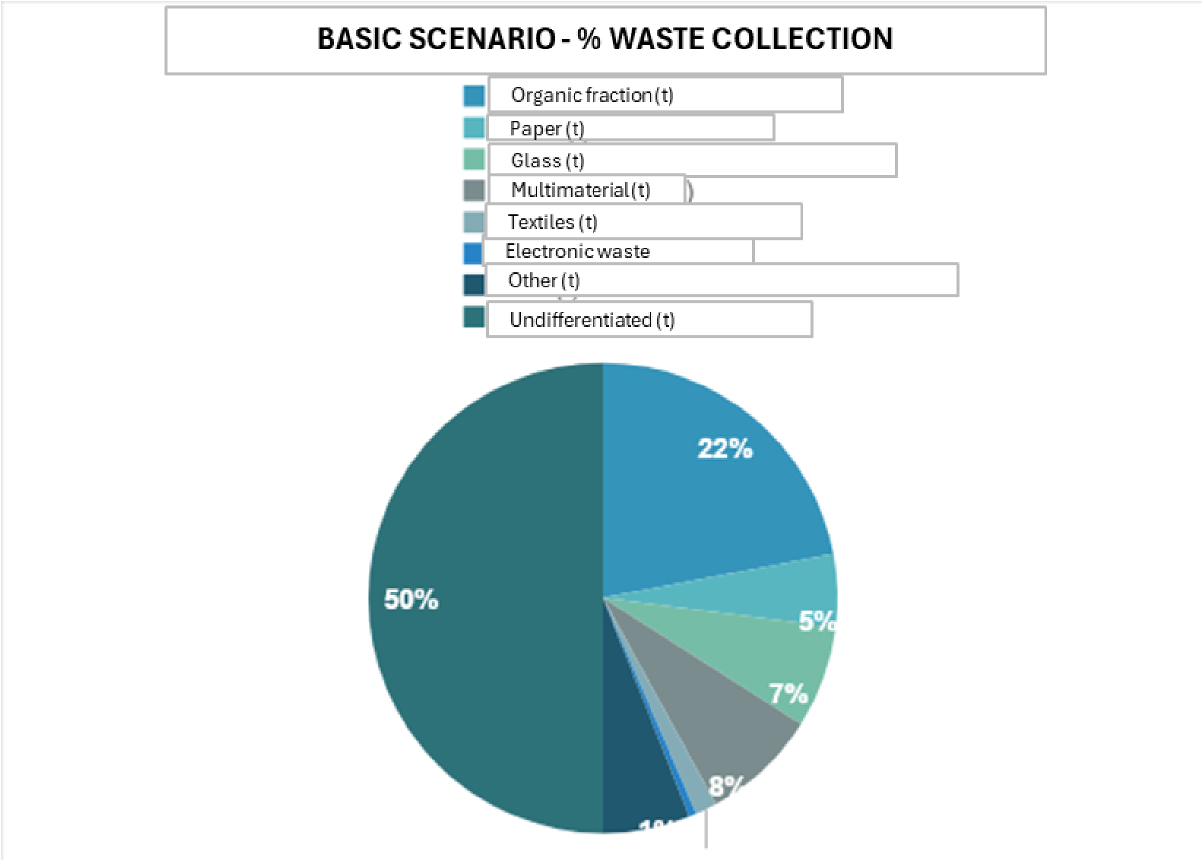


Figure 27: Separate collection percentage

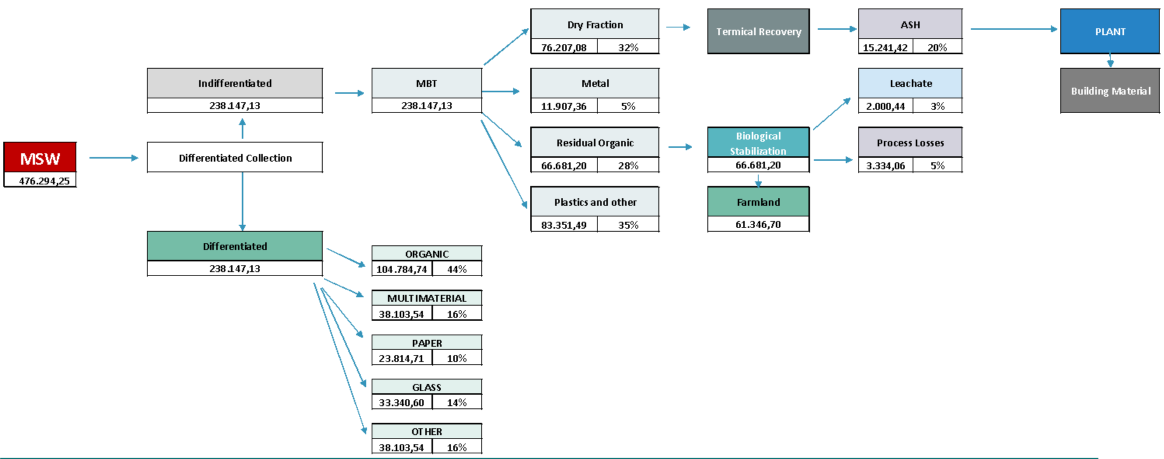


Figure 28: Process flow chart waste management target 50% differentiated waste

3.2.2 State scenario at 60% of RD

- Plan RD target 2035: 60%;
- Waste production rate: annual growth of 3.0%;
- Organic waste fraction: average of 24% by 10 years (2035)

Urban waste fractions	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
	(ton/year)	(ton/year)	(ton/year)	(ton/year)	(ton/year)	(ton/year)	(ton/year)	(ton/year)	(ton/year)	(ton/year)	(ton/year)
Organic fraction (t)	20.503,88	21.619,34	22.774,96	23.992,35	25.274,82	26.625,83	27.914,14	29.264,78	30.680,77	32.165,27	33.721,60
Paper (t)	5.980,30	6.305,64	6.642,70	6.997,77	7.371,82	7.765,87	8.141,62	8.535,56	8.948,56	9.381,54	9.835,47
Glass (t)	8.543,29	9.008,06	9.489,57	9.996,81	10.531,17	11.094,10	11.630,89	12.193,66	12.783,65	13.402,20	14.050,67
Multimaterial (t)	8.543,29	9.008,06	9.489,57	9.996,81	10.531,17	11.094,10	11.630,89	12.193,66	12.783,65	13.402,20	14.050,67
Textiles (t)	1.281,49	1.351,21	1.423,43	1.499,52	1.579,68	1.664,11	1.744,63	1.829,05	1.917,55	2.010,33	2.107,60
Electronic waste (t)	427,16	450,40	474,48	499,84	526,56	554,70	581,54	609,68	639,18	670,11	702,53
Other (t)	5.980,30	6.305,64	6.642,70	6.997,77	7.371,82	7.765,87	8.141,62	8.535,56	8.948,56	9.381,54	9.835,47
TOTAL RD	**51.259,71**	**54.048,34**	**56.937,40**	**59.980,88**	**63.187,04**	**66.564,58**	**69.785,34**	**73.161,94**	**76.701,92**	**80.413,18**	**84.304,01**
UNDIFFERENTIATED (t)	**34.173,14**	**36.032,23**	**37.958,26**	**39.987,25**	**42.124,69**	**44.376,39**	**46.523,56**	**48.774,63**	**51.134,61**	**53.608,79**	**56.202,67**
TOTALE RU	**85.432,85**	**90.080,57**	**94.895,66**	**99.968,13**	**105.311,73**	**110.940,97**	**116.308,91**	**121.936,57**	**127.836,53**	**134.021,97**	**140.506,69**
POPULATION	**494.882,00**	**506.150,46**	**517.675,51**	**529.462,98**	**541.518,85**	**553.849,23**	**563.735,44**	**573.798,12**	**584.040,42**	**594.465,54**	**605.076,75**
Waste output per capita (kg/year)	172,63	177,97	183,31	188,81	194,47	200,31	206,32	212,51	218,88	225,45	232,21
Waste output per capita (kg/day)	0,473	0,488	0,502	0,517	0,533	0,549	0,565	0,582	0,600	0,618	0,636

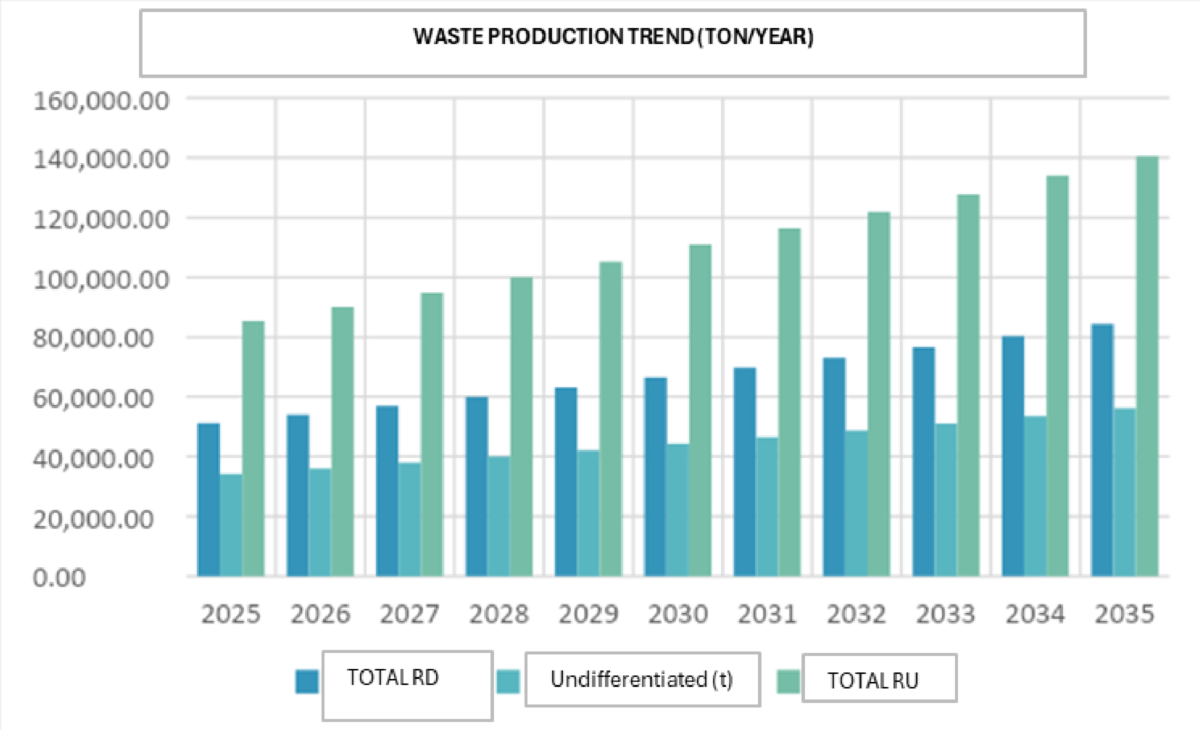


Table 14: Intermediate scenario - Zone 1

Urban waste fractions	2025 (ton/year)	2026 (ton/year)	2027 (ton/year)	2028 (ton/year)	2029 (ton/year)	2030 (ton/year)	2031 (ton/year)	2032 (ton/year)	2033 (ton/year)	2034 (ton/year)	2035 (ton/year)
Organic fraction (t)	26.411,84	27.848,70	29.337,30	30.905,47	32.557,46	34.297,76	35.957,27	37.697,09	39.521,08	41.433,33	43.438,10
Paper (t)	7.703,45	8.122,54	8.556,71	9.014,10	9.495,93	10.003,51	10.487,54	10.994,98	11.526,98	12.084,72	12.669,45
Glass (t)	11.004,93	11.603,63	12.223,88	12.877,28	13.565,61	14.290,73	14.982,20	15.707,12	16.467,12	17.263,89	18.099,21
Multimaterial (t)	11.004,93	11.603,63	12.223,88	12.877,28	13.565,61	14.290,73	14.982,20	15.707,12	16.467,12	17.263,89	18.099,21
Textiles (t)	1.650,74	1.740,54	1.833,58	1.931,59	2.034,84	2.143,61	2.247,33	2.356,07	2.470,07	2.589,58	2.714,88
Electronic waste (t)	550,25	580,18	611,19	643,86	678,28	714,54	749,11	785,36	823,36	863,19	904,96
Other (t)	7.703,45	8.122,54	8.556,71	9.014,10	9.495,93	10.003,51	10.487,54	10.994,98	11.526,98	12.084,72	12.669,45
TOTAL RD	**66.029,61**	**69.621,75**	**73.343,25**	**77.263,68**	**81.393,66**	**85.744,40**	**89.893,19**	**94.242,71**	**98.802,70**	**103.583,31**	**108.595,24**
UNDIFFERENTIATED (t)	**44.019,74**	**46.414,50**	**48.895,50**	**51.509,12**	**54.262,44**	**57.162,93**	**59.928,79**	**62.828,48**	**65.868,46**	**69.055,54**	**72.396,83**
TOTALE RU	**110.049,34**	**116.036,25**	**122.238,75**	**128.772,79**	**135.656,10**	**142.907,34**	**149.821,98**	**157.071,19**	**164.671,16**	**172.638,85**	**180.992,07**
POPULATION	**637.476,55**	**651.991,89**	**666.837,75**	**682.021,64**	**697.551,28**	**713.434,52**	**726.169,32**	**739.131,45**	**752.324,94**	**765.753,94**	**779.422,65**
Waste output per capita (kg/year)	172,63	177,97	183,31	188,81	194,47	200,31	206,32	212,51	218,88	225,45	232,21
Waste output per capita (kg/day)	0,473	0,488	0,502	0,517	0,533	0,549	0,565	0,582	0,600	0,618	0,636

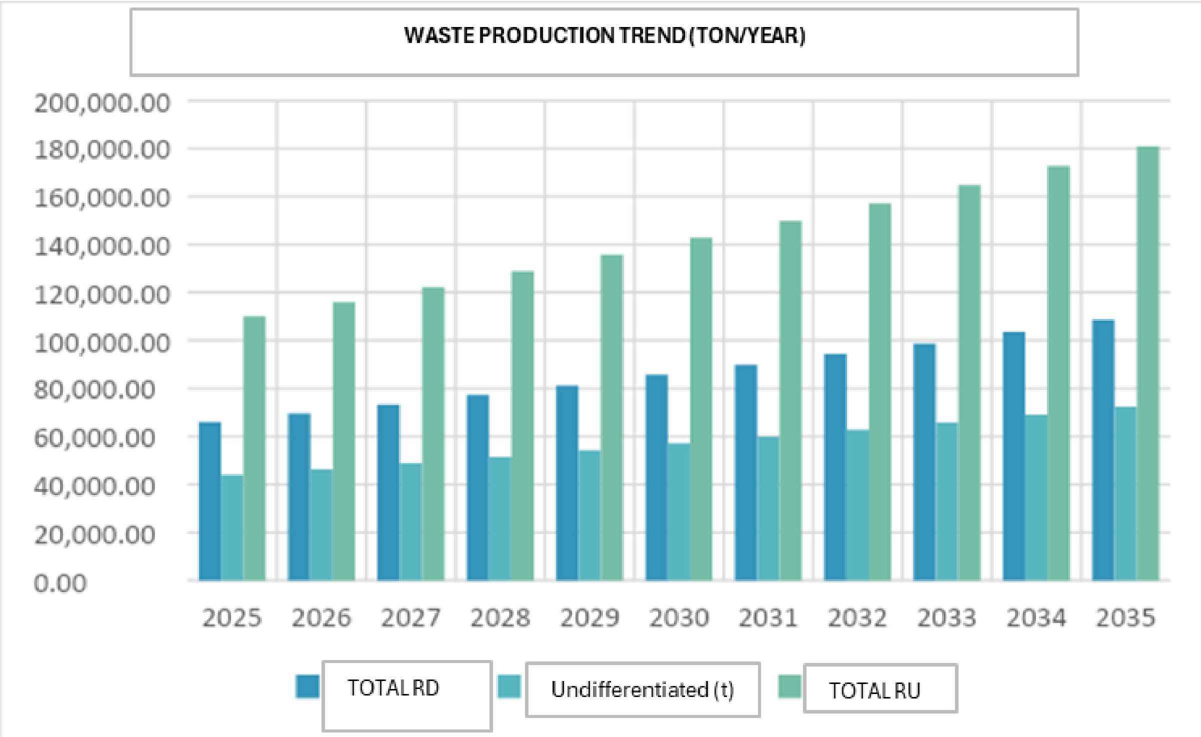


Table 15: Intermediate scenario - Zone 2

Urban waste fractions	**2025 (ton/year)**	**2026 (ton/year)**	**2027 (ton/year)**	**2028 (ton/year)**	**2029 (ton/year)**	**2030 (ton/year)**	**2031 (ton/year)**	**2032 (ton/year)**	**2033 (ton/year)**	**2034 (ton/year)**	**2035 (ton/year)**
Organic fraction (t)	22.589,02	23.817,91	25.091,05	26.432,25	27.845,13	29.333,54	30.752,86	32.240,85	33.800,84	35.436,31	37.150,92
Paper (t)	6.588,47	6.946,89	7.318,22	7.709,41	8.121,50	8.555,62	8.969,58	9.403,58	9.858,58	10.335,59	10.835,68
Glass (t)	9.412,09	9.924,13	10.454,61	11.013,44	11.602,14	12.222,31	12.813,69	13.433,69	14.083,68	14.765,13	15.479,55
Multimaterial (t)	9.412,09	9.924,13	10.454,61	11.013,44	11.602,14	12.222,31	12.813,69	13.433,69	14.083,68	14.765,13	15.479,55
Textiles (t)	1.411,81	1.488,62	1.568,19	1.652,02	1.740,32	1.833,35	1.922,05	2.015,05	2.112,55	2.214,77	2.321,93
Electronic waste (t)	470,60	496,21	522,73	550,67	580,11	611,12	640,68	671,68	704,18	738,26	773,98
Other (t)	6.588,47	6.946,89	7.318,22	7.709,41	8.121,50	8.555,62	8.969,58	9.403,58	9.858,58	10.335,59	10.835,68
TOTAL RD	**56.472,56**	**59.544,78**	**62.727,63**	**66.080,62**	**69.612,84**	**73.333,86**	**76.882,15**	**80.602,13**	**84.502,11**	**88.590,79**	**92.877,29**
UNDIFFERENTIATED (t)	**37.648,37**	**39.696,52**	**41.818,42**	**44.053,75**	**46.408,56**	**48.889,24**	**51.254,77**	**53.734,76**	**56.334,74**	**59.060,52**	**61.918,20**
TOTALE RU	**94.120,93**	**99.241,30**	**104.546,06**	**110.134,37**	**116.021,39**	**122.223,10**	**128.136,92**	**134.336,89**	**140.836,85**	**147.651,31**	**154.795,49**
POPULATION	**545.208,94**	**557.623,35**	**570.320,43**	**583.306,63**	**596.588,52**	**610.172,84**	**621.064,43**	**632.150,43**	**643.434,31**	**654.919,61**	**666.609,93**
Waste output per capita (kg/year)	172,63	177,97	183,31	188,81	194,47	200,31	206,32	212,51	218,88	225,45	232,21
Waste output per capita (kg/day)	0,473	0,488	0,502	0,517	0,533	0,549	0,565	0,582	0,600	0,618	0,636

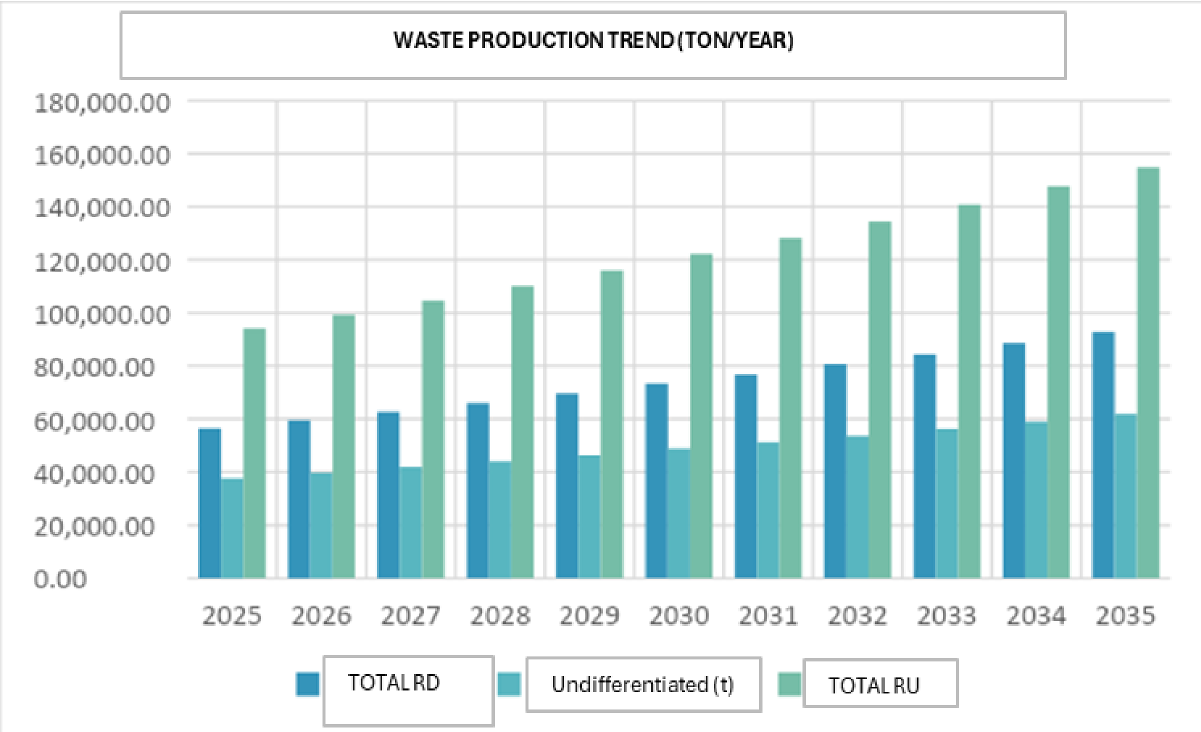


Table 16: Intermediate scenario - Zone 3

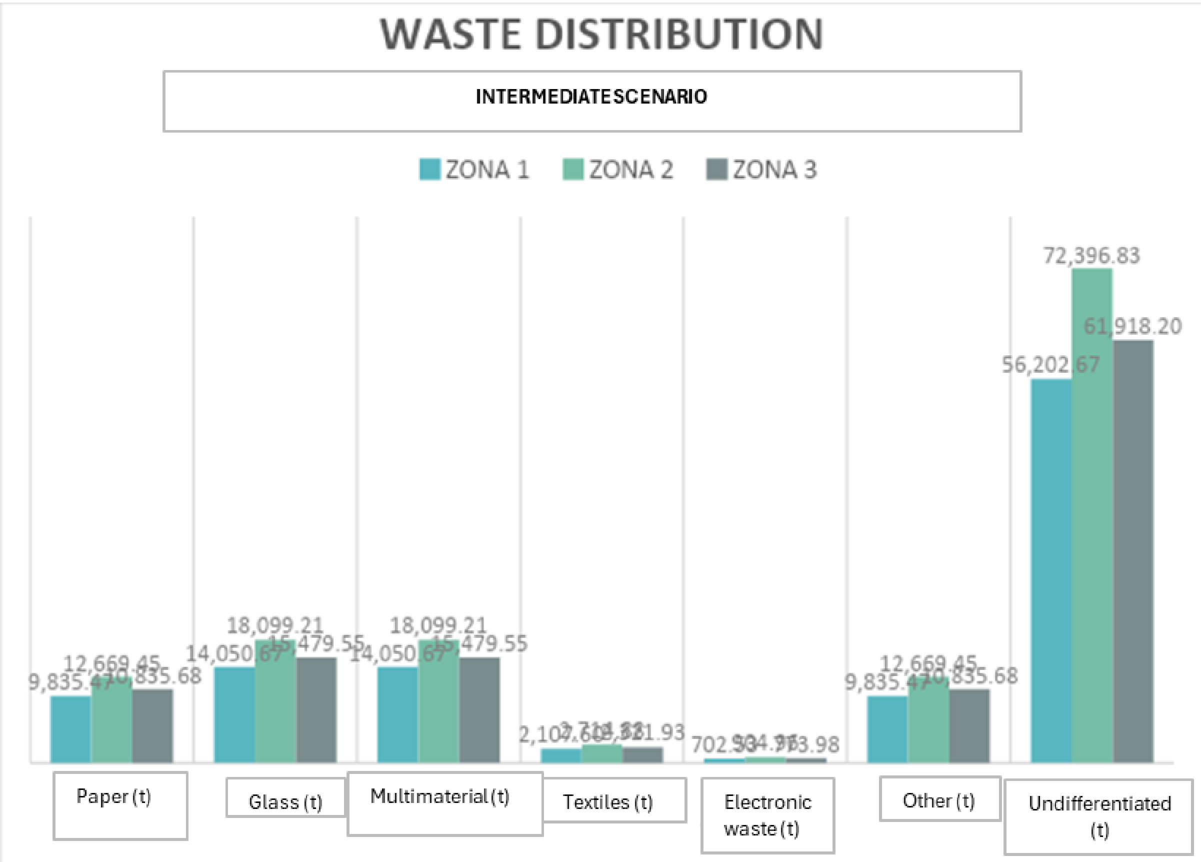


Figure 29: Waste distribution – Intermediate scenario

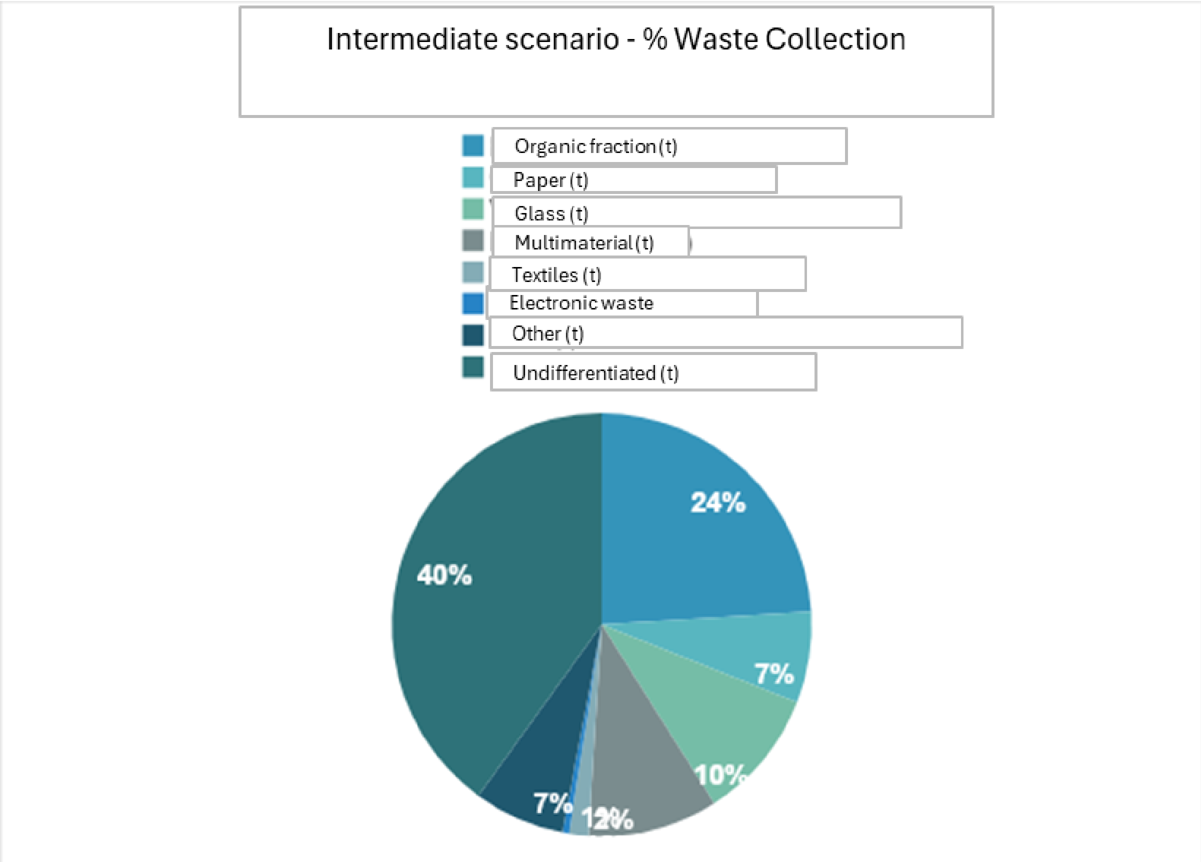


Figure 30: Separate collection percentage

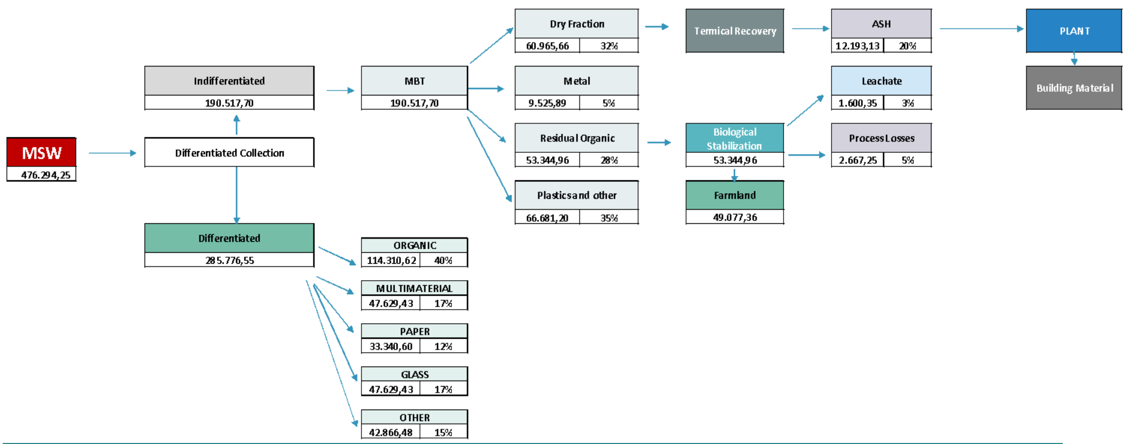


Figure 31: Process flow chart waste management target 60% differentiated waste

3.2.3 State scenario at 60% of RD

- Plan RD target 2035: 60%;
- Waste production rate: annual growth of 3.0%;
- Organic waste fraction: average of 24% by 10 years (2035)

Urban waste fractions	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
	(ton/year)	(ton/year)	(ton/year)	(ton/year)	(ton/year)	(ton/year)	(ton/year)	(ton/year)	(ton/year)	(ton/year)	(ton/year)
Organic fraction (t)	22.212,54	23.420,95	24.672,87	25.991,71	27.381,05	28.844,65	30.240,32	31.703,51	33.237,50	34.845,71	36.531,74
Paper (t)	7.688,96	8.107,25	8.540,61	8.997,13	9.478,06	9.984,69	10.467,80	10.974,29	11.505,29	12.061,98	12.645,60
Glass (t)	10.251,94	10.809,67	11.387,48	11.996,18	12.637,41	13.312,92	13.957,07	14.632,39	15.340,38	16.082,64	16.860,80
Multimaterial (t)	10.251,94	10.809,67	11.387,48	11.996,18	12.637,41	13.312,92	13.957,07	14.632,39	15.340,38	16.082,64	16.860,80
Textiles (t)	1.708,66	1.801,61	1.897,91	1.999,36	2.106,23	2.218,82	2.326,18	2.438,73	2.556,73	2.680,44	2.810,13
Electronic waste (t)	854,33	900,81	948,96	999,68	1.053,12	1.109,41	1.163,09	1.219,37	1.278,37	1.340,22	1.405,07
Other (t)	6.834,63	7.206,45	7.591,65	7.997,45	8.424,94	8.875,28	9.304,71	9.754,93	10.226,92	10.721,76	11.240,53
TOTAL RD	**59.803,00**	**63.056,40**	**66.426,96**	**69.977,69**	**73.718,21**	**77.658,68**	**81.416,23**	**85.355,60**	**89.485,57**	**93.815,38**	**98.354,68**
UNDIFFERENTIATED (t)	**25.629,86**	**27.024,17**	**28.468,70**	**29.990,44**	**31.593,52**	**33.282,29**	**34.892,67**	**36.580,97**	**38.350,96**	**40.206,59**	**42.152,01**
TOTALE RU	**85.432,85**	**90.080,57**	**94.895,66**	**99.968,13**	**105.311,73**	**110.940,97**	**116.308,91**	**121.936,57**	**127.836,53**	**134.021,97**	**140.506,69**
POPULATION	**494.882,00**	**506.150,46**	**517.675,51**	**529.462,98**	**541.518,85**	**553.849,23**	**563.735,44**	**573.798,12**	**584.040,42**	**594.465,54**	**605.076,75**
Waste output per capita (kg/year)	172,63	177,97	183,31	188,81	194,47	200,31	206,32	212,51	218,88	225,45	232,21
Waste output per capita (kg/day)	0,473	0,488	0,502	0,517	0,533	0,549	0,565	0,582	0,600	0,618	0,636

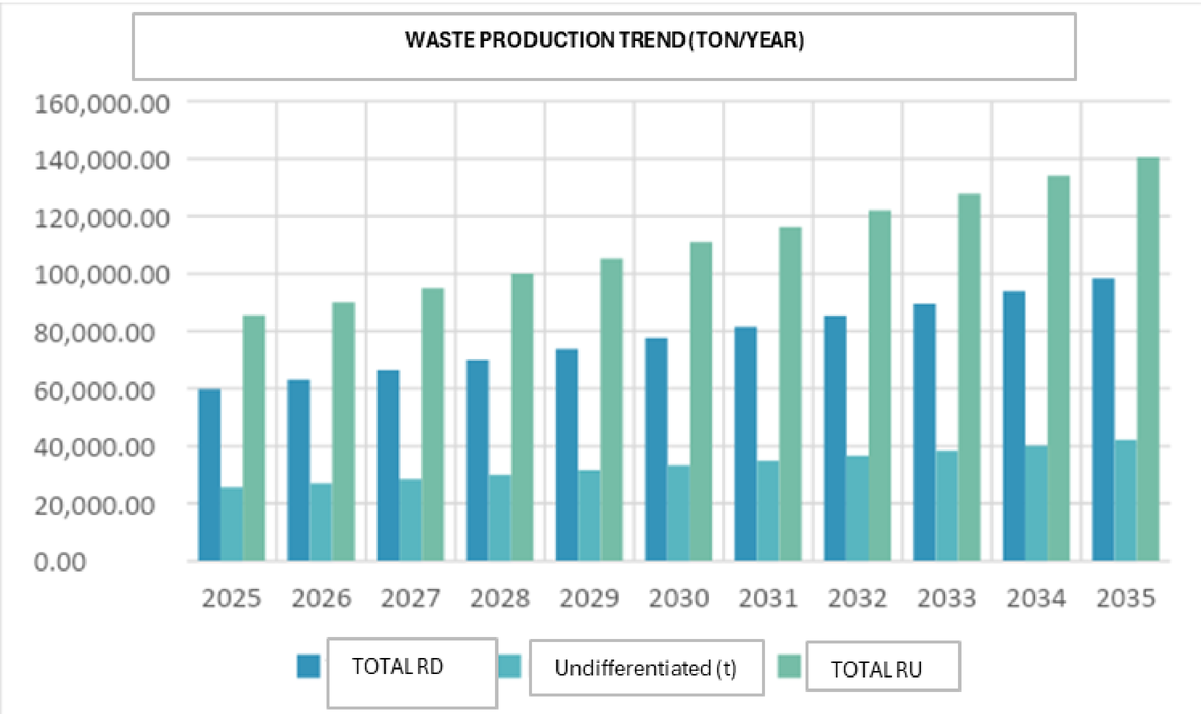


Table 17: Advanced scenario - Zone 1

Urban waste fractions	**2025** (ton/year)	**2026** (ton/year)	**2027** (ton/year)	**2028** (ton/year)	**2029** (ton/year)	**2030** (ton/year)	**2031** (ton/year)	**2032** (ton/year)	**2033** (ton/year)	**2034** (ton/year)	**2035** (ton/year)
Organic fraction (t)	28.612,83	30.169,43	31.782,08	33.480,93	35.270,59	37.155,91	38.953,71	40.838,51	42.814,50	44.886,10	47.057,94
Paper (t)	9.904,44	10.443,26	11.001,49	11.589,55	12.209,05	12.861,66	13.483,98	14.136,41	14.820,40	15.537,50	16.289,29
Glass (t)	13.205,92	13.924,35	14.668,65	15.452,74	16.278,73	17.148,88	17.978,64	18.848,54	19.760,54	20.716,66	21.719,05
Multimaterial (t)	13.205,92	13.924,35	14.668,65	15.452,74	16.278,73	17.148,88	17.978,64	18.848,54	19.760,54	20.716,66	21.719,05
Textiles (t)	2.200,99	2.320,73	2.444,78	2.575,46	2.713,12	2.858,15	2.996,44	3.141,42	3.293,42	3.452,78	3.619,84
Electronic waste (t)	1.100,49	1.160,36	1.222,39	1.287,73	1.356,56	1.429,07	1.498,22	1.570,71	1.646,71	1.726,39	1.809,92
Other (t)	8.803,95	9.282,90	9.779,10	10.301,82	10.852,49	11.432,59	11.985,76	12.565,70	13.173,69	13.811,11	14.479,37
TOTAL RD	**77.034,54**	**81.225,38**	**85.567,13**	**90.140,95**	**94.959,27**	**100.035,14**	**104.875,39**	**109.949,83**	**115.269,81**	**120.847,20**	**126.694,45**
UNDIFFERENTIATED (t)	**33.014,80**	**34.810,88**	**36.671,63**	**38.631,84**	**40.696,83**	**42.872,20**	**44.946,59**	**47.121,36**	**49.401,35**	**51.791,66**	**54.297,62**
TOTALE RU	**110.049,34**	**116.036,25**	**122.238,75**	**128.772,79**	**135.656,10**	**142.907,34**	**149.821,98**	**157.071,19**	**164.671,16**	**172.638,85**	**180.992,07**
POPULATION	**637.476,55**	**651.991,89**	**666.837,75**	**682.021,64**	**697.551,28**	**713.434,52**	**726.169,32**	**739.131,45**	**752.324,94**	**765.753,94**	**779.422,65**
Waste output per capita (kg/year)	172,63	177,97	183,31	188,81	194,47	200,31	206,32	212,51	218,88	225,45	232,21
Waste output per capita (kg/day)	0,473	0,488	0,502	0,517	0,533	0,549	0,565	0,582	0,600	0,618	0,636

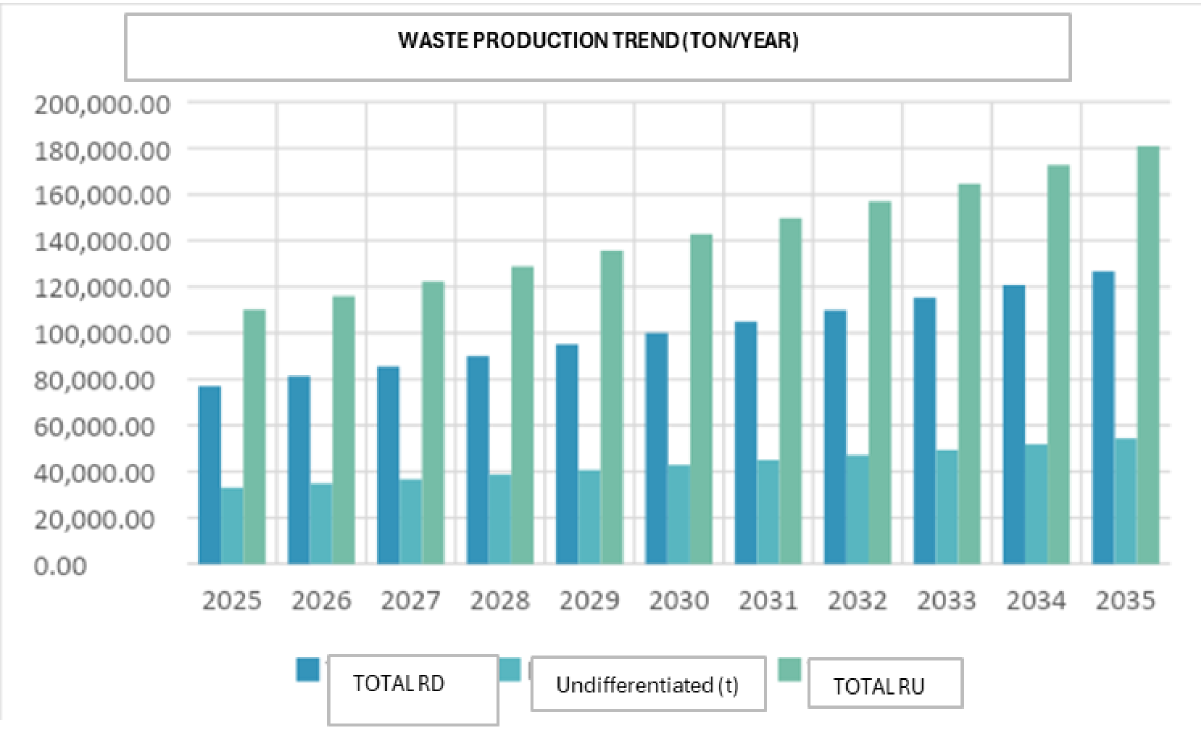


Table 18: Advanced scenario - Zone 2

Urban waste fractions	2025 (ton/year)	2026 (ton/year)	2027 (ton/year)	2028 (ton/year)	2029 (ton/year)	2030 (ton/year)	2031 (ton/year)	2032 (ton/year)	2033 (ton/year)	2034 (ton/year)	2035 (ton/year)
Organic fraction (t)	24.471,44	25.802,74	27.181,98	28.634,94	30.165,56	31.778,00	33.315,60	34.927,59	36.617,58	38.389,34	40.246,83
Paper (t)	8.470,88	8.931,72	9.409,15	9.912,09	10.441,93	11.000,08	11.532,32	12.090,32	12.675,32	13.288,62	13.931,59
Glass (t)	11.294,51	11.908,96	12.545,53	13.216,12	13.922,57	14.666,77	15.376,43	16.120,43	16.900,42	17.718,16	18.575,46
Multimaterial (t)	11.294,51	11.908,96	12.545,53	13.216,12	13.922,57	14.666,77	15.376,43	16.120,43	16.900,42	17.718,16	18.575,46
Textiles (t)	1.882,42	1.984,83	2.090,92	2.202,69	2.320,43	2.444,46	2.562,74	2.686,74	2.816,74	2.953,03	3.095,91
Electronic waste (t)	941,21	992,41	1.045,46	1.101,34	1.160,21	1.222,23	1.281,37	1.343,37	1.408,37	1.476,51	1.547,95
Other (t)	7.529,67	7.939,30	8.363,68	8.810,75	9.281,71	9.777,85	10.250,95	10.746,95	11.266,95	11.812,10	12.383,64
TOTAL RD	**65.884,65**	**69.468,91**	**73.182,24**	**77.094,06**	**81.214,97**	**85.556,17**	**89.695,84**	**94.035,82**	**98.585,79**	**103.355,92**	**108.356,84**
UNDIFFERENTIATED (t)	**28.236,28**	**29.772,39**	**31.363,82**	**33.040,31**	**34.806,42**	**36.666,93**	**38.441,08**	**40.301,07**	**42.251,05**	**44.295,39**	**46.438,65**
TOTALE RU	**94.120,93**	**99.241,30**	**104.546,06**	**110.134,37**	**116.021,39**	**122.223,10**	**128.136,92**	**134.336,89**	**140.836,85**	**147.651,31**	**154.795,49**
POPULATION	**545.208,94**	**557.623,35**	**570.320,43**	**583.306,63**	**596.588,52**	**610.172,84**	**621.064,43**	**632.150,43**	**643.434,31**	**654.919,61**	**666.609,93**
Waste output per capita (kg/year)	172,63	177,97	183,31	188,81	194,47	200,31	206,32	212,51	218,88	225,45	232,21
Waste output per capita (kg/day)	0,473	0,488	0,502	0,517	0,533	0,549	0,565	0,582	0,600	0,618	0,636

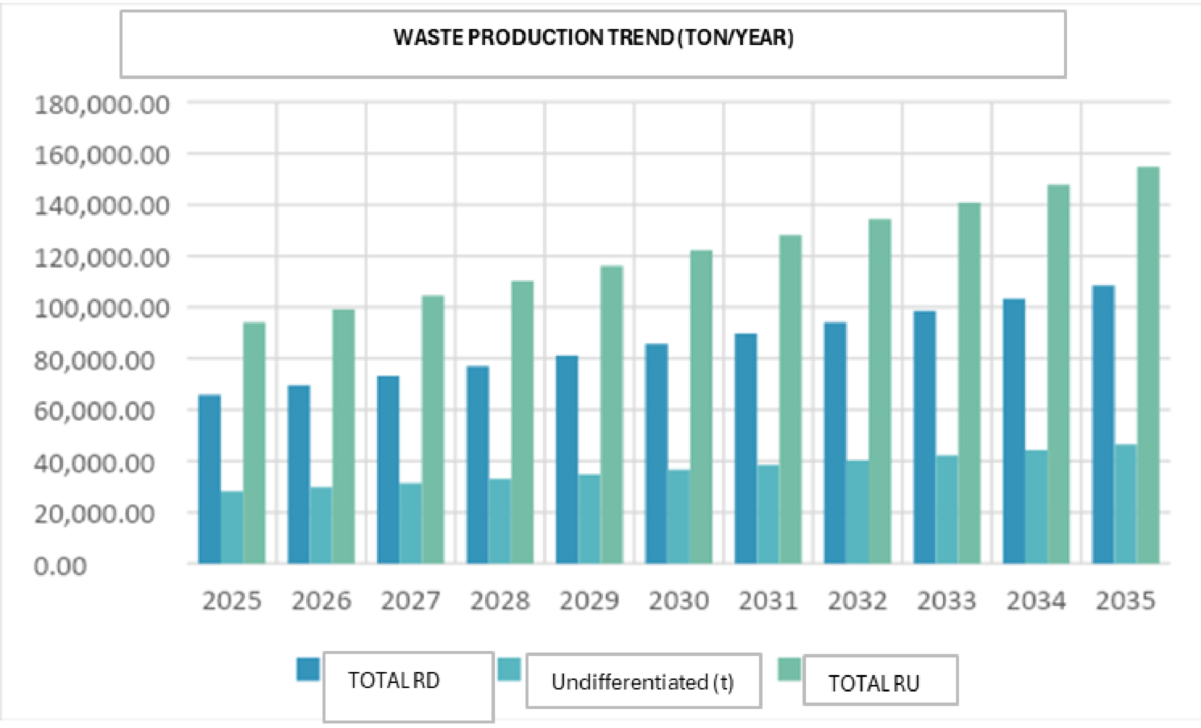


Table 19: Advanced scenario - Zone 3

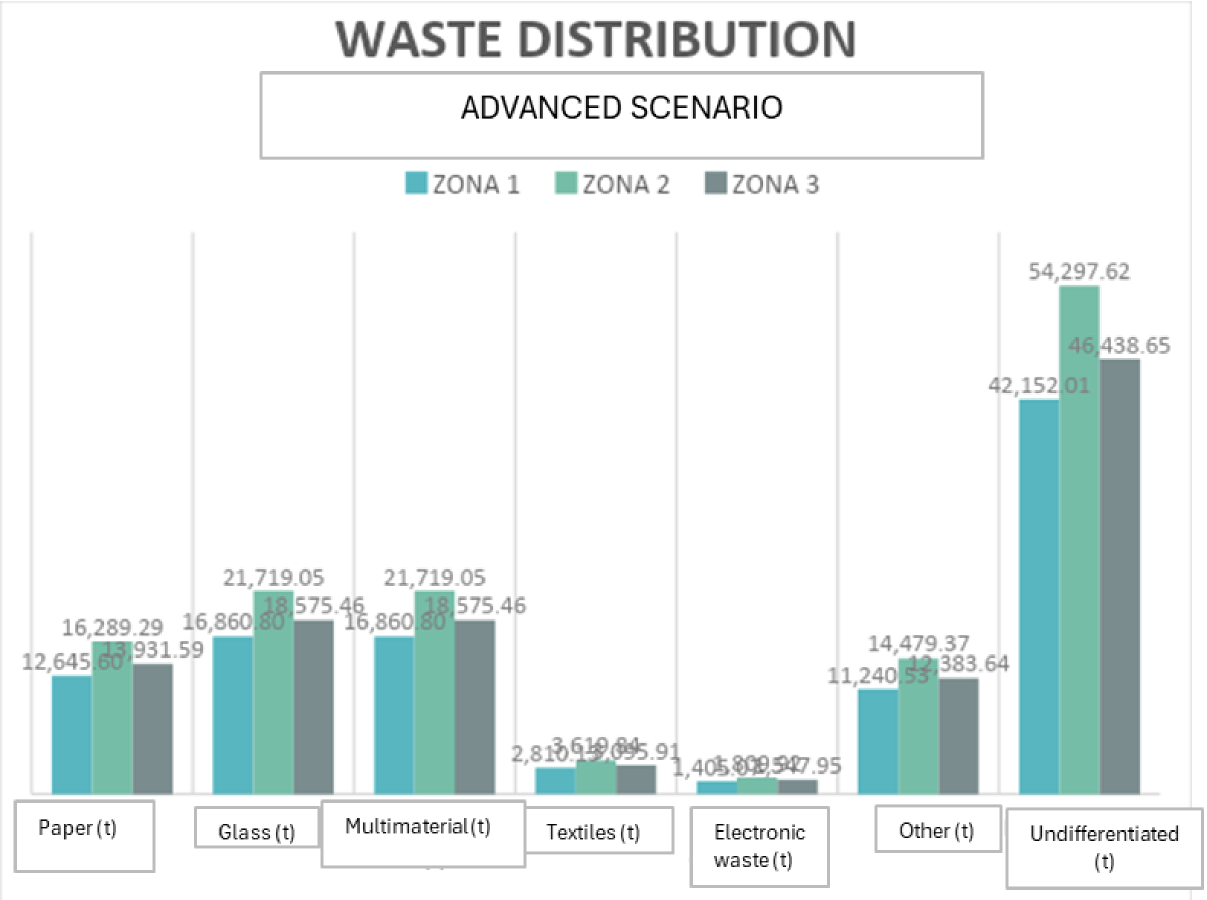


Figure 32: Waste Distribution - Advanced scenario

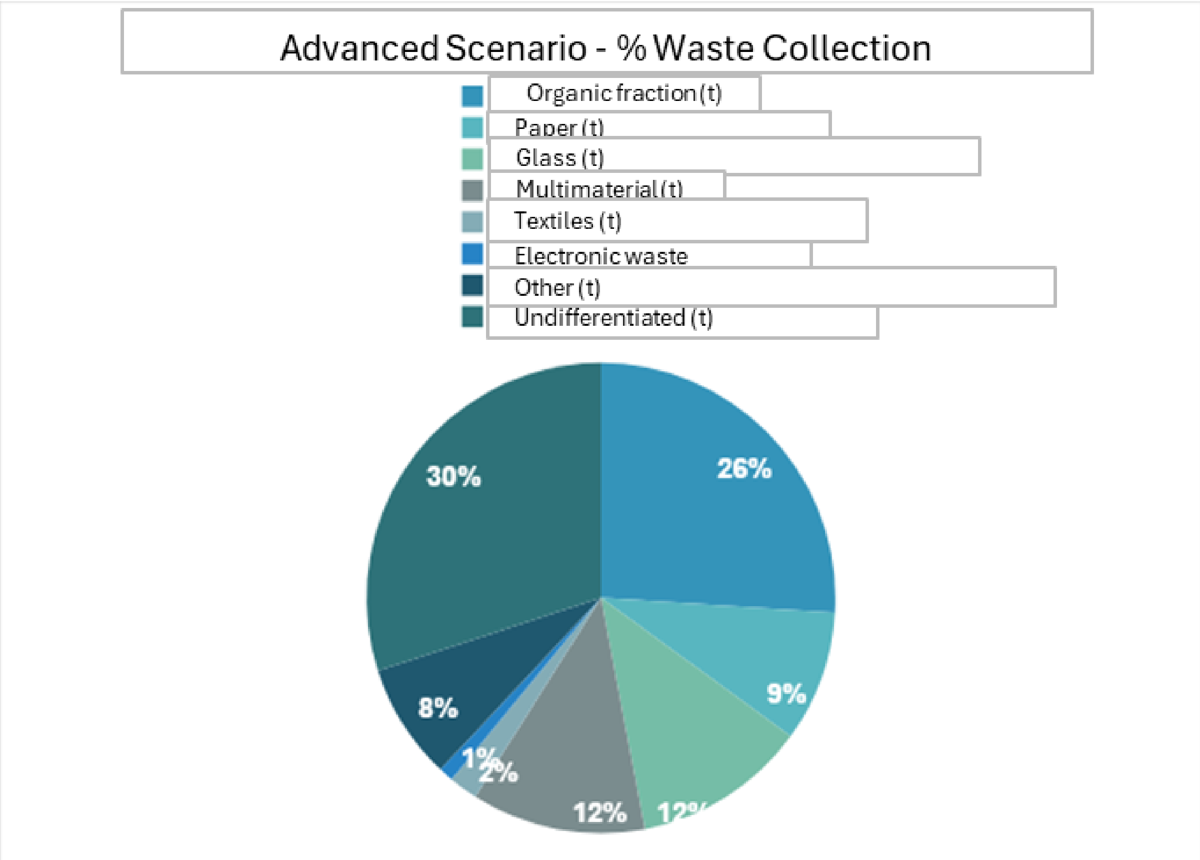


Figure 33: Separate collection percentage

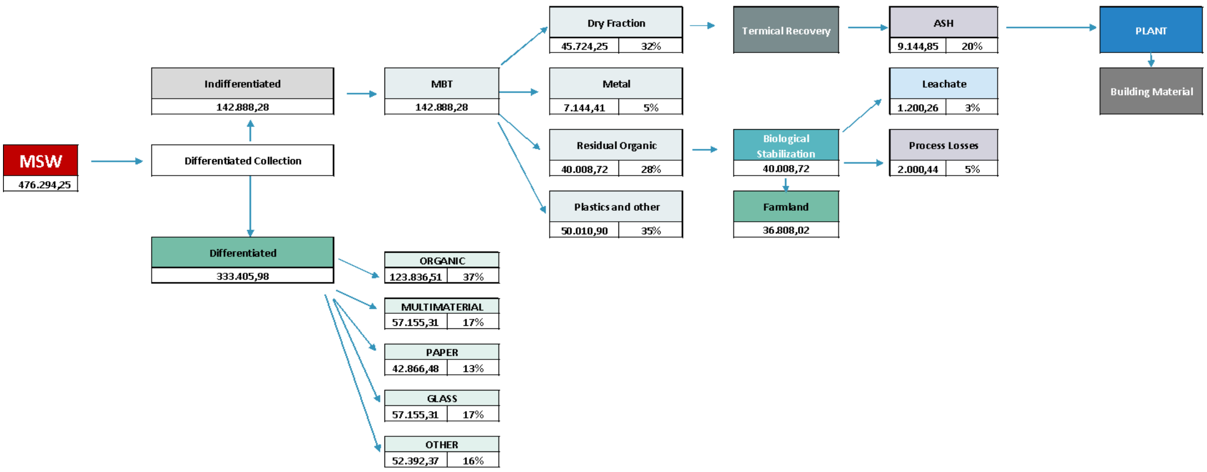


Figure 34: Process flow chart waste management target 70% differentiated waste

3.3 Municipal Waste Production And Treatment Needs (Plant)

Based on the 3 scenarios, an analysis of the plant necessary for waste treatment and disposal as well as possible energy production from recyclable waste was carried out.
Below is a summary table in which, for each type of plant, the minimum value required for the sizing of the plant has been indicated.

	SCENARIO 1 - RD 50%	SCENARIO 2 - RD 60%	SCENARIO 3 - RD 70%
Plants	Required capacity (t/year)	Required capacity (t/year)	Required capacity (t/year)
Composting Plant	104.784,74	114.310,62	123.836,51
Mechanical Biological Treatment (MBT)	238.147,13	190.517,70	142.888,28
Glass recovery plant	33.340,60	47.629,43	57.155,31
Plastic and paper recovery plant	61.918,25	80.970,02	100.021,79
Ash recovery plant	15.241,42	12.193,13	9.144,85
Landfill plant	47.629,43	38.103,54	28.577,66
Waste-to-energy plant	71.444,14	57.155,31	42.866,48

Table 20: Values required for plant dimensioning

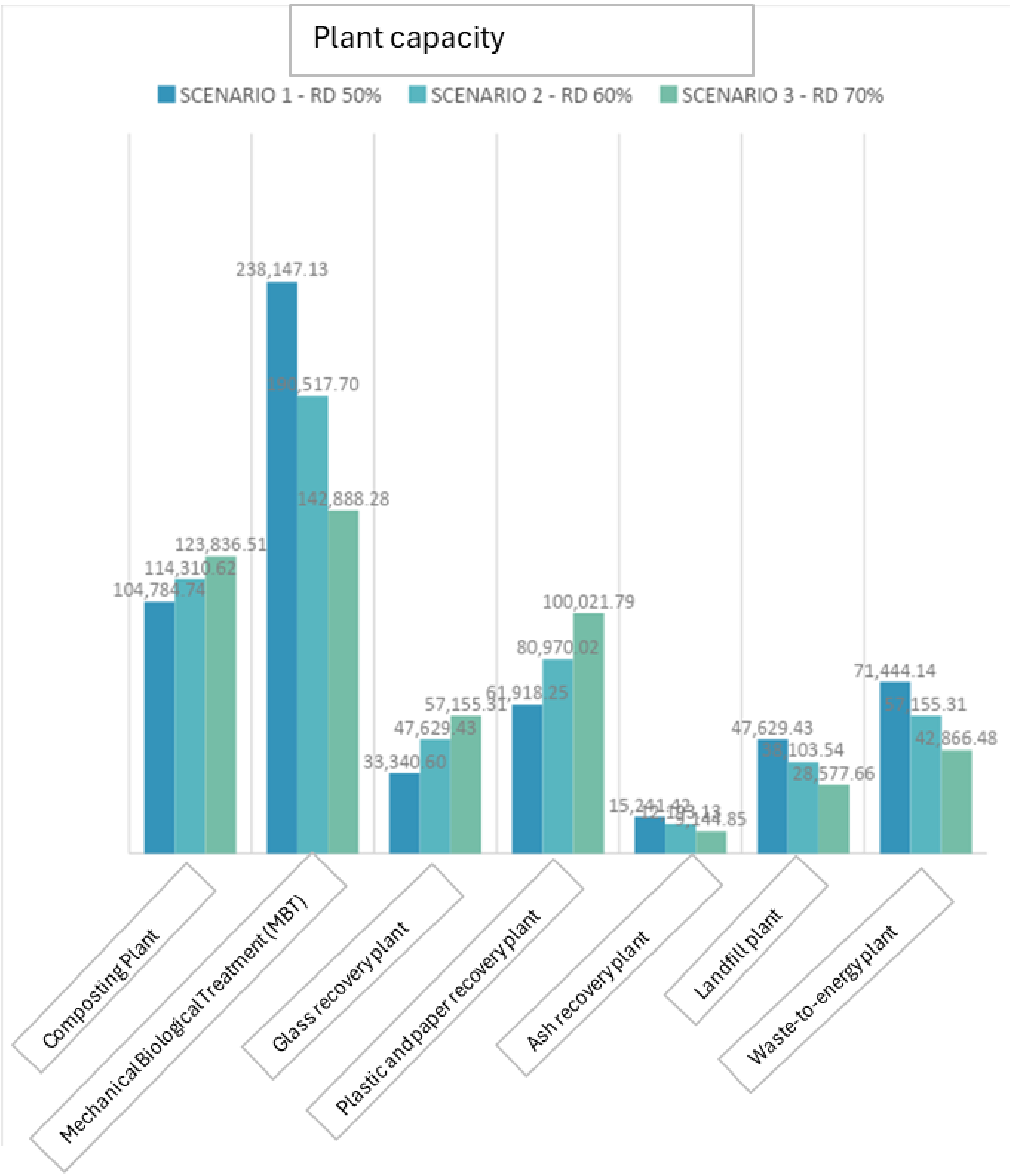


Figure 35: Plant capacity

3.4 Service Sizing

The development of the calculation of the resources needed to carry out the service of collection of solid urban waste and transport to final treatment platforms should be considered a guide for learning the techniques of dimensioning the means of Equipment of the necessary infrastructure and human resources. The approach to starting a new collection system must be dynamic, however, and must take into account that the overall picture of the factors determining the process is changing. In summary, it should be borne in mind that:

- The new service will be launched for progressive land areas;
- the users who will be involved as they go along will need to be informed and sensitized on how waste separation is done;
- Areas affected by the new service modes should be planned for a gradual expansion taking into account the availability of resources, infrastructure and final processing plant;
- the distribution of resources used for the collection and transport of differentiated fractions must be consistent with the actual responses of users, In summary, the percentage distribution of the collected materials will have a transitional phase until stabilization in times that can be estimated in five years and more.

The observations made show that the management of a service which by its nature (given the numerous factors involved: economic, social, cultural etc.) is to be considered complex and dynamic, therefore calculation models are useful as methodological and rational approach, But they must be modulated in the specific context and dynamically adapted to field responses.

ZONE		n. inhabitants	t/year
1	Baganuur + Bagahangaj + Bajanzhurh + Nalajh	462.560	99.555
2	Bajangol + Han Uul + Suhbaatar	595.841	128.241
3	Cingeltej + Songinohajrhan	509.600	109.679
TOTAL		**1.568.000**	**337.475**

Table 21: References Districts

The socio-economic characteristics of a territory, its geographical location, the dislocation of the population and the resulting urban peculiarities have a significant influence on the management of municipal waste and similar wastes; The type of collection service. In general, these typologies can be very different and with many possible variables that allow to adapt to the geographical and socio-economic needs of the territory.

The waste collection methods may be:

- Street collection: Disposal of waste in containers/bins on roads and public areas
- Household collection: The various types of waste are collected directly from the utilities on different days, according to calendar.

The analysis of the experiences of numerous municipal entities outlines a multiplicity of solutions ranging from municipalities that do not collect separately the organic moist fraction, but only the dry fractions recyclable with road containers, to municipalities that practice the home collection dry/ wet push and mono material eliminating from its territory all road containers.

The solutions can be varied but, in response to territorial requirements for efficiency and economic sustainability, they can be simplified as follows:

- collection without dry/wet separation: the user does not make any selection on the various types of waste
- dry/wet collection: the user selects the various types of waste
- Dry/wet collection at home: the user selects the various types of waste

It should be noted that the harvest with dry/wet separation, even considering different size bands of municipalities, always presents very clearly the best results for the following factors:

- It allows for less waste production;
- Allows higher yields of separate collection.

In particular, home harvesting has the best separate collection yields, often with yields above 50% and tips over 80%.

It is known that a structured system with street and public areas with waste bins (road containers), often large, facilitates the delivery of any kind of waste, also of those which should not be delivered to the municipal waste collection service, such as special and hazardous waste, while leaving private costs to the public service.

The problem is that the road container does not make the user responsible, either at behavioural or economic level (system of premiums/penalties).

It was also found that in municipalities which move from a street collection to a home, there is always an unequivocal and substantial reduction in the production of waste.

In this step of passage the reduced waste generation may be partly attributed to a waste migration to another site where road collection is applied. But if the application of home collection affects the entire municipal territory, not only limited areas of territory, this phenomenon is modest and limited in time only in the initial phase. It is important that the lower per capita production of municipal waste in the home system seems to be linked to a greater responsibility and awareness of users in the differentiation and delivery of special waste, urban and similar, which influence their purchases and consumption.

In particular, in the case of Mongolia where there is no clear separation between special and urban waste, legislative and organizational policies should be initiated to allow and ensure the separation of special waste from non-domestic municipal waste (allowing partial application of the "polluter pays" principle).

The service of home collection with dry/wet separation is better than all other systems of collection in terms of waste production, because it intervenes in a reflective way both on prevention, the correct flow of different waste streams, preventing mixtures between different types of waste.

In fact, the results obtained by the municipalities that have adopted this type of separate collection show that the household collection with dry/wet separation has significantly higher yields than any other methodology.

The aim of this plan is to achieve a level of separate collection of municipal solid waste and similar waste produced by the users of the city of Ulaanbaatar that complies with the regulatory provisions and reaches high levels of quality of the materials collected to improve the current result also through the punctual analysis of emerging criticalities and an adequate and widespread awareness raising and information campaign to the citizenry.

In the first phase of the design, it is planned to organize the collection service by separating the wet (organic) fraction from the dry fraction (paper, plastic, metal, residue). Only later can a "forced" differentiated collection system be defined, which would involve the separation of all product fractions.

The waste sorting service will involve a total of approximately 1,500,000 inhabitants, resident in the urban area of Ulaanbaatar as documented.

3.4.1 Collection Calendar

The collection calendar for household users is the same for each district in the same area and is alternate days between different districts with a view to greater optimization of service. The reasons for the need for a schedule that differentiates the collection times of the different waste fractions are related to the need to separate the flows avoiding the mixing of the waste which would lead to the loss of recoverable materials. The second requirement which requires a correct organization of the service is the definition of the weekly collection calendar. This timing is linked to several factors which we can summarise:

- Putrefaction of waste;
- The product of urban waste
- percentage of material actually intercepted (this estimated value must be evaluated by the operator in the course of performing the service)

In particular, it should be pointed out that the scheduling of the service is based on conditions which may change over time depending on the actual flows of materials intercepted. For example, if the recyclable fractions exceed a certain minimum percentage, the collection frequency of the undifferentiated dry fraction may be reduced. Therefore, it must be clear that the structure of services should be interpreted in a flexible way according to the real response of users.

1.1.7 Information on the staff employed

The personnel required for collection and transport services is deduced from the combined approach of many factors, as examples:

- Amount of waste and extent of the area served;
- Mix of vehicles used for the service (capacities);
- Collection schedules;
- distance transfer area from collection area;
- number of bags or empty bins per operator per shift.

The cross-referencing of these data should allow to have for each commodity fraction, including the undifferentiated residue, and for each area/lot of the Municipality, a simple summary grid as follows: Downstream of the above, for the purposes of planning and then determining the number of vehicles and personnel required to ensure the expected service of collection and transport of the different fractions of commodities, it is necessary to take into account certain CONSTRAINTS which affect the correct determination of the quantities subject to calculation and determine their value. In the context of separate waste collection projects, no 3 constraints can be defined against which the calculation of the number of vehicles and the number of personnel employed must be compared and possibly modified.

The constraint no.1 is represented by the means and in particular the technical and mechanical characteristics of the same; in particular, it must take into account the volumetry, of the maximum load capacity per type of material and therefore of the maximum load which depends on the volume of the medium and the compaction ratio in relation to those with a compactor plant.

The constraint no.2 is related to the personnel employed for the collection and in particular it is related to the maximum quantity of waste to be collected per operator per shift and consequently to the quantity collected per operator per hour.

The number of jobs to be taken during a shift or an hour per operator is the average number of jobs

The personnel sizing was carried out by providing for the collection of organic, multi-material and dry undifferentiated a work team composed of n.2 Operator/ Collector and n.1 Driver/ Collector, For the glass, a work team composed of n.1 Operator/Collector and n.1 Driver/Collector was provided.

Knowledge of the volumes to be collected per shift, the loading capacity of the vehicles and the collection schedules allows the determination of the number and type of vehicles as well as the number and type of personnel to be employed daily to ensure the collection service and transport to

the installations of the various product fractions. The design and sizing of harvesting equipment is based on determining the productivity of the equipment.
For "Productivity of the Trucks" it is meant the number of days per year of actual functionality of the vehicle, excluding, therefore, the days of downtime for maintenance.
The table shows the productivity values used for this dimensioning. The data on productivity of trucks comes from literature values.

days/year	***Downtime days***	***Working days***
365	65	300

Table 22: Vehicle productivity

The design and sizing of collection teams is based on determining their productivity.

By "Productivity of the Operators" is meant the number of days actually worked per year, taken into account the working days for rest, holidays, accidents, sickness and union rest.

The table shows the productivity values used for this dimensioning.

days/year	***Rest***	***Vacations***	***Illness, Maternity, Leave, Accidents***	***Training, Leave***	***Worked days***
365	52	32	20	1	260

Table 23: Personal days worked

3.4.1.1 Additional staff planned

For the correct calculation of personnel employed two additional rates must be considered. In particular:

- Substitution and complementary services (about 20% of the total)
- Administrative staff (about 10% of the total).

3.4.2 Instructions for the configuration of equipment and equipment

The required transport capacity is a function of:

- Road use of the areas;
- Frequency and collection methods;
- location of collection areas;
- location of transfer areas.

For example, in areas with good road accessibility and high density of dwellings, vehicles with a high transport capacity are used, whereas in areas with low density of dwellings and very poor accessibility means with limited loading capacity are used, but of minimum footprint and, therefore, excellent flexibility of use.

For the means destined to transfer to the final installations, the number and type are a function of the available logistics and the spatial location of the final installations in relation to the transfer areas. The choice of suitable means for collection and transport is also naturally related to the type of waste.
The following is a list of the types of vehicles most used for the collection of the different fractions of goods in urban areas and for their transport to plants.
The compactor truck (or self-compactor) is a vehicle for the collection of waste equipped to compact it in its interior, often equipped with a system of rear, front or side box coupling. The self-packer is mainly used for the collection of road waste on wide and smooth roads, with the presence of n.1 driver and n.2 operators, and can be of three models:

- Truck, mounted on vans, trucks or other commercial vehicles;
- It is a sled-out system mounted on a frame with a sliding box;
- Mini compactor, mounted on small vans.

The truck-mounted model is divided into two further types: the 4-axis compactor and the 3-axis compactor, which differ mainly in the number of axes present and consequently in the volumetric capacity. The 4-axle compactor usually has a volumetric capacity of 32 m3 and the 3-axle compactor has a volumetric capacity of 25 m3. In addition, the compaction ratio is 6.5 for the 4-axis compactor and 6 for the 3-axis compactor.

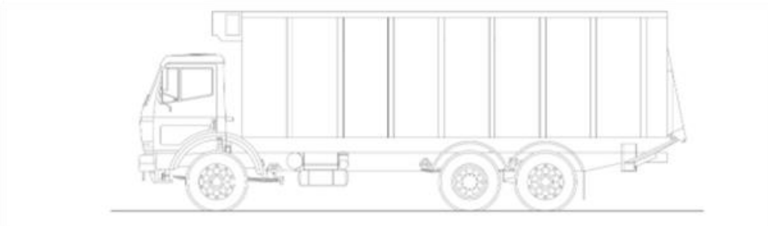


Figure 36: 3-axis compactor

Figure 37: 4-axis compactor

The mobile model is mainly used for the transport of waste inside containers thanks to the presence of a hook and a derailment plant takes the container from the ecological island and transports it to the plants. In this case they are used to transport the open-air containers of wet and glass.

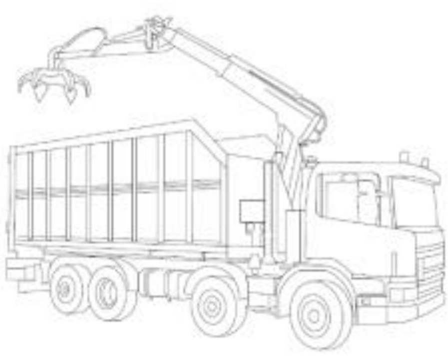


Figure 38: 4-axis truck

The standard size of the container length is approx. 6 meters, while the off-standard size is approx. 7 meters. The containers have a volume capacity of approx. 30 m3. In addition, there are press-containers used exclusively for multimaterial fractions, paper and cardboard with different compaction ratios and volumetric capacity of approx. 20 m3.

Press-Container

Container

Figure 39 Press-cointeners

The mini compactor model consists of a 2-axis compactor, which has the same characteristics as the 3-axis compactor in terms of compaction ratio but has a lower volumetric capacity (approx. 10 m3).

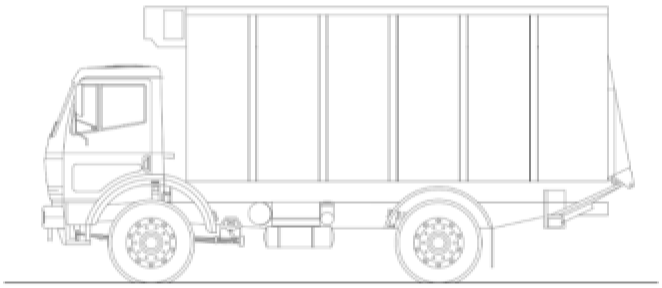


Figure 40: 2-axis compactor

The second type of road waste collection vehicles includes the defined tank vehicles with the presence of n.2 operators, both of which are used for the collection of waste within roads with restricted traffic, of hilly type and within the historic city center. These vehicles have the blades in the loading area to avoid compaction of waste, favoring its compaction: for this characteristic are defined as single-hull rammers, mini rammers and simple tank vehicles. The single-hull rammers (volume capacity of 7 m3) and the small-scale rammers (volume capacity of 5 m3) have a single-hull lower floor similar to a tank and are used for collecting the multi-material fraction and the undifferentiated dry. Single-vessel vessels have a volume capacity of 5 m3 and are suitable for the collection of glass and wet waste fractions.

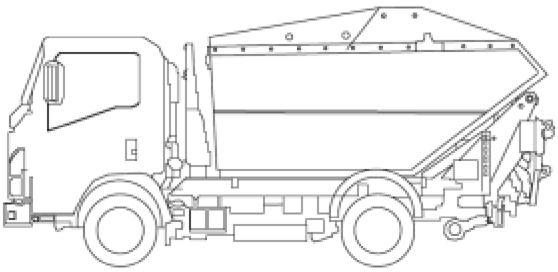


Figure 41: One-piece rammer

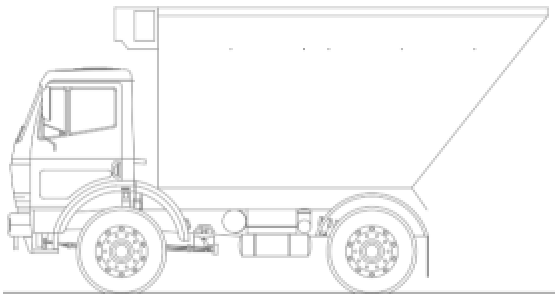


Figure 42: 5 m3 tank

For the purposes of this plan, 7-cubic-metre mini compactors and 10-cubic-metre compactors for the multi-material, organic and undifferentiated fraction and a 7-cubic-metre tank medium for the collection of glass have been identified for the door-to-door collection of waste produced by citizens. For the transport to the plants, 4-axle compactors are used for undifferentiated dry and multi-material compactors and 4-axle mobile trucks with open-top container for glass and organic fraction.
The values taken into consideration for the calculation regarding the compaction ratio and capacity by type of medium and type of material collected are given below.

	Compactor 4 axes	Compactor 3 axes	Compactor 2-axis	Rammer 7 mc	Tank vehicle 7 mc
Organic				1	1
Glass				1	1
Multimaterial	5	5	5	5	1
Dry	6	6	6	4.5	1

Table 24: Constipation Report

The following table shows the quantities of waste which can be transported by type of vehicle. The values are derived from the volume of the vehicle for the density of the transported material.

	Compactor 4 axes [kg]	Compactor 3 axes [kg]	Compactor 2-axis[kg]	Rammer 7 mc [kg]	Tank vehicl e 7 mc [kg]
Organic			5000	3500	3500
Glass					1750
Multimaterial	4725	3675	1750	1225	175
Dry	14580	11340	5400	2835	450

Table 25: Transportable waste weight (kg/vehicle unit)

3.4.3 Dimensioning Zone 1 - Baganuur + Bagahangaj + Bajanzhurh + Nalajh

In the table below, a possible harvest schedule is given for the area of Baganuur + Bagahangaj + Bajanzhurh + Nalajh.

DAY	*FRACTION*
Monday	**Multimaterial**
	Glass
Tuesday	**Organic**
Wednesday	**Undifferentiated**
Thursday	**Organic**
Friday	**Multimaterial**
	Glass
Saturday	**Organic**
	Undifferentiated

Table 26: Household Utilities Collection Calendar - Baganuur + Bagahangaj + Bajanzhurh + Nalajh

On the basis of the assumptions made above about the specific daily production and the product composition of the waste, the weekly quantities of material to be intercepted are reported for each product fraction and, depending on the frequency of collection, the volume and mass of material per shift.

District	*Type of utilities*	*Production*	*Fractions*	
Baganuur + Bagahangaj + Bajanzhurh + Nalajh	*Domestic utilities*	***0,6362***	*Organic, Glass, Multimaterial, Undifferentiated*	

Table 27: Weekly material quantities

3.4.3.1 Type of service

The service that is expected to activate is the dry/ wet separation characterized by domestic separation of wet, glass, multi-material (plastic, paper and tinplate) and the Undifferentiated Dry Waste to be sent to the different treatment/recycling plants

3.4.3.2 Volumes and Frequencies Collection

3.4.3.2.1 Organic fraction

The organic fraction is collected 3 days a week (Tuesday, Thursday, Saturday), the frequency of collection of this fraction is the highest as the organic fraction obviously has biological degradation processes with problems related to the production of percolates and malodorous gases (These phenomena are due to the initiation of anaerobic degradation in case of excessive time inside containers).
The weekly waste production is 666 tonnes, which distributed on the days of collection allows us to plan a service that provides for withdrawals by operators of about 285 tons on Tuesday, 190 tons on Thursday and 190 tons on Saturday, the difference in tonnes over the various days is given by the days between the different harvests, in addition to the data already indicated, the density in tonnes per cubic metre of staff has also been reported in the following table:

Organic		
Production (t/weekly,)	666	
Density (t/mc)	0.42	
Collected quantity (t/turn)	*Tuesday (prod.on 3 days)*	285
	Thursday (prod. on 2 days)	190
	Saturday (prod. on 2 days)	190

Table 28: Density in tonnes per cubic meter organic

It is clarified that to size the resources required for collecting the organic waste fraction, once the expected quantity by weight has been established, the weight in volume is transformed using a characteristic mean parameter of the specific fraction called bulk density by making a simple ratio ie Weight in Tons/Bulk Density in mc per ton. Once the volume is determined, the number of trucks to be used is defined in relation to the volume of each (considering that the organic fraction is assumed to be incompressible).
The above mentioned operations of collection of organic fraction are carried out by means of compactors of 10 mc having the following characteristics.

10 mc compactors	
Volume [mc] e (t)	10 mc
Compaction Coefficient	0
Volume after compaction [mc] and (t)	10 mc

Minimum Useful Flow Rate	4.200 kg

Table 29: Compactor characteristics

Therefore, with reference to the weekly collection days, the quantities of organic fraction to be intercepted and the capacity of the vehicle indicated above (10 mc), it is necessary to equip yourself with the following number of vehicles.

	Quantity to collect	n. vehicles
Tuesday	285 t – 680 mc	45
Thursday	190t – 453 mc	30
Saturday	190t – 453 mc	30

Table 30: No. of means required per Q to be collected

The number of trucks and teams has been dimensioned considering that in a working shift are collected quantities equal to 1.5 times volume of the vehicle as 2 collection tours are carried out. This assumption must however take into account in the drafting of the project, the road, the distance of the collection area from the point of discharge and the availability of ecological hubs for the transfer of waste.

For each means used to collect the organic fraction it is necessary to provide the presence of n.1 driver and n.2 operators involved in the collection, therefore, the number of personnel employed for each shift of collecting the organic fraction is shown in the following table.

	n. vehicles	n. operators
Tuesday	45	136
Thursday	30	91
Saturday	30	91

Table 31: No. of vehicles and operators needed

Downstream of the collection in the hypotheses formulated, the organic fraction is transported to the Municipal Collection Center or Ecological Hub and is transhipped, through a ramp, from vehicles 10mc to container. Therefore, in the strategies of organization of the service becomes decisive the availability of Ecological Hubs that allow to reduce the transfer times and increase those of collection.

Container	
Volume (tonn.)	25

	Quantity to transport	n. vehicles
Tuesday	285 t – 680 mc	11
Thursday	190t – 453 mc	8

Saturday	190t – 453 mc	8

Table 32: Means required per Q to be collected

Therefore, considering that the transports carried out will be with trailer carrabile we get 11 transports on Tuesday and 8 on Thursday and Saturday. The number of transports by means of a mobile vehicle possible per shift is a function of the distance of the final plants from the collection area and the Ecological Hubs. Assuming at least 2 full daily transports of trailers (2 containers per transport) the minimum number of trailer vehicles required is N.6, taking into account the needs of reserve and maintenance can be assumed an increase of approx. 15% therefore estimating N.7 trucks

3.4.3.2.2 Glass

The glass is collected every 2 days per week (Monday, Friday). The weekly production of waste is equal to 190 tons, which distributed on the days of collection allows us to plan a service that provides for withdrawals by operators of about 82 tons on Monday, 109 tons on Friday, the difference in tonnes over the various days is given by the days between the different collections, and in addition to the data already indicated, the density in tonnes per cubic metre of Glass is also shown in the following table:

Glass		
Production (t/weekly)	190	
Density (t/mc)	0.25	
Collected quantity (t/turn)	*Monday (prod.on 3 days)*	82
	Friday (prod.on 4 days)	109

Table 33: Weekly glass production

The above mentioned operations of collecting glass are carried out by means of 7-cubic-metre tanks which have the following characteristics.

10 mc compactors	
Volume [mc]	7 mc
Compaction Coefficient	0
Volume after compaction [mc]	7 mc
Minimum Useful Flow Rate	1.750 kg

Table 34: Vehicle characteristics

The number of trucks and teams has been dimensioned considering that in a working shift are collected quantities equal to 1.5 times volume of the vehicle as 2 collection tours are carried out. This assumption must, however, in the drafting of the executive project, take into account the road network, the distance of the collection area from the discharge point and the availability of ecological hubs for the transfer of waste.
Therefore, in reference to the weekly collection days, the quantities of glass to be intercepted and the capacity of the truck indicated (7 mc), it is necessary to equip yourself with the following number of vehicles.

	Quantity to collect	***n. vehicles***

Monday	82 t – 326 mc	23
Friday	109 t – 435 mc	31

Table 35: Means required per Q to be collected

For each means used to collect the glass it is necessary to provide the presence of n.1 driver and n.1 operators involved in the collection, therefore, the number of personnel employed for each shift of collecting the glass is given in the following table.

	n. vehicles	***n. operators***
Monday	23	47
Friday	31	62

Table 36: No. of vehicles and operators needed

Downstream of the collection, the glass fraction is transported to the municipal collection center and transhipped, via a ramp, from 7-cubic-metre tanks to open-pit container.

Container	
Useful volume	25 mc

Table 37

Downstream of the collection in the hypotheses formulated, the fraction glass is transported to the Municipal Collection Center or Ecological Hub and is transhipped, through a ramp, from 7 mc vehicles to container. Therefore, in the strategies of organization of the service becomes decisive the availability of Ecological Hubs that allow to reduce the transfer times and increase those of collection.

	Quantity to transport	***n. container***
Monday	82 t – 326 mc	6
Friday	109 t – 435 mc	8

Table 38: No. of containers per Q to be transported

Therefore, considering transport carried out by trailer, we get 6 transports on Mondays and 8 on Fridays. The number of transports by means of a mobile vehicle possible per shift is a function of the distance of the final plants from the collection area and the Ecological Hubs. Assuming at least 2 full daily towing transports (2 containers per transport) the minimum number of tow trucks required is N.4, Taking into account the needs of stock and maintenance, it can be assumed that there will be an increase of approx. 15% and therefore N.5 mobile trucks are estimated.

3.4.3.2.3 Multi-material

The collection of the Multimaterial takes place with a frequency of 2 days per week (Monday, Friday). The weekly waste production is 571 tonnes, which distributed on the days of collection allows us to plan a service that provides for about 245 tons on Monday, 326 tons on Friday, the difference in tonnes over the various days is given by the days between the different collections, and in addition to the data already indicated, the density in tonnes per cubic metre of the Multimateriale has also been reported in the following table:

Multimaterial

Production (t/weekly)	571	
Density (t/mc)	0.05	
Collected quantity (t/turn)	*Monday (prod. on 3 days)*	245
	Friday (prod.on 4 days)	326

Table 39: Weekly multi-material production

The above mentioned operations of collection of the Multimateriale fraction are carried out by means of 10-cubic metre compactors having the following characteristics.

10 mc compactors	
Volume [mc]	10
Compaction Coefficient	6
Compactable volume[mc]	60

Table 40: Compactor Characteristics

Therefore, with reference to the weekly collection days, the quantities of Multimateriale to be intercepted and the capacity of the vehicle indicated above (10 mc), it is necessary to equip yourself with the following number of vehicles.

	Quantity to collect	***n. vehicles***
Monday	245 t –4.894 mc	54
Friday	326 t – 6.525 mc	73

Table 41: No. of means per Q to be collected

The number of trucks and teams has been dimensioned considering that in a working shift are collected quantities equal to 1.5 times volume of the vehicle as 2 collection tours are carried out. This assumption must, however, in the drafting of the executive project, take into account the road network, the distance of the collection area from the discharge point and the availability of ecological hubs for the transfer of waste.
For each means used it is necessary to foresee the presence of n.1 driver and n.2 collection operators, therefore, the number of personnel employed for each shift of collection of the multi-material fraction is given in the following table.

	n. vehicles	***n. operators***
Monday	54	163
Friday	73	218

Table 42: No. of vehicles and operators needed

After collection, for transport to treatment plants, the material is transferred for transhipment from 10-cubic meters to 35-cubic meters compactors located at the municipal collection center, it is essential to equip ourselves with suitable vehicles for transhipment between the 10 m2 and 35 m2 vehicles.

35 mc compactors	
Volume [mc]	35
Compaction Coefficient	6

Compactable volume[mc]	192

Table 43: Compactor characteristics

	Quantity to transport	**n. transports**
Monday	245 t –4.894 mc	23
Friday	326 t – 6.525 mc	31

Table 44: No. of transports per Q to be transported

Thus, considering the transport carried out with a 35-cubic metre compactor, we obtain 23 transports on Mondays and 31 on Fridays. The number of transports per possible means per shift is a function of the distance of the final plants from the collection area and the Ecological Hubs. Assuming at least 2 transports per day, the minimum number of compactors required is N.16. Taking into account the needs for reserves and maintenance, an increase of approx.

3.4.3.2.4 Dry residue (undifferentiated)

The collection of the residue takes place with a frequency of 2 days a week (Wednesday, Saturday). The weekly waste production is 476 tonnes, which distributed on the days of collection allows us to plan a service that provides for withdrawals by operators of about 272 tonnes on Wednesday, 204 tonnes on Saturday, in addition to the data already indicated, The density in tonnes per cubic metre of the residue is also given in the following table:

Dry residue		
Production (t/weekly)	476	
Density (t/mc)	0.065	
Collected quantity (t/turn)	*Wednesday (prod. on 4 days)*	272 t
	Saturday (prod.on 3 days)	204 t

Table 45: Weekly dry residue production

The above-mentioned operations of collection of the residue are carried out by means of compactors of 10 mc having the following characteristics.

10 mc compactors	
Volume [mc]	10
Compaction Coefficient	6
Compactable volume[mc]	60

Table 46: Compactor characteristics

Therefore, with reference to the weekly collection days, the quantities of waste to be intercepted and the capacity of the vehicle indicated above (10 mc), it is necessary to equip yourself with the following number of vehicles.

	Quantity to collect	**n. vehicles**
Wednesday	272 t – 4.183 mc	35
Saturday	204 t – 3.137 mc	26

Table 47: No. of means per Q to be collected

The number of trucks and teams has been dimensioned considering that in a working shift are collected quantities equal to 2 times volume of the vehicle as 2 collection rounds are carried out. This assumption must, however, when drafting the executive project, take into account the road network, the distance of the collection area from the discharge point and the availability of ecological hubs for the transfer of waste

For each vehicle used, it is necessary to provide the presence of n.1 driver and n.2 collection operators, therefore, the number of personnel employed for each shift of collection of the remaining fraction is shown in the following table.

	n. vehicles	***n. operators***
Wednesday	35	105
Saturday	26	78

Table 48: No. of vehicles and operators needed

After collection, for transport to treatment plants, the material is transferred for transhipment from 10-cubic meters to 35-cubic meters compactors located at the municipal collection center, it is essential to equip ourselves with suitable lorries for transhipment between the 10-cubic metre and 35-cubic-metre vehicles.

35 mc compactors	
Volume [mc]	35
Compaction Coefficient	6
Compactable volume[mc]	210

Table 49: Compactor characteristics

	Quantity to transport	***n. transports***
Wednesday	272 t – 4.183 mc	20
Saturday	204 t – 3.137 mc	15

Table 50: No. of transports per Q to be transported

Therefore, considering the transport carried out with a 35-cubic metre compactor, we obtain 20 transports on Wednesdays and 15 on Saturdays. The number of transports per possible means per shift is a function of the distance of the final plants from the collection area and the Ecological Hubs. Assuming at least 2 transports per day, the minimum number of compactors required is N.10. Taking into account the needs for reserves and maintenance, an increase of approx.

3.4.3.3 Summary of design

The following table summarizes the type and number of means required for the collection and transport of the different fractions of goods and the number of operators needed for the service.

	Type of waste	***10 mc Compactor***	***7mc tank***	***N. operators***	***35 mc Compactor***	***Transport Container***
Monday	***Multimaterial***	54		163	23	

	Type of waste	*10 mc Compactor*	*7mc tank*	*N. operators*	*35 mc Compactor*	*Transport Container*
	Glass		23	47		3
Tuesday	***Organic***	45		136		11
Wednesday	***Undifferentiated***	35		105	20	
Thursday	***Organic***	30		91		8
Friday	***Multimaterial***	73		218	31	
	Glass		31	62		4
Saturday	***Organic***	30		91		8
	Undifferentiated	26		78	15	
TOTAL		**73 (Maximum)**	**31 (Maximum)**	**280 (Maximum)**	**31 (Maximum)**	**11 (Maximum)**
Additional personnel		**Administrative**		**28**		
		Substitutions and supplementary services		**56**		
TOTAL PERSONNEL				**364**		

Table 51: Summary table

3.4.4 Dimensioning Zone 2 - Bajangol + Han Uul + Suhbaatar

In the table below, a possible collection calendar is given for the area of Bajangol + Han Uul + Suhbaatar.

DAY	FRACTION
Monday	**Multimaterial**
	Glass
Tuesday	**Organic**
Wednesday	**Undifferentiated**
Thursday	**Organic**
Friday	**Multimaterial**
	Glass
Saturday	**Organic**
	Undifferentiated

Table 52: Household Utilities Collection Calendar - Bajangol + Han Uul + Suhbaatar

On the basis of the assumptions made above about the specific daily production and the product composition of the waste, the weekly quantities of material to be intercepted are reported for each product fraction and, depending on the frequency of collection, the volume and mass of material per shift.

District	*Type Utilities*	*Production*	*Fractions*	
Bajangol + Han Uul + Suhbaatar	*Domestic utilities*	*0,6362*	*Organic, Glass, Multimaterial, Undifferentiated*	

Table 53: Weekly material quantities

3.4.4.1 Type of service

The service that is expected to activate is the dry/ wet separation characterized by domestic separation of wet, glass, multi-material (plastic, paper and tinplate) and the Undifferentiated Dry Waste to be sent to the different treatment/recycling plants

3.4.4.2 Volumes and Frequencies Collection

3.4.4.2.1 Organic fraction

The organic fraction is collected 3 days a week (Tuesday, Thursday, Saturday), the frequency of collection of this fraction is the highest as the organic fraction obviously has biological degradation processes with problems related to the production of percolates and malodorous gases (These phenomena are due to the initiation of anaerobic degradation in case of excessive time inside containers).
The weekly waste production is 858 tonnes, which distributed on the days of collection allows us to plan a service that provides for withdrawals by operators of about 368 tonnes on Tuesday, 245 tonnes on Thursday and 245 tonnes on Saturday, the difference in tonnes over the various days is given by the days between the different harvests, in addition to the data already indicated, the density in tonnes per cubic metre of staff has also been reported in the following table:

Organic		
Production (t/weekly)	858	
Density (t/mc)	0.42	
Collected quantity (t/turno)	*Tuesday (prod. on 3 days)*	368
	Thursday (prod.on 2 days)	245
	Saturday (prod. on 2 days)	245

Table 54: Weekly organic production

It is clarified that to size the resources required for collecting the organic waste fraction, once the expected quantity by weight has been established, the weight in volume is transformed using a characteristic mean parameter of the specific fraction called bulk density by making a simple ratio ie Weight in Tons/Bulk Density in mc per ton. Once the volume is determined, the number of trucks to be used is defined in relation to the volume of each (considering that the organic fraction is assumed as incompressible)
The above mentioned operations of collection of organic fraction are carried out by means of 10 mc compactors having the following characteristics.

10 mc Compactors	
Volume [mc] and (t)	10 mc
Compaction Coefficient	0
Volume after compaction [mc] and (t)	10 mc
Minimum Useful Flow Rate	4.200 kg

Table 55: Compactor characteristics

Therefore, with reference to the weekly collection days, the quantities of organic fraction to be intercepted and the capacity of the truck indicated (10 mc), it is necessary to equip yourself with the following number of vehicles.

	Quantity to collect	*n. vehicles*
Tuesday	368 t – 876 mc	58
Thursday	245 t – 584 mc	39
Saturday	245 t – 584 mc	39

Table 56: No. of means required per Q to be collected

The number of trucks and teams has been dimensioned considering that in a working shift are collected quantities equal to 1.5 times volume of the vehicle as 2 collection tours are carried out. This assumption must however take into account in the drafting of the project, the road, the distance of the collection area from the point of discharge and the availability of ecological hubs for the transfer of waste.
For each means used to collect the organic fraction it is necessary to provide the presence of n.1 driver and n.2 operators involved in the collection, therefore, the number of personnel employed for each shift of collecting the organic fraction is shown in the following table.

	n. vehicles	*n. operators*
Tuesday	58	175
Thursday	39	117
Saturday	39	117

Table 57: No. of vehicles and operators needed

Downstream of the collection in the hypotheses formulated, the organic fraction is transported to the Municipal Collection Center or Ecological Hub and is transhipped, through a ramp, from vehicles 10mc to container. Therefore, in the strategies of organization of the service becomes decisive the availability of Ecological Hubs that allow to reduce the transfer times and increase those of collection.

Container	
Volume (tonn.)	25

Table 58 Weight Organic Capacity Container

	Quantity to transport	*n. vehicles*
Tuesday	368 t – 876 mc	15
Thursday	245 t – 584 mc	10
Saturday	245 t – 584 mc	10

Table 59: No. of vehicles required per Q to be transported

Therefore, considering that the transports carried out will be with carrabile trailer we get 15 transports on Tuesday and 10 on Thursday and Saturday. The number of transports by means of a mobile vehicle possible per shift is a function of the distance of the final plants from the collection area and the Ecological Hubs. Assuming at least 2 full daily towing transports (2 containers per transport) the minimum number of tow trucks required is N.8, taking into account the needs of reserve and maintenance can be assumed an increase of approx. 15% therefore estimating N.9 trucks

3.4.4.2.2 Glass

The glass is collected every 2 days per week (Monday, Friday). The weekly waste production is 245 tonnes, which distributed on the days of collection allows us to plan a service that provides for about 105 tons on Monday, 140 tons on Friday, the difference in tonnes over the various days is given by the days between the different collections, and in addition to the data already indicated, the density in tonnes per cubic metre of Glass is also shown in the following table:

Glass		
Production (t/weekly)	245	
Density (t/mc)	0.25	
Collected quantity (t/turn)	*Monday(prod. on 3 days)*	105
	Thursday (prod. on 4 days)	140

Table 60: Weekly glass production

The above-mentioned operations of collecting glass are carried out by means of 7-cubic-metre tanks which have the following characteristics.

10 mc Compactors	
Volume [mc]	7 mc
Compaction Coefficient	0
Volume after compaction [mc]	7 mc
Minimum Useful Flow Rate	1.750 kg

Table 61: Compactor characteristics

The number of trucks and teams has been dimensioned considering that in a working shift are collected quantities equal to 1.5 times volume of the vehicle as 2 collection tours are carried out. This assumption must, however, in the drafting of the executive project, take into account the road network, the distance of the collection area from the discharge point and the availability of ecological hubs for the transfer of waste.
Therefore, with reference to the weekly collection days, the quantities of glass to be intercepted and the capacity of the truck indicated above (7 mc), it is necessary to equip yourself with the following number of vehicles.

	Quantity to collect	***n. vehicles***
Monday	105 t – 420 mc	30
Friday	1040 t – 560 mc	40

Table 62: No. of means per Q to be collected

For each means used to collect the glass it is necessary to provide the presence of n.1 driver and n.1 operators involved in the collection, therefore, the number of personnel employed for each shift of collecting the glass is given in the following table.

	n. vehicles	***n. operators***
Monday	30	60
Friday	40	80

Table 63: No. of vehicles and operators needed

Downstream of the collection, the glass fraction is transported to the municipal collection center and transhipped, via a ramp, from 7-cubic-metre tanks to open-pit container.

Container	
Useful volume	25 mc

Table 64 Volume Glass Capacity Container

Downstream of the collection in the hypotheses formulated, the fraction glass is transported to the Municipal Collection Center or Ecological Hub and is transhipped, through a ramp, from 7 mc vehicles to container. Therefore, in the strategies of organization of the service becomes decisive the availability of Ecological Hubs that allow to reduce the transfer times and increase those of collection.

	Quantity to transport	***n. container***
Monday	105 t – 420 mc	8
Friday	1040 t – 560 mc	10

Table 65: No. of containers per Q to be transported

Therefore, considering transport carried out by trailer, we get 6 transports on Mondays and 4 on Thursdays. The number of transports by means of a mobile vehicle possible per shift is a function of the distance of the final plants from the collection area and the Ecological Hubs. Assuming at least 2 full daily towing transports (2 containers per transport) the minimum number of tow trucks required is N.5, Taking into account the needs of reserve and maintenance, it can be assumed that there will be an increase of approx. 15% and therefore N.6 mobile trucks are estimated.

3.4.4.2.3 Multi-material

The collection of the Multimaterial takes place with a frequency of 2 days per week (Monday, Friday). The weekly production of waste is equal to 735 tons, which distributed on the days of collection allows us to plan a service that provides for withdrawals by operators of about 315 tons on Monday, 420 tons on Friday, the difference in tonnes over the various days is given by the days between the different collections, and in addition to the data already indicated, the density in tonnes per cubic metre of the Multimateriale has also been reported in the following table:

Multimaterial	
Production (t/weekly)	735
Density (t/mc)	0.05

Collected quantity(t/turn)	*Monday (prod.on 3 days)*	315
	Friday (prod. on 4 days)	420

Table 66: Weekly multi-material production

The above mentioned operations of collection of the Multimateriale fraction are carried out by means of 10-cubic metre compactors having the following characteristics.

10 mc Compactors	
Volume [mc]	10
Compaction Coefficient	6
Compactable volume[mc]	60

Table 67: Compactor characteristics

Therefore, with reference to the weekly collection days, the quantities of Multimateriale to be intercepted and the capacity of the vehicle indicated (10 mc), it is necessary to equip yourself with the following number of vehicles.

	Quantity to collect	***n. vehicles***
Monday	315 t –6.304 mc	70
Friday	420 t – 8.405 mc	93

Table 68: No. of vehicles per Q to be collected

The number of trucks and teams has been dimensioned considering that in a working shift are collected quantities equal to 1.5 times volume of the vehicle as 2 collection tours are carried out. This assumption must, however, in the drafting of the executive project, take into account the road network, the distance of the collection area from the discharge point and the availability of ecological hubs for the transfer of waste.
For each means used it is necessary to foresee the presence of n.1 driver and n.2 collection operators, therefore, the number of personnel employed for each shift of collection of the multi-material fraction is given in the following table.

	n. vehicles	***n. operators***
Monday	315 t –6.304 mc	210
Friday	420 t – 8.405 mc	280

Table 69: No. of vehicles and operators required

After collection, for transport to treatment plants, the material is transferred for transhipment from 10-cubic meters to 35-cubic meters compactors located at the municipal collection center, it is essential to equip ourselves with suitable vehicles for transhipment between the 10 m2 and 35 m2 vehicles.

35 mc Compactors	
Volume [mc]	35
Compaction Coefficient	6
Compactable volume[mc]	192

Table 70: Compactor characteristics

	Quantity to transport	n. trasports
Monday	315 t –6.304 mc	30
Friday	420 t – 8.405 mc	40

Table 71: No. of transports per Q to be transported

Therefore, considering the transport carried out with a 35-cubic metre compactor we obtain 30 transports on Mondays and 40 on Fridays. The number of transports per possible means per shift is a function of the distance of the final plants from the collection area and the Ecological Hubs. Assuming at least 2 daily transports, the minimum number of compactors required is N.20. Taking into account the needs for reserve and maintenance, an increase of approx.

3.4.4.2.4 Dry residue (undifferentiated)

The collection of the residue takes place with a frequency of 2 days a week (Wednesday, Saturday). The weekly waste production is 613 tonnes, which distributed on the days of collection allows us to plan a service that provides for withdrawals by operators of about 350 tonnes on Wednesday, 263 tonnes on Saturday, in addition to the data already indicated, The density in tonnes per cubic metre of the residue is also given in the following table:

Dry residue		
Production (t/weekly)	613	
Density (t/mc)	0.065	
Collected quantity (t/turno)	Wednesday (prod. on 4 days)	350 t
	Saturday (prod. on 3 days)	263 t

Table 72: Weekly dry residue production

The above-mentioned operations of collection of the residue are carried out by means of compactors of 10 mc having the following characteristics.

10 mc Compactors	
Volume [mc]	10
Compaction Coefficient	6
Compactable volume[mc]	60

Table 73: Compactor characteristics

Therefore, with reference to the weekly collection days, the quantities of waste to be intercepted and the capacity of the vehicle indicated above (10 mc), it is necessary to equip yourself with the following number of vehicles.

	Quantity to collect	n. vehicles
Wednesday	350 t – 5.388 mc	45
Saturday	263 t – 4.041 mc	34

Table 74: No. of vehicles per Q to be collected

The number of trucks and teams has been dimensioned considering that in a working shift are collected quantities equal to 2 times volume of the vehicle as 2 collection rounds are carried out. This assumption must, however, when drafting the executive project, take into account the road network, the distance of the collection area from the discharge point and the availability of ecological hubs for the transfer of waste

For each vehicle used, it is necessary to provide the presence of n.1 driver and n.2 collection operators, therefore, the number of personnel employed for each shift of collection of the remaining fraction is shown in the following table.

	n. vehicles	*n. operators*
Wednesday	45	135
Saturday	34	101

Table 75: No. of vehicles and operators required

After collection, for transport to treatment plants, the material is transferred for transhipment from 10-cubic meters to 35-cubic meters compactors located at the municipal collection center, it is essential to equip ourselves with suitable lorries for transhipment between the 10-cubic metre and 35-cubic-metre vehicles.

35 mc Compactors	
Volume [mc]	35
Compaction Coefficient	6
Compactable volume[mc]	210

Table 76: Characteristics of compactor

	Quantity to transport	*n. transports*
Wednesday	350 t – 5.388 mc	26
Saturday	263 t – 4.041 mc	19

Table 77: No. of transports per Q to be transported

Therefore, considering the transport carried out with a 35-cubic metre compactor we obtain 26 transports on Wednesdays and 19 on Saturdays. The number of transports per possible means per shift is a function of the distance of the final plants from the collection area and the Ecological Hubs. Assuming at least 2 transports per day, the minimum number of compactors required is N.13. Taking into account the needs for reserves and maintenance, an increase of approx.

3.4.4.3 Summary of design

The following table summarizes the type and number of means required for the collection and transport of the different fractions of goods and the number of operators needed for the service.

	Type of Waste	*10 mc Compactors*	*7 mc tank*	*N. operators*	*35 mc Compactor*	*Transport Container*
Monday	***Multimaterial***	70		210	30	
	Glass		30	60		8

Tuesday	***Organic***	58		175		15
Wednesday	***Undifferentiated***	45		135	26	
Thursday	***Organic***	39		117		10
Friday	***Multimaterial***	93		280	40	
	Glass		40	80		10
Saturday	***Organic***	39		117		10
	Undifferentiated	37		135	19	
TOTAL		**93 (Maximum)**	**40 (Maximum)**	**360 (Maximum)**	**40 (Maximum)**	**15 (Maximum)**
Additional personnel		**Administrative**		**36**		
		Substitutions and supplementary services		**72**		
TOTAL PERSONNEL				**468**		

Table 78: Summary Collection Calendar Table

3.4.5 Dimensioning Zone 3 - Cingeltej + Songinohajrhan

In the table below, a possible harvest schedule is given for the chosen reference area and in particular for the area of Cingeltej + Songinohajrhan.

DAY	FRACTION
Monday	**Organic**
	Undifferentiated
Tuesday	**Multimaterial**
	Glass
Wednesday	**Organic**
Thursday	**Undifferentiated**
Friday	**Organic**
	Glass
Saturday	**Multimaterial**

Table 79: Household Utilities Collection Calendar - Cingeltej + Songinohajrhan

On the basis of the assumptions made above about the specific daily production and the product composition of the waste, the weekly quantities of material to be intercepted are reported for each product fraction and, depending on the frequency of collection, the volume and mass of material per shift.

District	Type Utilities	Production	Fractions	
Cingeltej/Songinohajrhan	*Domestic utilities*	*0,6362*	Organic, Glass, Multimaterial, Undifferentiated	

Table 80: Weekly material quantities

The recyclable dry materials are specified below in order to inform and clarify for the user what will be differentiated as recyclable for the further steps of the separate collection.

3.4.5.1 Type of service

The service that is expected to activate is the dry/ wet separation characterized by domestic separation of wet, glass, multi-material (plastic, paper and tinplate) and the Undifferentiated Dry Waste to be sent to the different treatment/recycling plants.

3.4.5.2 Volumes and Frequencies Collection

3.4.5.2.1 Organic fraction

The organic fraction is collected 3 days a week (Monday, Wednesday, Friday), the frequency of collection of this fraction is the highest as the organic fraction obviously has biological degradation processes with problems related to the production of percolates and malodorous gases (These phenomena are due to the initiation of anaerobic degradation in case of excessive time inside containers).
The weekly production of waste is equal to 735 tons, which distributed on the days of collection allows us to plan a service that provides for withdrawals by operators of about 315 tons on Monday, 210 tons on Wednesday and 210 tons on Friday, the difference in tonnes over the various days is given by the days between the different harvests, in addition to the data already indicated, the density in tonnes per cubic metre of staff has also been reported in the following table:

Organic		
Production (t/weekly)	732	
Density (t/mc)	0.42	
Collected quantity (t/turn)	*Monday(prod. on 3 days)*	315
	Wednesday (prod. on 2 days)	210
	Friday (prod. on 2 days)	210

Table 81: Weekly organic production

It is clarified that to size the resources required for collecting the organic waste fraction, once the expected quantity by weight has been established, the weight in volume is transformed using a characteristic mean parameter of the specific fraction called bulk density by making a simple ratio ie Weight in Tons/Bulk Density in mc per ton. Once the volume is determined, the number of trucks to be used is defined in relation to the volume of each (considering that the organic fraction is assumed as incompressible)

The above mentioned operations of collection of organic fraction are carried out by means of 10 mc compactors having the following characteristics.

10 mc Compactors	
Volume [mc] and (t)	10 mc
Compaction Coefficient	0
Volume after compaction [mc] and (t)	10 mc
Minimum Useful Flow Rate	4.200 kg

Table 82: Compactor characteristics

Therefore, with reference to the weekly collection days, the quantities of organic fraction to be intercepted and the capacity of the vehicle indicated above (10 mc), it is necessary to equip yourself with the following number of vehicles.

	Quantity to collect	*n. vehicles*
Monday	314 t – 747 mc	50
Wednesday	209t – 498 mc	33
Friday	209t – 498 mc	33

Table 83: No. of vehicles per Q to be collected

The number of trucks and teams has been dimensioned considering that in a working shift are collected quantities equal to 1.5 times volume of the vehicle as 2 collection tours are carried out. This assumption must however take into account in the drafting of the project, the road, the distance of the collection area from the point of discharge and the availability of ecological hubs for the transfer of waste.
For each means used to collect the organic fraction it is necessary to provide the presence of n.1 driver and n.2 operators involved in the collection, therefore, the number of personnel employed for each shift of collecting the organic fraction is shown in the following table.

	n. vehicles	*n. operators*
Monday	50	150
Wednesday	33	100
Friday	33	100

Table 84: No. of vehicles and operators needed

Downstream of the collection in the hypotheses formulated, the organic fraction is transported to the Municipal Collection Center or Ecological Hub and is transhipped, through a ramp, from vehicles 10mc to container. Therefore, in the strategies of organization of the service becomes decisive the availability of Ecological Hubs that allow to reduce the transfer times and increase those of collection.

Container	
Volume (tonn.)	25

Table 85 Weight Organic Capacity Container

	Quantity to transport	n. vehicles
Monday	314 t – 747 mc	13
Wednesday	209t – 498 mc	8
Friday	209t – 498 mc	8

Table 86: No. of vehicles per Q to be transported

Therefore, considering that the transports carried out will be with trailer carrabile we get 15 transports on Monday and 10 on Wednesday and Friday. The number of transports by means of a mobile vehicle possible per shift is a function of the distance of the final plants from the collection area and the Ecological Hubs. Assuming at least 2 full daily towing transports (2 containers per transport) the minimum number of tow trucks required is N.8, taking into account the needs of reserve and maintenance, it can be assumed that there will be an increase of approx. 15% and therefore estimate N.10

3.4.5.2.2 Glass

The glass is collected every 2 days per week (Tuesday, Friday). The weekly waste production is 210 tons, which distributed on the days of collection allows us to plan a service that provides for about 120 tons on Tuesday, 90 tons on Friday, the difference in tonnes over the various days is given by the days between the different collections, and in addition to the data already indicated, the density in tonnes per cubic metre of Glass is also shown in the following table:

Glass		
Production (t/weekly)	209	
Density (t/mc)	0.25	
Collected quantity (t/turn)	Tuesday (prod. on 4 days)	119
	Friday (prod. on 3 days)	90

Table 87: Weekly glass production

The above-mentioned operations of collecting glass are carried out by means of 7-cubic-metre tanks which have the following characteristics.

10 mc Compactors	
Volume [mc]	7 mc
Compaction Coefficient	0
Volume after compaction [mc]	7 mc
Minimum Useful Flow Rate	1.750 kg

Table 88: Compactor characteristics

The number of trucks and teams has been dimensioned considering that in a working shift are collected quantities equal to 1.5 times volume of the vehicle as 2 collection tours are carried out. This assumption must, however, in the drafting of the executive project, take into account the road

network, the distance of the collection area from the discharge point and the availability of ecological hubs for the transfer of waste.
Therefore, with reference to the weekly collection days, the quantities of glass to be intercepted and the capacity of the truck indicated above (7 mc), it is necessary to equip yourself with the following number of vehicles.

	Quantity to collect	*n. vehicles*
Tuesday	119 t – 478 mc	34
Friday	90t – 359 mc	26

Table 89: No. of vehicles per Q to be collected

For each means used to collect the glass it is necessary to provide the presence of n.1 driver and n.1 operators involved in the collection, therefore, the number of personnel employed for each shift of collecting the glass is given in the following table.

	n. vehicles	*n. operators*
Tuesday	34	68
Friday	26	52

Table 90: No. of vehicles and operators required

Downstream of the collection, the glass fraction is transported to the municipal collection center and transhipped, via a ramp, from 7-cubic-metre tanks to open-pit container.

Container	
Useful volume	25 mc

Table 91 Volume Glass Container Capacity

Downstream of the collection in the hypotheses formulated, the fraction glass is transported to the Municipal Collection Center or Ecological Hub and is transhipped, through a ramp, from 7 mc vehicles to container. Therefore, in the strategies of organization of the service becomes decisive the availability of Ecological Hubs that allow to reduce the transfer times and increase those of collection.

	Quantity to transport	*n. container*
Tuesday	120 t – 478 mc	9
Friday	90t – 359 mc	6

Table 92: No. of containers per Q to be transported

Therefore, considering the transport carried out by road trailer we get 9 transports on Tuesday and 6 on Friday. The number of transports by means of a mobile vehicle possible per shift is a function of the distance of the final plants from the collection area and the Ecological Hubs. Assuming at least 2 full daily towing transports (2 containers per transport) the minimum number of tow trucks required is N.5, Taking into account the needs of reserve and maintenance, it can be assumed that there will be an increase of approx. 15% and therefore N.6 mobile trucks are estimated.

3.4.5.2.3 Multi-material

The collection of the Multimaterial takes place with a frequency of 2 days a week (Tuesday, Saturday). The weekly waste production is 629 tonnes, which distributed on the days of collection allows us to plan a service that provides for about 270 tons on Tuesday, 359 tons on Saturday, the difference in tonnes over the various days is given by the days between the different collections, and in addition to the data already indicated, the density in tonnes per cubic metre of the Multimateriale has also been reported in the following table:

Multimaterial		
Production (t/weekly)	627	
Density (t/mc)	0.05	
Collected quantity (t/turn)	*Tuesday (prod. on 3 days)*	269
	Saturday (prod. on 4 days)	358

Table 93: Weekly multi-material production

The above mentioned operations of collection of the Multimateriale fraction are carried out by means of 10-cubic metre compactors having the following characteristics.

10 mc Compactors	
Volume [mc]	10
Compaction Coefficient	6
Compactable volume[mc]	60

Table 94: Compactor characteristics

Therefore, with reference to the weekly collection days, the quantities of Multimateriale to be intercepted and the capacity of the vehicle indicated above (10 mc), it is necessary to equip yourself with the following number of vehicles.

	Quantity to collect	***n. vehicles***
Tuesday	269 t –5.377 mc	60
Saturday	358 t – 7.169 mc	80

Table 95: No. of vehicles per Q to be collected

The number of trucks and teams has been dimensioned considering that in a working shift are collected quantities equal to 1.5 times volume of the vehicle as 2 collection tours are carried out. This assumption must, however, in the drafting of the executive project, take into account the road network, the distance of the collection area from the discharge point and the availability of ecological hubs for the transfer of waste.

For each means used it is necessary to foresee the presence of n.1 driver and n.2 collection operators, therefore, the number of personnel employed for each shift of collection of the multi-material fraction is given in the following table.

	n. vehicles	***n. operators***
Tuesday	60	180
Saturday	80	240

Table 96: No. of vehicles and operators needed

After collection, for transport to treatment plants, the material is transferred for transhipment from 10-cubic meters to 35-cubic meters compactors located at the municipal collection center, it is essential to equip ourselves with suitable vehicles for transhipment between the 10 m2 and 35 m2 vehicles.

35 mc Compactors	
Volume [mc]	35
Compaction Coefficient	6
Compactable volume [mc]	192

Table 97: Compactor characteristics

	Quantity to transport	***n. transports***
Tuesday	270 t – 5391 mc	28
Saturday	359t – 7189 mc	37

Table 98: No. of transports per Q to be transported

Therefore, considering the transport carried out with a 35-cubic metre compactor, we obtain 28 transports on Tuesdays and 37 on Saturdays. The number of transports per possible means per shift is a function of the distance of the final plants from the collection area and the Ecological Hubs. Assuming at least 2 transports per day, the minimum number of compactors required is N.19. Taking into account the needs for reserves and maintenance, an increase of approx.

3.4.5.2.4 Dry residue (undifferentiated)

The collection of the residue takes place with a frequency of 2 days a week (Monday, Thursday). The weekly waste production is 627 tonnes, which distributed over the days of collection allows us to plan a service that provides for the operators to take approximately 300 tonnes on Monday, 300 tonnes on Thursday, in addition to the data already indicated, The density in tonnes per cubic metre of the residue is also given in the following table:

Dry residue		
Production (t/weekly)	523	
Density (t/mc)	0.065	
Collected quantity (t/turn)	*Monday (prod.on 4 days)*	299 t
	Thursday (prod. on 3 days)	224 t

Table 99: Weekly dry residue production

The above-mentioned operations of collection of the residue are carried out by means of compactors of 10 mc having the following characteristics.

10 mc Compactors	
Volume [mc]	10

Compaction Coefficient	6
Compactable volume [mc]	60

Table 100: Compactor characteristics

Therefore, with reference to the weekly collection days, the quantities of waste to be intercepted and the capacity of the vehicle indicated above (10 mc), it is necessary to equip yourself with the following number of vehicles.

	Quantity to collect	***n. vehicles***
Monday	299 t – 4.595 mc	38
Thursday	224 t – 3.447 mc	29

Table 101: No. of vehicles per Q to be collected

The number of trucks and teams has been dimensioned considering that in a working shift are collected quantities equal to 2 times volume of the vehicle as 2 collection rounds are carried out. This assumption must, however, when drafting the executive project, take into account the road network, the distance of the collection area from the discharge point and the availability of ecological hubs for the transfer of waste
For each vehicle used, it is necessary to provide the presence of n.1 driver and n.2 collection operators, therefore, the number of personnel employed for each shift of collection of the remaining fraction is shown in the following table.

	n. vehicles	***n. operators***
Monday	38	114
Thursday	29	87

Table 102: No. of vehicles and operators required

After collection, for transport to treatment plants, the material is transferred for transhipment from 10-cubic meters to 35-cubic meters compactors located at the municipal collection center, it is essential to equip ourselves with suitable lorries for transhipment between the 10-cubic metre and 35-cubic-metre vehicles.

32 mc Compactors	
Volume [mc]	32
Compaction Coefficient	6
Compactable volume [mc]	192

Table 103: Compactor characteristics

	Quantity to transport	***n. transports***
Monday	299 t – 4.595 mc	24
Thursday	224 t – 3.447 mc	18

Table 104: No. of transports per Q to be transported

Therefore, considering the transport carried out with a 35-cubic metre compactor, we obtain 24 transports on Mondays and 18 on Thursdays. The number of transports per possible means per shift is a function of the distance of the final plants from the collection area and the Ecological Hubs.

Assuming at least 2 transports per day, the minimum number of compactors required is N.12. Taking into account the needs for reserves and maintenance, an increase of approx.

3.4.5.3 Expected production

After defining the production of waste, the analysis of products, the characteristics of domestic/non-domestic utilities, the equipment type is formulated to predict the interception of various fractions of goods.

<table>
<tr><td colspan="2"></td><td colspan="3"></td></tr>
<tr><td rowspan="3">Total Production</td><td rowspan="3">109028 t/year</td><td><u>Material</u></td><td><u>t/year</u></td><td><u>t/week</u></td></tr>
<tr><td>ORGANIC</td><td>38.160</td><td>734</td></tr>
<tr><td>GLASS</td><td>32.708</td><td>629</td></tr>
<tr><td colspan="2">% Collected</td><td>MULTIMATERIAL</td><td>10.903</td><td>209</td></tr>
<tr><td>Organic</td><td>35</td><td rowspan="3">Tot. Differentiated</td><td rowspan="3">81.771</td><td rowspan="3">1.572</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
</table>

Table 105: Waste Expected Production

All collection operations carried out by the above-mentioned personnel and vehicles end with the transport of the material to equipped collection areas called Collection centers where, through transhipment, the waste is deposited in larger volumes and/or Open-air container containers for subsequent transport to treatment and disposal facilities.

3.4.5.4 Staff employed

Commodity Fraction	***Quantity per round collected** (kg)*	***Employee capacity** (kg/h/employee)max*	***n. collection hours***	***n. operators***
Organic	314.000	250	1258	199
Glass	119.000	150	799	126
Multimaterial	269.000	200	1350	213
Dry fraction	299.000	250	1198	189

Table 106: Staff employed

The following tables show the number of means needed to collect the different fractions and the number of operators to be employed in the service increased compared to the previous calculations of the rate of "Additional Operators" to take account of the contemporaneity of the collection of certain fractions of products.

<table>
<tr><td colspan="5">HOUSEHOLDS</td><td></td></tr>
<tr><td></td><td>Organic</td><td>Multimaterial</td><td>Glass</td><td>Residue</td><td>TOTAL a day</td></tr>
<tr><td>Monday</td><td>1258</td><td></td><td></td><td>1198</td><td>2456</td></tr>
</table>

Tuesday		*1350*	799		2149
Wednesday	1258				1258
Thursday			799	1198	1198
Friday	1258				2057
Saturday		*1350*			1350
			Total Hours per week		10468
Sizing Operators for collection (minimum)					
h/week	10468				
h/year	545786				
days/year	86222				
n. operators	**332**				
Sizing Means for collection (7/10 mc)					
h/week	10468				
h/year	545786				
days/year	86222				
n. vehicles	**288**				

Table 107: Cingeltej + Songinohajrhan - Number of Harvest Hours

	Organic	*Multimaterial*	*Glass*	*Residue*	***TOTAL per day***
Monday	199			189	388
Tuesday		*213*	126		339
Wednesday	199				199
Thursday			126	189	189
Friday	199				325
Saturday		*231*			213

Table 108: Cingeltej + Songinohajrhan - Verification Daily Employment of Harvesting Operators

It is therefore required a commitment of additional 56 operators compared to those of the project on Monday and 7 operators on Tuesday

3.4.1.9 Collection center

The dimensioning of the collection center and the determination of the number of compactors 4 axes, the mobile trucks and open-top mobile containers required for the transport of materials from separate collection to treatment and recovery plants were carried out on the basis of data relating to the weekly production of different waste streams, Assuming that the same are transported to the installations according to a weekly frequency equal to that of collection. The table shows for the district of Cingeltej and Songinohajrhanthe number of planned collection centers, the quantities to be stored weekly and the number of waste containers/bins needed.

District	***n. Collecti***	***Commodity Fractions***	***Maximum quantity***	***n. compactors/bins per collection center***

	on Centers		(t./shift harvest)	
Cingeltej	***2***	*Organic*	49	6
		Glass	19	4
		Multimaterial	56	4
		Dry fraction	47	4
Songinohajrhan	***4***	*Organic*	54	6
		Glass	20	4
		Multimaterial	61	5
		Dry fraction	51	4

Table 109: Quantities per Collection Centre

Cingeltej					
Fraction	***ton/week***	***Vehicles***	***Capacity [ton]***	***n. trips/week***	***n. trips/year***
Organic	115	Container (N.4)	12,5	5*	260
Glass	33	Container (N.4)	7,5	2*	102
Multimaterial	98	4 Assi	9,6	10	521
Residue	82	4 Assi	13,5	6	313

Table 110: Plant Transport Dimensioning - Cingeltej per Collection Point

Songinohajrhan					
Fraction	***ton/week***	***Vehicles***	***Capacity [ton]***	***n. trips/week***	***n. trips/year***
Organic	126	Container (N.4)	12,5	5*	260
Glass	36	Container (N.4)	7,5	3*	156
Multimaterial	108	4 Axes	9,6	11	572
Residue	90	4 Axes	13,5	7	364

Table 111: Equipment transport dimensioning -Songinohajrhan per Collection Point

*Note: *Trasports truck with trailer*

It is necessary to identify delivery platforms for each material collected and define the transport times/capacity/costs.
The materials correctly stored at the Collection center are transported directly to the treatment and disposal plants located in the territory.
The dimensioning of the transport service to the installations was carried out by providing the following types of means:
Mobile trailer + open-pit container for organic fraction (from 30 mc) - total capacity 12.5 + 12.5 ton = 25 ton

Mobile truck + open-top container for glass fraction (from 30 mc) - total capacity 7.5 + 7.5 ton = 15 ton
Compactor 4 Axes for transport Dry fraction - Capacity 13,5 ton
Compactor 4 Axes for transport Multimaterial Fraction - Capacity 9,6 ton

3.4.5.5 Summary of design

The following table summarizes the type and number of means required for the collection and transport of the different fractions of goods and the number of operators needed for the service.

	Type Waste	*10 mc Compactor*	*7 mc tank*	*N. operators*	*32 mc Compactor*	*Transport Container*
Monday	***Organic***	50		150		13
	Undifferentiated	38		114	24	
Tuesday	***Multimaterial***	60		180	28	
	Glass		34	68		9
Wednesday	***Organic***	33		99		8
Thursday	***Undifferentiated***	38		114	18	
Friday	***Organic***	33		99		8
	Glass		26	52		6
Saturday	***Multimaterial***	80		264	37	
TOTALI		**80 (Maximum)**	**34 (Maximum)**	**264 (maximum)**	**37 (Maximum)**	**13 (Maximum)**
Additional personnel		**Administrative**		**27**		
		Substitutions and supplementary services		**54**		
TOTAL PERSONNEL				**345**		

Table 112: Summary Collection Calendar Table

3.5 Plant configurations

As described in the previous chapter, based on the 3 scenarios, an analysis of the plant necessary for the treatment and disposal of waste was carried out, as well as a possible energy production from recyclable waste.
Below is a summary table in which, for each type of plant, the minimum value required for the sizing of the plant has been indicated.

	SCENARIO 1 - RD 50%	SCENARIO 2 - RD 60%	SCENARIO 3 - RD 70%

Plants	Required capacity (t/year)	Required capacity (t/year)	Required capacity (t/year)
Composting Plant	104.784,74	114.310,62	123.836,51
Mechanical Biological Treatment (MBT)	238.147,13	190.517,70	142.888,28
Glass recovery plant	33.340,60	47.629,43	57.155,31
Plastic and paper recovery plant	61.918,25	80.970,02	100.021,79
Ash recovery plant	15.241,42	12.193,13	9.144,85
Landfill plant	47.629,43	38.103,54	28.577,66
Waste-to-energy plant	71.444,14	57.155,31	42.866,48

Table 113: Plant dimensioning

The individual plants planned within the overall plan are described below.

3.5.1 Landfill

The controlled landfill is a place where solid urban waste and all waste from human activities (construction debris, industrial waste, etc.) that has not been recycled or could not be recycled are deposited and disposed of in an unselected manner, Send to mechanical-biological treatment, gasify or use as fuel in waste-to-energy plants.
Each waste must be placed in suitable landfills which, according to the EU directives, can be of three different types:

- Landfill for inert waste (demolition waste, construction, excavation)
- Landfill for non-hazardous waste (including municipal solid waste)
- Hazardous waste landfill (including ash and waste from incinerators)

Waste must be treated using a number of measures to ensure maximum protection of the environment and public health. In particular, the protection of all environmental "matrices" that may be affected by the presence of the landfill: groundwater, soil around the facility and outside air must be ensured.
The following precautions should be taken, as required by current legislation:
Create a protective barrier at the bottom of the landfill and on the side walls to prevent any sewage from entering the landfill (so-called leachate, that is, the liquid formed by the contact of rainwater with the waste deposited) may move into the surrounding soil and slowly reach the aquifers, with the risks that could result in terms of pollution;
To set up suitable installations for the recovery of biogas produced in landfills, to prevent it from being released into the atmosphere with the consequent negative impacts;
cover the daily waste that is deposited in landfills and stored following the precautions established by law (so-called "storage" phase), with the aim of guaranteeing the best hygienic and sanitary conditions for the management of the plant;
To create, at the end of the "useful life" of the landfill, a suitable cover that allows a perfect "disconnection" with the outside, in order to avoid any contact between the waste contained inside and the environmental matrices of the territory.
Other problems to be faced in the construction of a landfill are the stability and settlement conditions of the waste body, the stability problems of the ground, slopes and containment structures (embankments) and the final disposal and recovery of the landfill site.
In general, depending on the geomorphological and hydrogeological characteristics of the site chosen, three types of landfill are basically realized:

- Sunken landfills: they are made for filling old disused quarries or "pits" dug into the ground;

- Landfills in the field: they are located at the level of the countryside and develop in height;
- Slope landfills: they are built close to slopes, for filling open gaps along the sides due to caves, calanchive or impluvi areas.

The following is a schematic representation of the different types of possible landfills:
(a) landfill in the valley; (b) landfill in the field; (c) landfill on the slope.

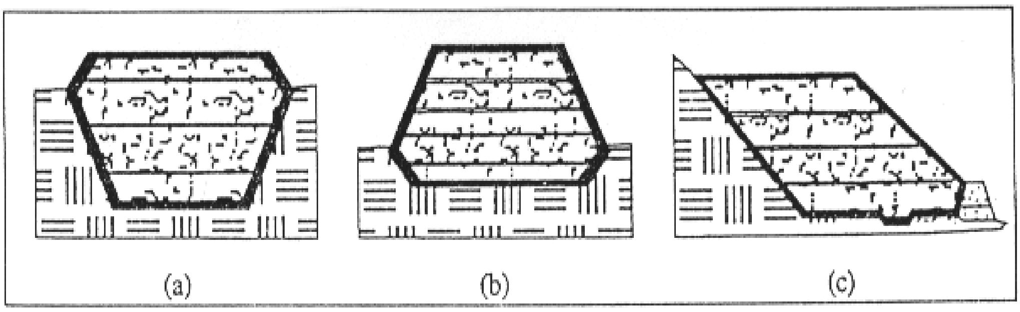


Figure 43: Landfill types

Design of a controlled landfill

The criteria for constructing a controlled landfill must ensure that the flow of pollutants to the external environment is limited by means of waterproofing barriers, drainage systems for leachate and biogas collection wells.

To fulfil its task effectively, namely limiting harmful emissions and not becoming a source of pollution for soil, air or the hydrosphere, a landfill must be properly designed and in accordance with all relevant legal provisions.

Modern landfills must be built with a geological barrier structure to isolate waste from the ground, comply with hygiene standards and the biosphere, reuse biogas produced as fuel for energy generation.

The structure is generally of the "underground storage" type, consisting from bottom to top as follows:

- Foundation ground and landfill background;
- a waterproofing barrier on the bottom and sides made of geomembranes to prevent leachate from leaching;
- a leachate drainage system;
- the storage of waste in compacted layers;
- the covers between the layers;
- a system for the capture of biogas;
- the final cover with plants.

It is important that the wet fraction of the waste is collected separately or that the waste is composted and/or treated mechanically and biologically before being placed in landfills (these processes allow 100% of the methane to be recovered as they take place in closed reactors).

For example, from a landfill of about 1,000,000 cubic meters that grows by 60,000 m3 each year (equivalent to about 51,000 t/year), almost 5.5 million cubic meters of biogas can be extracted per year (over 600 m3 per hour).

A controlled landfill of municipal or special waste, whether hazardous or non-hazardous, managed according to the regulatory requirements does not cause environmental problems and can be considered an industrial facility like any other, although with specific criticalities.

Management of a controlled landfill

The design of a landfill is important, but so is its management.

Each landfill is designed to receive certain types of waste (inert, non-hazardous or dangerous) and therefore, unless subsequently modified, it should only receive that type of waste.

Each landfill is designed to accommodate a certain volume of waste and therefore has a limited life span which can be extended but not indefinitely.

Waste treatment and disposal procedures must also be carried out in such a way as not to jeopardise the safety of those working there or to encourage pollution.

The environmental pollution associated with a well-controlled and managed landfill can be significantly reduced (including greenhouse gases), as well as by implementing appropriate preselection of the material to be delivered, Exploiting the use of compostable fraction for the production of biogas and agricultural soil improver.

There are, however, disadvantages such as the defacing of the landscape and the need to monitor the area for a certain period of time after the cessation of activity, in addition to the occupation of the land, which becomes unusable for other purposes after the disposal of the landfill, Which can also be turned into a green area.

The processes of decomposition of organic substances by anaerobic bacteria in landfills lead to the production of leachate and biogas, whose diffusion into the surrounding environment would cause pollution of soil, surface water, groundwater and air.

The landfill must therefore be constantly monitored at all stages of its life, from construction to management after closure. All controls are carried out following a monitoring and control plan which includes a set of parameters to be measured through equal sampling and analysis systems for all so that there is no discrepancy between the data.

Monitoring shall be carried out on:

- groundwater;
- Storm water flowing through the landfill;
- Leachate from waste in the process of deterioration;
- Landfill gas emissions and air quality in the vicinity of the landfill;
- Landfill sites for asbestos-containing waste;
- Climatic weather parameters of the area where the landfill is located;
- Morphology of the landfill.

The extraction of groundwater is possible thanks to certain piezometric wells upstream and downstream of the landfill sites. Monitoring groundwater can reveal any damage to the geomembranes that would result in leachate leaching and consequent pollution of the soil and water below the site.

Another problem is rainwater that washes the landfill and may also contain leachate. This water could end up in streams near the landfill if not collected. An in-depth analysis of the leachate from waste may reveal the presence within the landfill of non-landfilled waste (e.g. hazardous waste in a landfill).

A control of the gases emitted, mainly methane (CH_4) and carbon dioxide (CO_2), can be useful to detect any leaking of the biogas produced as a result of breaks in the gas collection system. The leakage of biogas could cause inconveniences if there were houses near the landfill.

For asbestos-containing landfills, the measurement of airborne asbestos fibres is crucial for well-known problems compared to asbestos inhalation.

A landfill should be built in areas that are not too wet and not too dry depending on the type of waste it contains. Monitoring the morphology of the landfill allows to follow over time the structural deformation of the landfill which occurs slowly with the deterioration of the waste and, therefore, with its decrease in volume. The land on which a landfill is built must be solid, not located in flood plains and the area must not be strongly seismic. Sites built in highly seismic areas could be subject to rupture of geomembranes and leachate and biogas capture systems.

3.5.2 TMB - Mechanical Biological Treatment Plant

The TMB plant for mechanical and biological treatment of mixed dry waste is a solid municipal waste treatment plant. The plant treats municipal solid waste as such.

The production process starts from the reception section, which includes the selection phase of bulky waste, WEEE, tyres, textiles, wood and other types with storage in waste bins and start to the

subsequent recovery phases. The receiving section then presents the pit for the discharge of mixed waste and the system for collecting it by crane and feeding the shredders.
Then, within the municipal waste sorting section, municipal waste is shredded and conveyor belts are divided into lines that carry the waste, after passing through a primary sieve, to a secondary sieve, a magnetic separator and the subsequent stages of storage of the organic fraction, of the selection of plastics and to the pressing and packaging section of the bales of the dry fraction of urban waste.
In the stabilization section, both main and secondary, placed in series, the wet fraction tritovagliata (FUT), is stored for subsequent refining and preparation to soil-improving for agriculture.
Therefore, the process is aimed at recovering the following product fractions:

- bulky materials, WEEE, tyres, textiles, wood and other types to be sent for recovery or disposal (receiving section);
- ferrous and non-ferrous metals to be fed into the secondary raw material circuit (sorting section);
- Recovered plastic polymers (screening section);
- a stabilized and refined organic fraction to be used as an organic soil improver (stabilization section and refining section);
- a dry fraction of urban waste packaged in bales (Other waste - including mixed materials - produced by mechanical waste treatment), to be used for subsequent energy recovery processes and/or to be disposed of in landfills (sorting section and pressing and packing section).

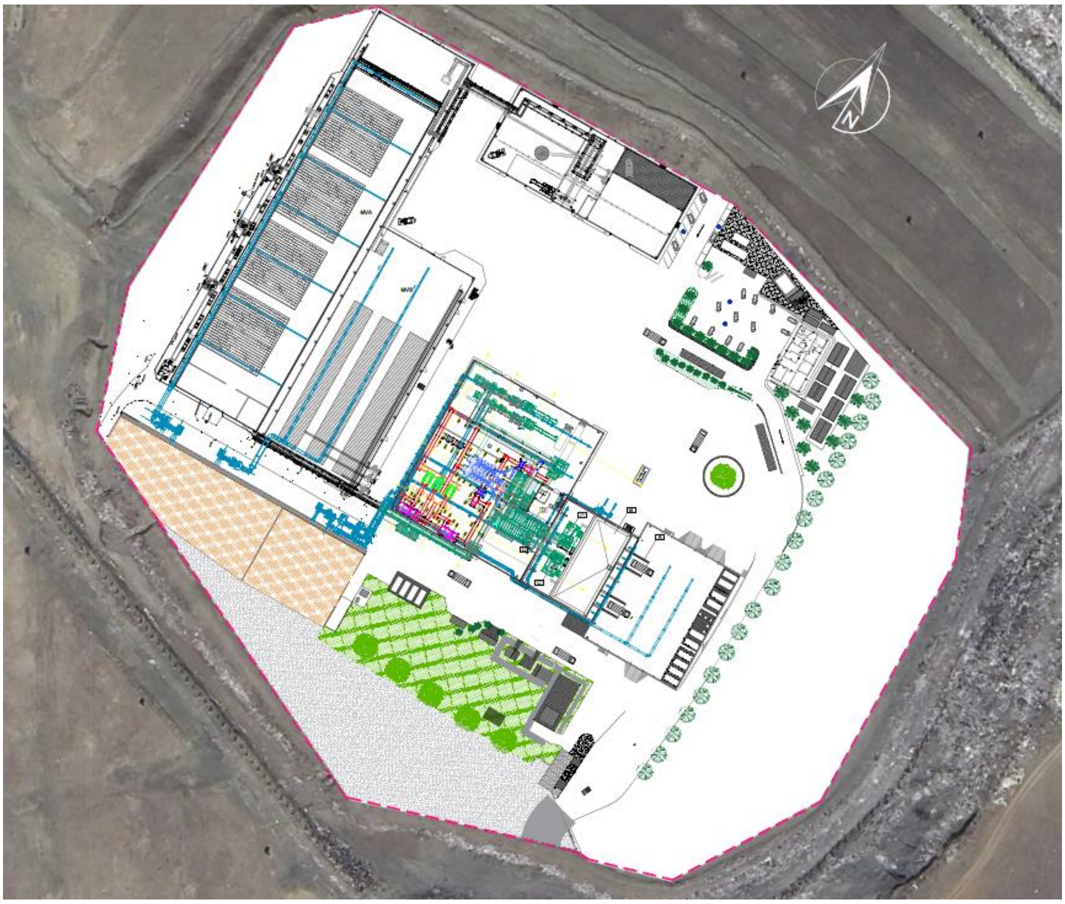


Figure 44: General project plan

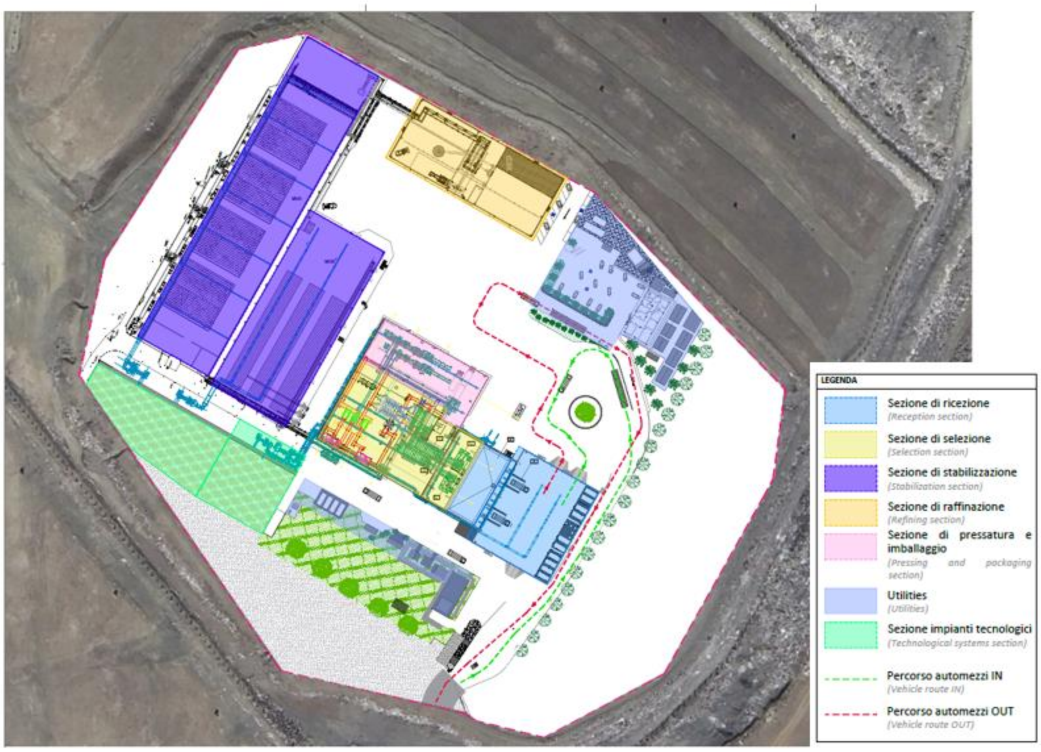


Figure 45: Project layout plan

The plant will be divided into two treatment lines. Each of the two lines has an hourly treatment capacity of about 25 t/h and an annual treatment capacity of about 250,000 t/year.
The plant as a whole consists of the following sections:
reception section
selection section;
stabilisation section;
refining section;
pressing and packaging section;
utilities section;
technological plants section.
The plant occupies an area of approximately 50,000 square metres and the production process is described below.
The plant mainly performs material recovery, stabilisation of the organic fraction present in residual municipal solid waste, and preparation of residual waste for energy recovery, managing to process an annual input of 250,000 tonnes/year.
The process starts from the reception section, which includes the reception hall, the waste discharge pit, the overhead crane collection system and the feeding of the shredding lines. Subsequently, within the sorting section, the municipal waste is shredded and the conveyor belt lines that take the waste, after passing through a primary screen, a secondary screen and a magnetic separator, to the

subsequent stages of sorting the plastics and maturing the organic fraction or producing bales of the dry fraction of municipal waste.

The shredded wet fraction is sent to aerobic stabilisation after which the material is sent to the refining section.

The process involves the production of the following product fractions:

- bulky materials, WEEE, tyres, textiles, wood and other types to be sent for recovery or disposal (reception section);
- ferrous and non-ferrous metals to be fed into the secondary raw materials circuit (sorting section);
- recovered plastic polymers (sorting section);
- a stabilised and refined organic fraction to be used as an organic soil improver (stabilisation section and refining section);
- a baled dry fraction of municipal waste (Other waste - including mixed materials - produced by mechanical waste treatment), to be used for subsequent energy recovery processes and/or to be disposed of in landfills (sorting section and baling and packaging section).

The plant has a capacity to treat approximately 250,000 t/y of municipal solid waste.

This capacity, divided by the approximately 313 working days per year, corresponds to 800 t/y (250,000 t/y / 313 days = 800 t/y). this quantity is processed over 16 working hours, from which it follows that the average hourly capacity of the plant is approximately 50 t/h.

The vehicles entering the plant will first undergo a weighing and visual merchandise control phase aimed at verifying their homogeneity and quality requirements, with particular reference to the presence of non-biodegradable fractions. They will then be preliminarily checked at the weighing station where, at the outcome of the check, three different alternatives are possible for the incoming load:

- Compliant: the load is allowed to be unloaded inside the shed at the unloading bush;
- Uncertain: in the event that the admissibility of the load is doubtful, further investigations are carried out, including the turning of the volume, to verify its admissibility to the plant;
- Non-compliant: if an excessive amount of waste is found to be unacceptable because it is a non-biodegradable fraction, the vehicle will be immediately removed for disposal at authorised plants.

After the regularity check, the waste will be recorded using the weighing system.

Afterwards, the vehicles will be directed to the transfer areas.

The plant will be divided into two treatment lines. Each of the two lines has an hourly treatment capacity of approximately 25 t/h.

The process consists of the following stages

RECEPTION SECTION

1. acceptance of incoming waste
2. radiometric detection, aimed at detecting the possible presence of radioactive waste;
3. storage and separation of bulky waste, WEEE, tyres, textiles, wood and other types of waste for recovery or disposal;
4. disposal of residual waste in the pit;
5. loading of waste into the shredding section by means of 2 polypropylene buckets equipped with loading cells for counting waste entering the line.

The incoming waste transport vehicles unload the waste into an underground concrete pit with the following dimensions:

- Depth: 8 m;
- Plan dimensions: 15 x 36 m.
- Maximum storable capacity: 4,000 cubic metres.

It should be noted that this receiving pit technically acts as a 'lung' for the waste entering the TMB plant. In fact, the surplus waste, i.e. the difference between the plant's treatment capacity and the waste entering the plant, will be temporarily stored there.

The maximum quantity that can be stored in the pit is 1,333 tonnes. Considering a density of approximately 300 kg/m3 , this results in a maximum storage volume of 4,000 m3.

SORTING SECTION

1. **Waste shredding**, aimed at carrying out the following activities:

- **coarse shredding of incoming waste**, aimed at opening the bags containing the waste and obtaining material of optimal size for subsequent treatment;
- **primary screening of the waste**, carried out using rotating drum screens with a mesh size of 120 mm, sized for a dwell time sufficient to ensure separation of the material into two streams

-primary over screen (fraction above the diameter of the screen holes)

-primary under screen (fraction passing through the screen holes).

The primary oversize is mainly made up of light product fractions (paper, plastic, wood, etc.) with a high calorific value and is therefore sent to the production of the dry shredded fraction. The primary under screening, on the other hand, consists mainly of organic parts and inert material and is sent for secondary screening;

1. **Magnetic deferrialisation**, with recovery of ferrous materials;
2. **ECS eddy current separation**, with recovery of non-ferrous materials;
3. **Sorting and manual separation** of plastic waste, tyres and waste materials not suitable for processing into a shredded dry fraction;
4. **Sorting plastic polymers**. The objective to be pursued is the creation of a refining and sorting line for the dry fraction of waste delivered to the plant, aimed at obtaining the valorisation of the fractions of economic interest present in the waste, i.e. plastics of various polymers, otherwise destined for landfills, such as PVC, HDPE, LDPE, PET and PP, to be sent to the subsequent material recovery phases.

STABILISATION AND REFINING SECTION

The primary under screen is essentially made up of organic parts and inert material. It undergoes secondary screening by means of rotating drum screens with a mesh size of 50 mm, which in turn subdivides the flow into an overflow and secondary underflow. The secondary over screen, after deferrialisation with recovery of ferrous and non-ferrous materials, is sent to the sorting section where, similarly to the shredded dry fraction produced by the primary screening, it may be pressed or not before loading or sent to the pressing and packaging section. The secondary under screening undergoes deferrialisation in its entirety, producing a wet fraction and is then destined for stabilisation and refining.

The stabilisation operations of the wet fraction essentially consist of the degradation of the organic matter under aerobic conditions. This phase will be conducted within the stabilisation section, which is made up of two areas: the MVS area (semi-automatic turner machine) and the MVA area (automatic turner machine).

The oxidation of the organic fraction transforms the raw organic material into a stabilised, low moisture, non-putrescible, shredded wet fraction. The process lasts 21 consecutive days and is operated using the dynamic heap method, under controlled conditions of oxygenation, temperature and humidity, with forced ventilation. The output product is a stabilised comminuted wet fraction.

The resulting stabilised comminuted wet fraction is sent to the refining section, which is operated by means of a rotating drum sieve with a mesh size of 25 mm capable of separating the fine fraction, smaller than 25 mm, and the oversize, larger than 25 mm. The latter, containing cellulosic and plastic materials, is processed into a shredded dry fraction, while the under screen constitutes the stabilised end product (stabilised and refined shredded wet fraction), to be used as an agricultural soil conditioner.

PRESSING AND PACKAGING SECTION

1. **pressing and packaging** of the recovered shredded dry fraction. In fact, this fraction can be loaded for the subsequent transport phases for energy recovery and/or landfill disposal in bulk form or coated and packaged with plastic film, so that it can be stored outdoors, if necessary, before being sent to the next phases

UTILITIES SECTION

Within the plant, areas have been identified to be dedicated to utilities, i.e. the management, administrative, operational, logistical and maintenance part of the plant. In these areas will be located

1. **Personnel office, weighing office and employee services;**
2. **Material depot;**
3. **Workshop;**
4. **Other services.**

TECHNOLOGICAL INSTALLATIONS SECTION

The technological installations section will concern those installations aimed at reducing air and water pollution and improving the visual impact. Specifically, the following will be built:

1. **Exhaust air treatment plant consisting of a scrubber - biofilter system**
2. **Water treatment plant**
3. **Perimeter screening plant and air misting plant.**

The following types of waste are not allowed, by way of example and not exhaustively, and are discarded if they are detected within the load delivered

- batteries;
- tyres;
- radioactive waste;
- flammable waste;
- explosive waste;
- bulky waste;
- etc.

The staff, already at the entrance, is careful to identify these types and ready to eliminate any non-compliant waste. In order to detect the possible presence of radioactive waste among the MSW, each vehicle entering the STIR is checked by means of a radiometric portal, located at the STIR entrance. If

radioactive waste is found to be present, a procedure followed by a qualified expert in radioactive emergency management is activated.
Below is a summary table of the waste managed within the TMB mechanical-biological treatment plant.

Waste		Production process / Production phase	Quantity ton/year
Denomination	Type		
Undifferentiated waste	Input		250.000,00
Bulky waste, WEEE, wood, textiles and other recovered materials	Output	Reception	30.000,00
Ferrous and non-ferrous materials	Output	Selection	5.000,00
Non-ferrous materials	Output	Selection	3.000,00
Leachate	Output	Stabilisation - Refining	3.000,00
Shredded dry fraction	Output	Selection - Screening (over screen)	80.000,00
Plastic polymers	Output	Selection	60.000,00
Grinded and Sieved Organic Fraction	Intermediate Product	Selection - Screening (over screen)	72.000,00
Grinded and Sieved Organic Fraction Stabilized	Intermediate Product	Stabilisation	65.000,00
Grinded and Sieved Organic Fraction Stabilized after Composting	Output	Refining	60.000,00

Table 114: Waste managed by the TMB plant

Figure 46 MBT Plant Rendering

3.5.3 Waste-to-energy

The waste-to-energy plant will have a treatment capacity of 300,000 tonnes/year of undifferentiated municipal solid waste (MSW) and will have a maximum total thermal load of 125 MWt.
The quality of atmospheric emissions of the proposed plant will guarantee compliance with and improvement over the limits defined by the best available technologies.
It will be built using the best available technologies in order to maximise its energy efficiency and minimise its impact on the environment, with emission parameters at or below the lower limits of the best available technologies.
The plant consists of two furnace-boiler lines (air-cooled moving grate technology) with respective semi-dry type flue gas lines (dry reactor with hydrated lime and activated carbons, bag filter, washing tower with injection of activated carbons and NaOH, DeNOx SCR) and a single thermal cycle with condensing steam turbogroup and spillage, prepared for cogeneration set-up (civil district heating and industrial cogeneration).

The choice of the semi-dry type line makes it possible to

- Maximize the abatement of concentrations of organic and inorganic micropollutants;
- Obtain treatment residues that can be inertised at dedicated external plants, with greater market alternatives than would be the case if other flue gas treatment technologies using the sodium bicarbonate reagent were used (in the latter case, fewer mature inertisation technologies are available for residual sodium products characterised by high solubility);
- Not be affected by a restricted market over the convention period for the reagents used, which would be the case if the flue gas line with use of sodium bicarbonate had been chosen, mitigating the risk of an increase in operating costs.

The plant has also been designed to guarantee the lowest possible water consumption, intervening in the process through various optimisations and recoveries.
Optimisation and recovery are pursued through the internal recovery of process purges and the partial condensation of water vapour in the flue gas.
The additional demand for water resources will also be met by resorting to the following alternatives listed in order of priority of use

- recovery of rainwater
- reuse of purified water;
- recourse to external sources.

The aforementioned water balance solves the needs of the plant hub, waste-to-energy and ancillary plants.

- waste handling (pit, pit);
- thermal treatment (grate, combustion furnace and steam generator for thermal

thermal recovery);

- flue gas treatment (pollutant abatement systems and stack);
- heat utilisation (thermal cycle, turbine, condenser);
- slag treatment;
- experimental district (CO2 capture and storage);
- water management;
- civil and industrial district heating;
- photovoltaic plant;
- other auxiliaries.

The main parameters of the waste-to-energy plant are summarised below:

- Reference environmental conditions: -5 °C / 40 °C; Ur: ≤ 90%; Altitude: +122 m above sea level;
- Maximum thermal load: 125 MWt;

- the plant line, designed to operate for a limited number of hours per day in overload up to a value of approximately 60 MWt. The overload condition is always foreseen in the design of this type of plant in order to be able to handle fluctuations in the calorific value of the incoming waste;
- Range of the PCI of the incoming waste: 8,000 - 14,235 kJ/kg (with a guarantee of maximum thermal load in the range of 9,000-14,235 kJ/kg); this range is better than the one indicated as a reference for the calculation of the nominal capacity and the nominal thermal load of the plant; in this way it is possible to manage at maximum thermal load waste even with lower PCI, guaranteeing maximum plant flexibility;
- Combustion diagram developed with a wide operating range without the need to use auxiliary fuel and with a minimum thermal load per line of approx. 60% of the maximum thermal load;
- Use of natural gas as auxiliary fuel to manage plant start-ups and shut-downs and in the event of the need to sustain combustion; this choice was considered environmentally sustainable compared to the use of diesel fuel; this natural gas is managed by 2 burners per incineration line;
- Storage capacity of the waste pit: approx. 25,000 cubic metres which, considering an average density over the storage height of 350 kg/m3 is equivalent to approx. 8. 500 t; this capacity can be reached either by using a raised forebay (+ 6.5 m) with respect to the zero height, which makes it possible to increase the useful volume of the pit without having to resort to excessive excavation depths, or by designing the internal walls of the waste pit facing the loading hoppers so that the waste can be accumulated in support of the hoppers if necessary, above the level at which the vehicles are unloaded;
- Waste unloading in a controlled vacuum environment (forebay) to contain the potential odorous and acoustic impact during unloading of waste from vehicles into the pit;
- Inclusion in the project of an environmental safety garrison for waste storage capable of treating the air in emergency situations of unavailability of both lines, as provided for by the best available techniques for the management of potential odours (deodorisation plant);
- Inclusion in the project of a radiometric control facility for incoming waste and related quarantine areas for subsequent control in accordance with management procedures;
- Air-cooled grid divided into sectors and zones with the possibility of differentiated combustion air regulation for the different grid sectors;
- Steam generator with 3 vertical radiant channels, horizontal convection and vertical tailpipe economisers, with flue gas outlet temperature of approx. 160 °C to maximise boiler efficiency;
- Use of high-quality materials for the sections of the steam generator most subjected to the aggression of the combustion fumes, in order to increase the reliability of the system;
- Unified thermal cycle for the two lines with high-performance air-cooled condenser (ACC) 0.1 bar(a) at 25°C;
- Sizing for 100% bypass operation of the steam turbine in order to guarantee continuity of operation of the waste combustion even in the event of turbine failure;
- Gross electric power at alternator terminals in fully electric operation (full condensation): approx. 40 MWe;
- Dedicated spillage from the turbine for industrial cogeneration: 10 MWt (in addition to spillage for civil cogeneration up to 1 MWt);
- Electrical power absorbed by auxiliaries of the waste-to-energy plant (excluding ancillary plants for slag treatment, district heating, CO2 capture and treatment): approx. 4.5 MWe;
- Gross electrical efficiency of the waste-to-energy plant: approx. 32%;
- Expected operation: 8,200 hours/year per line (guaranteed for the entire operating life of the waste-to-energy plant: 8,000 hours/year);
- Flue gas line consists of: semi-dry section (dry reactor with hydrated lime and activated carbons, bag filter), wet scrubber with injection of activated carbons and NaOH in aqueous

solution, DeNOx SCR; the flue gas line is able to guarantee the following parameters on emissions, less than or equal to the BAT minimum value, except for CO equal to the central value of the best available techniques (CO control is carried out only through combustion optimisation and there is no dedicated abatement device in the flue gas line)

Pollutants	Average daily values (mg/m³)(1)(2)	RANGE BAT- Daily average values expressed (mg/m^3)	Average values over 30 minutes expressed in (mg/m^3) (100%)A(3)	(97%)B(4)
Total dusts	1	<2 - 5	16	6
Organic substances in the form of gases or vapours expressed as TOC	3	<3 - 10	18	9
Hydrochloric acid (as HCl)	2	<2 - 6	50	8
Fluoridic acid (HF)	<1	<1	4	2
Sulphur dioxide (SO_2)	5	5 -30	180	40
Nitrogen oxides (NO_x) expressed as NO_2	40	50 - 120	150	100
Ammonia (NH_3)	2	2 - 10	30	10

Table 115 Emission Standard Value 1- Plant – Waste to Energy

Pollutants	Average values over the sampling period expressed in (mg/Nm3) - dry fumes 11% O2	RANGE BAT- Average values over the sampling period expressed in (mg/Nm3) - dry fumes 11% O2
Cadmium and its compounds expressed as cadmium (Cd)	0,005	0,005 - 0,02
Thallium and its compounds expressed as thallium (Tl)		
Antimony and its compounds expressed as	0,01	0,01 - 0,3
Arsenic and its compounds expressed as arsenic (As)		
Lead and its compounds expressed as lead (Pb)		
Chromium and its compounds expressed as chromium (Cr)		
Cobalt and its compounds expressed as cobalt (Co)		
Copper and its compounds expressed as copper (Cu)		
Manganese and its compounds expressed as Manganese (Mn)		
Nickel and its compounds expressed as		
Vanadium and its compounds expressed as vanadium(V)		
Dioxins and furans (PCDD+PCDF)	0,01 x 10-6	< 0,01 x 10-6 - 0,04 x 10-4
Polycyclic aromatic hydrocarbons (IPA)	0,01	Note: no reference range in BAT

Table 116 Emission Standard Value 2 - Plant – Waste to Energy

- Condensation of water vapour from the flue gas line with recovery of water used in the process in order to minimise the use of external water supply and with recovery of approx. 5 MWt in total, which can possibly be used for internal purposes;
- Chimney height 85 m (height defined on the basis of a specific preliminary pollutant fallout study);
- Raw flue gas emission analysis booth for continuous monitoring of HCl, SOx and Hg in order to optimise reagent dosing;
- Emission Monitoring System (EMS) equipped, in addition to the basic instrumentation for the continuous monitoring of pollutants, with: continuous mercury monitoring, continuous dioxin samplers and hot FTIR backup systems for the two lines, in case the main monitoring system goes out of service;
- Inclusion in the design of all regulatory requirements for waste incineration, including in particular compliance with T2S (residence time of at least 2 s of the flue gas at a minimum T of 850 °C) and compliance with the maximum unburnt content in the slag measured as COT (COT < 3% by mass);
- Flue gas expulsion temperature in the range 135 -145 °C in order to reduce the 'plume' effect at low outside temperatures;
- Zero' water discharge design objective: pursued by maximising the reuse of process effluent and the recovery of rainwater, the latter by means of a dedicated chemical-physical treatment

plant and the construction of a large underground tank for second rainwater in compliance with hydraulic invariance criteria;

- Entirely ‘indoor’ plant engineering to improve the landscaping of the site and to maximise mitigation in terms of acoustic impact;
- Use of perimeter visual barriers to screen certain plant sections in order to harmonise their inclusion in the general context of the architectural design, without penalising plant functionality.

In general, the main components of a plant and their stages are:

1. Waste reception
2. Waste storage
3. Pre-treatment of the waste, where necessary, which can be done on-site or off-site
4. Loading of the waste into the process
5. Thermal treatment of the waste
6. Energy recovery and conversion
7. Exhaust gas cleaning
8. Spent gas cleaning residue management
9. Exhaust gas discharge
10. Waste water control and treatment
11. Ash management and treatment
12. Solid residue storage

Process Description

The sizing of the municipal solid waste incineration plant was carried out assuming a productivity of 300,000 t/year of waste to be treated as it exits the Mechanical Biological Treatment plants where undifferentiated waste undergoes mechanical selection to eliminate putrescible substances and recoverable materials.

The plant covered by this project is divided into the following main areas:

- Area 1 - Waste reception, storage and handling
- Area 2 - Combustion and thermal recovery
- Area 3 - Energy recovery
- Area 4 - Flue gas treatment

The plant is supplied with approximately 910 tonnes of fuel per day for an annual operating time of 8000 hours. The assumed number of treatment lines is 2 for a unit treatment capacity of 20 t/h.

Area 1 - Waste reception, storage and handling

At the entrance and exit of the plant, there are weighing systems for the trucks transporting the waste. Thanks to this system, it is possible to monitor the waste flows circulating in the waste-to-energy plant, both incoming and outgoing. The incoming lorries, after having been weighed and recorded on the transport form, drive to the feeding pit inside the plant.

From the pit, constant feeding is carried out by means of two side-by-side hoppers, underlying extractors and inclined transfer belts to the furnace. The various operations are constantly monitored by plant personnel.

The pit must be equipped with a waterproofing system such as to allow the appropriate tightness checks to be carried out and, if intervention is necessary, such as to facilitate maintenance operations.

The choice of material also guarantees resistance to the mechanical impacts of the bucket as well as to the chemical aggressiveness of the leachate.
The accumulation characteristics of the storage pit are as follows:
Geometric data

Length	30
Width	12,5
Dumping Platform Height - Bottom	6,5
Hopper Height - Bottom	16,5
Geometric' volume	2437,5
Maximum stacking	6187,5

Table 117: Storage pit data

Assuming that

Waste Specific Weight	350 kg/m^3
Average volume of MSW disposed	20,0 t/h

Table 118 Capacity Data

Storage capacity

"Geometric"	1,7 days
Maximum	4,5 days

Table 119: Storage Capacities

The fuel is transferred to the furnace hopper by means of a conveyor belt system, using the crane, and then to the feed lines of the incinerator.
To ensure continuity of operation, n.2 conveyor belts and n.2 plate belts are made which discharge directly into the rubber-coated oven loading belts; The waste is fed by an operator in a room close to the storage tanks.

Area 2 - Combustion and heat recovery

The main parts of the system are:

- Grid complete with hydraulic drives, air cooling system, ash hoppers and all accessories to make it functional;
- Waste and ash discharge system under grid;
- Hydraulic system for the operation of grid and power supply complete with control unit, tanks, cooling systems, filtration systems and interconnecting pipes;
- Primary and secondary combustion air systems, complete with dampers and ducts;
- Recirculation fume distribution system, complete with dampers and ducts.

The fuel, which is continuously transferred 24 hours a day into the hopper of the furnace loading line, is pushed into the combustion chamber by means of a system of hydraulic pushers, which act as a regulator of the supply flow. The material transfer phase is carried out in such a way that the transfer duct is always kept full of material; This provides a substantial heat seal between the hopper and the combustion chamber, preventing the propagation of heat backwards. The fuel then reaches the combustion chamber, whose bottom is a grid system. Thanks to a series of alternating movements of

the plates which make up the grid itself, the fuel advances, undergoing a series of chemical-physical reactions until it completely burns. The grid is air-cooled, which allows to ensure an optimal surface temperature of the same even with fuels with high calorific value, guaranteeing limited wear over time.
The combustion chamber operates at a temperature above 850 °C and is assisted, in the case of fuel with non-constant PCI, by n. 2 burners. The fuel used by these burners for the operation of the plant is methane (auxiliary fuel) which also takes part in the phases of start-up, shutdown and transient
The time of residence in the combustion chamber is expected to be at least 2 sec at a temperature of 850 °C.
The combustion chamber will have a volume of approximately 400 m3. Therefore, it is necessary to verify the compliance of residence time at a temperature of 850°C.

Combustion chamber volume	400 m^3
Flue gas flow rate ***100.000 Nm^3/h*(273,15+850)/273,15***	411,184 m^3/h
T(850°C) ***3600 s/h*400 m^3/411,184 m^3/h***	3,5 s

Table 120: Combustion chamber characteristics

Air Insufflation
The air required for combustion is supplied by two systems:

- primary air system: it is sucked from the fuel tank, which is therefore kept in a vacuum confining the internal atmosphere, and introduced through the combustion grid by means of a special fan;
- secondary air system: it is blown into the passage section connecting the combustion chamber to the post-combustion chamber. This system creates the conditions for improved combustion efficiency.

Waste Recovery
After combustion, the residual slag falls into the water of the slag well, in which the slag extractor with quenching bath is located, where they are removed by means of a piston which ejects the slag and places it on a vibrating plate fitted with an electromagnetic tape separator to separate the ferrous materials sent into a dedicated trench. The remaining part of the slag is discharged into the slag pit. The slag and ferrous materials are taken from the silo by crane operator using a bucket with a pulpo to be loaded onto trucks with which transport is carried out.

Thermal recovery
Combustion fumes from the combustion chamber enter the boiler at a temperature between 850°C and 900°C.
The generator is of water tube type, that is made up of tubes internally run by water or water-steam mixture (steam in superheaters) sucked externally by combustion gases.
The superheated steam produced in the recovery boiler is used to drive the turboalternator and thus produce electricity.
The boiler is single-pressure, with natural circulation, a cylindrical upper body and equipped with a hammer cleaning system for removing soot from convective banks.
The steam generator consists of a radiant part, formed by three vertical channels and a horizontal convective channel in which are placed the superheater tube bundles, the evaporator and the economizer.
The main components of the system are:

- Cylindrical body

- Irradiation system
- Convection section
- Evaporating screens
- Superheaters
- Evaporator
- Economizer
- Ash collecting hopper
- Water - Steam system

Area 3 - Energy recovery

The energy recovery section consists of a traditional thermal cycle in which the steam produced by the boiler is sent to an expansion turbine; the low-pressure waste steam is condensed in an air-cooled condenser and the condensate collected to the condensed tank and then to the degaser and water feed tank.

The condensate is returned to the boiler by means of the feed pumps, thus closing the Rankine cycle.

Area 4 - Smoke treatment

The function of recirculation of fume is to control the combustion temperature without introducing excessive amounts of air into the system: this minimises heat losses by dilution and at the same time controls the formation of nitrogen oxides.

The fumes are taken downstream of the induced fan, then dusted and treated, and with a dedicated fan fed in the designated areas of the grid and the combustion chamber.

The recirculated fumes are fed in on two levels: one through the bottom grate, through the hoppers, and the other on the front wall of the combustion chamber for the purpose of controlling the combustion temperature, Improving the reliability and flexibility of the combustion system, and CO emissions, also contributing to the reduction of NOx nitrogen oxides.

In addition, the smoke recirculation, with the same fuel burned, allows to reduce the smoke discharge flow to the chimney from 10 to 30% compared to conditions without recirculation.

Combustion fumes from the boiler pass through the treatment system which consists mainly of the following stages:

- Gas humidification in the conditioning tower
- Dry reaction
- Physical dust removal in the bag filter
- Cleaning of flue gases in the wet scrubber
- DeNOx and DeDiox effect in SCR process

Smoke treatment systems either retain pollutants, then dispose of them in dedicated facilities, or transform them into harmless substances before releasing them back into the environment. The main pollutants in fumes are:

- Acid gases (HCl, HF, SOX)
- Ammonia (NH3)
- Heavy metals
- Organic micro-pollutants (PCDD/F, IPA)
- Nitrogen oxides (NOX)
- Unburned
- Dust and particulates

To facilitate effective abatement, the fumes are cooled in the air conditioning tower from the boiler outlet temperature (160-200 °C) at a temperature of 150°C. The water used in the cooling tower will be taken from the purging of the cooling towers of the energy recovery plant. In the first part of the conditioning tower, formed by cyclone, there is the separation of coarse dust carried by the fumes, while in the second part there is the cooling of the fumes by evaporation of the water sprayed.

Downstream of the conditioning tower, the reagent is injected in line through a venturi tube (reactor) with the dual purpose of improving the elimination of pollutants from the fume and reducing consumption in the subsequent washing column.
The following filter with sleeves operates the dust removal of the fumes and is formed by several internal cells which work independently. The dust discharged from the filter is partly recirculated and sent to the dry reaction section, so as to maximise the utilisation of the reagents, and partly sent to the two dust storage silos by a pneumatic transport system.
The filter is supplied with a flue-gas heat exchangerprimary fumes, which serve the dual function of cooling the fumes coming out of the filter to facilitate the absorption of acidic substances in the scrubber and heating the flow from the washing column before being fed into the SCR system.
The scrubber (flue gas scrubber) is divided into two stages, one acid and one neutral. In the lower section takes place the absorption of acids. The recirculated aqueous solution is partly purged and sent to the water treatment plant. The evaporated water and the water removed by purging are compensated for by the water from the purging of the cooling towers. Before passing to the neutral upper stage, the fumes pass through a droplet separator to remove acid drag.
In the upper stage, SO2 and remaining acid traces still contained in the fumes after passing through the acid stage are removed.
The neutralization stage with 30% caustic soda solution involves a plate system for smoke/liquid contact. An organic precipitating agent is injected to improve the removal of heavy metals.
Before leaving the washing column, the fumes pass through a droplet separator to remove the drag-outs and prevent them from reaching the smoke/fumes exchanger.
The fumes from the scrubber pass through the primary flue/gas exchanger and are sent, via the draw fan, to the preheating system necessary to reach the optimum temperature for the catalytic reaction which is 260-280°C. This system consists of a secondary flue/smoke heat exchanger fed by the flue gases coming out of the SCR reactor and a methane burner, which will provide an additional thermal input to reach the desired temperature.
The DeNOx DeDiox (SCR) process uses a 25% ammonia solution necessary for the NOx reduction reaction, this particular technology allows the abatement of nitrogen oxides and dioxins.
The dosage of the ammonia solution will be such that there are no slips inhibiting the catalyst.
Before sending the purified fumes to the chimney, there is a heat recovery in a tertiary exchanger that preheats the condensate in the thermal cycle.

The project will be developed on the basis of compliance with the following parameters: i) annual waste input of 300,000 tonnes; ii) maximum thermal load of 1250 MW; iii) Lower Calorific Power ("PCI") in the range 2,600-3,400 Kcal/kg (i.e., 10,880-14,235 kJ/kg) - reference value of the ICP project.
Clearly, depending on the annual average PCI, a different operation of the Termovalorizzatore will be determined according to what can be deduced from the combustion diagram.
It should be pointed out that, assuming an average annual operating time of 8,000 hours (guaranteed for the entire life of the waste-to-energy plant), for wastes with certain PCIs too high, given the constraint of a maximum thermal load of 125 MW, it is technically not possible to incinerate 300,000 tonnes/year of mixed waste; similarly, for waste with certain too low PCIs, given the 300,000 tonnes/year input waste constraint; Electricity production is limited. In addition, wastes with PCIs not compatible with the combustion diagram (i.e., more than 14235 kJ/kg or less than 8000 kJ/kg) do not permit incineration.

3.5.4 Anaerobic digestion plants for organic fraction

The project involves the construction of an anaerobic organic-matrix waste digestion and composting line for the production of high quality biomethane and compost. In order to provide a clear picture and illustration of all the activities that will be carried out under this project, the main stages of the process are described below:

1. Reception of bio-waste;
2. Pre-treatment/separation of unwanted materials from organic fraction;
3. Anaerobic digestion of organic fraction with biogas production;
4. Biogas purification (upgrading) with dual PSA stage for the production of pure biomethane;
5. Biomethane distribution with direct connection to an adjacent service station;
6. storage with liquefaction plant of the biomethane produced;
7. Aerobic composting of digestate.

The plant will be built using the best available techniques for waste pre-treatment, anaerobic fermentation and biogas purification into biomethane (upgrading) with subsequent liquefaction and distribution; Biofiltration of waste air and the production of agricultural compost.

In order to clearly frame and illustrate all the activities that will take place with this project, we report the main sections of the plant:

- Reception section
- FORSU pretreatment section
- Digestate separation section
- Section for treatment of exhaust gases
- Biomethane upgrading section
- Composting section of digestate
- Liquefaction plant
- Leachate treatment plant/fire fighting system/apron water treatment plant.

The flow diagram of the plant is shown below.

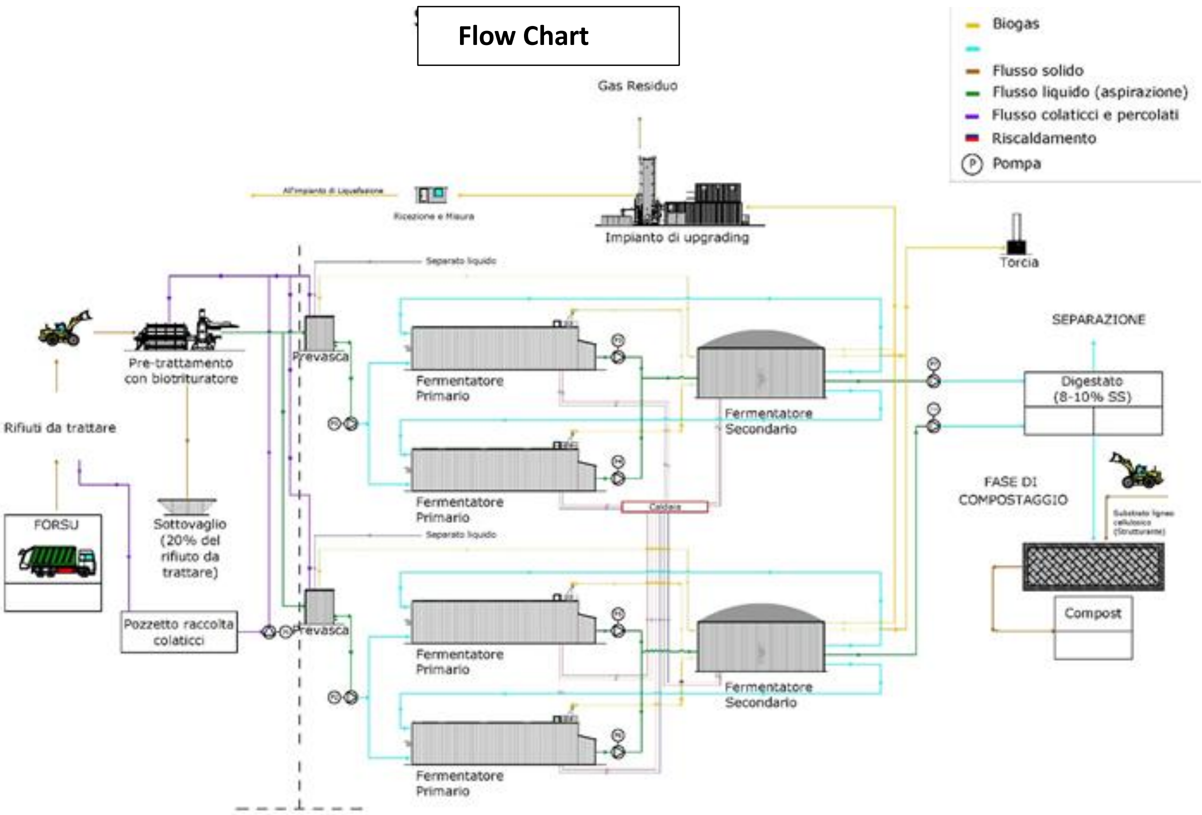


Figure 47: Flow chart

Reception and pre-treatment of incoming waste
The reception and pre-treatment section consists of a hall consisting of the following ideal areas with different functions:

- area for positioning and handling of the equipment;
- Waste discharge area (trenches/hoppers);
- Organic material pretreatment area;
- Storage area of the pre-treated overlay
- the area where the digestate is separated from the biogas plant by means of special machines; the solid fraction will then be used as a structuring agent in the composting plant, The liquid one will be used to facilitate the pre-treatment of waste entering the plant.

The layout of the shed is shown below.

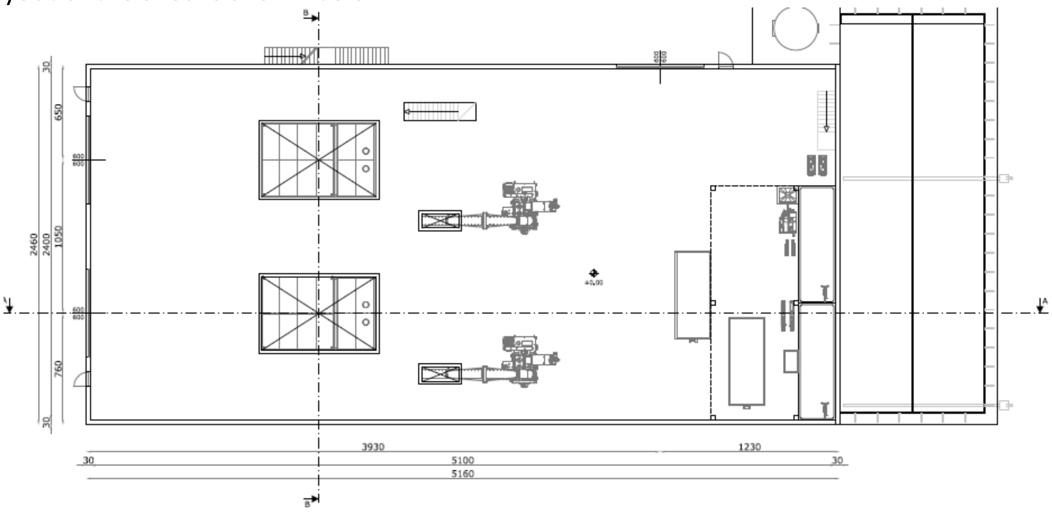


Figure 48: Planimetry of shed typology

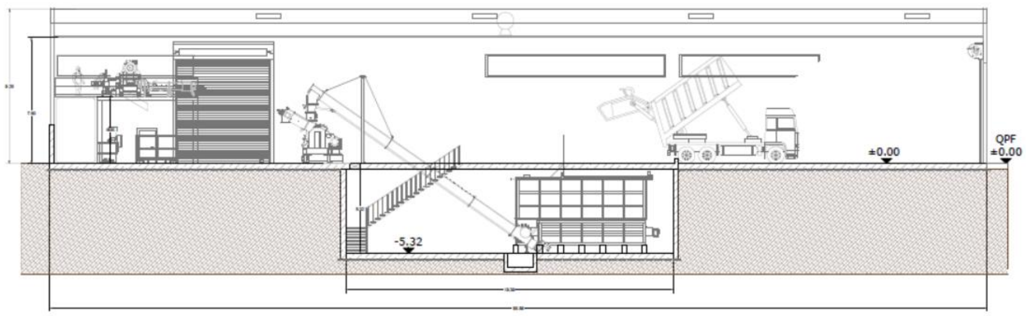


Figure 49: Shed type section

3.5.4.1 Anaerobic digestion plant

The main plant unit of the complex will be the anaerobic digestion section In this area will take place the anaerobic process of conversion of FORSU into biogas (raw).

Figure 50: Plant typological view

- FORSU pretreatment system with hopper 100 mc
- Prevasca;
- Primary fermenter;
- Secondary fermenter;
- Substrate pumping system - feed dispenser
- System for the determination of iron chloride
- Condensation collection sump
- Gas line
- Substrate piping
- Heating pipe
- Torch for combustion
- Natural gas/LPG boiler and heat distribution system
- Technical room / Picture room
- Digestate grilling system huber
- Huber digestate dewatering system

The following are the plant construction diagrams.

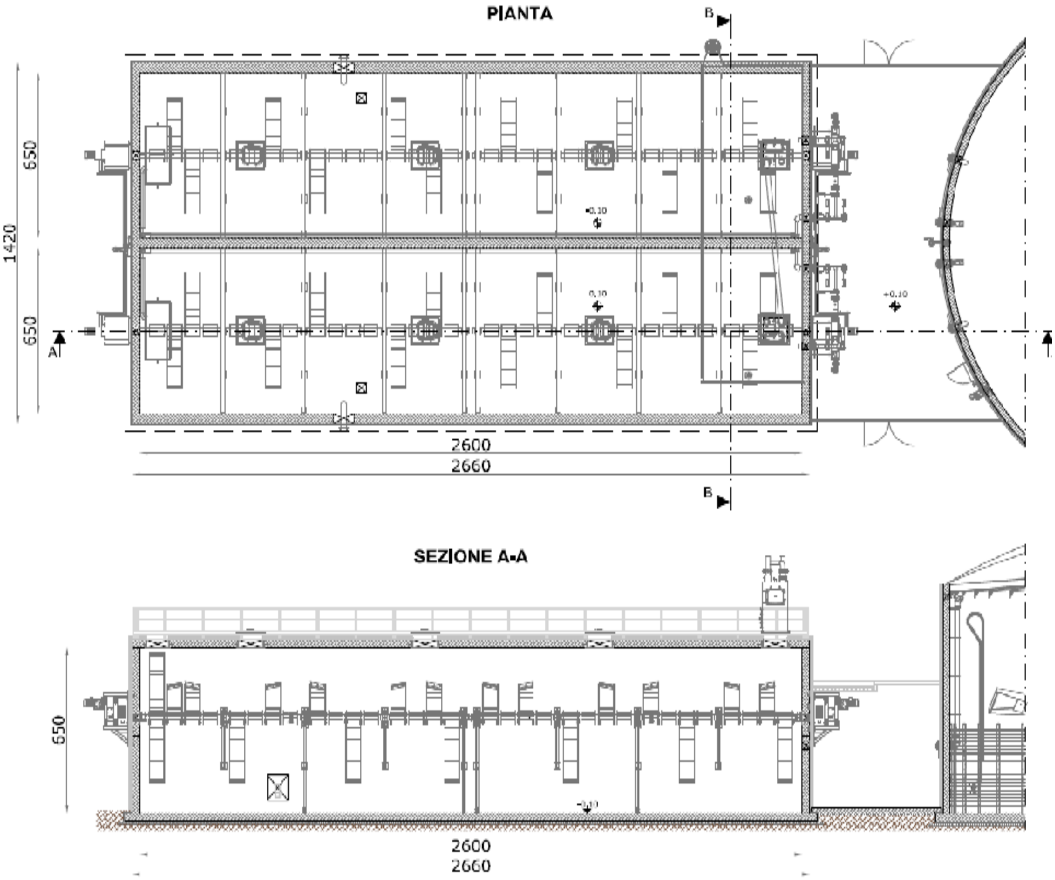


Figure 51: Typological construction elements primary digester

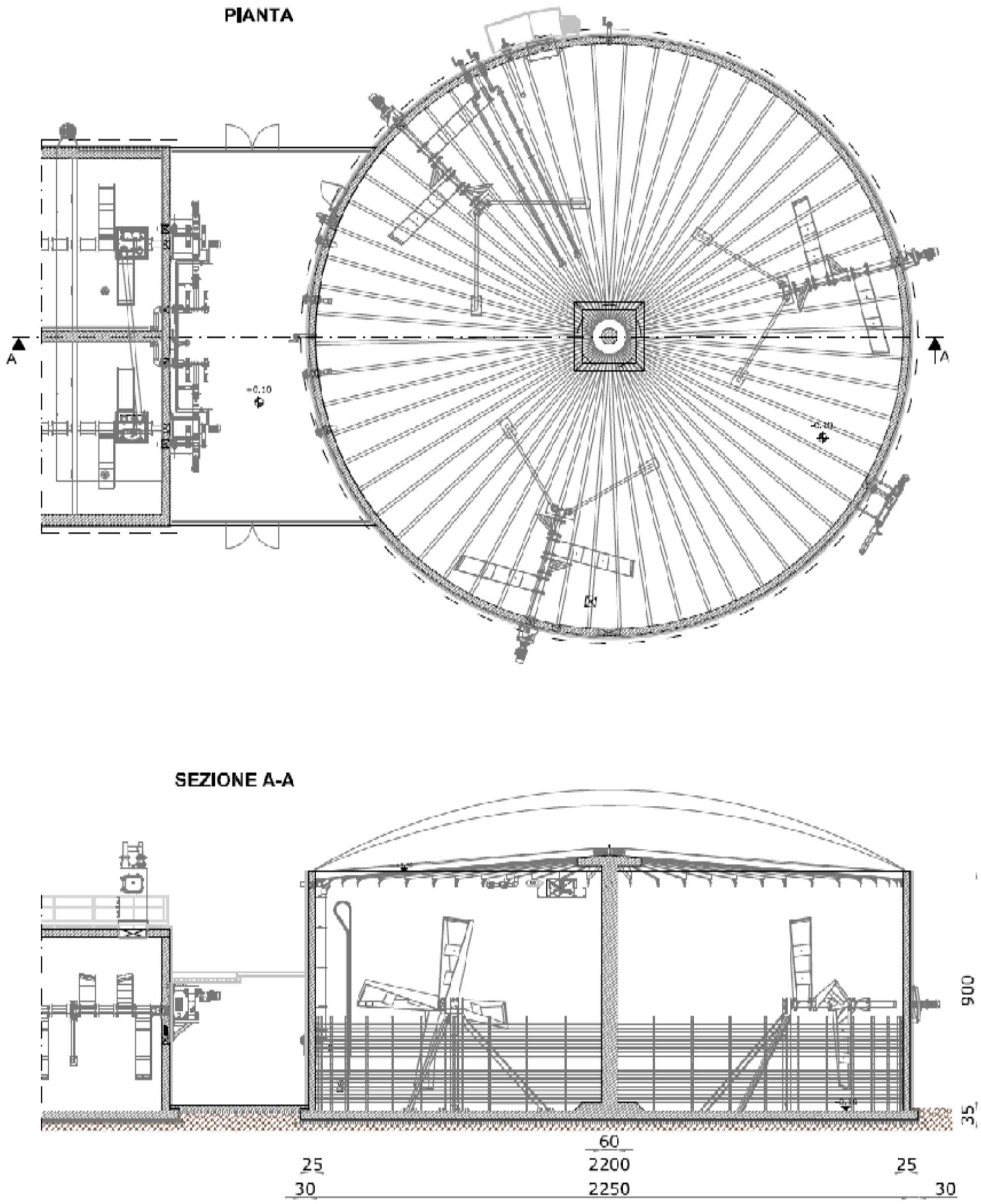


Figure 52: Typological construction elements secondary digester

Installation of biomethane upgrading plant

The production process is called PSA (Pressure Swing Adsorption). The basic unit of the plant is represented by carbon molecular sieves (CMS) which, after removal of condensate and hydrogen sulfide, provide for the removal of CO_2 (carbon dioxide), and other residual impurities such as oxygen (O_2), nitrogen (N_2) and humidity.

The whole system is installed to operate automatically. The start, stop, normal operation and emergency stop are automatically executed and controlled by the control system.

The monitoring of the plant by service personnel is essentially limited to regular inspection procedures and maintenance of the plant at fixed intervals.

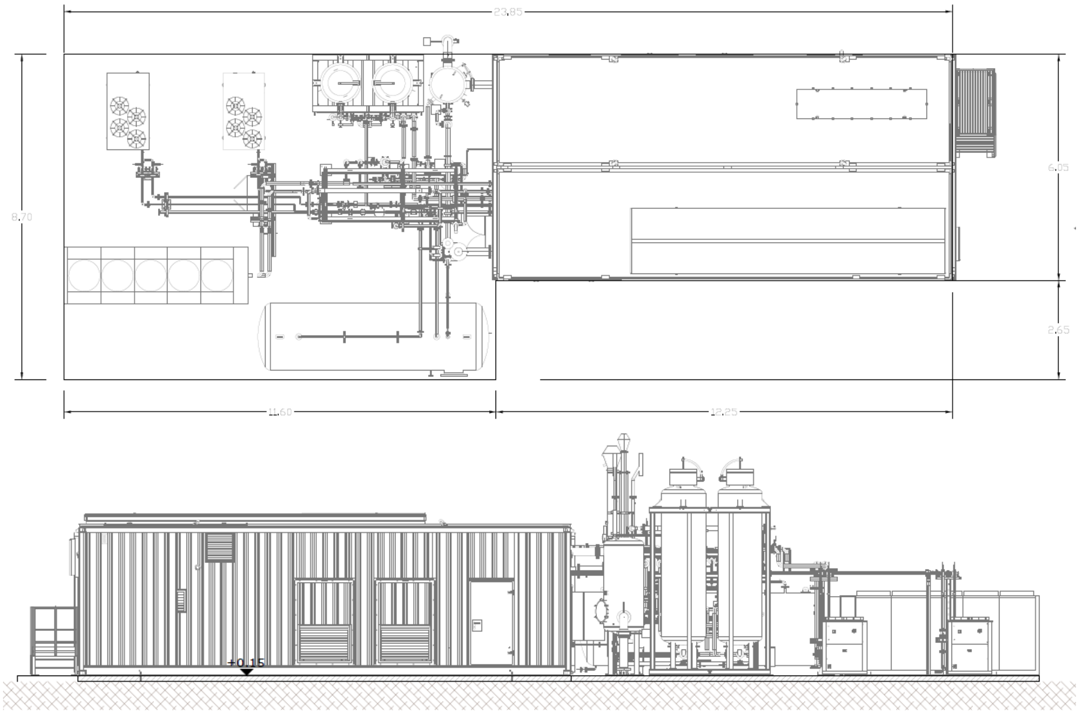


Figure 53: Biogas to biomethane upgrading plant type drawings

Composting section of digestate

The digestate resulting from dehydration is sent to the composting section. The system in question is an atypical composting process, involving the treatment of liquid matrices, such as sewage or digestate, on a bed of absorbent material consisting of straw, corn cobs, sawdust, The traditional composting process is typically solid.

The substrate, besides playing the role of structuring for the biological process, acts as a natural biofilter for emissions because in the bed it selects and develops a bacterial microflora able to degrade, mineralizing them, the molecules of the polluting compounds (organic and inorganic) so that no emissions or odours develop. The process is shown in a representative diagram.

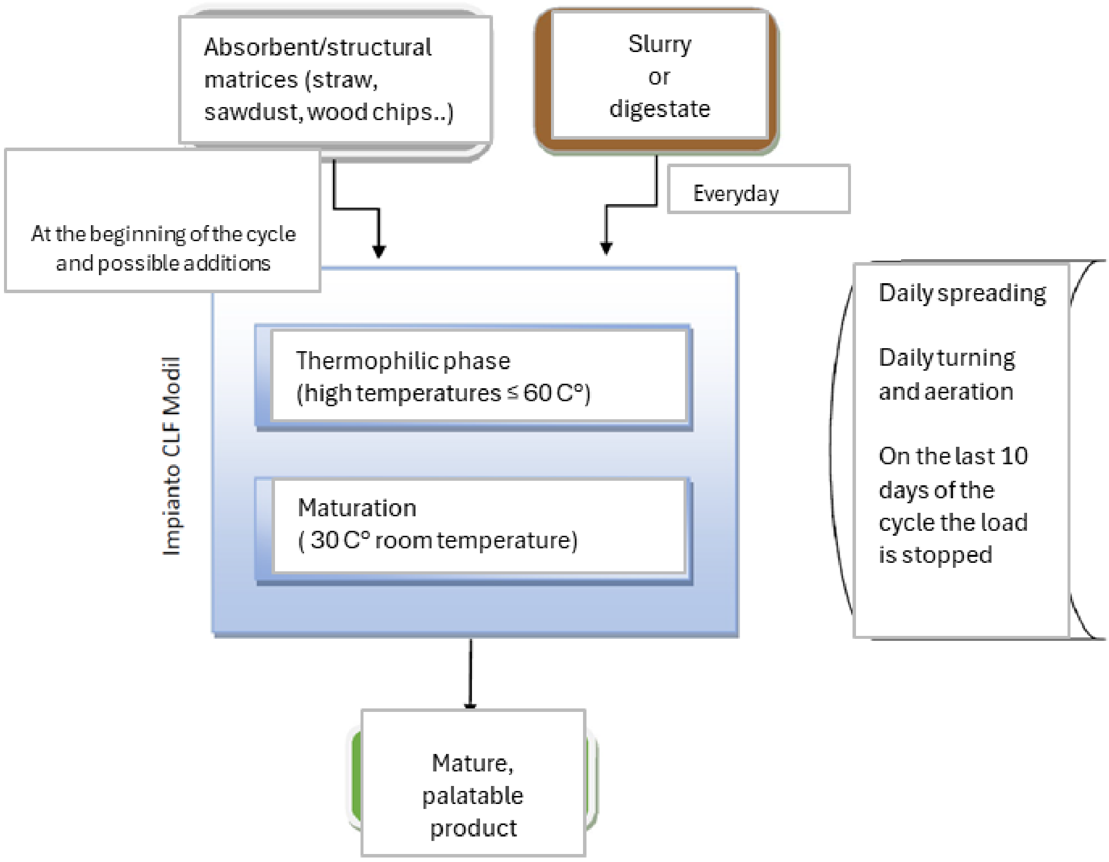
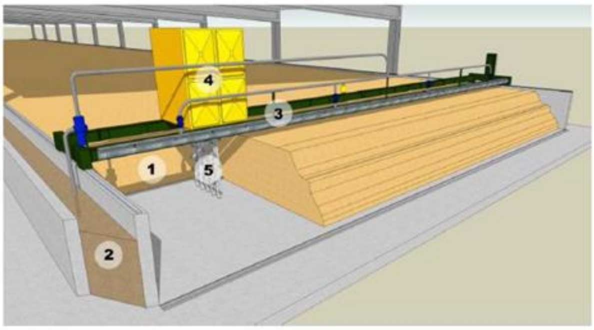


Figure 54: Representative diagram of the process

The process takes place in a horizontal-developing mechanical biological processing plant. On the walls of the tank is installed a mechanical equipment, on crane, which runs daily on tracks the plant carries out the distribution of sewage and/ or digestate and handling and oxygenation of biomass.



Schematic diagram of the plant in evidence:
1. the treatment 'tank';
2. the sewage loading channel;
3. the overhead crane for the distribution and oxygenation of the mass;
4. the self-displacement and motor drive unit;
5. air insufflation (Publication No. 1)

Figure 55: View of composting section

The output is a high-quality fertilizer (compost) for use in agriculture.

The following are plans and details of the construction of composting trenches.

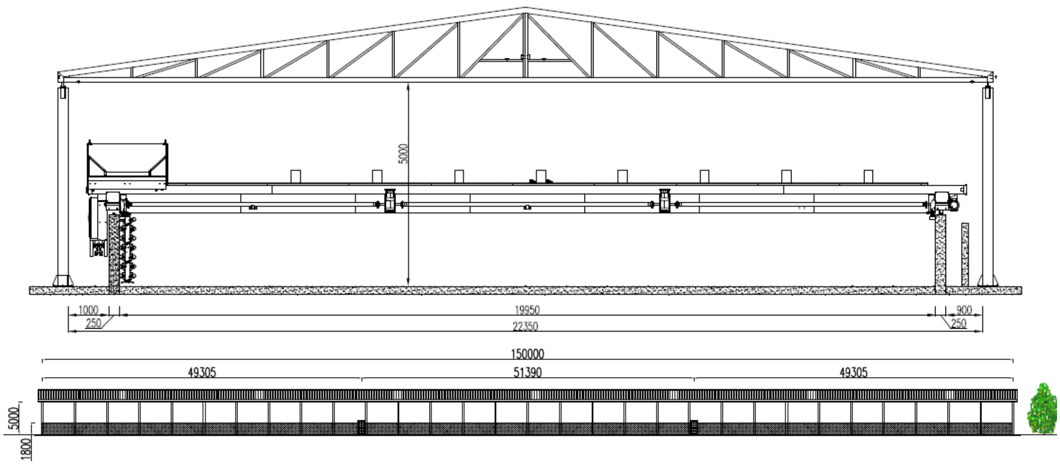


Figure 56: Front view

3.5.5 Recycling plants for the treatment of fractions

3.5.5.1 Multi-material processing plant

The present report is concerned with the description and design of a plant for the selection of the Multimaterial fraction.
The treatment will be carried out through the realization of a plant of mechanical-manual selection, in which the waste is subjected to selection with the separation of the valorizable flows to start to recovery of matter.
The technological facility will consist essentially of five blocks:

- Loading pit and conveyor belt to shredder/opener
- Shredder/ opener
- Sieve loading belt
- Rotary drum sieve
- Ferrous metal separators
- Non-ferrous metal separators
- Conveyor belts and conveyors
- Sorting station
- Sorting and sorting tapes
- Storage silos under the cab
- Loading belt pressing line
- Compaction press.

The plant will include:

- Air intake and treatment system consisting of a bag filter, with the function of allowing suitable sanitary conditions inside the building and avoid the emission of dust and odors;
- Electrical and earthing system.

Description of the Plant

The annual production capacity of the plant is defined in 70,000 t
The work will be carried out on 8 hours per day, for 6 days per week and for 50 weeks per year.
It is therefore estimated that 2,400 h of operation per year. The operation on n.2 parallel treatment lines is expected.

GENERAL PLANT DATA	
Maximum annual production capacity of the plant	70.000 t/year
Average daily production capacity of the plant	235 t/d
Average hourly production capacity of the plant	30 t/h
Number of operating days in a year	300 days
Number of operating hours per day	8 days

Table 121: Plant data

Acceptance

The means of transport of the multi-material from separated collection, after access to the plant and discharge authorization, enter the building where the sorting line is located and unload the material in the temporary storage box. Then an operator with wheel loader picks up the waste and provides for loading in the feeding hopper to the opening.

Entrance to the opening

The waste is conveyed from the hopper to the box opener via a conveyor belt. This is a machine in which the closed bags are torn by the differentiated rotation of two toothed cylinders. In particular, the first cylinder, rotating more slowly, holds the material while the second, with a faster rotation, tears the bag.

The material coming out of the box opener will be deposited on a roller blind lift designed to convey the raw heterogeneous material to the next treatment stage.

Screening

The screening department will consist of a rotary drum sieve, which has the function of sorting waste by passing through a cylinder made up of perforated sheet metal, with the fine parts falling into the hopper under the sieve. The grid foronomy shall have a diameter of 50 mm. The fine fraction ("sub-sieve") obtained as a result of the screening will fall into a special box placed under the screen, and from here it will be disposed of as waste. The larger fractions of waste will continue on the sorting line.

Manual sorting

After screening, the two main streams selected are taken to the sorting booth for manual selection at four double stations.

Manually selected materials are stored in silos placed under the sorting booth. Each of these silos is automatically emptied into the collecting belt, which carries the material, by means of an additional two-way conveyor belt to the press, or to the conveyor belt to be recirculated in the sorting booth for further quality control and improved section yield.

Deferrization

The waste remaining on the sorting line, following screening, will be sent to the deferral section. The magnetic tape-type separator separates the waste from the various ferrous materials present in it. These ferrous materials will be discharged into a dedicated storage bin, located below the sorting line, and then sent to third-party authorised plants for recovery.

Separation of non-ferrous metals

The next step in the selection is the separation of non-ferrous metals (for example aluminium). The eddy current separator is a conveyor belt with a magnetic rotor at one end. This rotor, rotating very quickly on itself, generates a magnetic field: when the non-ferrous metal comes close to the magnetic field, it is lifted and ejected away from the machine (in the above mentioned storage bin), while the inert materials continue their path on the sorting line to the baling press.

Volumetric reduction in bales

The press is fed through a roller blind lift with its own conveyor belt which will bring the material to the loading hopper. The line will end with the packaging press, which will pack the selected material (plastic waste, paper and board MPS waste/waste), preparing it for final storage and transport. Packaging allows storage without spreading of bulk materials and, by greatly reducing volumes, saves economic resources for transport.

Sizing

Storage of incoming materials

Incoming waste will be discharged into the designated covered area adjacent to the loading zone of the sorting line.

The site will be sized to store a quantity of input waste needed to power the plant for 7 days.

Whereas, therefore:

- Annual capacity of the plant: 70,000 t;
- Average volumetric mass of the product to be treated: 0.15 t/m3 (estimated value);

The maximum volume of stored input material is approximately **11,000 m3**.

Storage of outgoing materials

The storage of materials (packed and/or in bulk) prior to their dispatch to the recycling chain will mainly take place in the areas of the equipped pitch.

The maximum volume of material to be stored is estimated in about 7 working days.

Whereas:

- an average volumetric mass of about 0.3 t/m 3;

The storage volume is approximately 5,500 m3.

Sizing Areas

The areas of the plant are defined on the basis of the plant chosen for treatment.

Covered surface	5.800 m^2
of which: Offices Workshop Treatment Area + Indoor Storage	500 m^2 300 m^2 5.000 m^2
Outdoor surface Outdoor storage areas (manoeuvring yards, parking areas, green areas)	8.000 m^2 20.000 m^2

Table 122: Plant areas

3.5.6 Glass processing plant

The present report deals with the description and design of a plant for selecting glass.

The plant in question will, in particular, aim at recovering glass from the separate collection system, with a view to preparing a secondary raw material which can be used in the melting process of glass.

The technological facility will consist essentially of five blocks:

1. Preselection section;
2. Cleaning section;
3. Selection Section;
4. Grinding section.

<u>Description of the Plant</u>

The annual production capacity of the plant is defined in 50,000 t

The work will be carried out on a daily basis for 24 hours, 6 days per week and 50 weeks per year.

It is possible to estimate that the actual hours of production during a working day will be 22, and therefore 6,600 h of operation per year are estimated.

GENERAL PLANT DATA	
Maximum annual production capacity of the plant	50.000 t/year
Average daily production capacity of the plant	167 t/d
Average hourly production capacity of the plant	7,6 t/h
Number of operating days in a year	300 days
Number of daily hours of operation	24 days
Number of daily hours of actual treatment	22 days

Table 123: Plant data

Sizing

Waste in the input

The vehicles assigned to the transport of incoming glass will be stationed at the parking lot and enter the plant in order of arrival for the completion of the procedures for receiving waste. These include:

- verification of transport documents;
- weighing;
- visual inspection;
- registration.

If they comply, incoming vehicles will be able to proceed with unloading operations at the dedicated covered areas. By means of pallets, the waste is transported to the technological block where treatment takes place.

The site will be sized to store a quantity of input waste needed to power the plant for 2.5 months.

Whereas, therefore:

- Annual capacity of the plant: 50,000 t;
- Average volumetric mass of the product to be treated: 1 t/m3 (estimated value);

The maximum volume of the stored input material is about **10,500 m3.**

Preselection Section

In this section the raw glass follows a series of treatments in order to create a homogeneous product in the piece, free from bulky pollutants and dried so as to reduce its variability. In particular, the process will develop along the following flow:

- Loading of the raw material into hoppers by mechanical loaders.
- Continuous extraction and dosing of the material.
- Extraction of the bulky ferrous material from the flux by means of several magnets.
- Subdivision of the material into four size classes by vibrating sieve; the estimated size fractions are:

0 12 mm;
12 20 mm;
20 60 mm;
 > 60 mm.

The fine material (0 12 mm) will be sent directly to the dryer, while the other three granulometric fractions will be loaded into machines for the separation of light fraction thanks to the aid of a breath of air placed under the flow of product. The light fraction will be sent to the metal recovery line, the passing material will proceed to a subsequent screening step.

The coarse fraction (>60 mm) will be passed in the vicinity of a magnet for the extraction of further metal fraction and then on a disc sieve which has the dual function of crushing the whole bottles and screening the product. The product is then reassembled to the intermediate fractions (12 20mm and 20 60mm), the above sieve will be sent to the metal recovery line from the waste.

The product will then undergo a new screening step in which three granulometric fractions are subdivided:

- 0 20 mm;
- 20 45 mm;
- >45 mm

The flow of material with a size greater than 45 mm will proceed through the following steps, such as:

- Manual sorting: for the separation of any bulky components which could clog up the downstream cylinder;
- Reduction of size: by means of a cylinder;
- Product screening: the passing fraction will be returned to the sieve, the over sieve will instead be sent to the metal recovery line from scrap.

All the passing product with fraction less than 45 mm will be dried in a rotary drum dryer, in order to reduce its moisture to a useful value for subsequent treatment sections. The dryer also removes materials attached to the glass, such as labels, by means of a mechanical glass-on-glass clutch.
The drying air will then be filtered by a sleeve filter before being released into the atmosphere.
All separated waste will be treated in a metal fraction recovery line with the following steps:

- Magnetic separator for the extraction of ferrous metal;
- Eddy current separator for the extraction of non-ferrous metals.

Section of Cleaning

In this section the glass will be cleaned of metal pollutants, organic fraction, plastic fractions, lead-containing glass and heat resistant glass. In particular, the main process will develop along the following flow:

1. Remove the fraction of product less than 3 mm by vibrating sieve and send to dry grinding section.
2. Subdivision of glass into three particle size fractions and feeding of three ferrous and non-ferrous metal fraction extraction systems by means of a magnet and a eddy current separator.
3. For each of the three particle size fractions, the extraction of the light organic fraction shall be carried out by means of a zig-zag separator in which the separating air generated by a fan will flow through the separator from bottom to top and this will make sure that the material is aircrossed and separated. The product will have to cross the airflow at each curve of the channel and then collide against the opposite wall of the sorter, this will allow the material of higher density to settle on the bottom of the channel. The light material will then be sucked in with the air flow directed upwards.

The air extracted with the pollutants will be cleaned in a cyclone downstream and reused in the circuit. The product coming out of the cyclones will be screened and that below 3 mm, sent to the grinding section, while the product with higher size will be sent to the recovery line present in the preselection section.
The two particle size fractions with a size greater than 6 mm will undergo two passes in optical selectors in particular:

- **First step** in selector with NIR technology for the extraction of heavy plastics, which will be sent to the recovery line present in the preselection section.
- **Second step** in selector with X-ray fluorescence technology for the extraction of lead-containing glass, surface lead-content ceramics and heat resistant glass. The extracted product will be placed in the pile of inert material for its subsequent disposal.

Selection section

In this section the glass will be definitively purified from all pollutants, divided by color and ready to be sold to the glass industry. In particular, the main process will develop along the following flow:
Selection zone coloured glass
Subdivision of the glass into five granulometric fractions, glass with a particle size less than 3 mm will be sent to the grinding section, the other 4 granulometric fractions will continuously feed five optical separation towers each having the following steps:
First selection step for extraction:

- pollutants such as ceramics, stones, porcelain and metals sent to the refill line;
- of amber glass sent to the purification line

Second selection step for extraction:

- pollutants such as ceramics, stones and porcelain sent to the refill line;
- of the "white + half-white" glass sent to the purification line.

Third step for purification of glass from pollutants such as ceramics, stones and porcelain, the discarded material goes to loop and recirculated from the beginning. Coloured glass is now ready as a secondary raw material for the production of glass.
Purification zone for "white" glass

The "white + half-white" glass extracted from the colored glass selection area will undergo the following steps:

- Screening for the extraction of fine glass, less than 3 mm, which will be sent to the grinding line and subdivision of the remaining part into two granulometric fractions each of which will feed an optical sorting machine.
- Pass for purification of glass from pollutants such as ceramics, stones and porcelain, the discarded material will be recirculated from the beginning. The "white + half-white" glass, at this point, will be ready as secondary raw material for the production of glass.

Purification zone for "amber" glass

The "amber" glass extracted from the colored glass selection area will undergo the following steps:

- Screening for the extraction of fine glass, less than 3 mm, which will be sent to the grinding and feeding line of an optical sorting machine.
- Pass for purification of glass from pollutants such as ceramics, stones and porcelain, the discarded material will be recirculated from the beginning. The "amber" glass will be ready at this point as secondary raw material for the production of glass.

Rehearse area

The ceramics, stones and porcelain discarded in the selection lines will contain a high content of glass, in order to recover as much glass as possible these will be collected and sent to this section where the product will undergo the following steps:

- Screening for the extraction of the fine product, less than 3 mm, which will be placed in the pile of inert material for subsequent disposal, the remaining part being divided into two granulometric fractions each of which will feed an optical sorting machine.
- Pass for purification of glass from pollutants such as ceramics, stones, porcelain and metals, the extracted material will be recirculated from the beginning of the selection section. The passing material will be the waste that will be put in the pile of inert material for its subsequent disposal.

Area of accumulation

The glass thus selected in the different qualities will be sent to the stores of the ready-to-use furnace. The material stored will be sampled at regular intervals to verify that the quality of the product conforms to the glass industry acceptability specifications.

Grinding Section

In this section the fine waste will be ground to a grain size below 800 µm, such product can be reused in the melting process of glass.

In particular, the process will develop along the following flow:

- Storage of the incoming product in a feed silo to allow constant feeding of the product at the following stages.
- Screening by dividing the product into three granulometric fractions:

0 800 µm to be stored as a finished product;

800 µm 10 mm sent to the next stages;

> 10 mm which will be put into the pile of inert material for its subsequent disposal.

- Grinding of the glass and sending the product into the feed silo of the plant.

The light organic fraction will be extracted from the product with a particle size of 800 µm 10 mm by means of a zig-zag separator, in which the separating air generated by a fan will flow through the separator from below upwards, facilitating the separation of the material. The product will have to cross the airflow at each curve of the channel and then collide against the opposite wall of the sorter, in this way the material with a higher density will fall down on the bottom of the channel. The light material will be sucked in with the air flow directed upwards.

The air extracted with pollutants will be cleaned in a cyclone downstream and reused in the circuit.

The product coming out of the cyclone will be sent to the recovery line in the pre-selection section.

Sizing Storage

The treatment plant will have at its base a series of reinforced concrete boxes in which all the divided products will be stored.

In particular, there will be boxes containing the scraps:

- Non-ferrous metals;
- Ferrous metals;
- Light waste;
- Heavy waste;
- Dust;
- Waste inert material such as: Ceramics, Stones, Porcelain, lead-containing glass and heat resistant glass;
- Fine glass waste 0 3 mm.

In addition, boxes are provided for the final product defined as secondary raw material separated into:

- Coloured glass;
- Amber glass;
- Flint glass.

The maximum volume of secondary raw material to be stored divided by colours is estimated in about 12 working days.

Whereas:

- an average volumetric mass of about 1.35 t/m 3;
- a plant yield of 70% on the input material;

The storage volume is approximately 1,040 m3.

The volume to be stored is estimated on the basis of the following assumptions:

- One week (7 days) storage of waste from treatment operations;
- Percentage of rejects equal to 10%

the maximum volume of waste will be about 100 m3.

Sizing Areas

The areas of the plant are defined on the basis of the determinations made regarding the volumes needed for storage and on the basis of the plant chosen for treatment.

Covered surface	**12.800 m^2**
of which: Offices Workshop Treatment Area	 500 m^2 300 m^2 5.000 m^2
Outdoor surface External storage areas (manoeuvring yards, parking areas, green areas)	 4.000 m^2 20.000 m^2

Table 124: Plant areas

3.5.7 Ash disposal plants and/or landfills

The heavy ash (slag) treatment plant is designed for the recovery of heavy ash produced by waste combustion and is designed for a treatment capacity of 75,000 t/a. In summary, through screening, crushing, deferrization treatments, separation of metal elements and the use of cement, the final output is obtained from the metal residues of slag (divided into ferrous and non-ferrous) to be exploited on the market and a mineral material suitable for use as secondary building material or in other production processes in the logic of End of Waste. As regards the CO2 capture and storage off-site plant, recalling that in the waste to energy sector the first applications of this technology on a European scale have only recently been launched, an experimental type facility is proposed.

Figure 57: Experimental plant

The proposed plant for "Carbon Capture and Storage" consists of a CO2 capture and liquefaction plant and its subsequent transfer to a site suitable for permanent storage.

As regards the plant responsible for the distribution of heat and/or energy carriers to possible public and/or private third parties insistent in the vicinity of the plant, the feasibility project investigated the possibility of serving users closer to the area of the thermovalorizzatore.

The planned plant for waste-to-energy can supply up to 10 MW of steam at 12 bar 200 C for industrial use: this arrangement has been inserted to allow subsequent interventions according to specific needs and/ or following the emergence of new requirements. The plant preparation of the pole suitable to serve industrial users is also a further element of project improvement as a precursor to the development of an industrial network that can promote the connection of the industries already present in the area and favor The development of new production sites.

The planning has included additional plant and/ or additional annexes to support the waste-to-energy plant; the project includes:

- the construction of a photovoltaic power plant, placed on the roof of the heavy ash recovery building, with a capacity of about 1 MW;
- the maximization of green accommodations to take care of landscape and mitigation aspects in the context of architectural and landscaping enhancement of the site, with the use of extensive and intensive greenery;
- **the creation of a scientific research center in partnership with universities and international research bodies, which will find space in the functional lot.**

THE OUTPUT OF THE ASH TREATMENT PLANT IS SUMMARISED:

INERT MATERIAL IN DIFFERENT SIZE FRACTIONS:

They are made up of the fractions selected from the waste input following their mechanical treatment carried out in the Rigenera platform by crushing, screening, sorting, etc. If, following the refining operations, the fractions meet the criteria of UNI EN 13285/2010 (non-bonded mixtures), UNI EN 13242/2008 - (Aggregates for non-alloyed materials and hydraulic binders for use in civil engineering works and road construction), UNI EN 13043/2004 - (Aggregates for bituminous mixtures and surface treatments for roads, airports and other traffic areas), UNI EN 12620/2008 - (Aggregates for concrete), UNI EN 13139/2003 - (Properties of aggregates and fillers obtained from the processing of natural, artificial or recycled materials mixed to be used in mortar for construction and engineering works), the material is qualified as EoW.

FERROUS AND NON-FERROUS METALS:

Through the processes carried out in the sections of crushing, screening, selection, with the use of magnets and induced currents, etc. the iron and non-ferrous metal fractions are separated from the rest of the materials. These fractions are carried out in specific processes which will further separate the ferrous and non-ferrous parts.

MINERALS:

In each of the production sections of the platform, mineral fractions are collected which decompose mainly from the treatment of soils and heavy ash, but also present, albeit to a lesser extent, in other types of waste.

INERT MATERIAL IN DIFFERENT PARTICLE SIZE FRACTIONS	**FERROUS AND NON-FERROUS METALS**	**MINERALS**
		

Figure 58: Minerals

3.5.8 Waste collection centers

Collection centers shall be manned and equipped areas where only collection activities are carried out, by grouping them into homogeneous fractions for transport to recovery, treatment and non-recoverable fractions, of municipal and similar waste, delivered in a differentiated manner by domestic and non-domestic users respectively, as well as by other entities required to collect specific types of waste from domestic users.
The collection center must be set up in accordance with all the rules on protection of human health and the environment, as well as occupational safety.
The collection center must be equipped with:

A. Adequate internal road;
B. Waterproofing of waste disposal and storage areas;
C. An appropriate management system for storm water and waste water collection areas;
D. fence height not less than 2 m;
E. adequate external barrier, made of hedges and/or trees or movable screens, designed to minimise the visual impact of the plant.

Outside the plant area must be provided with lighting systems and specific and explicit signs, clearly visible for size and location, which show the characteristics of the collection center, the types of waste that can be delivered, Opening hours and rules of conduct.

Figure 59: Example of a waste collection centre

The collection center is not intended to install technological facilities or carry out treatment processes; the plant has only the function of integrating urban hygiene services. The facility will also be used by the operator of the public collection service, to optimize the subsequent transport of materials from separate collection to recovery or disposal facilities.
The disposal of municipal waste must not pose a danger to human health, it must not be harmful to the environment and it must be carried out in compliance with occupational safety rules, in particular:
do not pose a risk to water, air, soil and fauna and flora;
do not cause noise and odour inconveniences;
They do not damage the landscape and are carried out on a site of no particular interest;
There are no virgin raw materials on site with which the waste to be recovered may come into contact;
The collection center must be structured as follows:
a. area for the delivery and storage of non-hazardous waste, equipped with removable bins/containers, even underground, and/or sealed and suitably delimited platforms.

In the case of waste storage in dump bins, it is appropriate to provide for the presence of ramps for the delivery of organic and glass; The following is an example of a ramp with material from a collection truck being transferred to an open-top container used for transport.

Figure 60: Transhipment operation from tank vehicle to roll-off container

Figure 61: Open-top trailer hooking up a roll-off container

Figure 62: Ramp

b. Area for the delivery and storage of hazardous waste, protected by a fixed or movable cover against atmospheric agents, equipped with containers placed on a watertight surface and having an appropriate slope, to channel any accidental spillage to a collection well, watertight; alternatively, each container intended for the delivery of hazardous liquid waste shall have a containment tank with a capacity equal to at least 1/3 of that of the container;

Figure 63: Demountable skips

In the area where the plant is located, on the platform made of industrial flooring, there are the sealed, removable bins used as containers for non-hazardous waste. Some of these boxes will be protected from the elements by means of a metal roof. In particular, each steel container is designed to accommodate a homogeneous product fraction.

The multi-material and undifferentiated dry can be transferred by transhipment from 10-cubic-metre compactor to 4-axle compactor with volume reduction function in order to optimize transfers to recovery platforms, (The key to purchasing trucks is to check the correct coupling between the 10 mc compactor and the 4 axis compactor so that the small medium can deliver in the large medium).

The storage period for each batch of goods delivered to the collection center must not exceed two months under Italian legislation.

The wet organic fraction must be started at the recovery plants within 72 hours (for the Italian legislation), in order to prevent the formation of odour emissions.

3.6 Reduction And Reuse Projects

At the bottom of the reverse pyramid of municipal solid waste management are all actions that can be taken to prevent and reduce waste generation. An integrated waste management system must address the real causes of increased waste generation by acting at multiple levels to manage and reduce this problem. Only if it is based on a serious reduction policy will the waste cycle be truly integrated, virtuous and sustainable. Specific actions to reduce waste generation, which a public administration can implement, are:

a) Actions against domestic users

- support for the dissemination of consumer education initiatives such as the conscious use of goods and services, and the dissemination of exchange markets and/or collection centers;
- Promotion of municipal incentives for household composting with tariff reductions;
- Definition of guidelines for the application of the tariff, including tariff incentives to reduce waste with the adoption of the punctual application of the tariff at each civic number: less waste from users = less variable part of the tariff.

b) actions against the users of production activities (industrial and craft industries) whose waste is assimilated in terms of quantity and quality

- Promotion of a programme agreement for the reduction of waste;
- Premiums for reduction activities, for interventions on production cycles and packaging management, for proven lower waste generation.

c) Actions against commercial users

- Promotion of a programme agreement for the reduction of packaging;
- Promotion of tariff incentives at municipal level for waste reduction with the promotion of trials of the punctual application of the tariff to each exercise (less waste delivered by users = smaller amount of variable part of the tariff)

d) actions against public (especially school) and private canteens

- Encourage the prohibition and/or disincentive of the use of single-use tableware, for example by applying tariff increases to disposable tableware;
- Promotion of tariff incentives to reduce waste by testing the punctual application of the tariff to each individual canteen (less waste delivered by users = smaller amount of variable part of the tariff).

e) actions against offices

- Dissemination and promotion of the use of recycled paper;
- Tariff incentives to reduce waste by promoting trials of the punctual application of the tariff to each individual office (less waste delivered by users = smaller amount of variable part of the tariff).

With specific reference to the social, economic and cultural context of the city of Ulaanbaatar, the actions described in the following paragraphs are considered applicable, at least in the first phase of implementation of the new system of separate waste collection.

3.6.1 Home composting

Organic waste is produced daily in every home, canteen, restaurant, bar, garden and garden. They account for more than 35-40% of the total waste produced annually. Nature is able to recycle these wastes completely by producing a natural fertilizer for use in the garden, in the garden or for potted plants. Recovering these wastes through the practice of household composting reduces disposal costs, slows down landfill depletion and reduces odour and leachate problems, to reduce the problems of reducing the calorific value of waste sent for incineration. The raw materials for the production of composted soil are all organic, biodegradable waste:

- Kitchen scraps such as cleaning residues of vegetables, peels, skins, coffee grounds, etc...
- garden and vegetable waste such as pruning wood, mowing of meadows, dried leaves, faded flowers, stems, garden scraps, etc.
- other biodegradable materials such as uncoated paper, cardboard, sawdust and untreated wood chips.

The domestic composting, in particular, is a voluntary practice with which the individual users can independently dispose of the putrescible organic fraction of the waste, both in its green component and in its wet component. The aim is to accompany and facilitate the natural aerobic fermentation process of biodegradable organic waste. By providing for a direct recovery of organic waste within the household economy, domestic composting intercepts materials that can be recovered before they are delivered to the collection system, subtracting them from the total amount of waste managed. In general, home composting can play a role:

- replacement of dry-wet waste collection in rural communities and dispersed housing, where it is not possible or economically viable to organize home collection circuits;
- The recycling system is also integrated into the sorting system in the areas served by the sorting system.

The best results can be obtained in the reality of the field where it has been carried out:

- An extensive communication and awareness campaign;
- technical training of the population with composting courses given by experienced technicians and also possibly of different degree of technicality (e.g. basic courses in schools, simplified courses for the population who approaches home composting for the first time and then in-depth courses for those interested or already experienced users);
- a substantial tariff reduction, between 10% and 20%.

The practice of household composting also has strong potential for synergy with the waste collection method. When in rural or residential areas dispersed massive autocompostaggio adhesions are obtained (between 40% and 60%), it can also be considered, in the case of a door-to-door system of organic collection, to change the traditional collection frequencies, even planning not to serve areas that have obtained high percentages of adherence. Or, if such a collection method is to be introduced, a first step can be taken to provide strong incentives for household composting, and then based on the adhesions design a collection system that excludes areas of high adhesion from the wet and green collection service.

3.6.2 Food recovery and/or meal surplus

The practice of food recovery is carried out through initiatives aimed at recovering unsold food products, near expiration or redistribution of unserved meals from hotels, company and hospital canteens, school refectories, retail shops, etc. Every day, large volumes of food products generated by the organized supermarket can be recovered and therefore not sent for disposal. These are tons of food products withdrawn from the counters and shelves that are still intact and edible but for various reasons, such as a short deadline, promotional activity residues, damaged outer packaging, etc. may no longer be marketed. The activation of these projects allows to donate products still fit for consumption to non-profit organizations active in social use them for the preparation of daily meals for their assisted, so as to transform a waste into resource. The environmental value of such projects is evident, as the disposal of unsold products reduces the amount of waste to be disposed and consequently reduces pollution in terms of transport, destruction and disposal. Quality food produced in surplus, but still excellent as first courses, dishes, fruits and vegetables, bread and cakes are recovered instead of being disposed as waste. Recovery can only be achieved through a network of volunteers who daily and with adequate equipment transfer the food surpluses to charitable associations where redistribution takes place.

3.6.3 Used markets and exchange points

In recent years, have developed, by cultural associations and charities, but also by clothing distribution chains and not only, used markets and/ or real exchange points of goods such as: children's clothing, Equipment for early childhood (prams, high chairs, strollers, etc.), sports equipment, books. Many of these initiatives are configured as real used markets where there is who sells and who buys while others are organized by associations of citizens where it is possible to exchange books already read completely free, DVD and/or CD already seen and heard, with others made available by other people. Each of these initiatives, in addition to having a considerable environmental value, as they lengthen the life of exchanged and reused goods, delaying the time of their disposal, are often points of solidarity for families.
In general terms, a day of reuse can prevent about 72-74% of the material circulating at the sites indicated to become waste. The amount of material that a day of reuse puts in circulation is about 0.5 kg per family to be understood as a user reached, resulting in an avoided waste of about 350 grams per user.

3.6.4 Reduction of disposable plastic consumption in schools

Plastic is one of the main components of solid waste, it is not biodegradable and some types if burned can become toxic; therefore it is essential to dispose of plastic as much as possible, However, one of the most pressing environmental challenges is to reduce plastic waste production. The area where intervention can have an immediate effect and positive consequences for the whole system is definitely the school. Schools play a key role in the education and training of children and can play a central role in raising awareness among new generations about the threat posed by plastic pollution and the importance of protecting the environment and ecosystem. In a class, pupils consume on average one bottle of water every day, so that in an entire school year, about four thousand bottles are consumed. One school, with an average of about 25 classes, uses 100,000 in a school year. The progressive replacement of plastic water bottles in schools with aluminium bottles represents a waste reduction project characterized by considerable social and educational value because it sensitizes new generations to a use resource-conscious and progressively reducing the use of packaging, It is also a

high environmental value instrument due to the consequences in terms of avoided impact generated by the non-use of plastic.
This initiative can also be complemented by the gradual replacement of single-use plates and cutlery in canteens with reusable dishes and utensils. For example, a disposable 1.5-litre plastic bottle weighs on average 33 g, of which 14 g is secondary packaging. A 0.5 litre bottle weighs 18 g, of which 12 g is secondary. The weight avoided for those who use glass packaging is therefore 18.75 g per litre.

4 PART FOUR: MONITORING

Effective waste management is a crucial challenge for modern cities, with environmental, social and economic implications. A comprehensive and transparent data monitoring and dissemination system is essential to optimise waste collection, transport, treatment and disposal, maximising efficiency and minimising environmental impact.

4.1 Monitoring of integrated collection, transport and urban hygiene services

The main objectives of a waste data monitoring and dissemination system are:

- Gain a thorough knowledge of the quantities, types and origins of waste produced in the territory.
- Monitor the effectiveness of waste collection, treatment and disposal services.
- Identify problem areas and critical issues in waste management.
- Inform policy decisions to optimise waste management strategies and promote reduction, re-use and recycling.
- Promote transparency and accountability for citizens and businesses.
- Raise awareness of the importance of sustainable waste management.

4.1.1 Communication strategies

The communication and information project is part of a comprehensive programme of measures to have, in a given territorial reference scale, an efficient waste management system based on separate collection.
The specific objective of this communication activity is to inform citizens about the waste separation process and make them understand how proper waste management requires coordinated actions in which each actor contributes to the achievement of the result. The project is an indispensable element in educating citizens, making them aware that separate collection is a necessary right/duty to be able to reduce the overall environmental impact of raw material management, to provide the practical rules for proper waste separation and delivery.
In the light of the methodological matrix which crosses priorities and pillars, the information, communication and awareness-raising activity will therefore have the specific task of:

- Inform citizens on how to buy goods and services and adopt sustainable behaviours and lifestyles which, in both cases, can contribute to waste reduction on the one hand and their

usefulness for treatment and separate collection, On the other hand, to educate citizens themselves on waste prevention and sustainable consumption;
- To communicate waste-related issues to citizens, decision makers and businesses in order to raise awareness of waste and to try to influence and change their behaviour in a more sustainable way;
- Raise awareness among key actors (waste management bodies, trade associations, environmental organisations and citizens themselves) to involve them directly in the implementation of concrete activities that can lead to waste reduction, By defining and promoting specific voluntary agreements and better management of collection, also avoiding abandonment phenomena.

In addition, two key concepts of separate collection can be further developed through appropriate information, communication and awareness-raising actions:
- the reuse/recovery of the material delivered;
- recycling.

The separate collection is not only separation of materials according to the indications given by each Municipal Administration, but it is above all recovery and recycling. Citizens, therefore, must understand the meaning of recovering and recycling material, also through the promotion of reuse centers (especially in the most populous realities).

The key points of the communication strategy document are therefore:
- Starting with separate collection, highlighting best practices;
- Identify an information and communication route that is able to develop recovery/reuse, making citizens understand the reasons for separate collection and possible developments. Identifying best practices will also be essential;
- Start a process of collecting data from the territory, to activate subsequently an awareness-raising process on the same data, focusing the latter at a very high local level. The data may be used in the creation of ad ho c tools that can involve one or more categories of recipients;
- To foresee and prepare customer satisfaction systems, to verify the degree of satisfaction of citizens, but also active listening of the territory.

The integrated communication campaign that is being carried out should make all citizens aware of a few but specific **key messages:**
- what we have done: what has been done so far, through the use of data held and their dissemination, a basic information on the rules of separate collection;
- what we want to do: what will be done in the future by emphasizing that TOGETHER it is possible to aim for something new and better, thinking of a real call to action that encourages us to do better, more, more;
- why it is appropriate to do so: integrate as much as possible the themes of environmental education by linking them to the concept of sustainability of green. Consequently, integrate as much as possible the promotion of green (CEAS) and its continuous protection through differentiated, recycling, reuse, etc. all activities, the latter being within the citizen’s reach and thus making him an actor in the process;
- What we gain as a community: to make greater use of the socio-economic benefits on the territory.

When using the tools to which you give more weight, it will be necessary to start from the analysis of the target, considering mainly the average age of the communication recipients and their use of the media. This will also help to better define the weight of traditional and digital tools in information and communication aspects, Assuming, for the moment and based on the context analysis carried out previously, the following report:

- 70% digital, both because of the natural evolution of the population towards digital borders, and because it is intended to invest more in future generations, more attentive to the use of these tools;
- 30% paper/ traditional, to intercept segments of the population less attentive to digital communication and encourage them however to a greater orientation towards the use of devices and telematics platforms.

4.1.2 Planning methodology and choices

Based on the above, it should be stressed that the choices made in defining an intervention strategy and the development of communication objectives for each stakeholder and target group imply the need to act according to three levels of planning on which they will have to base themselves also the proposers of specific communication actions:

- Identify the 'target/objectives' combination;
- Identify the 'communication objectives/purpose' combination;
- Building functional matrices to define the intervention strategy, tools, content and languages to be used.

Among the various opportunities outlined by the methodological framework, two proposal matrices for the first two levels of planning (Tables 125) and a tool functional to the methodology of choosing the best possible combinations of tools are given below, The pillars and, therefore, the objectives to be achieved (Table 126).

GOALS	TARGET ADDRESSEE
Raising awareness of waste-related issues, seeking to influence and change behaviour in a more sustainable direction	Citizens Young people Professionals Local authorities Stakeholders
Educating on waste prevention and sustainable consumption issues, informing on how to purchase goods and services and how to adopt behaviours and lifestyles that can contribute to waste reduction	Citizens Young people
Involve in the implementation of concrete activities aimed at waste reduction, through the definition and promotion of specific voluntary agreements	Young Sector operators Local authorities Stakeholders

Table 125: Target/objective matrix

The mass and digital media are not fully included in the above table because they are both information and communication tools to reach the different target audiences identified and, in turn, recipients of targeted actions to increase the level of knowledge and expertise around the issue of integrated waste management and practices related to reduction, reuse and recycling.

GOALS	***INTERPERSONAL COMMUNICATIONS***	***DIRECT MEDIATED COMMUNICATION S***	***INDIRECT (MASS) MEDIATED COMMUNICATION S***
Knowledge	*Events and webinars* *Printed/digital products* *Promotional material*	*Website/landing page* *Direct marketing* *Social media* *App*	*Media relations and editorials* *Print/digital products* *Institutional advertising*

Reputation	*Events and webinar* *Social media* *Capacity Building* *Cascading communication*	*Website/landing page* *Social media* *Community* *App*	*Media relations and editorials* *Print/digital products* *Institutional advertising*
Participation	*Webinar* *Social media* *Cascading communication*	*Website/landing page* *Direct Marketing* *Social media* *Community* *App*	*Media relations and editorials* *Events and webinars* *Print/digital products*

Table 126: Objectives/methods matrix

4.1.3 Horizontal segmentation: the stakeholders

From the general perspective just described, an initial segmentation sees a direct link between the individual targets defined and the three specific objectives (raise awareness, educate, involve). In this sense, without prejudice to the possibility that all targets can operate according to the three objectives, a more effective communication action should aim to operate.

4.1.4 Vertical segmentation: the interlocutors

The integration and synergy between different audiences becomes a strategic asset in the development of the communication strategy, because, as mentioned, it is able to combine a transversal communication to heterogeneous groups that cannot be reduced to defined clusters with similar characteristics. In particular, audiences of this nature are those that are most suited to take on a role of interlocutor. This is both because they are direct recipients of certain actions and because they in turn take on the role of advocates of the strategy itself and, therefore, accredited and privileged sources of communication and listening activities.
Young people represent a vast audience for dialogue and word-of-mouth especially through social media and, in any case, within their family and social environment.
The stakeholder system assumes a primary role as advocates of the most significant experiences of a functional and functioning system. In addition to individual realities, it is necessary to consider that this category of stakeholders also includes associative forms. For all subjects identified as interlocutors it will be necessary to activate a specific empowerment action aimed at socialising the values of the communication strategy and its key messages, also on the basis of the stakeholders of each stakeholder category. In this way, the main stakeholders identified will also be the best territorial advocates, as well as the most interesting indicators of listening and continuous improvement.

4.1.5 The tools of the strategic plan

4.1.5.1 Network and digital tools

The new digital media necessarily imply forms of social interaction, expanding and pluralising the flow of communication and relationships between people. The use of these tools and the potential they offer makes communication more pervasive and effective. In line with the communication objectives, digital communication will be an indispensable window for promoting the project's activities. The tools chosen, described below, will always be complementary and integrated with the programmatic choices of traditional communication channels.

Web platform/landing page: in view of the evolution of digital communication, the most efficient choice is to create a structured platform or landing page that will serve as 'support' for the basic information that will then be conveyed with the other tools.

The web space is, therefore, understood in this document as a dedicated space in a web platform to be defined, and will be the transversal tool for the various target/stakeholders and complementary to the other off-line and on-line communication tools envisaged. A web space, to be useful and effective, needs to make use of a content organisation consistent with the specific objectives and must contain correct, original, updated and optimised information.

In this respect, it is necessary to plan a web space dedicated to the project objectives. In particular, the realisation of the tool will consist of the articulation of the navigation tree that will serve to subdivide the sections and contents according to a result-oriented scheme, the realisation of the technical wireframes for the organisation of the spaces of the home and internal pages, and the final graphic draft that combines the reasoned subdivision of the contents and services within the space and the web page with the graphic output elements of the space itself. The website will have as design features the activation of an intuitive navigation system, which will allow access to the contents in a short time, an editorial slant that balances a section dedicated to up-to-date news with sections dedicated to thematic in-depth analysis, a space dedicated to scheduled events, a service dedicated to initiatives and general information related to the main themes of the project. The quality of the information will also have to provide for the proper integration of the so-called 'web 2.0' tools, which allow for direct participation, especially by young people, and the use of multimedia supports that will complete the information used. In particular, a multimedia section (audio, video and photos) created on the most popular social platforms (YouTube, for example) should be envisaged. Particular attention should be paid to those activities aimed at increasing the volume of traffic that a web space receives from search engines, according to the practice, now in use, of optimisation, or SEO (Search Engine Optimisation), which is part of a more complex strategy of search engine marketing, SEM (Search Engine Marketing).

SEO activities are usually divided into OffPage SEO relating to the technical activities of promotion, dissemination, sharing and socialisation within the web, and OnPage SEO, i.e. the activities carried out directly on web pages (beware of duplicate content, typos, using a minimum of 300 words per article, including categories, etc.). The search engine optimisation activity is functional to the positioning of the web space in the response pages of the search engines, in order to give greater visibility to the content and services on the site. A website that can be found in the top places of search engines (Google, Yahoo, Bing, etc.), i.e. in the top 5-10 entries, is recognised as a quality site and therefore enjoys greater popularity on the web and an influx of visitors.

4.1.5.2 Social media mix

Social networks represent an important communication tool for making oneself visible and disseminating one's activities, especially if these also involve a youth population. The decision to implement a communication based on the use of several social networks presupposes a knowledge of

the organisational and functional dynamics of the various tools, as well as a planning of the presence, the consistency of communication of the contents and the methods of contact with users.
Each social network is born with a purpose, therefore the choice of the social media mix to be associated with the web space dedicated to the project must be made by considering the different types and potential of the most widespread social networks. It is not necessary to use all the tools of Web 2.0, while it is necessary to have a clear understanding of the function of the social network, in order to manage the facilitations and criticalities that its use entails and to make a functional discernment for successful communication. To be useful and effective, moreover, the presence on the social network must be thought out in relation to the project's objectives and identity. This reflection has repercussions not only on the choice of social media, but also and above all on the language to be used.
The strength of information on social media certainly lies in its gratuitousness and ease of use, in its penetration within the target's lifestyle and type of consumption, and, from a functional point of view, also in its synergy. The social network is intended for the creation of long-term relationships, capable of promoting institutional activity and providing feedback to it. Web space, Facebook, Twitter, etc. must, therefore, be complementary to each other in order to spread one's message in a capillary and perfectly integrated manner, giving substance, resilience and longevity to the online presence. The social network is an opportunity for dialogue and confrontation with one's target audience. It is therefore necessary to have a constant institutional presence that moderates the messages left on the noticeboard and does not allow, for example, the insertion of unauthorised advertising messages or polemical discussions. For organisational purposes, social media were ideally grouped into three groups, related to the different activities to be undertaken:

1. Social networks and collaborative tools:
- Facebook
- Twitter
- Linkedin
- Whatsapp
- Telegram
2. Video and data sharing platforms:
- SlideShare
- Youtube
- Instagram
- Tik Tok

3. Aggregators: RSS.

4.1.5.3 WebAPP

The idea is to offer the information conveyed through the other channels, especially the digital ones, also through an application for smartphones - Android, iOS, Windows mobile - that performs an informative function and offers the possibility of a customised use according to the interests of each individual recipient.
Searching for and accessing information today mainly takes place from mobile devices. For web and mobile apps for sharing and acquiring information, the perceived added value is that of speed of action. If these apps are then supplemented with a filtering mechanism that allows the user to receive and share information that directly meets his or her interest and a series of useful services for the management of more or less daily activities, the data tell us that the use of the app becomes systematic (at least once a day) and continuous (the app is hardly ever removed from the smartphone).
The app that you want to make must be designed to respond more precisely to the user's need for information and service. It will allow the user to select not only the topic on which he wishes to be informed, but also the geographic area on which his interest is focused and, based on his selections, the app will provide him with information and news (news, initiatives, etc.). It is important that the

app responds to the needs of the different types of recipients and that it can enable dual and interactive communication, with a special section aimed at operators carrying out actions in the field of waste management.

4.1.5.4 Mass media

Information in local and regional newspapers and specialised periodicals: These media will be used mainly to provide in-depth information on significant moments or important milestones in the implementation of the project.

Radio information: initiatives will be set up that envisage the use of the local radio medium to organise, according to need: information spots, radio passages, participation in in-depth programmes.

Television information: similarly to what is envisaged for the radio media, the possibility of collaborating with television broadcasters will be assessed for the provision of services, both production and broadcasting, assuming various television ‘products’, such as, for example, journalistic formats; videos and documentaries.

The main objective of the media relations activity will be to organise stable relations with the mass media in order to give visibility and keep the target audience's interest in the project high. The objective will be pursued through the tools and activities of the press office, which will accredit itself as an institutional source of information able to produce press releases, organise press conferences, prepare thematic press kits and plan interviews or reports with newspapers, radio and television stations and implement other actions of contact with the media in order to obtain attention on the key issues of the project.

The actions of the press office must be aimed at obtaining attention and visibility in the main media present, in particular, the information will be constructed to be conveyed in newspapers with local circulation, local periodicals, local television stations, radio stations, and on-line information newspapers present at the regional level. In particular, media relations activities will have the following specific objectives:

- inform the public;
- inform and raise awareness among stakeholders;
- disseminate practical information on how and when to implement the project;
- disseminate results and good practices;
- monitor the press and the project's topics of interest to check sentiment on key topics;
- plan and design the production of articles and editorial television reports to reinforce the dissemination of messages and offer in-depth coverage based on the target audience;
- support with press office activities the organisation and dissemination of events.

Media relations will be managed in such a way as to transfer content through a simple, clear and concise language that avoids redundancies and can therefore be adapted in a versatile manner to the needs of the various media, always keeping the general objectives and goals of the strategy designed at the center of the message.

Media relations actions will be implemented in constant coordination and connection with the Press Office structure, as well as with the other communication activities and with particular attention to web and social tools that can also convey the content released by the press office.

In order to guarantee a punctual and efficient media relations activity, a continuous and constant monitoring of the media will have to be carried out with the aim of obtaining a point of observation towards the socio-economic scenario, the reference themes related to the project, the stakeholders and the reference targets. This activity will have to be placed side by side with the periodic monitoring of the activities carried out for the implementation of the communication strategy, with the final aim of processing the information gathered internally and externally and giving rise to the most appropriate strategies for the implementation of media relations actions. This is a fundamental listening and analysis work useful to define the methods and timing of media relations activities and

to provide information in the most responsive way possible to the needs of the media and thus obtain the best visibility and circulation of information.
Within the media relations activities, particular importance will be given to Media Planning activities for the purchase and management of editorial space on local television stations with the aim of ensuring greater and constant visibility for the project contents. Through the editorials, the individual project activities will be able to obtain specific in-depth spaces within programmes and columns in order to reach the reference targets as well as the mass audience. The purchase of editorials will be planned and their contents will be designed in such a way as to schedule them in conjunction with the organisation of events and press conferences and thus achieve an information amplification effect. These specifically are the tools that will be adopted to implement the objectives:

- monitoring of press releases and programming of editorial services;
- preparation, management and continuous updating of media lists;
- drafting and sending press releases and press folders;
- production and dispatch of content for specific containers in the various media (columns, news, in-depth reports, interviews, etc.);
- one-to-one contacts with the press;
- support for the organisation of press conferences;
- press office activities to support the organisation of events;
- identification and creation of content for editorial releases;
- production of digital and printed press releases.

<u>Kick-off press conference</u>
In an effective integrated communication strategy, the first step is the presentation to the press, public opinion, stakeholders and the target audience of the organisational structure, objectives and initiatives to be implemented for the success of the project. Obviously, in order for the presentation to be targeted and successful, there must be fundamental premises that avert the risk - often underestimated or even worse ignored - of creating an event that has the effect of a boomerang and damages the reputation and positioning in the public arena of the communication strategy and the project. To avert this hypothesis, the preparation of the presentation press conference should take place once the first organisational structuring goals have been achieved, the start of the activities envisaged in the strategy document and the web positioning of the online tools.
Through the press conference, it will thus be possible to achieve a first level of promotion of the activities, share the key principles and tools of communication and the project, and foster the dissemination and accessibility of information to the relevant target/stakeholders. The objective of the press conference will be to present to participants the strategic aims and programme of initiatives, interventions, etc. that are to be pursued with the project.
The target audience for the press conference will primarily be journalists from agencies, print media, TV, the web, but also other institutions, associations and of course citizens. For the realisation of the press conference, it will be necessary to decide on the most suitable location and provide an adequate logistical or, if necessary, online set-up. As far as possible, it will be necessary to inquire about possible related events planned for the chosen date, also assessing the scheduling of periodicals (especially those in the sector), as well as newspapers. The conference should not last longer than 1.5 hours. Since the target audience is also likely to include a stratification of young people, agreements could be envisaged with some schools and training institutes to have delegations of students present, who will then become promoters (word of mouth) to their peers of the activities and purposes of the communication.
Tools to promote the press conference are: press invitation, planning of related press office activities and press kit. The announcement of the conference should have a specific and targeted content to intrigue the press. It will be necessary to monitor and pace the press release accordingly for newspaper agendas and agency notebooks.

The press kit should tend to contain: press invitation, press release, speech of the mayor and governor or whoever is delegated to represent the institution, presentation sheet of the strategic communication document, profile of the speakers, any additional documentation.

Own publishing products

Information material (below the line): information material such as leaflets and brochures, posters, posters and flyers, brochures, etc. will be prepared. The use of the paper format will be particularly reduced, while the digital format should have the greatest preponderance. In any case, information material will be prepared mainly for situations of territorial animation and for the valorisation of initiatives that take place in lesser known areas or for areas of local relevance.
The proposal of editorial products was born with the idea of achieving a double objective: one communicational and one informative. Given the themes, the type of target audience and the possibilities of distribution and use, various specific editorial lines are hypothesised according to content and target audience. In this section we illustrate example-proposals of products to be realised over the course of the project.
The quantities and types envisaged constitute a hypothesis consistent with what has been outlined so far, but will have to be contextualised in the execution phase. All editorial products may, eventually, be printed, and the relevant digital formats will certainly be created to enable their dissemination via the web and better use on portable devices such as smartphones, tablets and PCs. The information material will also have to be disseminated and shared on the 'SlideShare' social platform and other social solutions such as Facebook, Twitter, etc. As far as video formats are concerned, in addition to the social networks mentioned, a dedicated channel on the YouTube platform will be provided.

Promotional poster

In order to promote broad participation by the different targets, posters will be produced with the distinctive elements of the final communication, any other chosen visual elements, etc. In particular, posters could be designed to publicise events, with QR-codes through which additional content of the communication campaign can be accessed online and on the move, directing e.g. to pages of the dedicated web space where value-added content can be found, debates within the social community, videos on YouTube, texts or text messages.

Publication

At the end of the project, we envisage the realisation of a publication on good practices, also in downloadable e-book format. This will be a publication of a technical and informative nature, the main purpose of which will be to 'summarise' the specific features of the project and to describe the good practices implemented. The publication may have an institutional slant, which will be reflected in the choice of language and graphic design, favouring simple lines, a judicious use of colours and graphic elements. Consistent with the communication objectives, the language will be concrete and practical, guaranteeing the accuracy and punctuality of the contents while attempting, at the same time, to make some linguistic simplifications to make the contents accessible also to non-experts. The paper version will be flanked by a multimedia version that will also collect video testimonies with related photographic reviews that highlight and emphasise the selected interventions.

Brochure

A first-level communication tool, intended for a wide dissemination and audience. The brochure takes the form of a classic multi-page leaflet and its primary objective is to convey the main contributions of the project, its objectives, the extent of funding, information sources, etc. Using simple language that is accessible to the general public and especially to young people, the brochure will be clearly organised so that it can be readily consulted and understood.

4.2 Monitoring the management of waste treatment plants for the application of Best Available Techniques

The following is a table of general prescriptions that go into the merits of how the activity is to be conducted, dictating provisions and prescriptions concerning environmental management systems and other essential aspects concerning monitoring and certain environmental impacts common to all types of plants.
In order to improve the overall environmental performance of the installation, all techniques listed below will be used.

a. Prepare and implement pre-acceptance and waste characterisation procedures.
b. Develop and implement waste acceptance procedures.
c. Develop and implement a waste traceability system and inventory.
d. Establish and implement a quality management system for the output of products.
e. Ensure segregation of waste.
f. Ensure the compatibility of waste before dosing or mixing.
g. Sorting of incoming solid waste.

In order to promote the reduction of emissions into water and air, an inventory of waste water flows and gas discharges shall be maintained within the environmental management system, including all of the following:

1) information on the characteristics of waste to be treated and waste treatment processes, including:
   a. simplified flow charts of processes, indicating the source of emissions;
   b. Descriptions of process-integrated techniques and treatment of waste water/gas at source, including their performance;

2) information on the characteristics of waste water flows, including:
   a. mean values and variability of flow, pH, temperature and conductivity;
   b. Average concentration and loading values of relevant substances (for example COD/TOC, nitrogen compounds, phosphorus, metals, priority substances/micro pollutants) and their variability;
   c. Bio-eliminability data [for example BOD, BOD/COD ratio, Zahn-Wellens test, biological inhibition potential (for example activated sludge inhibition)

3) information on the characteristics of waste gas flows, including:
   a. mean values and variability of flow and temperature;
   b. Mean values of concentration and loading of relevant substances (for example, organic compounds, POPs such as PCBs) and their variability;
   c. Flammability, lower and higher explosivity limits, reactivity;
   d. Presence of other substances which may affect the waste gas treatment system or the safety of the plant (e.g. oxygen, nitrogen, water vapour, dust).

All the techniques listed below will be used to reduce the environmental risk associated with the disposal of waste.

A. Optimal location of the depot. Techniques include:

- Location of the repository as far away from sensitive receptors, watercourses etc. as technically and economically feasible,

- location of the repository which can eliminate or minimise unnecessary waste handling within the installation (for example, to avoid that a waste is handled twice or more times or transported on unnecessarily long routes within the site).

B. Storage capacity is adequate. Measures shall be taken to avoid the accumulation of waste, for example:

- the maximum capacity of the waste repository is clearly established and not exceeded, taking into account the characteristics of the waste (for example with regard to fire risk) and the treatment capacity,
- the quantity of waste deposited is regularly monitored in relation to the maximum permitted storage capacity,
- The maximum retention time of the waste is clearly defined.

C. Safe operation of the storage facility. Measures include:

- Clear documentation and labelling of equipment used for the loading, unloading and storage of waste;
- Waste known to be sensitive to heat, light, air, water etc. is protected from such environmental conditions,
- containers and drums and are fit for purpose and safely stored.

Separate space for the storage and handling of packaged hazardous waste. Where appropriate, a space shall be used for the storage and handling of packaged hazardous waste.
In order to reduce the environmental risk associated with waste handling and transfer, a procedure shall be implemented which will include:

- Waste handling and transfer operations by competent personnel,
- Properly documented, validated before execution and verified after execution waste handling and transfer operations,
- Taking measures to prevent, detect and limit spills,
- When waste is dosed or mixed, precautions are taken at the operational and design level (for example aspiration of powdery or floury waste).

Handling and transfer procedures shall be risk-based taking into account the likelihood of incidents and accidents and their environmental impact.
For emissions to water identified as relevant in the waste water flow inventory, the best available technique will be to monitor key process parameters (e.g., flow, pH, temperature, conductivity, BOD of waste water) at key points (for example, at the inlet and/or outlet of pre-treatment, at the inlet of final treatment, at the point where emissions escape from the installation).
Water emissions shall be monitored at least at the following frequency:

Substance/Parameter	Waste treatment process	Minimum monitoring frequency
Adsorbable organic halogen compounds (AOX)	Treatment of water-based liquid waste	Once a day
Benzene, toluene, ethylbenzene, xylene (BTEX)	Treatment of water-based liquid waste	Once a month
	All waste treatments except water-based liquid waste treatments	Once a month

Substance/Parameter	Waste treatment process	Minimum monitoring frequency
Chemical oxygen demand (COD)	Treatment of water-based liquid waste	Once a day
Free cyanide (CN-)	Treatment of water-based liquid waste	Once a day
Hydrocarbon Index (HOI)	Mechanical treatment in metal waste shredders	Once a month
	Treatment of WEEE containing VFC and/or VHC	
	Waste oil regeneration	
	Physico-chemical treatment of waste with calorific value	
	Washing contaminated excavated soil with water	
	Treatment of water-based liquid waste	Once a day
Arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), lead (Pb) and zinc (Zn)	Mechanical treatment in metal waste shredders	Once a month
	Treatment of WEEE containing	
	Mechanical biological treatment of waste	
	Waste oil regeneration	
	Physico-chemical treatment of waste with calorific value	
	Physico-chemical treatment of solid and/or pasty waste	
	Regeneration of spent solvents	
	Washing contaminated excavated soil with water	
	Treatment of water-based liquid waste	Once a day

Substance/Parameter	Waste treatment process	Minimum monitoring frequency
Manganese (Mn)	Treatment of water-based liquid waste	Once a day
Hexavalent chromium Cr(VI)	Treatment of water-based liquid waste	Once a day
Mercury (Hg)	Mechanical treatment in metal waste shredders	Once a month
	Treatment of WEEE containing VFC and/or VHC	
	Mechanical biological treatment of waste	
	Waste oil regeneration	
	Physico-chemical treatment of waste with calorific value	
	Physico-chemical treatment of solid and/or pasty waste	
	Regeneration of spent solvents	
	Washing contaminated excavated soil with water	
	Treatment of water-based liquid waste	Once a day
PFOA PFOS	All waste treatment	Once every six months
Phenols index (6)	Waste oil regeneration	Once a month
	Physico-chemical treatment of waste with calorific value	
	Treatment of water-based liquid waste	Once a day
Total nitrogen (total N)	Biological waste treatment	Once a month
	Waste oil regeneration	
	Treatment of water-based liquid waste	Once a day

Substance/Parameter	Waste treatment process	Minimum monitoring frequency
Total organic carbon (TOC)	All waste treatment except water-based liquid waste treatment	Once a month
	Treatment of water-based liquid waste	Once a day
Total phosphorus (total P)	Biological waste treatment	Once a month
	Treatment of water-based liquid waste	Once a day
Total Suspended Solids (TSS) (6)	All waste treatment except water-based liquid waste treatment	Once a month
	Treatment of water-based liquid waste	Once a day

Monitoring of emissions to air at least at the following frequency
The pollutants related to the "biological waste treatment" process applicable to the wet fraction are listed below.

Substance/parameter	Minimum frequency (1)
H_2S (4)	semiannual
NH_3 (4)	semiannual
Odour concentration (5)	semiannual

Periodic monitoring of odour emissions. Odour emissions can be monitored using:

- Dynamic olfactometry to determine the concentration of odour emissions or by determining exposure to odours
- The impact of smell

Frequency of monitoring determined by an odour management plan. Applicability is limited to cases where olfactory harassment at sensitive receptors is probable and/or proven.
Monitoring at least once a year of the annual consumption of water, energy and raw materials as well as the annual production of waste and sewage.
Monitoring includes direct measurements, calculation or recording using, for example, invoices or appropriate counters. Monitoring shall be conducted at the most appropriate level (for example,

process or plant/installation level) and take into account any significant changes made to the plant/installation.

To prevent odour emissions, or if this is not possible to reduce them, an odour management plan shall be prepared, implemented and regularly reviewed as part of the environmental management system, including all of the following:

- a protocol containing actions and deadlines;
- a protocol for the monitoring of odours;
- a response protocol in the event of identified odour events, for example in the case of complaints;
- a programme for the prevention and reduction of odours, to identify the source or sources; characterise the contributions of the sources; implement measures for prevention and/or reduction.

Applicability is limited to cases where olfactory harassment at sensitive receptors is probable and/or proven.

To prevent odour emissions, or if this is not possible to reduce them, one or a combination of the techniques below shall be applied.

a. Minimising retention times: Minimising the time spent in storage or handling systems of (potentially) odorous waste (eg piping, tanks, containers), especially under anaerobic conditions. Where appropriate, appropriate arrangements shall be made for the acceptance of seasonal peak waste volumes. Applicable only to open systems.

b. Use of chemical treatment: use of chemicals to destroy or reduce the formation of odorous compounds (for example, by oxidation or precipitation of hydrogen sulfide). Not applicable if it may hinder the desired quality of the output product.

c. Optimisation of aerobic treatment: in case of aerobic treatment of water-based liquid waste, it may include:

- Use of pure oxygen,
- Removal of foams in tanks,
- Frequent maintenance of the ventilation system.

In order to prevent diffuse emissions into the atmosphere - especially of dust, organic compounds and odours - or if this is not possible to reduce them, an appropriate combination of the techniques described below should be used.

a. Minimise the number of potential sources of diffuse emissions: techniques include:

- Properly design the layout of the piping (for example, minimising the length of the pipes, reducing the number of flanges and valves, using welded fittings and tubes);
- gravity transfer rather than pumps;
- limiting the height of fall of the material,
- limit the speed of circulation,
- Use of windbreaks.

b. Selection and use of high integrity equipment: techniques include:

- dual-seal valves or equally efficient equipment,
- high integrity seals (such as spiral metal seals, ring joints) for critical applications,
- pumps/compressors/agitators with mechanical seals instead of seals,
- magnetic pumps/compressors/agitators,

- appropriate access doors to service sleeves, punching pliers, punching heads (for example for degassing WEEE containing VFC and/or VHC).

c. Corrosion prevention: techniques include:

- appropriate selection of building materials,
- Internal or external coating of equipment and coating of pipes with corrosion inhibitors.

d. Containment, collection and treatment of diffuse emissions: techniques include:

- storage, treatment and handling of waste and materials that may generate diffuse emissions in buildings and/or equipment indoors (for example conveyor belts),
- maintaining the equipment or buildings indoors under adequate pressure,
- Collection and delivery of emissions to an appropriate abatement system using a system for extraction and/or aspiration of air near the emission sources.

(The use of equipment or buildings indoors is subject to safety considerations such as explosion risk or reduced oxygen content, and may also be subject to waste volume).

e. Wetting: Wet, with water or mist, potential sources of diffuse dust emissions (for example waste dumps, circulation zones, handling processes in the open).

f. Maintenance: techniques include:

- Ensure access to equipment that could leak,
- Regularly check protective equipment such as lamellar curtains, quick-action doors.

g. Cleaning of storage and waste treatment areas: includes techniques such as regular cleaning of the entire waste treatment area (rooms, circulation zones, storage areas etc.), conveyor belts, equipment and containers.

h. Leak Detection and Repair (LDAR) program. If emissions of organic compounds are expected, a leak detection and repair programme shall be developed and implemented using a risk-based approach taking into account: in particular, the design of the installations and the quantity and nature of the organic compounds concerned.

To prevent noise and vibration emissions, or if this is not possible to reduce them, develop, implement and regularly review as part of the environmental management system, a noise and vibration management plan including all of the following:

1. A protocol containing actions to be taken and appropriate deadlines;
2. A protocol for noise and vibration monitoring;
3. A response protocol in the event of recorded noise and vibration events, for example in the case of complaints;
4. A noise and vibration reduction programme to identify the source or sources of noise and vibration, measure/estimate exposure to noise and vibration, characterise the contributions of sources and apply prevention and/or reduction measures.

To prevent noise and vibration emissions, or if this is not possible to reduce them, apply one or a combination of the techniques below.

a. Appropriate location of equipment and buildings: noise levels can be reduced by increasing the distance between source and receiver, using buildings as sound-absorbing barriers and moving building entrances or exits.

b. Operational measures. Techniques include:

- Inspection and maintenance of equipment

- Closing doors and windows in indoor areas, if possible;
- Equipment used by experienced personnel;
- Avoid noisy activities at night, if possible;
- Noise abatement measures during maintenance, circulation, handling and treatment activities.

c. Low noise equipment: may include direct drive motors, compressors, pumps and torches.
d. Noise and vibration control equipment. Techniques include:

- owners of the property,
- Vibration and sound insulation of equipment;
- Indoor confinement of noisy equipment;
- Noise insulation of buildings.

e. Noise attenuation: The propagation of noise can be reduced by placing barriers between transmitters and receivers (for example, protective walls, embankments and buildings).

In order to optimise water consumption, reduce the volume of waste water produced and prevent emissions into soil and water, or if this is not possible to reduce them, use an appropriate combination of the techniques below.

a. Water management: Water consumption is optimised through measures which may include:

- water saving plans (for example setting water efficiency targets, flow charts and water mass balances),
- optimal use of wash water (e.g., dry cleaning instead of washing with water, use of trigger systems to regulate the flow of all washing equipment), reduction of water use for creating vacuum (for example by using liquid ring pumps, with liquids having a high boiling point).

b. Water recirculation: the water flows are re-circulated in the plant, after treatment if necessary. The degree of recycling is dependent on the water balance of the installation, the content of impurities (for example oily compounds) and/or the characteristics of the water flows (for example nutrient content).
c. Impermeable surface: depending on the risks of contamination of soil and/or water by waste, the surface of the entire waste treatment area (for example reception, handling, storage, treatment and dispatch areas) is made impermeable to the liquids in question.
d. Techniques to reduce the likelihood and impact of overflows and malfunctions in tanks and reservoirs: depending on the risks posed by liquids contained in tanks and reservoirs in terms of soil and/or water contamination, the techniques shall include:

- Sensors of overfilling;
- overflow pipes connected to a confined drainage system (that is, the secondary containment system or another reservoir),
- Liquid tanks located in a suitable secondary containment system; the volume is normally sized so that the secondary containment system can absorb the spillage of contents from the largest tank,
- Isolation of tanks, reservoirs and secondary containment systems (for example by closing valves).

e. Coverage of waste storage and treatment areas: depending on the risks they pose in terms of soil and/or water contamination, The waste is stored and treated in covered areas to avoid contact with rainwater and thus minimise the volume of contaminated run-off water.

f. Separation of water flows: each flow of water (for example surface run-off, process waters) is collected and treated separately, based on the pollutant content and the combination of treatment techniques used. In particular, uncontaminated wastewater streams are separated from those requiring treatment.
g. Adequate drainage infrastructure: the waste treatment area is connected to the drainage infrastructure. Rainwater falling on storage and treatment areas is collected in drainage facilities along with wash water, occasional spillage etc. and, depending on the pollutant contained, recirculated or sent for further treatment.
h. Design and maintenance arrangements to enable leak detection and repair: regular monitoring of potential leaks is risk based, and equipment is repaired if necessary. The use of underground components is minimised. If underground components are used and depending on the risks of soil and/or water contamination from the waste contained in these components, a secondary containment system shall be provided for these components.
i. Adequate temporary storage capacity: adequate temporary storage capacity for wastewater generated under non-standard operating conditions shall be established, using a risk-based approach (taking into account, for example, the nature of pollutants, the effects of downstream wastewater treatment and the receiving environment). Discharge of wastewater from the temporary storage is only possible after appropriate measures have been taken (for example monitoring, treatment, reuse).

To reduce water emissions, use an appropriate combination of techniques.

To prevent or limit the environmental consequences of incidents and accidents, use all techniques listed below as part of the accident management plan.

a. Protective measures. The measures include:
- protection of the installation against vandalism,
- Fire and explosion protection system, including prevention, detection and extinguishing equipment,
- Accessibility and operability of relevant control equipment in emergency situations.

b. Management of emissions from incidents/accidents: Procedures and technical arrangements (in terms of possible containment) are established to manage emissions from incidents/accidents, such as emissions from spills, from fire-extinguishing water or safety valves.
c. Recording and evaluation system of incidents/accidents. Techniques include:
- a log/journal of all accidents, incidents, changes to procedures and results of inspections,
- Procedures for identifying, responding to and learning from incidents and accidents.

To use energy efficiently, apply both techniques below.

a. Energy efficiency plan. The energy efficiency plan defines and calculates the specific energy consumption of the activity(s), establishes key performance indicators on an annual basis and plans periodic improvement targets and related actions.
b. Energy balance register. Energy consumption and production (including export) are reported by type of source (i.e., electricity, gas, conventional liquid fuels, conventional solid fuels and waste). Data include:
- information on energy consumption in terms of energy supplied;

- Information on energy exported from the installation;
- Information on energy flows (for example, Sankey diagrams or energy balances) indicating how the energy is used in the process.

To reduce the amount of waste to be disposed, reuse packaging as much as possible, within the framework of the waste management plan.

Packaging (drums, containers, IBCs, pallets, etc.) is reused for waste after a compatibility check with the previously contained substances when it is in good condition and sufficiently clean. Where necessary, packaging is treated (for example, reconditioned, cleaned) before re-use.