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Policies for Achieving Circular Economy Goals in Urban Environments: Case Studies in Greece

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Abstract

The survey refers to the European Union's policies and guidelines for tackling environmental challenges by achieving circular-economy objectives, specifically in urban environments, while considering Sustainable Development objectives. The research then focuses on the national-level policies and key directions proposed in Greece to achieve circular economy goals in urban environments. It focuses mainly on the Municipality of Nea Smyrni, which has undertaken substantial efforts in this direction. Specifically, it examines the strategies developed to promote the circular economy across waste management, the reuse of natural resources, and public information and awareness. To conduct this in-situ research, personal interviews with the Municipality's technical service and statistical data were used. Finally, the adopted policies are evaluated, and new measures are proposed to further strengthen the circular economy and the sustainable development of the urban environment.

4.1 Introduction

Recently, the European Union (EU) has committed to tackling the climate crisis by issuing directives and guidelines to protect natural resources as part of

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the transition to a circular economy. Within this context, the EU has extensively revised its waste management framework. Specifically, updates were made to Directives (EU) 2018/851 (OJEU, 2018) (waste framework), 2018/852 (packaging) (OJEU, 2018a), 2018/850 (landfill) (OJEU, 2018b), 2018/849 (WEEE) (OJEU, 2018d), and 2018/853 (environmental reporting) (OJEU, 2018c). Furthermore, Directive (EU) 2019/904 was adopted in 2019 to reduce the environmental impact of single-use polymer products (OJEU, 2019; OJEU, 2025)

According to new regulations, the EU sets revised, binding quantitative targets. The overall target for the preparation for reuse and the recycling of municipal waste increases from 55% (by 2025) to 65% (by 2035). Specifically for packaging waste, the overall recycling target is set at 65% by 2025 and 70% by 2030 (OJEU, 2018).

To meet European requirements, Greece has adopted these directives in national law. Now, large producers must separately collect recyclable materials like metal, glass, plastic, and paper/cardboard. The separate collection of bio-waste is also required, and single-use plastics are restricted.

To strengthen local authorities in waste management and environmental protection, the State provides financial incentives (rewards) to municipalities based on their performance in separate waste collection and in reducing landfill waste (OJHR, 2023).

In addition, Law 4819/2021 (OJHR, 2021) mandates the separate collection of packaging waste into distinct streams in municipal public spaces, such as sports facilities, playgrounds, and nurseries. At the local level, the preparation of Local Waste Management Plans (LWMPs) by First-Level Local Authorities has become mandatory, alongside the registration of operational data in the Electronic Waste Registry (EWR). Compliance with these requirements is now a binding prerequisite for municipalities to access financial programs.

To manage solid waste and meet circular economy goals, the Ministry of Environment and Energy recommends using the European waste hierarchy: a) prevention, b) preparation for reuse, c) recycling, d) energy recovery, and e) final disposal.

Therefore, the main objective of this research is to examine the strategies municipalities implement to prevent waste and to evaluate the extent to which these efforts achieve the objectives of the circular economy through proper management of municipal waste.

4.2 Methodology

Initially, the research centers on EU policies on solid waste management, aimed at conserving and protecting natural resources, and then on



Figure 4.1 Municipality of Nea Smyrni.

national-level policies. In addition, case studies, circular design strategies, and best practices applied in the urban environment are investigated. The survey focuses mainly on the Municipality of Nea Smyrni, which has undertaken substantial efforts, particularly in implementing circular-economy measures, waste management, the circularity of natural resources, and social awareness.

The research uses fieldwork, statistical data on the Municipality's performance, and interviews with the technical service staff. Implemented policies are assessed, and new actions are proposed to strengthen the circular economy and urban sustainability.

4.3 Case Study

4.3.1 Geographical location and main characteristics of the area

The Municipality of Nea Smyrni is located in the southern sector of the Attica region in Greece. It is bordered by the Municipality of Aghios Dimitrios to the east, Palaio Faliro to the south, Kallithea to the west, and the municipalities of Athens and Dafni to the north (Figure 4.1).

According to the Hellenic Statistical Authority (HAS, 2023), Nea Smyrni experienced significant population growth over the past four decades, peaking at 76,508 in 2001. From 2011 to 2021, the population stabilized, with a slight decrease from 73,076 to 72,853 (Table 4.1).

The demographic profile of Nea Smyrni over the last four decades reveals a period of significant growth followed by a phase of stabilization. The population peaked in 2001 at 76,508 residents, reflecting the era's intense urbanization. However, from 2011 to 2021, the population remained remarkably stable, with a negligible decrease from 73,076 to 72,853.

Table 4.1 Population Evolution of Nea Smyrni (1981–2021).

Census Year	Population	Growth Rate (%)
1981	67,408	-
1991	69,749	+3.47%
2001	76,508	+9.69%
2011	73,076	-4.49%
2021	72,853	-0.31%

Statistical data show that Nea Smyrni is among the most densely populated municipalities in Greece, with about 20,000 residents per km² in an area of just 3.52 km².

The area hosts numerous businesses, with commercial and service activities as the primary drivers of the local economy.

High urban density and economic activity have increased municipal solid waste, posing a challenge for local authorities. In response, the Municipality of Nea Smyrni has implemented robust environmental policies and developed a comprehensive solid waste management system, detailed below.

Population and economic growth have led to a sharp increase in the generation of Municipal Solid Waste (MSW), posing a critical management challenge for the Local Government. As a result, the Municipality of Nea Smyrni implements a structured framework of environmental policies to ensure public health and maintain a sustainable urban environment. Thus, it has developed a solid waste collection and management system, whose structural characteristics are presented below.

4.3.2 Existing municipal solid waste management (MSW) system

The Municipality of Nea Smyrni operates an integrated solid waste collection and management network, which is fundamentally based on the principles of

source separation (SS) and differentiated multi-stream collection. Specifically, the following bin categories were identified during the in-situ investigation:

1. Green bins (metal and plastic): Used for the disposal of mixed (non-recyclable) household waste.
2. Blue bins: Serve the recycling of packaging materials such as plastic, paper/cardboard, tinplate, and aluminum.
3. Blue bells: Used exclusively for the separate collection of glass bottles and packaging, promoting (SS) at both the household level and within the local commercial network (for example, catering businesses).
4. Purple/Red bins: Specialized systems for collecting clothing and footwear, strategically positioned throughout the city.
5. Brown bins: Facilitate the separate collection of the biowaste (organic) stream for composting.
6. Submerged (underground) systems: Installed in central squares and major arteries, these systems aim to aesthetically upgrade the urban landscape while optimizing available public space

The system is further supported by infrastructure designed to maximize collection efficiency. In 2021, a temporary storage model provided households with small-capacity bins (100- and 300-liter) (MNS, 2021). Agreements with the Municipality allow bins to be stored on private premises, reducing visual pollution, and to be placed in public areas only during scheduled collection times. The Municipality has now procured additional bins to meet current collection needs.

4.3.3 Collection, transport, and final disposal system (Logistics)

A significant modernization phase of the municipal mechanical equipment took place between 1999 and 2008. During this period, the fleet was expanded to include tractors for transporting waste containers to the landfill, as well as new collection vehicles, street sweepers, and crane trucks.

Currently, waste collection is carried out by an active fleet comprising 14 waste collection trucks and 14 compactor vehicles of varying capacities (9 14 m³, 3 16 m³, and 2 1 m³ compactors) (MNS, 2021).

The department's specialized personnel manage route optimization, and each vehicle completes one to two routes daily, covering an average distance of 10–15 km with an average duration of 4–5 hours. Vehicle capacity utilization (fill rate) reaches 90% at the end of each route.

Following collection, mixed municipal waste is transported to the Municipality's Local Transfer Station, which covers 4.03 acres in the southeastern part of the study area. Regarding final disposal and treatment, recyclable waste streams are forwarded to the material recovery facilities of the Hellenic Recovery Recycling Corporation (HERRCO / EEAA S.A.). For the mixed waste stream, 70% is directed for final disposal at the Fyli Sanitary Landfill, while the remaining 30% is routed through the Schisto Transfer Station (MNS, 2021).

4.3.4 Historical evolution and quantitative analysis of recycling programs

4.3.4.1 Early stages and network development (2002-2008)

The waste management practices in the Municipality of Nea Smyrni date back to the 2002–2005 period, when a pilot program for the recycling of Waste Electrical and Electronic Equipment (WEEE) was implemented. This program was co-funded by the European Union and the Ministry of Environment, under the scientific guidance of the Ecological Recycling Society.

In 2006, Nea Smyrni joined the national packaging recycling system, installing 600 blue bins and achieving a daily collection rate of 15 tons of recyclables. Between 2007 and 2008, the network expanded, focusing on commercial zones and high-waste areas. Active citizen participation was crucial, as residents helped determine bin locations and monitored fill levels, reporting to municipal authorities (MNS, 2019).

4.3.4.2 Expansion of source sorting streams (2017-2019)

During 2017–2019, the municipality further expanded its recycling strategy, introducing separate source-sorting streams for paper, glass, lighting equipment, small electrical appliances, batteries, and clothing reuse. According to the municipality's statistical data, the total quantity of recovered materials amounted to 1,744.86 tons in 2017, 1,568.16 tons in 2018, and 1,913.69 tons in 2019. Despite these intensified recycling projects, the vast majority of generated municipal solid waste continued to be directed to sanitary landfills for final disposal (MNS, 2021).

4.3.4.3 Intensification of recycling and bio-waste management (2021-2024)

Statistical data from 2021 to 2024 show significant fluctuations in material recovery rates, with an overall upward trend. Collected recyclables totaled

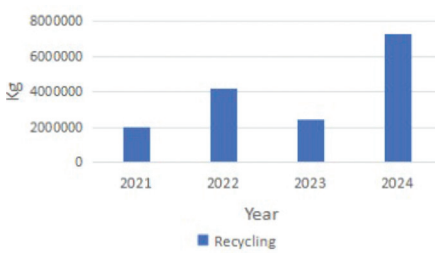

Figure 4.2 Recycling in Municipality of Smyrni (2021-2024) (Source: MNS, 2025).



Figure 4.3 Bio-Waste in Municipality of Smyrni (2021-2024) (Source: MNS, 2025).

2,016,571 kg in 2021. In 2022, this increased by 76.39% to 4,154,597 kg. In 2023, this fell by 34.76% to 2,418,966 kg, but in 2024 it surged by 189.12% to 7,296,608 kg (Figure 4.2).

In 2021, the Municipality launched a home composting initiative, distributing 100 domestically manufactured composters (model "Garden King," 330 liters) to residents free of charge to reduce green waste and produce compost. This was complemented by deploying 350 brown bins citywide. As a result, separate biowaste collection increased steadily, reaching 155,210 kg in 2022, 202,680 kg in 2023, and 299,380 kg in 2024 (Figure 4.3).

4.3.5 Environmental education and awareness

Targeted environmental education initiatives have systematically strengthened the waste management system. The active involvement of local schools and the 'School Recycling Championship' has been key in fostering ecological awareness among youth and in promoting circular economy principles at the municipal level.

4.3.6 Complementary rewarding programs: "Green City" (2022-2023)

During 2022–2023, material recovery rates improved further through the Municipality's participation in the 'Green City' reward-based recycling program. Supported by the Attica Region and EDSNA, this program offers direct incentives to citizens and complements the blue bin collection system (SIMAA, 2026).

Statistical data show an 8% increase in materials recovered through this network, totaling 26.87 tons in 2023, up from 24.87 tons in 2022. Metal recovery rose from 1.12 to 4.41 tons, and the amount of collected aluminum

more than doubled. Plastic bottle (PET) recovery also doubled, reaching 3 tons in 2023, up from 1.5 tons in 2022. However, paper recovery decreased by 2 tons compared to 2022 (Table 4.2).

This decrease is attributed to residents' preference for the blue bin network for paper disposal because of its convenience. For Waste Electrical and Electronic Equipment (WEEE), while the collection of conventional appliances declined, the recycling of air conditioning units increased.

Table 4.2 Composition and Percentage Distribution of Recyclable Material Categories (2022–2023), Recycling (Green City Program).

Material Category	2022 (tn)	2023 (tn)	Change (%)
Paper & Cardboard	10.50	8.29	−2.21
Metallic Objects	1.12	4.41	+3.29
PET (Plastic Bottles)	1.54	3.06	+1.52
Glass	3.21	2.91	−0.30
Clothing & Textiles	2.67	2.57	−0.10
Hard/Other Plastics	1.89	1.99	+0.10
Small Appliances (WEEE)	2.84	1.46	−1.38
Aluminium	0.42	1.03	+0.61
Waste Oils(UCO) (Used Cooking Oils)	0.64	0.65	+0.01
Air Conditioners (WEEE) Waste Electrical and Electronic Equipment	0.02	0.46	+0.44
Batteries	0.00	0.05	+0.05
Total	24,87	26.87	+2.00

Source: author's elaboration of SIMAA (2026)

4.3.7 Evolution of rates of source sorting, recycling, separate collection of biowaste and energy recovery

During the period 2022-2024, the Municipality of Nea Smyrni showed a steady upward trend across all key alternative management indicators, including the recovery of recyclable materials, the separate collection of biowaste, and energy recovery.

Specifically, the overall Source Separation Index (SSI) demonstrated a considerable increase, rising from 4.90% in 2021 to 16.16% in 2024. The diversion rate of recyclable materials followed a similarly significant trajectory, rising from 4.20% in 2021 to 15.08% in 2024.

At the same time, the separate collection rate for the organic biowaste stream improved to 1.12% in 2024, up from 0.70% in 2021. Thus, beyond material recycling, developments in energy recovery (Waste-to-Energy) proved highly significant, with the recovery rate nearly quadrupling to 9.56% in 2024 from 2.50% in 2021 (Table 4.3).

Table 4.3 Evolution of rates of source sorting, recycling, separate collection of biowaste and energy recovery in the Municipality of Nea Smyrni (2021-2024).

Year	Source Separation (SS) %	Recyclables %	Biowaste %	Recovery (Energy/ Waste-to-Energy)%
2021	4.90	4.20	0.70	2.50
2022	6.40	5.20	1.10	3.80
2023	6.28	5.53	0.75	3.69
2024	16.16	15.08	1.12	9.56

Source: author's elaboration of SIMAA (2026)

4.3.8 Interview results

Interviews with the Deputy Mayors for Cleanliness and Recycling reveal that, despite a modernized fleet, the Municipality faces significant operational challenges. High rates of waste mixing in the blue bin stream mean that only a small portion of the collected materials is processed at Material Recovery Facilities (MRFs).

Considering that, for the year 2019, the total cost of MSW management amounted to 6.49 million euros (198.33 euros per ton, out of a total of 32,724 tons of MSW, or 88.82 euros per inhabitant), it becomes clear that the economic benefit resulting from recycling is very small (MNS, 2021).

Economically, revenue from recyclable material sales is low (about €20,000), insufficient to cover operating costs. The recycling system relies on the Municipality's budget and co-financed European and regional programs.

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4.4 Discussion

To address these challenges, the Municipality is implementing initiatives to further reduce waste generation at the source. The updated strategic plan includes establishing a Creative Materials Reuse Center (CMRC), introducing a 'Pay-As-You-Throw' (PAYT) system, and strategically locating Green Points and Recycling Corners. The Municipality will install 35 public drinking water taps to reduce disposable plastic use and will divert collected biowaste to biogas and energy production facilities. These actions align with the European waste management hierarchy, prioritizing prevention, reuse, and recycling over disposal.

Notably, the Municipality of Nea Smyrni achieved a significant increase in recycling rates in 2024 compared to the previous year. Given that the local population has remained relatively stable, the sharp increase in 2024 suggests that this growth is independent of demographic fluctuations. Instead, the increase can be attributed to increased environmental awareness among residents, a more efficient collection infrastructure (specifically increased bin density), and changes in consumer behavior.

Despite significant investment in infrastructure and financial incentives, the current recycling rate (15.08%) remains well below the European 2025 target of 55%.

Achieving these goals is a multifactorial process that depends directly on existing infrastructure, the financial resources raised for waste management, the institutional actions over the last decade, and citizens' level of environmental awareness.

In-situ research confirms that the Municipality has the necessary technical equipment and a dense source-separation network, with collection points for all waste streams located near residences. Despite ongoing public information campaigns, further efforts are needed to strengthen civic mobilization and encourage greater citizen commitment to waste separation.

Analysis of the Sorting at Source (SS) index for the 2021–2024 period (Table 4.4) reveals that Municipalities within the Attica Region are mainly concentrated in the mid-performance tiers. In 2024, the highest proportion of Local Government Organizations (LGOs) was 30.30%, falling within the 11%–15% range. Concurrently, a marginal decrease was observed in the lowest performance category (<6%), declined slightly from 19.70% in 2021 to 18.18% in 2024.

Table 4.4 Distribution of Municipalities in the Attica Region (66 municipalities) by Source Separation (SS) Performance Rates (2021–2024).

Source Separation (SS) Rate	**2021 (%)**	**2022 (%)**	**2023 (%)**	**2024 (%)**
21% – 30%	13.64	21.21	6.06	10.61
16% – 20%	19.70	12.12	16.67	21.21
11% – 15%	31.82	28.79	33.33	30.30
6% – 10%	15.15	21.21	31.82	19.70
< 6%	19.70	16.67	12.12	18.18
Total	100	100	100	100

Source: author's elaboration of SIMAA (2026)

A similar trend is reflected in the recovery rates of clean recyclable materials (Table 4.5). Throughout the four-year study period, the majority of local authorities remained concentrated within the 11%–15% range, accounting for a significant share of 34.85%-40.91%.

The distribution at the extremes is notable. The highest performance category (21%–30%) was marginally represented in 2021 (1.52%) and was absent in subsequent years. Conversely, participation in the 16%–20% range increased from 3.03% in 2021 to 9.09% in 2024. This indicates an improvement in performance for a segment of local governments that was previously classified in the 6%–10% category (which declined from 33.33% to 27.27%) (Table 4.5).

Table 4.5 Distribution of Municipalities in the Attica Region (66 municipalities) by Recycling Rate (2021–2024).

Recycling Rate Tier	2021 (%)	2022 (%)	2023 (%)	2024 (%)
21% – 30%	1.52	0.00	0.00	0.00
16% – 20%	3.03	4.55	4.55	9.09
11% – 15%	39.39	34.85	40.91	40.91
6% – 10%	33.33	34.85	31.82	27.27
< 6%	22.73	25.76	22.73	22.73
Total	100.00	100.00	100.00	100.00

Source: author's elaboration of SIMAA (2026)

Despite some improvements in specific performance tiers, the overall outlook remains unsatisfactory. In 2024, 22.73% of municipalities still recorded low recycling performance (<6%). The data indicate a significant gap between Attica Local Authorities and the 55% European target, highlighting the need to review the current solid waste management model.

Local Government Organizations must intensify efforts by adopting innovative policies and best practices. Key factors for improving recycling rates include:

- The structured integration of environmental education at all levels of formal education.
- The continuous cultivation of ecological awareness and the active participation of citizens.
- The implementation of targeted information campaigns regarding recyclable materials, optimized sorting practices, and acceptable waste streams

In general, there is an urgent need to scale up efforts by Local Government Organizations through the adoption of new policies and best practices. The continuous cultivation of environmental awareness, supported by integrating environmental education at all levels, is expected to play a key role. At the same time, systematic and targeted information on which materials are recycled and how to properly involve all citizens in the process is a fundamental prerequisite for improving recycling indicators.

With 5,440,000 tons of waste are produced annually nationwide, most of it ending up in landfills, and annual per capita landfill waste reaching 422 kilograms, the problem is more worrying and requires immediate measures.

4.5 Conclusion

Regarding the framework for adapting to climate change and the transition to a circular economy, the European Union has adopted a comprehensive set of directives. Member States have incorporated this framework into national legislation and subsequently developed specific strategies and national action plans for the sustainable management and protection of natural resources.

In Attica, the most populous region in Greece, research indicates that in 2024, only a small percentage of municipalities achieved recycling rates within the 16%–20% range. This performance falls significantly short of the binding European targets for 2025 and 2030; as a result, most solid waste continues to be diverted to sanitary landfills for final disposal.

Research in Nea Smyrni found a recycling rate of 15.1% in 2024. Although this is a significant improvement over previous years, it remains well below the European target of 55%–65%. However, policy evaluations show that the Municipality has implemented targeted waste management actions aligned with national and European strategies.

A solid foundation for integrated solid waste management has been established, enabling future increases in material recovery. Recycling targets depend on municipal planning and active citizen participation.

This survey highlights the importance of ongoing efforts to inform and engage citizens. Increasing motivation to participate and raising awareness through education across all age groups are essential. Adopting best practices for managing and protecting natural resources is also crucial.

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