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PROGRESS AND CHALLENGES IN REDUCING WASTE IN THE ENVIRONMENT

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ABSTRACT
This study examines the development of mechanisms aimed at achieving the objectives of the circular economy and addressing contemporary environmental challenges. Particular emphasis is placed on enhancing resource efficiency through the reduction of environmental waste. The research identifies key challenges to waste reduction at both macro and micro levels. The study further aims to analyze shifts in individual environmental behavior, using case examples from one of the main districts of the Bulgarian capital, Sofia. The results of the study provide guidelines for managing sustainable consumer behavior.

Keywords: Circular Economy, Waste, Requirements
JEL: Q53, Q56, Q58

INTRODUCTION

The ecological survival of the planet is a widely discussed issue, a number of goals are set, various policies and regulations are adopted (1, 2) at all levels: from international and at the level of the Single European Policy, through national strategies, to the consumer behavior of companies and individuals in terms of environmental protection. The pursuit of ecological balance is increasingly associated with the adoption of the concept of the "circular economy". The concept is gaining popularity, both among the general public and among an increasing number of scientists and researchers. Among the main advantages of adopting the "circular economy" approach is the provision of multiple tools to address the economic, social and environmental challenges caused by the linear production model (3, 4).

According to most researchers in the field, the path to achieving the goals of the circular economy is closely linked to resource efficiency, by establishing a hierarchy in the generation and recovery of waste, including the prevention of waste generation, its reuse and recovery through recycling, reducing landfills and limiting their harmful impact on the environment and human health (5). This requires businesses to think about the implementation of their basic “entrepreneurial” and “social” processes. Companies that ignore circular goals, not understanding the need for recycling and recovery of waste, find themselves in an increasingly unfavorable situation compared to companies that are aware of it (6). Naturally, achieving resource efficiency by reducing waste is a very complex process, requiring large organizational and financial resources, both at the micro and macro levels.

Among the main activities at the macro level can be listed: introduction of environmental standards; financing of business expansion for the introduction of eco-design of products and technologies for efficient use of resources; training; high control over unregulated waste disposal/landfilling; involvement of the private sector in waste recycling; financing of new technologies for separation, treatment and processing of waste, etc. (7). Macro activities that provide conditions for waste reduction are as important as those at the micro level. The awareness of business organizations and individuals and their commitment are the other main participant in this ecological chain (8). Some of the main activities on their part, related to achieving the circular waste reduction goals, require: awareness of the need to reduce waste;

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introduction of innovative approaches to the choice of materials and product design; equipment; training; research and development. All this is related to the introduction of production models based on the philosophy of reduce, reuse, discard, rethink, redistribute, repair, recover, reuse, recycle and recover (9). It is important to note that business investments in this area lead to direct competitive advantages and the development of context-specific capabilities, as effective waste reduction leads to a reduction in company costs, a reduction in their harmful footprint, guarantees greater resource security, and increases their reputation and share price (10-12). In addition, they mediate the relationship between external pressure to reduce waste and firm performance (11).

The opportunity for waste reduction by end-users (households) should not be overlooked. Hamilton and Richards, 2019 (13) examine the waste of unused household food products. They define this group of waste (FLW) as a critical target for the world. On the one hand, from the point of view of their ecological footprint, and on the other hand, for the achievement of the UN Sustainable Development Goals No. 2 (zero hunger) and No. 12 (responsible consumption and production). A study by FAO shows that about 1.3 billion tons of edible food is lost as waste. It would be enough to feed about 97% of the undernourished population (14). In addition, it should be borne in mind that the resources invested in wasted food are equal to about one third of the available agricultural land, fresh water, fertilizers and pesticides used in production (14); In addition, a large group is waste from various product packaging. According to Abdalla at al., 2020 (15), plastic waste management is one of the critical issues that requires global measures due to its serious impact on the environment, economic activities, and social perceptions.

The purpose of this paper is to investigate the change in sustainable consumer behavior of end users. The examples for this are based on the realized behavior of a community of people inhabiting the capital of Bulgaria - Sofia. The main research question in this study is related to studying the reasons for the change in sustainable consumer behavior, which would suggest appropriate measures to encourage behavior to reduce waste and increase sustainable consumer practices. In order to find an answer to the research question below, the following paragraphs are presented sequentially: 2. Fundamentals of sustainable consumer behavior; 3. Effects of sustainable behavior and generation of consumer waste; 4. Example of change in sustainable consumer behavior; and 5. Guidelines for managing sustainable consumer behavior.

2. Fundamentals of sustainable consumer behavior

Sustainable consumer behavior is defined as one of the factors for achieving the UN Sustainable Development Goals and is based on the intersection of two concepts: first, the behavioral theory of human behavior in business; and second, the theory of a circular and sustainable economy.

First, in terms of behavioral theory, it expresses the understanding of the process by which individuals make decisions in a business environment. In many cases, it refers to the motivation of individuals in a particular business situation. In addition, consumer behavior studies the emotional, mental, and behavioral reactions of consumers related to product selection decisions (16, 17). Thus, it is perceived that the psychological, biological and social state of the individual determines the order and manner in which he chooses /products/ for himself and/or for the organization for which he works.

Second, resilience can be defined as the ability of ecosystems to maintain their functions and processes over time, while adapting to changing conditions. This includes maintaining ecological integrity, economic viability, and social justice for present and future generations (18). Following this understanding, sustainability in business is related to the impact/projection of the impact of business decisions on ecological stagnation and ecosystem maintenance in a way that ensures that businesses do not impact the biosphere and its long-term viability is not threatened (19).

In this context, "**sustainable consumer behavior** " should be seen as the end result of the actions of (end) consumers, which actions are related to satisfying their current consumer needs, without compromising the ability of future generations to satisfy their own consumer

and societal needs. Thus, sustainable consumer behavior includes choices and practices that minimize negative environmental impacts, promote social justice and support economic sustainability (20-22). In summary, sustainable consumer behavior considers the process of balancing economic, environmental and social goals and consequences that each individual pursues in the market.

Thus defined, sustainable consumer behavior is expressed in the presence of varying degrees of rationality of consumer choices depending on a number of differentiating /for society/ psychological, social and economic factors. Among the leading ones are: social stratification and income level; generational differences; attitude and perception towards consumer behavior, etc. The reason for this is the limited rationality and social (altruistic) preferences of individuals, which determine their attitude and perceptions towards sustainability (23). Moreover, sustainable consumer behavior can be induced by **including moral and ethical motivations in the sale of products and, accordingly, national environmental policies based on social norms, rewards and sanctions** can be more effective than pure price mechanisms in encouraging this sustainable behavior.

In terms of assessing social factors influencing sustainable behaviour, a distinction should be made between "sustainable behaviour" and "green behaviour". Green behaviour was introduced as a term by Ottman, 1993 (24) and developed by Gabriel and Lang, 1995 (25) as it is characteristic of consumers who are strongly motivated by environmental values and attitudes, expressed in an increased search for information about environmental products, and make a purchase decision based on these environmental criteria and in relation to environmental costs (26).

Additionally, understanding sustainable consumer behavior is related to measuring the results of this behavior. Thus, it is related to measuring the footprint that consumers and households leave behind their behavior and is related to improving the ecological and sustainable level of society (27). In this way, it is possible to understand the individual social and psychological factors of behavior that lead to neglect or stimulation of environmentally friendly consumer behavior. In this way, Goldstein and al., 2024 (28) posit the importance of ethnicity, education level and geo-demographic characteristics (age, income and gender) as influencing sustainable consumer behavior. Similarly, Guazzini and al., 2025 (29) also concluded that external factors such as demographic characteristics, education, and political beliefs can influence environmental behavior. In addition to the above, Nguyen and Tran, 2025 (30) investigated how collectivist culture and environmental concern influence the intention to make green purchases. Thus, the authors confirmed that Asian societies characterized by minimalism (Japan, China, Vietnam, etc. – ed.) express a clearer orientation towards environmental behavior, compared to consumerist societies (USA, EU, etc. – ed.). Similar conclusions are also drawn by Goswami and al. (31), who determine that in Eastern cultures, religious beliefs and spiritual practices often emphasize harmony with nature and responsibility towards the environment, and also values such as collectivism and long-term orientation, also strongly expressed in Eastern societies, encourage individuals to make decisions that benefit the community and future generations, including choosing sustainable products.

Considering the above, personal attitudes towards environmental practices cannot be linked to sustainable behavior. Thus Boyer and al., 2025 (32) found that green and sustainable shopping represent different social practices. Moreover, positive attitudes towards sustainable consumption often do not lead to a decrease in purchases due to the presence of unique combinations of meanings, perceptions and competencies. Similar conclusions are drawn by Lee S., 2025 (33), who found that consumers who believe they have control over their actions are more likely to purchase environmentally friendly products. Furthermore, while social influences play a role, individual attitudes and perceived control have a greater impact on consumer behavior.

In a summary of research on sustainable behavior Canoğlu and Üstüner, 2025 (34) analyzed how personal norms, social norms, and environmental awareness influence sustainable consumption intentions among Generation Z. Their findings confirm that social norms play the strongest role in promoting

sustainable behavior, while **environmental knowledge weakens the influence of social norms,** suggesting that social pressure matters less for more informed consumers. A further explanation of this social phenomenon is provided by Harantová and Mazanec, 2025 (35), with the social media generation choosing to shop at second-hand stores as a way to reduce their carbon footprint and oppose fast fashion culture, and they are also inclined to support brands and initiatives that demonstrate a commitment to sustainability and transparency.

3. Effects of sustainable behavior and generation of consumer waste

According to the theoretical study of "sustainable consumption", the results of this behavior should be determined, expressed in an assessment of waste /from consumption/, which result can be evaluated.

According to the European Commission, the EU generates over 2,000 million tonnes of waste annually from all economic activities and households, or 4.8 tonnes of waste per capita (36). In 2022, around 1,992 million tonnes of waste were treated in the EU (36). Due to the high costs of the required company investments to build complex waste reuse installations and redesign processes, a large part of companies resorts to illegal dumping, landfilling, off-site treatment or third-party management (37). Statistics show that currently between 15% and 30% of waste shipments are most likely illegal. Some waste shipments are not checked and are likely to be dumped or treated incorrectly, which increases environmental risks. Illegal waste trade is a serious missed opportunity for the reuse and recycling of materials (36). Waste levels in Europe can be seen in **Table 1**.

Table 1. *Waste levels in the EU*

Sector	Million tons	Title
construction	807	37.5%
mining industry	504	23.4%
waste and water	232	10.8%
production	230	10.7%
households	203	9.4%
services	95	4.4%
energy	50	2.3%
agriculture, forestry and fisheries	21	1%
wholesale of waste and scrap	10	0.5%

Source : Eurostat 2020, available at:
https://ec.europa.eu/eurostat/databrowser/view/ENV_WASGEN/default/table?lang=en

The wide variety of waste requires different approaches to its management (38). For this reason, the specifics of some of the main varieties are discussed below.

2.1. Municipal waste

In 2023, the total amounts of municipal waste generated vary significantly, from 303 kg per capita in Romania (2022 data) to 803 kg per capita in Austria (2022 data). The variations reflect differences in consumption patterns and economic wealth, but depend on the way waste is collected and managed. There are also differences between countries in the extent to which waste from commerce and administration is collected and managed together with waste from households (39).

Figure 1 illustrates the generation of municipal waste with a ten-year lag, in the EU countries arranged in ascending order (39). From the figure it can be summarized that despite the measures taken, the level of municipal waste has not been significantly reduced, on the contrary. In the EU only 46% of all waste is recycled, and globally less than 20%. This shows that there is a great potential for increasing recycling rates (40).

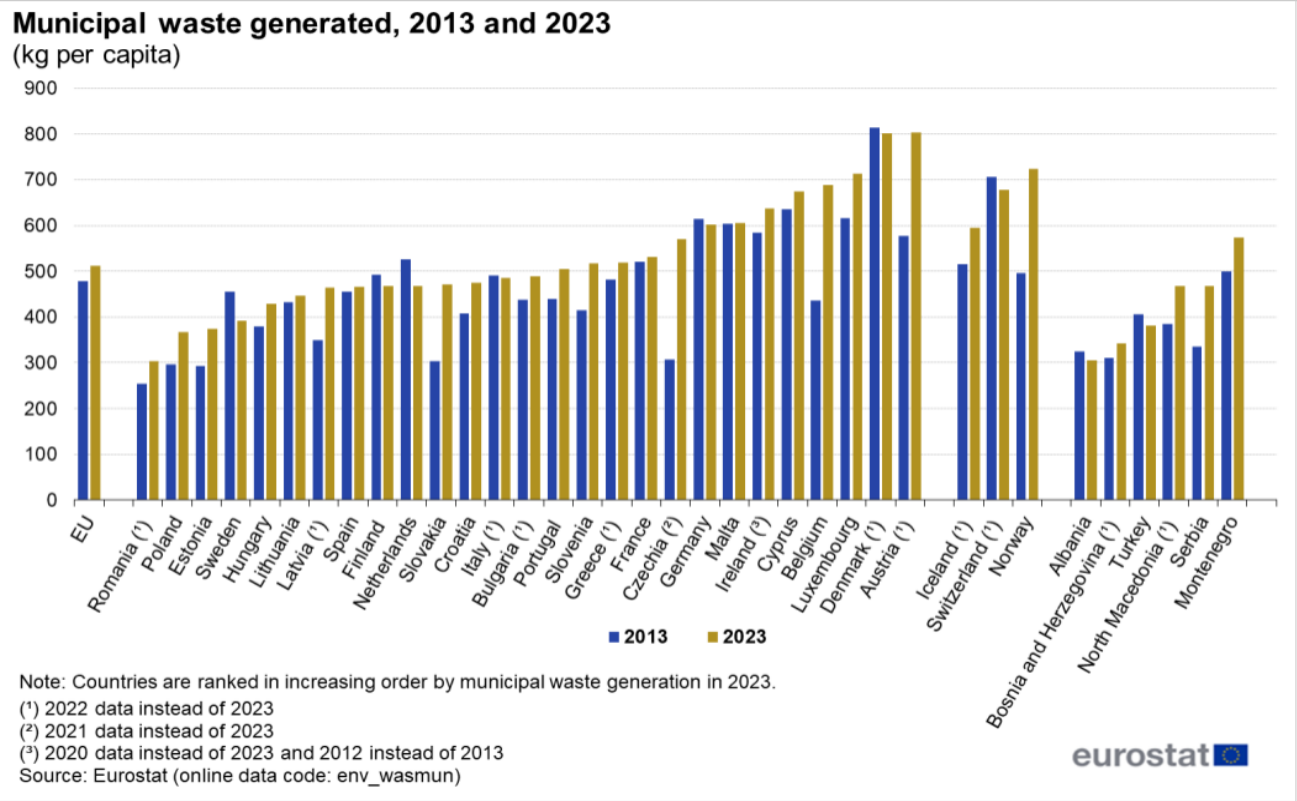

Figure 1. Municipal waste generation in the EU (comparison between 2013 and 2023)
Source: Eurostat, available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Municipal_waste_statistics

2.2. Plastic waste

Plastic waste causes lasting negative consequences on the planet. These include soil fertility and agricultural production; water pollution (rivers, lakes, oceans) and the threat to aquatic ecosystems. It should not be forgotten that the persistence of plastic waste in the environment raises serious concerns about the long-term effects on wildlife and human health, as microplastics enter the food chain and accumulate in organisms (41). The alarms related to the level of plastic waste are very worrying. A study by the Swedish Environmental Protection Agency in 2022 shows that the recycling rate of plastic waste in one country is 35%, and for the EU it is 40% on average (42). In terms of plastic waste management, it can be said that three main methods are applied: recycling, incineration and landfilling, with recycling considered the most effective, since converting waste into a reusable material would reduce the need for virgin plastic (43). However, according to Van Fan and al., 2022 (44) the effectiveness of recycling systems is controversial due to a number of technological aspects of waste sorting. At the same time, the costs of managing plastic waste are too high. According to a World Bank report, global management costs for 2025 are in the order of $ 375 billion (45). These costs represent a huge burden on municipal budgets, especially in developing countries where financial resources are scarce (43).

2.3 Construction and demolition waste

Construction and demolition waste (CDW) is the main generator of waste in society. The amount of CDW is growing along with the current global urbanization. According to a study by Kabirifar and his team (2020), China, the United States (US), and the European Union (EU) are the three largest generators of CDW (46). The composition of CDW includes many materials, the predominant part of which is concrete, which accounts for over 80% of CDW by weight in Europe (47), bricks, gypsum, wood, glass, metals, plastic, solvents and excavated soil, plastic, insulation (48). They are characterized by being mostly recyclable (49). The size of concrete in the total size of this waste group requires an emphasis on its management. Its recycling is expressed in the processing (wet processing system, advanced dry recovery system (ADR), thermal separation system and intelligent crushing system) of waste concrete into products and materials for

the production of new ones (48). However, statistics show that in some European countries concrete is still disposed of by landfilling (48). With regard to the remaining components in construction waste, it should be borne in mind that they have different resource values, but in their overwhelming part can be easily processed and returned to the production of construction materials. Despite their potential, the level of recycling and material recovery of construction and demolition waste varies significantly in the EU. In some countries it is less than 10%, while in others it is over 90% (50).

2.4. Hazardous waste

Hazardous waste can pose an increased risk to human health and the environment if not managed and disposed of safely. Akpan and Olukanni (2020) state that they are a serious risk to humans, and their consequences are associated with the emergence of a number of cancers, infectious diseases, hepatitis B and C (51). Statistics show that in 2022, 119.0 million tons (5.3% of the total) of waste classified as hazardous were generated in the EU (52). Unfortunately, their generation is increasing. Compared to 2010, 31.1% more hazardous waste was generated in the EU in 2022. This is an increase in quantitative terms from 90.8 to 119.0 million tons. Even more alarming is that in recent years the increase in their level has increased even more. Between 2020 and 2022, they increased by (25%), which is largely due to an almost eightfold increase in the volume of hazardous waste in Finland during this period. In 2022 the share of hazardous waste in total waste generation is between 0.7% in Romania and 24.6% in Finland (52).

Figure 2 shows the levels of hazardous waste over a 12-year period. It can be concluded from this that despite the period that has passed, no significant progress has been recorded in their reduction.

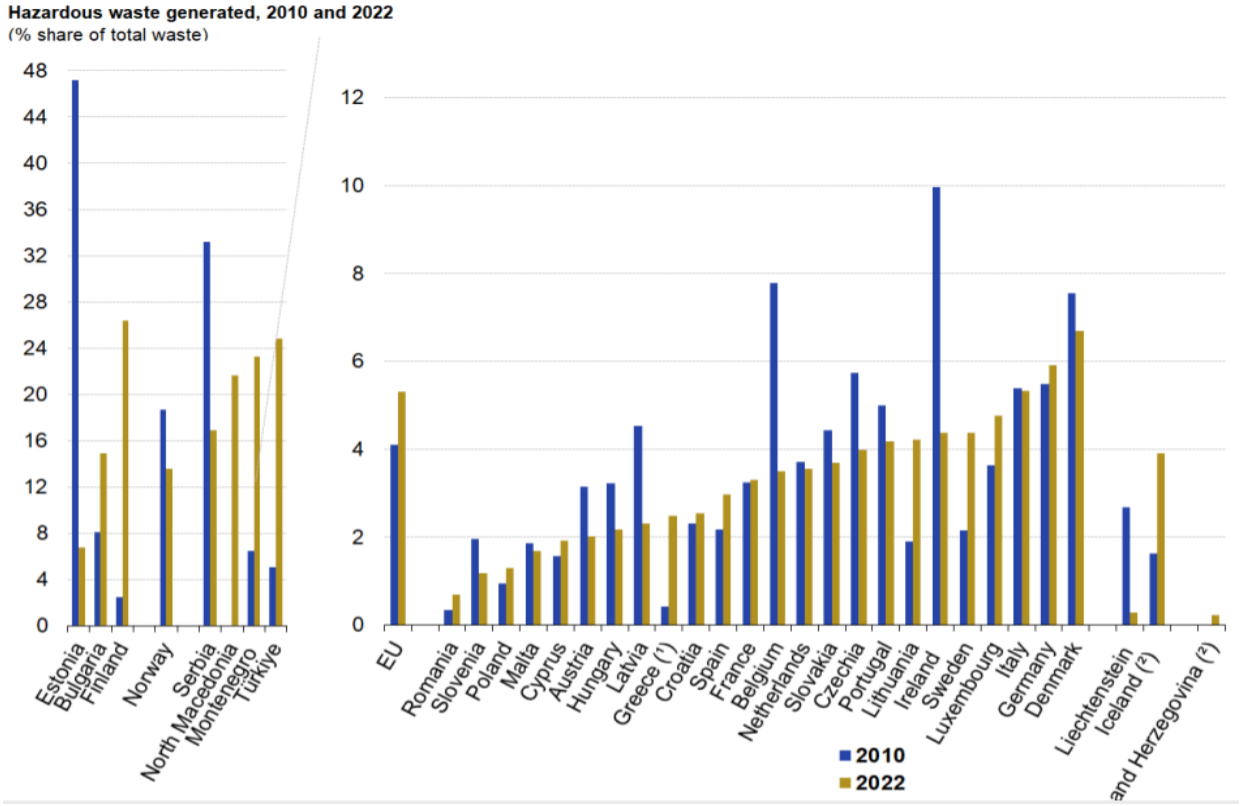

Figure 2. Hazardous waste generated, 2010 and 2022 (% of total waste)
Source : Eurostat (env_wasgen)

A total of 99.6 million tonnes of hazardous waste were treated in the EU in 2022, with more than 70% of this being treated in just four EU countries, Finland (29.3 million tonnes or 29.5% of the EU total), Germany (21.4 million tonnes or 21.5%), Bulgaria (13.7 million tonnes or 13.7%) and France (7.5 million tonnes or 7.5%) (51).

4. Sustainable consumer behavior: the example of Sofia

As was established by the literature review, sustainable consumption is associated with

established differences in the psychological, demographic and economic status of consumers. On this basis, the study of the manifestation of sustainable behavior can be conducted for one of the districts of Sofia: Krasna Polyana.

From the disclosed data, (53, 54) the following features of the Krasna Polyana region can be systematized:

- The Krasna Polyana district is located in the western part of Sofia and is one of the 24 administrative districts of Sofia Municipality. With an area of 9.20 km², it ranks 15th in size in the city. According to 2023 data, its population is approximately 63,790 people.
- The Krasna Polyana district is characterized by a lower share of the economically active population compared to other districts of Sofia. According to data, the share of economically active persons aged 15 to 64 varies from 42.4% to 77.9% in the different administrative districts of the capital, with Krasna Polyana being among the districts with lower values. However, the district has potential for economic development, especially in the field of services and trade, thanks to its good transport connections and the presence of educational and cultural institutions.
- The Fakulteta neighborhood, part of the Krasna Polyana district, is known for its compact Roma population and is considered one of the largest Roma neighborhoods in Sofia. Historically, the neighborhood has been isolated from the rest of the city, which has led to social and economic challenges for its residents. The neighborhood is characterized by high unemployment rates and low incomes. These factors, along with limited access to education and healthcare, contribute to the social and economic vulnerability of the residents of Fakulteta.

Regarding the assessment of sustainable behavior, the indicator chosen is: household waste generation. The reason is that a large part of plastic, construction and hazardous waste is generated by business and their reporting can change the assessment of sustainable behavior. Moreover, according to the NSI, household waste includes waste generated by households, as well as other waste that is similar in nature and composition to household waste. This definition encompasses waste from commercial establishments, offices and institutions that are similar in nature to household waste.

Thus, the data of the Sofia Municipality on the collected household waste from the Krasna Polyana region in Sofia for the period 2023-2024 vary between 17.5 and 29.0 kilograms of household waste per person per month, with the average monthly waste being 22.08 kilograms of household waste. **Figure 3** shows the level of household waste generated in Krasna Polyana district.

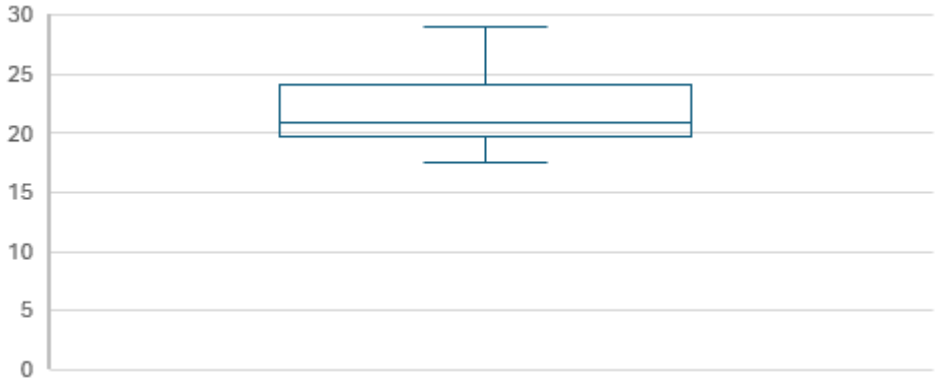

Figure 3. Generated household waste, Krasna Polyana region, 01.2023 – 03.2025.
Source : Sofia Municipality

Compared to the annual data for 2010 (55), according to which the amounts of household waste generated in the country vary between 1–2 kg per day per inhabitant, they decrease, and for the period 2023-2024 in the Krasna Polyana region they vary from 0.6 kg to 1.0 kg. per day per inhabitant.

The identified change can be traced in **Figure 4**, which tracks the average annual household waste in Sofia for the period 2004 - 2023.

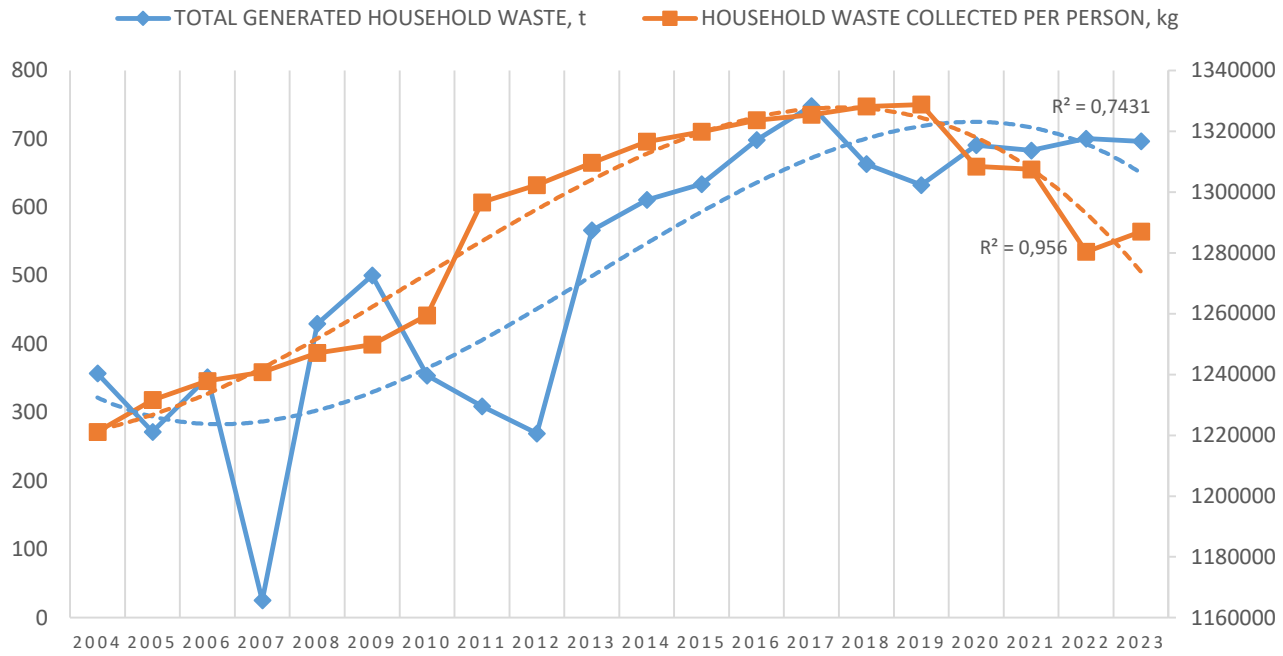

Figure 4. Generated household waste, in Sofia, by year, 2004-2023
Source : Sofia Municipality

The change in sustainable behavior towards reducing the generated household waste for the Krasna Polyana region can be traced in **Figure 5**, which shows that the average monthly waste decreases by nearly 20% in 2025 compared to 2023, i.e. by over 4.5 kg of household waste per month per resident.

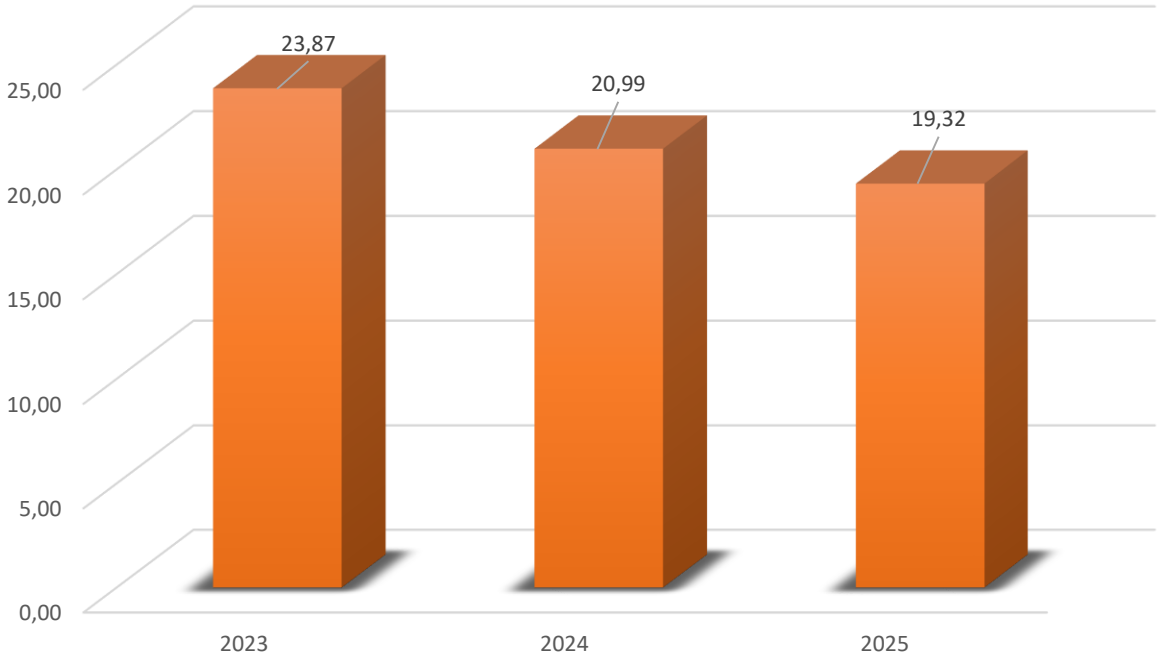

Figure 5. Generated household waste, Krasna Polyana region, by year, 2023-2025
Source : Sofia Municipality

As a summary of the data, a curve can be drawn that shows the trend for reducing household waste.

Trends in generated household waste, Krasna Polyana region are shown in **Figure 6**.

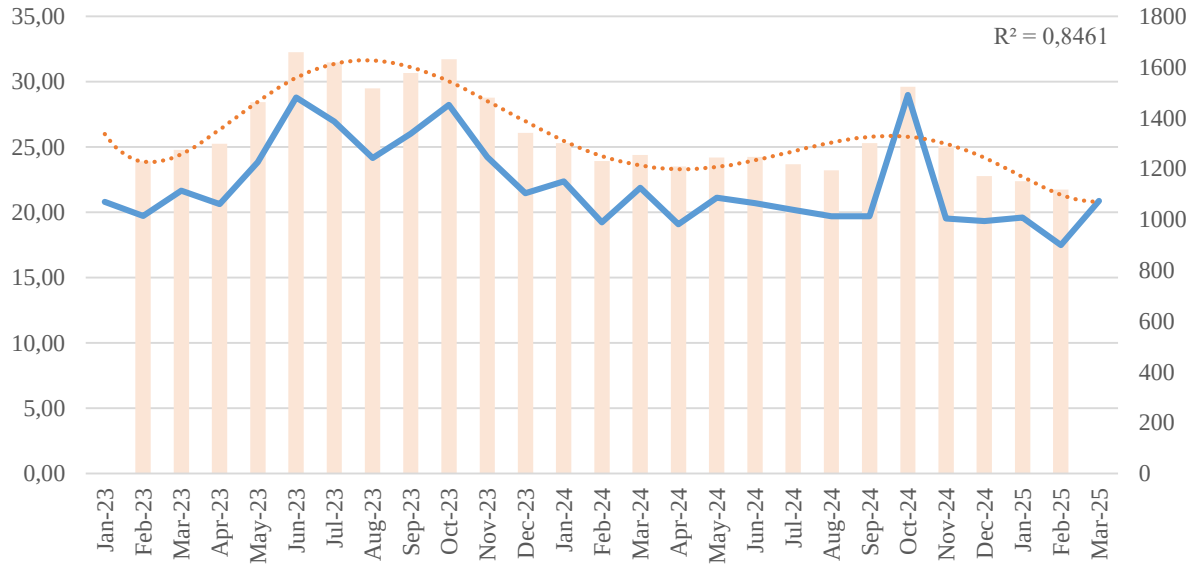

Figure 6. Trend in generated household waste, Krasna Polyana region, 2023-2025
Source : Sofia Municipality

The main reasons for the shown decrease in the generated household waste in the Krasna Polyana region compared to the average for the city of Sofia are:

- lower share of the economically active population compared to other areas of Sofia;
- The neighborhood is isolated from the rest of the city, which has led to social and economic challenges for its residents.
- There is also the highest share of the young population, for whom social factors are much stronger than individual behavior.

5. Guidelines for managing sustainable consumer behavior

Regardless of the good indicators regarding the sustainable behavior of the residents of the Krasna Polyana region, it is necessary for this sustainable behavior to be linked to municipal environmental protection policies.

Following the data above and by conducting a brainstorming session among representatives of Generation Z, related to social and economic measures to encourage sustainable behavior of residents, the following recommendations can be derived to the Sofia Municipality for inclusion in the plan for the so-called Green Capital:

- Expanding the bio-waste collection program

It is proposed to expand the existing separate collection infrastructure by including large manufacturers, health food stores, supermarkets, hospitals, children's camps and farmers' markets. This can be achieved by providing specialized containers (bins) for the collection of biodegradable waste, in order to improve selection at the point of generation and minimize mixed waste.

- Creating community composting sites

It is proposed to build localized compost areas in city parks and inter-block spaces, especially where significant amounts of green waste accumulate - foliage, branches and plant residues. Composting should be carried out without the use of artificial additives, under strictly controlled natural conditions, which guarantees an environmentally friendly process and the production of high-quality humus.

- Encouraging sustainable behavior through a digital reward system

Introducing an app to scan properly disposed waste in the appropriate container could actively engage citizens. Each scanned piece of waste earns points that are accumulated in a user profile and can be exchanged for products or services from local merchants. This solution encourages individual responsibility and creates positive feedback through gamification.

- Educating children about environmental behavior through interactive machines in parks

It is proposed to install machines near playgrounds that respond with a thank-you message or provide coupons when throwing waste in the correct bin. After accumulating a certain number of coupons, the child can receive a symbolic reward at specialized points. This approach combines fun with educational effect

and building ecological habits from an early age.

- Organizing events with recyclable access

To promote sustainable practices, cultural and musical events can be organized where, instead of a traditional ticket, access is secured by handing over a certain amount of recyclable waste. Such initiatives raise awareness about waste management and engage participants in a non-standard and interactive way.

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