WASTE HIERARCHY IN ACTION

Italian and European Models for a Sustainable Future

Edited by Giulia Romano

FrancoAngeli

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Summary

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Foreword[1]

The volume presented is part of a historical passage in which waste management has now ceased to be a technical issue to become one of the crucial challenges of our time. Waste, today, does not speak only of what we consume or throw away, but of the quality of our social organization, the maturity of our decision-making systems and the coherence between political strategies and concrete practices.

In this sense, Professor Romano's work takes on a strategic role, because it brings back to the center a principle often evoked but little practiced: that of the "waste hierarchy". The merit of this book lies in treating this principle not as an abstract statement, but as a concrete structure, which guides the operational choices, investments, policies, and even the mentalities of the subjects involved.

The approach that emerges is multidisciplinary and action-oriented. The numerous regulatory references, the examination of the data, the review of performance indicators and above all the rich section dedicated to European case studies provide a dynamic and profound picture, capable of informing, inspiring and guiding. The text, in this way, becomes a bridge between the world of research and that of practice, between analysis and governance.

The hierarchy of waste – prevention, reuse, recycling, recovery, disposal – is often interpreted in a sequential and static way. In this book, however, it is treated as a logical and systemic architecture: a compass, rather than a scale; an order of priority that requires conscious, coordinated and coherent choices, not a grid to be applied mechanically.

This change of perspective is particularly relevant, because it makes it possible to overcome a certain institutional and operational inertia, which is still too tied to linear and sectoral solutions. The research clearly shows that the effectiveness of hierarchy does not depend on its normative enunciation,

[1] This chapter was written by Paolo Contò, Director of the Priula Basin Council, Treviso.

but on the ability of institutions, companies and communities to translate it into concrete operating models and habits.

This is why the results obtained by cities such as Paris and Gothenburg, or by companies such as Ecoambiente and Revet, take on an exemplary value: they demonstrate that, when principles are systematized and shared, it is possible to generate real impacts. These are not merely "best practices", but systemic strategies based on explicit political commitments, administrative coherence, involvement of local actors and forward-looking investments.

One of the most relevant aspects of the volume is its focus on measuring results. The analysis of data, the comparison between countries, the construction of aggregate and disaggregated indicators for each step of the hierarchy, bring out an often underestimated need: that of making environmental policies transparent, assessable and comparable.

In fact, it is not enough to declare that you want to reduce waste or increase recycling: it is necessary to equip yourself with tools that allow you to constantly monitor progress, identify bottlenecks, and adapt strategies. In this, the text provides a valuable contribution, not only from a cognitive point of view, but also from a methodological one.

It is through the dialogue between numbers and contexts, between indicators and decisions, that the widespread awareness necessary for public action is built. The integrated reading of the data, in fact, gives a snapshot of a reality that is still too fragmented: tangible progress is highlighted in some areas and stagnation, or even regression, in others. This requires not only technical interventions, but transformative action on the logic of governance.

In the path outlined by the volume, it is clear that the most effective innovations are those that put people at the center. Not in the abstract, but as concrete subjects, capable of acting, reacting, resisting or engaging. Citizens, public officials, entrepreneurs, operators in the sector are an integral part of waste management systems. And like any complex system, this one too responds to logics that are not only mechanical, but also cultural, relational and behavioral.

In this perspective, one of the major contributions of the book is the analysis of enabling factors. The research clearly shows that the most advanced contexts are not those equipped with the most sophisticated technologies, but those capable of creating strategic alliances between actors, of activating trust, of making the path recognizable and meaningful.

Experience shows that individual responsibility emerges when the context solicits it, recognizes it and makes it effective. Organisational choices, such as punctual pricing, information campaigns, reuse centres, are not simple technical tools: they are devices of social activation. They make the link between individual behavior and collective outcome visible. And when

that link is clear, when the trust between the system and citizens is mutual, change takes place.

One of the questions that runs through the entire volume is: how do you build replicable models? How can we move from virtuous chance to normality? The answer that emerges, even in filigree, is that there are no rigid ways to export, but there are adaptable models, approaches and principles, light structures that allow local regeneration.

Replicability is not a copy, but a process: it requires the ability to adapt, to listen, to interpret the territory. The cases analyzed demonstrate this: what works is what is rooted in a context, which understands its resistance, which enhances the resources present. It is a patient work, which holds together vision and detail, planning and operational humility.

In this sense, the book represents an important contribution to the construction of a culture of circular transition, capable of holding together the different levels of responsibility: institutional, technical, social and personal.

The volume edited by Giulia Romano is, ultimately, a valuable work for anyone who is called upon to design, manage or evaluate public policies in the environmental field. Its strength lies in its ability to combine scientific rigor, methodological depth and transformative tension.

It reminds us that rules are not enough if there is no relationship, that data is not enough if there is no listening, and that strategy is not enough if there is no trust. And it invites us to recognize, in every waste management process, an opportunity for regeneration that involves not only materials, but also social ties and cultural visions.

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1.
Introduction[1]

In recent decades, waste management has become increasingly important, both in Europe and globally. According to the latest available data, each European citizen produces about five tonnes of waste per year. Inadequate waste management has exacerbated economic, environmental, and social problems over time, prompting citizens and businesses to urgently call for more effective and sustainable strategies and policies to reduce its impacts.

The principle of the "waste hierarchy" is a cornerstone of European environmental policy. First introduced by the Waste Framework Directive (Directive 2008/98/EC), it establishes that waste management must follow a scale of priorities: first and foremost, the prevention of waste generation; alternatively, preparing waste for reuse or recycling its materials and recovering energy. Only as a last resort should incineration without energy recovery and landfilling be used, with the most sustainable solutions always being preferred.

All Member States are required to incorporate the waste hierarchy principle into their national laws and regulations. Although the European Union (EU) sets common objectives, each country retains considerable autonomy in implementation, deciding how to incentivize the most virtuous actions (reduction, reuse, recycling) and discourage the less sustainable ones (incineration and landfilling). The result is significant heterogeneity, both in the strategies adopted and in the outcomes achieved: while some countries have made substantial progress, others still show considerable room for improvement[2].

[1] This chapter was written by Giulia Romano.

[2] See chapter 4 and, among others, the data made available on the European Union website (Open data to track progress in the EU's recycling targets | data.europa.eu, accessible at: *data.europa.eu/en/publications/datastories/open-data-track-progress-eus-recycling-targets*), the recent information of the European Parliament reporting data to 2000 and 2022 (Eco-

The urgency of implementing targeted and ambitious policies was recently emphasized in a report by the European Environment Agency (EEA)[3], which highlighted that achieving the EU's 2030 objectives – namely, to significantly reduce waste generation and cut residual waste sent to landfills and incinerators by 50% – remains unlikely without bold waste prevention strategies and a shift toward a circular economy. Reducing waste production, including hazardous waste, can help lessen the burden of pollution on both the environment and human health, representing a key element of the EU's broader strategy to reduce and eliminate environmental pollution[4].

In Italy, Directive 2008/98/EC was transposed through Legislative Decree No. 205 of 3 December 2010. As a result, Article 179 of Legislative Decree No. 152 of 3 April 2006 (known as the "Consolidated Environmental Act") was amended to explicitly include the waste hierarchy as a priority criterion in waste management decisions, recognising waste management as an activity of public interest.

Italian legislation, in line with European law, establishes a hierarchy of priorities for waste management: prevention, preparation for reuse, recycling, recovery (including energy recovery), and, only as a last resort, disposal. This order reflects environmentally preferable options, with prevention at the top. However, a certain degree of flexibility is allowed, based on comprehensive assessments and specific analyses of different waste streams, under the assumption that the hierarchy generally indicates the best environmental option.

Concrete decisions must in fact ensure the best possible outcome, taking into account not only environmental aspects but also health, social and economic impacts, as well as technical and economic feasibility.

The available data on the application of the waste hierarchy principle reveal partly positive and encouraging trends, but also highlight insufficient results and, in some cases, signs of deterioration.

As regards waste prevention and reduction – the first step in the hierarchy – between 2010 and 2022, per capita production in the EU remained broadly stable, recording a slight decrease of 0.5% (about 26 kg per inhabitant)[5].

responsible waste management: EU strategies | Themes | European Parliament, accessible at: *www.europarl.europa.eu/topics/it/article/20180328STO00751/gestione-eco-responsabile-dei-rifiuti-le-strategie-adottate-dall-ue*) and D'Inverno G., Carosi L., Romano G. (2024), Meeting the challenges of the waste hierarchy: A performance evaluation of EU countries, *Ecological Indicators*, vol. 160, 111641, with the bibliography cited therein.

[3] European Environment Agency and Joint Research Centre (2025), *Zero pollution monitoring and outlook 2025*.

[4] *Ibidem*.

[5] See the dedicated website of the European Environment Agency: *www.eea.europa.eu/en/analysis/indicators/waste-generation-and-decoupling-in-europe*.

Figure 1.1 – Outline of the waste hierarchy principle

Source: adapted from *ec.europa.eu/environment/topics/waste-and-recycling/waste-framework-.Directive_en*

This data highlights a persistent link between economic growth and waste generation, signaling a decoupling that is still incomplete.

"High and constantly increasing quantities of packaging generated, as well as low levels of re-use and collection and poor recycling, present significant barriers to achieving a low-carbon circular economy"[6].

In line with the waste hierarchy principle, it is therefore essential to reduce the amount of packaging placed on the market, eliminating unnecessary packaging and encouraging reuse.

The recent Regulation (EU) 2025/40 on packaging and packaging waste, citing Eurostat data, points out that "packaging uses large quantities of primary raw material (virgin materials). 40% of plastics and 50% of paper used in the Union is used for packaging, and packaging represents 36% of municipal solid waste".

As for municipal waste, in 2023, each EU citizen produced an average of 511 kg, but only less than half of this (48%) was actually recycled, considering both material recycling and composting[7].

[6] Regulation (EU) 2025/40 of the European Parliament and of the Council of 19 December 2024 accessible at: *eur-lex.europa.eu/legal-content/IT/TXT/HTML/?uri=OJ:L_202500040*.

[7] For more details, see *ec.europa.eu/eurostat/statistics-explained/index.php?title=Municipal_waste_statistics*, and the ISPRA Waste Report (2024), available at *www.isprambiente.gov.it/files2024/pubblicazioni/rapporti/rapportorifiutiurbani_ed-2024_n406_versione_integrale.pdf*.

According to a recent report by the European Environment Agency[8], between 2010 and 2022 waste production in Italy increased, while gross domestic product (GDP) remained almost stable. This trend indicates that, even in the Italian context, there has been no decoupling between economic growth and waste generation. The figure appears even more significant if we consider that, since 7 October 2013, the Italian National Waste Prevention Programme has been in force, adopted by the then Ministry of the Environment (now the Ministry of the Environment and Energy Security – MASE), with the aim of guiding local authorities in planning waste management policies.

The Programme, since its adoption over ten years ago, aimed to "*decouple economic growth from the environmental impacts linked to waste production*"[9], setting among the objectives a 5% reduction in municipal waste per unit of GDP. It is currently still being updated, as required by Directive 2008/98/EC, which requires it to be reviewed every six years. In 2022, the National Waste Management Programme (PNGR) was approved. It serves as a tool to guide and support regional waste management planning, while also summarising European and national targets, highlighting progress made, and identifying remaining critical issues.

The reduction of waste generation is also closely linked to the technical, organisational and economic opportunities of reuse and the activities of preparation for the reuse of goods and materials offered to citizens and businesses.

As regards preparation for re-use – the second step of the hierarchy – the available data[10] show that in 2023, the first year of application of the reporting obligation under Directive 2008/98/EC (with reference to 2021 as the base year), construction products and materials recorded the highest per capita reuse in Europe (11 kg), while textiles are at the bottom of the ranking with only 2 kg. The recent *European Reuse Barometer* report[11] highlights the growth potential of the sector, linked both to the expansion of business initiatives and to the growing interest from consumers. However, there is still a need for stronger awareness-raising campaigns, more ambitious legislation – in particular against single-use – and economic incentives for prevention and reuse. The report also highlights the importance of cooperation between

[8] The report is available at: *www.eea.europa.eu/en/topics/in-depth/waste-and-recycling/municipal-and-packaging-waste-management-country-profiles-2025*.

[9] See the summary available on the MASE website: *www.mase.gov.it/sites/default/files/archivio/comunicati/Programma%20nazionale%20prevenzione%20rifiuti.pdf*.

[10] For further information, please refer to what is available at: *www.eea.europa.eu/en/circularity/sectoral-modules/waste_prevention/weight-of-reuse?activeTab=658e2886-cfbf-4c2f-a603-061e1627a515*.

[11] The document is accessible at: *zerowasteeurope.eu/wp-content/uploads/2024/06/ZWE_June24_Report_InOff-plastic-european-reuse-barometer-.pdf*.

industry players to share costs and infrastructure and achieve greater efficiency and scalability.

The recent Regulation (EU) 2025/40 on packaging and packaging waste, which does not require transposition at national level and has been in force since 11 February 2025, aims to stimulate the development of new business and consumption models based on the reuse of packaging. The measure aims to promote eco-design, so that packaging is increasingly durable, washable and repairable; in addition, there are: re-use obligations for certain sectors, with minimum targets (e.g. for beverage and take-away food packaging) and also for Member States at national level; promotion of standardised reuse systems, to facilitate joint investments in logistics infrastructure; restrictions on the production and use of single-use packaging; traceability of packaging; and extended producer responsibility, which will have to contribute to management costs and ensure the reintegration of packaging into the system.

Among the most relevant changes, the Regulation establishes that by 12 February 2027, final distributors operating in the EU in the hotel, restaurant and catering sectors, who offer hot or cold drinks or ready-to-eat food in take-away packaging, will have to allow customers to use their own reusable containers, "*at no higher cost and under no less favourable conditions than when selling the sales unit consisting of the same product and single-use packaging*". In addition, they will be required to "*inform consumers at the point of sale, through clearly visible and legible information boards or signs, about the possibility of obtaining the products in a refillable container provided by the consumer*".

Starting from 12 February 2028, the same companies operating in the hotel, restaurant and catering sectors, which provide drinks or ready-to-take food, will also have to offer consumers the possibility of receiving products in reusable packaging, as part of a structured reuse system.

In addition, in Italy, Decree No. 119 of 10 July 2023 was issued – entitled "Regulation determining the conditions for the exercise of preparations for reuse in simplified form, pursuant to Article 214-ter of Legislative Decree No. 152 of 3 April 2006"; the Regulation introduced a simplified procedure for the opening of re-use preparation centres, defining operational, technical and structural requirements. The standard aims to facilitate the interception of specific waste streams, such as electrical and electronic waste, which can be repaired and returned to use without compromising functionality or safety, thereby contributing to the conservation of raw materials and energy. Moreover, repair and reuse – thanks to the lower cost of the refurbished products – can make these items accessible even to the most vulnerable social groups.

The MASE estimates, in fact, that in Italy waste deriving from electrical and electronic equipment (WEEE) "constitutes one of the fastest growing waste

streams in the domestic market, with an annual rate currently equal to 2%, which, due to constant technological innovation and planned obsolescence, push for faster consumption. In fact, over seven kilos of electronic waste are produced per capita"[12].

As far as recycling is concerned – the third step of the hierarchy –, data from the European Parliament indicate that between 2004 and 2022 the amount of waste recovered increased by 40.6%, from 870 to 1,223 million tons. Recycling is a central element of European waste management policy, to achieve the objective of contributing to the transition to a circular economy by maximising the recovery of high-quality resources from discarded materials.

The recycling rate in Europe has also grown significantly thanks to the binding targets introduced by European regulations. However, in recent years there has been a slowdown in progress, and in some cases a reversal of the trend: in 2022, for example, the overall *recycling rate* was lower than in the previous decade. In that same year, most of the waste was still disposed of by incineration or landfill[13].

In 2020, according to Eurostat, EU-27 countries generated a total of 2.15 billion tonnes of waste. Of these, 19 million tons were plastic, 17 million tons were glass, 64 million tons were ferrous metals and about 43.5 million tons were paper and cardboard; therefore, even a few percentage points increase in recycling means a very large amount of reused material that will not end up in landfills[14].

Effective recycling requires well-structured separate collection systems, supported by incentives[15] that enhance the commitment of households and firms to separate materials at source. However, collection alone is not enough: it is essential to have adequate plants to transform waste into secondary raw materials and efficient supply chains capable of reintroducing recycled materials into production and consumption circuits. Without these conditions, separation at source risks losing effectiveness.

The EU is strengthening not only incentives to reduce the consumption of single-use plastics, but also those aimed at increasing the recycling rate among Member States. Since January 1st, 2021, following the implementation of Council Decision (EU, Euratom) 2020/2053[16], a national contribution has

[12] *www.mase.gov.it/pagina/riuso-e-preparazione-il-riutilizzo*.

[13] *www.eea.europa.eu/en/analysis/indicators/waste-generation-and-decoupling-in-europe*.

[14] Open data to track progress in the EU's recycling targets | data.europa.eu, available at: *data.europa.eu/en/publications/datastories/open-data-track-progress-eus-recycling-targets*.

[15] Brown Z. (2024). Household waste practices: New empirical evidence and policy implications for sustainable behaviour, *OECD Environment Working Papers*, n. 249, OECD Publishing.

[16] The text is accessible at: *eur-lex.europa.eu/legal-content/IT/TXT/HTML/?uri=CELEX:32020D2053*.

been introduced, calculated on the amount of non-recycled plastic packaging waste: €0.80 for each kilogram generated and not recycled[17].

Between 2010 and 2022, the total amount of waste sent to landfills in the EU decreased by 21%, from 173 to 137 million tonnes. The delivery rate – i.e. the percentage of waste disposed of in landfills out of the total produced – also fell, from 23% to 17%. This improvement is partly due to the reduction in household waste sent to landfills, but also to the increase in waste from sorting and separate collection[18].

The available data therefore highlight the crucial importance of strengthening not only the quantity but also the quality of separate waste collection, in order to ensure truly effective material recovery and to limit the use of landfills and incineration through appropriate policies and strategies[19].

According to a report by the European Environment Agency[20], Italy has made steady progress since 2010 in increasing recycling and reducing the landfilling of municipal waste. However, the recycling rate of packaging waste could improve further, helping to strengthen the trajectory towards European targets[21]. In 2022, in fact, Italy recycled 71% of packaging waste and 53% of municipal waste, data that indicate the need to intensify efforts, especially on the municipal waste front. While Italy is not considered at risk of failing to meet the 2035 target of limiting municipal waste sent to landfills to 10%. Nevertheless, it could take further action to divert more waste from landfills, also considering that the level of landfill taxation is quite low compared to the EU-27 average[22].

The importance of the transition from a linear to a circular economy has been enshrined in the *Circular Economy Package*, adopted by the European Commission on 2 December 2015, and strengthened by the *New Circular Economy Action Plan* adopted by the European Commission in March 2020 as one of the fundamental pillars of the *European Green Deal*.

[17] See also Regulation (EU) 2025/40 on packaging and packaging waste.

[18] *www.eea.europa.eu/en/analysis/indicators/diversion-of-waste-from-landfill*.

[19] Brown Z. (2024). Household waste practices: New empirical evidence and policy implications for sustainable behaviour, *OECD Environment Working Papers*, n. 249, OECD Publishing, Paris .

[20] Please refer to the March 2025 document entitled *Waste management country profile with a focus on municipal and packaging waste, Italy*, accessible at: *www.eea.europa.eu/en/topics/in-depth/waste-and-recycling/municipal-and-packaging-waste-management-country-profiles-2025*.

[21] Open data to track progress in the EU's recycling targets | data.europa.eu, available at: *data.europa.eu/en/publications/datastories/open-data-track-progress-eus-recycling-targets*.

[22] Please refer to the March 2025 document entitled *Waste management country profile with a focus on municipal and packaging waste, Italy*, accessible at: *www.eea.europa.eu/en/topics/in-depth/waste-and-recycling/municipal-and-packaging-waste-management-country-profiles-2025*.

In this context, studies and research that support reflection on how to apply the waste hierarchy principle effectively, efficiently, and sustainably over time are particularly valuable for political and business decision-makers, who are called upon to translate this principle into concrete actions. In fact, the literature has highlighted a lack of studies that look at concrete experiences of circular economy implementation[23].

It therefore seems essential to combine quantitative studies with qualitative insights, on business cases but also public administrations[24] capable of providing data and information on concrete experiences already carried out in the field of waste reduction, reuse and recycling[25].

This study adopted a multidisciplinary perspective, involving researchers, professionals and managers with business, legal, geographical and mathematical skills applied to economics. The goal is to answer three research questions:

- What is the state of the art of the literature, legislation and available result indicators, regarding the implementation of the waste hierarchy principle in Europe?
- Why, how, and through which enabling factors, is it possible to implement effective and sustainable strategies and policies that allow the concrete application of the waste hierarchy principle?
- What are the main bottlenecks and how can they be overcome?

The first objective of the research is therefore to provide a clear picture of the existing literature and legislation, at national and international level, as well as on the indicators available so far and on the positioning of the various European countries with respect to the achievement of the objectives related to the waste hierarchy principle.

To this end, the first part of the volume presents Chapter 2, which analyzes studies published in leading international scientific journals, and Chapter 3,

[23] Russell M., Gianoli A. & Grafakos S. (2020). Getting the ball rolling: an exploration of the drivers and barriers towards the implementation of bottom-up circular economy initiatives in Amsterdam and Rotterdam. *Journal of Environmental Planning and Management*, *63*(11), 1903-1926.

[24] Klein N., Ramos T.B. & Deutz P. (2022). Factors and strategies for circularity implementation in the public sector: An organisational change management approach for sustainability. *Corporate Social Responsibility and Environmental Management*, 29(3), 509-523.

[25] Galvão G.D.A., De Nadae J., Clemente D.H., Chinen G. & De Carvalho M.M. (2018). Circular economy: overview of barriers. *Procedia Cirp*, *73*, 79-85; Russell M., Gianoli A. & Grafakos S. (2020). Getting the ball rolling: an exploration of the drivers and barriers towards the implementation of bottom-up circular economy initiatives in Amsterdam and Rotterdam. *Journal of Environmental Planning and Management*, *63*(11), 1903-1926.

which examines the evolution of the most relevant legislation and case law, including the most recent judgments and guidelines. Finally, Chapter 4 proposes a ranking of European countries, based on specific performance indicators designed to systematize the results achieved at all levels of the hierarchy.

In the light of the state of the art, the need emerged to refine the evaluations of the strategies and policies adopted, not only at the state level but also at the local and company level, encouraging and rewarding more the results obtained in the introduction of virtuous practices and discouraging and penalizing strategies still based on disposal.

The analysis therefore highlighted the importance of increasing and making more complex the evaluation of the policies of countries, but also of companies and local authorities, taking into account the results achieved on the basis of the application of the waste hierarchy principle; in fact, the importance of making greater use of the results achieved at the top of the hierarchy – in prevention, reuse and effective recycling – emerges, while penalizing the choices that persist in the massive use of landfills and incinerators.

The quantitative analysis also highlighted the need to define quantitative objectives at the regulatory level for all levels of the hierarchy and to expand the availability of data, in particular for some levels of the hierarchy – such as reuse – which still have a significant lack of information as well as institutional-regulatory support[26].

Both quantitative and qualitative methodologies were adopted to answer the research questions. Qualitative techniques, in particular, make it possible to collect detailed information on specific contexts through documentary analysis, direct interviews, participation in events and collecting evidences from managers, stakeholders and experts. This approach proves to be particularly effective in the study of complex phenomena, such as the implementation of the waste hierarchy principle in articulated organizations – municipalities, provinces or companies. In addition, the qualitative methodology is characterized by its flexibility, which allows questions and insights to be adapted as new relevant elements emerge during the research.

The analysis of emblematic cases presented in the second part of the volume – selected across different contexts based on geographical location, size, and the nature of the promoter – was conducted using a qualitative methodology for theory building and based on a multiple-case study design[27].

[26] Ranta V., Aarikka-Stenroos L., Ritala P. & Mäkinen S.J. (2018). Exploring institutional drivers and barriers of the circular economy: A cross-regional comparison of China, the US, and Europe. *Resources, Conservation and Recycling*, *135*, 70-82.

[27] Yin R.K. (1988). Case Study Research: Design and Methods, Sage, Newbury Park, CA;

This approach is also particularly useful in the study of new or little-explored phenomena, as it allows us to understand not only their effects, but also their root causes (the "why") and the methods of implementation (the "how")[28].

In particular, 35 interviews were carried out for a total duration of over 2,000 minutes. The interviews were almost always carried out by several members of the research team, recorded and transcribed, and their contents were used and analyzed according to a consolidated qualitative methodology, known as *Giaia Methodology*[29]. Some interviews involved several subjects at the same time and some interviewees were listened to several times. After defining the reference framework on the waste hierarchy principle, the research then focused on the analysis of some emblematic cases of municipalities and companies, in Italy and Europe, which have carried out concrete initiatives inspired by this principle. Six cases were selected, representative of the three virtuous steps of the hierarchy:

- *Prevention*: analyzed through the case of the City of Paris and the "Ambition zéro plastique à usage unique" project, launched in view of the 2024 Olympic Games.
- *Preparation for reuse*: deepened with the experience of the Alelyckan Krepstoppelpark in Gothenburg (Sweden), the ReTuna Center in Eskilstuna (Sweden) – the first reuse shopping center in the world – and the Daccapo repair and reuse centers in Capannori (Tuscany), inspired by the Swedish model.
- *Recycling*: studied through two Italian business cases. The first concerns Ecoambiente, an in-house company of the Province of Rovigo, promoter of an ambitious project to improve the quantity and quality of separate waste collection, thanks to the introduction of pay-as-you-throw (PAYT) tariff and a broad program of citizens and businesses engagement. Since, as is well known, separate waste collection does not necessarily mean effective recycling, the second case concerns Revet, a mixed public-private owned company that serves about 200 municipalities in Tuscany and over 80% of the regional population, managing collection, preparation and

Eisenhardt K.M. & Graebner M.E. (2007). Theory building from cases: Opportunities and challenges. *Academy of management journal*, *50*(1), 25-32; Bourgeois III L.J. & Eisenhardt K.M. (1988). Strategic decision processes in high velocity environments: Four cases in the microcomputer industry. *Management science*, *34*(7), 816-835.

[28] See the recent Rouse E., Reinecke J., Ravasi D., Langley A., Grimes M. & Gruber M. (2025). Making a Theoretical Contribution with Qualitative Research. *AMJ*, 68, 257-266.

[29] Gioia D.A. & Chittipeddi K. (1991). Sensemaking and Sensegiving in strategic change initiation. *Strategic Management Journal*, *12*(6): 433-448; Gioia D.A., Corley K.G. & Hamilton A.L. (2013). Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational Research Methods*, 16(1): 15-31.

recycling of plastics and glass, in synergy with local companies (glass factories, paper mills, and so on), helping to activate virtuous supply chains of effective recycling of glass, tetrapak and mixed plastics.

For each case, data and information were collected through the analysis of documents (financial statements, sustainability reports, presentations, websites, etc.), direct interviews and field visits.

This book aims to contribute to the debate on the transition to a circular economy in Italy and Europe. In addition to outlining the current framework from a multidisciplinary perspective, it seeks to offer guidance to political and business decision-makers, based on an analysis of the "whys" and "hows" behind the success of the international experiences examined.

These good practices demonstrate the concrete possibility of: reducing waste, preventing its formation; allow the reuse of products through the creation of state-of-the-art repair and reuse centers; send materials for effective recycling, obtaining valuable materials from waste; implement concrete strategies to involve citizens and businesses in the implementation of the waste hierarchy principle through separate collection and the introduction of economic incentives such as with PAYT[30], thus implementing the *polluter pays principle* and *stakeholder engagement*.

From the cases analysis, a model emerges that inspires and suggests to *decision makers* (politicians, technicians, managers) "*why*" to implement ambitious projects, despite the opposition of some subjects and categories, through the analysis of the results of the projects studied and "*how*" to implement the hierarchy principle concretely. The model therefore makes it possible to prevent and help overcome the many "*walls of no*", i.e. the main obstacles and barriers[31], and to achieve ambitious goals, offering concrete opportunities to change the future of entire communities, even going beyond the territories of reference, instilling virtuous effects of replication.

[30] Brown Z. (2024). Household waste practices: New empirical evidence and policy implications for sustainable behaviour, *OECD Environment Working Papers*, n. 249, OECD Publishing.

[31] Kirchherr J., Piscicelli L., Bour R., Kostense-Smit E., Muller J., Huibrechtse-Truijens A. & Hekkert M. (2018). Barriers to the circular economy: Evidence from the European Union (EU). *Ecological Economics*, 150, 264-272; Ranta V., Aarikka-Stenroos L., Ritala P. & Mäkinen S.J. (2018). Exploring institutional drivers and barriers of the circular economy: A cross-regional comparison of China, the US, and Europe. *Resources, Conservation and Recycling*, *135*, 70-82; European Commission: Directorate-General for Environment, BIO Intelligence Service, Ecologic, IEEP, IVM and psi (2014). *Scoping study to identify potential circular economy actions, priority sectors, material flows and value chains – Final report, Publications Office*; De Jesus A. & Mendonça S. (2018). Lost in transition? Drivers and barriers in the eco-innovation road to the circular economy. *Ecological Economics*, *145*, 75-89.

From the empirical analysis, the enabling factors to implement good practices – such as the definition of effective guidelines for the reduction in ordinary waste management and during major events, the creation of attractive and economically sustainable recycling plants and reuse centers, the definition of circular supply chains for the recovery of materials, the organization of separate waste collection and incentive systems through PAYT and information campaigns extended to citizens – are:

- a strong and sustained commitment on the part of key decision-makers in waste management policy, a commitment that should be clearly expressed through the approval of formal documents (such as manifestos, political programs, business plans, etc.) that clarify the strategy and make deviations during implementation more difficult;
- the involvement and active collaboration of motivated experts and professionals (consultants, managers, researchers), who bring prior experience that can help overcome the initial, physiological difficulties and "keep the course steady" in pursuing the fundamental principles of the adopted strategy;
- the engagement of employees, citizens and firms, through extensive and widespread information and training programs also on the "high" motivations underlying the choices made;
- the availability of adequate and dedicated financial and/or human resources, especially to allow the rapid achievement of the sustainability of the projects after the start-up phase and the objectives outlined;
- the flexibility to adapt the initial project – in both timing and approach – to actual needs, thus allowing useful suggestions from stakeholders to be embraced and progressively internalizing new solutions to emerging problems.

The case study also highlighted the main bottlenecks encountered in the implementation of ambitious projects aimed at applying the waste hierarchy principle, which were mainly found in:

- the lack of clear rules and regulations that do not discourage – but rather actively incentivize – strategies, policies, and projects that concretely implement the waste hierarchy principle; for example, by reducing bureaucracy, minimizing taxation, and allowing greater regulatory flexibility;
- in the presence of political and/or industrial lobbies capable of opposing the most innovative and ambitious strategies, acting at different levels of pressure and intercepting the weakness of policies and decision makers at different levels (national, local, firm);

- the need for adequate financial and human resources to enable a constant and long-term commitment and to ensure that the waste hierarchy principle is implemented in a sustainable manner and with lasting solutions.

Overcoming bottlenecks and preventing the formation of "walls of no" not only facilitates the introduction of good practices, but also makes it easier to replicate those already tested and implemented in other contexts – practices that have demonstrated their economic, environmental, and social sustainability. According to the European Environment Agency, in order to foster the transition to a circular economy and reduce the environmental impact of the use of natural resources, "*continuous ambitious waste management policies to incentivise recycling and discourage landfills and incineration*"[32] are essential.

In fact, even the analysis of the geographical distribution of cases shows that there is no ideal context or a single model to climb the waste hierarchy, just as it is not possible to identify a "best practice" but a plurality of good practices that can be combined synergistically through the mediation of different elements and acting on both structural and cognitive aspects.

The study of virtuous experiences presented in this volume not only confirms and reiterates the real possibility of undertaking innovative actions to effectively implement the waste hierarchy principle and advance the transition to a circular economy, but also promotes ambitious yet realistic policies capable of delivering concrete results.

Moreover, it helps identify a model to follow for replicating good practices in Italy and Europe, and for overcoming existing challenges related to the growing generation of waste, the limited reuse of materials, and the lack of supply chains suited to effectively initiating recycling.

The text therefore proposes a replicable model to overcome cultural and regulatory resistance, offering concrete guidance to political decision-makers, technicians and managers who intend to implement ambitious strategies capable of combining environmental sustainability, social equity and economic balance, making the circular economy no longer just a vision but a transformative practice.

The pursuit of the ambitious goal of creating economic models that create well-being through sustainable development, capable of ensuring "*the needs of the present without compromising the ability of future generations to meet their own needs*"[33] increasingly requires the virtuous integration of

[32] For further information, please refer to *www.eea.europa.eu/en/analysis/indicators/waste-recycling-in-europe*.

[33] United Nations (1987), *Report of the World Commission on Environment and Development, Our Common Future*.

reduction, reuse, and recycling strategies and policies, in order to enhance their mutually reinforcing positive impacts[34].

By simultaneously implementing projects that primarily target one step of the hierarchy, while also generating positive effects on the others, it is possible to define a path that synergistically enhances the efforts made, achieves tangible progress – even in the short term – and contributes to meeting European, national, and local objectives.

This book owes deep gratitude to the many people who made this work possible – those who dedicated their time to provide valuable information and insights, agreed to be interviewed, and enriched the research process with their suggestions.

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[34] Brown Z. (2024). Household waste practices: New empirical evidence and policy implications for sustainable behaviour, *OECD Environment Working Papers*, n. 249, OECD Publishing, Paris.

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Prof. Giulia Romano
University of Pisa

Coordinator of the Research Unit of the University of Pisa of the research project of relevant national interest (PRIN) Climbing the Waste Hierarchy: enabling factors and policies, CLIWEP (codice Progetto 2022K5PSNP, CUP I53D23002730006).

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Part I

The waste hierarchy between theory, regulations, and compliance in different European Countries

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2.

Strengths and approaches on the waste hierarchy: the evolution of the international literature[1]

Municipal waste management has gone through a transition process in recent decades, moving from management models based on landfill disposal to more sustainable management approaches[2].

The concept of waste hierarchy, proposed at European level, sets a priority among waste management actions. This hierarchy originates from the Lansink scale of 1979[3], which, since 2008, has become a strategic pillar of European legislation on waste management with the primary objective of reducing waste production and, in addition, promoting recycling and recovery as a priority over landfill or incineration[4]. The Waste Directive 2008/98/EC identified the EU waste hierarchy as the framework for waste management. However, each country decides and implements waste management plans taking into account its own culture, tradition, social norms and also different treatment costs[5]. The selection of appropriate policy instruments seems to be crucial to be able to achieve results in terms of perspective and progress

[1] This chapter was written by Sara Latini.

[2] See for example: Agamuthu P., Fauziah S. (2010). Challenges and issues in moving towards sustainable landfilling in a transitory country – Malaysia. *Waste Management & Research*, *29*, 13-19; Li N., Zhang T., Liang S. (2013). Reutilisation-extended material flows and circular economy in China. *Waste Management*, *33*, 1552-1560; Shekdar A. (2009), Sustainable solid waste management: An integrated approach for Asian countries. *Waste Management*, *29*, 1438-1448, with the bibliography cited therein.

[3] Lansink A. (2018). Challenging Changes – Connecting Waste Hierarchy and Circular Economy, *Waste Management and Research*, *36*, 872.

[4] See for example: Achillas C., Vlachokostas C., Moussiopoulos N., Banias G., Kafetzopoulos G., Karagiannidis A. (2011). Social acceptance for the development of a waste-to-energy plant in an urban area. *Resources, Conservation and Recycling*, 55, 857-863; Neo H. (2010). The Potential of Large-Scale Urban Waste Recycling: A Case Study of the National Recycling Programme in Singapore. *Society and Natural Resources*, 23, 872-887.

[5] Egüez A. (2021). Compliance with the EU waste hierarchy: A matter of stringency, enforcement, and time. *Journal of Environmental Management*, 280, 111672.

achieved in the transition to the circular economy[6]. For this reason, we believe that it is essential to draw inspiration from the "good practices" already implemented in other contexts and which have proven to generate positive results.

The literature on waste management is extensive and international in scope. In fact, numerous researchers have explored this topic from different perspectives and using different methodologies.

Some of these studies analyse the performance of waste management in terms of compliance with the EU hierarchy[7], while many others study practices that favour or disadvantage certain rungs that characterise it.

One of the strategies that best represents the waste hierarchy is the so-called zero-waste (ZW), adopted by some municipalities, which is based on 10 steps: separation at source; door-to-door collection systems; composting; recycling; reuse, repair and deconstruction; waste reduction initiatives; economic incentives; research and residue separation facilities; better industrial design; temporary landfills. Romano and Masserini[8] conducted an analysis showing that in municipalities with a ZW strategy, the rate of separate collection is higher and unsorted municipal waste per capita lower, with a higher per capita cost. This confirms the effectiveness of the strategy in promoting sustainable waste management and focuses on the importance of balancing costs through the sale of recyclable materials.

Another well-studied practice is the impact of modern pricing systems on the transition to a circular economy of the waste management sector and on the proactive involvement of users[9]. A pricing system adopted in many countries is Pay as You Throw (PAYT), in which the rates paid by users are modulated according to the amount of mixed waste delivered, with the aim of implementing the "polluter pays" principle in a fair way. The spread of this system is motivated by its expected contribution in terms of improving family responsibility and promoting proper waste management. Indeed, this strategy should promote the first points of the waste hierarchy by helping to minimise the volume of mixed waste and facilitating the expansion of reuse, composting

[6] See for example: Agovino M., Ferrara M., Marchesano K., Garofalo A. (2020), The separate collection of recyclable waste materials as a flywheel for the circular economy: the role of institutional quality and socio-economic factors. *Economia Politica*, 37, 659-681; Romano G., Marciano C., Fiorelli M. (2021). *Best Practices in Urban Solid Waste Management: Managing Knowledge, Performance and Governance in a Zero Waste Framework*. Emerald.

[7] D'Inverno G., Carosi L., Romano G. (2024), Meeting the challenges of the waste hierarchy: A performance evaluation of EU countries. *Ecological Indicators*, 160, 111641.

[8] Romano G., Masserini L. (2023). Does a zero-waste strategy in sustainable urban waste management affect hierarchy targets and costs? *Utilities Policy*, 85, 101659.

[9] Di Foggia G., Beccarello M. (2023). Designing circular economy-compliant municipal solid waste management charging schemes. *Utilities Policy*, 81, 101506.

and recycling within a circular economy framework. The implementation of this strategy has been the subject of extensive research, particularly at the municipal level[10], but also at the national and company level[11].

A study of the factors influencing the implementation of home recycling and PAYT programs in U.S. local governments[12] shows that PAYT may prove to be more effective than household recycling in reducing municipal waste generation, which is the first point in the waste hierarchy. However, it is crucial that citizens are properly informed about the effectiveness of economic incentives and that policymakers are convinced that the benefits outweigh the costs.

Starr and Nicolson[13] showed that, in Massachusetts, the impact of PAYT differed based on the type of recycling service used (collection points, subscriptions with private recycling companies, door-to-door collection) and showed greater effectiveness when integrated with home collection.

The available analyses indicate that one of the arguments in favour of PAYT (and point tariffs in general), is the cost savings due to better separation of municipal waste and the reduction of the quantities of waste that are disposed of in landfills. Slavik and Pavel[14] posed the question of whether these economic tariffs persist in countries where landfilling is the most cost-

[10] See for example: Allers A., Hoeben C. (2010). Effects of Unit-Based Garbage Pricing: A Differences-in-Differences Approach. *Environ and Resource Economics*, 45, 405-428; Dahlén L., Lagerkvist A. (2010). Pay as you throw: Strengths and weaknesses of weight-based billing in household waste collection systems in Sweden. *Waste Management*, 30, 23-31; Karagiannidis A., Xirogiannopoulou A., Tchobanoglous G. (2008). Full cost accounting as a tool for the financial assessment of Pay-As-You-Throw schemes: A case study for the Panorama municipality, Greece. *Waste Management*, 28, 2801-2808; Messina G., Tomasi A., Ivaldi G., Vidoli F. (2023), "Pay as you own" or "pay as you throw"? A counterfactual evaluation of alternative financing schemes for waste services. *Journal of Cleaner Production*, 412, 137363; Romano G., Masserini L. (2023), Pay-as-you-throw tariff and sustainable urban waste management: An empirical analysis of relevant effects. *Journal of Environmental Management*, 347, 119211.

[11] See for example: Slavik J., Pavel J. (2013). Do the variable charges really increase the effectiveness and economy of waste management? A case study of the Czech Republic. *Resources, Conservation and Recycling*, Volume 70, 68-77, for a company-level study; and Minoja M., Romano G. (2024). Effective stakeholder governance in circular economy: Insights from Italian companies. *Journal of Cleaner Production*, 474, 143584, for a company-wide study.

[12] Gradus R., Homsy G., Liao L., Warner M. (2019). Which US municipalities adopt Pay-As-You-Throw and curbside recycling? *Resources, Conservation and Recycling*, 143, 178-183.

[13] Starr J., Nicolson C. (2015). Patterns in trash: Factors driving municipal recycling in Massachusetts. *Resources, Conservation and Recycling*, 99, 7-18.

[14] Slavik J., Pavel J. (2013). Do the variable charges really increase the effectiveness and economy of waste management? A case study of the Czech Republic. *Resources, Conservation and Recycling*, 70, 68-77.

effective method of waste treatment. This study revealed that, in the Czech Republic, the costs associated with different pricing schemes are similar, confirming that variable tariffs remain the most economically advantageous in this context as well. In addition, other studies conducted in the past[15] confirm that, contrary to conventional expectations, variable pricing does not increase the overall cost of waste collection. Similar results have also been achieved in other works[16].

Elia, Gnoni and Tornese[17] have developed a set of guidelines for waste managers and researchers involved in the evaluation of the most critical processes in the design and management phases of a PAYT scheme, starting from the definition of the cost model up to the feasibility analysis on the methods and technological infrastructures to support waste tracking. However, some decisions affecting the design of a PAYT system are closely linked to local conditions and constraints that affect the municipal solid waste management service. For this reason, the analysis conducted does not identify a single optimal solution for each process examined, but allows the selection of the most effective tool, to be applied based on local constraints and holistic considerations, as required by European directives.

In addition to pricing, other strategies have been adopted, especially at the municipal level, which focus on the second and third steps of the waste hierarchy: "Preparation for reuse" and "Recycling". One of these concerns the implementation of prize programs, the method of implementation of which differs between the various municipalities. For example, in 2005 the UK government invited local authorities to propose innovative pilot projects to increase the practice of recycling, using shopping vouchers as incentives. The results obtained were studied[18], showing that the offer of vouchers that can be spent in local shops led to an increase of between 10 and 20% in participation rates, without this increase being conditioned by the socioeconomic status of the areas concerned. Whereas, in a densely populated metropolis like Hong Kong, it has been seen that using economic

[15] Skumatz L. (2008), Pay as you throw in the US: Implementation, impacts, and experience. *Waste Management*, 28, 2778-2785; Van Beukering P., Bartelings H., Linderhof V., Oosterhuis F. (2009). Effectiveness of unit-based pricing of waste in the Netherlands: Applying a general equilibrium model. *Waste Management*, 29, 2892-2901.

[16] See for example: Isely P., Lowen A. (2007). Price and substitution in residential solid waste. *Contemporary Economic Policy*, 25, 433-443; Karagiannidis A., Xirogiannopoulou A., Tchobanoglous G. (2008), Full cost accounting as a tool for the financial assessment of Pay-As-You-Throw schemes: A case study for the Panorama municipality, Greece. *Waste Management*, 28, 2801-2808.

[17] Elia V., Gnoni M., Tornese F. (2015). Designing Pay-As-You-Throw schemes in municipal waste management services: A holistic approach. *Waste Management*, 44, 188-195.

[18] Harder M., Woodard R. (2007). Systematic studies of shop and leisure voucher incentives for household recycling. *Resources, Conservation and Recycling*, 51, 732-753.

incentives has a significant impact in promoting the recycling of household waste[19].

In addition to economic incentives, other policy instruments that facilitate this transition process towards a circular economy have been analysed in the literature.

Three distinct policy approaches were examined in Yang and Innes' study[20]: a pricing policy in Taipei City that requires households to purchase official garbage bags for the collection of unsorted waste, a mandatory recycling program in Kaohsiung, and a national policy of charging the cost of plastic bags. The results of the study indicate that the policies implemented in Taipei and Kaohsiung result in significant increases in recycling levels and a reduction in waste. The policy regarding plastic bags is generally considered to be a contributing factor to a reduction in recycling rates, as well as total waste volumes.

A further aspect of general interest for public services is the concept of co-production formalized in 2016[21], and defined as the involvement, voluntary or involuntary, of users in any phase of the design, management, provision and/or evaluation of public services. The importance of this concept is due to the fact that it is believed to have the potential to improve the efficiency and effectiveness of services, becoming a fundamental response to the need for public sector reform[22].

In fact, a lot of research has analysed the results of community engagement projects, although these studies often do not include an explicit reference to

[19] Yau Y. (2010). Domestic waste recycling, collective action and economic incentive: The case in Hong Kong. *Waste Management*, 30, 2440-2447. A similar result regarding the separation of organic waste was also obtained in Boonrod K., Towprayoon S., Bonnet S., Tripetchkul S. (2015). Enhancing organic waste separation at the source behavior: A case study of the application of motivation mechanisms in communities in Thailand. *Resources, Conservation and Recycling*, 95, 77-90.

[20] Yang H., Innes R. (2007). Economic Incentives and Residential Waste Management in Taiwan: An Empirical Investigation. *Environmental and Resource Economics*, 37, 489-519.

[21] Osborne S., Radnor Z., Strokosch K. (2016). Co-Production and the Co-Creation of Value in Public Services: A suitable case for treatment? *Public Management Review*, 18, 639-653.

[22] See for example Di Liddo G., Vinella A. (2020). Co-Production in Local Public Service Delivery: The Case of Waste Management. *The B.E. Journal of Economic Analysis & Policy*, 20, 1-27; Landi S., Russo S. (2022). Co-production "thinking" and performance implications in the case of separate waste collection. *Public Management Review*, 24, 301-325; Loeffler E., Bovaird T. (2018). From Participation to Co-production: Widening and Deepening the Contributions of Citizens to Public Services and Outcomes. *The Palgrave Handbook of Public Administration and Management in Europe*, 403-423; Osborne S., Radnor Z., Strokosch K. (2016), Co-Production and the Co-Creation of Value in Public Services: A suitable case for treatment? *Public Management Review*, 18, 639-653; Pestoff V. (2006). Citizens and co-production of welfare services. *Public Management Review*, 8, 503-519.

co-production. For example, in a 2022 study[23], the authors highlight the need for collaboration between the parties involved in the sustainability transition process, involving citizens in particular. The latter, in fact, being directly involved in current environmental challenges (e.g. in the production of waste) can develop practical methods to address them[24]. In addition, citizens play a crucial role in the dissemination of sustainability policies[25].

In the area of waste management, a 2022 study[26] suggests that local authorities that take a user-oriented approach to improve co-production are more likely to achieve optimal results in terms of separate collection. This seems to corroborate what has already emerged from a previous study, which shows that policies characterized by greater practicality in waste management generate a greater positive impact on citizens than those that penalize disposal[27]. In other words, you get a better result by focusing on promoting the correct action rather than penalizing the wrong one. Jomehpour and Behzad also[28] highlight a direct correlation between the active participation of citizens and the effectiveness of the municipal waste management service.

The importance of involving citizens, highlighted by the co-production, underlines the need to implement more awareness and adequate information campaigns.

Montevecchi[29] notes that a mix of policies, including an effective combination of information campaigns, differentiated waste tariffs and

[23] Trischler J., Svensson P., Williams H., Wikström F. (2022). Citizens as an innovation source in sustainability transitions – linking the directionality of innovations with the locus of the problem in transformative innovation policy. *Public Management Review*, 25, 2093-2115.

[24] See for example: Kuhlmann S., Rip A. (2018). Next-generation Innovation Policy and Grand Challenges. *Science and Public Policy*, 45, 448-454; Schot J., Kanger L., Verbong G. (2016). The Roles of Users in Shaping Transitions to New Energy Systems. *Nature Energy*, 1, 1-7.

[25] See for example Bradonjic P., Franke N., Lüthje C. (2019). Decision-makers' Underestimation of User Innovation. *Research Policy*, 48, 1354-1361; Nielsen K. (2020). Policymakers' Views on Sustainable End-user Innovation: Implications for Sustainable Innovation. *Journal of Cleaner Production*, 257, 1-12; Svensson P., Hartmann R. (2018). Policies to Promote User Innovation: Makerspaces and Clinician Innovation in Swedish Hospitals. *Research Policy*, 47, 277-288.

[26] Landi S., Russo S. (2022). Co-production "thinking" and performance implications in the case of separate waste collection. *Public Management Review*, 24, 301-325.

[27] Mueller W. (2013). The effectiveness of recycling policy options: Waste diversion or just diversions? *Waste Management*, 33, 508-518.

[28] Jomehpour M., Behzad M. (2020). An investigation on shaping local waste management services based on public participation: A case study of Amol, Mazandaran Province, Iran. *Environmental Development*, 35, 100519.

[29] Montevecchi F. (2016). Policy Mixes to Achieve Absolute Decoupling: A Case Study of Municipal Waste Management. *Sustainability*, 8, 442.

a developed collection system, can promote a shift of waste away from landfills. However, this policy mix has proven inadequate to meet more stringent waste management standards, such as the complete elimination of landfills or a sustained reduction in overall waste generation.

In another study[30], the impact of the collection system, the adoption of a PAYT System and awareness campaigns on home composting in three different small Italian municipalities was analyzed. In particular, the awareness campaign was formalized through the creation of a dedicated register containing the names of the families who had joined the practice, allowing them to be monitored by the municipality, to ensure the success of the program, receiving a 20% reduction in the rate. The simultaneous implementation of the door-to-door (DtD) system and the PAYT system resulted in a significant decrease in the total amount of waste; on the other hand, the start of DtD collection alone has led to a reduction in unsorted residual waste and an increase in sorted waste, but the overall volumes have subsequently shown an increase, until the introduction of the PAYT system. It can therefore be concluded that the implementation of a system that requires individuals to pay for the waste they generate is a fundamental element in reducing the overall quantities of waste.

Timlett and Williams[31] studied the results of three different policies: the first is the introduction of DtD waste collection, the second offers incentives for citizens that improve the quality of the materials delivered, and the third provides residents with personalized feedback that is part of awareness campaigns. Each project was conducted on an area of about 10,000 families, excluding large condominiums, in order to ensure the fairness of the comparison between the three projects. The results show that the DtD approach was not particularly effective, probably due to the relatively high baseline participation rate (>60%). However, the strategy has proven effective in engaging residents and expanding the range of recycled materials. Regarding the incentive program, only 13% of households said that the possibility of a reward was their main motivating factor. Finally, the feedback approach proved to be an effective method of reducing contamination and providing better value for money, as it was the lowest budget approach. The results of the study suggest that most people are unable to achieve the desired result (differentiating in the correct way) due to a lack of understanding of

[30] Bosio L., Bonelli M., Cavallo R., Gianolio U., Marengo P. (2016). Waste prevention impacts on small municipalities: Three experiences from northern Italy. *Waste Management and Research*, 34, 1014-1025.

[31] Timlett R., Williams I. (2008). Public participation and recycling performance in England: A comparison of tools for behaviour change. *Resources, Conservation and Recycling*, 52, 622-634.

the steps needed in waste management. This is also found in another study from 2010[32] where it is observed that educating the population increases the recycling rate. In particular, the authors conclude that investing one dollar per person per year in education/training would increase the recycling rate by about 2%.

Although most studies focus on municipal or national level investigating policies and results achieved by individual municipalities or countries, companies also play a crucial role in facilitating a transition to more sustainable waste management models and towards a circular economy. For example, Minoja and Romano[33] shed light on stakeholder governance as a practical tool for achieving circular economy goals. In fact, from a business perspective, addressing this transition is also a matter of stakeholder governance. Another study[34] examines the process of "remunicipalization", i.e. the process in which a company totally owned by the municipality replaces another company that can be private, mixed or public owned but at a supra-municipal level. This process results in significant improvements in a company's performance, provided that certain key success factors are met, relating to the municipality, the company and its management. On the other hand, Bel and Sebő[35] examined the impact of competition between companies in the city of Barcelona, which, following a far-reaching reform of municipal waste management, was divided into four zones with four separate contracts for waste collection awarded to private companies, with none being allowed to obtain more than one zone. The results of the study revealed that companies with productions located in larger areas report higher costs. In addition, it emerged that increased competition did not generate a decrease in costs, and that no company operates with increasing returns to scale. These results suggest that competing multiple companies does not always improve performance in waste management.

The analysis of the existing bibliographic production has highlighted the complexity and multidimensionality of the subject matter. The studies conducted so far have made significant contributions, offering different theoretical and methodological perspectives. However, some gaps also emerge, in particular the lack of in-depth studies on the issues of reuse and

[32] Sidique S., Joshi S., Lupi F. (2010). Factors influencing the rate of recycling: An analysis of Minnesota counties. *Resources, Conservation and Recycling*, 54, 242-249.

[33] Minoja M., Romano G. (2024). Effective stakeholder governance in circular economy: Insights from Italian companies. *Journal of Cleaner Production*, 474, 143584.

[34] Romano G., Marciano C., Minoja M. (2022). Successful remunicipalization processes in Italian waste management: Triggers, key success factors, and results. *International Review of Administrative Sciences*, 89, 648-666.

[35] Bel G., Sebő M. (2020). Introducing and enhancing competition to improve delivery of local services of solid waste collection. *Waste Management*, 118, 637-646.

reduction, with most of the research focused on separate collection and tariffs. While these aspects also favour reduction and reuse, there is a lack of studies that consider these rungs of the European hierarchy as the core of research. There is also a lack of availability of qualitative investigations, i.e., case-based studies aimed at deepening the "whys" and "hows" of the phenomenon investigated[36], in this case therefore of the introduction of strategies and policies capable of concretely implementing the principle of the waste hierarchy.

[36] Rouse E., Reinecke J., Ravasi D., Langley A., Grimes M. & Gruber M. (2025). Making a Theoretical Contribution with Qualitative Research. *AMJ*, 68, 257-266.

3.

From waste to resource: legal foundations, governance models and critical issues for the circular economy[1]

3.1. From a waste-oriented to a resource-oriented policy and regulatory framework

The circular economy is proposed as an effective strategy to address the progressive scarcity of natural resources and the significant environmental impacts of the traditional linear economic model. This approach aims to extend the life cycle of products, minimizing the production of waste through reuse, recycling, regeneration of materials and reduction of consumption, according to the principles of the 4Rs: Reduce, Reuse, Recycle and Recover.

While the European Union has been at the forefront with initiatives such as the European Green Deal and the Circular Economy Action Plan, which aim to make Europe climate-neutral by 2050 and to develop a low-emission and resource-efficient economy, however, the declination of Circular Economy at the level of European institutions is very recent. In fact, it is only with Decision no. 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 "Living well within the limits of our planet" that the concept is the subject[2] of an official document of the European Union, where in point 40 it is written that

> Barriers to recycling activities in the Union's internal market should be removed and existing targets for prevention, reuse, recycling, recovery and alternatives to landfill should be reviewed in order to move towards a "circular" life-cycle economy, with almost non-existent seamless use of resources and residual waste[3].

[1] This chapter was written by Giovanni Giaretti.

[2] In the "Roadmap to an Efficient Europe of 2011" with reference to the reuse of metals in which in point 4.3 there is the statement that "*in the transition to a sustainable management of materials, effectively based on consumption, or to a 'circular economy' in which waste becomes a resource, a more efficient use of minerals and metals will be achieved*".

[3] Point 1 of the annex states that: "*In 2050 we will live well within the ecological limits*

But if one wanted to look for a real definition of "circular economy" in the acts of the European institutions[4], this would not be found[5], forcing the jurist to take a hermeneutic interpretation that, starting from the title of the seventh European environmental action program "Living well within the limits of our planet", highlights how the fundamental concept is that of limit, as planet Earth represents a finite system whose resources available to mankind are not infinite.

The idea of the circular economy is therefore, starting from the awareness of the limits of resources, that it is necessary to design and produce goods that at the end of their cycle constitute as few pressure factors as possible on the environment or, even, can contribute to improving it. In natural ecosystems,

of our planet. Prosperity and a healthy environment will be based on a waste-free circular economy, where natural resources are managed sustainably and biodiversity is protected, valued and restored in a way that strengthens the resilience of our society. Our growth will be characterized by low carbon emissions and will long ago be decoupled from the use of resources, thus setting the pace for a secure and sustainable global society".

[4] In December 2015, the EC Commission presented the proposal for the so-called second "Circular Economy" package in a plenary session of the European Parliament, attaching the communication "Closing the loop: an EU action plan for the circular economy". There are four directives that make up the "Circular Economy" package, published in the OJEU 14-6-2018: the first is no. 851/2018/EU (hereinafter referred to as the "Waste Directive); the second is Directive 852/2018/EU (hereinafter referred to as the "Packaging Directive"); the third is Directive 850/2018/EU ("landfill directive"); the fourth is the dir. 849/2018/EU ("Vehicles, Batteries and WEEE Directive"). However, the "Circular Economy" package does not find a specific definition of circular economy.

[5] The circular economy model, which is holistic by nature, is based on principles, such as, for example, those identified by UNI/TS 11820:2022: In the transition to a circular economy, companies must use the four inspiring principles: Value Creation; Value Sharing; Availability of Resources and Traceability of Resources. They must also use the eight operating principles: Systems Thinking; Circular Value Generation; Optimization of Circular Value; Preservation of Circular Value; Cooperation; Innovation; Awareness; Inclusion. ISO 59004 – Circular Economy Framework and principles for implementation: In the transition to a circular economy, companies must use the six principles: Systems thinking; Value creation; Value sharing; Resource availability; Resource traceability; Ecosystem resilience Standard BS 8001:2017 *Circular Economy:* System Thinking; Innovation, Stewardship; Collaboration; Value Optimization; Transparency. 10 R: Reduce; Reuse; Recycle; Recover; Rethink; Refurbish; Remanufacture; Repurpose; Re-Mine. Ellen Macarthur Foundation: Regenerating Natural Capital; optimize the performance of resources; minimize or eliminate negative externalities thanks to a design capable of eliminating them. The World Business Council for Sustainable Development, in the "CEO Guide for Circular Economy" study, identifies 5 circular business models: 1. make circular procurement: use of renewable energy, bio-based or recyclable raw materials to replace single-use ones; 2. offer access to the use of products while maintaining ownership to internalize the benefits of circular resource productivity; 3. extend the life cycle of the product and its parts through resale, repair, remanufacture and upgrade; 4. recover materials, resources and energy from waste or by-products; 5. share platforms, increasing the rate of use of products by making it possible to share use/access and ownership of goods and services.

we are witnessing virtuous cycles in which the final phase of the life of a tree, a plant, an animal return to be an added value for the soil or, in general, for ecosystems. Respecting limits means designing and designing products that can be reused and recycled several times: it is about making sure that the materials and energy used to manufacture the products retain their value for as long as possible, minimizing waste production and using as few resources as possible[6].

The ambitious energy and environmental targets set at European and national level, which aim at decarbonisation by 2030 and climate neutrality by 2050, require strategic decisions capable of profoundly transforming current production and consumption models. The adoption of the Paris Agreement in 2015 represented a turning point in international climate governance, binding signatory countries to limit global warming to 1.5 °C. This event officially marked the beginning of the ecological transition, a phase in which the economic and industrial system is called upon to structurally reduce its environmental impact, adopting innovative solutions that integrate sustainability and competitiveness. In this scenario, new political and regulatory guidelines have emerged, such as the European Green Deal, which outlines an overall strategy to reform the regulatory framework in order to achieve climate neutrality by mid-century. This path is part of the broader context of the United Nations 2030 Agenda, which with its 17 Sustainable Development Goals aims to address the great global challenges – environmental, economic and social – in a coordinated way. Within this complex and ambitious landscape, the circular economy takes on a key role. It represents an innovative model, an alternative to the traditional linear paradigm, and aims to transform production chains by promoting practices based on reuse, recycling and efficient use of resources. The goal is to create a regenerative growth, in which the concept of waste is progressively overcome through a continuous enhancement of materials, both as secondary raw materials and as energy sources.

However, if the definition of the concept of circular economy is very recent at European level, the adoption of European regulatory acts concerning "waste" dates back to date. The need to combat the oil crisis of the 1970s led to Council Directive 75/439/EEC of 16 June 1975 on the disposal of waste oils. The contemporary Council Directive 75/442/EEC of 15 July 1975, in the recital, noted what would become fundamental principles:

> that a disparity between the provisions in application or in preparation in the various Member States for the disposal of waste may create inequality in the

[6] Dossier of the Senate and the Chamber of Deputies, XVII legislature, Proposals on the circular economy, ed. agg., 19-1-2016.

conditions of competition and therefore have a direct impact on the functioning of the common market; whereas it is therefore necessary to proceed in this field to the approximation of laws provided for in Article 100 of the Treaty; environment and improvement of the quality of life; whereas it is therefore necessary to lay down some specific provisions; Whereas, since the necessary powers of action have not been provided for in the Treaty, recourse must be had to Article 235;Whereas the European Communities' action programme for the protection of the environment stresses the need for Community action, including the harmonization of legislation; whereas effective and consistent rules on waste disposal, which do not impede intra-Community trade and do not adversely affect the conditions of competition, should apply to movable property discarded or discarded by the holder under the national provisions in force, with the exception of radioactive, mining and agricultural waste, carrion, waste water, gaseous effluents and waste subject to specific Community regulation.

In the Western world, therefore, it is with the oil crisis that we realize that the linear growth model, established with the industrial revolution, has entered into crisis, with the acquired awareness of dependence on limited resources, thus trying to use the resource to its maximum potential to promote its regeneration.

In this context, waste management actions were developed at European level, leading in 2008 to the fundamental Framework Directive 2008/98/EC on waste, the cornerstone of European Union policies and legislation, with a twofold objective:

- minimising the negative impacts of waste production and management;
- improve resource efficiency.

In this framework, waste management actions are placed in an order of priority that constitutes a hierarchy generally identified in an inverted pyramid with the most preferable options at the top and disposal at the base, as a last resort for waste management.

Art. Article 4 of the Directive provides:

1. The following waste hierarchy shall apply as an order of priority in waste prevention and management legislation and policy:
   a) prevention;
   b) preparation for reuse;
   c) recycling;
   d) other recovery, such as energy recovery; and
   e) disposal.
2. When applying the waste hierarchy referred to in paragraph 1, Member States shall take measures to encourage the options that deliver the best overall environmental outcome. To that end, it may be necessary for specific waste

> streams to deviate from the hierarchy where this is justified by the life-cycle approach in relation to the overall impacts of the generation and management of such waste. Member States shall ensure that the development of waste legislation and policy is carried out in a fully transparent manner, in compliance with existing national rules on consultation and participation of citizens and stakeholders. In accordance with Articles 1 and 13, Member States shall take into account the general environmental protection principles of precaution and sustainability, technical feasibility and economic viability, protection of resources as well as overall social, economic, health and environmental impacts.

The prevention of waste, already a fundamental principle of environmental law, is identified in point 12) of art. 3 of the Directive as measures, taken before a substance, material or product has become waste, which reduce:

- the quantity of waste, including through the reuse of products or the extension of their life cycle;
- the negative impacts of the waste generated on the environment and human health;
- the content of hazardous substances in materials and products.

In this regard, the definition of by-product by the Directive is particularly important, according to which in Art. 5 reads:

> A substance or object resulting from a production process the primary purpose of which is not the production of that article may not be considered waste within the meaning of Article 3 (1) but a by-product only if the following conditions are met: (a) it is certain that the substance or object will be further used; (b) the substance or object is not a waste within the meaning of Article 3 (1) but a by-product only if the following conditions are met:object can be used directly without any further treatment other than normal industrial practice; (c) the substance or object is produced as an integral part of a production process, and (d) the further use is legal, i.e. the substance or object meets, for the specific use, all relevant requirements regarding products and the protection of health and the environment and will not lead to overall negative impacts on the environment or human health.

Attention to the possibility of recovering products, so that they never become waste or, in any case, become waste as late as possible, leads to rethinking the very concept of "product", because "downstream" management takes on importance, to be improved with a wider range of services suitable for ensuring greater durability and usability of goods, but above all the "upstream" design phase.

If the by-product is a production residue that, although not the main product of the process, can be reused directly in another production cycle without being considered waste, the principle of prevention has evolved to rethink processes from an eco-design perspective, adopting an approach that considers the reduction of environmental impacts throughout the life cycle, from the selection of materials to production, from distribution to use, up to final disposal and possible recyclability of the products themselves.

The recent publication by the European Union of Regulation 2024/1781 is a milestone in the path envisaged by the Action Plan on the circular economy within the Green Deal. This Regulation establishes the framework for the definition of eco-design requirements for sustainable products (ESPR) and includes (and makes mandatory for obliged entities) the ecodesign approach within European legislation in several aspects:

- extended life cycle: to envisage a long-term vision of the useful life and value of products that are therefore durable and circular;
- recycling and reuse: design of products and components that can be easily recycled or reused in new products;
- modularity: creating modular products that can be upgraded and repaired by replacing only damaged or obsolete parts, rather than the entire product;
- waste reduction: optimization of production processes to minimize waste materials and energy used;
- collaboration between sectors: implementation of industrial symbiosis strategies, where waste from one industry becomes resources for another.

3.2. The transposition of the waste hierarchy into the national regulatory framework

Waste management today represents a matter of absolute centrality and one of the most significant challenges to ensure environmental sustainability. A crucial element is the strict application of the waste management hierarchy, which includes prevention as a first step, aimed at reducing the production of waste at source. Next, it is essential to implement effective separate collection systems and promote recycling, including material and energy recovery activities, in order to limit the use of landfill disposal.

The 2008 Waste Framework Directive shows that prevention manifests itself through an intervention "upstream" of the production or consumption process; This intervention is aimed at reducing the quantities of materials produced and placed on the market in order to save natural resources. From

this point of view, it is a question of applying the elementary principle that the lower the industrial production, the less waste is generated.

However, this principle is also the valorisation of waste-material goods: in fact, if waste becomes an economically assessable good, reducing its circulating quantity as much as possible increases its value and, on the market for recyclable waste, its price.

The European Directive 2008/98/EC has already set a precise goal since 2008: to bring the share of municipal waste sent to landfills below 10%. However, more than fifteen years later, Italy has not yet reached this goal. According to ISPRA's 2022 Urban Waste Report[7], in 2021 19% of municipal waste produced in the country was disposed of in landfills, showing a significant delay compared to EU targets.

Added to this is a growing criticality linked to the progressive depletion of the residual capacity of landfills. According to Utilitalia estimates[8], on average, Italian regions will reach saturation of their disposal plants within a few years. However, the phenomenon presents a strong territorial inhomogeneity: in the South, saturation could already occur within a couple of years. This unbalanced distribution of plants means that a significant part of the waste is transferred to the northern regions, resulting in economic and environmental inefficiencies, as well as increased costs and emissions related to transport.

In this regard, however, it is worth mentioning the recent Judgment no. 8144 of 11.10.2024 of the Council of State, according to which the authorized volume of landfills must be calculated net – and not gross – of the material used for the daily containment and coverage of waste. The calculation relating to the authorized quantity of transfers for disposal purposes must include only the waste stored in the plant, "*i.e. the only material that is actually polluting*" subject to the company's activity. The administrative judges therefore clarified that the calculation of the volume must exclude the material used to cover and contain the waste, thus freeing up more space for disposal.

Although the concept of "circular economy" has been a topic of discussion since at least the 70s, it has only recently become the responsibility of national institutional bodies with Legislative Decree 12-7-2018, no. 86 conv. in Law no. 97 of 9-8-2018, for which "*policies for*

[7] Waste management is a key pillar of the circular economy model, helping to reduce pressure on the environment through the recycling and reuse of materials. Italy, in 2022, produced 3,212 kilograms of waste per inhabitant, a value significantly lower than the EU average (4,991), France (5,076) and Germany (4,604) but higher than that of Spain (2,480). In addition to an overall low production of waste, our country stands out in the European panorama for a solid performance in material recycling, with 53.3% of total municipal waste being recycled against 49.1% of the EU average (ISPRA data).

[8] Study "Urban waste, current plant needs and to 2035", carried out by Utilitalia (2022).

the promotion of the circular economy and the efficient use of resources, without prejudice to the competences of the Ministry of Economic Development" were also added to the competences of the Ministry of the Environment and with the Presidential Decree 19-6-2019, no. 97 the "circular economy" directorate was established within the organization of the Ministry of the Environment.

In this context, the Ministry of the Environment and Protection of Land and Sea (MATTM) – now MASE – and the Ministry of Economic Development (MISE) – now MIMIT – in November 2017 drafted and published the document "Towards a circular economy model for Italy" with the aim of providing a general framework of the circular economy.

Five pillars have been identified on which to base the circular economy:

1. *sustainable inputs*: the use of renewable resources and waste materials is central to the consolidation of circular production models for the production of energy, products and to manage and maintain plants and infrastructures;
2. *extension of useful life*: this includes the eco-design of products, new infrastructures and the reconversion or repowering of existing ones, favoring the adoption of materials that have a lower environmental impact, given their wider durability that maximizes the efficiency in use, thus avoiding further consumption, pollutants, waste and waste;
3. *symbiosis*: the development of new models of industrial symbiosis allows the sharing of resources between different economic sectors and the territory. This collaboration between economic operators makes it possible to use available resources more efficiently, creating partnerships that can lead to an optimized use of raw materials and waste materials;
4. *reduce, reuse, recycle and recover*: extending the useful life of products, as already mentioned, is crucial to reduce the environmental impact since in this way the production of waste is reduced and, consequently, the use of virgin raw materials is severely limited. This is also achieved through practices of reduction, reuse and recycling, maintaining the productive value of the resources used. Waste, damaged or discarded products from recovery chains that preserve their qualities, acquire value again and can be used, instead of virgin raw materials, in the same or in other production processes. When a product has finished its function, it can take on a new value if the materials of which it is composed are separated and reintroduced, when possible, into the various production processes through recycling practices. In this way, not only is unnecessary waste avoided, but real resources are created.
5. *sustainable outputs*: Sustainable output includes the production of materials, products, energy, and fuels from renewable, waste, waste, and

secondary raw materials. This not only reduces dependence on virgin resources, but also contributes to a more sustainable production cycle. The goal is to maintain the productive value of resources through a waste management system that promotes reuse, recycling and recovery.

In the national regulatory framework, a fundamental moment is 2022, as with Decree of the Ministry of Ecological Transition no. 259 of 24 June 2022, the National Strategy for the Circular Economy was approved which, together with the National Programme for Waste Management (approved by MITE Decree no. 257 also of 24 June 2022), represents the pillar for the concrete promotion and application of criteria and methodologies for effective waste management in economic, environmental and social terms and, in general, for the adoption of tools aimed at concretely defining a circular vision of the economy.

As part of the National Strategy for the Circular Economy (SNEC), a significant role is entrusted to the "industrial symbiosis", i.e. the integrated system for sharing resources (materials, water, by-products, waste, services, skills, tools, databases, etc.) according to a cooperative approach in which the output of a company can be used as input by a third party company as part of its production process. A new vision that calls for a synergy between companies in the use of resources, to achieve and guarantee competitive advantages to the companies themselves. This is a way to optimize production processes also through the creation of "circular districts", but also to stimulate the transfer of knowledge on the efficient use of resources with consequent positive repercussions on productivity, innovations and ecological practices, as well as on competitiveness. The "industrial symbiosis" is, therefore, a systemic strategy that acts on all industrial components and involves many subjects that traditionally carry out activities separately: it induces collaboration and the sharing of experiences and resources (by-products or production waste, energy and water waste, services) between two or more industries belonging to different sectors. It is important to underline that an effective implementation of "industrial symbiosis" makes it possible to achieve environmental objectives more effectively, by virtue of the valorisation of residues, both recovered internally and destined for other production processes or other uses. As a result, there will be a minimization of the production of waste to be sent for disposal, the reduction of the exploitation of natural resources, energy savings, the reduction of CO_2 emissions and the reduction of incident activities on the territory. This also takes on an important significance for the economic support initiatives that the PNRR provides to support partnership projects on the entire value chain, aimed at supporting industrial symbiosis initiatives.

The operational and virtuous model that embodies this vision is represented by circular districts: real territorial centers of the circular economy, designed as "citadels of recycling" in which each phase of waste management is oriented towards the recovery and enhancement of resources, supported by adequate plants.

If these are the objectives of SNEC, to date there is a strong lack of infrastructure, which leads to waste management that is still too dependent on the disposal of a significant share of unsorted municipal waste in landfills. The system is also influenced by external factors, often resorting to export for the treatment of a substantial part of special waste. The recurrent emergencies in waste management that affect various areas of the country – especially in the Centre-South, but also in some areas of the North that are not self-sufficient – are largely due to the progressive decrease in the availability of landfills, historically used as an emergency solution for the system.

The plant gap involves not only the treatment of the undifferentiated fraction, but also affects separately collected waste. In some areas of the country – particularly in the North – there are excellent supply chains for recovery, as in the case of glass and paper. However, for other materials, significant delays remain compared to the European targets.

In this context, circular districts are decisive and functional to build the conditions for a real industrial symbiosis, essential for the creation of value and economic and environmental benefits for a given territory, as they are made up of a complex of integrated and interconnected plants. The plants, designed to transform waste into energy and new materials (secondary materials) that are then reused elsewhere, work synergistically with each other: what comes out of one plant becomes food for the other. This hub of coordinated plants makes it possible to obtain added value for the territory and to overcome the inefficiencies that often characterize the daily management usually based on the transfer of waste from one plant to other plants suitable for treating it.

An industrial symbiosis strategy, which is based precisely on the optimization of the use of resources (material, energy, water, spaces, skills, etc.) by the industries of a given territorial district, provides a significant contribution to the circular economy. In particular, in the mechanical industrial sector, the industrial district is the model that mainly characterizes the national production fabric. It is typically composed of a large number of small and medium-sized enterprises, which usually operate in close interdependence and are strongly integrated with the territory, also in socio-economic terms (employment levels, related industries, etc.). This close interdependence means that the value chain also includes those products that have been considered "waste" until now and which, in a logic of circularity,

constitute resources that can be used by another company, also operating in a different production sector. This practice can therefore lead to the expansion of the industrial district, multiplying collaborations and synergies between companies even in different sectors.

In its Report on the Circular Economy, Confindustria[9] highlights an emblematic case of a territorial production system in the field of mechanics, with particular attention to the manufacture of valves and taps. The analysis highlighted the widespread presence of industrial poles on a national scale, with a high concentration in some areas such as Piedmont (Verbano-Cusio-Ossola area, near Lake Orta), Lombardy (provinces of Brescia and Bergamo) and Emilia-Romagna, in particular Piacenza.

In relation to the production of valves, the use of metallic materials such as brass allows effective management of recovery and recycling. It is precisely in these regions that the world's leading center for brass processing is located, representing over 30% of Italian production and more than 15% of global exports in the taps and valves sector.

During machining steps such as turning, milling or cutting, metal residues are generated in the form of chips and filings, as well as defective components. These materials, however, are not considered waste, but represent a resource to be reintroduced into the production cycle. Reuse can take place through an internal recycling system, in which waste is collected and remelted to create new material, thus reducing the use of virgin resources; Alternatively, they can be sent to external foundries, often located in the districts themselves, where they are processed into ready-to-use ingots. Brass, in fact, can be remelted numerous times without losing its technical characteristics, making the process highly sustainable.

The study also shows the economic and employment importance of this sector: according to ISTAT data from 2019, companies in the sector employ about 11,000 people, generating a total turnover of more than two billion euros, with about 66% destined for export. The production fabric consists of over 170 industrial companies (with an average of 10 employees) that employ about 2,000 employees, flanked by over 1,000 small craft companies (2-3 workers each), for a similar total of employees.

In these districts, collaboration between companies plays a strategic role. The principle of circular economy is achieved through the systematic reuse of residual resources and materials deriving from processing, such as scraps, scraps or production leftovers. The district is thus configured as a real industrial ecosystem, strongly rooted in the territory, from which it draws not only skills and technical know-how, but also logistics infrastructures, specialized services and dedicated financial instruments.

[9] *www.confindustria.it//home/policy/position-paper/dettaglio/rapporto-economia-circolare.*

3.3. Legal models of waste governance

Articles 28 and 29 of Directive 2008/98/EC require Member States to identify the authorities competent to draw up waste management plans and waste prevention programmes, respectively, which may also be an integral part of the former. It is important to note that Directive 2018/851/EU has modified the content of these plans by including an explicit assessment of the need to close existing plants or possibly to create additional ones, in accordance with the principles of proximity and self-sufficiency referred to in art. 16 of the same directive. At the national level, the Environmental Code attributes to the Region the fundamental planning function just mentioned. More precisely, art. 199 of the Environmental Code assigns to the Region the preparation of the regional waste management plan. This is a general act of an eminently technical nature, which brings together the two planning instruments of European origin[10].

As for the content of this regional plan, this essentially translates into the establishment of *policies* and the territorial organization of activities related to the waste cycle. The plan identifies the general waste management policies at the regional level starting from the analysis of the waste management existing in the geographical area concerned and identifying the measures to be taken to improve the environmental effectiveness of the various operations that concern them. It also sets the objectives of separate collection and waste reduction, also providing for any reward mechanisms to encourage the achievement of the aforementioned objectives. Finally, it delimits the regional territory into optimal territorial areas and provides for criteria for the location of waste treatment and disposal plants.

In this regard, art. 182-bis of the Environmental Code establishes the fundamental criteria for the construction of integrated networks of plants:

- achieve self-sufficiency in the disposal of non-hazardous municipal waste and its treatment in optimal territorial areas;
- allow the disposal of waste and the recovery of unsorted municipal waste in one of the suitable facilities closest to the places of production or collection, in order to reduce the movement of the waste itself, taking into

[10] The Court of Justice, in Joined Cases C-53/02 and C-217/02, Municipality of Braine-le-Château, with regard to the exact location of the disposal facilities, held that "*the management plan(s) which the competent authorities of the Member States are required to draw up pursuant to that provision must contain a map showing thethe exact future location of the places of disposal of the waste or sufficiently precise location criteria for the competent authority responsible for issuing a permit pursuant to Article 9 of that directive to be able to determine whether the place or installation in question falls within the scope of the management provided for in the plan*".

account the geographical context or the need for specialised facilities for certain types of waste;
- use the most suitable methods and technologies to ensure a high degree of protection of the environment and public health.

The approach followed by the Environmental Code for the construction of infrastructural systems prefers the optimal size by territorial area, in parallel with the organization of the public service of integrated management of urban waste, with the sole exception of those specialized plants that treat particular types of waste, always urban, and for which it would be economically inefficient to impose its implementation for each territorial area.

Today, the National Strategy for the Circular Economy and the National Programme for Waste Management aim to respond to the elements that emerged from the 2014 Competition Authority (AGCM) survey. In that document, the AGCM noted that the regulatory framework on which the management of urban waste and its implementation at regional level are based are characterized by a multi-level governance system that has not so far proven itself in terms of:

- coordination skills between the various institutional actors involved;
- overcoming, primarily institutional, the exclusively local dimension of the service;
- speed in the evolution towards the new structures outlined at the regulatory level.

According to the AGCM, the lack of coordination derives in general from the stratification of rules that are often inconsistent with each other, as well as from the disconnect between the two fundamental levels entrusted with regulation: Regions and Optimal Territorial Authorities (ATO), on the one hand, and Municipalities, on the other. In fact, the planning of the service takes place at a supra-municipal level – partly regional and partly at the level of the ATOs – but the financing of the activity – which derives mainly from the waste tax paid by citizens – remains strictly municipal competence. The inability to evolve rapidly towards institutional structures that favour a consolidation of the sector towards industrial logics is manifested, in particular, in the extreme heterogeneity with which the Regions have structured local governance, both in terms of size and in terms of the timeliness of the implementation of the primary regulations. These last two elements, in particular, play a significant role from a competitive point of view, as the heterogeneity and regulatory uncertainty are likely to negatively influence the competitiveness of companies when participating in public tendering procedures and their incentives to invest in the construction of plants.

3.4. The principle of proximity

Starting from the previous observations, it should be noted that the location in the same territory of different waste treatment plants makes it possible to:

- minimise the transport costs of certain materials and their impact in terms of local CO_2 emissions, thus minimising economic inefficiency and increasing environmental sustainability;
- share the energy produced in the different processes, optimizing the energy balance and practically eliminating waste;
- offer new employment opportunities in the development and management of plants;
- allow the best use of the territory, since several plants are grouped in a limited area, centralizing zero-kilometer processes.

From a regulatory point of view, it should be noted that for the management of municipal waste sent for recovery, including the treatment of organic waste, the Environmental Code (art. 181, paragraph 5) states the following principle: "*For the fractions of municipal waste subject to separate collection destined for recycling and recovery, free circulation on the national territory is always allowed*". Principle accompanied by the indication to "*encourage their recovery as much as possible by privileging, also with economic instruments, the principle of proximity to recovery plants*". The legislator, therefore, expresses the principle of proximity – which finds its rationale by looking at the historical evolution of waste recovery in Italy – without limiting free movement and allowing proximity to be declined within unavoidable free market dynamics.

It should be remembered that the concept of proximity and the remarks from the point of view of competition have recently been addressed in a procedure for the award of the treatment service for the recovery of the wet fraction of municipal solid waste from separate collection (judgment no. 7412 of 31 July 2023, Council of State). In particular, the dispute concerns the request for annulment of the acts of the procedure for awarding the public contract for the aforementioned service, awarded with the negotiated procedure and without prior publication of the call for tenders, on the basis of the regional resolution that identified the so-called "minimum" composting/anaerobic digestion plants, establishing that the organic waste produced in the regional territory was destined for recovery operations to be carried out at the minimum installations, in application of the principle of proximity.

This procedure was also the subject of an appeal in light of the AGCM report no. 1875 of 23.12.2022 relating to similar cases for which:

> The resolutions were adopted with intentionally protectionist purposes to prevent the leakage of volumes of OFMSW from the territory of the two Regions and to ensure the planning andactivities to the plants present in the regional territory according to the predetermined flows at regional level and with the application of the access tariffs set by ARERA. This Authority wishes to point out that situations such as those described above are seriously detrimental to competition as they are capable of removing the entire production of regional OFMSW from market dynamics […] without integrating the requirements of the plant deficit or structural rigidities at the regional level. In this way, moreover, a disparity in treatment is created between neighboring regions that have similar characteristics with reference to the treatment of OFMSW.

Any profile of possible violation of the principle of competition was rejected by the Council of State for which:

> In general, the rule that is imposed on the "management and provision of integrated municipal waste management services" is the competitive rule of awarding by tender; "free movement on the national territory" and "proximity to recovery plants" are not exceptions to the rule of competition, but principles that may interact with thisthe last rule (also with a "mitigating" value, in particular the second of the two). In particular, the Board considers that the statement of this Council, reported above (reference is made to Council of State, no. 5257 of 2023, § 18.1, highlighted in § 8.4. of this judgment), which, although referring to the "privative" regime, is, in reality, a general statement, namely that the derogation from the principle of competition provided for in Articles 101-109 of the Treaty on the Functioning of the European Union in order to be admitted to the system, must be provided for by an explicit provision of law, without it being able to be derived or extended by way of interpretation, is justified in the light of the principle of competition. The principle of "proximity to recovery plants", although it is, in turn, teleologically connected to environmental protection, does not absolutely restrict competition, allowing, as argued by the Region, the direct award without a tender of a contract or a service concession, but it allows to enhance – on the basis of what is derived from national legislation and without prejudice to the preliminary assessment of compatibility by the competent supranational Court –, as part of the procedure for selecting the contractor of the service carried out by tender, those offers that best guarantee compliance with it.

Recently, in line with the above-mentioned regulatory approach, the clause contained in a call for tenders for the assignment of the recovery service of the organic fraction of municipal waste, which limits participation to operators equipped with treatment plants located within a certain distance from the headquarters of the contracting authority (25 or 35 km, depending on the lot). The Council of State, with judgment no. 2680 of 31 March 2025, confirmed the validity of this provision, considering it to be in compliance with the

principle of proximity established by art. 181, paragraph 5, of Legislative Decree 152/2006. This provision requires contracting authorities to give priority, also through economic instruments, to the use of recovery plants close to the place of production of the waste, with a view to environmental sustainability.

According to the Administrative Judge, the territorial limitation responds to legitimate environmental purposes and cannot be considered in contrast with the principle of free competition. Therefore, the appeal brought against the tender was rejected, recognizing the full legitimacy of the clause that excluded competitors without plants located within the mileage limits established by the tender, referring to the registered office of the contracting municipality, located in Emilia-Romagna.

Finally, it should be remembered that the new Public Procurement Code in art. 108, paragraph 7, governing the criteria for the evaluation of technical offers, adopts the principle of proximity by establishing that

> For the purposes of protecting free competition and promoting the pluralism of operators in the market, the procedures relating to the awards referred to in Book II, Part IV, may provide, in the call for tenders, in the notice or in the invitation, reward criteria aimed at encouraging the participation of small and medium-sized enterprises in the evaluation of the offer and at promoting, for services dependent on the principle of proximity for their efficient management, the assignment to economic operators with operational headquarters in the territorial area of reference.

Therefore, from the reading of the aforementioned provision, it seems to be clear that, where in the context of public tendering it is necessary to integrate the principle of competition with the principle of proximity – as can be found in the procedures aimed at awarding urban waste recovery and disposal services pursuant to Article 181, paragraph 5, of Legislative Decree no. 152/2006, the territorial clause may be declined as a reward criterion to be enhanced in the context of the technical offer, as it is suitable for affecting the efficiency of the service and not only its cost-effectiveness.

3.5. The need for planning in waste management: food for thought from a non-virtuous case

As for all sectors of general economic interest, the issue of opening up to competition is also relevant for the management of municipal solid waste: in fact, there is a risk of creating a position income for the operator of the plant to which the unsorted municipal waste collected in a given territorial area is

destined, giving the latter a certain market power that allows it to obtain and apply excessive allocation rates to collection companies (AGCM, 2016, par 539).

During 2023, a private economic operator informed 170 municipalities in the Region of Sicily, in its capacity as signatories of the waste disposal agreement that, due to the definitive closure of the plants located in the Region and the consequent need to deliver non-reusable waste only to plants located on the national and extra-national territory, it would be forced, for the costs incurred, to apply the rate of €380/ton.

This communication is part of the downstream phase of the waste management procedure of the Sicily region which the AGCM had already highlighted in its 2016 Survey of Municipal Solid Waste to be particularly delicate:

> 275. These include Sicily and Liguria which, despite having transfer tariffs of EUR 111.2 and EUR 111.3/tonne respectively, which exceed the national average, still have an excessive landfill disposal rate. These are regions in which the transfer tariff net of the eco-tax is also higher than the national average. […]
> This probably points to a situation in which landfill owners are granted a high margin on costs, probably determined by the existence of scarcity rents, in a situation in which there is an irrepressible supply capacity constraint, due to the impossibility or difficulty of creating new landfills.

But if the tariff in 2014 was 111.2 euros/ton, in 2024 the tariff rose to 380 euros/ton, verifying the predictive content of an anti-competitive system that the AGCM had already stigmatized during the last Survey of municipal solid waste in 2016:

> 403. The higher cost of unsorted waste compared to sorted waste depends on a number of factors that can be assessed differently from a competitive point of view. The increase in the costs of managing unsorted waste […] derives from an inefficient management of the unsorted fraction of waste, linked to: the absence of competitive incentives in the treatment phase of the TMB plants.
> 523. With reference to the mechanical-biological treatment activity, the activity carried out in the context of this Investigation has highlighted various aspects of local regulation (authorizations to operate, definition of tariffs, identification of plants) that hinder competition in the market, contributing to the detected plant undercapacity and the oligopolistic structure of the offer.
> 524. First of all, the failure to complete the process of setting up ATOs in some Regions has led to the failure to identify an adequate plant network that would allow the ATOs and Regions to be self-sufficient. As we have seen, there is not a sufficient number of authorizations for TMB plants on the market. This in itself represents an obstacle to access to the market which, from a competitive point

of view, as well as from an environmental point of view, appears suboptimal, because it contributes to the plant deficit.
525. Furthermore, it has emerged that the environmental regulation applied to TMB plants by the bodies responsible for the municipal waste management service (the Regions, and the Provinces where delegated by the former) is sometimes likely to create considerable disparities between the companies operating in this market.
542. As mentioned in the introduction, the planning of the plant phase of the municipal waste management cycle at regional level is sometimes unbalanced in favour of some forms of management and lacks organicity and a holistic vision of the sector that allows it to "close the circle". Especially in the Central-Southern Regions, this has translated into the privilege of disposal in landfills to the detriment of the enhancement of energy recovery capacity.
543. The data show that the use of landfills in Italy is still significant. This result is the result of very specific regulatory choices: in fact, it derives primarily from excessively low levels of the eco-tax applied to landfill disposal, which incentivize the use of this form of urban waste management by the entities entrusted with collection and, on the contrary, discourage the investment in the recovery of materials from separate collection and energy from unsorted waste.

Coming to the Sicilian Region[11], it is evident that in the last two decades it has lived in a perennial state of waste emergency characterized by contingency and urgent procedures, without any technical and administrative planning.

[11] It is also worth mentioning that recently (19 October 2023, Application 35648/2010) the European Court of Human Rights in the case LOCASCIA AND OTHERS v. ITALY, condemned Italy for violation of Article 8 ECHR due to the lack or incorrect management of waste disposal in Campania. The passages of the sentence are interesting, peacefully overlapping with the Sicilian situation. In fact, the Court recalls the duty of the State to prepare an administrative and regulatory framework capable of managing "waste management" as a public service activity to protect health (incidentally, it should be noted that a Regional Waste Plan has been in place in Campania since 2016, which is still absent in Sicily today): "*84* […] *had been hit by the effects of the regional waste management crisis. Waste had periodically piled up in the streets, producing unbearable smells and attracting stray dogs, rats and insects. Uncontrolled fires had been lit to burn waste and had released dioxin.* […] *Moreover, the accumulation of large quantities of waste along public roads had constituted an illegitimate interference with their right to respect for their home and private life, impairing free movement and resulting in the temporary closure of schools and local markets. 120. The Court reiterates that severe environmental pollution may affect individuals' well-being and prevent them from enjoying their homes in such a way as to affect their private and family life adversely (see López Ostra, § 51; Guerra and Others, § 60; and Di Sarno and Others, § 104, all cited above). 121. The Court further points out that the adverse effects of environmental pollution must attain a certain minimum level if they are to fall within the scope of Article 8. The assessment of that minimum is relative and depends on all the circumstances of the case, such as the intensity and duration of the nuisance, and its physical or mental effects (see Cordella and Others, cited above, § 157). […] 123. Furthermore, Article 8 does not merely compel the State to abstain from arbitrary interference: in addition to this primarily negative undertaking, there may be positive obligations inherent in effective respect for*

As a preliminary point, it should be remembered that from an economic point of view, the treatment of the dry fraction of municipal waste, i.e. the residual part of separate collection, whether it is incineration with energy recovery or disposal activities, represents a cost item for the local authority. In Sicily, the municipalities interested in the disposal of residual unsorted municipal solid waste enter into an agreement with economic operators for the treatment and disposal of waste collected in the municipality's area, in accordance with its nature and in compliance with the measures issued over time by the competent administrative authorities. In these cases, the operator undertakes, after verifying the conformity of the incoming waste, to treat and dispose of the aforementioned waste in compliance with the current legal requirements and regulations and the administrative measures issued by the competent authorities. Waste must be delivered to the plant, by and at the expense of the municipalities, also through the entities entrusted with the collection management service, with suitable vehicles and in compliance with the regulations in force for the transport of waste contained in Legislative Decree no. 152/2006 and subsequent amendments and additions. In fact, the management of the undifferentiated fraction is realised through the relative landfilling with expensive trips of the different waste fractions from one part of the island to another. The closure of some landfills for municipal solid waste on the island has done nothing but amplify the critical issues for the simple reason that the remaining ones would never have been able to meet the real needs of the entire community, thus favoring the few economic operators in the activity of transporting waste abroad.

This plant structure is, among other things, consistent with the fact that in the Southern and Central Regions undifferentiated waste collection still assumes a significant weight, and this explains a greater authorized capacity, necessary as the levels of differentiation of urban collection are still relatively low. In this regard, the AGCM noted that:

private or family life. In any event, whether the question is analysed in terms of a positive duty on the State to take reasonable and appropriate measures to secure the applicant's rights under Article 8 § 1 or in terms of an "interference by a public authority" to be justified in accordance with Article 8 § 2, the applicable principles are broadly similar (see López Ostra, § 51; Guerra and Others, § 58; and Cordella and Others, § 158, all cited above). 124. In the context of dangerous activities in particular, States have an obligation to set in place regulations geared to the special features of the activity in question, particularly with regard to the level of risk potentially involved. They must govern the licensing, setting up, operation, security and supervision of the activity and must make it compulsory for all those concerned to take practical measures to ensure the effective protection of citizens whose lives might be endangered by the inherent risks (see, mutatis mutandis, Öneryıldız *v. Turkey [GC], no. 48939/99, § 90, ECHR 2004-XII; Di Sarno and Others, cited above, § 106; and Cordella and Others, cited above, § 159)*".

516. […] the markets downstream of the collection phase, for the segment of the undifferentiated fraction, and in particular those relating to mechanical-biological treatment, energy recovery and landfill disposal, are characterised by an oligopolistic structure, as a result of the high barriers to entry linked to the geo-morphological constraints that limit the construction of plants (especially as regards landfills), transport costs, high investment costs (it is estimated that the depreciation period only for the electromechanical part of mechanical-biological treatment plants is 7-12 years), bureaucratic costs and the length of procedures to obtain authorizations, as well as stringent environmental regulation, and, finally, the social opposition that has developed against these activities

523. With reference to the mechanical-biological treatment activity, the activity carried out in the context of this Investigation has highlighted various aspects of local regulation (authorizations to operate, definition of tariffs, identification of plants) that hinder competition in the market, contributing to the detected plant undercapacity and the oligopolistic structure of the offer.

524. First of all, the failure to complete the process of setting up ATOs in some Regions has led to the failure to identify an adequate plant network that would allow the ATOs and Regions to be self-sufficient. As we have seen, there is not a sufficient number of authorizations for TMB plants on the market. This in itself represents an obstacle to access to the market which, from a competitive point of view, as well as from an environmental point of view, appears suboptimal, because it contributes to the plant deficit.

536. […] The principle of proximity, in particular, guarantees the operator of the installations territorial exclusivity which makes it possible to supply them with a certain flow of waste, which makes it easier to recoup the investments made in the construction of those infrastructures. […]

539. The attribution of territorial exclusivity to each installation, resulting in particular from the principle of proximity, appears to partially remedy the abovementioned market failure, but ends up producing other distortions. First of all, the maintenance of exclusivity in some cases could lead to inefficient choices in terms of technological progress and adequate sizing of the capacity that is made available to the market. Furthermore, and this is most important in the present context, it also leads to the creation of a position income for the operator of the plant to which the unsorted municipal waste collected in a given territorial area is destined. As a consequence of the principle of proximity, a TMB or TMV plant located in a given geographical area represents, for the management of unsorted waste, the only, or one of the few, outlets for the companies that manage the waste collection service in the area served by that plant. This gives the latter a certain market power and allows it to obtain and apply excessive input rates to collecting undertakings. In particular, the more stringent the application of the principle of proximity, the smaller the operator's range of action, the greater the chances that the operator of the disposal plant will hold a dominant position and abuse it to the detriment of the entity entrusted with the collection service.

The Court of Auditors of the Region of Sicily itself already in 2010 highlighted "the impossibility of treating waste, differentiated and undifferentiated, continues to be an endemic and structural problem of the Sicilian Region due to the lack of an adequate and integrated network of plants" (Court of Auditors-Sec. Control of the Sicily Reg., Considerations on the implementation of regional law no. 9 of 2010, p. 20).

Currently, in light of the aforementioned SNEC and the National Waste Management Program, the President of the Region in his capacity as Extraordinary Commissioner with Ordinance No. 3 of 21 November 2024 has adopted a Regional Waste Plan which aims at an increasingly marginal use of the landfill, taking into account that by 2035 landfill disposal must not account for more than 10% of the residues produced.

3.6. Extended Producer Responsibility (EPR) and CONAI

Extended Producer Responsibility (EPR) is an environmental policy principle that gives producers responsibility for the entire life cycle of their products, including the post-consumer phase.

EPR Systems aim to reduce the environmental impact of products by incentivizing manufacturers to take charge of the end-of-life management of their products. To date, EPR Systems cover numerous waste streams in Europe and for each supply chain there are organisational differences in the performance achieved, in the models of responsibility, in the dynamics of competition and in the methods of covering costs, in particular[12]:

- *Type of liability*: liability in EPR systems can be financial, when producers finance waste management systems, or organizational, when producers directly manage waste collection and treatment activities.
- *Approach to activities*: EPR systems can be Individual, in which each producer manages its own waste, or Collective, where a group of producers collaborate through Consortia to optimize operations and reduce costs.
- *Nature of competition*: competition in EPR systems can occur between different consortia within the same sector, incentivizing cost and operational efficiency, or between waste management operators, improving the quality of services.
- *Cost coverage*: EPR systems must ensure that costs are covered for essential operational activities, such as separate collection, transport,

[12] Circular economy network and Enea Report (2025) 7th Report on the Circular Economy in Italy, p. 23 ss.

treatment and recycling. Some Systems provide additional funds for awareness raising and research.
- *Transparency and oversight*: Transparency is crucial to enable manufacturers to make informed choices and to enable governments to monitor the performance of EPR programs, ensuring that operations are compliant with regulations and optimized in terms of cost.

From the analysis of the European experiences of the EPR Consortia, it is possible to extrapolate good practices that improve waste management and the economic efficiency of the supply chains. These practices allow Consortia to offer quality services to their members without high costs and are[13]:

- *Widespread geographical coverage of collection points*: Successful EPR systems must ensure widespread coverage of collection points, ensuring that the majority of citizens can easily access these services even in remote areas. This incentivizes manufacturers to participate in Collective Systems, avoiding the need to create Individual Systems that would require a greater logistical and financial commitment.
- *Surveillance and transparency*: it is essential that EPR Systems produce annual reports on their performance, detailing both the quantities of waste collected and the methods of management. This allows manufacturers to make informed decisions and governments to monitor the effectiveness and compliance of programs.
- *Outreach activities*: Consumer outreach activities are crucial to the success of EPR Systems and include the use of online maps to locate collection points, social media presence and engagement activities in local communities.
- *Adaptation to regulatory changes*: EPR Systems must be flexible and ready to adapt to changes in regulations to ensure manufacturers' compliance with the new requirements, including through regular information to Consortium members about expected changes and the possible impact on their activities.
- *Efficient management and coordination*: for the proper functioning of EPR Systems, efficient coordination is required between all actors involved in waste management, including local authorities, collection facilities, sorting operators and treatment plants[14].

[13] Circular economy network and Enea Report (2025) 7th Report on the Circular Economy in Italy, p. 23 ss.

[14] Confindustria, Report on the Circular Economy, 2025, p. 111.

According to the "sixth report on the circular economy in Italy"[15] by the Circular Economy Network, in 2021 Italy achieved a packaging waste recycling rate of 71.7%, 8% higher than the EU 27 average (64%). It should also be noted that the recycling of municipal waste in 2022 reached 49.2%, compared to an EU average of 48.6%.

In particular, for the packaging supply chain, the role played by the CONAI Consortium System (National Packaging Consortium) is essential, to which about 760,000 companies producing and using steel, aluminum, paper, wood, plastic, bioplastic and glass packaging belong. In 2023, Italy recycled 75.3% of its packaging waste: 10,470,000 tons out of a total of 13,899,000 tons released for consumption, thus exceeding the European targets for 2030. A percentage of recycling that is growing sharply compared to about 71% in 2022.

CONAI (National Packaging Consortium), founded on 30 October 1997, is a private, non-profit business body made up of packaging manufacturers and users. It operates according to private rules, although it pursues public interest purposes in the environmental field, in application of the principle of horizontal subsidiarity referred to in Article 118, paragraph 4, of the Constitution. The Consortium's activity is based on Legislative Decree 152/2006, the Consolidated Environmental Act, which gives it a central role in ensuring the achievement of the objectives of recovery and recycling of packaging waste, promoting coordination between separate collection, public entities and private operators. In detail, CONAI is entrusted with the functions of liaison between institutions, supply chain consortia and companies (art. 221 and 224), the collection and publication of data on the sector (art. 220), the drafting of the General Prevention and Management Programme, the support for cooperation between EPR systems and the management of relations with the Supervisory Authority. Since its inception, the system has worked through a close synergy between CONAI and the supply chain consortia, which have managed the operational part relating to the collection and recycling of packaging delivered by the municipalities.

The operation of the consortium system is ensured not only by the payment of the CONAI Environmental Contribution (CAC)[16] by the obliged parties, but also by the revenues from the sale of the selected waste.

CONAI directs the activity and guarantees the recovery results of 7

[15] *circulareconomynetwork.it/wp-content/uploads/2024/05/CEN2024- Impagina-TOT-DEF.pdf*.

[16] To cover the costs of separate collection, recycling and the recovery of packaging waste, CONAI's integrated extended responsibility system has, in fact, established the CONAI Environmental Contribution (CAC), divided between producers and users who, on the basis of the provisions of Legislative Decree 152/06, pay the CAC "*in proportion to the total quantity, the weight and type of packaging material placed on the national market*".

supply chain consortia: steel (Ricrea), aluminium (Cial), paper/cardboard (Comieco)[17], wood (Rilegno), plastic[18] (Corepla), bioplastic (Biorepack), glass (Coreve), ensuring the necessary connection between these and the Public Administration.

Of particular importance, also due to the strong environmental impact, is the management of plastic, so just think that during 2022 about 32 million tons of post-consumer plastic waste were collected in Europe[19]. In this context, a significant difference in the share that ends up in landfills is represented by the collection methodology. In fact, for post-consumer plastic collected in mixed waste collection, 36.5% (5.8 million tonnes) is destined for landfills, while for plastic collected separately, the share destined for landfills decreases to about 11% (1.8 million tonnes). As proof of the above, there is an even more relevant figure regarding the recycling of post-consumer plastic. In the case of undifferentiated collection, only 600,000 tons are destined for recycling (just 3.8%) while in the case of separate collection, the figure grows significantly, reaching over 8 million tons destined for recycling (thus recording a rate of 49.4%). The Plastics Europe report shows that, in 2022, for the first time, the share of separately collected post-consumer plastic waste was slightly higher than unsorted collection streams, reaching 50.7% (16.4 Mt). In addition, for the first time, the share of post-consumer plastic waste recycled compared

[17] For further information, see: Minoja M. & Romano G. (2020). *Consortium entrepreneurship and circular economy in the paper supply chain. The Comieco case*. Aegean coast.

[18] The plastic packaging waste chain is managed by two consortia: Corepla and *Biorepack*. Corepla is the National Consortium for the Collection, Recycling and Recovery of Plastic Packaging. It is a non-profit organization that brings together companies in the packaging supply chain, whose purpose is in the public interest: the achievement of the recycling and recovery objectives of plastic packaging provided for by European legislation, with a view to shared responsibility between companies, Public Administration and citizens. A strong impulse to the spread of virtuous end-of-life management systems has been represented in Italy by the birth at the end of 2018 of *Biorepack*, the first National Consortium in the world for the biological recycling of biodegradable and compostable plastic packaging certified EN 13432 (and similar fractions) delivered to the separate collection and recycling circuit of the organic fraction of municipal waste, as well as the seventh CONAI Consortium. The Biorepack Consortium pursues the optimization of the end-of-life management of compostable plastic packaging: from the promotion of its labeling to the related recognisability, from the correct disposal by citizens in the separate collection of domestic organic waste to the guarantee of the achievement of recycling objectives through composting, also through specific communication campaigns. *Biorepack* represents the first Europe-wide extended producer responsibility (EPR) system established for the end-of-life management of compostable plastic packaging. *Biorepack*, like the other Consortia, is required to ensure the balance of its financial management, using the Environmental Contribution as a financial means.

[19] Plastics Europe: The Circular Economy for Plastics – a European analysis – 2024.

to that sent to landfill was higher, accounting for 26.9% (8.7 Mton) of waste treated in 2022.

The paper and cardboard recycling system in Italy is supported by a well-developed infrastructure. In 2022, with around 5.3 million tonnes of paper and cardboard packaging released for consumption, Italy set up an advanced recycling network, with a recycling rate of 80%, just below the EU average of 83.2%140. This percentage is growing in 2023, reaching 92%, with a reduction in the amount released for consumption of 6.5% compared to the previous year141. This good recycling rate is attributable to efficient collection methods and public awareness campaigns that encourage participation in recycling. Glass lends itself particularly well to recycling because it can be processed repeatedly without loss of quality; Italy has a recycling rate of 80.8%, above the EU average of 75.6%. Glass packaging, thanks to its durability and recyclability, has multiple uses such as in the food, beverage and pharmaceutical sectors and in Italy, in 2022, about 2.8 million tons were produced. The glass packaging supply chain was affected by a reduction in the amount released for consumption of 6.9% in 2023 and a slight contraction in the percentage of recycling.

4.

Compliance with the waste hierarchy in the European Union: a comparative assessment[1]

4.1. Introduction

As already noted, the Waste Hierarchy promoted by the European Union establishes a priority order among waste management actions: first is "Prevention", followed by "Preparation for reuse", "Recycling", "Recovery" and, finally, "Disposal". This principle has its roots in the "Lansink Scale"[2] of 1979 and, since 2008, has become a strategic pillar of European waste management legislation. The Waste Framework Directive 2008/98/EC identified the Waste Hierarchy as the roadmap for waste management in Europe. Member States have been called upon to implement policies to reduce waste generation ("Prevention") and to promote treatment methods at the top of the hierarchy ("Preparing for reuse" and "Recycling" are preferred to "Recovery" and "Disposal").

With the adoption of the Circular Economy Package in 2015 and subsequent related directives, the Waste Hierarchy has maintained a central role. The shift to a more circular economy has led the European legislator to set ambitious environmental targets, closely linked to the priority order of the Waste Hierarchy: mandatory minimum levels for recycling rates and a maximum threshold for landfilling have been established. Currently, the European Commission, in collaboration with the European Environment Agency, is monitoring Member States' deviations from the objectives set and is developing an early warning system to support national governments in meeting their commitments[3].

[1] This chapter was written by Giovanna D'Inverno, Laura Carosi, Giulia Romano, and extends the work of D'Inverno G., Carosi L. & Romano G. (2024). Meeting the challenges of the waste hierarchy: A performance evaluation of EU countries. *Ecological Indicators*, 160, 111641.

[2] Lansink A. (2018). Challenging changes – connecting waste hierarchy and circular economy. *Waste Management & Research*, 36(10), 872-872.

[3] See, for example, the monitoring sheets for 2025, drawn up for each individual country

In the context of European waste policies, a composite indicator that captures Member States' progress across all levels of the waste hierarchy can complement institutional monitoring efforts and provide valuable insights for policymakers. It is worth asking how aligned the different European countries are with the EU's waste management strategy and to what extent they are progressing in the transition to a circular economy.

To answer this question, starting from the Waste Hierarchy, a set of indicators has been identified for each level of the hierarchy, establishing reference thresholds. The proposed innovative framework enables a comprehensive assessment of EU Member States' performance by integrating the compliance metrics defined by European directives with the extent of deviations from established performance thresholds. This is an improvement over traditional approaches, which have focused almost exclusively on formal compliance to the hierarchy, neglecting discrepancies with objectives. To achieve this goal, a new composite index, referred to as AGRUE (from the Italian *Aderenza alla Gerarchia dei Rifiuti nell'Unione Europea*), is proposed to measure compliance with the Waste Hierarchy in the European Union. A composite index is based on the aggregation of different indicators, and the weighting system adopted plays a crucial role in ensuring a balanced and coherent representation of the phenomenon. The use of this index enables a concise and comparable assessment of EU Member States' performance across the multiple dimensions of the waste hierarchy, thereby supporting the monitoring of compliance with its principles. The AGRUE index integrates two consolidated methods, particularly suitable for the type of performed analysis: the Analytic Hierarchy Process (AHP) and the Goal Programming Synthetic Indicator (GPSI). The AHP is used to prioritize between different tiers of the hierarchy and between actions taken at each tier and define aggregation weights. This method makes it possible to account for the relative importance of actions at each level of the waste hierarchy and to aggregate the selected performance indicators accordingly. GPSI, on the other hand, is used to measure countries' deviations from predefined thresholds. For each country, the strengths and related criticalities are reported, with respect to the established targets. Two indicators are thus constructed, one that aggregates the deviations associated with the strengths and one that aggregates the deviations associated with the criticalities. The two indicators are then combined into a global index, the AGRUE index.

The proposed methodology allows for the analysis and evaluation of waste management policies adopted by EU-27 countries between 2011 and

by the European Environment Agency. The sheets are available at: *www.eea.europa.eu/en/topics/in-depth/waste-and-recycling/municipal-and-packaging-waste-management-country-profiles-2025*.

2022. The results provide valuable insights for both European and national authorities, helping to identify which strategies have proven effective and which actions are still needed to achieve national targets.

The contribution to the existing literature and to the ongoing debate on waste management assessment is divided into three main aspects. First, we propose an analysis based on the principle of the waste hierarchy that also considers deviations from thresholds set by European directives, where available, or from expert-agreed targets. From a methodological point of view, this type of integrated assessment is based on the construction of a composite index using AHP and GPSI methods. Although there are several studies that combine AHP with goal programming techniques, the integration with GPSI is a novelty compared to the existing literature. Second, unlike standard GPSI applications, where a single weight system is used, our study considers different weight systems to aggregate deviations. In this way, we highlight the fact that positive deviations (strengths) and negative deviations (weaknesses) can have different scales of importance. Third, the study contributes to the debate on how to measure European countries' compliance with the EU waste hierarchy. While previous studies exclude the highest level of the hierarchy and consider only waste treatment actions, our approach also includes prevention, offering a more systemic perspective and one that better reflects the principle of prioritizing waste reduction at the source.

The rest of the chapter is organized as follows. Section 4.2 provides an overview of European legislation on waste management and a brief review of the literature. Section 4.3 illustrates the empirical analysis by highlighting the methodology adopted and the choices made to pursue the evaluation objectives. Section 4.4 discusses the results and provides an interpretation of the rankings obtained. Section 4.5 concludes the work by providing recommendations for policymakers and suggestions for future policies.

4.2. The Waste Hierarchy in the context of the European Union and a brief review of the literature

The principle of the Waste Hierarchy was first introduced into EU legislation with the 2008 Waste Framework Directive and was later reaffirmed in 2016 through the United Nations 2030 Agenda, specifically in Sustainable Development Goal 12.

Directive 2008/98/EC established a new regulatory framework for waste management in the EU. In addition to setting out a clear hierarchy, it introduced the "polluter pays" principle and Extended Producer Responsibility (EPR), requiring waste producers to take responsibility and cover the costs of waste management. It also imposed an obligation on Member States to establish

waste management and prevention plans, as well as recycling and recovery targets to be achieved by 2020.

Ten years later, Directive (EU) 2018/851 was included in the Circular Economy Package, with the aim of guiding the EU towards a circular economy model, overcoming the linear model. In this context, the EU has adopted a long-term vision on waste management, aimed at increasing recycling and limiting landfilling and incineration. Directive (EU) 2018/851 reinforced the need for waste prevention policies and set new recycling targets for municipal waste, establishing that at least 55%, 60% and 65% of the total mass of municipal waste must be recycled by 2025, 2030 and 2035 respectively. In addition, the Directive has made separate collection of organic waste (or its recycling at source) mandatory by 2024 and of textile and hazardous waste by 2025. To incentivize strategies consistent with the Waste Hierarchy, measures such as the taxation of landfills and incinerators, separate collection and the "Pay As You Throw" system have been promoted.

As regards packaging waste, the EU approved Directive 94/62/EC on packaging and packaging waste, subsequently amended by Directive 2018/852/EU, which is also part of the Circular Economy Package. The aim was to prevent the generation of packaging waste and to incentivise the reuse, recycling and recovery of packaging, in line with the hierarchy. Member States have been called upon to establish extended producer responsibility schemes for all packaging materials by 2024 and specific recycling targets have been set, including an overall target of 65% by 2025 and 70% by 2030.

As already highlighted in the introduction of the volume, EU countries have significant differences in waste generation and in the policies and strategies adopted for its management. Each country defines and implements its waste treatment plans in a way that is dependent on the national context, considering cultural factors, traditions and social norms, as well as different treatment costs[4]. The EU Directives, in fact, have underlined the importance of introducing incentives and penalties to promote a correct application of the principle of the waste hierarchy.

According to the European Commission, in countries where energy production is closely linked to waste, the overall recycling rate largely depends on how waste associated with energy generation (i.e., energy recovery) is managed[5]. EU Directive 2018/850 established that reducing landfill disposal must not lead to the excessive development of treatment plants for residual

[4] See Egüez A. (2021). Compliance with the EU waste hierarchy: A matter of stringency, enforcement, and time. *Journal of Environmental Management*, *280*, 111672.

[5] Eurostat (2019). *Municipal waste statistics*. Available at: *ec.europa.eu/eurostat/statistics-explained/index.php/Municipal_waste_statistics*.

waste, such as energy recovery plants, as this could undermine the Union's reuse and recycling targets. In national strategic planning, economic costs must be balanced against the environmental and social impacts of different waste management choices, aiming to achieve synergies between the economy, society, and the environment.

In recent years, several studies have analysed the performance of EU countries in waste management, adopting different methodologies. Some research has focused on comparing countries. For example, Castillo-Giménez *et al*.[6] assessed the convergence among EU countries in the use of different waste treatment methods, concluding that the introduction of the 2008 Waste Framework Directive accelerated progress in many Member States. Egüez[7] developed a Waste Hierarchy compliance index, finding that countries with stricter environmental regulations tend to perform better.

However, many studies focus only on specific aspects of waste management, without considering the whole picture. The main gaps in the literature are as follows. Firstly, the lack of focus on prevention: most studies focus on the final stages of waste management (recycling, incineration, landfill), neglecting the importance of prevention. In addition, many studies use separate indicators without aggregating them into a composite index that considers the entire system. To overcome these knowledge gaps, we propose a new assessment tool based on a composite indicator that integrates waste hierarchy priorities with deviations from EU targets.

4.3. Evaluation of municipal waste management in EU countries: methodology and empirical analysis

As already mentioned, in this study, the evaluation of European countries' performance in waste management is based on a composite indicator that considers both EU guidelines and deviations from established targets.

The methodological approach adopted for the construction of this index is divided in the following four main steps.

- Step 1. Choice of actions, indicators and thresholds.
  We identify the actions in the hierarchy and select a set of performance indicators to assess compliance with it.

[6] Castillo-Giménez J., Montañés A. & Picazo-Tadeo A.J. (2019). Performance and convergence in municipal waste treatment in the European Union. *Waste Management*, *85*, 222-231.

[7] Egüez A. (2021). Compliance with the EU waste hierarchy: A matter of stringency, enforcement, and time. *Journal of Environmental Management*, *280*, 111672.

- Step 2. Validation with experts.
  We interview a panel of experts to confirm the validity of the proposed indicators and the corresponding thresholds.
- Step 3. Computation of weights.
  Using the Analytic Hierarchy Process (AHP) methodology[8] we determine the relative importance of each level of the waste hierarchy and the actions taken within each level.
- Step 4. Aggregation of indicators into a final index (AGRUE).
  Preliminarily, for each country, the strengths and relative criticalities with respect to the targets established in two distinct indicators are aggregated through the Goal Programming Synthetic Indicator (GPSI) method[9]. Finally, these two indicators are combined into a global index, the AGRUE index, to calculate the ranking of countries.

4.3.1. Step 1. Choice of actions, indicators and thresholds

To assess the extent to which European countries comply with the waste hierarchy principle, Eurostat data for the period 2011-2022 for the 27 EU countries were collected. A country's ability to stay on the right track towards the transition to the circular economy and to advance to the upper levels of the hierarchy is measured by comparing its performance against a set of predetermined thresholds. From "Prevention" to "Disposal", different indicators were then identified for each of the levels of the hierarchy, selected based on the availability of data and information relating to the reference thresholds. As pointed out by Pires and Martinho[10], there can be difficulties in measuring waste prevention and preparation for reuse. Due to the limited data availability, the absence of specific targets for "Preparing for Reuse" and the close relationship between this action and "Recycling", the two categories are treated as a single macro-category in this analysis: "Preparing for Reuse and Recycling".

Two indicators are identified for "Prevention". The first one follows the guidelines provided by Zero Waste Europe, a non-governmental organization that promotes the zero waste strategy both at municipal and international level. The organisation has proposed to complement European legislation

[8] See Saaty T.L. (1977). A scaling method for priorities in hierarchical structures. *Journal of mathematical psychology*, *15*(3), 234-281.

[9] See Blancas F.J., González M., Lozano-Oyola M. & Pérez F. (2010). The assessment of sustainable tourism: Application to Spanish coastal destinations. *Ecological indicators*, *10*(2), 484-492.

[10] See Pires A. & Martinho G. (2019). Waste hierarchy index for circular economy in waste management. *Waste Management*, *95*, 298-305.

with more stringent provisions on prevention, suggesting a global waste reduction target defined as a maximum limit for residual waste, to promote the reduction of waste generation. Since the "Prevention" action focuses on the total amount of non-recyclable municipal waste, a target in kg per capita is preferable to a percentage reduction target. According to the 2020 Zero Waste Europe report[11], the recommended maximum limit for 2030 is 120 kg per capita of non-recyclable municipal waste: this threshold was therefore adopted for the analysis. The second indicator is the circular material use rate, which is part of the indicators of the EU's Sustainable Development Goal (SDG). This indicator measures progress towards SDG 12 ("Responsible consumption and production") and contributes to the assessment of the global SDG 11.6.1 indicator on municipal waste management in cities. The European Commission's new Circular Economy Action Plan highlights a strong relationship between waste prevention and high values of the circular material use rate. The European Commission has established a minimum reference value of 19% for this indicator.

For the macro-category "Preparation for reuse and recycling", several indicators are considered: the recycling rate of municipal waste, the packaging recycling rate and the specific packaging recycling rates for paper, plastic, wood and glass. The reference thresholds for these indicators correspond to the targets to be met by 2030 set by the Waste Framework Directive.

As for the "Recovery" category, the indicator chosen is the energy recovery rate. Currently, European directives do not provide a specific target for this indicator, although the European Parliament has recently asked the Commission to propose binding targets. Following the general principles of the Waste Framework Directive, as already mentioned, energy recovery is considered a preferable solution only when the actions at the higher level of the Waste Hierarchy cannot be implemented. A 2015 European Commission communication highlights that incineration capacity with energy recovery should be limited to avoid economic losses or infrastructure barriers that hinder the achievement of higher recycling rates. Therefore, a reference value of 35% for incineration with energy recovery was set for the analysis, considering that European countries should recycle at least 60% of municipal waste and that a small percentage of waste disposed of in landfills is unavoidable.

For the lowest level of the Waste Hierarchy, "Disposal", the landfill rate was used. To prevent harmful impacts on human health and ensure waste treatment in line with the hierarchy principle, EU Directive 2018/850 defined

[11] See Condamine P. (2020). *Can the European Union support waste prevention without a proper legislation*. Tech. rep., Zero Waste Europe. Available at: *zerowasteeurope.eu/wpcontent/uploads/2020/06/zero_waste_europe_policy-briefing_waste_prevention_framework_en.pdf*.

this option as the least preferable and set the maximum limit for municipal waste disposed of in landfills at 10% by 2035. *Table 4.1* summarizes the data used. The last column shows the type of indicator that is defined as "positive" if values above the target set correspond to better performance and "negative" if not.

Table 4.1 – Indicators and thresholds used in the analysis

Waste Hierarchy Level	*Indicator*	*Target Threshold*	*Source for Threshold Definition*	*Indicator Type*
Prevention	Residual waste per capita (kg)	≤ 120 kg	Zero Waste Europe	Negative
	Circular material use rate (%)	≥ 19%	EU SDG targets	Positive
Preparing for reuse and recycling	Recycling rate of municipal waste (%)	≥ 60%	EU Directive 2018/851	Positive
	Packaging recycling rate (%)	≥ 70%	EU Directive 2018/852	Positive
	Paper recycling rate (%)	≥ 85%	EU Directive 2018/852	Positive
	Plastic recycling rate (%)	≥ 55%	EU Directive 2018/852	Positive
	Wood recycling rate (%)	≥ 30%	EU Directive 2018/852	Positive
	Glass recycling rate (%)	≥ 75%	EU Directive 2018/852	Positive
Recovery	Energy recovery rate (%)	≤ 35%	EU Commission	Negative
Disposal	Landfill Rate (%)	≤ 10%	Directive EU 2018/850	Negative

4.3.2. Step 2. Validation with experts

To ensure diversity of thought and robustness of the analysis, the selected indicators and set thresholds were validated by a panel of experts composed of:

- a member of the OECD Network of Economic Regulators;
- the scientific coordinator of Zero Waste Europe;
- a policy officer at the European Environmental Bureau;
- an expert from the European Environment Agency;
- two policy officers at the DG Environment of the European Commission.

First, the appropriateness of the chosen indicators was discussed with the experts. There was general consensus on the need to include waste prevention in the analysis and to define actions in accordance with the hierarchy itself. This holistic approach is crucial from a circular economy perspective and is considered crucial in future revisions of the European Waste Directives.

Second, experts were consulted on the performance indicators associated with each hierarchy level and their thresholds. Legally binding targets set by the European legislator (such as recycling rates) are judged to be the most natural choice. In the area of waste prevention, experts highlighted the need to develop new indicators for monitoring progress and to set clear, binding targets accordingly. The decision to consider residual waste per capita as a key indicator was welcomed, in line with a 2021 European Parliament resolution. Finally, experts were asked to elicit their preferences to assess the relative importance of the different actions of the waste hierarchy.

4.3.3. Step 3. Computation of weights

After the validation of the indicators, the Analytic Hierarchy Process is used to calculate the weights to be assigned to each indicator and used for the construction of the AGRUE composite index. First, the experts were asked to make pairwise comparisons between the different levels of the hierarchy, using the fundamental Saaty scale[12] (from 1 = equal importance to 9 = extreme importance). The following weights are thus attributed to the different actions associated with the levels of the waste hierarchy, as presented in *Table 4.2*[13].

Table 4.2 – The weights assigned to the levels of the waste hierarchy by the experts

Hierarchy Level	*Assigned weight (%)*
Prevention	58%
Preparation for reuse and recycling	30%
Recovery	8%
Disposal	4%

Waste prevention is the priority, followed by recycling, while recovery and disposal are less relevant in the evaluation of countries' performance. Since we have two indicators for the level "Prevention" and six for the level "Preparation for reuse and recycling", the panel of experts was asked to make pairwise comparisons between the indicators within the same level. In this way, the weight assigned to each indicator reflects both the importance of

[12] See Ishizaka A. & Nemery P. (2013). *Multi-criteria decision analysis: methods and software*. John Wiley & Sons.

[13] For a detailed presentation of the methodology used, see the work D'Inverno G., Carosi L. & Romano G. (2024). Meeting the challenges of the waste hierarchy: A performance evaluation of EU countries. *Ecological Indicators*, 160, 111641.

the hierarchy level it belongs to and its relevance relative to other indicators within the same level.

The weights thus obtained are shown in *Table 4.3*.

Table 4.3 – Weight assigned to the different indicators by the experts

Hierarchy Level	*Indicator*	*Assigned weight (%)*
Prevention	Residual waste per capita	48%
	Circular material utilization rate	10%
Preparation for reuse and recycling	Recycling rate of municipal waste	13%
	Packaging recycling rate	8%
	Paper recycling rate	2%
	Plastic recycling rate	3%
	Wood recycling rate	2%
	Glass recycling rate	2%
Recovery	Energy recovery rate	8%
Disposal	Landfill disposal rate	4%

4.3.4. Step 4. Aggregation of indicators into a final index (AGRUE)

For each country, the AGRUE index is obtained by adding the indices $AGRUE^s$ (which aggregates the strengths) and $AGRUE^w$ (which aggregates the weaknesses), both derived from observed deviations from threshold values and appropriately normalized. The $AGRUE^s$ index aggregates the deviations of the indicators when the value of the indicator is better than the set threshold. On the contrary, the $AGRUE^w$ index aggregates the deviations of the indicators that exhibit a value worse than the established threshold.

Two distinct approaches have been identified for aggregating deviations:

- *Hierarchical circular perspective*.
  In this case, the weights used for the deviations are those indicated in *Table 4.3*, regardless of whether the indicator observed constitutes a strength or a critical point for the country analyzed. This type of approach rewards countries that perform well in the higher levels of the Waste Hierarchy.
- *Linear treatment penalizing perspective*.
  In this case, the weights used are those indicated in Table 4.3 for the indicators that constitute a strong point for the country and therefore in the

construction of the AGRUE^{s} index. Conversely, in the construction of the AGRUE^{w} index, associated with the critical points of the country, greater weights are attributed to the lower levels of the waste hierarchy. The new system of weights is obtained taking into account the opinion of the experts, through the AHP method: the pairwise comparisons between the various levels of the hierarchy and between the various indicators within the same level were made starting from this question: "in the comparison between two levels (or two indicators), what level of importance/severity is attributed to the failure to comply with the identified threshold?" This type of approach penalizes underperforming countries in the lower levels (recovery and disposal). Targets set for the bottom of the hierarchy are considered minimum requirements that must be met.

Two final country rankings are thus drawn up, one for each of the two approaches. *Table 4.4* summarises the weights used to aggregate deviations from the threshold values for each indicator according to the circular and linear treatment penalizing approaches, taking into account strengths (when performance exceeds EU targets) and weaknesses (when performance does not reach targets).

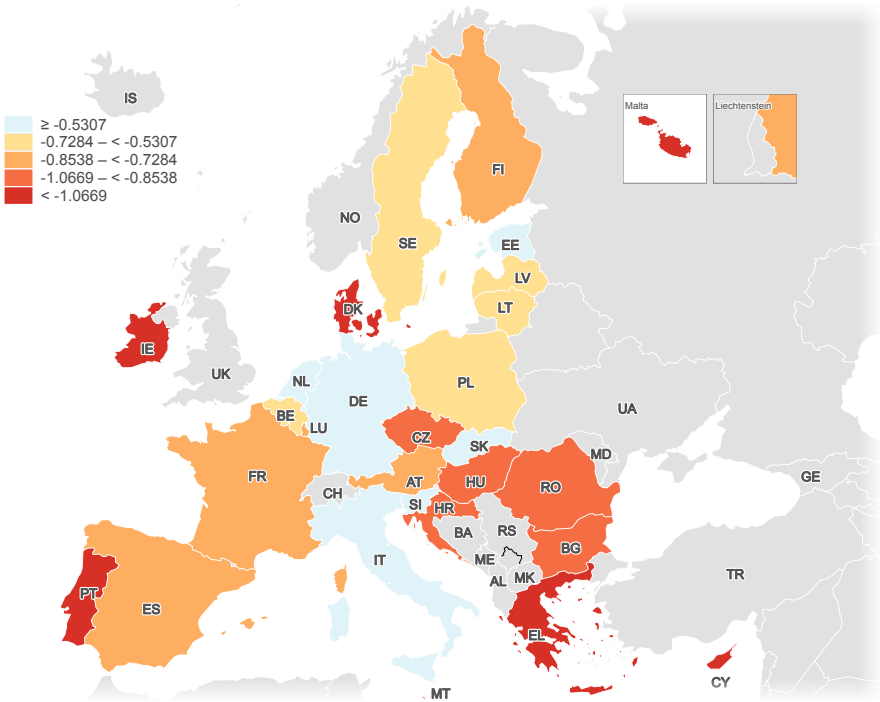
Table 4.4 – Weights assigned according to the two different perspectives used for the analysis

		Hierarchical circular perspective		*Linear treatment penalizing perspective*	
Hierarchy Level	*Indicator*	*Weight in AGRUE^{s}*	*Weight in AGRUE^{w}*	*Weight in AGRUE^{s}*	*Weight in AGRUE^{w}*
Prevention	Residual waste per capita	48%	48%	48%	3%
	Circular material utilization rate	10%	10%	10%	1%
Preparation for reuse and recycling	Recycling rate of municipal waste	13%	13%	13%	3%
	Packaging recycling rate	8%	8%	8%	2%
	Paper recycling rate	2%	2%	2%	1%
	Plastic recycling rate	3%	3%	3%	1%
	Wood recycling rate	2%	2%	2%	1%
	Glass recycling rate	2%	2%	2%	1%
Recovery	Energy recovery rate	8%	8%	8%	32%
Disposal	Landfill disposal rate	4%	4%	4%	55%

4.4. Discussion of results and implications for EU policies

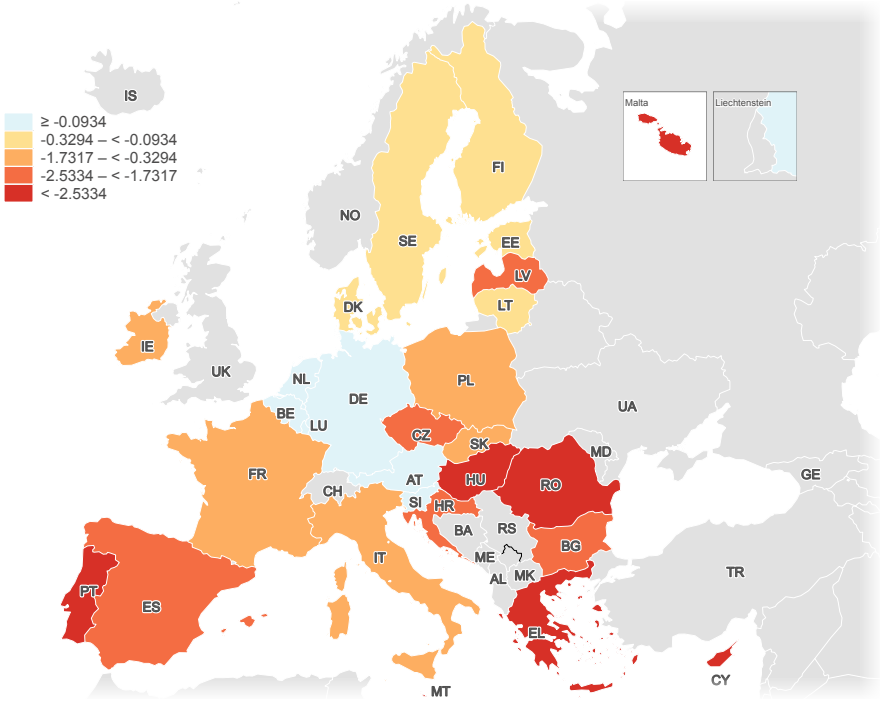
The AGRUE index proposed to measure compliance with the Waste Hierarchy in the European Union is presented below, considering both a hierarchical circular perspective and the linear treatment penalizing perspective. The maps in *Figures 4.1* and *4.2* provide an overview of the countries' performance based on the AGRUE index calculated for the last available year, i.e. 2022. In particular, countries that report a critical performance (i.e. they report a very low score) are colored in red, those with average performance in orange and yellow, while those with positive performance (i.e., they report a very high score) in light blue.

Figure 4.1 – AGRUE Index in the hierarchical circular perspective



Source: Authors' elaboration on Eurostat data 2011-2022

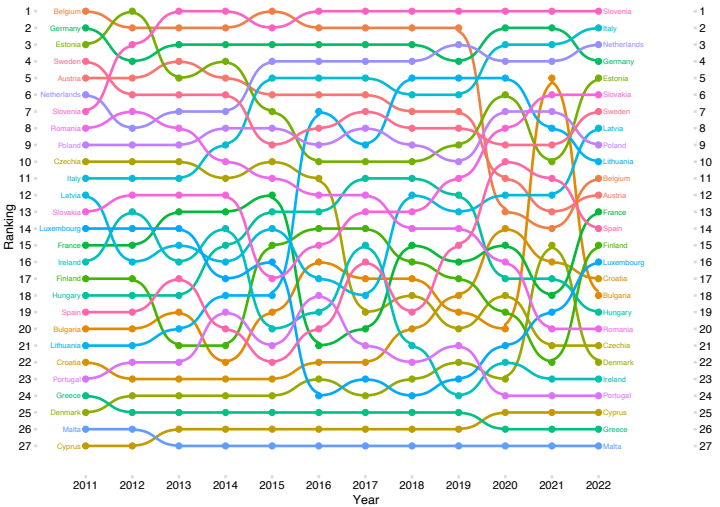
Figure 4.2 – AGRUE Index in the linear treatment penalizing perspective



Source: Authors' elaboration on Eurostat data 2011-2022

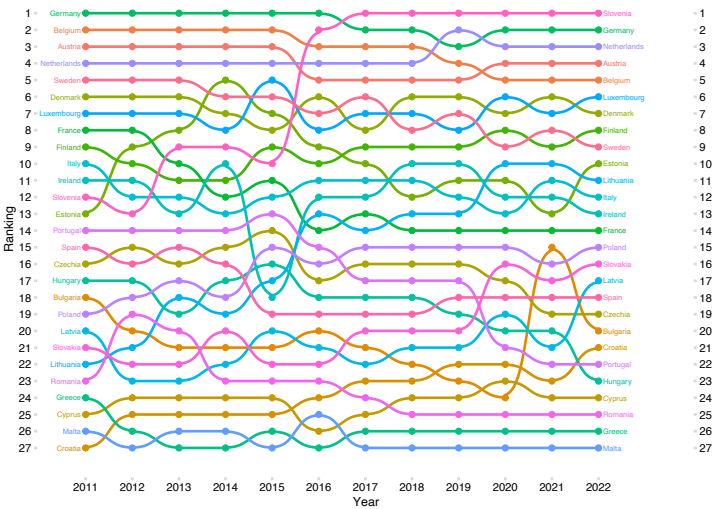
In addition to the analysis of a single year, interesting insights can emerge by analyzing the evolution of the performance of the EU-27 countries over time. For this reason, we replicated the analysis for each year, from 2011 to 2022, and compared the change in country rankings between the two scenarios described. *Figure 4.3* shows the change in the ranking of EU-27 countries based on the AGRUE index values over time obtained following a hierarchical circular perspective, while *Figure 4.4* shows the change following a linear treatment penalizing perspective.

Figure 4.3 – Evolution of the AGRUE index obtained following a hierarchical circular perspective and ranking of the EU-27 countries



Source: Authors' elaboration on Eurostat data 2011-2022

Figure 4.4 – Evolution of the AGRUE index obtained following a linear treatment penalizing perspective and ranking of the EU-27 countries



Source: Authors' elaboration on Eurostat data 2011-2022

4.4.1. Hierarchical circular approach: discussion of the results

In a hierarchical circular perspective, we can observe that Slovenia, Italy, the Netherlands, Germany, Estonia and Slovakia are the countries with the best performance, while Denmark, Ireland, Portugal, Cyprus, Greece and Malta are ranked at the bottom of the ranking. The latter countries, which are characterized by very low performance, have high landfill rates, low overall levels of recycling rate and a rather modest circular material utilization rate. In addition, they show a high production of residual waste per capita. In many cases, these countries are heavily affected by tourist flows so the production of waste is also linked to the behavior of people who are only temporarily in those countries and are evidently less involved than resident citizens and businesses. The European directives have in fact highlighted the importance of the "active engagement of citizens and businesses"[14], which instead represents, as will be said later in the book, one of the most successful factors in the prevention and recovery of waste. It is no coincidence that EU Regulation 2025/40 has introduced new information obligations to be provided to users also through, for example, harmonized labelling. It has also introduced bans and requirements for the catering and hospitality sectors to discourage single-use items, promote reuse, and standardize user information, making it more accessible to tourists.

The EU-27 countries contribute positively to the AGRUE index only with regard to the recycling rate of wood and glass packaging, in addition to the energy recovery rate. For all other indicators, we have negative scores, indicating that, on average, Europe is still far from achieving the objectives set by the European legislator and fully respecting the principle of the waste hierarchy.

Slovenia is the only country with a positive AGRUE index, which means that the areas where it has already achieved the targets exceed those where it is still in the process of adapting. Slovenia is also the only country that has achieved Zero Waste Europe's goal of reducing residual waste per capita below 120 kg. This success is the result of effective awareness campaigns that motivated citizens to achieve high recovery rates, along with a deliberate decision not to invest in new incinerators. Instead, the focus was on building a facility capable of maximizing material and energy recovery from unsorted waste, including composting the organic fraction. Ljubljana, in fact, was declared European Green Capital in 2016 and was the first European capital to embark on a path towards zero waste[15].

[14] Point no. 6 of the EU DIRECTIVE 2018/851 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 30 May 2018 amending Directive 2008/98/EC on waste.

[15] See Romano G., Marciano C. & Fiorelli M.S. (2021). *Best practices in urban solid*

The Netherlands and Italy stand out as leaders in the recycling rate of packaging and are among the very few countries that have already achieved the long-term goal of a circular material utilization rate above 19%. In 2022, Italy achieved a recycling rate of 72% for packaging waste, exceeding the targets set for 2025. At the same time, the landfill rate fell from 42% to 18% compared to 2011. The success was supported by legislative decrees implementing the EU Circular Economy Package, a National Waste Management Plan and a Strategy for the Circular Economy, as well as effective tools within the CONAI system, advanced separate waste collection, especially in some areas of the country, and initiatives for reuse and prevention[16]. Germany, like Austria and Slovenia, has already reached the recycling target for 2030 and is positioned as a world leader in industrial regeneration activities. As concerns the landfill rate, only 9 of the 27 EU countries have already made sure that they will not exceed 10% of municipal waste disposed of in landfills by 2030.

Looking at the trend of the ranking over time as of 2020, four countries (Slovenia, Italy, the Netherlands and Germany) steadily occupy the top positions, albeit with some variations in order. In general, the countries at the top of the hierarchy remain almost unchanged over the years, except for a significant change in the case of Belgium. The deterioration in its performance can be traced back to at least two factors. On the one hand, there was the update of the statistical reporting system, which has led to the inclusion of new types of waste, doubling per capita volumes between 2011 and 2022. On the other hand, there has been an increase in waste recorded in 2020, the year of the pandemic, in particular due to the growth in hospital waste[17]. In contrast, Bulgaria shows an almost abnormal improvement in 2021, which deserves further investigation. This apparent progress seems to depend more on irregularities and gaps in data collection than on real progress in waste management. In the same year, in fact, there was a sharp drop in the volumes of municipal waste disposed of in landfills, without there being clear indications on the actual treatment of unaccounted waste[18].

waste management: Ownership, governance, and drivers of performance in a zero-waste framework. Emerald Publishing Limited.

[16] See also the Italian cases recounted in Part II of the book, to which reference is made.

[17] See the 2025 monitoring sheet, relating to Belgium, prepared by the European Environment Agency. The sheet is available at: *www.eea.europa.eu/en/topics/in-depth/waste-and-recycling/municipal-and-packaging-waste-management-country-profiles-2025/be-municipal-waste-factsheet.pdf*.

[18] See the 2025 monitoring sheet, relating to Bulgaria, prepared by the European Environment Agency. The sheet is available at: *www.eea.europa.eu/en/topics/in-depth/waste-and-recycling/municipal-and-packaging-waste-management-country-profiles-2025/bg-municipal-waste-factsheet.pdf*.

Other countries show interesting trends that deserve attention. For example, Lithuania has seen a significant improvement over time, by putting increasing efforts to achieve prevention and recycling targets. Between 2011 and 2022, residual waste per capita decreased by 29%. The recycling rate grew by 142%, with improvements in most types of packaging, and the landfill rate decreased by 82% between 2011 and 2022, with a particularly sharp decline between 2015 and 2016 (-45% in just one year). Energy recovery has also been increased, although between 2017 and 2018 there was a reduction of 28%.

On the contrary, countries such as Romania, Ireland and Portugal show an opposite trend. As for Romania, there has been a sharp increase in packaging waste generation in recent years and the recycling rate remains low (37% in 2022 against an EU average of 63%) and fluctuating. The management of packaging waste still has significant critical issues, including poor quality of available data, insufficient separate collection and the need for reforms, which is why the country risks not reaching the EU target of 65% by 2025. Data from Ireland and Portugal highlight the lack of a clear strategy for following the waste hierarchy and improving their ability to meet targets. While Portugal has shown discontinuous changes, often reversed in the following years, Ireland has shown a progressive deterioration[19].

Luxembourg offers interesting food for thought, showing significant improvements in waste management, especially in terms of increasing recycling and reducing landfill rate, with significant changes starting from 2016. Among the main reasons are the improvement in data collection and reporting (with an expansion of the definition of municipal waste in 2016), the strategic shift from landfill to incineration and finally to recycling, and a steady reduction in the share of waste in landfill, which fell to 2.8% in 2022, well below the EU target of 10% by 2035. The recycling rate of municipal waste has also reached 55.6%, exceeding the EU average. The country has introduced a number of effective policies, including an update of the waste legislation (transposing EU Directives), the adoption of a National Waste Management Plan and a Waste Prevention Programme that includes quantitative targets, reuse and repair initiatives. In addition, Luxembourg actively promotes the circular economy and zero-waste strategies, strengthening separate collection (including PAYT systems) and the extended producer responsibility (EPR). Although there is no landfill tax, high charges are applied and there is a ban on disposing of untreated waste. The EU has also suggested introducing a tax on incineration to reduce the use of this method.

[19] See the 2025 monitoring sheets, relating to Ireland, Luxembourg, Portugal and Romania prepared by the European Environment Agency. The sheets is available at: *www.eea.europa.eu/en/topics/in-depth/waste-and-recycling/municipal-and-packaging-waste-management-country-profiles-2025*.

4.4.2. Linear treatment penalizing perspective: discussion of the results

Moving from the circular approach to the penalizing one, significant differences emerge. For example, among the top five countries, Austria outperforms Italy, which shows only an average performance compared to the other countries. Despite progress in recycling, the challenge of waste disposal remains open in Italy, penalizing this country. Similarly, Romania slips to the bottom of the ranking, having one of the highest landfill rates.

In general, more systematic clusters emerge between European countries in this scenario. In line with the existing literature[20], Central and Northern European countries perform better than Mediterranean and Eastern European countries, for which reducing landfills is one of the main challenges. However, achieving the target of 10% of waste sent to landfills could lead to wrong choices in terms of the waste hierarchy. For example, Denmark has complied with the landfill limit, but is also one of the countries with the highest amount of residual waste per capita (378 kg in 2022) and with the highest level of waste generated per capita together with Austria (802 kg in 2022). Finland shows a similar situation, with most of the waste destined to incineration for energy recovery. However, incineration cannot be considered a circular solution, as materials are permanently lost and secondary residues are usually disposed of in landfills. In addition, the EU has clarified in the EU Regulation 2020/852 that economic activities leading to a significant increase in the production, incineration or disposal of waste hinder the transition to the circular economy.

The change in perspective also influences the evolution of countries' performance over time. For example, the improvement of Slovenia in recent years is particularly evident. The analysis clearly captures the leap in quality that took place in 2016. In 2015, in fact, the construction of the plants for the mechanical and biological treatment of waste within the RCERO center was completed in Ljubljana, considered a state-of-the-art waste recovery plant in Europe[21]. In a short time, Ljubljana was declared the European Green Capital and Slovenia achieved the goal of Zero Waste Europe by reducing both landfilling and incineration through energy recovery. On the other hand,

[20] See Castillo-Giménez J., Montañés A. & Picazo-Tadeo A.J. (2019). Performance and convergence in municipal waste treatment in the European Union. *Waste Management*, *85*, 222-231.

[21] See Romano G., Marciano C. & Fiorelli M.S. (2021). *Best practices in urban solid waste management: Ownership, governance, and drivers of performance in a zero-waste framework*. Emerald Publishing Limited.

Italy and Romania have suffered a drop in the rankings. However, while Italy manages to compensate for the negative effect of landfilling with high recycling rates, Romania shows a progressive deterioration.

4.5. Conclusions

Over the past two decades, European countries have been increasingly urged to move towards a circular economy in waste management. The main goal is not only to reduce the amount of waste generated, but also to prevent its production at source. The waste hierarchy proposed by the European legislator incorporates this objective and identifies a series of actions that countries are called upon to take, placing Prevention at the top as the most desirable option and Disposal at the base as the least preferred choice.

In this paper we propose an innovative composite index referred to as the AGRUE index. It combines the Analytic Hierarchy Process (AHP) with the Goal Programming Synthetic Indicator (GPSI) methodology to assess the compliance of the 27 EU countries with the European waste hierarchy and several related objectives that Member States will have to achieve in the near future. The AHP makes it possible to effectively integrate the logic of the European legislator at the basis of the waste hierarchy, providing a system of weights to aggregate deviations from the targets into an overall index. From a methodological point of view, this is the first time that AHP and GPSI have been combined. This approach provides a performance evaluation tool in which decision-makers are strongly involved and more refined than existing ones that use the two techniques separately. With AHP, weights obtained through the preference elicitation of the decision-makers or experts interviewed can be included. With GPSI, the units under consideration can be classified using information on positive and negative deviations from expert-validated thresholds. With this approach, experts are involved in both the expression of preferences and the validation of thresholds.

Considering the peculiarities of our application, two different weight systems are proposed. In the first, the strengths and weaknesses in waste management of each country are treated on an equal footing, hierarchical circular perspective. In the second system, we focus on the concerns of European legislation about the poor performance of countries at the lower levels of the hierarchy. In this case, the indicators associated with negative deviations assume inverted weights compared to those expected for positive deviations. In this way, the countries with critical issues at the lower levels of the hierarchy are more penalized, outlining a linear treatment penalizing perspective and unfavorable with respect to the transition towards the circular economy.

The main findings show that EU countries have implemented European requirements in different ways and adopted different strategies. For the period analyzed 2011-2022, we identify a group of leading countries (Slovenia, the Netherlands and Germany), and a group of countries with still very low performance (Portugal, Cyprus, Greece and Malta), regardless of the weighting system used to construct the AGRUE index. Comparing the two scenarios makes it possible to identify the countries that have particularly improved or worsened over time. Only very few countries have already achieved the targets and, on average, the 27 EU countries show a virtuous trend in only some recycling activities. The overall AGRUE score is increasing over time, although lagging countries have failed to close the gap with the leading countries.

This study highlights the importance of having harmonised and detailed data to provide accurate analysis and well-founded recommendations to policymakers. Eurostat, in cooperation with EU countries, has made significant efforts to collect data that allows comparisons between countries and, consequently, the identification of effective strategies. Future studies should incentivise data collection at sub-national level and replicate analysis on a smaller territorial scale, in order to improve monitoring and offer more in-depth benchmarking exercises. As Romano *et al*.[22]. pointed out, case studies at local level could help to identify more precisely the actions taken to move away from the linear model or to improve outcomes, as was the case in Ljubljana, Porto or Helsinki. In addition, in view of the ever-changing European legislation, further research could consider the inclusion of new and different emerging indicators, as discussed with the expert panel. This is the case, for example, with the measurement of landfills. Our analysis is based on current legislation, according to which the share of municipal waste disposed of in landfills must be reduced to 10% by 2035. However, many stakeholders (including members of the European Parliament) are pushing to introduce a landfill use target expressed in kilograms of waste per person per year. Similarly, the indicator referring to generated municipal waste in kilograms per inhabitant would be a desirable measure for "Prevention", even if there is not yet a unanimous consensus on the threshold value to be used. Finally, the proposed methodology could also be used to analyse the extent to which European countries meet the requirements for other categories of waste, such as the management of industrial waste and hazardous waste.

[22] See Romano G., Marciano C. & Fiorelli M.S. (2021). *Best practices in urban solid waste management: Ownership, governance, and drivers of performance in a zero-waste framework*. Emerald Publishing Limited.

Part II

Strategies and experiences for waste hierarchy: emblematic Italian and European cases

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5.

Research methodology and data collection[1]

In order to answer the research questions – and in light of the analysis of existing literature, the legal context, and the results achieved by different national policies across European countries – the opportunity arose to explore a number of emblematic experiences involving municipalities and companies. Through strategies, policies, and projects, these actors have effectively progressed along the waste hierarchy: reducing waste generation at source, supporting the reuse of objects and materials, increasing both the quantity and quality of separate collection, and ensuring that appropriately sorted and selected waste is effectively sent for material recycling.

Qualitative analysis is particularly effective in the study of complex phenomena, such as the implementation of the waste hierarchy principle in articulated organizations – municipalities, provinces, regions or companies[2].

It was decided to identify and compare several emblematic cases focused on the three most virtuous steps of the waste hierarchy. A qualitative, exploratory methodology based on multiple case studies was considered the most appropriate approach to develop empirically grounded hypotheses about the enabling factors required and the bottlenecks that must be overcome to implement concrete projects[3] aimed at reducing waste, including through the reuse or recycling of materials[4].

[1] This chapter was written by Giulia Romano.

[2] Rouse E., Reinecke J., Ravasi D., Langley A., Grimes M. & Gruber M. (2025). Making a theoretical contribution with qualitative research. *Academy of Management Journal*, 68(1), 257-266.

[3] See Russell M., Gianoli A. & Grafakos S. (2020). Getting the ball rolling: an exploration of the drivers and barriers towards the implementation of bottom-up circular economy initiatives in Amsterdam and Rotterdam. *Journal of Environmental Planning and Management*, *63*(11), 1903-1926.

[4] Gioia D.A., Corley K.G., Hamilton A.L., 2013. Seeking qualitative rigor in inductive research: notes on the Gioia methodology. *Organizational Research Methods*, *16*(1), 15-31.

The cases were identified based on the knowledge of the waste management sector and the waste hierarchy principle acquired during the first phase of the research, as well as through discussions between the research group and several national and international experts, who suggested or validated emblematic cases of strategies and policies aimed at waste reduction, reuse, and recycling.

For prevention, the case of the City of Paris and its "Ambition Zéro Plastique à Usage Unique" project – launched in preparation for the 2024 Olympic Games – was selected. Paris is one of the most important and well-known metropolises in the world, as well as one of the most densely populated and most visited cities in Europe. Strongly committed to ecological transition for years, it hosted the 2024 Olympics, one of the most significant and iconic sporting and cultural events worldwide.

With regard to preparation for reuse, the experience of the Alelyckan recycling park in Gothenburg (Sweden) was selected. Known among professionals as the first significant example of integrating a reuse center into a municipal recycling facility, its aim is to intercept reusable items before they are legally classified as "waste".

The Gothenburg model has since been replicated in other Swedish contexts and beyond. Two examples inspired by this approach were therefore selected for analysis:

- Capannori, in Tuscany, which has integrated reuse centers into its broader municipal "Zero Waste" strategy and has, in turn, become a reference point for the international Zero Waste Cities network[5];
- Eskilstuna, where ReTuna was established – the world's first shopping center made up entirely of stores selling donated goods collected at the entrance of the recycling center.

Finally, with regard to recycling, two cases were selected: one focusing on significant separate collection efforts, and the other on the effective recycling of materials collected separately from households and businesses – based on the understanding that both activities are synergistically necessary to achieve the goals set by the waste hierarchy principle.

The first case concerns Ecoambiente, the in-house operator responsible for waste management across the entire Province of Rovigo. Ecoambiente has promoted an ambitious project aimed at improving both the quantity and quality of separate waste collection, through the introduction of a

[5] See also the information available at: *circular-cities-and-regions.ec.europa.eu/pilots/capannori*; *zerowasteeurope.eu/press-release/capannori-becomes-the-first-zero-waste-certified-city-in-italy-and-the-third-in-europe/*.

standardized pay-as-you-throw (PAYT) system at the provincial level and a broad engagement program targeting citizens and businesses.

The second case concerns Revet, a mixed public-private company that serves about 200 municipalities in Tuscany and over 80% of the regional population. Revet manages the collection, sorting, and recycling of multi-material waste – such as plastics, aluminum, and glass – in collaboration with local companies (e.g., glassworks and paper mills). It has played a key role in developing virtuous supply chains for the effective recycling of glass, Tetra Pak, and mixed plastics.

Emblematic cases that have advanced along the waste hierarchy – each in very different contexts and through distinct projects – were therefore selected. These range from a metropolis that implemented its project in parallel with a global event such as the Olympic Games, to medium and large cities that have introduced innovations creating new opportunities for waste reduction while ensuring economic sustainability and achieving both social and environmental goals. The selection also includes: a municipality that, starting at the provincial level, has become a virtuous model for many other cities in Italy and across Europe by leveraging synergies with associations and volunteer organizations; a mixed-capital company that derives its competitive advantage from collaboration with industry and technological innovation; and a publicly owned company that, in a short period, succeeded in implementing tariff incentives and a widespread communication campaign to significantly improve separate waste collection.

The cases, although so different, are united by being based on a "*sustainable business model*", i.e. a business model that adopts the triple bottom line approach[6], while pursuing economic, environmental and social objectives, and considering the interests of a plurality of stakeholders. All the case studies integrate sustainability into their raison d'être and their mission[7].

The different sources (*Table 5.1*) have made it possible not only to familiarize with the waste management sector and with the specific contexts studied, collecting detailed information, but also to triangulate the information, increasing the internal validity by having a more complete view of the phenomena studied[8].

[6] Elkington J. (1997). *Cannibals with Forks. The Triple Bottom Line of 21st Century Business*. Capston Publishing Ltd.

[7] Bocken N.M.P., Short S.W., Rana P., Evans S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production*, 65, 42-56.

[8] Eisenhardt K.M. (1989). Building Theories from Case Study Research. A*cademy of Management Review*, 14(4), 532-550.; Yin R.K. (2018). *Case Study Research and Applications: Design and Methods* (6th ed.). Sage; Stake R.E. (1995). *The Art of Case Study Research*. Sage.

The following table summarises the data sources used and how they have been used.

Table 5.1 – Data sources and use

Data source	*Type of Data*	*Use in the analysis*
Formal and informal conversations with experts	8 interviews lasting about 550 minutes with 8 experts Formal/informal conversations with national and international experts such as business executives, representatives of associations, public officials, ranging from short exchanges to longer interviews	Familiarize with the waste sector and the waste hierarchy principle Suggest or validate the identification of emblematic cases Triangulate evidence and interpretations that emerge from the interviews Discuss insights, clarify uncertainties, and support emerging interpretation
Archival material	Case study documents (Annual Reports, Sustainability Reports, Presentations, Materials used for the training of employees and collaborators or citizens)	Familiarize with the contexts studied Triangulate evidence and interpretations that emerge from the interviews
Interviews and on-site visits	27 interviews lasting about 1.500 minutes to 27 managers, former managers, public officials and policy makers of municipalities, local regulators, relevant stakeholders Field visits to the selected cases	Familiarize with the context studied Obtain information and improve understanding of the case study, its history, projects developed, business model, corporate governance, key stakeholders, economic, environmental and social performance

In particular, several visits were carried out:

- to Paris, to take part in guided tours of locations where single-use plastics have been eliminated, such as the municipal employees' canteen and the fan zones of the 2024 Olympic Games – including the *Terrasse des Jeux* at the Hôtel de Ville (in the 4th arrondissement) – as well as to attend some conferences organized by the city;
- to the reuse centers in Gothenburg and Capannori (Lammari and Coselli), and to the ReTuna shopping center in Eskilstuna;
- to the Revet and Vetro Revet facilities.

A total of 35 interviews were conducted with managers, public officials, regulators, experts, politicians, and activists – individuals either specialized in waste management or involved in the management and activities related to the cases analyzed (*Table 5.2*). In some instances, multiple interviewees were interviewed simultaneously. In addition, some respondents were met on more than one occasion to further explore emerging themes or refine the information collected.

This reflects the flexible nature of the qualitative methodology, which

allows for the adaptation of questions and insights as new relevant elements emerge during the research process.

Table 5.2 – Details of the interviews carried out

N.	*Stakeholder type*	*Approximate duration in minutes*
1	expert-activist	40
2	civil servant civil servant civil servant	90
3	civil servant	60
4	manager	30
5	regulator regulator	80
6	manager	115
7	politician-manager politician-manager manager	40
8	regulator regulator	60
9	manager regulator	60
10	civil servant	120
11	civil servant	60
12	civil servant	75
13	manager	90
14	expert	30
15	civil servant	30
16	civil servant	30
17	manager regulator	90
18	manager regulator	30
19	civil servant	60
20	civil servant	60
21	manager	90
22	manager-politician	30
23	expert-activist	60
24	manager	30
25	expert	60
26	manager	60
27	manager	30
28	politician-manager	45
29	manager	80
30	expert	60
31	manager	60
32	manager-activist manager-activist	75
33	expert manager-politician	30
34	manager	60
35	politician	30

Public documents were also analyzed, such as annual reports and financial statements, sustainability reports, documents and information contained on company websites and documents provided directly by the interviewees (e.g. power point presentations of the projects or material used for information and training activities).

The Gioia Methodology, developed by Dennis A. Gioia and colleagues, was used for data analysis[9]. It is an approach to qualitative and inductive data analysis to ensure qualitative rigor in inductive research while avoiding imposing pre-existing theoretical frameworks[10].

From an operational point of view, the recorded interviews were transcribed and the *1st-Order Concepts* were identified – that is, categories emerging directly from the language of the interviewees, reflecting their perspective without immediate theoretical interpretation.

These concepts were then interpreted and grouped into more abstract *2nd-Order Themes*, which were linked to the existing literature.

Finally, the second-order themes were synthesized into broader theoretical dimensions (*Aggregate Dimensions*) that outline the main findings: the enabling factors and the bottlenecks in the implementation of the waste hierarchy principle (*Table 5.3*).

Table 5.3 – The results of the analysis of the interviews: some examples of the codification

Interviews (excerpts)	*First Order Concepts*	*Second Order Themes*	*Aggregate Dimensions*
"*The ambition of the Mayor of Paris to eliminate single-use plastic was the first thing she thought of in 2016 when she offered to host the Olympic Games*" (official of the City of Paris)	Ambition to reduce single-use plastics	Importance of a "vision" to climb the hierarchy	The commitment of the main decision makers

[9] Gioia D.A. & Chittipeddi K. (1991). Sensemaking and sensegiving in strategic change initiation. *Strategic management journal*, 12(6), 433-448; Gioia D.A., Corley K.G. & Hamilton A.L. (2013). Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational research methods*, *16*(1), 15-31; Magnani G. & Gioia D. (2023). Using the Gioia Methodology in international business and entrepreneurship research. *International Business Review*, 32(2), 102097.

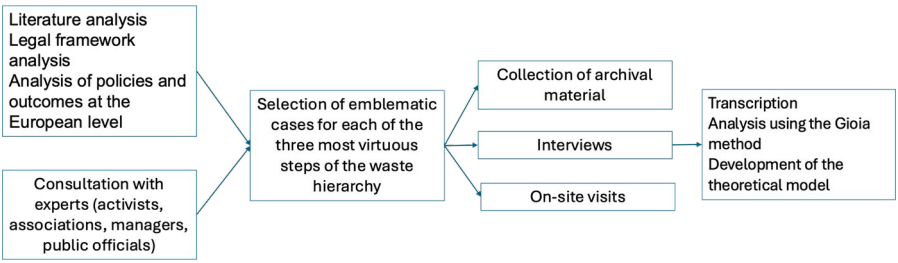
[10] For applications of the method, see among others Stigliani I. & Ravasi D. (2012). Organizing thoughts and connecting brains: Material practices and the transition from individual to group-level prospective sensemaking. *Academy of Management Journal*, 55(5): 1232-1259; van Eechoud T. & Ganzaroli A. (2023). Exploring the role of dynamic capabilities in digital circular business model innovation: Results from a grounded systematic inductive analysis of 7 case studies. *Journal of Cleaner Production*, 401.

Interviews (excerpts)	*First Order Concepts*	*Second Order Themes*	*Aggregate Dimensions*
"*The path of creating reuse centers with the support of the municipality and public urban waste managers has been simplified by the existence of a twofold strong motivation. On the one hand, what I expressed as a councilor is the associationism linked to environmental issues, and on the other the motivation linked to social, solidarity and response to need. At that point it was a combination of several wills that met in trying to do the good of the territory*" (former councilor of the Municipality of Capannori)	Strong motivation to create reuse centers	Importance of aligning multiple stakeholders' intentions for the benefit of the territory.	The commitment of the main decision makers
"*18 months after the announcement of the assignment of the Olympic Games, the Mayor with her political team, produced the "political vision of the Games", a document still freely available online, called Olympic Transformation, presented in June 2019. The document contains 20 measures to transform Paris in view of the Games, including the zero single-use plastic strategy*". (Official of the City of Paris)	Production of the document on the political vision of the Olympic Games	Role of vision formalization in an official document	The commitment of key decision-makers, formally expressed through official documents and policy statements.
"*I saw so many things coming to be thrown away… So we developed a project to concentrate the recycling, reuse and separate collection of waste in one place, paying particular attention to the prevention of bulky household waste, such as furniture, bicycles, electronic equipment and furnishings, creating a "park" with the availability of different activities. We then asked the public company to finance it. The public company accepted, also because it was a good opportunity to invest in a "green" project, which was also positive for the reputation of the city. Anyway, they built it, but we were the ones who decided to design it this way and gave them the directions*" (former director of the Gothenburg reuse center)	Development of a project for a new model of recycling center, which would encourage reuse	Importance of a project's vision to climb the hierarchy and formalization in an official document	The commitment of key decision-makers, formally expressed through official documents and policy statements.
"*Ever since we shared the general strategy with the resolution to join the Zero Waste Strategy, in 2007, the issues of reduction and reuse have been put on the agenda. In addition to door-to-door collection and the punctual tariff, in fact, an important point was linked to initiatives for waste reduction and the launch of reuse centers. So the mayor, from this point of view, left "carte blanche" so that the strategy we had approved would be implemented and grow more and more*". (former councillor of the Municipality of Capannori)	Approval of the resolution by the city council formalizing the adhesion to the Zero Waste strategy	Put a vision of a project to climb the hierarchy in an official document to facilitate its implementation	The commitment of key decision-makers, formally expressed through official documents and policy statements.

Interviews (excerpts)	*First Order Concepts*	*Second Order Themes*	*Aggregate Dimensions*
"*The main elements of the Ecoambiente project were defined in the area plan and in the business plan, based on an organizational model that provides for home collection for the fractions of residual dry waste, wet waste, paper, plastic and cans, glass and vegetables throughout the territory; The introduction of the corresponding tariff, the unitary model of services, the single tariff regulation and the single service regulation were the pillars of the approved project. Those pieces were voted unanimously by the members, so they allowed for a solid and clear guide and helped to define a challenging path, which required new resolutions to be changed; Evidently, this aspect allowed the management to have "virtuous inertia" in a clear direction in the following months and years. As time went by and the different steps of the project were implemented, the possibilities of "going back" became more and more limited*." (Technical Director, Ecoambiente)	Definition and approval of the area plan and business plan voted by the company's shareholders	The formalization of a project to carry out the separate collection and introduce the PAYT throughout the province facilitates implementation, avoiding subsequent changes to the project	The commitment of key decision-makers, formally expressed through official documents and policy statements.

Figure 5.1 illustrates the path of analysis followed.

Figure 5.1 – The qualitative analysis process followed in the research



Source: Authors' elaboration

The following four chapters describe the selected cases. For each case, the history and main stages of development, the business model, and the economic, environmental, and social outcomes were analyzed, with the aim of identifying the enabling factors and the bottlenecks encountered.

Chapter 10 presents an analysis of the six cases from a geographical-comparative perspective.

Finally, the last chapter outlines the aggregate dimensions that emerged from the cross-case analysis and develops the theoretical model that highlights and connects these dimensions.

6.

Waste reduction in a complex urban setting: the city of Paris and the 2024 Olympic Games[1]

6.1. Waste management in France and the origins of the Ambition zéro plastique à usage unique strategy

In recent decades, international attention has grown on the impact of plastic on the environment and human health. As recently shown by the Organization for Economic Co-operation and Development (OECD), without the introduction of more ambitious policies, the proliferation of plastic production, use and waste will increase by a further 70% by 2040[2]. The recent European Union (EU) Regulation 2025/40 on packaging and packaging waste has highlighted how packaging accounts for 36% of the EU's municipal solid waste and how the high and growing quantities of packaging produced, combined with the low percentages of reuse, collection and recycling, constitute a significant obstacle to achieving a low-carbon circular economy.

The ambition to make Paris a "Zéro Plastique" city began long before the enactment in France of the "anti-waste for a circular economy" law (*Loi anti-*

[1] The case was written by Giulia Romano (paragraphs 6.1., 6.2., 6.3 and 6.4) and Raphael Rossi (6.5), using public sources and data and information obtained through 9 interviews carried out with 8 officials of the City of Paris of the Direction de la Propreté et de l'Eau and de la Transition écologique et du Climat, including in particular Lila Durix (Cheffe de mission Sortie des Plastiques à usage unique) and Paul Vinot (Directeur de cabinet de Pierre Rabadan *Adjoint à la Maire de Paris Chargé du sport, des Jeux olympiques et paralympiques et de la Seine*), waste management experts and consultants and collaborators of the City of Paris for a total duration of about 450 minutes. In addition, the authors participated in guided tours organized by the City of Paris (in particular at one of the "Parcours Commenté Zero Plastique" in September 2024) and in the conference "Paris sans plastique à usage unique" organized by the City of Paris in November 2024.

[2] "*Without more ambitious policies, the proliferation of plastic production, use and waste will further expand by 70% by 2040*": OECD (2024). *Policy Scenarios for Eliminating Plastic Pollution by 2040*. OECD Publishing.

gaspillage pour une économie circulaire – AGEC). AGEC was adopted in 2020 to encourage businesses in various sectors, municipalities and citizens to reduce waste and adopt circular practices.

On the reduction front, AGEC envisages the elimination of the use of single-use plastic packaging by 2040, with: intermediate reduction, reuse and recycling targets set for each five-year period; the ban from 2022 on the destruction of unsold non-food products, with the obligation for companies to donate or recycle them; the obligation to separate the collection of organic waste from January 2024, for composting or biogas production. There are also targets for reuse and recycling, including through separate collection.

In particular, from January 2023, all plastic packaging, not just bottles and flasks, in France must be placed in the separate collection container, in which paper and cardboard packaging and metal packaging, such as cans, must also be placed. In France, around 30,000 companies finance the separate collection and recycling of paper and packaging and in 25 years they have invested more than €10 billion to finance recycling, thus allowing the French to have recycling bins close to home[3].

With 65% of household packaging being recycled, France ranks in the average of European countries. However, further progress is needed[4] to align with best practices, considering the challenges for the separate collection of organic, wood and textile waste, low recycling rates and high use of landfills.

Although France appears to be on track to meet the 2025 target for the recycling of total packaging waste and the 2035 target for landfilling municipal waste, it is considered by the European Environment Agency to be at risk of not meeting the 2025 target for preparing for reuse and recycling of municipal waste and for recycling plastic packaging waste. According to the European Agency, in fact, France would benefit from an improved and extended separate collection system and from more effective economic incentives for citizens to sort waste at source[5]. In addition, the most recent data available on municipal waste generation show that in 2022, the country produced 535 kg per capita of municipal waste, which is higher than the

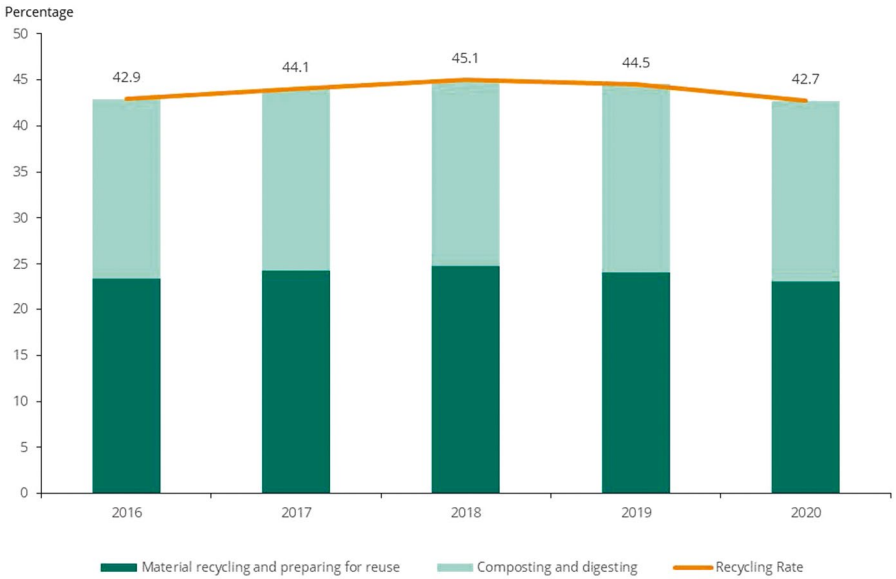
[3] Source: Documentation provided during the interviews by the City of Paris.

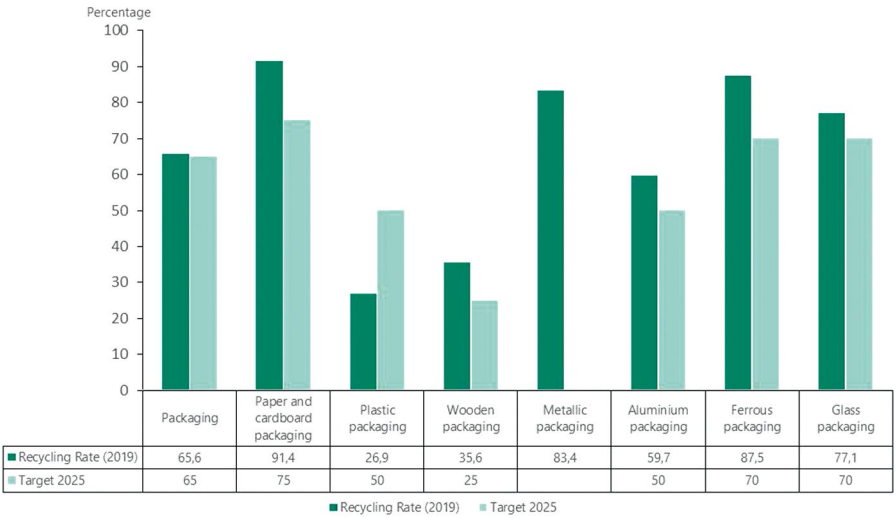
[4] In particular, please refer to the *Country profiles on municipal and packaging waste management report – 2025*, European Environment Agency's home page available at: *www.eea.europa.eu/en/topics/in-depth/waste-and-recycling/municipal-and-packaging-waste-management-country-profiles-2025*.

[5] *Country profiles on municipal and packaging waste management – 2025*, European Environment Agency's home page of the European Environment Agency available at: *www.eea.europa.eu/en/topics/in-depth/waste-and-recycling/municipal-and-packaging-waste-management-country-profiles-2025*.

(estimated) EU-27 average of 513 kg/capita. The generation of packaging waste has remained relatively stable since 2010[6].

Figure 6.1 – Recycling rates (in percentages) and breakdown by product category (right)





	Packaging	Paper and cardboard packaging	Plastic packaging	Wooden packaging	Metallic packaging	Aluminium packaging	Ferrous packaging	Glass packaging
Recycling Rate (2019)	65,6	91,4	26,9	35,6	83,4	59,7	87,5	77,1
Target 2025	65	75	50	25		50	70	70

Source: EEA, 2022 based on Eurostat and EU data

[6] *Ibidem*.

Paris' attention to the impacts of the increase in the use of plastic and the reduction of waste began about fifteen years earlier, with the Plan Climat of 2007, and then continued with the Plan Alimentation Durable of 2015 and the Plan Economie Circulaire of 2018; finally, the latest acceleration accompanied the project to host the Olympic Games in 2024.

The city of Paris and its previous mayors, Jacques Chirac and Bertrand Delanoë, had already tried unsuccessfully to get the Games organized in Paris in 1992, 2008 and 2012.

Mayor Anne Hidalgo was elected in 2014 and initially showed opposition to a new city candidacy for several reasons: firstly, the potential negative impact on the image and pride of the city of a possible new rejection was emphasized[7]; moreover, the economic aspect linked to the high costs to be incurred even just to present the candidacy was also emphasized, with the economic effects suffered by Athens and Montreal still in mind; moreover, last but not least, there was concern about the environmental impact and the possible negative contribution to the ecological transition of events of global appeal such as the Olympics.

In fact, to dispel the initial perplexities, the new mayor set three essential conditions for her support for the new candidacy: first ethics and transparency, then a new economic model and finally compliance with stringent environmental requirements[8].

2015, however, was a dark year for Paris. The city suffered terrorist attacks that deeply shocked its inhabitants: in January 2015 there was a first attack against the headquarters of the satirical newspaper Charlie Hebdo; subsequently, in November of the same year, a series of terrorist attacks caused 130 deaths among Parisians and tourists and over 300 injured in various places in the city, including the Bataclan, the Stade de France and some restaurants.

The mayor felt the need to raise the morale of the city and its citizens through initiatives that could bring back hope, joy and the desire to attend

[7] In interviews at the time, Anne Hidalgo pointed out that it was not a question of making a symbolic candidacy for Paris and France. "*Having dreams is wonderful, but making them come true is even better*" and "*I know what happens when the dream is shattered*" ("*il n'est pas question pour Paris et pour la France d'avoir une candidature de témoignage. Avoir des rêves c'est magnifique, les réaliser c'est encore mieux. Je ne suis pas dans la surenchère ni dans les rêves parce que je sais ce qui se passe quand le rêve se fracasse*"). Le Monde (2014), *JO 2024 à Paris: Hidalgo répond à Hollande et pose ses conditions. Au lendemain des propos du président en faveur d'une candidature de Paris, la maire de la capitale assure qu'aucune décision ne sera prise avant janvier*. *www.lemonde.fr/sport/article/2014/11/07/les-jo-2024-a-paris-hidalgo-repond-a-hollande-et-pose-ses-conditions_4520221_3242.html*.

[8] Capital (2017), *Quand Anne Hidalgo ne voulait pas des JO*. *www.capital.fr/economie-politique/quand-anne-hidalgo-ne-voulait-pas-des-jo-1244084*.

public places. Not surprisingly, the historic motto of the city of Paris is "*Fluctuat nec mergitur*", which means "it is tossed by the waves but does not sink". The city of Paris would then recover from the terrorist attacks and once again show its resilience in the face of adversity.

In early 2016, several international campaigns were launched: the city's bid for the 2024 Olympic Games and the mayor's bid for president of the C-40, a global network of mayors from the world's major cities who are united to tackle the global climate crisis.

In this regard, Lila Durix, Cheffe de mission sortie du plastique à usage unique, Direction de la Transition écologique et du Climat of the City of Paris, recalls: "*At that time I was not working in the Department of Ecological Transition, but in the political sector that deals with international affairs. So I was following Anne Hidalgo's international campaign and in 2016 the great political campaign in favor of the Olympic Games in Paris started. The city wanted to welcome back the Games 100 years after those of 1914. The first thing the mayor thought of was to pursue the ambition of eliminating single-use plastic. In fact, she wanted a project, a candidacy, that was in line with the objectives of COP 21 in December 2015 and the Paris climate agreement. It was a historic agreement that we could not and did not want to ignore. Even though she was only the mayor of Paris, her determination to give a strong push to the fight against the climate crisis was strong and fundamental; at the same time we needed a joyful project that would help Paris recover from the terrorist attack. Thus was born the new impetus to present a "different" project to host the Olympic Games in Paris*".

The candidacy envisaged the construction of a few new sports facilities; when it was presented, almost 95% of the equipment of the facilities necessary and planned for the Games were already in operation. Only one new stadium would be built, namely the Adidas Arena, located in the northern part of Paris, while all the other structures were already existing and needed only some renovations.

Durix recalls: "*In 2015 there were 5 candidate metropolises: Paris, Los Angeles, Rome, Budapest and Hamburg. Of these, 3 abandoned the race, something never seen before. The populations of the candidate territories had in fact submitted petitions because they did not want to host the Games and suffer their impacts, also considering the negative financial legacy that was left for decades to the host cities. In fact, the IOC (International Olympic Committee) found itself with only two candidates: Paris and Los Angeles. In September 2017, when the Games were awarded, there was a double allocation: Paris 2024 and Los Angeles 2028. Something like this, never seen before, was done to allow a better preparation of the cities for the Games, giving more time for the organization. The city of Paris' bid*

aimed to keep to the budget, build very little and be compatible with the Paris agreements. Thus, in September 2017, in Lima (Peru), the mayor of Paris won the candidacy for the Paris 2024 Games and, 18 months later, with her political team, produced a document in which she clearly outlined the political vision of the 2024 Games".

In fact, in 2019 a document called "Transformations Olympiques. Des jeux au service des parisien" was released[9]. The mayor's message was clear: "*The main goal is to leave a tangible and positive legacy for all citizens, improving infrastructure, fostering social inclusion and promoting a more active lifestyle*". Among the objectives mentioned, the first was to make "Paris more sustainable", also through the elimination of single-use plastic. By 2024, Paris would become a city without single-use plastics, with the installation of new public fountains in addition to the 1,200 already existing at the time and the promotion of sustainable alternatives.

In June 2019, the City of Paris' "zero single-use plastic" ambition by 2024 was launched for the first time.

6.2. The development of the Ambition zéro plastique à usage unique project

The ambition to make Paris plastic-free by the start of the Olympic Games started from the convergence of the ideas of two councillors: Célia Blondel, Deputy mayor in charge of climate, water and cleanliness, and Jean-François Martins, deputy mayor with responsibility for sport and tourism. In the 2019 policy document[10], addressed to all interested stakeholders, the city of Paris started from some elements that well describe the context: "*By 2050, if no measures are taken, 12 billion tons of plastic waste will have accumulated on the planet and the weight of plastic in the oceans will be equal to or greater than that of fish. The main use of plastic is for the packaging of single-use and disposable products. Bags, take-away containers and plastic bags now account for half of the volume of our waste and a third of its weight. To address this environmental emergency, the French regulatory environment has changed in recent years, with the ban on single-use plastic bags from 2017, followed by the elimination of disposable tableware, cotton buds and cosmetics containing microplastics from 2020. By adopting the Paris Climate Plan and the Plan for the*

[9] The document is still freely accessible at the following link: *www.api-site.paris.fr/paris/public/2019%2F5%2FTransformations%20olympiques%20%282%29.pdf*.

[10] *www.api-site.paris.fr/paris/public/2019%2F5%2FTransformations%20olympiques%20%282%29.pdf*.

Circular Economy, the City of Paris has committed to action to prevent and reduce plastic waste at source. This approach is part of a broader zero-waste strategy at the city level, which aims to develop reuse and repair, combat waste, improve the separate collection and recycling of materials, and promote a sharing economy".

The city, from an administrative point of view, has equipped itself with a "Directorate of Ecological Transition and Climate" (DTEC) with the role of coordinating action on ecological transition and climate. The Directorate is responsible for ensuring the guidance of the Climate Plan (PCAE), as well as the elaboration and implementation of the municipal project on the environment and sustainable development and for leading the Paris' socio-ecological transition and resilience strategy, committing itself to supporting the most vulnerable citizens in this process[11].

In 2019, the city of Paris also established a department for the preparation of the Olympic Games, a very small structure, consisting of about fifteen people, directly working under the supervision of the General Secretariat of the City of Paris, which represents "a control tower" for all the departments of the City Council.

In the autumn of 2020, a major consultation conference of all stakeholders, including companies in the Paris area and the sports federation, was launched to outline Paris' ambition to eliminate single-use plastic. The conference aimed to identify solutions to eliminate single-use plastic, trying to understand how to work with the main stakeholders and how to collaborate, overcoming what Lila Durix calls "*the many walls of no*".

In March 2021, a second conference was organized and the role of the Cheffe de mission sortie du plastique à usage unique was created within the organization of the municipality as part of the Direction de la Transition écologique et du Climat. Thanks to this well-defined role and the presence of a person with the necessary professionalism, the action plan was defined from autumn 2021 to implement the Ambition zéro plastique à usage unique strategy in a much clearer way, relying on a person who was responsible for making the plan concrete on a full-time basis.

As Lila Durix recalls, "*in 2021, we still had a lot of things to solve, for example it was not clear whether compostable plastic was a single-use plastic, whether aluminum and steel cans were single-use plastics, whether biodegradable plastic was a single-use plastic. So, my initial task was to produce scientific know-how, conducting studies and analyses to provide a clear and precise picture and define how to proceed. This phase proved to be very important, because we were under strong pressure from companies such as Coca-Cola, the Federation of the Metallurgical Industry, the can industry,*

[11] Internal document for staff training, 7 October 2024.

the paper supply chain. We have defined a very strict vision of 'zero plastic', which for us means that there must be no replacement of single-use plastic with another material that still has an environmental impact. We have chosen to act on pure waste reduction, providing a precise and clear picture, closing all possible options and giving rigid prescriptive indications to be able to actually obtain results".

Three levels of action were defined: the Olympic Games, the Paris region, and public administration. The main areas of intervention were also outlined: drinks, food and advertising gadgets.

The city of Paris is a huge institution, there are almost 60,000 employees, 20 departments, with a budget of 8 billion euros; as Durix recalls: "*It was immediately clear that interactions with suppliers would be very complicated, because apparently miraculous solutions are often proposed, but in fact incompatible with the basic principles we had outlined. The work done by the Parisian administration was to convey clear and understandable information. This has made it possible to avoid falling into false solutions and bad adaptations, with respect to the waste reduction target for the Olympic Games*".

A consulting firm, Circulab, was brought in to develop a strategy to guide elected officials and a system to support Parisian retailers and professionals in exiting single-use plastics. In particular, collective consultations, participatory workshops and annual conferences were organised and benchmarks, documentary research and an online platform were developed.

The definition of single-use plastic (*plastique à usage unique* or *PUU*) was based on indications from the European Union and includes "*everything that contains totally or partially plastic*", so any object, product or material that has plastic as a component, even in a small part, falls within this definition. The definition therefore includes not only classic plastic bottles, but also cans, tetrapak beverage containers, bioplastic products and everything that was produced with recycled plastics.

In addition, a threshold of duration of use was also set, less than one year to define what was disposable and what was reusable.

The approach followed therefore envisaged: eliminating unnecessary plastic packaging and increasing the sale and administration of bulk products, without packaging, or the reuse of existing containers and packaging.

The City of Paris has commissioned scientific studies from experts in recycling and materials science to have valid scientific support available "*to cope with the many pressures that purchasers routinely receive from manufacturers; the latter, in fact, sometimes offer materials presenting them as plastic-free but which, in reality, contain polymers*", Durix concludes.

The replacement of materials is in fact an alternative to be limited that has created and still creates a series of critical issues, especially because, as

Durix points out: "*today there are more and more suppliers, very innovative companies, who propose some alternatives, which, however, do not go in the direction we hope for reduction, but only a change of materials; They are in fact full of plastic anyway, they are disposable and are barely recyclable. For us, however, it is essential to use fewer materials in terms of ecological transition and to oppose the interests of those who want to sell small products because the margins they get from them are much higher*".

There are numerous examples of materials that are often proposed as alternatives: from aluminum and steel cans which, Durix recalls, "*are single-use plastics because they contain an artificial polymer*", to paper cups used for the consumption of disposable liquids that "*employ different technologies, from PFAS, to aluminum, to micro or nano plastic particles, to allow paper not to absorb liquids*", to plastic bottles "*sold as reusable because they are thicker than PET bottles but which we already know will not be largely reused, so it would only contribute to an increase in the material used then transformed into waste*".

The definition of single-use plastic adopted by the City of Paris does not provide for exceptions, related to the amount of plastic. The reference is much clearer and concerns the presence or absence of plastic: whether it is a lot or a little, the mere presence excludes its usability within the project; as highlighted by Lila Durix: "*the problem is also the production of the can itself, the extraction of the necessary resources, the carbon that is released, because the ovens have to be heated to very high temperatures. So, replacing plastic with cans is not acceptable. Switching to glass-only packaging is also not acceptable: even if glass is inert, the carbon footprint for its production is huge and there are not enough silica deposits on earth to continue producing at the current rates. The point of view to be adopted is precisely this, reduction and not replacement, an approach that is well understood even when thinking about the composting of bioplastics. We have regulations that say that plastic can be composted, but the problem is that these standards consider plastic as compostable even if only 90% of it biodegrades. If I look at the issue from the right point of view, I understand that 10% of it does not biodegrade, so 10% will remain with its long-term impact. Not to mention the fact that bioplastics are not often accepted in composting plants because they degrade the quality of the compost. In fact, we do not have industrial plants available that allow us to carry out on a large scale what has only been tested in the laboratory*".

Particular attention was paid to events, the health sector and logistics. Paris through the project "Ambition zéro plastique à usage unique" and in particular through *Le Pari(s) du zéro plastique*[12] – the professional network

[12] "Pari(s) du Zéro Plastique" is a play on words, the word *pari* in French means bet or

created by the City of Paris to support the transition of private actors, with a dedicated website – sought to represent an exemplary public administration, committed to setting a good example in terms of sustainability and plastic reduction.

Concrete measures included, for example: banning the free distribution of plastic bottles, providing water fountains, and eliminating superfluous items such as disposable gadgets, often produced with harmful materials and under poor working conditions, while encouraging the use of local and/or French zero-kilometer products.

In this regard, guides were made available both for public offices and for suppliers of public administrations, to help them easily comply with the project's guidelines. Acceptable alternatives were also suggested, such as organizing attractive events without distributing gadgets, offering instead activities like workshops, or providing alternative items such as tickets to concerts or shows, visits to unique and usually inaccessible sites, edible gifts, or even the opportunity to meet a well-known public figure.

The only gadgets allowed must be durable, such as water bottles, remembering to always consider the impact of distribution after the event is over.

As for sporting events, these must have drinking water fountains available. In addition, all road sports activities must be organized "plastic-free", i.e. without distribution, for example, of free bottles or cans.

Finally, according to the plan, urban environments had to strive to produce less waste, especially plastic, for example by proposing markets with reduced use of plastic packaging and "circular neighborhoods", encouraging the adoption of circular economy models at the neighborhood level.

Particular attention was paid to raising awareness of plastic among schoolchildren, organizing dedicated training events in the central Climate Academy, a few steps from the main headquarters of the Municipality, in Place de l'Hôtel de Ville, thus investing in the education of young people, to raise awareness of the impact of plastic on the environment.

In the "zero goodies" scheme, it is stated that gadgets such as toys, balls, balloons, glasses, t-shirts, water bottles, bags, backpacks, umbrellas, key rings, USB sticks and the like could not be distributed. This dynamic stems from the observation that in order to have a positive environmental impact in terms of CO_2 emissions, biodiversity, water consumption, plastic consumption and so on, the replacement of a single-use plastic shopping bag with a reusable cotton one must be used more than 150 times. In the case of

challenge and by adding an S the word becomes Paris. Therefore, creating a zero-plastic city is a challenge, but the city of Paris has always been a challenge, an ambition. So the slogan poses the challenge, the ambition and points to the pride of the city.

replacing a disposable plastic bottle with a double-walled aluminum water bottle, the replacement is sustainable if you use it for at least 5 years.

6.3. Widespread training on the project "Ambition zéro plastique à usage unique"

Once the project was defined and the responsible organizational structure was created, the need for training of the internal teams of the Municipality involved in the preparation of the Games clearly emerged, to raise awareness on the issue and inform them adequately. Lila Durix points out: "*As the organisational complexity increased, month by month, with the teams working on the various fronts multiplying, it was necessary to clarify what 'reduction' meant for Ambition zéro plastique à usage unique, what was to be considered 'single-use plastic' and the objectives that the city had set itself. For this reason, in the last 3 years, I have done a huge job, training about 1,500 municipal employees. This fieldwork has produced tangible results. By way of example, I can mention that a meeting was held to organize the Olympic torch relay. As is well known, it is a media event very popular with citizens and tourists, during which the runners carry the torch around Paris. As with the Tour de France, there are normally partners, sponsors, who offer gadgets. A meeting was held between three people, who had been trained by me at three different times: a person from the mayor's office, a person in charge of Olympic celebration and a person in charge of the Olympic torch relay project. Thanks to the training they received, during the meeting they wondered if it was possible to allow Coca Cola, which was the partner of the torch relay, to distribute cans along the route, that is, they wondered if the cans fell within the defined concept of single-use plastic. One of them remembered that during the training it was made clear that cans are also part of the exclusions to be made and consequently, the city of Paris was the only city in the Olympic torch relay to refuse to distribute cans to the public, as had been done until then also for the Tour de France. This episode showed us how important it was for all decision-makers at different levels of the organization to have been given clear information and clear direction on how to act*".

The material used for the training contained precise references, data and numbers that help explain the reasons for the strategy, providing reliable and authoritative sources to support it. For example, information was provided on the lifespan in nature of plastic packaging (up to 1,000 years) and on the fact that only a small part of plastic packaging was actually recycled. In fact, it was reiterated that in 2021, only 65% of household packaging (paper, cardboard, aluminum, plastic, glass) was recycled, but only 24% of plastic

packaging; moreover, 61% of plastic packaging is made of PET bottles. In this regard, the difference between separate collection and actual recycling was explained and the limits of recycling itself, which in order to be effective requires the existence of large-scale supply chains, the extension of separate collection and the simplification of plastic packaging materials, mainly using mono-material packaging.

Information was then provided to raise awareness and counter the increasing use of plastics, especially in less visible applications, such as:

- the construction sector is the largest user of plastic in Paris;
- synthetic fibers are a source of microplastics generated through wear;
- disposable diapers are 40% of the waste of an average family that has a newborn between 0 and 2 years old;
- whole fresh fruit and vegetables (citrus fruits, melons, papayas, mangoes, avocados and pineapples) can be subjected to a coating process with polyethylene wax (E914);
- beauty and hygiene products, may contain micro plastics (PEG 10 Carbomer);
- detergents with micro plastic capsules are a source of micro plastics;
- tires and shoe soles are a source of microplastics from wear.

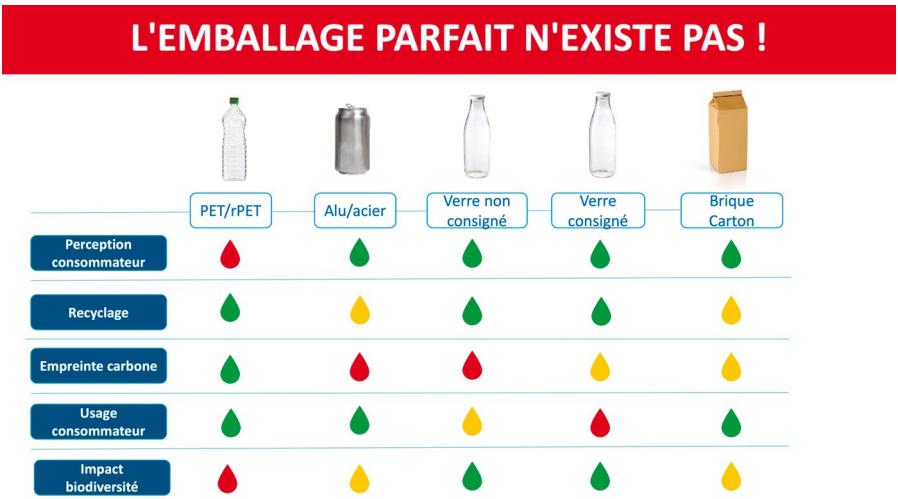
The in-depth section explained why and how plastic production is problematic. Between 4% and 8% of the world's oil production is used to manufacture plastics. This figure is growing and is estimated to reach 20% by 2050. It takes 2.3 liters of oil to make one kilogram of polystyrene. To this must be added the energy needed for the manufacture of plastic. Plastic can also be manufactured from algae, sugar cane, corn or casein, this improves the CO_2 impact even if the end of life of the products remains problematic as well as diverting raw materials from the diet.

During the information sessions, the operation of both the deposit mechanism for returnable packaging and "bulk" purchases was explained. With reference to the former, it was explained that, by purchasing a product with returnable packaging, you pay for two components: the content and the container. After use, you can recover the deposit amount by taking the packaging back to the store. Also in this case, the explanation was accompanied by precise data, illustration of pros and cons, also allowing an international comparison between France and other more virtuous countries. As far as bulk products are concerned, the example of soft drinks was provided, which, instead of being served in single-use packaging, can be supplied through dispensers on tap, which have packaging in any case but with a reduced environmental impact, especially if accompanied by the use of returnable or reusable cups.

Widespread training and information made it possible to find at least one person in all decision-making committees and tables who had assimilated the principles and indications defined as part of the "Ambition zéro plastique à usage unique" strategy, preventing errors and actively contributing to the reduction of waste in the city. The underlying message was that perfect packaging does not exist, all materials have critical issues and the preferable solution for Paris is to reduce them, whatever the material, but starting with those that contain plastic in whole or in part.

The comparison was made between a PET/rPET bottle, an aluminum or steel can, a disposable glass bottle and a returnable glass bottle, finally a beverage carton. The assessment focused on consumer perception, recycling, carbon footprint, consumer experience, impact on biodiversity (*Figure 6.2*).

Figure 6.2 – Evocative images of the different impacts of packaging of different materials



Source: Paris City Council, training material

Capacity-building activities targeted not only municipal administration staff engaged in organizing the Games or working in procurement, but also individuals not directly involved in these areas, in line with a proactive approach aimed at extending training opportunities more broadly. These training activities would enrich them not only on a professional level, but also and above all on a personal level. Says Durix: "*I went around all the management committees and all the departments in the city, which was*

unprecedented, just to present the approach. We produced an administrative guide, which was then made available to everyone. I formed teams that had nothing to do with the Olympic Games and the ambition zero single-use plastic. In order for the underlying message to spread widely, it was very important that there was a global understanding, which could spread throughout the city. It was therefore a way to enter all departments, at all levels of the city, because the city of Paris is a mini state in effect. You can't control all interactions and you can't ban plastic just on the basis of one line of text: it doesn't work. If people don't understand, the strategy doesn't work".

The widespread training has also helped to overcome what Lila Durix calls "the wall of no", that is, the various objections that can be made by the many people involved at different levels in the administration of the Municipality and in the organization of the Olympic Games, from the office manager to a competition organizer, from Coca-Cola to a stadium director: "*it is not hygienic, it will be dangerous, it is not practical, it is not cheap*" are just a few examples.

There is no one-size-fits-all solution, so in Paris it was decided to adapt the indications to each situation of use of single-use plastic, identifying different solutions for a food truck or a stadium, for a cinema or a museum, for an outdoor event or for an administrative building.

"*What's really important is to adapt to every situation, every type of user or customer. You can't have the same relationship with children, with a nursing home or with people who come to a festival*" says Durix. "*First of all, to reassure the many people I spoke to, I said that we could adapt, we could reduce with reusable containers or with large format bottles. The simplest solution was to no longer use cans or small-format plastic bottles, choosing for example to serve drinks in 1.5-2 liter plastic bottles, also taking advantage of economic convenience. In general, we proceeded without preconceptions, showing ourselves open to experimenting. In addition, all the policies we have implemented have been tested and revised, to remove all technical, safety, health and usage barriers. I think we have done about fifty experiments between markets, the Rugby World Cup, food trucks and fairs*".

In conclusion, as Durix recalled, "*there are two main points of the Paris experience: the decision-maker and the operator must be convinced of the approach, and clear information and guidance must be available to support decision-making*".

6.4. Negotiation with partners of the Olympic Games and major sporting events

The document that outlined the guidelines and objectives of the 2024 Olympics had outlined a clear political vision of what would be the legacy of the Games: zero single-use plastic to minimize the environmental impact of this extraordinary event for the city. Says Durix: "*It was important that this political will, taken at a high level, both by the councillor's cabinet, the deputy mayor and the mayor herself and her team, was accompanied by a budget commitment transformed into people dedicated to this full-time to achieve this ambition. This strong commitment of the top management was felt in all key moments, that is, all the times the mayor spoke on the subject of the 'Olympics', giving a strong signal of the importance and need to comply with the Ambition zéro plastique à usage unique strategy*".

In many cases, decisions do not rest solely with the mayor of a city. This is the case with the Olympic Games or other sporting events. However, as Paul Vinot, Chief of Staff of Pierre Rabadan, Deputy Mayor of Paris with responsibility for Sport, the Olympic and Paralympic Games and the Seine, points out, "*even just the possibility of exerting political pressure with the risk of* name and shame *for some economic operators is a very powerful weapon, combined with determination and the will to take a firm position on the ideas and objectives of the city*".

Although it is not within the powers of a mayor of the city hosting the Olympic Games to decide who will sponsor the Games, the mayor announced to the press her position against a partnership of the Paris 2024 Games with Total, the French oil multinational, making it clear to everyone that a different choice would have placed the Games and the IOC in opposition to the City of Paris.

The Ambition zéro plastique à usage unique strategy had to deal with many companies and associations of companies, partners of the Olympics as sponsors or as suppliers in events and in the many initiatives organized. In some cases, the city has had to deal with explicit lobbying activities, aimed at putting pressure on local politicians to take a more moderate approach to plastic or apparently alternative materials to plastic.

Recalls Lila Durix: "*the greatest lobbying pressures around the strategy, were carried out by Coca Cola and the organization that represents and promotes the beverage can industry in France, called boîte boisson*".

The discussion activity with the main partners of the Games with a high potential impact of the use of single-use plastic lasted over two and a half years.

Coca Cola was one of the so-called premium Olympic partners, considered the global sponsors of the Paris 2024 Olympics. Coca Cola has been a partner

of the Olympic Games since 1928. For the Games, it was estimated that 18 million cold drinks would be consumed at the various Paris 2024 sites[13].

Discussions with the American multinational were held at the highest levels, directly between the cabinet of the mayor of Paris Hidalgo and the world vice president of the Coca Cola group with responsibility for sustainability, Michael Goldman. In particular, there were two meetings between them, during which the City of Paris had the opportunity to assert the city's position despite not having direct competence over the sponsors of the games, which was instead the responsibility of the IOC.

Vinot recalls: "*We held the point with determination, emphasizing that the City rejected single-use plastic. The organizers of the Games aimed to reduce plastic by 50%*[14]*, we wanted to eliminate it*".

Durix recalls: "*A discussion has been undertaken with Coca-Cola for two and a half years on the subject. We explained our ambition to them, so no plastic bottles and no recycled plastic bottles, no cans, no cardboard drinks. Then we started negotiating site by site, trying each time to dismantle technical topics that were being posed as crucial but really weren't*".

The clear direction given has materialized with the implementation of several alternatives to the "disposable" model, including a distribution of beverages to significantly reduce the use of single-use plastic by focusing on the reuse and recycling of components, co-developed with Coca-Cola; the use of 100% reusable tableware for meals in the Athletes' Village; a deposit system for the reuse of containers for certain take-away offers at tender and non-tender sites.

In particular, with Coca Cola it was decided and obtained in the Paris area to have tap water available in all Olympic sites, to allow water bottles and reusable containers to be brought to all sites, and to install 254 beverage dispensers in the Paris Olympic sites[15].

Following the negotiations, it was thus possible to avoid, for example, the free distribution of single-use cans during the Olympic flame passage event and to obtain the sale of drinks on tap in the main Olympic village, using reusable cups upon payment of a returnable deposit.

Durix points out: "*In the end, we were exhausted, but we managed to have 8 out of 11 Olympic sites only use dispensers on tap for Coca Cola products instead of traditional cans and bottles, with Coca Cola using the theme of its commitment to reducing single-use packaging in its communication*"[16].

[13] See the PARIS 2024 SUSTAINABILITY & LEGACY PRE-GAMES REPORT released in May 2024 by the IOC.

[14] *Ibidem*.

[15] *Ibidem*, for further details on the impacts on the whole of France.

[16] Coca Cola, in April 2024, in a press release underlined its commitment to making

With other multinational companies such as Danone, collaboration was easier; as Durix recalls: "*Danone, for example, already had a sales technology available that was loose yogurt; So, we incentivized them to switch to providing yogurt in reusable containers. They also worked on the question of the spoon, finding a valid solution, the edible spoon, which can be eaten in the end. I know that Danone really enjoyed this experience*".

As for the Federation of the Can and Metallurgy Industries, the lobbying activity was a real "*work of encirclement*" recalls Durix.

"*In other words, they met with all the departments, the Department of Waste Management, the Department of Water, the Department of Circular Economy, and four councilors to convince them that cans are the solution to single-use plastic and that they do not contain plastic. They also met with elected representatives, asking to meet them and bombarding them with emails. I then referred the matter to the Legal Affairs Office, which examined the matter and decided that since they were not registered as lobbyists with what is called the 'High Authority for Public Life' they were not allowed to interact in that way considering the current regulatory framework*".

There was similar pressure from the sponsor of one of the world's best-known running races, the "20km of Paris", one of the largest races in France with 40,000 runners. This race has historically been sponsored by the first French mineral water company called Source-Alma.

"*Meetings were held with the organizing association of the race and the sponsor in the presence of elected politicians. The sponsor in those meetings supported the recyclability of PET water bottles and gave a mandate to a public affairs company to take care of the issue and contact the mayor's advisors to look for a way to "soften" the city's position. In addition, they presented an impact study arguing that banning recycled plastic bottles and encouraging the use of reusable cups would lead to greater use of plastic*".

In this case, however, Paris maintained its position and enforced its decision, accepting the potential consequences, including the cancellation of the event.

the Olympics more sustainable: "*The Coca-Cola Company Sustainability at Paris 2024. The Coca-Cola Company's ambition is to have an Olympic and Paralympic Games without waste. The company will be providing packaging options to help minimize waste and reduce carbon emissions. Coca-Cola will also work to collect and recycle bottles to give them new life or so that they can be refilled. This includes drink and water fountains with refill options, returnable glass bottles and bottles made with recycled materials. Coca-Cola products will be transported more sustainably during last-mile delivery*". See: *investors.coca-colacompany.com/news-events/press-releases/detail/1105/the-coca-cola-company-celebrates-everyday-greatness-with-global-program-in-advance-of-olympic-and-paralympic-games-in-paris*.

The economic pressures have therefore been very strong and the difficulty of managing relationships with the partners of the many sporting events has not been easy.

6.5. The environmental, social and economic results of the Paris sans Plastique project

"*The addiction to plastic is terribly destructive. For living organisms and for the planet*" affirmed Anne Hidalgo, Mayor of Paris, Opening speech at the international forum to end plastic pollution in cities that took place in Paris in May 2023.

An evaluation of the environmental, social and economic results of the Paris sans Plastique project requires a two-part analysis, one covering the pre-Olympic period and the other the Olympic and post-Olympic period.

6.5.1. Balance and results – Pre-Olympic period: an exemplary administration

In the document (*Ambition zero plastique a usage unique – Bilan annuel – 2023*) the city of Paris provides an assessment of the first phase, i.e. at the end of 2023. The work done by the Directorate of Ecological Transition and Climate (DTEC) of the city of Paris places it at the center of the environmental action of the Games, as can be seen in the figure below.

Around the Directorate of Ecological and Climate Transition of the City of Paris we have the partners of the Olympic Games, the 40 referents in the different directions of the City of Paris and then the 1200 actors of the Paris Zero Plastic network of which 150 are signatories of commitments for a transition of their practices.

The goal that the city sets itself is to be exemplary before the start of the Olympic Games.

The balance of the plastic avoided is:

- Nurseries for children: 2 tons of plates, cups and glasses avoided;
- Social action in the city: 29 tons equal to 150,000 items in the winter assistance plan for people in need, as well as 865,000 PET bottles thanks to home delivery;
- Refreshment of municipal agents: 6.6 tons of food packaging and drinks;
- Sporting events: 2.2 tons avoided during the Rugby World Cup on the Concorde website;
- Exemplary purchases: 1 ton of items avoided for agent equipment.

It is a total of 41 tons, equal to the weight of 2.5 Parisian buses.

The balance of the means deployed refers to the 150 signatories of commitments for a transition of their practices, the 900 public buildings that are members of the "Network that chooses the water of Paris", the creation of a zero plastic certification, 14 municipal museums that have committed to reducing plastic waste, 25 events organized at the Climate Academy, an international conference with the United Nations, 1,300 operators trained in health and environmental issues, 950 children sensitized to plastic pollution and eco-responsible gestures, 11 initiatives funded in the Sustainable Food plan 2022-2024, 600,000 spectators tried zero plastic solutions in the Rugby village installed during the World Cup, 70 water fountains, The sites of the celebrations will be zero plastic for drinks and food.

In 2023, the City of Paris launched a call for the reuse of packaging in the major events sector by financing eight facilities and allowing the transformation of several major events such as the We Love Green festivals, Festival Aux Arts, the Paralympic athletics world championship, the Jazz festival at La Villette, the Rugby World Championship Village, or the Change Now salon. A cartography and a visual identity have been created. More than 140 restaurants in Paris have adopted the method.

In 2023, several Parisian nightclubs have come together to "go green". They have joined a Zero Plastic Club promoted by the Byebyeplastic foundation with 26 participating venues.

Municipal Museums

The city's 14 municipal museums have promoted a plan to reduce the use of materials from the petrochemical industry. They have promoted the installation of public water dispensers in museums and in all eight restaurants of the municipal museums they have committed to offering drinks without plastic bottles and cups and a food offer without disposable plastic.

Water Use

To facilitate access to tap water during Parisian events, Eau de Paris has set up a new "Water in the City" service to help sporting and cultural events move away from single-use plastic bottles. A preferential tariff offer has also been made available to district municipalities (the arrondissements) for their local events, at the rate of two events per district per year. Around ten events benefited from this service in 2023.

To encourage restaurateurs to allow customers to refill their water bottles free of charge, the City explained that the average cost for the operator is only 2 euros per year, considering that on average about 500 people enter the business and that, during their stay, they could also make other purchases.

A poster was created for the canteens and restaurants participating in the campaign: Slogan: "Here we have gone to bulk!", "Whether for tea, coffee or breakfasts, plastic packaging has been suppressed", "Plastic bottles and cans, are finished", "All our soft drinks are contained in glass bottles", "Reusable tableware or nothing!", "We have suppressed all disposable tableware from our canteen".

Exhibition "Plastic, I leave you"

A nice exhibition entitled "Plastic, I leave you" was held at the sewage museum in Paris: a playful and interactive exhibition produced together with the Surf Rider Europe association. The exhibition was seen by over 31 thousand people.

Social action

The various social actions of the city of Paris have already been mentioned, both in assistance to people in difficulty in winter, and in initiatives against the heat and in solidarity spaces. In each of these initiatives, packaging and disposable objects were replaced and 5 water fountains and 7 dishwashers were installed, interrupting the purchase of single-dose products in disposable packaging. 15 thousand users of these services now benefit from a better quality of hospitality.

Before the start of the project, every year there were about 43 thousand objects that were purchased in single-use plastics and which represent over a ton of plastic waste avoided.

Figure 6.3 – Examples of communication carried out by the City of Paris

Climate Academy

To continue amplifying its impact on young people, the Climate Academy has used educational kits to raise awareness among over 700 pupils and children about the impact of plastic, the impact of plastic in the oceans and the importance of limiting the production and consumption of plastic (especially single-use plastic). As for the events hosted at the Climate Academy in 2023, many of them were focused on ambition:

- 10 working groups and workshops for Parisian traders and businesses;
- 6 outreach sessions for the general public, workshops or project launches;
- 2 conferences, one of which is international;
- 1 Ocean Culture Festival;
- 3 working meetings with the 40 representatives of the exemplary administration.

The Academy also served as a base for NGOs involved in the second round of negotiations (INC2) of the International Plastics Treaty of May 2023.

The fourth annual conference on the ambition for zero single-use plastics took place on 6 November 2023 at the climate academy.

Plastic in horticulture

The Horticultural Production Center (CPH) of the city of Paris is trying to limit the use of single-use plastic pots for the production of ornamental plants above ground. To support this approach, it conducted experiments in greenhouses and nurseries, with encouraging initial results on alternatives to single-use plastic pots (metal pots, reusable pots, sawdust pots, peat pots, etc.). Longer-term trials (almost a year) were conducted in 2022-2023.

Starting in early 2025, 100,000 pieces of single-use plastic will be replaced by biodegradable alternatives made of wood sawdust, which are totally biodegradable.

Growing up plastic-free

After signing the "Cities and Territories without Endocrine Disruptors" program in 2018, the City launched a proactive action plan to eliminate all endocrine disruptors in municipal nurseries. The plan provides for the renewal of supply contracts, the search for alternatives to plastics, the organization of experiments with substitute products and the gradual replacement of equipment in the city's 400 plants. The management team is committed to purchasing materials such as cardboard, wood and fabric for children's toys and games, and using glass or stainless steel for tableware. The transition to all-glass bottles was already made in 2020. Overall, by 2023, the replacement of tableware in schools helped avoid almost two tons of plastic in kindergartens. In 2023, subsidies for plastic spillage grew to 585 thousand euros in investments.

Sustainable Nutrition

Paris' Sustainable Food Plan 2022-2027 plans to eliminate plastic in municipal collective catering. Here are the key points of this initiative:

- *Objective*: Eliminate plastic in the preparation, heating and serving of the 30 million annual meals served to Parisians.

- *Funding*: The Sustainable Food Division (DAS) has subsidized 11 innovative projects in 2023 to promote healthier and greener catering.
- *Homemade development*: Emphasis is placed on home cooking to reduce the use of plastic, with the acquisition of suitable equipment such as preparation tables, stainless steel pastry utensils and cooling rooms.
- *Container replacement*: Financing of reusable glass containers, stainless steel trays with compartments, stainless steel containers and lids, and isothermal containers to replace plastic material.
- *Ongoing study*: The DAS, in collaboration with DASCO, is funding a study on the elimination of plastics in school canteens in the 19th and 20th arrondissements, the results of which are expected in 2024.
- *Global commitment*: 21 managers of the Parisian collective catering are involved in this approach.
- *Broader targets*: The plan also aims for 75% organic produce, 100% seasonal produce, and 50% local produce by 2027.

This initiative is part of a broader trend of reducing plastic in mass catering, with similar efforts observed in other French regions.

6.5.2. Balance and results after the Paris 2024 Olympic and Paralympic Games

The balance of the "zero plastic for single use" ambition during the Olympic and Paralympic Games is contained in the City of Paris document "Zero plastic for single use"; This document refers to:

- more than 300 economic and commercial activities qualified as "zero plastic for single use";
- 45 tonnes or 3.6 million single-use plastic containers avoided;
- 16 tons of CO_2 equivalent less than in a scenario with single-use plastic on the only accommodation site in the square of the Hotel de Ville;
- 2,200 water fountains;
- 450 people made aware;
- 450,000 bottles of water avoided in the marathon event for everyone alone.

The goal set was the reuse and reduction at source of all products composed totally or partially of plastic, in particular soft drinks, food and promotional items. The definition placed recycled, compostable or plant-produced plastics as included in the definition of plastics since due to pollution, lifespan and chemical composition they are not solutions that eliminate the presence of plastics.

The goal was to include all Olympic sites and fan zones. In particular, therefore:

- in the fan zones, i.e. the celebration sites of the city of Paris, a welcome offer was provided that included reusable containers and drinks on tap, a policy of zero promotional items;
- in the Paris 2024 competition and celebration areas, more than 250 dispensers of draught drinks have been installed and in the "marathon for all" support for sportsmen has been provided that does not include bottles;
- for all accommodation sites there was a promotion of their zero plastic offers available in an online yearbook, in all Olympic sites water bottles were accepted, free drinking water fountains were provided, with over 1,000 partner merchants offering free water bottle filling (Ici je choisis l'Eau de Paris).

At the same time, the city of Paris ensured that delegations interested in the technical aspects of the project could visit the activities.

At the same time, the city has developed a dynamic of awareness about the city and in collaboration with the Climate Academy (i.e. a structure of awareness of the city) thematic ateliers, a quiz on plastic frescoes, and an immersive game on "Emilie in Paris di zero plastic" referring to a popular TV series have been organized.

With the aim of being exemplary, the city has converted its canteens to a policy of zero plastic packaging for single use, managing to return to cutlery, plates, glasses, washable jars, in metal or glass.

6.5.3. Balance and results – Olympic and Paralympic event

Paris aimed to ensure that one of the Olympic legacies would be a set of good practices that would continue and, over time, possibly become further consolidated. To measure the results, the city of Paris[17] carried out a double audit on the sites of the Olympic celebrations managed by the City of Paris, a first at the end of July, i.e. at the beginning of the Olympic Games and a second at the end of August, i.e. at the end of the Olympic Games and just before the Paralympic Games.

The balance began with the identification of the data of the containers used and usable by asking each of the Olympic sites for the details of the sales of reusable containers.

[17] See Bilan zero puu jop 2 – pag. 13.

The fan zones, i.e. the eight celebrative sites managed by the city of Paris, welcomed more than 2.6 million visitors: more than 885,000 disposable containers were avoided, equal to nine tons of single-use plastic.

It is reported that thanks to the fountains, 3.6 million containers – equivalent to 45.7 tons of plastic – were avoided in the City of Paris, Club de France and Paris 2024 areas.

The report presented after the Olympics indicates that the organizers' target was met and surpassed: 54.6% less CO_2 emissions, 52% less single-use plastic used in the supply of beverages, in terms of weight and a 70% reduction in the number of single-use plastic bottles used to serve drinks compared to the 2012 London Olympics; moreover, 80% of spectators brought a water bottle to the Games sites[18].

[18] PARIS 2024 RAPPORT POST-JEUX DURABILITÉ & HÉRITAGE DE PARIS 2024, *presse.paris2024.org/*.

7.

The Reuse and Contamination of good practices, from Sweden to Tuscany: From Alelyckan in Gothenburg, to ReTuna and Daccapo[1]

7.1. The Alelyckan Reuse Center in Gothenburg

7.1.1. History and stages of development

Alelyckan in Gothenburg is the first reuse park built in Sweden, designed to provide citizens with a single, easily accessible location where they can not only dispose of bulky and electronic waste, but also donate items that are still in good condition – so they can be sold at affordable prices and reused by those in need.

Gothenburg has over 600,000 inhabitants and is the second most populous city in Sweden after Stockholm. Until 2004, the city had four recycling centers where residents could dispose of items that could not be placed in regular household bins. People typically used their own cars, rental trailers, or other suitable means of transport to reach these centers. Each recycling center usually had a container where items could be donated for reuse. These donations were generally managed later by non-governmental organizations, since reuse is not considered a direct responsibility of the City of Gothenburg.

[1] This chapter was written by Giulia Romano. For the realization of the case, interviews were carried out with Pål Mårtensson, former director of the Recycling Park (Kretsloppsparken) of Alelyckan in Gothenburg from its establishment until 2012; Per Hogedal since 2015 Head of Unit Municipality of Gothenburg, Waste Sector, Recycling Park (Kretsloppsparken) of Alelyckan; Simon Glimtoft, Director of the ReTuna Återbruksgalleria Shopping Center in Eskilstuna, Alessio Ciacci, former councilor for the environment of the Municipality of Capannori and Giordano Del Chiaro Mayor of the Municipality of Capannori, Giulia Mariani and Anna Lisa Pace, respectively President of Nanina Social Cooperative Society and Community Cooperative and President of the Listen to my Voice Association, which manage the Daccapo reuse centers, as well as some volunteers of the Daccapo reuse centers. The reuse centers under study were visited between April and May 2025. Some interviewees were interviewed more than once to better explore some emerging issues.

The idea of creating a park for reuse and not just for recycling arose by observing the dynamics in existing recycling centers. As Pål Mårtensson, former director of the Kretsloppsparken Alelyckan center in Gothenburg until 2012, recalls, "*I saw so many things coming to be thrown away! People threw them away because they had bought new things, but those items that were thrown away were often still in good condition, potentially useful. We then reflected on the obligation not only to recycle, but also to see if it is possible to reuse and extend the life of the products*".

The idea of creating an attractive reuse center with repair workshops emerged at that time, as it was noted that 2,200 tons of reusable products were being sent to landfill every year. Expanding the perspective to the whole Sweden, it was estimated that around 80,000 tons of potentially reusable items were being landfilled annually[2].

The initial idea was to concentrate recycling, reuse, and the separate collection of waste in a single location, with particular attention to the prevention of bulky household waste such as furniture, bicycles, electronic equipment, and furnishings. The goal was to create a "park" offering a variety of activities.

The Alelyckan recycling park differs from most other recycling centers: visitors are first welcomed by shops that sell, among other things, second-hand clothes and furniture, building materials, and electronics. Only afterwards do they reach a sorting station, where staff members ask whether any of the items being disposed of can be donated for resale. The vast majority of visitors are willing and happy to donate reusable goods, which are then sold in one of Alelyckan's shops. In this way, visitors are actively involved and can see how various objects can be reused instead of becoming waste.

Only after passing through the sorting station visitors can dispose of their waste in the appropriate containers at the recycling center. The sorted waste is then either recycled, used for energy recovery, repurposed as construction materials, or, when none of these is possible, sent to landfill.

The Kretsloppsparken Alelyckan covers a total area of 30,000 square meters distributed between:

- the sorting station;
- a thrift store run by Stadsmissionen, a non-profit organization, offering furniture, textiles, and various household items;
- a retailer of all kinds of building materials, as well as electronic and gardening products (Återbruket);

[2] Ljunggren Söderman M., Palm D. & Rydberg T. (2011). *Förebygga avfall med kretsloppsparker: Analys av miljöpåverkan*. IVL Svenska Miljöinstitutet.

- a repair shop (Returhuset), where visitors can fix broken items, with a particular focus on bicycles;
- the recycling center;
- an eco-bar and restaurant.

The funding for Kretsloppsparken was initially secured through a request to the public real estate company, which agreed to carry out the project for the construction of the reuse park. The company invested approximately 20 million SEK (about 2-3 million euros), in exchange for the Municipality of Gothenburg committing to pay rent for the facility thereafter. Mårtensson recalls: "*The public company accepted, also because it was a good opportunity to invest in a 'green' project, which was also good for the city's reputation. In any case, they carried out the construction, but we were the ones who designed it and gave them the guidelines*".

The opening of the Kretsloppsparken Alelyckan took place in 2007, "*and it was immediately a great success*", Mårtensson recalls. "*People love to go there because they love to donate. They think it's a good idea to donate something that is still in good condition, instead of throwing it away*".

Alelyckan has thus become one of Gothenburg's five recycling centers and receives about 15 percent of the total waste delivered to the city's recycling centers.

Currently, the composting activity that was initially introduced is no longer in place. However, the cafeteria offers homemade cakes and sandwiches, as well as soups and savory pies prepared using vegetables grown by the local horticulture group. Everything served at the café is vegetarian and, for the most part, organic. Once or twice a year, reconditioned bicycles are sold by the repair shop, with the event also promoted on the center's social media channels.

The only activities managed directly by the city of Gothenburg with its own employees were and still are the resale of building and building materials (Återbruket) and the recycling center. The other activities have always been managed by non-governmental organizations, although the entire park is managed by the Återbruket (and therefore indirectly by the municipality), which collects a rent from the other activities. In fact, the Non-Governmental Organization (NGO) that runs the thrift store has its own employees, as does the cafeteria. With the revenues from the sales of used products in the store, the NGO carries out support initiatives for disadvantaged categories of people. In addition, "*by regularly collecting large quantities of clothes, it is also able to provide clothing to people in need, not just resell it*", says Per Hogedal, current manager of the Park and director of Återbruket.

7.1.2. The Business Model

Kretsloppsparken Alelyckan was built next to the recycling center, with a sorting station placed at the entrance, where all visitors are welcomed by the center's staff. This allows staff to inspect the items before they are discarded and to recover reusable or repairable goods (such as bicycles), which are then given free of charge and resold in the various shops within the park. "*The concept was really good from a commercial point of view, because we had all the items available for free to resell*", Mårtensson points out.

Potentially reusable objects that are functional and still in good condition are then allocated, depending on the material, to the various spaces and shops within the center. In the workshop, staff catalog building and electronic materials – such as TVs and household appliances – record their origin, and weigh both the recovered and discarded items after thorough inspections. The waste is partly recycled, partly used for energy recovery or as construction material, and finally, what remains is sent to landfill.

The building that hosts the resale of building materials – such as doors, windows, sanitary ware, handles, appliances, and so on – occupies a large space ("*It is an old tram station, dismantled and reassembled*", recalls Hogedal), where visitors can easily browse through the shelves and departments. Appliances are displayed switched on and working, allowing for a proper evaluation of their condition and quality.

All products are clearly priced and are often posted on the center's Facebook page, so that potential customers can follow updates on new arrivals and know the prices in advance. Occasionally, new doors or windows can also be found, made available by construction sites due to incorrect measurements or surplus orders: "*New products are put on sale for no more than a third of the price of the new one on the market*", points out Hogedal.

The center also includes an eco-bar and a restaurant which, after opening, quickly became popular among those looking to relax and find affordable items. Alelyckan can be reached from the city center by public transport via a regular bus line.

A training and job placement center was also planned, featuring workshops where simple repairs – especially of bicycles – are carried out. The training center is dedicated to people who face difficulties in accessing the labor market, due, for example, to physical disabilities, legal issues, or drug addiction. "*Since the opening, there were always at least 6 people in the center who could have 6-7 months of training in the center; then some stayed permanently and others took other paths*", Mårtensson recalls.

This social reintegration initiative is still ongoing, providing job opportunities for citizens from disadvantaged backgrounds.

Bicycles are put on sale by Returhuset a couple of times a year (the most

recent was on April 5, 2025), giving a second life to bikes that are still in good condition and only required minor repairs.

The center has received study visits from across Sweden and abroad, and has inspired other municipalities – such as Eskilstuna in Sweden and Capannori in Italy – to replicate its model.

7.1.3. Economic, environmental and social performance

The Alelyckan recycling park in Gothenburg has proven capable of delivering significant economic, environmental, and social results. Compared to conventional recycling centers, it enables progress up the waste hierarchy by reducing both incineration and landfilling and also recycling in favor of reusing many objects that not only remain functional but also retain commercial value.

The center is visited annually by over 30,000 second-hand shoppers and does not place a burden on the municipal budget. From an economic standpoint, the park covers its operating costs through revenues from the sale of used goods – except for the cost of the recycling center itself, which is covered by waste management fees. Emphasizes the Director: "*In the last 10 years, the Center has managed to cover the costs. The revenues come from the rental of sales space and direct sales of the Återbruket*".

Per Hogedal points out: "*In 2024, 8 million kroner (about 720 thousand euros) were made from the sale of construction material to Återbruket and the year before, about 7.2 million (about 650 thousand euros). The trend is growing and obviously depends on the quantity and quality of donated objects to be reused that we receive*".

The environmental impacts were measured in 2011, when an environmental impact analysis was carried out at the initiative of the Recycling Office of the City of Gothenburg. The analysis, conducted by the Swedish Institute for Environmental Research and documented in a detailed report[3], showed that the site had prevented the generation of 360 tons of waste per year – an environmental benefit equivalent to the greenhouse gas emissions of 430 cars each traveling 1,500 kilometers.

In 2010, nearly 500 tons of products and materials were left at Kretsloppsparken to be reused, and just under 30% of them were eventually discarded, either directly at the sorting station or later in the park's shops. This means that, thanks to the park, the amount of bulky waste delivered to the recycling center decreased by more than 5%[4].

[3] *Ibidem*.
[4] *Ibidem*.

Additionally, the report assessed the potential impact of converting all five recycling centers in Gothenburg into circular economy parks, mirroring the model in Alelyckan. This conversion was estimated to prevent approximately 2,200 tons of waste annually, reduce greenhouse gas emissions by 8,000 tons of carbon dioxide equivalent, and lower primary energy consumption by 32 GWh. The latter is equivalent to the emissions from 2,700 cars driven 15,000 km each, or the heating requirements of 1,900 homes. Moreover, had Sweden's more than 600 landfills been transformed into recycling centers, an estimated 80,000 tons of waste could have been avoided, which accounts for over 5% of all waste currently disposed of in landfills.

According to the 2011 report, the waste disposed of at Alelyckan primarily consisted of clothing (24% of the total by weight), furniture (23%), building products (12%), wooden building materials (11%), and metal products (10%).

From the most recent data available, it appears that in the last two years 600 tons of products diverted from landfills and incinerators have been sold. As recalls Per Hogedal, director of the Återbruket: "*approximately last year we received 660 tons of products that seemed reusable and we only threw away about 60 tons, so we are able to sell 90% of the goods selected for resale*".

Finally, from a social point of view, the Alelyckan recycling park contributes to job creation, including opportunities for disadvantaged groups. It also supports sustainable economic conditions for NGOs, which use donated goods to generate income for social initiatives in the city. A total of 15 people work at the recycling center and Återbruket. In addition, there are employees and collaborators working in the second-hand shop run by Stadsmissionen and in the on-site bar and restaurant.

7.2. The contaminations of the Gothenburg experience: ReTuna in Eskilstuna

7.2.1. ReTuna's Story in Eskilstuna

Every year in Sweden, 1.8 million tonnes of bulky waste are disposed of in the country's recycling centres, of which an estimated 18 percent are commercially reusable, not only in traditional second-hand market categories such as clothing and household goods, but also in building products, furniture, pallets and tools[5].

[5] Hultén J., Youhanan L., Sandkvist F., Fång J., Belleza E., Vukicevic S. (2018). *Potential för ökad återanvändning – fallstudie återvinningscentraler, Återanvändbara produkter och farliga ämnen i avfall*.

Starting from these data, the experience of Gothenburg has inspired many municipalities to continue on the path of reuse of goods and materials; as stated by Per Hogedal: "*I believe that many have replicated our model. We've been receiving visitors for 18 years – they come here, see how we do things, and I assume they go on to create something similar*".

ReTuna Återbruksgalleria is one of these initiatives inspired by Gothemburg: it is the first shopping center in the world, built next to the recycling center, entirely dedicated to the sale of recycled, reused and restored items that attracts visitors from all over the world. It is located in Eskilstuna, a city in Sweden about 120 kilometers from Stockholm with over 107 thousand inhabitants. The recycling center is also a reference point for the municipality of Strängnäs, about 30 kilometers away from Eskilstuna. In total, Eskilstuna and Strängnäs outline a local catchment area of about 160,000 inhabitants.

The story of ReTuna began in 2007, inspired by the passion for sustainability of two now-retired individuals who were active in the local community and eager to find a solution to the problem of so many still-usable items being thrown away every day. However, the idea was not immediately realized – it took a few years before it became a reality. The project to open a shopping center for second-hand goods was developed by the Municipality, with the goal of creating a circular and sustainable business model over time. "*Initially, there was no guarantee of success – the first political vote did not pass, and a second vote was needed, which fortunately turned out in favor of the project*", recalls Simon Glimtoft, Director since February 2023 of the ReTuna Återbruksgalleria Shopping Center.

In 2010, the city realized that the only existing recycling center, given the increase in population – which had gone from about 88 thousand inhabitants in 2000 to over 96 thousand in 2010[6] – was no longer sufficient. It was therefore decided to build a second recycling center: in 2012 the project for the construction of the new recycling center was combined with the original idea of 2007 and thus an overall project was carried out to build the two structures at the same time: recycling center and reuse shopping center, side by side. The buildings began to be built in 2014 and then opened to the public in 2015 with the first seven stores in the mall.

ReTuna occupies about 6,000 square meters including shops, warehouses, sorting area, adult school called "Recycle Design", bar-restaurant, area for school materials and common areas.

The property is owned by the municipal energy and waste management company Eskilstuna Energi och Miljö (EEM). The total investment for the creation of the recycling centre and the reuse shopping mall was SEK 85

[6] Source: *www.eskilstuna.se/kommun-och-politik/fakta-statistik-och-kartor/befolkning*.

million (approximately EUR 7.3 million), financed mainly by the municipal company, with a contribution from the Municipality of Eskilstuna. The funds were used to build the recycling centre (SEK 40 million) and to redevelop an adjacent former DHL logistics centre (SEK 45 million).

As Glimtoft points out: "*With this initiative, the municipality aimed – and still aims – to reduce environmental impact through the promotion of reuse and the optimization of waste management, in line with its ambitious environmental and climate goals. These include reducing the amount of waste through reuse, lowering the costs associated with recycling, and supporting environmental objectives such as cutting the Municipality's carbon emissions by 80% by 2030 and achieving effective climate positivity by 2045*".

ReTuna, given its public ownership, does not intend to prohibit or discourage the purchase of new products, nor to hinder traditional retail or negatively impact the local economy. Emphasizes the director of ReTuna: "*Our goal is to encourage people to think twice before making a purchase by asking two key questions: 'Do I really need this?' and, if the answer is 'I want it', then 'Can I find it second-hand?'. We encourage people to look for used goods first, and only buy new if the second-hand option isn't available – favoring quality products in that case. Ultimately, we are not asking people to stop shopping, but to adopt a more conscious and sustainable approach to consumption*".

ReTuna can be reached by a city bus that runs approximately every 20 minutes. An electronic display at the entrance shows the bus schedule, allowing customers to shop with peace of mind, knowing in advance when they need to leave to catch their ride home. A large parking lot is also available for visitors arriving by car.

7.2.2. The Business Model

ReTuna's business model works and is sustained thanks to donations from citizens who, instead of throwing away unwanted items, choose to give them away so they can be reused by those in need. Private individuals and companies visiting the recycling center next to ReTuna – or any of the four other centers in the city – have the opportunity, before disposing of their waste, to drop off for free any items they believe can be reused, in a large covered area.

Every day, many people are welcomed by at least three or four staff members, who help them unload their cars and trailers and thank them for their donation. There are also additional incentives: companies, for instance, pay a disposal fee only when they drive up the recycling center ramp to

separate waste destined for traditional recycling – a process that is free of charge for private individuals. "*Donating to ReTuna comes at no cost, so companies are encouraged to set aside reusable items*", the director explains. If the items are reusable, staff members take them in and transport them to the sorting center, where other employees quickly sort them by category and make them available for selection by ReTuna's shopkeepers. The sorting staff is highly trained and able to assess the resale potential of donated goods and clothing, as well as to allocate them appropriately to the various stores within the shopping center.

Director Glimtoft emphasizes: "*In my opinion our success is based on three key factors: supportive policies, solid funding and financial planning, and efficient logistics. People are already used to driving their cars or small trucks to recycling centers to dispose of items like toys, furniture, and more. They already have a destination in mind. So, placing the shopping center right next to the recycling center makes the process very simple – it's easier to unload reusable materials and choose to donate them instead of throwing them directly into the containers. Moreover, there is an incentive to leave items with us, because our staff is available to help unload vehicles – something that doesn't happen when disposing directly into a container. There's also an important psychological aspect. We want people who donate to us to receive something in return, and that something is primarily pride. We always thank donors so that they feel they've done something good and experience a sense of satisfaction. We also want them to feel proud of ReTuna. This brings us to another initiative: we interviewed our shopping center customers and found that all of them intend to return or bring someone else with them. This is an extraordinary result*".

At ReTuna, as in any shopping center, several shops operate: they are private companies that rent space for their commercial activities. The rent they pay helps cover the center's operating costs. To lease a store, prospective tenants must present a solid business plan, detailing the type of store (e.g., sports, electronics, clothing), the products they intend to offer, the planned assortment, and their expected needs for restocking items through donations and reuse.

The rent of the shops includes access to all the material that is donated to the reuse center and that can be resold, so the stores stock up for free and have no costs for the purchase of raw materials or goods. However, to ensure fairness among all tenants, any item coming from outside and intended for sale inside ReTuna must necessarily pass through the sorting center. The only external purchases allowed are those of spare parts necessary for used products to be repaired. Says the director: "*Without this procedure, it would be easy to create an unfair situation – especially if one shop were to collaborate externally and end up competing with*

the others. Our centralized distribution system ensures that all shops have equal opportunities to access materials. However, it is permitted to purchase external components if they are needed to repair or refurbish items received through our system. For example, if an electronics shop receives non-functioning equipment, it can purchase the necessary spare parts to repair and resell it. On the other hand, citizens are not allowed to bring items directly to the shops. All materials must go through our sorting center so that we can manage their distribution to the various stores in a fair and controlled manner".

Figure 7.1 – The entrance to the ReTuna shopping center and a glimpse of the interior

Source: photo by the Authors

The shopping center also hosts an IKEA store, which receives furniture and items produced and sold by the Swedish multinational. "*ReTuna was the site of IKEA's first reuse experiment*" Glimtoft proudly recounts. Today, IKEA stores feature the "Circularity Corner" which – through the "Bring Back and Resell" service – allows customers to return their used furniture in good condition in exchange for a voucher toward future purchases at IKEA. At the same time, customers can buy affordable second-hand furniture at reduced prices.

In ReTuna there are now 16 shops and 22 different economic operators operate there. In addition to the shops, the center also hosts a school for adults called "Recycle Design", where it is possible to study for a year learning techniques for working both soft materials, such as fabrics, and hard

materials, such as wood and metal. There is also a conference center to host local companies and politicians for their meetings.

All of Reduna's spaces are furnished with donated furniture and objects. Even for the school, equipment and materials come from donations.

Each shop in ReTuna can fill out a "wish list" in which it specifies the type of material it needs. The staff at the sorting center selects the donated material and distributes it to the various stores and organizations based on these requests.

Says Glimtoft: "*Once we receive the donated material, we decide what type of store will receive it, with the aim of always being fair. For this reason, the selection is not made directly by the stores, but by our staff. This system ensures an equitable distribution of material and minimizes potential conflicts. Subsequently, the material is selected by the stores, which have the freedom to choose whether to keep it in stock, display it for sale or discard it. In the latter case, the material follows the next path in the waste management hierarchy, which is recycling*".

Continues Director Glimtoft: "*My role as mall manager also includes ensuring a wide variety of products are available. This serves both to meet customer expectations – who want to find certain items in specific seasons – and to ensure store profitability. If a store doesn't offer the right products at the right time, sales decline and profits drop*".

Visitors should perceive ReTuna as a real shopping mall – a place where they can find a wide variety of shops with different assortments all in one location. The basic idea is that, when someone visits ReTuna, they should know exactly where to go based on what they are looking for. Emphasizes the director: "*if they need a computer, they go to the electronics store, if they look for clothes, they go to the clothing store, if they need toys, they go to the children's store. We want to recreate as much as possible the experience of a normal shopping center. We also make sure that each store has its own identity and offers specific services, just like a traditional store would: for example, in the sports and leisure store you can rent skis or have ice skates sharpened, and in a furniture store you can find different options for home décor*".

Among others, ReTuna also hosts a store that gives new life to used furniture and home décor through creative reuse and upcycling, offering customers a sustainable way to furnish their homes. "*It is possible, for example, to change the color of the purchased sofa or have it restored*", emphasizes the Director.

ReTuna has a large warehouse, where each store has its own storage space, for which it pays a subsidized rent. This warehouse is essential, because during the winter recycling centers usually receive summer items and, vice versa, during the summer winter items arrive. It is necessary to store these

products in order to be able to sell them in the most appropriate period. Says Glimtoft: "*This serves both to meet customers' expectations – who look for certain items during specific seasons – and to ensure the profitability of the stores. If a store doesn't have the right merchandise at the right time, its sales may suffer and it may struggle to generate profit*".

ReTuna also hosts a reuse center aimed at serving kindergartens and elementary schools within the municipality. Glimtoft points out: "*We ensure that all materials made available free of charge are free from toxic substances and harmful chemicals, guaranteeing their safety for use by children. Experienced staff work in this space who select only what guarantees absolute safety. Schools and teachers can come and take everything they need to spark creativity in their classrooms for free. This initiative saves municipal schools millions of kroner in purchase costs, reduces carbon emissions and promotes a more creative environment for children, who learn to collaborate better and have more fun with materials that are safe to use*".

Since the municipality's logistics center, which delivers food to school canteens, is located next to ReTuna, an additional service is offered to schools: "*if teachers cannot bring back the boxes with the material previously taken, they can ship them together with the canteen food and return them free of charge with carbon-neutral transport, therefore*".

Like any shopping mall, ReTuna also has a bar and restaurant that welcomes visitors. At lunch, a buffet is also offered with typical local dishes at a fixed price with an "*all you can eat*" formula and free fresh water through a dispenser available to customers.

The director is constantly seeking new collaborations with local businesses and organizations that can help create new channels for reuse. For example, a partnership with a construction company is currently being tested to find a use for donated building materials.

The business model is easily replicable; every year, the director meets with people from all over the world who are interested in learning about the model and how it is implemented: "*I accompany them on visits, explain our model to them and illustrate our work with total transparency, with the aim of making it replicable*". For example, as a result of visits and contacts, in Östersund, in the north-central part of Sweden, a shop was opened next to the recycling center that is inspired by ReTuna although on a smaller scale and the same happened in Denmark. The first ReTuna-inspired center will soon be opened in Finland as well.

7.2.3. Economic, environmental, and social performance

ReTuna was created and developed around the idea of encouraging and enhancing reuse, reducing the need and costs of waste management[7] and recycling. As Simon Glimtoft says: "*Our main aim is not to generate profit for the municipal company or the municipality, but to create an environment in which the various stores can operate profitably, prosper, and grow their businesses. This, in turn, allows them to create more jobs, contributing to both economic and social development. At the same time, we divert goods worth over €2.3 million per year from landfills and incinerators*".

When ReTuna opened, one of the main concerns was the risk of competing with the other existing second-hand businesses in the city. Glimtoft recalls: "*We have decided to invite all second-hand stores to open their stores inside ReTuna. Some accepted and opened here, while others preferred not to. Unexpectedly, the opening of ReTuna had a positive effect on the entire second-hand market: more people started buying second-hand items, and as a result, sales of the pre-existing stores also increased in their original locations*".

Another initial concern was that there wouldn't be enough material to supply the shops and organizations at ReTuna. However, this concern proved to be unfounded. Says Glimtoft: "*The number of items people donate is incredibly high – we are constantly in a state of abundance. In the following years, our main goal therefore became to increase the amount of material we could actually reuse, as at first we weren't able to handle everything that was donated*".

As of February 2023, ReTuna was able to reuse around 40% of all items people left behind; the rest of the material was destined for traditional recycling. Currently, the reuse capacity has increased significantly, reaching a rate of 70%. As Glimtoft said: "*This means that we are able to breathe new life into 70% of everything that is delivered, which is a very impressive amount. For this reason, we always encourage people to visit in person to truly understand the scale of this volume. Our ultimate goal is, of course, to reuse 100% of the material. However, another important objective is to progressively reduce the amount of incoming material. Ideally, we would like the rate of consumption to stabilize and normalize at more sustainable levels – which would mean receiving fewer items, but still enough to sustain our activities. At the moment, given our current consumption habits, I believe it will still take years before we reach a point where the amount of reusable items actually begins to decline. I believe the European Union has a crucial*

[7] According to data provided by the director of ReTuna, families in Eskilstuna pay an average of 218 crowns per month for waste management, equal to about 20 euros.

role to play in ensuring the implementation of proper regulations for both consumers and producers".

ReTuna is working on implementing artificial intelligence to accurately quantify the volume of material being reused and the percentage that is recycled. Once completed, the project will make it possible not only to count the number of donated items, but also to calculate the amount of carbon emissions saved.

ReTuna today has about 360 thousand visitors a year, about 30 thousand a month, an average of a thousand a day. The shopping center has about 12 thousand transactions per year, with annual increases in attendance and transactions of about 10-15%.

The recycling center, on the other hand, has about 170 thousand visitors a year; therefore, the director proudly points out: "*there are in fact more people shopping in the shopping center than people donating things*".

Most visitors are local residents. However, during peak tourist seasons, such as summer holidays, 50% are local visitors and 50% are from Stockholm, neighboring municipalities and, frequently, also from abroad.

ReTuna also receives about 120-140 study visits a year, "*from those interested in replicating our model*" the director points out, with an equal division between international and national visitors. Since 2020 it has been included in the Guinness Book of Records.

From an economic point of view, Glimtoft recalls: "*in the first year, with only seven stores, ReTuna could not cover its costs. The basic idea, however, was to invest in the future, with the prospect that the reduction of costs related to recycling and the increase in activity would lead to break-even over time. Fortunately, we had a very high turnout of customers and a great media response at national and international level (with visits and articles from CNN*[8]*, BBC*[9]*, Daily Mail*[10] *etc.). This media visibility was followed by numerous study visits and all this made the structure a real attraction of our municipality, consequently attracting even more shops*".

In 2019, ReTuna reached enough rent-paying stores to start covering costs, becoming financially self-sufficient. The operating costs of the shopping center now amount to about 6 million crowns per year (about 540,000 euros). As the director of ReTuna recalls: "*the primary objective is to cover expenses, but also to ensure the financial sustainability of our tenants, while keeping rents low: 1,500 crowns (about 140 euros) per square*

[8] *edition.cnn.com/2019/06/03/world/retuna-shopping-mall-sweden-only-sells-recycled-items-intl/index.html*.

[9] *www.bbc.com/news/stories-47001188*.

[10] *www.dailymail.co.uk/femail/article-6677793/Inside-worlds-recycled-shopping-centre.html*.

meter per year for a shop and about 750 crowns (about 70 euros) per square meter per year for the warehouse. From the rents of shops and warehouses, ReTuna earns about 6.2 million crowns (about 560 thousand euros). Today it is therefore economically sustainable".

With reference to sales, the ReTuna center, through its stores, in 2020, during Covid, recorded sales of 15.1 million crowns (over 1.3 million euros). Two years later, in a context of greater social freedom, sales rose to 20.1 million kronor (1.8 million euro). The growth trend has continued in recent years: in 2023, the volume of sales reached 23.3 million crowns (over 2 million euros), and last year it stood at 26 million crowns (over 2.3 million euros). Says Glimtoft: "*In 2025 we are already observing a further increase in sales. This indicates growth in the second-hand market. Despite potential negative influences from politics and inflation, we are seeing more people choosing to buy sustainably, leading to annual growth in the second-hand sector of around 10-15%. This trend suggests that reuse can generate new employment opportunities, allowing the economy to continue functioning while offering more sustainable solutions – helping to offset job losses in other sectors*".

Currently, 83 people work at ReTuna – a significant increase from the 20 employees at the time of its opening. Approximately 60% of the workforce is employed in the shops, 20% work in the sorting facility, and 10% in the recycling center. The remaining staff is responsible for administrative tasks.

The center could expand further in the future: as Glimtoft points out: "*the exclusive ownership of the building – which currently also houses two logistics companies – gives us a significant advantage: the possibility of expanding our shopping center by 7,000 to 8,000 square meters in the future*".

There are still areas that could be improved to further promote reuse. First and foremost, taxation on second-hand items could be reduced, to avoid taxing the same object multiple times. This would allow for higher profit margins for those involved in the resale of used goods, making these businesses more financially stable, better positioned to grow, and able to hire more staff. An example comes from IKEA's experience in ReTuna, which resells its used products brought and donated to the recycling centre. The director points out: "*IKEA applies new barcodes to all products, registers them at the time of sale, and if the exact same item is returned, they re-register it to track resales. Over three years, some items have been resold up to five times. This means that both our customers and shops end up paying tax on the same item multiple times. Considering the high cost of unemployment for our country, a reduction or elimination of second-hand taxes could lead to the creation of new*

jobs, thus compensating for the loss of tax revenue with the reduction of unemployment benefits".

ReTuna is publicly owned and is therefore subject to all regulations concerning publicly owned companies, including bureaucracy.

"*This involves significant constraints. We can't compete aggressively with the traditional consumer market, which limits our ability to promote ourselves as strongly as we'd like. We are subject to strict regulations that state that only companies approved by the municipality or by our own company can carry out certain constructions within our area. This can result in higher costs, due to lack of competition, or longer lead times. In addition, our public nature requires us to manage our finances extremely prudently, always acting in the interests of our citizens and taking every decision with a long-term view. If we had been a private company, we would have been able to solve many problems more quickly*".

ReTuna's public experience therefore shows that even a public company that has a different *core business* (energy and waste) can achieve an innovative and sustainable commercial management experience: "*We want to show the private sector that this model is feasible – and that if we can do it, it should be even easier for them*", Glimtoft points out.

7.3. The contaminations of the experience of Gothenburg: Daccapo in Capannori, Tuscany

7.3.1. The history of the Capannori reuse center and the stages of its development

The "Capannori model" for the management of urban waste and the implementation of best practices in waste reduction and reuse has over time become a subject of study at both national and international levels. Many other Italian municipalities – and even countries as far as Tunisia and Brazil – have shown interest in learning about and, where possible, replicating the good practices implemented in this Tuscan municipality in the province of Lucca[11].

The company that deals with waste management in Capannori is an in-house company called Ascit Spa, which has been part of the Retiambiente group since 2021[12].

[11] See also Romano G. (2022). *La gestione dei servizi pubblici: governance, regolazione, criticità e opportunità*, FrancoAngeli.

[12] As can be read on its website, "*RetiAmbiente is the sole manager of the integrated waste cycle within the perimeter of the Optimal Territorial Area (ATO) Toscana Costa and – in terms*

With over 40 years of experience, Ascit operates in the waste collection and disposal sector across twelve municipalities in the province of Lucca, through a direct assignment. The company serves a population of over 100,000 residents in the Lucca area, with Capannori being the largest municipality among those served.

In 2005 the Municipality of Capannori and Ascit pioneered door-to-door collection in some areas of the municipal area. Two years later, in 2007, for the first time in Italy, the municipal administration of Capannori launched the Zero Waste Strategy theorized by Paul Connet[13] and supported by local activists, through the adoption of a formal resolution of the city council.

The Zero Waste strategy outlines a ten-step approach aimed at achieving the goal of sending no waste to landfill. The ten steps are:

1. separation at source through separate collection;
2. door-to-door collection (DTD) of separated waste;
3. composting through the construction of a composting plant;
4. recycling through the construction of plant platforms for the recovery of materials;
5. the reduction of waste through home composting, the replacement of single-use products, the use of tap water and products such as tap milk;
6. reuse and repair by creating centers for the repair, reuse and deconstruction of buildings;
7. pay-as-you-throw tariff by charging users on the basis of the actual production of non-recyclable waste and rewarding the virtuous behavior of citizens, encouraging them to make more informed purchases;
8. the recovery of waste in plants that treat unsorted waste, to recover materials, stabilize the residual organic fraction and prevent toxic waste from being sent to landfills;
9. the research and redesign centre, to carry out residual waste analysis, encourage the industrial redesign of non-recyclable objects, provide information and raise awareness among businesses and promote good practices;
10. zero waste, maintaining a small residual share of waste to be disposed of in controlled and carefully managed landfills.

of economic and financial size and catchment area – is the second operator in Tuscany and sixth in Italy in the environmental hygiene sector. It is a joint-stock company with total public capital, owned by one hundred municipalities in the provinces of Pisa, Livorno, Lucca and Massa Carrara".

[13] Connet P. (2013). *The Zero Waste Solution*, Chelsea Green Publishing. See also Romano G., Marciano C., Fiorelli M.S. (2021) *Best practices in Urban Solid Waste Management: Ownership, Governance, and Drivers of Performance in a Zero Waste Framewor*k, Emerald Publishing.

The Zero Waste strategy signed by the Municipality of Capannori committed the town to a goal of progressively reducing waste, by reimagining it as a resource rather than as waste.

The councillor for the environment of the Municipality of Capannori at the time, Alessio Ciacci – now a well-established expert in urban waste management at the national level – promoted the adoption of the Zero Waste strategy and the experimental introduction of door-to-door waste collection. He also supported the idea of creating a reuse center, inspired by the example of Gothenburg, Sweden.

Ciacci recalls: "*It was an idea shared together with the zero waste research center that had been created in Capannori, together with the 'zero waste' activists led by Rossano Ercolini*[14]*. In 2010 we went to visit the Kretsloppsparken Alelyckan center in Gothenburg, a state-of-the-art reuse center. With the adhesion to the zero waste strategy, in 2007, the issues of reduction and reuse were put on the agenda, so we did not encounter resistance from the Municipality and the Ascit company towards the implementation of the steps that had already been approved by the city council by a large majority*".

The first reuse center was established in Lammari, on a site made available by Ascit, by renting an abandoned warehouse. Ciacci recalls: "*The area was 1,000 square meters, and from the very beginning, it was planned to allocate 600 square meters to a recycling drop-off center and the remaining 400 to reuse. Thanks to an association and its volunteer network, this initiative was launched in 2011 next to the Salanetti recycling center, and it immediately achieved the hoped-for success: in fact, many solidarity-based initiatives for collecting used items and clothing – made available to those in need – had already emerged in the area*".

The inauguration was also attended by Pål Mårtensson, then coordinator of the Swedish reuse park, highlighting the collaboration between two geographically distant realities united in promoting good practices.

Inspired by the Swedish center, the volunteers would often position themselves near the entrance to the recycling area to check and intercept items that could still be reused. Volunteers and staff were then responsible for organizing the warehouse, which was structured into "thematic areas", as well as the emporium, where clothing, shoes, children's toys, cutlery, plates and glasses, and appliances were displayed.

Starting the following year, in 2012, the councillor for the environment of Capannori supported the project to expand the range of services by opening artisan workshops in carpentry, tailoring, and shoemaking, and by launching training and work programs focused on recycling and repair.

[14] Ercolini R. (2018). *Rifiuti zero: Dieci passi per la rivoluzione ecologica*. Baldini & Castoldi.

In 2013, the Municipality of Capannori introduced a pay-as-you-throw system – an innovative method at the time – for waste collection and disposal services. This system aligns with the "polluter pays" principle, charging higher fees to users who generate more non-recyclable waste requiring disposal.

In the same year, due to the frequent arrival of still-usable items and the growing number of people in need – as well as those interested in making sustainable and solidarity-based purchases – two additional reuse centers were opened.

The first, located in the hamlet of Coselli, is structured as an emporium accompanied by tailoring, decoration, and carpentry workshops. The second center, located in Pontetto, serves the same functions as the Lammari reuse center, with a warehouse and a repair and re-creation workshop.

In March 2014, these initiatives converged into the broader Daccapo project, aimed at addressing the social and environmental needs of the area, while adhering to the "Zero Waste" strategy and receiving support from the Archdiocese of Lucca and the Caritas Pastoral Office.

The Daccapo project has deep roots, particularly in the commitment of the association *Listen to My Voice* (Ascolta la Mia Voce), which was born in a parish context and has been active since 2003 in supporting people in vulnerable situations and in recovering used goods for solidarity purposes.

A strong partnership was thus established between the association, the Archdiocese of Lucca and its Caritas pastoral office, the Listening and Distribution Center of the Parish of Monte San Quirico, the waste management companies of Lucca and Capannori (Sistema Ambiente and Ascit, respectively), and the Municipalities of Lucca and Capannori. This gave rise to a "solidarity reuse system" developed across three sites, each adjacent to a recycling station located in the Municipalities of Lucca (Vicopelago – Pontetto) and Capannori (Lammari and Coselli).

The Daccapo reuse centers are currently managed by the *Listen to My Voice* Association and the Nanina Cooperative. The cooperative is named after the small hen known for incubating not only its own eggs but also those of other animals – a symbol of its mission to "hatch and nurture experiences of good". This mission includes not only recovering materials and preventing them from being discarded, but also promoting social inclusion by creating pathways to employment and support for disadvantaged individuals, such as people who have lost their jobs, civil service volunteers, individuals eligible for alternative sentencing, and others facing hardship.

Nanina is a social cooperative founded in 2018 with among its founding members the volunteers engaged in Daccapo, the associations "Listen to my voice" and "Quindi", and has the support of the Archdiocese of Lucca. It is based in Lucca, in whose province it mainly carries out its activity. The

cooperative has a Board of Directors composed of seven members, three males and four females, of which two worker cooperator members and five voluntary cooperator members. Both President and Vice-President are two women. The Association "Listen to my Voice" and the Association "Quindi", each express one director within the board of directors. In addition to the activities of the Daccapo reuse centers, a "proximity economy" service has also been developed. This service connects the supply and demand for small household jobs that neighborhood residents may need – such as fixing a leaking pipe, painting a room, or repairing a light switch. The service is offered by individuals who have the skills to carry out these tasks but are temporarily unemployed.

The *Listen to My Voice* Association is based on volunteer work and has been active in the province of Lucca for over 20 years. Inspired by the desire to put the Gospel into practice, the association began two decades ago by supporting people in need through the collection and free distribution of furniture, household items, and clothing. It has played an active role in the creation of both the Daccapo project and the Nanina cooperative.

7.3.2. The Business Model

The three Daccapo reuse centers collect furniture, household items, and clothing that are still usable, preventing them from becoming waste and giving these objects a second life.

The centers were inspired by the Gothenburg model and were therefore located near three recycling stations managed by Ascit and Sistema Ambiente – the companies responsible for urban waste management in the province of Lucca. These companies provide, free of charge, the premises needed for the reuse centers (with the exception of the most recent one in Coselli, where part of the space is rented by the Nanina Cooperative from private owners).

Items found at the reuse centers are either brought directly by individuals who wish to dispose of them – instead of accessing the recycling station – or collected from homes by volunteers from the association and the cooperative.

The Daccapo project was created and developed with the support of the municipalities and waste utilities, based on the belief that it could carry out an activity capable of simultaneously reducing the volume of waste to be disposed of while providing solidarity-based support to those in need. Over time, the two centers in the Municipality of Capannori have become more specialized: the one in Lammari focuses on clothing and small household items, while the center in Coselli houses furniture and wooden objects.

Now well known in the area, the Daccapo project is frequently contacted by citizens via phone or email regarding bulky items that are still in good condition. The team arranges home collection of these items, requesting only a small reimbursement for expenses.

The objects donated to the three reuse centers of the Daccapo project are made available to those who may need them: free of charge, for those who are in economic hardship thanks to the "Listen to My Voice" association, or through the payment of small prices for all other interested visitors. Access to the goods in the reuse centers is coordinated with the Caritas listening centers and the social services of the Municipalities of Lucca and Capannori.

For individuals in need, those who present documentation at the beginning of the year certifying that their household's Equivalent Economic Situation Indicator (ISEE) is below 10,000 euros can, after making a phone appointment, select items free of charge once a month – up to ten clothing items per family member and up to six household items.

All items are displayed following a careful selection carried out by the many volunteers and 30 staff members, including 20 from the cooperative and 10 from the association.

Clothing products for sale are priced on average at 1-2 euros per garment. In 2023, Daccapo centers were visited by about 7,000 people. In the same year, around 300 families received free home furnishings.

Initially, the donated clothing also found an alternative destination capable of creating another revenue stream for the solidarity activities of the Association and Cooperative: the collection by companies in the Prato district. As some volunteers from the Lammari center say: "*Unfortunately, with the drastic decrease in the quality of clothing in circulation, often made with artificial fibers instead of wool and cotton, this destination has decreased until it disappeared. While in the past donated garments were more often of good quality and made from materials that companies could collect and reuse, today we increasingly see almost new clothing made from such low-quality materials that it is often difficult even to give them away – and disposal becomes the only option*".

Among the furniture, there are many valuable objects for sale for a few tens of euros each, in solid wood or decorated by hand, which are increasingly also rented for shows or event set-ups.

In addition, in the Daccapo headquarters in Coselli, there are currently three workshops: a bicycle workshop (called *Pedala*), which repairs bicycles and assembles new ones from recovered pieces, a tailor's shop (called *Quindi*) that carries out repairs, sews clothes for every occasion, but above all for theater and furniture and a carpentry, which takes its name from the overall project, Daccapo, who, in addition to restoring the wooden objects

and furniture collected as donations, designs and manufactures new ones with recycled wood.

In recent years, both the partner municipalities, Lucca and Capannori, and other local and Tuscan activities, such as the Teatro del Giglio, have commissioned some activities from the workshops, the proceeds of which contribute to the economic support of the solidarity initiative: the creation of wooden composters to be used in restaurants in the Capannori area, the making of stage clothes for some theatrical performances, the preparation of a stock of bicycles to be allocated to guests of local reception centers and so on.

7.3.3. Economic, environmental, and social performance

Since the early years after their inauguration, the Daccapo system reuse centers have demonstrated that they actively contribute to recovering items still in good condition, diverting them from landfills and incinerators. They also continue to positively support the chain of circulation and transmission of good practices that began in Gothenburg. In fact, within the first few months of operation, delegations from other Italian municipalities began visiting, interested in seeing concrete examples of reuse initiatives implemented in Capannori[15].

The initiative has always placed great importance on reporting, in order to justify the contribution made each year by municipalities and utility companies, which provide the spaces used for these activities free of charge. Ciacci argues: "*Through transparent reporting, citizens understand that reuse is not a cost to the community. They see how these enormous flows of items – which should not be treated as waste – are instead recovered. As a result, not only are disposal costs avoided, but social value is also created through solidarity initiatives that support those in need*".

Past reports had already highlighted the large quantity of recovered items. In fact, the former councillor wrote in September 2012: "*Since the beginning of the year, more than 41 tons of furniture and appliances have already been recovered and therefore diverted from landfills. These items were repaired by the center's staff and distributed to citizens, particularly those belonging to the most vulnerable segments of the population. Chairs are the most in demand: 104 have been delivered, totaling over 620 kilograms. Wardrobes are also highly requested (43 units for 4.3 tons), along with beds (42 for a total of 1 ton), mattresses (40 for 1.2 tons), sofas (39 for 2.3 tons), and, among*

[15] *www.ciaccimagazine.org/successo-per-il-primo-anno-del-centro-del-riuso-al-via-il-piano-per-il-potenziamento/.*

household appliances, TVs (42 units for 1 ton), refrigerators (10 for 400 kilograms), and washing machines (7 for 500 kilograms). The Reuse Center also offers clothing – especially jackets and shoes – as well as tablecloths, sheets, towels, and carpets. Other types of items for children are available too, such as strollers, playpens, walkers, and high chairs, along with stoves and bicycles"[16].

In 2012, the Reuse Center distributed 93 tons of clothing and furniture to the most vulnerable groups of citizens – nearly 1,700 clothing items and over 1,500 household items[17]. Already in the following six months, the numbers showed a growing interest in the initiative.

In the first half of 2013 alone, the center collected 59 tons of goods, with a particularly strong increase in clothing donations: 15.9 tons were recovered in just six months, surpassing the 13.5 tons collected throughout all of 2012.

There was also a noticeable increase in furniture donations: 43 tons in the first six months of 2013, compared to 79.5 tons during the entire previous year[18].

Since that period, the environmental impact has grown steadily also thanks to the many information channels used, from parishes to social workers, from a communication agency that collaborates with Caritas, to the two waste utilities Ascit and Sistema Ambiente, to the use of social networks, such as Facebook where photos and prices of some available items are highlighted. In addition, the "All you can dress" initiative is periodically organized, which allows citizens to buy a bag specially made by the tailor's shop of the reuse center that can be filled as long as possible by paying a fixed price of 28 euros.

In fact, in the latest social report presented by the Nanina cooperative, it is stated that in 2023 the Daccapo centers recovered "*furniture and other material for almost 100 tons and over 50 tons of clothes*", highlighting how the activities of the centers have "*a big impact by reducing the amount of waste, but also for the dissemination of the culture of recycling and reuse, raising awareness of environmental sustainability and the circular economy*". The reuse centers of the Daccapo system had about 7000 accesses in 2023.

In 2024, the annual report on the activities of the Daccapo system shows that about 210 tons of goods have entered, of which about half are clothes and the other half are furniture, taking into account that it is not possible to quantify the weight of plates, glasses, small appliances and so on, which

[16] *www.ciaccimagazine.org/cresce-sempre-piu-il-centro-del-riuso-di-capannori/.*

[17] *Ibidem.*

[18] See Il Tirreno (2013, August 10). *Centro del riuso, in sei mesi prese 59 tonnellate di merce*. Edizione di Lucca.

are brought to the centers and continue to increase over time, reaching the weight of many quintals. In addition, over 150 bicycles have been repaired and distributed or sold. Of the materials collected, 44% of the clothes were disposed of by handing them over to the collection of used clothes and only about 8% of the furniture was delivered to the drop-off points.

From an economic point of view, revenues come primarily from public and private contributions, while most of the costs are related to labor – reflecting the cooperative's strong social mission. In 2023, it recorded a modest profit of around €4,800.

The reuse centers, relying solely on employees and the proceeds from selling donated goods, are not financially self-sufficient. This is partly because they are designed primarily to offer social support to those in need and to implement the Zero Waste strategy by recovering materials and diverting them from landfills and incinerators.

Volunteer work continues to play a crucial role in their operations, enabling proper selection and display of donated items in the available spaces. The workshop activities also rely heavily on volunteers. As the President of the Association "Listen to my voice" recalls, "*our activity was born from the thought of helping others, of listening and then providing concrete help, following the teaching of the Gospel*".

In fact, the reuse centers follow the path of free of charge as a priority, even if they do not exclude the possibility of obtaining revenues from sales and services offered. "*Recovered items are primarily allocated to people in need*", said the volunteers of the Lammari center, linked for decades to the solidarity initiatives organized by the Parish of Monte San Quirico and the Daccapo centers.

In fact, the latest report of the Daccapo centers shows that in 2024, 15% of clothes and 32% of furniture were distributed to people in need free of charge (296 families for clothes and 179 families for furniture). The offers received concerned only 6% of the clothes and 18% of the furniture. Giulia Mariani, the President of cooperative, recalls: "*The bicycles arranged, for example, can have a price ranging from 30 to 60 euros. We are trying to brand them, especially for the supply of multiple vehicles in order to also enhance the social message linked to the purchase of these objects, but help is always in first place. For example, I have just delivered a bicycle to a lady who did not know how else to reach her workplace*".

With regard to social impact, the Daccapo reuse centers – through the activities of the Nanina Cooperative and the *Listen to My Voice* Association, which manage them – aim to represent "*that outstretched hand each of us would like to know we can count on in times of hardship*" emphasize Presidents Mariani and Pace.

As can be read in the latest social report of the Nanina Cooperative, relating

to 2023, "*many of the services carried out by the cooperative are placed alongside the action of the public administration, producing significant savings in resources, particularly with regard to the adaptation of housing. Measuring only the free delivery of furniture to about 300 families, a value of over 450,000 euros can be considered; equally significant is the cost that the public administration would have to bear for the people who work for us, it is certainly a figure of more than 150,000 euros per year*".

In fact, in 2024 the Daccapo centers welcomed six people who carried out public utility work under the "probation regime".

Today about 30 people find stable employment between the cooperative and the association. The cooperative has 20 employees, 15 of whom are people in situations of physical or mental disadvantage, former drug addicts, rehabilitated after prison. The employment pathway begins with training courses, as Mariani points out, "*followed by personalized support for each individual, taking into account their personal aptitudes. We try to guide and support these people with an individual plan, developing a tailored path. We've had several people who started their personal journey with us and later moved on – either because they found other jobs or started their own businesses, such as becoming nautical carpenters or tailors*".

8.

Pay-as-you-throw tariff and stakeholder engagement to increase separate waste collection: the Ecoambiente Rovigo case[1]

8.1. The history of Ecoambiente and the stages of its development

The company Ecoambiente Srl was established on 24/08/2012 (effective as of 31/08/2012) following the signing of the deed of merger between the two companies that managed the integrated urban waste cycle in the province of Rovigo: ASM Ambiente Srl and Ecogest Srl.

The former operated exclusively in the provincial capital, the Municipality of Rovigo, which was also its sole shareholder. Ecogest, on the other hand, managed waste services in the rest of the province and was indirectly owned by the other 49 municipalities through the RSU Consortium.

With the establishment of Ecoambiente, the province of Rovigo created a single provincial company to manage the integrated waste cycle, entrusted with providing the service under an "in-house" model. In 2024, Rovigo became the first province in Italy to adopt a single Economic and Financial Plan (PEF) and a unified pay-as-you-throw tariff system to replace the so-called TARI tax, with pricing and collection managed by the company rather than by individual municipalities.

The transition to the new tariff model was supported by a structured communication plan, which included over one hundred public information sessions held across the provincial area and addressed to citizens, local administrators, and municipal technicians.

Ecoambiente serves an area of about 1,800 square kilometers distributed

[1] This chapter was written by Giulia Romano. For the realization of the case, interviews were carried out in the period March-June 2024 with the Chairman of the Board of Directors Pier Paolo Frigato, the Vice President Chiara Turolla, the CEO Adriano Tolomei, the Technical Director Walter Giacetti; in addition, the President and the Director in office of the Rovigo Waste Basin Council, Vinicio Piasentini and Giovanni Biagini, respectively, as well as the previous President and Director of the Basin Council, Gino Alessio and Monica Bettiol, were interviewed. Some interviewees were interviewed more to better explore some issues.

over 50 municipalities, where over 220 thousand inhabitants reside and with 1.5 million annual tourist presences. Its main assets are vehicles, collection centers, three operational bases, a warehouse for logistics and workshop, a mechanical biological treatment plant and a landfill.

Ecoambiente holds 100% of the shares in Polaris and a 2% stake in Polesine TLC. Polaris operates in the field of special waste management, including the collection, recovery, and disposal of waste, asbestos handling, bankruptcy clearances, and related services such as waste brokerage. Polesine TLC, on the other hand, is active in the installation and management of broadband and fiber optic networks in the Polesine area.

As former CEO Adriano Tolomei states, "*the company aims to be a key player in the region, capable of offering an integrated service where innovation and digitalization are central*".

The capital of Ecoambiente – as well as that of the two pre-existing companies – has always been entirely held by public shareholders, who exercise a form of control comparable to that exercised over their own internal departments. recalls Gino Alessio, former president of the Rovigo Waste Basin Council and former mayor and current councilor of Villadose municipality: "*In the past, there was some push toward a mixed model, with some mayors attracted by the possibility of securing funds through a potential tender for the sale of capital shares. However, the main motivation of these mayors was the desire to establish a point of comparison with the in-house model*".

The establishment of the Basin Council in 2019 – following Regional Law 52/2012, which identified it as a contracting authority distinct from the municipalities – was a crucial first step for Ecoambiente. Equally important was the assignment of regulatory responsibilities at the national level to ARERA, the Regulatory Authority for Energy, Networks and the Environment[2]. Tolomei recalls: "*The process followed for the province-wide unified management project was as follows: approval of the area plan, approval of the industrial plan, and in-house assignment with a system-wide vision and the goal of implementing projects gradually, in line with the specific characteristics and complexity of the territory*".

In the first years of activity, the direction of the Basin Council was entrusted to Monica Bettiol, an official of the Priula Basin Council of the province of Treviso, thanks to a cooperation agreement. As Gino Alessio

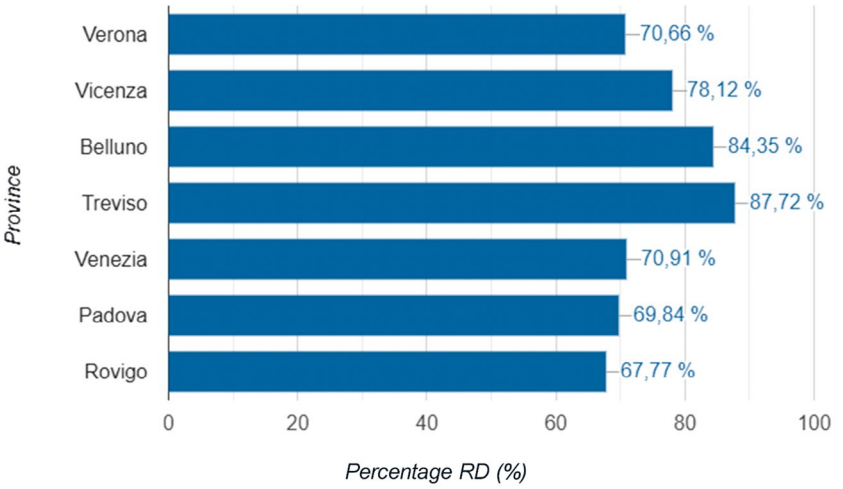
[2] The regulation on waste was attributed to ARERA with a 2018 Law and concerns the improvement of the service to users, the homogeneity between the areas of the country, the assessment of cost-quality ratios and the adaptation of infrastructure. The first regulatory period ran from 1 April 2020 to 31 December 2023. The second regulatory period is currently underway.

recalls, "*as early as 2017 there were contacts and a first approach to Paolo Contò, director of the Priula Basin Council, identified as an important benchmark to be inspired by*".

Walter Giacetti, technical director of Ecoambiente, says: "*The Priula model*[3]*, together with the Contarina company that deals with the management of urban waste in 49 municipalities in the province of Treviso, was the one that inspired us. There was a very close collaboration both with the Contarina company, which supported Ecoambiente for the drafting of the business plan, and through the management of Bettiol of the Basin Council. It was a double channel, both corporate and institutional, which allowed a transfer of experiences, albeit with appropriate adaptations to the specific context*".

As can be seen from *Figures 8.1* and *8.2*, in 2020 the Province of Rovigo had the lowest percentage of separate waste collection among the Veneto provinces, with 20 percentage points less than the province of Treviso; moreover, the province of Rovigo recorded the highest per capita production of waste, equal to almost 560 kg per year, compared to 406 in Treviso.

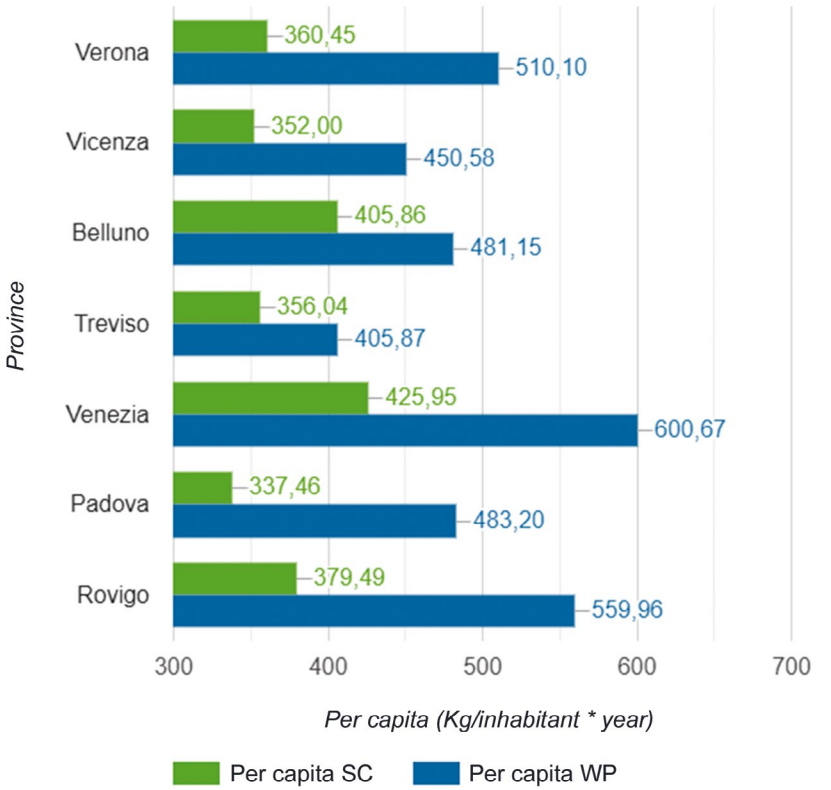
Figure 8.1 – Percentage of separate waste collection on a provincial scale of the Veneto Region for the year 2020



Source: Ispra

[3] See for further information: Contò P. (2023). *La gestione responsabile dei rifiuti: Il cuore innovativo del modello Priula Treviso*,. Linea Edizioni; and Romano G. (eds.) (2024). *La buona gestione e il buon governo delle aziende di servizi pubblici locali. Tratti distintivi e fattori critici di successo delle aziende a totale capitale pubblico*, FrancoAngeli.

Figure 8.2 – Per capita waste production (WP) and separate waste collection (SC) on a provincial scale – Veneto region, year 2020



Source: Ispra

The transfer of knowledge and prior experience from the local authority (Priula) and the company (Contarina), both recognized as best practices, enabled the province of Rovigo to set the goal of aligning with the most virtuous examples in a short period of time.

Monica Bettiol, former Director of the Basin Council, recalls: "*The benchmark and the direction we wanted to pursue were clear to everyone, overcoming political divisions. The provincial capital, Rovigo, was the last municipality to formally join the project for a single provincial operator with its own infrastructure, but it always strongly believed in the chosen path*".

As highlighted by Bettiol and Alessio, the objectives of the project led by the Province of Rovigo and Ecoambiente were clear:

- to improve environmental outcomes, measured in terms of separate waste collection rates and overall waste generation;
- to standardize tariffs across the province, eliminating disparities in treatment among citizens living in neighboring areas;
- to increase fairness by applying the polluter-pays principle – replacing the use of dwelling size (in square meters) as a basis for tariff calculation with actual household waste generation, measured by the quantity of unsorted waste delivered.

The current president of the Basin Council Piasentini recalls in this regard: "*We copied from the best – we had a solid, functioning model essentially 'in-house' to draw inspiration from and turn to for support. In Treviso, they had already experienced the importance of building relationships and collaborating with associations such as Confindustria and Confartigianato, as well as how to manage waste in private schools, for example*".

The year 2020 was a turning point in the company's history, as until then Ecoambiente had operated through very short-term contracts. In the absence of an industrial plan and a comprehensive area-wide strategy, the company was limited to managing routine services, without the ability to plan for a broader and more forward-looking path aligned with the emerging challenges of the sector.

In September 2020, the Basin Council defined and approved the area plan, which became the main point of reference for the company as well. At the same time, with support from Contarina, Ecoambiente drafted its business plan based on the area plan, including projections for significant investments – above the national average.

As Giacetti recalls, "*we were coming from a period in which few investments had been made, due to the short-term nature of previous contracts*". The business plan was formally approved in December 2020.

Ecoambiente therefore received the assignment from the Basin Council starting from 1 January 2021 and expiring on 31/12/2050. "*A thirty-year, long-term assignment, perhaps one of the longest-lasting in the field of urban waste made in Italy recently*" recall both Giacetti and Tolomei.

The main elements of the Ecoambiente project were defined in the area plan and the business plan, based on an organizational model that provides for door-to-door collection of residual dry waste, organic waste, paper, plastics and metals, glass, and green waste across the entire territory. The project received unanimous approval from all member municipalities, as Giacetti recalls: "*The introduction of a pay-as-you-throw tariff, a unified service model, a single tariff regulation, and a single service regulation were the pillars of the approved project. Those components were unanimously approved by the member municipalities, which provided a solid and clear*

framework. They helped define a challenging path – one that could only be altered through new resolutions. This structure clearly gave the management team a kind of "virtuous momentum" in the months and years that followed, moving steadily in a clear direction".

The reorganization of the door-to-door collection system is considered a key step not only to increase the percentage of separate waste collection, but also to reduce the amount of residual waste produced and to improve the quality of the various waste streams. At the same time, it enables the application of the pay-as-you-throw tariff, in line with the "polluter pays" principle[4].

In November 2022, the Basin Council approved the Single Tariff Regulation and the establishment of the pay-as-you-throw tariff for the first half of the area served. A two-phase implementation was decided: about half of the territory and municipalities introduced the pay-as-you-throw tariff in 2023, and the remaining half followed in 2024. In February 2023, the single Economic and Financial Plan (PEF) for 21 municipalities in the Upper Polesine area and the municipality of Rovigo was approved by the Basin Council, and the pay-as-you-throw tariff was introduced in those municipalities, based on a unified supra-municipal PEF and a single tariff structure.

Following the approval of the unified service regulation in December 2023, the provincial PEF was approved in March 2024, and the unified tariff was extended to the entire service area.

8.2. The Business Model

Ecoambiente manages environmental urban waste services throughout the province of Rovigo, from separate street collection to door-to-door collection, from manual and mechanized sweeping to the collection of abandoned waste, from waste transport to its treatment and final disposal.

Ecoambiente has four operational bases, a logistics base, a transfer station, over 300 employees and about 270 vehicles. It also manages 14 municipal eco-centres, a mechanical biological treatment plant in Sarzano (RO), the "Taglietto 1" landfill in operation and the "Taglietto 0" landfill in post-operation in Villadose. In the area served of about 1800 square kilometers, it collects about 121,000 tons of waste annually in a basin of 50 municipalities.

[4] Economic and Financial Plan and Business Plan for the management of the integrated waste cycle of the Rovigo Basin (approved by the Board of Directors at the meeting of 16 December 2020 and updated at the meeting of 20 January 2021).

The percentage of separate waste collection in 2020 stood at less than 68% and the goal was to reach the minimum threshold of 80% by 2023, therefore an increase of at least 17% and the decrease in unsorted waste produced from 198 kg per capita to 67 kg, with a decrease of more than 130 kg. These objectives were taken as a reference for the sizing of the service in the design phase.

While door-to-door collection had already been common practice for some time in many municipalities of the province, in the municipality of Rovigo, starting in 2018, full door-to-door collection was introduced in ten municipal hamlets (Boara Polesine, Granzette, Concadirame, Grignano Polesine, Sant'Apollinare, Fenil del Turco, Buso di Rovigo, Sarzano, Mardimago, and Borsea), whereas the rest of the city was served by a roadside collection system. In 2021, a specific project was drafted to extend the door-to-door service to all neighborhoods and to a limited part of the historic city center. For most of the historic center, however, the plan called for a collection system based on street collection points equipped with controlled-access, multi-user containers.

The business plan also envisaged the use of controlled-access roadside containers for high-rise residential buildings (condominiums) in urban areas lacking sufficient space.

By 2021, all the municipalities in the province had implemented door-to-door waste collection, with the exception of a tourist hamlet in a coastal municipality (Rosolina Mare) and the historic center of Rovigo. These areas are still managed using magnetic cards and "smart bins" – or street containers equipped with volumetric limiters and controlled-access delivery systems – thanks to a derogation provided for in the area plan for the time needed to amortize the equipment.

In addition to the collection method, a crucial element of the Ecoambiente project is the tariff model chosen, that of the pay-as-you-throw tariff, "*which is not only the means of collecting the revenue that makes it possible to guarantee full coverage of the costs of the waste service, but is a fundamental constituent element of the integrated management system that contributes to achieving the assigned environmental objectives*"[5].

With pay-as-you-throw, the billing phase was transferred from the municipality to the waste utility, along with issues related to non-payments and, consequently, the risk of financial imbalance. These challenges are addressed through investments in IT systems and the use of continuously updated databases.

The model chosen is defined by the main corporate managers as "*empowering, fair and transparent*" and "*territorial*".

[5] Company presentation "Tariffa puntuale e gestione sovracomunale: l'esperienza Ecoambiente Rovigo".

In line with the model that inspired the Ecoambiente project and the actions of the Basin Council – namely that of Contarina and Priula in the province of Treviso – the focus is on responsibility, expressed both through door-to-door collection and a tariff system that rewards virtuous behavior and discourages non-virtuous practices[6].

In addition, the Ecoambiente model is a "territorial model" adapted to the characteristics of the territory served, characterized by municipalities with an average size of 4 thousand inhabitants, therefore very small, as highlights CEO Tolomei: "*where the relationship of administrators with citizens, especially in smaller municipalities, is a very direct, almost personal relationship that is also very much based on the use of social channels, of Facebook groups, WhatsApp chats that administrators hold with citizens, with merchants and so on. Every territory has its own specific characteristics, and one must understand them with humility before proposing predefined solutions*".

Giacetti says again: "*The new service was strongly based on overcoming municipal divisions to arrive at a single tariff area, therefore, a single financial plan, a unified tariff and a unified service model in the area, with some territorial variants, but a unitary logic that goes beyond municipal boundaries*".

As far as the municipality of Rovigo is concerned, the transition to the new door-to-door collection model took place through a series of phases. The communication phase accompanied the change, from the contact phase to the start of the door-to-door collection. The city has been divided into seven areas, where from June to November 2022 the door-to-door service has been progressively introduced. Only in part of the historic center were street collection points with "calotte" bins installed (spherical, globe-shaped containers with a volumetric limiter and a capacity of 20 liters), the placement of which was completed in the summer of 2023. These are accessible to users in the city center. In the neighborhoods, a few street collection points remain in place to serve certain apartment buildings that did not have sufficient space to accommodate the household containers required for door-to-door collection. Giovanni Biagini, current director of the Basin Council, highlights: "*The particular shape, suitable for accommodating bags and non-recyclable packaging, has been designed to encourage differentiation in any case. Moreover, it was decided that the historic center would be the last area to be activated, in order to prevent illegal dumping at the central collection points while the system had not yet been rolled out in the surrounding neighborhoods*".

[6] Contò P. (2023). *La gestione responsabile dei rifi uti: Il cuore innovativo del modello Priula Treviso*, Linea Edizioni.

The new model also includes a revision of the collection system for grass clippings, leaves, and small pruning. Through the "Equo Verde" project, a new service was introduced that uses a 240-liter wheeled bin emptied 42 times per year, replacing the previous bag-based system. The bag system was also considered outdated from a social standpoint, due to its negative impact on worker health – specifically the strain caused by manual handling – and to improve occupational safety.

The green waste collection service, active since 2023, is offered for a flat fee of €35 per year (VAT included), which can be requested individually and is supplementary to the standard waste tariff.

An incentive for users to engage in home composting has also been introduced. For those who choose this option, a reduction in the variable portion of the tariff has been established, based on the number of household members – reaching up to approximately €100 per year for families with six members. In the future, the provision of low-cost home composters is also being considered as an additional incentive.

The initiative was accompanied by a series of targeted information and training activities, including free online courses, which saw significant participation.

8.3. Ownership structure and corporate governance

Since 2012, the year of its establishment following the merger of two pre-existing companies, and until 2020, Ecoambiente had two shareholders: the municipality of Rovigo and the RSU consortium, owned by the remaining 49 municipalities in the province. On 17 December 2020, with a reverse merger, Ecoambiente incorporated the shareholder Consorzio RSU and the ownership of the company shares passed directly to all 50 municipalities in the Province of Rovigo[7]. The Municipality of Rovigo thus became the majority shareholder, with a stake of 51.13%.

Ecoambiente's corporate governance is today characterized by a fragmented ownership structure, made up of all 50 municipalities in the province of Rovigo, and a board of directors with president, vice president and CEO.

At the top of the managerial structure are the CEO and the technical director. A peculiar and specific role of the urban waste sector is played by the local regulatory body called Rovigo Basin Council.

[7] Before the merger, the shareholders of Ecoambiente divided the capital as follows: Consorzio RSU di Rovigo: shares owned: 61.40%; Municipality of Rovigo: shares owned: 38.60%.

8.3.1. The ownership structure

All 50 municipalities in the province of Rovigo are shareholders of Ecoambiente. According to the company's bylaws, only local authorities within the province of Rovigo may become shareholders.

Of the 50 shareholder municipalities, 41 have a population of fewer than 5,000 inhabitants, and 44 have fewer than 10,000. These are therefore small municipalities, in a province that has lost nearly 15,000 residents between 2001 and 2024, and currently has a population of around 227,000 – over 50,000 of whom reside in the city of Rovigo.

The average population per municipality, including the provincial capital, is just over 4,500 inhabitants

The Municipality of Rovigo has about 25% of the population of the province, but has 51% of the company's capital and this is due to a historical path that has led to the merge of two pre-existing companies with very diversified corporate structures. As Giacetti recalls: "*the company owned by the Municipality of Rovigo, being one of the two founding shareholders of Ecoambiente, brought with it, at the time of the company's establishment, certain assets that increased the value of its shares. This has been one of the most debated issues within the political dynamic, as there is a "dominant" municipality within the shareholder structure – a role it would not hold based solely on population size*".

As the CEO recalls: "*with the merger of the two pre-existing companies, there was not only an increase in the number of shareholders, but also a redefinition of ownership shares: some municipalities went from being majority shareholders to minority shareholders – and this understandably caused some tensions*".

The presence of a plurality of municipal shareholders is an aspect that differentiates the experience of Ecoambiente in the province of Rovigo from that of Contarina in the Priula basin of the province of Treviso from which Ecoambiente was inspired: the Priula Consortium is in fact the sole shareholder of the Contarina company. It is in fact the Priula Consortium that is participated by all the member municipalities.

The presence of a "hegemonic partner" has been managed through the provision of some corporate governance rules that seek to preserve the value of sharing and unity.

The shareholders' assembly, which holds specific powers of guidance and oversight, allows the member municipalities to exert a decisive influence over strategic objectives and the company's most significant decisions. However, the bylaws state that "*the company's shareholders' assembly is bound to deliberate on all matters within its competence in accordance with the resolutions of the Assembly exercising analogous control*".

The governance structure of Ecoambiente provides for the existence of essentially two assemblies for decisions falling under the competence of the shareholders:

- The Shareholders' Assembly, in which, pursuant to the agreement for *analogous control* signed by all shareholders, all municipalities – "*regardless of the position expressed by each individual municipality within the Analogous Control Assembly, agree to participate in and exercise their voting rights in the Shareholders' Assembly of Ecoambiente S.r.l. in accordance with the decision taken by the Analogous Control Assembly*". Resolutions of the Analogous Control Assembly are adopted with the favorable vote of at least 30 municipalities of the Province of Rovigo representing at least 600 thousandths of share capital;
- The Analogous Control Assembly, which, as will be discussed shortly, instead requires a qualified majority both by headcount and by share capital: "*this makes it more difficult to reach decisions, because out of the 50 municipalities, 44 are very small; many of them have between 1,000 and 2,000 inhabitants*" recalls Gino Alessio, former President of the Basin Council during the 2019-2021 term.

The agreement for analogous control provides for penalties for those who do not comply with these provisions: "*the municipality that, following the resolution of the Shareholders' Meeting of similar control, does not participate or does not comply with its vote in the Corporate Meeting* […] *is required to activate a contradictory with the same Assembly of similar control regarding its non-compliance*".

If the justifications for such behavior are rejected, "*a penalty of 5,000 euros can be applied which must be paid to the Basin Council*". Furthermore, in the event that "*the Shareholders' Meeting of similar control fails to resolve with the majorities referred to in the previous article, the Shareholders' Meeting may only adopt the resolutions required by law*". A series of safeguards have therefore been provided to manage the complexity of a very fragmented ownership structure and governance rules that require consensus and sharing.

Figure 8.3 – Fragmentation of the capital of Ecoambiente Rovigo among the municipalities of the province

Municipalities	*New shareholding structure €*	*New shareholding structure %*
Rovigo	4,394,771	51.1322%
Adria	430,730	5.0121%
Porto Viro	323,088	3.7591%
Lendinara	258,470	3.0072%

Municipalities	*New shareholding structure €*	*New shareholding structure %*
Badia Polesine	236,931	2.7566%
Occhiobello	236,931	2.7566%
Porto Tolle	215,392	2.5060%
Taglio di Po	172,313	2.0048%
Rosolina	129,235	1.5036%
Ariano Polesine	107,696	1.2530%
Villadose	107,696	1.2530%
Castelmassa	86,157	1.0024%
Ceregnano	86,157	1.0024%
Fiesso Umbertiano	86,157	1.0024%
Loreo	86,157	1.0024%
Lusia	86,157	1.0024%
Polesella	86,157	1.0024%
San Martino di Venezze	86,157	1.0024%
Arquà Polesine	64,618	0.7518%
Bergantino	64,618	0.7518%
Canaro	64,618	0.7518%
Castelnuovo Bariano	64,618	0.7518%
Corbola	64,618	0.7518%
Costa di Rovigo	64,618	0.7518%
Ficarolo	64,618	0.7518%
Fratta Polesine	64,618	0.7518%
Stienta	64,618	0.7518%
Trecenta	64,618	0.7518%
Bosaro	43,078	0.5012%
Castelguglielmo	43,078	0.5012%
Ceneselli	43,078	0.5012%
Crespino	43,078	0.5012%
Frassinelle Polesine	43,078	0.5012%
Gavello	43,078	0.5012%
Giacciano con Baruchella	43,078	0.5012%
Melara	43,078	0.5012%
Papozze	43,078	0.5012%
Pettorazza Grimani	43,078	0.5012%
Pontecchio Polesine	43,078	0.5012%
Villanova del Ghebbo	43,078	0.5012%
Bagnalo di Po	21,539	0.2506%
Calto	21,539	0.2506%

Municipalities	*New shareholding structure €*	*New shareholding structure %*
Canda	21,539	0.2506%
Gaiba	21,539	0.2506%
Guarda Veneta	21,539	0.2506%
Pincara	21,539	0.2506%
Salara	21,539	0.2506%
San Bellino	21,539	0.2506%
Villamarzana	21,539	0.2506%
Villanova marchesana	21,539	0.2506%
TOTAL	8,594,911	100%

Source: Ecoambiente 2022 Report

One of the critical issues is precisely due to the need to reach constitutive and deliberative quorums in company assemblies, which is not always easy to achieve without the compact participation of the mayors. As Vice-President Chiara Turolla, who is also mayor of Arquà Polesine, one of the shareholder municipalities, recalls: "*at least two or three times a year decisions have to be made in the assembly and very often out of 50 mayors we struggle to have the presence of the minimum number necessary to constitute the Assembly legitimately*".

The CEO Adriano Tolomei also adds: "*it is often difficult to reach a quorum because mayors have many responsibilities and perhaps tend to rely on and delegate much of the waste company's management*".

8.3.2. The Analogous Control Assembly

The municipalities of the Province of Rovigo exercise analogous joint control over Ecoambiente, as required for in-house assignments, through an agreement whose duration matches the lifetime of the Ecoambiente company.

According to the agreement, each municipality in the Province of Rovigo participates in the Analogous Control Assembly with a quota determined based on the size of its resident population, as recorded in the most recent ISTAT census.

The Shareholders' Meeting of Analogous Control is the body through which, in fact, analogous control is exercised, pursuant to the Articles of Association. In fact, the corporate bodies are required to make available to this assembly everything necessary for the exercise of its functions.

The voting mechanisms and required majorities are more stringent than those under traditional corporate rules: qualified majorities are needed both in

terms of the number of municipalities and their share quotas. The Analogous Control Assembly is validly constituted when at least 30 municipalities of the Province of Rovigo are present, representing a combined total of at least 600 thousandths of the share capital. Similarly, resolutions of the Analogous Control Assembly are adopted with the favorable vote of at least 30 municipalities representing at least 600 thousandths of the shares.

As Gino Alessio, former President of the Basin Council in the period 2019/2021, recalls: "*we have provided for a double majority because the heads somehow allow that the decision is not the prerogative of the municipalities that have many inhabitants, thus preventing only 3-4 larger municipalities from reaching the quorum on their own; moreover, a threshold of 600 inhabitants was also chosen for the criterion of inhabitants to prevent the larger municipalities, first and foremost the capital Rovigo, from having a strong veto power, effectively blocking decisions, which in our opinion should instead always be collective and shared, capable of guaranteeing representativeness even to small municipalities which are many in the Polesine*".

The Analogous Control Assembly convenes and deliberates before the Shareholders' Meeting of Ecoambiente on matters reserved to the competence of the corporate assembly, and defines the powers to be assigned to the Chief Executive Officer and, if necessary, to the President.

Vice-President Chiara Turolla, who is also mayor of one of the member municipalities, says: "*Some mayors in the past held a critical stance toward the company. This skepticism was partly justified by the fact that they often lacked knowledge of business dynamics and were therefore distrustful and prejudiced. Ecoambiente, however, has shown itself to be fully open and cooperative – not only by organizing and attending numerous public information sessions with its top management, but also by listening to the concerns of mayors, responding to their requests, and staying in contact with them, including through informal meetings at the company headquarters*".

The creation of a relationship of mutual trust and respect between the company and the shareholder-mayors has been essential for smoothly managing the introduction of all the changes related to the implementation of the unified pay-as-you-throw tariff.

8.3.3. The Board of Directors

The Board of Directors consists of three members, including the Chairman and the Chief Executive Officer (CEO). The current members are two men and one woman.

The Board of Directors appoints, on the recommendation of the

shareholders' meeting, a CEO who is assigned management and operational powers in relation to which he is responsible for the legal representation of the company.

As provided for by the agreement for analogous control, the CEO of Ecoambiente is designated by the Municipality of Rovigo. The other members of the Board of Directors are instead jointly designated by the municipalities of the Province which "*seek among themselves, in compliance with the principles of loyal collaboration and good faith, the unanimity of consensus*". Where unanimity is not possible, the designations take place with the quorums for heads and thousandths of inhabitants provided for the decisions of the assembly of analogous control. The search for a shared consensus among such a wide audience of municipalities, with different political orientations, is not easy but it is important because of the in-house assignment that Ecoambiente has. In the last appointment of the members of the Board of Directors, the unanimity of the voters was reached.

The remuneration provided for the Board of Directors is still linked to the remuneration paid to the administrative body in 2013 due to the delay in the approval of the delegated decrees provided for by Article 11 of the Consolidated Law on publicly-owned companies (Legislative Decree 175/2016): therefore it is an extremely low remuneration, equal to 80% of the remuneration envisaged over ten years ago[8]. As highlighted by Biagini "*it is a remuneration cap – extremely low and inappropriate*".

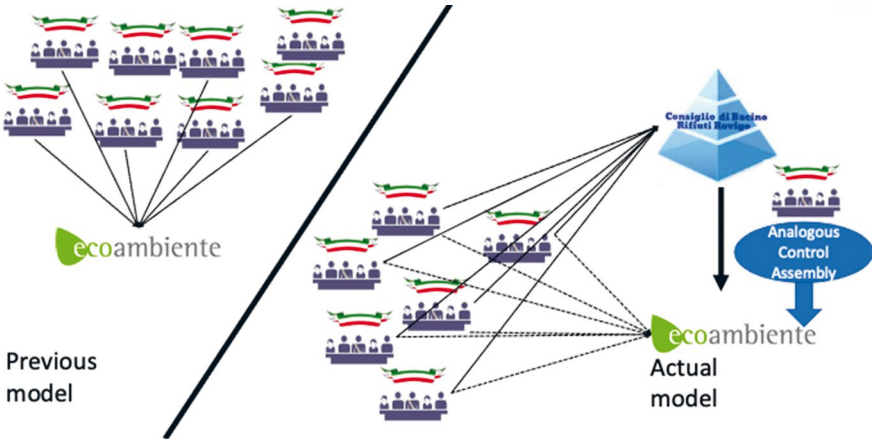
8.3.4. The Local Authority – Rovigo Waste Basin Council

Formally, the Rovigo Waste Basin Council was established on 10 October 2017 following the signing of the "Agreement for the establishment and operation of the Rovigo Waste Basin Council relating to the integrated management of urban waste in the Rovigo territorial basin", signed by all 50 municipalities in the province of Rovigo.

As provided for by the Regional Law establishing it (LRV 52/2012), the Basin Councils are responsible for planning, organizing, awarding and controlling the public service of integrated urban waste management in the Basin of their respective competence, taking over the functions already under the competence of the Area Authorities.

[8] At the time of appointment of the incumbent CEO, the shareholders' meeting, held in July 2022, provided for a remuneration of about 34 thousand euros for Tolomei, "*subject to calling a new shareholders' meeting as soon as the new regulation on the remuneration of the bodies of public companies provided for by the Madia decree Legislative Decree 175/2016 is approved*".

Figure 8.4 – The evolution of the governance model adopted



Source: Ecoambiente report

The Rovigo Waste Basin Council operates through its bodies:

- the Basin Assembly, which is the body of political and administrative direction and control and is made up of the legal representatives of the local authorities participating in the Basin Council, or their delegates;
- the President, who is a member of the Basin Committee and is chosen by the Basin Assembly from among its members;
- the Basin Committee, which is composed of 8 members, including the President, selected from among the members of the Assembly, remains in office for five years. The members are chosen from blocked lists proposed by the member municipalities after an informal discussion, thus outlining a body that is capable of composing the potential different requests of the municipalities. It is the executive body of the Basin Council and carries out all administrative acts that are not reserved by law and by the founding agreement to the Basin Assembly and that do not fall within the competence of the President and the Director;
- the Director is appointed by the Basin Assembly on the proposal of the Basin Committee. He is responsible for the operational structure of the Basin Council.

The Basin Council was endowed with new powers and broad functions. Beyond the formal constitution, the Basin Council provided for by the 2012 regional law became operational in September 2020 when, after the appointment of the bodies, the area plan was defined and formally approved.

As stated by Gino Alessio, former president of the Basin Council, "*the area plan became the reference element for the company as well. At the same time, the company's business plan was drawn up and then approved on the basis of the area plan*".

The Basin Council has played a fundamental guiding role, enabling Ecoambiente to design and implement a series of management reforms that have allowed for significant investments and, in a short time, led to highly positive results in terms of increased separate waste collection and reduced unsorted waste.

8.4. Managerial team and managerialization

Ecoambiente has a very streamlined administrative and hierarchical structure, currently centered around the CEO and the Technical Director, as there is no longer a General Manager, a role that existed in the past. The technical director, Walter Giacetti, was appointed in 2021 and as stated by the director of the Basin Council Biagini "*he is one of the most competent people in the urban waste sector in Italy*".

In both the Basin Council and Ecoambiente, the technical expertise brought by the top management – acquired in other, nearby utility companies – has been fundamental. The current CEO and the Technical Director of Ecoambiente have gained significant experience at other utilities in the Veneto region, specifically Veritas and Etra, respectively. These are multi-utility companies that also manage integrated water services and have therefore long been subject to regulation by the national authority ARERA. As a result, they are accustomed to managing the close relationship – typical of regulated sectors – between regulatory inputs and business strategies.

Similarly, within the Basin Council, the presence of directors – first Bettiol, then Biagini – who had significant experience in other contexts, facilitated the rapid acquisition of skills. As previously mentioned, Monica Bettiol served as director under a cooperation agreement (pursuant to Article 15 of Law 241/1990), while Giovanni Biagini had gained extensive experience in Emilia-Romagna as a technical officer of the Regional Agency for Water and Waste Services (ATERSIR).

The presence of technical expertise has guided Ecoambiente along a path of "*innovation introduced in an analytical and detailed manner*" says Biagini, who highlights the importance of collecting data in advance to build accurate and convincing plans – plans that, in most cases, were able to stay on course even when faced with the natural resistance to change from citizens and their representatives.

Currently, there is no General Manager in the company's organizational chart.

8.5. Ecoambiente's stakeholders

Ecoambiente's stakeholders are well identified in six main categories: Institutions and regulators, employees and suppliers, citizens, associations, the financial community and economic operators. According to Ecoambiente's management, the Basin Council is the main stakeholder "*first of all because it is our contractual interlocutor, it is the subject that dictates the rules and with which shared paths have been defined. In my opinion, a key to success is precisely the style of sharing, that is, the sharing of a path with respect to an area plan that set the objectives*".

As Giacetti points out again, the second main stakeholder of Ecoambiente are the municipalities, "*which are the direct shareholders and also the representatives of our customers, citizens, users of the service. The third stakeholder is the local citizen, for two fundamental reasons: with the pay-as-you-throw tariff, they are the ones who pay; but in order to achieve our goals for separate waste collection, they are also the ones we must persuade to sort their waste properly. Unlike other utility services, such as water, we know that the behavior and cooperation of citizens are essential for the service to function effectively. This citizen engagement and sense of responsibility are truly fundamental*".

Lenders are an increasingly crucial stakeholder for waste utilities, especially in a period like the current one in which expected investments are very high, also thanks to regulatory incentives and those linked to the National Recovery and Resilience Plan (NRRP); indebtedness is a necessary lever to be activated to allow what has been planned to be achieved. The thirty-year assignment allows Ecoambiente to present itself in front of lenders (in particular banks) as a solid and credible reality. Says Giacetti: "*Despite the completely public nature, we know that the contract is the main tool we have to be able to manage investments adequately, planning and obtaining the necessary funding*".

8.6. Communication and stakeholder engagement to implement change and Pay-as-you-throw tariff

Taking into account the characteristics of the population it serves, Ecoambiente has activated various communication channels with its users. As Tolomei notes: "*in addition to the utility bill and physical help desks in several municipalities across the province – designed also to engage directly with segments of the population less accustomed to technology, such as the elderly – we also have a call center, an updated website with a frequently asked questions (FAQ) section, and a mobile app. It's interesting to note that*

a significant portion of user inquiries actually comes through the app, which is being used more and more frequently".

The proposed changes were presented directly to citizens through public events held in the evenings and organized across the entire territory. Following the door-to-door distribution of flyers and the release of a press statement, the informational meetings – along with the operational and phased distribution of the new household equipment – represented the main components of the campaign. Says Giacetti: "*About 440 thousand bins have been distributed in the municipalities associated with the individual users or households, an enormous work, which however has reached all users, alerted to the imminent "novelty" and "discontinuity" due to the introduction of the new tariff. The door-to-door for our municipalities was not a novelty – with the exception of some hamlets of the capital Rovigo – while the new tariff was, and initially could in some way raise fears of increases and penalties considered unfair. The public information evening became the central communication event. At first, I had some doubts, as I believed that only a small number of citizens would actually be interested in participating, compared to the total number of users. But I changed my mind, because most of the information we shared was actually conveyed through these public events – around 110 in total, including online events that received 20 to 30 thousand views. The in-person meetings were held in the largest venues available – with 80, 100, or 150 seats – and they were always completely full*".

All the municipalities had at least one public "evening", the larger ones normally one evening per hamlet or couple of hamlets. In the Municipality of Rovigo the evenings were organized by neighborhood; therefore, each neighborhood had "its" public evening. "*In Rovigo, between online evenings and public evenings in presence, at least 10 events have been organized, with the involvement of 25 thousand inhabitants*" recalls Giacetti.

The evenings, which began in September 2021, were used to meet citizens, but also to discuss with the administrators of the municipalities, the mayors, the aldermen and the technical managers, as Giacetti recalls: "*the first people who needed to be informed about how the new service was organized were actually the municipal administrators themselves – mayors, deputy mayors, councilors, and municipal technicians*".

The president Pierpaolo Frigato, the CEO Tolomei, and the technical director Giacetti, repeat: "*The evenings were in fact a double channel, information for citizens, but also useful ideas for us; each evening was rather similar to the others, but in each evening there was always at least one 'new' question that differed from those made in previous meetings. We have learned a lot and made some changes to the initial plan*".

The president of the basin council, Vinicio Piasentini, highlights: "*For example, users suggested extending to 36 months the period during which*

families with newborns can benefit from dedicated diaper collection. On the other hand, we took a firm stance in response to requests to collect feminine hygiene products, which we did not accept, following the example of Contarina".

As Biagini points out, the evenings were also always attended by the top management together with the experts of the communication company Achab, "*which followed the whole process for about a year and a half and helped Ecoambiente to implement the transition to the pay-as-you-throw tariff and the distribution of new domestic equipment*".

In the evenings, preliminary information was first provided on the production of waste in the area and the results of separate collection, to also introduce the reasons for the proposed change and underline the benefits of separate collection.

In those meetings, for example, citizens were informed, in an evocative way, of the fact that in 2021 in the Municipality of Rovigo each citizen generated about 580 kg of waste, enough to "*cover a football field for a height of 124 m*"[9].

During the meetings, the topics covered concerned collection methods, the use of the bin with microchip, the rules for good separate waste collection also through the Junker App (which recognizes products by barcode and tells users how to separate them), how and when to obtain equipment, how to do home composting and so on.

Giacetti and Biagini say again: "*Ecoambiente's communication model for public events is based on an initial one-hour presentation, followed by one or even two hours of questions. It was a truly demanding but also very, very interesting experience, because in those moments, citizen-users ask you about everything. At first, we didn't have all the answers, and thanks to those meetings, we realized that some things needed to be defined more clearly. In general, we understood that being unable to provide answers – or postponing them – generated mistrust, leading some people to develop suspicions, especially regarding potential cost and tariff increases. We therefore came to understand how crucial it is to have clear answers, especially about tariffs, which must already be defined to prevent suspicion and to avoid conveying a message of poor transparency and lack of clarity*".

In fact, during the public meetings, the introduction of the pay-as-you-throw tariff was announced in advance, explaining that it would consist of a fixed component and a variable component.

While the fixed component is intended to cover general service costs – including overall management and street sweeping and cleaning services – the variable component is meant to cover the costs directly related to the

[9] Ecoambiente Rovigo, Door-to-Door Starts, Friday 2 September, 2022.

collection, transport, and treatment of waste. This variable portion is also quantified in proportion to the number of times the residual waste container is emptied.

More specifically, at Ecoambiente, the variable portion of the tariff is determined partly by certain tariff components that remain unchanged regardless of the amount of separately collected waste, and partly by the number of residual waste disposals made over the course of a year. The aim is to reduce the quantity of residual waste and to increase both the quality and quantity of recyclable waste.

In general, under the selected model, the number of residual waste bin collections carried out over the course of the year – beyond the minimum number allocated to each user – contributes to determining the waste bill. This system encourages users to take responsibility for their waste management by sorting as much as possible, while also discouraging illegal dumping or the contamination of recycling streams with unsorted waste. A minimum number of residual waste collections is always included in the base tariff.

Giacetti says: "*In the Ecoambiente experience, once the tariffs were defined, in subsequent meetings there could obviously be someone who disagreed, but the vast majority of citizens understood the objectives and, having complete information, which also includes how the tariff is calculated, how much additional collections cost, etc., they returned home with a clear idea of what would happen, adopting a more constructive approach. In fact, progressively in the meetings, as all the conditions, including the economic ones, were defined, the disputes were increasingly scarce. Information has spread in the community more and more thanks to word of mouth and the local press, which has always given ample emphasis to the initiatives organized*".

The meetings were also held online and the recordings made available on YouTube. Giacetti recalls: "*Overall, we reached about 20-30 thousand views, a sign that in addition to filling the 100-150 seat rooms used for face-to-face meetings, we were also able to reach another important slice of users through the online channel. The local press amplified the messages and word of mouth did the rest. In essence, we have managed to cover almost the entire population with our information activity*".

In addition, with specific reference to the introduction of the new pay-as-you-throw tariff, the company's top management and the Basin Council leadership held meetings with the technical departments and municipal secretaries of various municipalities, "*complementing the political and public engagement efforts with more technical information and discussions*" as Monica Bettiol and Gino Alessio point out.

Managerial unification is actively pursued on an ongoing basis, including through the management of recycling centers, which have become inter-municipal; "*Although the ownership of almost all the former municipal*

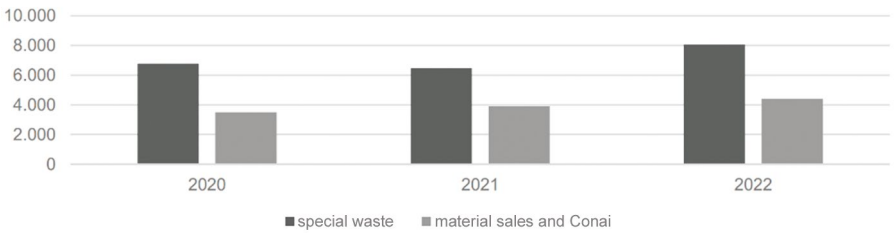
recycling centers remains with the individual municipalities, they are in fact managed by the company on an inter-municipal basis and are fully included in the company's financial and industrial plan".

8.7. Economic, environmental, and social performance

Ecoambiente's objectives have been set out in an area plan and a 2021-2050 business plan approved in 2020, in September and December, respectively.

The company has recorded increasing turnover, EBITDA and net profits in recent years (as can be seen from *Table 8.1*), showing a good general economic and financial performance; investments have also progressively grown. The increase in turnover is linked to the increase in revenues obtained from the valorisation of separate waste collection and the disposal of special waste in its plants.

Figure 8.5 – Trend in revenues from the disposal of special waste (left) and from the valorisation of sorted waste (right)



Source: 2022 Report, Ecoambiente

For the recovery of packaging, Ecoambiente has entered into agreements with the supply chain consortia within the National Packaging Consortium (CONAI), allocating cellulose-based packaging to COMIECO, plastic packaging to COREPLA, PET bottles to CORIPET, CDCNP for accumulators and batteries, CDCRAEE for waste from electrical and electronic equipment (WEEE).

In addition, since 2022 it has also entered into an agreement with a new consortium, BIOREPACK, which deals with biodegradable and compostable plastic packaging waste. Other waste has been sent for valorization by Ecoambiente on the free market, i.e. outside an agreement with the supply chain consortia. With reference to glass packaging, Ecoambiente exited the agreement with COREVE in 2024 in relation to the particular glass market trend which saw a significant increase in the sale values of glass cullet.

The tariff method established by ARERA sets cost limits that must be observed in order to avoid unjustified tariff increases for users. At the same time, it allows for the recovery of margins through revenue sharing from the disposal of special waste at the company's facilities and from the return on invested capital. These mechanisms have enabled Ecoambiente to implement a substantial investment plan.

As Biagini and Piasentini recall, in fact, "*Ecoambiente started immediately in the implementation of the investments envisaged by the area plan and the industrial plan, without hesitation*".

During 2023, the company managed to obtain funding for 14 projects out of a total of 15 submitted as part of the calls for tenders provided for by the Italy's National Recovery and Resilience Plan (NRRP), for an amount of about 20 million euros, resulting in positive economic and infrastructural effects throughout the Polesine area.

Table 8.1 – The main balance sheet data of Ecoambiente (values in €/000). AIDA data

Year	*Revenues*	*EBITDA %*	*Net profit*	*Equity*	*NFP*[10]	*Investments (tangible)*
2023	40.819	20.4%	941	16.006	-1.660	5.071
2022	45.802	14.1%	917	15.064	-5.927	8.110
2021	40.947	10.3%	802	14.147	-6.766	6.946
2020	39.799	10.0%	635	13.345	-2.655	2.660
2019	36.289	10.0%	116	12.278	834	10.497
2018	35.093	8.9%	124	8.667	207	-4.832
2017	34.016	9.8%	133	8.662	4.211	7.997

As highlighted in the management report attached to the 2021 financial statements: "*the company's objective is not to maximize profits, but rather to continuously improve service quality for the benefit of citizen-users, as well as the efficiency and cost-effectiveness of its management. In fact, for a company entrusted with an in-house public service such as the integrated management of municipal solid waste, it is particularly important to assess performance from the perspective of the service provided to the community*".

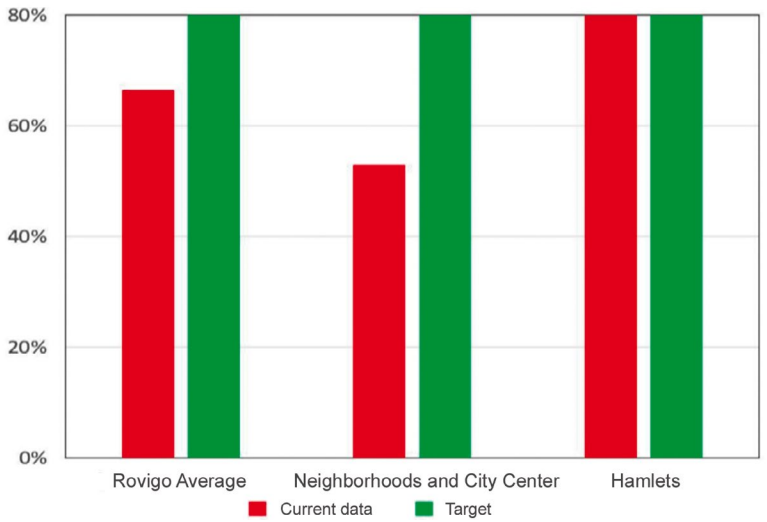
From an environmental point of view, the area plan has set ambitious goals: to achieve a percentage of separate waste collection of at least 80% by 2025, residual municipal waste of 67 kg per capita per year and total

[10] NFP stands for net financial position.

municipal waste of 430 kg per inhabitant per year. The subsequent plan of the Veneto region, drawn up in 2022, increased the separate waste collection target to 85% and recognized an adjustment of the amount of waste produced to 500 kg per year per capita for total waste, consequently the residual waste target was set at 80 kg per year per capita for 2030. For Ecoambiente, the fundamental tools to achieve these objectives, in line with the strategic framework proposed by ARERA, are the pay-as-you-throw tariff and the development of door-to-door collection system[11].

At the start of the change project, the Province of Rovigo showed uneven results. While the smaller municipalities had already achieved excellent outcomes through door-to-door collection, the municipality of Rovigo presented a more mixed picture: the hamlets, where 38% of the municipal population lives, performed more virtuously, with results already aligned with the objectives, whereas the city center and the urban districts showed much poorer performance, with about 27 percentage points less separate waste collection and a continued reliance on street bins[12] (*Figure 8.6*). About 18% of the population of the municipality lives in the historic center.

Figure 8.6 – Results (red) and objectives (green) at the start of the project in the Municipality of Rovigo – 2022



Source: Corporate

[11] Company presentation "Tariffa puntuale e gestione sovracomunale: l'esperienza Ecoambiente Rovigo".

[12] *Ibidem*.

The door-to-door service is also extended to non-domestic users.

With the transition to door-to-door, the collection frequencies for dry residual waste, paper and plastic and metals became biweekly, with the exception of organic waste, collected twice a week, glass every 8 weeks and green waste, collected 42 times a year. In condominiums with more than seven families, it was decided to assign condominium containers for all recyclable materials and single containers for dry residue. Only the condominiums that were not equipped with sufficient space to accommodate the condominium bins were assigned "Smart Islands" with bins that can only be opened with a magnetic card.

Comparing the production of unsorted dry waste in July 2022 with that of the same month of the previous year, the Municipality of Rovigo went from 793 to 670 tons, with a lower production of about 123,000 kg or minus 16%, demonstrating that citizens were responding well to the start of the new collection methods in the city, even before the transition to pay-as-you-throw pricing that was announced starting in 2023.

The environmental results are summarised in the table below, which shows the main macro-categories of waste available in the last three years and the percentage of the total for the last year, together with the changes recorded in the last year and in the three-year period. The consistent reduction of residual waste and a general reduction in the waste produced are evident.

Table 8.2 – Composition of municipal waste and 2021-2023 variation

Rovigo Basin	*Year 2023*	*%*	*Year 2022*	*Year 2021*	*DELTA 23-22*	*DELTA 23-21*
Residual	26.318.942	21,83%	31.980.870	34.284.991	-17,70%	-23,23%
Green	23.392.480	19,40%	23.358.952	23.443.615	0,14%	-0,22%
Biowaste	19.453.750	16,14%	18.462.030	18.950.670	5,37%	2,65%
Paper and cardboard	13.944.590	11,57%	13.219.099	13.393.640	5,49%	4,11%
Lightweight multi-material	10.900.110	9,04%	10.412.410	10.430.920	4,68%	4,50%
Glass	9.098.740	7,55%	9.361.540	9.121.510	-2,81%	-0,25%
Total waste produced	120.557.788		122.708.756	126.482.834	-1,75%	-4,68%

Source: Corporate

Ecoambiente has set itself the goal of drawing up the sustainability report in accordance with the new ESG criteria. The non-financial statement for the year 2022 shows that the added value created is mainly distributed to the benefit of employee remuneration (86% of net global value added, compared to 6% each for the public administration and the company itself and 2% for lenders).

With reference to employees, the company is characterized by a high gender gap among its staff (91.5% men). The training focuses on occupational health and safety. With reference to accident indices, there has been a reduction in the frequency index but an increase in the severity index in the last year (from 9.01 to 21.90).

From a social point of view, a substantial increase in the environmental awareness of the citizens of the province has emerged with an increase in reports of inefficiencies or abandonment in the area "*which, however, have not increased compared to the past*", recalls Piasentini. Biagini says: "*Even the quality of separate waste collection has not decreased, a sign that citizens, now more aware and attentive, have not diverted the undifferentiated waste into separate collection, which increases in quantity without sacrificing quality. People have become more sensitive*".

Table 8.3 – The quality of Ecoambiente's separate waste collection (2023 analysis)

Material	*Impurities%*
Plastics	20.9%
Glass	1.1%
Paper and Cardboard (standalone collection)	0.7%
Paper and Cardboard (mixed collection)	1.3%
Compostable	3.7%
Total (arithmetic mean)	5.6%

Source: corporate

To minimize risks, volumetric caps have been installed on all street containers still in use in Rovigo, in line with best practices.

Regarding the tariff and its impact on users, Piasentini notes: "*The province of Rovigo has few inhabitants, and the population has declined in recent years. This low population density affects the level of tariffs, as fixed costs must be distributed among fewer users compared to other provinces. Nonetheless, we are extremely satisfied with the results we are achieving. We are also proud of the consistency we have maintained with respect to the initial area plan and the decisions made – benefiting from a kind of 'positive inertia' over time, which makes it more difficult to reverse course once decisions have been implemented*".

Walter Giacetti adds: "*As time passed and the various phases of the project were implemented, the possibility of turning back became increasingly limited*".

9.
Effective recycling through research and development and integrated supply chains: the Revet case[1]

9.1. The history of Revet and the stages of its development

Revet S.p.A. is an Italian company based in Pontedera in the province of Pisa, a leader in waste management and recycling, with a particular focus on the recovery and treatment of plastic. Founded with the aim of making a significant contribution to environmental sustainability, the company has developed innovative solutions and integrated systems for the management and recovery of materials over time.

Its history is distinguished by its constant commitment to the adoption of sustainable practices and the strengthening of the *circular economy*.

The origin of Revet dates back to 1986 in Empoli, when a small entrepreneur, initially specialized in the trade of glass cullet, proposed to collect glass with the bell model that is still the model with which most of the glass collection is carried out in Tuscany and founded what would become a reference point in the recycling sector. The name "Revet" derives from "Recupero Vetro Toscano", a clear reference to the initial activity.

In the early 90s, Revet expanded its range of action to other materials: metals and then plastics discarded by some companies became attractive to other companies, so much so that Revet also began to take an interest in urban waste.

The Terrafino industrial area, in Empoli, becomes the site of the first Revet plant, where materials are brought to be sorted and sent to recyclers, with the aim of responding to the growing need for effective waste management and the recovery of recyclable materials in Italy.

[1] This chapter was written by Giulia Romano and Maria Silvia Fiorelli who wrote paragraphs 9.2, 9.3, 9.4.2, 9.4.3 and 9.5 and 9.1 and 9.4.1, respectively. For the realization of the case, in addition to the analysis of company documentation such as financial statements, sustainability reports, website, etc., two on-site visits to the Revet and Vetro Revet plants and interviews were carried out with the CEO Alessia Scappini, the Communication Manager Diego Barsotti, the Plant Manager Stefano Masci.

In 1994 in Italy, in the province of Livorno, in Rosignano, the first experiment of separate collection of multi-material packaging (glass, plastic, metals) was launched. A few years later, in 1997, with the introduction of the Ronchi Decree, the separate waste collection system was officially born in Italy, with the creation of CONAI and the signing of the first ANCI-CONAI framework agreement. In 1997, Revet quickly adapted to these new needs, expanding its field of intervention to other recyclable materials. As Ing. Alessia Scappini, CEO of Revet: "*since then, this private initiative has been increasingly evaluated positively; Local public administrations have given more and more strategic value to this activity, understanding that it was no longer appropriate to delegate the management of this recycling chain to a third party, representing a resource for communities, allowing virgin materials to be replaced and having a deposit of new materials available to replace virgin raw materials. So the public administrations gradually acquired the share capital of this company and also allowed its subsequent development*".

In the early 2000s, Revet was responsible for the management of separate waste collection in most Tuscan municipalities; the Empoli plant became insufficient, so alternative areas were identified, including the Gello area, in Pontedera, which is located in a central position with respect to the region and well connected to the main infrastructures. During the 2000s, Revet significantly expanded its activities, opening new plants and diversifying the services offered; the original founder was definitively liquidated.

It was during this period that the company started the construction of innovative plants for the treatment of plastics and the production of high-quality recycled materials, pursuing the goal of reducing dependence on landfills. Today Revet deals with the separate collection of glass in almost all of Tuscany, with 24,000 glass bells-containers.

In 2004, work began on the construction of the new plant in Pontedera, which included a plant for separating materials from separate waste collection, and in 2007 a more performing plant for the separation of polymers was inaugurated, responding to the changing needs of Tuscany, where some municipalities separated glass from multi-material, which thus became lighter. In 2008, Revet sold the majority of the glass sorting branch to the company LaVetri Srl, while maintaining a minority stake and an industrial synergy for the preparation of scrap destined for the glassworks.

In 2010, Revet became a joint-stock company with predominantly publicly-owned capital, with the Tuscany Region as the main shareholder through Fiditoscana, while the other shareholders are the former Tuscan municipal companies that deal with waste collection and treatment.

Since 2010, Revet has focused on new technologies to optimize the efficiency of the recycling process. State-of-the-art plants have been

developed for the treatment of plastic waste and the production of high-quality recycled materials, compliant with European regulations. During this period, the company has also embarked on a digitalization path, improving the management and monitoring of waste streams.

In 2012 Revet Recycling was born, a spin-off controlled 51% by Revet and 49% by Refri (Unieco group), with the aim of creating a new plant for the recycling of polyolefins extracted from plasmix, i.e. the fraction of heterogeneous mixed plastic that remains after the separate collection and selection processes.

In 2013, the first Italian plant dedicated to plasmix recycling and the production of granules derived from polyolefins was inaugurated, and Revet Recycling began to market its granules throughout Europe, destined for manufacturers of new plastic objects, such as components for construction, automotive, household items and outdoor street furniture.

In recent years (2021-2025), Revet has consolidated its commitment to environmental sustainability. The company has expanded its service offering, proposing innovative solutions for municipalities and businesses, in order to reduce environmental impact and improve the efficiency of waste management processes. In addition, he has collaborated internationally, participating in European projects to develop new technologies and recycling strategies.

The company has received numerous awards and recognitions for its innovations in the recycling sector and for the quality of the services offered. Just think that the collection of multi-material and glass in Tuscany is almost entirely in the Revet collection basin, both directly and indirectly (the managers bring the material to Revet). Some managers manage the collection of materials and provide transport (such as Geofor in the province of Pisa), while in some municipalities Revet takes care of the collection directly, since each municipality adopts specific models. The main differentiation concerns multi-heavy and multi-light materials. In the case of multi-heavy, glass is still considered part of the plastic in various municipalities in southern Tuscany. In addition, there are various collection systems, such as door-to-door and separate collection of glass and cans. Each municipality uses different types of collection bells, which requires the use of different vehicles, making logistics management complex.

9.2. The Business Model

Revet has four plants located in the Pontedera plant: a CSS (Selection and Storage Center) selection plant, a CC (Sorting District Center) selection plant, a steel proler production plant and a plastic granule production plant.

In addition, its subsidiary Vetro Revet, a joint venture with the Veneto-based company Zignago Vetro, owns the "oven-ready" cullet production plant in Empoli.

Revet plants receive the material to be treated by the municipalities, but as soon as that material crosses the gate, it becomes the property of Conai's supply chain consortia, such as Coreve for glass and Corepla for plastic.

The Pontedera and Empoli plants have a strategic position with respect to the main communication routes of Tuscany which has contributed to making possible the transformation of Revet from a territorial company to a company for the whole of Tuscany and central Italy. The areas where Revet plants are located have a surface suitable for hosting storage to meet the multiple needs of customers in a flexible and dynamic way; Revet also exploits areas available in satellite centers located throughout the region.

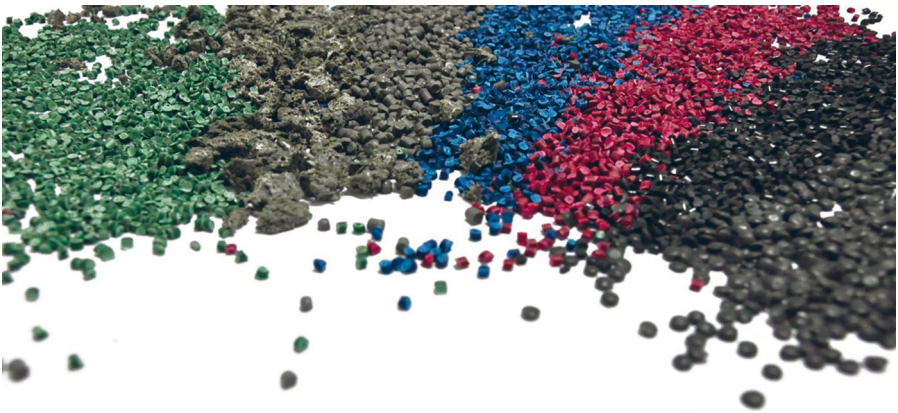
Revet is a company with a business model that is unique today on the national scene. As its CEO Scappini states, "*Revet has this strength, this advantage and this complexity of having three 'souls' within it: it is a majority public entity, which therefore deals with local public service, together with the waste utilities of Tuscany: it is therefore a company that interfaces directly with the local regulators, with the municipalities and with the waste collection and treatment service; it also has a soul aimed at recovering, selecting and recycling packaging which then, through CONAI and the various supply chain consortia, returns to being packaging: it therefore interfaces with the firms who then remake new packaging from the collected and selected materials; the last soul of the company is to be a recycler itself: Revet has gone a long way to directly recycle polymers that would otherwise not find a place on the market*".

Revet has made innovation in both business and governance one of its key strengths, seeking uniqueness in its ability to make the circular economy a tangible reality – even in areas where markets are still undeveloped or immature. In fact, it not only recycles glass, Tetrapak, and ferrous and metallic waste, but also produces a granule made from a mix of plastics, which represent the vast majority of packaging currently found in separate municipal waste collection.

Revet's business scope is limited to the Tuscany region. The waste collected from the many Tuscan municipalities – specifically multimaterial and glass waste – is sent to a single facility in Pontedera, where it is sorted and recovered by packaging type.

Revet serves around 200 municipal administrations and over 80% of the population of Tuscany, making it a key player in the collection and treatment of plastic, metal, and glass waste across the region.

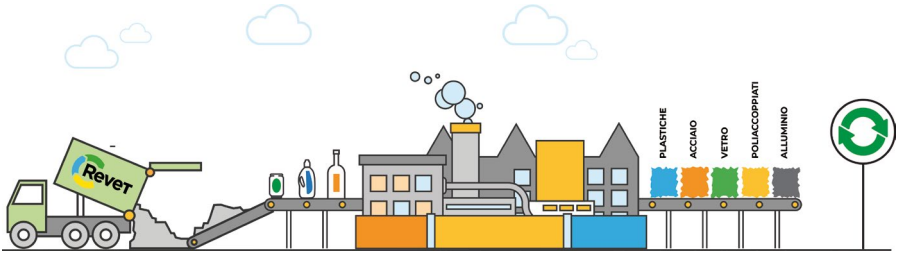
Figure 9.1 – The granules produced by Revet



Source: Corporate

With regard to glass – the company's original core business – Revet directly collects 88% of the glass waste generated in Tuscany, covering municipalities that are home to 3.2 million residents. The collected glass is transported to Vetro Revet, a joint venture with the glass manufacturer Zignago Vetro, which holds a 51% stake. The Vetro Revet sorting and treatment facility is located in Empoli, where the Zignago glassworks is also based. The latter specializes in the production of hollow glass – such as bottles and jars – primarily for the food industry.

Figure 9.2 – The materials treated by Revet



Source: Sustainability Report, 2023

Revet is also responsible for the collection of multi-material waste (plastics, ferrous and non-ferrous metals, aluminum, Tetra Pak, and glass in areas where the so-called "heavy multi-material" collection still includes glass alongside other packaging waste). This waste is collected using both

Revet's own fleet and in support of the services provided by other waste management operators in Tuscany.

The multi-material waste delivered to the Pontedera facility is sorted by material type, and in the case of plastic packaging, also by shape, color, size, and polymer type.

The selection is functional to allow the actual start of recycling, both through the transfer to CONAI or within recycling chains, and for the production directly by Revet of its granule to be resold for various productions, from furniture to car and motorcycle components.

As the CEO points out: "*if you look at how the contents of the multi-material separate collection bag are composed, today we have about 30% of plastic packaging that can go back to being, once recycled, new packaging, 5% metal packaging and 1% aluminum, 4% tetrapak: another 60% of material made up of many types of packaging remains, mainly made with polyethylene and polypropylene and, unfortunately, in recent years also composed more and more of polylaminates, therefore produced with different composite materials, plastics, but also increasingly of paper, especially in the packaging component for the food preservation chain; this type of packaging does not find the recycler downstream who makes that type of packaging perfectly; so, to date they are materials that have suitable characteristics for energy recovery but which are hardly used as material recovery*".

Having identified a business area not yet covered by existing operators, Revet began building a new plant in 2020, which has been operational since the end of 2021. The company has developed a highly integrated supply chain to extract, as a first step, all packaging materials that share the characteristic of being recyclable together. Scappini points out: "*These are packaging made from a material, which derives from the refining of oil as a by-product, ethylene. There is a wide availability of this substance and it has very diversified uses in industrial production, including packaging: the vast majority of packaging, about 72% of what we find in the multi-material delivered and which would remain 'orphaned' of packaging recycling is made of polyethylene and partly also of polypropylene, derived from ethylene. Revet has focused in recent years on understanding how to intercept this material and make it recyclable, both in the case of homopolymers and copolymers*".

The Revet plant achieves a very positive mass balance in terms of sorting and final recycling: over 68% of the packaging collected in Tuscany and processed at the plant is effectively recycled.

The CEO explains:

"*This capability is not only the result of Revet's technological investments, but is also inherent in its business model, which positions the company as a key player starting from the collection phase. This allows Revet to gain deep insight into the nature of the waste to be recycled – specifically plastic*

packaging, which is highly variable in composition, shape, color, and other characteristics. Through the collection and sorting processes, Revet conducts numerous input analyses that enable the optimization of optical sorters. These systems continuously enrich the company's database, thereby maximizing the ability to identify and recover recyclable packaging. This approach is truly unique".

In addition to this aspect, another strategic choice has proved to be a winning one for Revet: not to carry out monomer recycling for plastic packaging. In fact, as Scappini points out: "*we know that packaging recycling does not lead to a virgin 'green' polymer, but to an already modified polymer. This is because packaging contains several substances added for their function and aesthetics. When recycling different plastics together (e.g. polypropylene and high-density polyethylene), the resulting material is not heterogeneous, but a composite with its own chemical-physical and mechanical characteristics, different from the original virgin polymers, but constant. The recycling process shortens the polymer chains and increases the amorphous part, allowing the recycled polymer to accommodate a greater amount of fillers (such as the mineral ones used to make polyethylene more rigid). This ability to 'enrich' itself is greater in recycled polymer than in virgin polymer*".

The company's approach is therefore not to replace a specific virgin polymer with the same recycled polymer. Revet aims to analyze the mechanical characteristics required for a certain product (UV resistance if it has to be outdoors, water resistance, fire protection and so on, depending on the type of functionality and end use thinking about the manufacturer's needs to make a new product) and tries to achieve the same performance by using its own recycled composite polymer, taking advantage of the additives already present and adding new ones when necessary. In addition, the choice of making a two-phase extrusion allows the material to be plasticized by managing any inclusions of non-melted polymers and guaranteeing a final material with constant characteristics.

Scappini points out: "*Since there is no legislation that generally provides that in all plastic products there is at least a minimum recycled content, recycling is in fact left to the sensitivity of producers and information for consumers. For us, it is important to let citizens know that high-quality plastic can be produced through separate waste collection, and to show businesses that there are concrete opportunities for using recycled plastic. This is a key activity for us, with an economic impact as well. In fact, we have an in-house research and development department, including a dedicated division with a laboratory for material characterization and a pilot plant that allows us to simulate what happens when the granule is used in a specific type of application*".

In particular, Revet's Research and Development Center is dedicated to the development and qualification of innovative materials, obtained from qualified post-consumer or industrial waste. It focuses in particular on the technological development of polymers resulting from the reuse of plastic packaging.

The activities of the Centre, in collaboration with several university laboratories, include the design, engineering and implementation of prototypes and advanced technological systems for applications to "second-life" plastics. It also manages laboratories and experimental plants, even on a large scale. This approach makes it possible to significantly replace virgin raw materials with "enriched" recycled materials suitable for specific productions and already tested for certain performances, which are enriched by the possibility of declaring their packaging or materials used as "recycled" and therefore more sustainable because they have a lower impact in terms of CO_2 produced.

Scappini points out: "*Thanks to our unique model, a company that has its own regional collection basin, with a single logistics that brings separate waste collection within a single plant hub and where it is not only selected, but also recovered and transformed, a secondary raw material, polymers, with a very low carbon footprint is generated with a saving of 75% compared to virgin raw materials. It is a result that allows the user of these materials to make products more sustainable and that for this reason find their competitiveness on the market. This is the element that allows us to look directly at companies to propose our granules as an alternative*".

With the granules obtained in Revet, which has clear and constant performance, such that the user can insert it into their machinery as if it were a virgin raw material, it is thus possible to obtain new objects, from indoor or outdoor furniture to household objects, dashboards for the car, a building component, a component of a car or household appliance and so on.

In conclusion, Revet's business model is based on three elements: the first lies in its ability to trace plastic materials from the beginning to the end of the sorting and recycling process.

The second element is an intense research and development activity that allows the company to collaborate directly with manufacturers of plastic products. Revet supports these companies by studying their specific application needs, carrying out industrial tests directly on their machinery and proposing customized solutions.

Finally, another fundamental element of Revet's business model is the concentration of all the selection and treatment phases in a single plant in Tuscany. This centralization makes it possible to obtain a recycled granule with a significantly lower carbon footprint not only compared to virgin

plastic, but also compared to other types of recycled material. The latter, before being reused, often pass through four or five plants located throughout the country, with a much longer processing cycle than that of Revet, which instead significantly reduces environmental costs.

9.3. Ownership structure and corporate governance

9.3.1. The ownership structure

Born as a private entrepreneurial initiative in Empoli, as the strategic, economic, environmental and social importance of waste collection and management for local public administrations increased, the capital was gradually acquired by public entities. In 2003, in fact, four of the most important Tuscan public utilities of the time in the urban waste management sector entered the capital of Revet: Publiambiente, Quadrifoglio, Sienambiente and Geofor. The public shareholders became the majority at that stage[2].

At the end of the 2000s, in parallel with the launch of research projects to evaluate the recyclability of polyolefin blends selected from post-consumer plastics, Revet also saw the entry of FidiToscana into its capital and the launch of its turning point industrial plan[3].

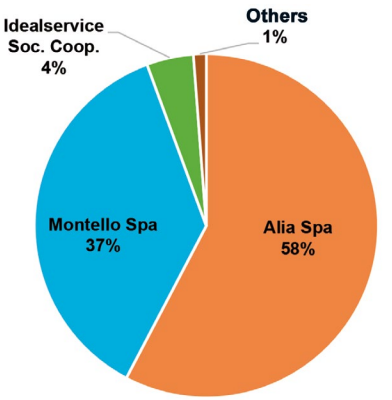
In 2019, in fact, Revet, with the aim of developing a technologically advanced plastic recycling hub and reference for central Italy, changed its ownership structure again, with the entry of Montello SpA with 30% of the shares, Sienambiente with 13.39% and Idealservice with 4.44%. Alia, born from the aggregation of the companies Quadrifoglio of Florence, ASM of Prato, Publiambiente of Empoli and Cis of Montale, remained the majority shareholder holding 51% of the shares.

With this corporate transition, the ownership and corporate governance of Revet has taken on its current structure with the presence of a public soul and the presence of a strong private partner to support its development through major plant investments.

Revet is therefore a mixed-owned, public-private company. In particular, for the public part, Alia Servizi Ambientali manages environmental services in central Tuscany; Retiambiente is the holding company that brings together the managers of the coastal provinces of Tuscany, with 0.46%.

[2] Revet, Sustainability Report 2019.
[3] *Ibidem*.

Figure 9.3 – The distribution of Revet's capital among the main shareholders



Source: Sustainability Report, 2023

The private component of Revet is guaranteed by the industrial partners: Montello Spa, a leading company in Italy in the recycling of plastics and in the recovery of materials and energy from separate organic waste collection, and Idealservice, a cooperative company with 4.44%; the latter is a long-standing partner of Revet, and operates in the fields of ecology and environmental services, facility management, recycling and reuse of waste.

Montello S.p.A. was founded as a steel company that produced steel and reinforcing bars until the end of 1995. Subsequently, due to the repeated crises in the national steel sector, it converted towards recovery and recycling of plastic packaging waste and organic waste from separate collection. Today, Montello has about 650 employees, with a considerable increase compared to the time of the closure of the steel business, when there were 320 employees. At the Montello plant, in the province of Bergamo, 350,000 tonnes of post-consumer plastic packaging are currently recycled per year, resulting in new products. In addition, 765,000 tons per year of organic fraction from separate waste collection are processed, from which biogas used to produce electricity and thermal energy, as well as biomethane, is obtained. The company also recovers carbon dioxide (CO_2) for industrial use and produces a high-quality organic fertilizer[4].

[4] Company website.

9.3.2. The Management Board

Alia Servizi Ambientali holds the majority of the shares and exercises significant influence on corporate decisions, including the appointment of directors. In 2021, the shareholders' meeting appointed Nicola Ciolini as Chairman and Alessia Scappini as Chief Executive Officer of Revet S.p.A., both coming from Alia Servizi Ambientali S.p.A.: the former had been its chairman since December 2020, while the latter held the position of Chief Operating Officer.

Revet's Board of Directors, at the time of approval of the 2023 financial statements, is composed of seven members, four men and three women.

Alessia Scappini, a graduate in chemical engineering, is responsible for the implementation of the strategic and managerial objectives of the Board of Directors.

9.4. Revet stakeholders and recycling supply chains

Revet has been preparing the sustainability report annually since 2018. It has identified some key stakeholders (*Figure 9.4*), with whom it maintains intense and continuous relationships. "*Dialogue with stakeholders creates value for us and for the community*"[5], the company states in its sustainability report.

Figure 9.4 – Revet stakeholders

Source: Sustainability Report, 2023

[5] Revet (2023), Sustainability Report.

Among the institutions, the Tuscany Region plays a central role, which in September 2018 included among the general principles of Article 3 of the Statute the promotion of the conditions for sustainable development and in the main purposes: "*The promotion of the circular economy, as an economic model suitable for regenerating itself, through the enhancement of consumer waste, the extension of the life cycle of products, the sharing of resources, the use of secondary raw materials and the use of energy from renewable sources*".

Revet is the most important recycling hub in Tuscany and central Italy, a reference point for the circular economy and has developed intense collaborations with some industrial partners, creating some "short" circular recycling chains. As can be read in its 2023 sustainability report, "*the main motivation that has guided the growth and development plans of recent years has in fact been the firm desire to give Tuscan separate waste collection a horizon and an industrial outlet*"[6], precisely by ensuring the effective start of recycling materials, enhancing the efforts of citizens and businesses in separating the urban waste produced at source. As the CEO, Alessia Scappini, points out, "*Revet has had the ability to systematize a series of supply chains and create a territorial circular economy system*".

9.4.1. The glass recycling chain: Vetro Revet and the relationship with Zignago Vetro

The glass recovery system is an element of excellence for Revet thanks to the creation of Vetro Revet, a company based in Empoli specializing in glass recycling. Founded in the early 80s, in 2017 it took on its current configuration with capital divided between Zignago Vetro S.p.A. (51%) and Revet (49%).

The company operates the plant in Empoli, where about 35 people work in several shifts, with an annual capacity of 150,000 tons; The collected glass is subjected to a high-tech selection and purification process. This process includes crushing, drying, screening, iron removal, plastic vacuuming, and optical sorting using high-definition cameras and X-rays to remove impurities such as ceramics, metals, and lead-containing glass.

The end result is a material ready to be reused in the melting furnaces of glassworks. In 2022, the plant treated 136,000 tons of glass, with a final yield of about 95% of the material introduced, of which 85% is recovered glass and 10% consists of other materials destined for external plants for further recovery processes.

[6] *Ibidem*.

Thanks to a short and integrated supply chain, Vetro Revet has contributed to a significant increase in glass recycling in Tuscany. Since 2010, separate glass collection has increased by 160%, while actual recycling has grown by 505%, reaching a recycling rate of 96.5% of the total collected in the region in 2024, equal to over 110,000 tons.

Barsotti points out: "*Glass has always been a recyclable material and indefinitely, but it is a material that does not tolerate impurities. This is why the work of Vetro Revet is important to clean everything that is not glass. The most important problem that needs to be solved concerns the material that looks like glass, but is not, such as crystal, baking dishes or mirrors, or porcelain or ceramics; the latter, in the process shatters into many pieces and even a small piece can contaminate even many bottles*".

Vetro Revet collects mainly in the area of Tuscany, and the Plant Manager, Stefano Masci, highlights: "*therefore even within a single region there are municipalities that are more virtuous because they have disseminated information better or in any case have involved the population more or have also adopted collection techniques that reward selectivity. Better quality leads to better yields and yields*".

The peculiarity of Vetro Revet is the presence of the Zignago production plant one kilometer from the headquarters in a historic site; the area, in fact, is a fairly fertile territory for companies that deal with glass production. Zignago Vetro is a historic Italian company, founded in the fifties by Gaetano Marzotto, specialized in the production of hollow glass containers for the food, beverage, cosmetics and perfumery sectors. Zignago Vetro has this plant in Tuscany, another plant in Portogruaro and two others abroad, one in France and the other in Poland. In France, glass containers for perfumery are mainly produced, while in Empoli and also in Portogruaro the production is mainly intended for *food and beverage*. In Portogruaro there are also lines dedicated to cosmetics (we are talking about glass containers for perfume or nail polishes), while in Empoli they mainly produce glass containers for beer, wine, oil.

Masci points out: "*It is really rare to have the glassworks, recovery and treatment a few kilometers away and in the same region where separate collection is done: the treatment plant that recovers the glass from the municipalities, recovers it, treats it and then sells it to the glassworks that produces the containers*".

This aspect represents a significant element of economy given that the bottles are light; therefore, transport has a significant impact on overall costs and therefore also on the final price. Normally, in fact, a glass factory has a preference in selling its products within a radius of about 300 kilometers.

The glass cycle starts with the dedicated street bells: in some areas of the region there is mono-material, but in others multi-material is still widespread: that is, glass is delivered together with metal or glass together with plastic.

Masci points out: "*The goal is to be more and more selective; door-to-door has contributed to creating a virtuous system of selectivity; however, for glass it is not yet convenient and the use of bells is preferred, which are widespread and distributed throughout the territory*".

Unfortunately, Revet glass does not only receive glass on acceptance, but a little bit of everything such as ceramic or glass that contains lead, i.e. crystal.

This happens because of incorrect disposal or because the jar, for example, is very often thrown away with a metal cap.

"Processing waste" is precisely ferrous and non-ferrous materials, such as iron and aluminum; A primary waste is glass contaminated by lead which is one hundred percent glass but cannot be recovered as it is not accepted by glassworks. Ceramic also creates problems inside the kiln because it melts at a higher melting point than glass, which is why it turns into an infusion, a foreign element that is then not homogenized inside the glass, creating a weakness inside the container.

In this circuit, Revet delivers everything it collects to Vetro Revet and all the selected glass currently goes to Zignago. The quantity of a truck leaving the furnace for each transport is about 30 tons, the plant has an authorization for 150 thousand tons, on average at least 130 thousand tons (average of recent years) are treated during the year with a yield of more than 80%.

In the first processing phase, the elimination of magnetic materials takes place, following which manual sorting, dimensional screening, crushing, drying, optical selections and X-ray selection are carried out for the separation of glass containing lead. The technological evolution of Vetro Revet has led to the possibility of separating glass by colour, between white (15% of the total) and coloured-mixed (85%).

4% of post-processing waste ends up in landfills because it is materials that can no longer be recovered; The discarded ceramic is sold to another plant that treats precisely this type of material and then turns them into the classic aggregates that are used, for example, for road surfaces.

The consolidated collaboration between Zignago and Revet represents a consolidated public-private relationship that has given rise to the project to create a new Revet plant even closer to the glass factory, with new technologies and superior performance compared to the current plant.

9.4.2. The Tetrapak recycling chain: the collaboration with Lucart

Another "short" circular supply chain that is present in Tuscany is that relating to Tetrapak. For this material, which was difficult to recycle in the past, Revet has proactively taken action to collaborate with a local industrial player and create a new recycling opportunity for cartons for liquid foodstuffs.

Revet, in fact, has implemented a technology that allows Tetrapak beverage packaging to be identified within the multi-material, allowing the material collected in Tuscany to be recycled.

Barsotti points out: "*Tetrapak's waste in Tuscany should be disposed of only and only together with plastic. Tetrapak is mainly composed, for almost three-quarters, of cellulose fiber, with just over 20% polymers and a small percentage of aluminum. By putting it in the paper it is mixed together with all the other types of paper sent for recycling and therefore there is a less valuable recovery. Since the cellulose fiber of which the Tetrapak is made is particularly valuable, if recycled alone it allows you to produce objects for the home or for the person such as napkins, handkerchiefs and toilet paper with that material: therefore a recycling with higher added value*".

In Tuscany, in the Lucca paper district, there is a plant of the multinational Lucart that recycles only tetrapak; It is one of the two largest European plants for the recycling of Tetrapak. This plant has the ability to separate and recover the cellulosic part, the plastic part and the aluminum foil contained in the tetrapak containers. Scappini points out: "*We thought it was appropriate to build a Revet plant that would sort the tetrapak after the waste of that material had been disposed of in the multi-material instead of in the paper; this in the knowledge that the tetrapak, being used as a container for liquids, put together with paper could easily deteriorate it with liquid residues inside, making it more difficult to recover paper waste. So we proposed to have the tetrapak containers collected in the multi-material in Tuscany, together with the other containers for liquids, so that it could then be easily selected with the same technologies of the optical selectors we use in Revet*".

This synergy between Lucart and Revet has allowed both companies to grow, with Revet now able to provide Lucart with a selected material from which to recover cellulose, aluminum and plastic materials, closing the cycle.

Lucart launched the EcoNatural project in 2010 to obtain two new materials from tetrapak recycling, a recycled cellulose and a homogeneous material composed of the polyethylene and aluminum component[7].

Scappini points out: "*Initially, Lucart had an initial recycling plant, but it was difficult to get a suitable recyclable material from the paper mills. Together, with our respective technologies, we have both had an evolution and in plant engineering we have calibrated ourselves on Lucart's ability to recover the tetrapak by creating the circular supply chain together*".

From 2013 to 2023, Lucart helped recover 10.7 billion beverage cartons, avoiding the use of more than 4.6 million trees and saving emissions equal to more than 2.1 million car trips from Rome to Milan[8].

[7] Lucart, 2023 Sustainability Report.

[8] *Ibidem*.

9.4.3. The plastic recycling chain: the partnership with the floriculture district

Revet plants receive and treat the multi-material collected in Tuscan separate waste collection. The plastic waste received is divided according to color and type. As Barsotti points out: "*for PET alone there are five different streams (transparent, blued, colored PET, transparent PET trays and opaque PET trays); Then there are, among others, polypropylene or polyethylene bottles, plastic films and bags. In the end, from the multi-material collected, 19 flows are obtained, plus metals, which have two other distinct ones (aluminum and tinplate)*".

The selection is carried out through different technologies and processes: magnets to separate metals, eddy currents for aluminum, ballistic screens for bags and optical selectors.

Barsotti points out: "*Each optical selector recognizes only one type of packaging. So when they invent a new product, such as opaque pet, we had to introduce a new reader and teach them to recognize that type of packaging*".

The plastics that have the most value and are easy to recycle through the Corepla consortium are sent to recyclers; Revet, on the basis of an agreement with Corepla, retains the mixed packaging that is taken to the recycling plant which, at the end of the process, allows a granule to be obtained that is subsequently sold to printers of plastic objects such as chairs, tiles, flower pots. Barsotti proudly points out: "*There are only two other companies in Italy that have this mixed plastics recycling chain: in the rest of Italy and Europe, mixed plastics usually go to energy recovery. So we subtract material from waste-to-energy and recover it as material*".

In the face of this positive result, so far it has not been possible to obtain real incentives, such as a VAT concession for products made from recycled materials – as says Barsotti: "*if an object is made of recycled plastic, this plastic has already paid VAT once; therefore, we asked ourselves why pay it again, or at least in our opinion a reduction would be useful, for example to 10% instead of 22%*".

All the granules it produces, Revet manages to sell; Barsotti says: "*The second line of the plant is under construction, so production will double, both because more and more separate waste collection arrives, and because the granule has a market, thanks to the ability to 'calibrate' production to customer needs. Most of our granules are destined for the floriculture industry*".

Horticulture is one of the most important districts in Tuscany and is a European leader in the production of ornamental plants. In recent years, it has embarked on a path towards sustainability, focusing on reducing the use of pesticides and chemical fertilizers and on the responsible use of water

in cultivation. Scappini points out: "*This is a leading industrial sector for our region and which, fortunately, has shown itself to be sensitive to sustainability issues. However, at a certain point, it was realized – and we, as Revet, have urged this awareness – that the plant that was placed on the market, and we are talking about a market where 80% of the plants produced in the Pistoia district are exported beyond the Italian borders, traveled with a pot of which the producers knew very little. These were plastic materials whose composition and fate were largely unknown*".

Revet has played a crucial role first of all in raising awareness in the Tuscan nursery sector, making sure that the same care and attention to sustainability that was dedicated to the production of the plant was also paid to its container, expanding attention to the entire value chain.

Revet proactively solicited and then implemented a memorandum of understanding in June 2024 with the companies in the district to ensure that the pots and plastic components for irrigation systems are reclaimed by Revet and then recycled together with the post-consumer packaging of Tuscan separate waste collection to obtain granules that can be used by the printers of new pots for nurseries. This protocol has allowed the floriculture industry to fully enter the circular economy, with benefits for all players in the supply chain: certain, economic and sustainable management of nursery waste; use of a sustainability label that guarantees a closed and circular recycling chain and certifies the low carbon footprint of the product; cancellation of the CONAI environmental contribution on the collected pots.

Scappini points out: "*It was our request. Historically, the plant pot is one of the objects that most often uses recycled materials. However, it is not certain that these materials come from the separate collections of citizens; indeed, much more frequently they derived from post-production waste or other types of plastic material production. The pot, especially the one used in the processing and growth phases of plants – because today less and less production takes place on the ground, and more and more in pots, thus generating a waste of pots directly from production –; that plant pot there, even if it historically uses recycled materials from all over the world, in any case from production waste, did not have a supply chain that could actually demonstrate significant environmental performance. We presented mass balances to the Pistoia district, and the nurserymen were happy to become the promoters of a circular conversion, urging the pot printers – an allied industry that was born and grew strongly around the Pistoia nursery district – to use materials whose carbon footprint was known and for which environmental and mass balances could be carried out, in order to actually calculate the* CO_2 *savings*".

Through a specific logistical activity, the process involves the collection of pot waste directly from larger nurseries and through collection centers,

the reclamation and treatment of these pots by Revet and the reintroduction of recycled material, together with plastic from the separate collection of citizens, to produce new pots.

This system therefore makes it possible to reduce the environmental impact of the nursery sector through a circular supply chain that reuses waste, which also represents a solution to the problem of disposing of used pots. It also makes it possible to obtain a production of 100% recyclable pots, compliant with European regulations and to trace the carbon footprint and quantify CO_2 savings. At the same time, this supply chain makes it possible to enhance the separate collection of citizens, offering a certain fate for the plastic collected in Tuscan municipalities.

In summary, thanks to the collaboration with Revet, the Pistoia nursery district is transforming an environmental problem into an opportunity for a circular and sustainable economy, with benefits for the entire territory.

Scappini points out: "*Revet in its plant obtains a granule that is used precisely for the production of pots, creating a completely closed supply chain, where even the nurseryman's waste finds its place, avoiding weighing on the disposal system. From that waste of the plant pot, the same plant pot is remade. This is a project that we have carried out and that has given and is giving excellent results. Before, there was also a fragility in the disposal system of these vessels, which for the vast majority ended up in disposal, or at most in energy recovery. Instead, in this way, we have set up a system that, thanks also to the fact that the materials with which nurserymen grow plants have greatly reduced the use of phytosanitary products, also allows us to wash pots without polluting the water. There is therefore a whole integrated activity, because clearly, if circularity can be created, it must be done well, so as not to simply transfer pollution, but to create a situation in which the overall environmental balance is positive and successful*".

In addition, downstream of this process it is important that the pot remains a recyclable pot. Scappini recalls: "*Today, wherever I go in the world, the jar obtained with the Revet granule is 100% recyclable, because it is compatible with all the regulations that require plastic pots to be shredded, selectable by flotation and recognizable by optical readers, which is exactly the process that takes place within Revet. It is with this strength that we have been able to approach such an important sector, which in any case had a significant consumption of plastic materials, and therefore have the possibility of introducing a closed supply chain that feeds itself and that finds on our part, from the public part 'of the public service', the location of separate collection, in order to increase the possibility of including the materials coming from the collections within the production cycle of the pots of citizens, also giving the latter a certain location*".

9.5. Economic, environmental and social performance

Revet's mission is "*to contribute to making the world better through environmental, social and economic sustainability*", looking at "*the circular economy through the lens of efficiency, innovation and industry*".

In its sustainability reports, the company has made explicit its desire to "*transform the 'urban deposits' of Tuscan separate waste collection into resources and new products*"[9].

Revet serves 80% of Tuscan citizens, collecting plastic, glass, aluminum, steel and tetrapak packaging in almost 200 of the 273 municipalities of the Region. In particular, it processes 20% of Tuscan separate waste collection (16% in 2019) and about 3/4 of plastic, glass, aluminum, polylaminate and tinplate packaging collected in Tuscany.

In 2024, the Pontedera plant treated about 175,000 tons of waste, more than 80% of the multi-material that is collected in the Tuscany Region and all glass waste, collected directly in the municipalities served or indirectly through the companies active in waste collection in Tuscany.

The dedicated collection of glass, in Tuscany, has contributed greatly to improving the recyclability of materials, with effects also on cost-effectiveness. Barsotti points out: "*Waste collection represents a critical challenge for us from multiple perspectives, as it is a service that is inherently complex to manage. For instance, plastic must be compacted during transport to optimize load efficiency – otherwise the operation would essentially amount to 'transporting air'. By contrast, the same practice cannot be applied to glass: when compacted in collection vehicles, glass fragments and consequently loses its recyclability*".

As the CEO points out: "*we are aware that companies still try to produce at low cost; therefore, the fact that we have imports that are not particularly controlled or regulated also in terms of sustainability or product safety, does not help our recycling chains*".

Despite this, Revet's recycling mass balance sees over 67% of incoming material actually sent for recycling, with a growth of over 50% in materials treated from 2018 to 2023 (*Table 9.1*).

[9] Revet, Sustainability Report 2019.

Table 9.1 – Materials processed (in tons) in the various recycling and treatment plants and lines

MATERIALS PROCESSED (in tonnes)	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2018-2023*
CC PLANT (District Centre for selection and pre-treatment)	54.660	70.637	84.225	94.128	95.636	94.699	73,30%
CSS PLANT (Sorting and Storage Centre)	47.859	53.247	49.251	38.758	52.329	56.386	17,80%
GRANULE RECYCLING LINE	11.222	11.901	5.371	4.496	12.932	14.328	27,70%
IRON TREATMENT LINE	Nd	1.100	6.771	6.468	6.693	5.963	442,10%
Total	113.741	136.855	145.617	144.274	168.590	171.376	50,70%

Source: Sustainability Reports, 2018-2023

Even including satellite plants, the total materials treated by the Revet system have grown in recent years. The figure for the percentage of recovery has risen again despite the concomitant increase in the percentage of extraneous fraction, which rose from 24% in 2021 to over 32% in 2023[10].

Table 9.2 – Volumes treated and recycling capacity

	Total materials treated/ processed (in tonnes)	*% disposal*	*% recovery*	*Extraneous fraction*
2021	316580	31.55%	68.45%	24,03%
2022	350465	34.49%	65.51%	27,07%
2023	354048	32.73%	67.27%	32,25%

Source: Sustainability Report, 2023

In 2023, almost 130,000 tons of recycled products came out of Revet and were put back on the market directly. The figure below shows the details.

Figure 9.5 – The products reintroduced on the market by Revet

Anno	*2021*	*2022*	*2023*
Raw material produced and sold to glassworks	42.600	66.800	82.000
Granules produced	2.986	8.158	9.277
Packaging for consortia	9.841	25.112	29.816
Recovered ferrous materials	5.140	5.397	4.879
Laminated polyethylene sent to paper mills	999	1.787	1.368
Total	61.556	107.254	127.340

Source: Sustainability Report, 2023

[10] Sustainability Report, 2023.

As far as the actual recycling of plastic is concerned, the economic convenience is linked to two exogenous elements: the cost of energy and the price of a barrel of oil. Plants such as those of Revet, requiring the presence of large hot sections, where temperatures must reach up to 220 degrees, are energy-intensive and fluctuations in energy prices therefore have a significant impact. In addition, the convenience of recycled granules is greater the higher the cost of the virgin raw material, oil, which tends to fluctuate over time. Increasingly, therefore, Revet has focused on the fact that its granule has a reduced certified carbon footprint, becoming essential for all those products that seek to differentiate themselves also in terms of reduced environmental impact.

In the last five years, Revet has invested more than 62 million euros, thus managing to double the capacity of its sorting plants and triple the amount of plastic it recycles directly. The company plans to continue on this path with an investment plan for the period 2024-2026, focusing on improving recycling lines and building new infrastructure.

Currently, Revet is also focusing on the quality of the materials collected to reduce the presence of impurities, strengthening the collection and selection systems, also through the research and development of new solutions and the creation of a special department[11].

The economic consequences of Revet's work translate into a continuous creation of wealth, with benefits both for the company and for the Tuscany region in which it operates. The distribution of added value in 2023, which exceeds 64 million euros, attests to its ability to generate spillovers for the territory in which it operates. An important indicator of its contribution to the local economy is the fact that most of the supply purchases in 2023 (62% of the 49 million euros) were made by Tuscan companies.

Furthermore, from a social point of view, in the last 10 years, Revet has increased the number of its employees by about 100 units (from 2018 to 223 they went from 185 to 234), with a female presence of 30% and a commitment to training above the sector[12] averages.

Table 9.3 – Data relating to Revet employees

	2018	2019	2020	2021	2022	2023
No. of direct employees	185	202	210	207	218	234
Annual hours of training per capita	19	20	11	22	24	28
Accident incidence	2,70%	2,90%	2,40%	1,90%	5,60%	3,50%

Source: Sustainability Reports

[11] Revet (2023). Sustainability Report.
[12] Sustainability Report, 2023

With 95% of employees on permanent contracts, the company invests significantly in training, with an average of 28 hours per capita in 2023. After hitting a low in 2021, the incidence of accidents rose in 2022 and then declined again.

From an economic and financial point of view, Revet has recorded increasing revenues in recent years, increasing its profitability. Over the years, it has always invested significantly, alongside a growing capitalization and a positive net financial position (*Table 9.4*).

Table 9.4 – The main balance sheet data of Revet (values in €/000)

Year	*Revenues*	*EBITDA*	*Net profit*	*Equity*	*NFP*[13]	*Investments (tangible)*
2023	57.467	13.122	4.961	44.329	21.275	10.296
2022	51.290	10.652	3.118	39.376	22.887	8.259
2021	41.715	7.168	1.257	36.223	22.877	12.551
2020	42.232	7.676	3.114	34.922	17.653	15.689
2019	43.107	6.124	2.078	31.702	12.933	9.097
2018	34.292	4.158	-131	16.552	16.088	3.357
2017	50.702	5.019	702	18.905	17.304	1.738

Source: AIDA data

[13] NFP stands for net financial position.

10.

Sustainable waste management models: geographical-comparative analysis of six European realities[1]

10.1. Geography and territorial contexts of the case studies

In recent decades, sustainable waste management has become a priority for local and national administrations, in response to the increase in waste generation and the resulting environmental impacts. The strategies adopted vary according to the geographical context, public policies and the involvement of local communities. This chapter analyzes six exemplary cases in Europe: Paris (France) for plastic reduction, Capannori (Italy), Gothenburg and Eskilstuna (Sweden) for reuse practices, Pontedera (Italy) for recycling and Rovigo (Italy) for excellence in separate collection.

10.2. The City of Light

Paris is located in the Île-de-France region, in the heart of northern France, along the banks of the Seine, the river that crosses it from east to west, dividing it into two main areas: the *Right Bank* (to the north) and the *Left Bank* (to the south)[2]. Its strategic position in the center of a vast plain has fostered, since ancient times, the development of an important commercial, cultural and political node[3]. The average altitude of the city is about 35 meters above sea level, with the highest point located on Montmartre Hill (130 meters).

The metropolis covers an area of about 105 km², however its economic, political and cultural influence extends far beyond its administrative borders, reaching the entire metropolitan region, known as *Grand Paris*, which covers

[1] This chapter was written by Paolo Rognini.

[2] Mottet G. (1993). *Géographie physique de la France*. Presses universitaires de France.

[3] Combeau Y. (2021). *Histoire de Paris. Que sais-je?* Presses Universitaries de France/ Humensis.

an area of more than 12,000 km²[4]. The urban structure is characterized by a radial system with an organization of concentric circles, with the Kilomètre Zéro, located in front of Notre-Dame Cathedral, as a central landmark. The city is divided into 20 arrondissements, numbered in a spiral starting from the center, each with its own identity and social dynamics currently organized according to the latest law of 2016[5].

Paris is one of the most densely populated cities in Europe[6]. It has about 2.1 million inhabitants in its municipal perimeter, while the metropolitan area, including the *Banlieue* (the suburbs), exceeds 12 million inhabitants, making it one of the main global megacities[7]. Historically, the city has attracted populations from all over the world, transforming itself into a multicultural mosaic. From this point of view, neighborhoods such as Belleville, Château Rouge or the 13th arrondissement are examples of urban spaces where different identities overlap, creating a hybrid culture made up of linguistic, gastronomic and religious[8] contaminations. Such multilocalism has led to tensions between integration and social segregation, raising discussions about the concept of cultural "creolization"[9]. The city also stands out as an international hub for culture, fashion, finance, and scientific research[10], serving as a hub for numerous organizations of global significance, including UNESCO, the OECD, and the European Space Agency.

From an environmental point of view, Paris is an emblematic example of how modern cities face the ecological challenges related to urbanization, pollution and climate change.

[4] "Les services départementaux de Paris", sur *Préfecture de la région Île-de-France*, 3 December 2015, *www.prefectures-regions.gouv.fr/ile-de-france/Region-et-institutions/La-prefecture-de-Paris-et-d-Ile-de-France/Les-services-de-l-Etat-a-Paris/Les-services-departementaux-de-Paris* (last access: 06.06.2025).

[5] Projet de loi relatif au statut de Paris et à l'aménagement métropolitain, n° 815, déposé le 3 août 2016 (voir le dossier législatif, in *www.assemblee-nationale.fr//14/dossiers/statut_paris_amenagement_metropolitain.asp*).

[6] Insee, Évolution et structure de la population en 2021 – Département de Paris, 27 juin 2024 (last consulted, 11 March 2025).

[7] Gomri A., Morer N. & Pancarte K. (2024). *Ville de Paris : un portrait de ses habitants*. INSEE.

[8] Bonvalet C., Bringé A. & Imbert C. (2016). Urban dynamics and residential trajectories in Paris. *Portuguese Journal of Social Science*, *15*(1), 25-46.

[9] Cruz-Rodriguez J.M. (2010). Antillanité et créolité : le travail sur la nomination pour bâtir une identité. *Nouvelles Études Francophones*, *25*(1), University of Nebraska Press; entry "Créolisation, créolité" in *geoconfluences.ens-lyon.fr/glossaire/creolisation-creolite -:~:text=Le terme de créolisation désigne,Cruz-Rodriguez, 2010)* (last access: 11.03.2025).

[10] Zhang X., Zhang Y., Chen T. & Qi W. (2024). Decentralizing the power of fashion? Exploring the geographies and inter-place connections of fashion cities through fashion weeks. *Urban Geography*, *45*(1), 73-92; *Paris, innovative capital*, www.paris.fr/pages/paris-capitale-innovante-2453 (last access: 11.03.2025).

For example, water and the Seine represent the ecological and cultural heart of the city and, as the main natural element that structures Paris, has influenced its urban development since Roman times. Although the river has had different functions throughout history, unfortunately, during industrialization it became a receptacle for waste of all kinds[11].

Today, the city is trying to restore the relationship with the river through redevelopment policies, such as the "Paris Plages" project which, since 2002, has transformed the banks into summer urban beaches. The plan to make the Seine swimmable was also strongly supported by the Municipal Administration for the holding of the 2024 Olympics[12].

As far as the general environmental aspect is concerned, Paris is one of the European cities most committed to the ecological transition[13]. This is being carried out through the implementation of multiple actions including: green roofs and urban gardens, which promote biodiversity and reduce the "urban heat island" effect[14]; the "15-minute city" project developed by Moreno[15], which aims to make each neighborhood self-sufficient in terms of services, reducing traffic and pollution[16]; the reduction of the use of private cars in favor of public transport; pedestrianisation[17] and cycle paths[18]; the reduction of single-use plastics covered by this study[19].

[11] Jeux olympiques: Paris a tenté par tous les moyens de nettoyer la Seine. Y est-elle arrivée? *National Geographic*, June 24, 2024, *www.nationalgeographic.fr/sciences/enquete-jeux-olympiques-2024-paris-a-tente-par-tous-les-moyens-de-nettoyer-la-seine-y-est-elle-arrivee - :~:text=Pendant des siècles, la Seine,déversées directement dans la Seine* (last access: 06.06.2025).

[12] *parisjetaime.com/article/paris-plages-a962*.

[13] *22 European cities recognized for climate leadership in annual CDP ranking*, *www.thesmartcityjournal.com/en/cities/22-european-cities-recognized-for-climate-leadership-in-annual-cdp-ranking* (last acess: 11.03.2025).

[14] *www.paris.fr/pages/la-vegetalisation-du-bati-21439; https://www.paris.fr/pages/paris-plus-vert-la-vegetalisation-s-accelere-la-preuve-en-images-27441* (last access: 06.06.2025).

[15] Moreno C. (2020). *Droit de cité, de la ville – monde à la ville du 1/4 d'heute*. Editions de l'Observatoire.

[16] Papas T., Basbas S. & Campisi T. (2023). Urban mobility evolution and the 15-minute city model: from holistic to bottom-up approach. *Transportation research procedia*, *69*, 544-551. See also: *www.paris.fr/dossiers/paris-ville-du-quart-d-heure-ou-le-pari-de-la-proximite-37*.

[17] Reyes Madrigal L.M., Nicolaï I. & Puchinger J. (2023). Pedestrian mobility in Mobility as a Service (MaaS): sustainable value potential and policy implications in the Paris region case. *European Transport Research Review*, *15*(1), 13.

[18] *www.paris.fr/mobilites* (last access: 06.06.2025).

[19] *pariszeroplastique.fr/*.

10.3. Gothenburg and Eskilstuna

10.3.1. Gothenburg

Gothenburg is spread over a territory that has peculiar geomorphological characteristics, with a combination of coastal areas, islands, rivers and hilly areas. The city is located at the mouth of the Göta älv, the main Swedish river by flow, which crosses it longitudinally and has historically influenced its urban and economic development.

The city area is characterized by an irregular morphology, with an alternation of flat surfaces and hilly reliefs that rise above all in the northern and eastern part of the municipal territory[20].

From a climatic point of view, Gothenburg has a temperate oceanic climate (Cfb according to the Köppen classification), characterized by mild and humid winters and cool and rainy summers[21]. The influence of Atlantic currents and the proximity to the North Sea determines a rather high rainfall regime, with rainfall evenly distributed throughout the year. Winter temperatures generally remain above freezing, due to the mitigating effect of the sea, while in summer they rarely exceed 25 °C[22].

Gothenburg's hydrography is dominated by the Göta älv, which in addition to serving as a natural artery for transport, provides water resources that are essential for the city's supply and for the production of hydroelectric energy[23].

Gothenburg is one of Sweden's largest cities both demographically and economically, with a population of around 600,000, rising to over a million considering the metropolitan area[24]. The urban layout of the city is the result of rational planning that has its roots in the seventeenth century, with a regular plan inspired by the models of Dutch cities and a network of artificial canals that still characterize the city center today[25].

From an economic point of view, Gothenburg stands out for the presence

[20] Westrin T. (1909). Göteborg. In: *Nordisk familjebok – Uggleupplagan* (pp. 890-898). Nordisk familjeboks förl. *web.archive.org/web/20150630232429/http://runeberg.org/nfbj/0481.html*. (last access: 13.03.2025)

[21] Upmanis H. & Chen D. (1999). Influence of geographical factors and meteorological variables on nocturnal urban-park temperature differences--a case study of summer 1995 in Göteborg, Sweden. *Climate research*, *13*(2), 125-139.

[22] Eliasson I. (2000). The use of climate knowledge in urban planning. *Landscape and urban planning*, *48*(1-2), 31-44.

[23] Han Z., Yin D., Zhao R., Liu Z., Cheng R., Lin G. & Jia H. (2024). The ecological effect of navigable canals on wetlands. *Water*, *16*(22), 3324.

[24] Source: *worldpopulationreview.com/cities/sweden/gothenburg - population-growth* (last access: 13.03.2025).

[25] Nisbet Bain R. (2006) *Scandinavia a political history of Denmark, Norway and Sweden from 1513 to 1960: A Political History of Denmark, Norway and Sweden from 1513 to 1900.*

of one of the most important ports in Europe, the *Gothenburg Hamn*, which represents Sweden's main commercial hub, handling a significant share of the country's exports and imports with a quantity of goods equal to about 900,000 TEUs[26]. The industrial sector has historically been linked to shipbuilding and mechanical manufacturing, with notable companies such as Volvo, founded in the city in 1927 and today a major global player in the automotive and engineering sectors[27]. In recent decades, Gothenburg's economy has seen increasing diversification, with significant development in the areas of technological innovation, scientific research, and sustainable economy.

The urban layout of the city is characterized by a moderate building density, with a significant presence of green spaces and urban parks such as the *Slottsskogen* and the *Jubileumsparken*, an area undergoing redevelopment as part of the city's sustainable development projects[28].

In recent years, Gothenburg has implemented an urban development model oriented towards environmental sustainability and ecological mobility, with ambitious CO_2 emission reduction targets and a significant investment in infrastructure for cycling and electric public transport[29].

10.3.2. Eskilstuna

Located in the south-eastern part of Sweden, Eskilstuna is located in the territory of the county of Södermanland, a region that represents a typical example of Swedish sub-boreal landscape. The area straddles the Eskilstunaån river, a waterway that connects Lake Hjälmaren to the Mälaren lake system, one of the largest in the country[30].

[26] *Significant increase in imports through the Port of Gothenburg*, Port of Gothemburg, *www.mynewsdesk.com/goteborgs_hamn/pressreleases/significant-increase-in-imports-through-the-port-of-gothenburg-3366964* (last access: 13.03.2025)

[27] James L., Vissers G., Larsson A. & Dahlström M. (2016). Territorial Knowledge Dynamics and Knowledge Anchoring Through Localized Networks: The Automotive Sector in Västra Götaland. *Regional Studies*, *50*(2), 233-244.

[28] Bäcklin O., Thorsson S. & Wing C. (2024). Urban greenery variation between residential typologies: Implications for recreation. *Trees, Forests and People*, *16*, 100566; Wallinder Y. (2024). Urban gardens as inclusive green living rooms? Gardening activities in Gothenburg, across and within social divides. *Journal of Organizational Ethnography*, *13*(3), 410-426; Berg P.G., Eriksson F., Eriksson T., Granvik M. & Hedfors P. (2024). Values of urban greening. Voices of residents on highly intensive densification (HID) in a Swedish case study. *Urban Forestry & Urban Greening*, *99*, 128422.

[29] Saldert H. (2024). Social sustainability for whom? The role of discursive boundary objects in Swedish strategic urban planning. *Geoforum*, *152*, 104022; Lund T., Bergman O. & McCormick K. (2021). Gothenburg. *Sharing Cities 2020: A Case-Based Approach*, 49-52.

[30] Statens Geotekniska Institut (2020). *Soil and Ground Conditions in Södermanland*, *www.*

The relief is generally flat or slightly undulating, the result of the erosive and depositional action of the Quaternary glaciations, in particular the Würm, which left moraines, *drumlins* and sandy-silty soils of glacial origin[31]. The climate belongs to the Dfb class of the Köppen-Geiger classification, with cold, snowy winters and short but temperate summers, moderately influenced by the proximity of the Baltic Sea[32]. The territory is rich in forest ecosystems (mainly conifers, birches and poplars) and wetlands that contribute to local biodiversity, often protected by nature reserves on a municipal and regional scale[33].

Eskilstuna now has about 70,000 inhabitants[34], making it one of the main urban centers of Mälardalen, a basin that is also home to the capital, Stockholm. The city developed around the historic core of Torshälla in medieval times and expanded significantly during the Industrial Revolution, specializing in the production of metals and cutting tools.

The urban structure reflects a historical industrial footprint with subsequent sustainable redevelopment interventions. The last few decades have seen demographic growth driven by international migration flows, particularly from the Middle East, giving the city a multiethnic and multicultural character[35]. Traditionally known as the "city of steel", Eskilstuna is now also a hub for the circular economy and environmental innovation. It is home to the ReTuna Återbruksgalleria, the first shopping center entirely dedicated to reuse and recycling[36]. The local economy is based on a hybrid model: alongside the engineering industry, growth sectors such as advanced services, environmental technologies, higher education (through the local campus of Mälardalen University) and sustainable tourism persist.

The infrastructure system ensures efficient connections to Stockholm,

government.se/government-agencies/swedish-geotechnical-institute-statens-geotekniska-institut-sgi/ (last access: 06.06.2025).

[31] Lidmar-Bergström K. (2020). The major landforms of the bedrock of Sweden – with a view on the relationships between physical geography and geology. *Geografiska Annaler: Series A, Physical Geography*, *102*(1), 1-11.

[32] SMHI (Swedish Meteorological and Hydrological Institute). (2022). *Climate Data for Eskilstuna*, *www.smhi.se/en/weather/warnings-and-forecasts/weather-forecast/q/Eskilstuna/2715953* (last access: 06.06.2025).

[33] Naturvårdsverket (2021). *National Inventory of Landscapes and Ecosystems*, *www.slu.se/en/Collaborative-Centres-and-Projects/nils_old/ - :~:text=The National Inventories of Landscapes,EU's Species and Habitats Directive* (last access: 06.06.2025).

[34] SCB (Statistics Sweden). (2024). *Population Statistics by Municipality*, *www.statistikdatabasen.scb.se/*.

[35] Emilsson H., Lundstedt M., Adebjörk L., Anvin M., Ramsøy I.J. & Åkesson M. (2022). *Immigrant integration in small and medium-sized towns and rural areas: local policies and policymaking relations in Sweden Country Reports on multilevel dynamics*.

[36] Sembiring D.A. & Rizqullah A. (2024). Evaluation of Sustainable Architecture Principles Application in Recycling Mall (Case Study: ReTuna Återbruksgalleria). In: *E3S Web of Conferences* (vol. 519, p. 03033). EDP Sciences.

thanks to an integrated rail and motorway network, as well as electrified and sustainable urban public transport[37].

The peri-urban and rural context of Eskilstuna is characterized by a strong integration between natural and man-made spaces. The agricultural areas – mainly arable land and fodder – alternate with managed forests and glacial lakes, configuring an environmental mosaic landscape. The extra-urban settlement forms are mainly made up of scattered villages and isolated farms (torp), in line with the Swedish tradition.

The environmental value of the territory is recognized by landscape protection and planning policies, with particular attention to the enhancement of wetlands, ecological corridors and green[38] infrastructures.

10.4. Capannori and "La Piana"

The municipality of Capannori, located in the province of Lucca, extends in the north-western part of Tuscany, within the "Plain of Lucca". This territory is configured as a predominantly flat area, bordered to the south by the mountain range of Monte Pisano and to the north by the first offshoots of the Tuscan-Emilian Apennines[39].

The morphology of the area is characterized by an alternation of plains, hills and modest mountain elevations. The central and western portion of the territory is dominated by a large alluvial plain, while the eastern sector shows a progressive rise in the ground, culminating in the heights that separate the province of Lucca from that of Pistoia. There is also a dense hydrographic network, consisting of both natural watercourses and numerous artificial canals, built for irrigation and reclamation purposes[40].

From a hydrographic point of view, the main watercourse is the Serchio river, which, together with a series of streams and minor streams, contributes to determining the water regime of the area. Water management has played a central role in the conformation of the territory, leading over the course of history to the implementation of numerous hydraulic regimentation interventions to prevent flooding phenomena[41].

[37] Eskilstuna Kommun (2023). *Miljöprogram och hållbar stadsutveckling*, in *www.eskilstuna.se/* (last access: 06.06.2025).

[38] Naturvårdsverket (2021), *op. cit*.

[39] Tuscany Region, Area no. 14, *The Plain of Lucca*, *www.regione.toscana.it/documents/10180/404161/ambito_14_piana_lucca_1_2/76f9a3dd-964c-4155-9b18-59fad1b30a7e - :~:text=La piana di Lucca è,e il colle di Montecarlo* (last access: 11.03.2025).

[40] Nardi R., Nolledi G. & Rossi F. (1987). Geology and Hydrogeology of the Lucca plain. *Quaternary Physical Geography and Dynamics*, *10*(1), 132-160.

[41] Feller L. (1996). *Chris Wickham, Community and clientele in twelfth-century Tuscany.*

As far as the climate is concerned, the proximity to the Apennine mountains favors a high temperature range between the different altitude bands of the municipal territory, with a progressive lowering of temperatures in hilly and mountainous areas[42].

Capannori is one of the largest municipalities in Tuscany and has a population of about 46,500 inhabitants[43]. The settlement structure of the territory is peculiar, as it is not configured around a single main urban center, but is divided into a network of inhabited nuclei of various sizes, distributed in the different hamlets of the municipality. This settlement structure is the result of a historical evolution linked to the development of agricultural villages, stately villas and small craft centers[44].

The economy of the area is traditionally based on agriculture, with a significant spread of the cultivation of vines and olive trees, particularly in the hilly areas already known since the early Middle Ages[45]. The flat area, on the other hand, is characterized by more intensive agriculture, linked to cereal and horticultural production[46]. A sector of strategic importance for the local economy is that of paper production, which is part of the Lucca industrial district specialized in the processing of paper and its derivatives[47].

In recent years, the municipality of Capannori has taken a leading role in environmental and sustainability policies, launching innovative programs regarding of waste management and the reduction of the environmental impact of production activities[48]. These initiatives have led the municipality to be considered a model at national level for the application of the concept of zero waste and for the adoption of circular economy strategies[49].

Le origini del comune rurale nella Piana di Lucca, Viella, 1995. *Histoire & Sociétés Rurales*, *5*(1), 265-268; Basile S. (2023). *Lucca Romana e Tardoantica. Spatial Analysis and Computational Models for the Study of Urban and Rural Landscapes*, BAR Publishing.

[42] Azzari M. (ed.) (2006). *Geoenvironmental Atlas of Tuscany* (Tuscany Region). De Agostini Geographical Institute.

[43] ISTAT, *Monthly demographic balance and resident population by sex, year 2024*, *demo.istat.it/app/?a=2024&i=D7B* (last access: 11.03.2025).

[44] Giovannini F. (2021). *Storia dello stato di Lucca*. Maria Fazzi Pacini Editore.

[45] Calissi C. (2012). Montecarlo: the Emperor's castrum pulchrum. *Via Francigena: society and territory in the heart of medieval Tuscany*, 369-400.

[46] Rovai M. (2023). Lucca's Food Plain: a stalled local food policy. *Journal of the Italian Network of Local Food Policies*, *2*(1), 82-99.

[47] Violi A. & Vitali G. (2016). *The supply chain of the paper district of Lucca*: FrancoAngeli.

[48] ZeroWaste Europa, *The history of* Capannori, *zerowastecities.eu/wp-content/uploads/2019/07/zero_waste_europe_cs1_capannori_it.pdf* (last access: 11.03.2025); *Capannori towards the creation of a Circular and Solidarity Economy District*, *www.comune.capannori.lu.it/notizia/capannori-verso-la-creazione-di-un-distretto-di-economia-circolare-e-solidale/* (last access: 11.03.2025).

[49] OnuItalia (2023), *Zero Waste: Italy brings the Capannori model to the UN*, *onuitalia.com/2023/03/30/zero-waste-litalia-allonu-porta-il-modello-di-capannori/* (last access:

10.5. Rovigo and its territory

Rovigo is located in the southern part of Veneto, in the heart of the Polesine, a vast flat area between the Po and Adige rivers. The territory is mainly of alluvial origin, shaped by the fluvial deposits accumulated over the centuries[50]. The altitude of the city is very low, with values that are around 5 meters above sea level and in some areas there are areas slightly below sea level due to soil subsidence[51].

The climate is located in climate zone "E", it is humid subcontinental, characterized by cold and foggy winters and hot and muggy summers, with rainfall distributed throughout the year, but more abundant in autumn and spring[52]. The proximity to rivers leads to high humidity and the risk of flooding, which throughout history have influenced the morphology of the territory and human activities[53].

From a hydrographic point of view, in addition to the Po and Adige, the province of Rovigo is crossed by a dense network of canals and minor watercourses, many of which are artificial, built for drainage and reclamation of the territory. The Po Delta, located in the eastern part of the province, is one of the most dynamic areas from a geomorphological point of view, with a continuous advancement of the coastline due to the sediments transported by the river[54].

Rovigo is the capital of the province of the same name and has a population

11.03.2025); Legambiente (2024), *Waste Today Report, Recycling Municipalities* 2024, in *www.legambiente.it/wp-content/uploads/2021/11/Comuni-Ricicloni-2024.pdf* (last access: 11.03.2025).

[50] Viero D.P., Roder G., Matticchio B., Defina A. & Tarolli P. (2019). Floods, landscape modifications and population dynamics in anthropogenic coastal lowlands: The Polesine (northern Italy) case study. *Science of the Total Environment*, *651*, 1435-1450.

[51] Viero D.P., Roder G., Matticchio B., Defina A. & Tarolli P. (2018, April). Past and current flood risk: human and landscape interactions in the anthropogenic floodplain of Polesine (Italy). In: *EGU General Assembly Conference Abstracts* (p. 13305); Schrefler B.A., Lewis R.W. & Norris V.A. (1977). A case study of the surface subsidence of the Polesine area. *International Journal for Numerical and Analytical Methods in Geomechanics*, *1*(4), 377-386.

[52] Climatic classification of Italian municipalities, Decree of the President of the Republic no. 412 of 26 August 1993 Decree of the President of the Republic no. 412 of 26 August 1993, in the Official Gazette, *www.gazzettaufficiale.it/eli/id/1993/10/14/093G0451/sg*.

[53] Province of Rovigo, Civil Protection Service, Provincial Emergency Plan for Hydraulic Risk from the Po River, *www.provincia.rovigo.it/myportal/P_RO/api/content/download?id=5c839c9c38fee700d9ee7727* (last access: 17.03.2025).

[54] Corrò E., Silvia P., Primon S. & Mozzi P. (2021). River dynamics and settlement conditioning in the plain landscape between the Venice Lagoon and the Po river. In: *Scheduled Schedules in the Upper Adriatic Arc? Deciphering, preserving, planning and communicating the landscape* (pp. 74-108). Ca' Foscari.

of about 50,000 inhabitants[55]. The city develops along the road axis that connects Padua to Ferrara, representing a transit node between Veneto and Emilia-Romagna.

From an urban point of view, Rovigo retains a compact historic center, characterized by buildings from the Middle Ages and the Renaissance[56]; Currently the city has an urban structure typical of lowland realities, with a building fabric that progressively expands towards the suburbs through residential districts and industrial areas[57].

The economy of Rovigo is traditionally linked to agriculture, due to the fertility of the soil and the presence of an important irrigation network. However, in recent decades the industrial and tertiary sector has acquired an increasingly important role. The area is home to several agri-food, engineering and chemical companies, as well as logistics and commercial centers[58].

From an infrastructural point of view, Rovigo is well connected both by road and rail: A13 motorway (Padua-Bologna) and State Road 16, which quickly connect it to the main cities of Northern Italy; railway station which is an important junction for connections with Venice, Bologna and Verona.

The entire provincial territory is characterized by a flat conformation and is part of the geographical region known as Polesine, covering almost the entire surface, with the exception of a small portion of the Valli Grandi Veronesi, located at the western end, and a part of the Municipality of Cavarzere (VE), located in the central-eastern[59] area. The area extends in length for about 100 km, extending from the border with the provinces of Verona and Mantua to the Adriatic coast. The province of Rovigo has a relatively low population density compared to other areas of Veneto, with

[55] ISTAT, *Monthly demographic balance and resident population by sex, year 2024*, in *demo.istat.it/app/?a=2024&i=D7B* (last access: 11.03.2025).

[56] Caniato L. (1974). *Rovigo, an unfinished city: urban history from its origins to the unification of Italy* (vol. 1). Canova; Traniello L. (ed.) (1988). *Rovigo. Portrait of a city*. Minelliana.

[57] Municipality of Rovigo (2024). *Integrated Sustainable Urban Development Strategy (SISUS) of the Rovigo urban area*, in *www.comune.rovigo.it/myportal/C_H620/api/content/download?id=6793739ceae6f5008f5d2843* (last access : 17.03. 2025).

[58] Province of Rovigo (2021). *Provincial Territorial Coordination Plan (P.T.C.P.)*, in *www.provincia.rovigo.it/dettaglio?contentId=6020fb6f546e9400d697a5ee&type=content* (last access: 11.03.2025); Veneto Region (2024). *Statistical Report 2024*, in *statistica.regione.veneto.it/Pubblicazioni/RapportoStatistico2024/pdf/volume.pdf* (last access: 17.03.2025); Unioncamere Veneto (2024). *Activity Report 2023 Lines of intervention, activities, results*, in *www.unioncamereveneto.it/wp-content/uploads/2024/06/Relazione-attivita-2023.pdf* (last access: 17.03.2025).

[59] Aa.Vv. (1976). *Rovigo, GE20*. De Agostini, pp. 113-114.

numerous small towns scattered throughout the territory[60]. The presence of a well-preserved rural landscape and wetlands of the Po Delta Park has encouraged nature tourism, which in recent years has been gaining more and more importance[61].

As described in the case, in recent years, Rovigo and its province have made significant progress in waste management, distinguishing themselves nationally for the effectiveness of separate waste collection.

10.6. Pontedera and the lower Valdarno

Pontedera is a town in the province of Pisa, located in the central-western part of Tuscany, within the Valdera, an area characterized by a combination of river plains and hills of Pliocene origin[62]. The city is located along the course of the Era river, a left tributary of the Arno, which crosses the municipal territory and has historically influenced its settlement development[63].

The morphology of the area is mainly flat in the area surrounding the urban center, while in the southern and eastern portions of the municipality there is a progressive transition towards a hilly landscape, typical of the inland areas of Tuscany. The geological substratum is characterized by the presence of Quaternary alluvial deposits, which testify to the millenary action of watercourses in the modeling of the territory[64].

From a climatic point of view, Pontedera falls under the classification of the temperate Mediterranean climate, with hot and dry summers and mild and humid winters. Rainfall is more abundant in autumn and spring, with a moderate risk of flooding in the areas adjacent to the main waterways[65].

The area of the Lower Valdarno, within which Pontedera is located, represents the southern portion of the Arno valley, developing along

[60] ISTAT (2024). *Monthly demographic balance and resident population by sex, year 2024*. Province of Rovigo, in *demo.istat.it/app/?a=2024&i=D7B* (last access: 11.03.2025).

[61] Veneto Tourism Observatory (2024). *Arrivals and presences indicators*, in *osservatorioturismoveneto.it/dati-e-indicatori/indicatori-arrivi-e-presenze/* (last access: 11.03.2025).

[62] Tuscany Region, PIT, *Livorno-Pisa-Pontedera Plain*, in *www.regione.toscana.it/documents/10180/12604324/08_Piana_Livorno_Pisa_Pontedera.pdf/322b6aaa-660b-4c12-b763-f9ea89c85dcf* (last access: 14.03.2025).

[63] Canuti P., Cencetti C., Rinaldi M. & Tacconi P. (1992). River dynamics of the Arno River – 5. Map of the morphological-sedimentary and anthropic characteristics of the riverbed and plain of the Arno River. Tav. 18–Pontedera. In: *77th Summer Meeting of the Italian Geological Society, The Basin Plans, Abstracts* (pp. 38-38).

[64] Carosi R., Pertusati P.C. & Montomoli C. (2008). *Geological Map of Italy F. 273 Pisa, section II-Pontedera (scale 1: 25,000)*.

[65] Bertacchi A., Sani A. & Tomei P.E. (2004). *The vegetation of the Pisan mountain*. Felici.

the medium-low course of the river between the provinces of Pisa and Florence[66].

From a hydrographic point of view, the Arno is the dominant element of the landscape, flanked by numerous minor tributaries, including the Era, the Elsa and the Pesa. These watercourses, in historical times, have played a crucial role in the definition of territorial planning and in the distribution of settlements[67].

Pontedera is one of the main economic and industrial centers of Tuscany. The city has experienced significant growth since the twentieth century, in particular due to the presence of Piaggio, a historic manufacturer of motorcycles and scooters, whose foundation has led to a profound transformation of the local socio-economic fabric[68].

The urban layout of the city is characterized by a relatively regular distribution, with a compact city center and peripheral expansion linked to industrial and residential development. The area is well connected in terms of infrastructure, due to the presence of the A11 motorway and the Florence-Pisa-Livorno motorway (FI-PI-LI), which allow quick connections with the main Tuscan centres.

As far as the demographic aspect is concerned, Pontedera has a population of about 30,000 inhabitants[69], with a constantly growing urbanization rate, favored by the presence of production and service centers. The city is also home to numerous educational institutions and research centers related to the mechanical and technological industry.

The local economy, in addition to the industrial sector, is characterized by a fair incidence of advanced tertiary and services, while agriculture, although still present in peri-urban areas, has progressively lost weight in favor of more profitable activities.

The extensive area in which Pontedera is located, the Lower Valdarno, is characterized by a polycentric distribution of settlements, with the presence of numerous medium-sized towns, including Empoli, San Miniato, Fucecchio and Santa Croce sull'Arno[70]. This settlement configuration is the result

[66] Federici P.R. & Mazzanti R. (1988). The evolution of paleogeography and the hydrographic network of the lower Valdarno. *Bulletin of the Italian Geographical Society*, 573-615.

[67] Tuscany Region, PIT, *Lower Valdarno*, in *www.regione.toscana.it/documents/10180/404161/ambito_17_valdarno_inferiore_1_2/4ea42c2e-dbd2-4293-9d28-4af2768d725c* (last access: 14.03.2025).

[68] Lazzeroni M. & Meini M. (2006). The industrial landscape of Pontedera: from traces to values. In: *Geographies of Industrial Landscapes in Italy. Reflections and case studies compared* (pp. 133-150). FrancoAngeli.

[69] ISTAT, *Monthly demographic balance and resident population by sex, year 2024*, in *demo.istat.it/app/?a=2024&i=D7B* (last access: 11.03.2025).

[70] Lucchesi F., Paba G. & Zetti I. (2015). The persistence of geophysical and historical matrices in the processes of regional urbanization. In: *Report on the territory. Urban configurations and territories in European spaces* (pp. 15-30). IRPET.

of a long historical evolution, in which the control of water resources and communication routes has influenced the economic and social development of the region[71].

The economy of the Lower Valdarno is traditionally based on a mix of agriculture, craftsmanship and manufacturing industry[72]. In particular, the area of Santa Croce sull'Arno and Fucecchio is renowned for its tanning district, specialized in the production and processing of leather, which represents one of the most important production chains at national and international level[73].

Agriculture continues to play a significant role, with specialized crops of vines, olive trees and cereals, as well as a strong presence of livestock[74] farming. However, in recent decades there has been a progressive reduction in the utilised agricultural area, in favour of urban and industrial development[75].

The urban layout of the area has a network structure, with a balanced distribution of economic functions and services among the different inhabited centers. This model has favored a polycentric development, in which each municipality retains its own historical and productive identity, while integrating into a broader territorial economic system[76].

In conclusion, the geographical analysis highlights a territory characterized by a strong interaction between physical and human factors, where the alluvial morphology and the presence of important watercourses have historically influenced the development of economic activities and urban settlements.

[71] Alberti A. & Baldassarri M. (2023). Settlements and material culture in the medieval Lower Valdarno: news and some food for thought. *Settlements and manufactures between Tuscany and the Mediterranean world. Archaeological and documentary research (Middle Ages-Modern Age). For Andrea Vanni Desideri*, *10*, 81; Galletti G. (2024). The changing agricultural landscape of the Lake/Marshes of Fucecchio. *Beauty and Productivity in the Italian Garden and Rural Landscape (Gardens and Landscape 1824-2804; 58)*, 195-205.

[72] Bertini L., Tangheroni M., Nuti L., Tosi A., Corucci L. (1993). History, economy *and society in the Valdera*. Pacini Editore.

[73] IRPET (2023), *The economic and employment fabric of Valdarno*, in *www.irpet.it/wp-content/uploads/2023/07/irpet-report-occupaz_valdarno-2023.pdf* (last access: 14.03.2025).

[74] Source: Valdera Rural District, Lower Valdarno, in *www.dr-valderavaldarnoinferiore.com/* (last access: 14.03.2025); Tuscany Region (2023). *Agriculture, recognized the Valdera Valdarno Inferiore Rural District*, in *www.toscana-notizie.it/-/agricoltura-riconosciuto-il-distretto-rurale-valdera-valdarno-inferiore* (last access: 14.03.2025).

[75] PIT (2022). *Val di nievole and val d'arno inferiore*, in *www.paesaggiotoscana.it/wp-content/uploads/2022/06/05_Val_d_Nievole_Val_Arno_Inferiore.pdf* (last access: 14.03.2025).

[76] Province of Pisa (2006). *Territorial Coordination Plan*, in *sit.provincia.pisa.it/sites/pisaprovincia/files/ptcp/qc001_sistema_demografico_produzione_edilizia.pdf* (last access: 14.03.2025).

The recent evolution of the area shows a growing interest in environmental sustainability and the enhancement of the territorial heritage, elements that could play a central role in the future development dynamics of the area[77].

10.7. Comparing territorial realities: a brief summary of the trajectories towards circularity

The comparative analysis of some emblematic European cases in waste management allows us to grasp the different trajectories through which cities and territories are trying to respond to the crisis of the linear model of production and consumption. The experiences of Paris, Capannori, Gothenburg, Pontedera, Rovigo and Eskilstuna offer an articulated spectrum of strategies, each with specificities, strengths and limitations, which reflect both the socio-institutional context in which they are inserted, and the different priorities attributed to reduction, reuse, recycling and separate collection. As Geels observed[78], sociotechnical transitions develop through the coevolution of technological, regulatory, cultural and organizational elements: it is this plurality of dimensions that is observed in the cases analyzed.

Paris is configured as a representative case of public policy oriented towards the reduction of single-use plastic, with an ambitious regulatory system that aims at prevention at source. This approach is part of the logic of "environmental steering", where the State guides change through regulation and centralized planning. However, this modality shows a modest flexibility in the involvement of citizens, relying more on regulation than on deliberative or educational processes. The French capital excels in its ability to impose binding frameworks, but appears less structured in integrating reuse practices or models of social circularity.

A very different perspective emerges in Capannori, the first European municipality to adopt the "Zero Waste" strategy, which is based on a participatory vision of change. Here the logic is that of "ecological citizenship"[79]: the citizen is not only a conscious consumer, but an active subject in the definition of environmental policies. The reuse centers, repair workshops and educational practices testify to a model in which the material dimension of sustainability is intertwined with the construction of meaning and collective identity. It is collaborative governance – as outlined

[77] Source: Fondazione Toscana Sostenibile, *www.ftsnet.it/* (last access: 14.03.2025).

[78] Geels F.W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research policy*, *31*(8-9), 1257-1274.

[79] MacGregor S. (2014). Ecological citizenship. In: *Handbook of political citizenship and social movements* (pp. 107-132). Edward Elgar Publishing.

by Bulkeley and Kern – that constitutes the invisible infrastructure of this experience[80].

Gothenburg is moving in a more institutional, but less communitarian, direction. The Swedish city has developed a network of reuse centres ("Återbruk") integrated into the public collection system, partly run in collaboration with *non-profit* organisations. This model, although efficient, seems to embody what Hajer has called "ecological modernization"[81]: an attempt to reconcile sustainability and development without questioning the fundamental assets of the economic system. The citizen is a user rather than a co-producer, and the transformation remains confined to tools, rather than meanings.

A significant discontinuity can be observed in Eskilstuna, where the ReTuna project reinterprets the shopping centre as a circular space. In this case, sustainability becomes not only practical, but also a symbolic experience: reuse is at the heart of a spatial, economic and pedagogical device. Here what Latour has called a semantic restructuring of agents in his Actor-Network theory is manifested[82]: the consumer, the object, the waste, the commercial space are reorganized in an innovative assembly that challenges the dominant narratives of consumption. Although supported by public funding, ReTuna expresses a high transformative potential precisely because of its ability to integrate material practices, cultural narratives and organizational innovation.

Pontedera, on the other hand, represents a technocentric trajectory, based on industrial innovation in recycling. The model recalls Von Weizsäcker's idea of "eco-efficiency"[83], where the main objective is to increase the environmental performance of the production system. Collaborations with research institutions and advanced plants make Pontedera an example of technical excellence. However, the lack of integration with prevention policies or environmental education limits the systemic scope of the model, which risks remaining anchored to an "end-pipe" logic, as already criticized in the literature on the green economy[84].

Finally, Rovigo stands out for its high performance in separate waste collection, achieved through advanced management tools such as punctual

[80] Bulkeley H., Davies A., Evans B., Gibbs D., Kern K. & Theobald K. (2003). Environmental governance and transnational municipal networks in Europe. *Journal of Environmental Policy & Planning*, *5*(3), 235-254.

[81] Hajer M.A. (1995). *The politics of environmental discourse: Ecological modernization and the policy process*. Clarendon Press.

[82] Latour B. (2022). *Reassembling the social: Actor-Network theory*. Mimesis.

[83] Seiler-Hausmann J.D., Liedtke C. & von Weizsäcker E.U. (eds.). (2017). *Eco-efficiency and beyond: Towards the sustainable enterprise*. Routledge.

[84] Jackson T. (2009). *Prosperity without growth: Economics for a finite planet*. Routledge.

pricing (TARIP). This is a case of "managerial environmentalism"[85], where the optimization of flows replaces transformative ambition. Organizational efficiency is high, but the model sometimes does not include the cultural and educational dimension, risking confining sustainability to a highly technical and administrative field.

Taken together, these cases demonstrate that there is no single model of circular economy, but rather a constellation of practices. The challenge is not to identify an absolute "best practice", but rather to understand how the different components – regulatory, technological, cultural – can be combined in a synergistic way. In fact, the ecological transition requires a hybridization of logics, a work of mediation between governance, innovation and common sense, capable of acting both on the material infrastructures and on the cognitive infrastructures of society[86].

[85] Perkins R. (2010). The internationalisation of managerial environmentalism: globalisation, diffusion and territorialisation. *Geography Compass*, *4*(8), 1069-1083; Newell P. & Paterson M. (2010). *Climate Capitalism: Global Warming and the Transformation of the Global Economy*. Cambridge University Press.

[86] Stengers I. (2015). *In Catastrophic Times: Resisting the Coming Barbarism*. Open Humanities Press.

11.

The enabling factors and bottlenecks of the circular economy: overcoming the "walls of no" to climb the waste hierarchy[1]

11.1. The results of the cross-sectional case analysis: enablers and bottlenecks to make the circular economy not just a vision, but a transformative practice

The cross-sectional analysis of the case studies sought to identify the main elements capable of supporting or hindering projects for the implementation of the waste hierarchy principle. The analysis of the cases was therefore aimed at answering the research questions:

- Why, how, and through which enabling factors, is it possible to implement effective and sustainable strategies and policies that allow the concrete application of the waste hierarchy principle?
- What are the main bottlenecks and how can they be overcome?

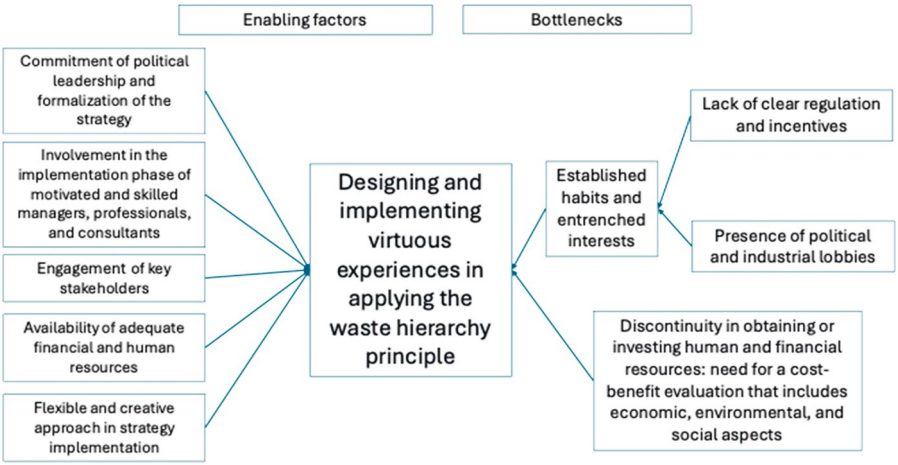
The model that emerges from the empirical research (*Figure 11.1*) identifies the elements that influence the ability of organizations – companies and local authorities – to design and implement virtuous experiences of application of the waste hierarchy principle.

The analysis highlights five *enabling factors* – elements necessary to initiate effective strategies for implementing the waste hierarchy principle – and three *bottlenecks* – significant obstacles and "walls of no" to be broken down in order to carry out the projects themselves.

A cross-cutting analysis of virtuous experiences in different contexts confirms, above all, the feasibility of undertaking innovative actions to effectively implement the principle of the waste hierarchy and to promote the transition toward a circular economy across very diverse settings.

[1] This chapter was written by Giulia Romano.

Figure 11.1 – The results of the cross-sectional analysis: the analysis model



Source: Own elaboration

The study also provided evidence of some elements – which we define as *enabling factors* – that are essential to give rise to new concrete practices of significant waste reduction, reuse and effective recycling. Furthermore, as highlighted in Chapter 3, for more than ten years the European Union has highlighted that "*barriers facing recycling activities in the Union internal market should be removed and existing prevention, re-use, recycling, recovery and landfill diversion targets reviewed so as to move towards a lifecycle-driven 'circular' economy, with a cascading use of resources and residual waste that is close to zero*"[2].

It is useful to recognize in advance the existence and possible impact of factors that can hinder or slow down initiatives and projects, to prevent them from turning into unexpected obstacles in the execution phase, without adequate answers and solutions. At the same time, it is necessary to intervene at the political level to progressively reduce bottlenecks, identifying the most effective strategies so that political and institutional decision-makers – at European, national, regional, municipal and company level – act promptly to remove them, thus helping to break down the numerous "walls of no" still present.

[2] Decision n. 1386/2013/EU of the European Parliament and of the Council of 20 November 2013.

11.2. Enabling factors strategies and policies capable of climbing the waste hierarchy

11.2.1. The commitment of the main decision makers and the formalization in deeds and documents

Successful transformation often relies on a vision of the future that is relatively easy to communicate and engages customers, shareholders, and employees[3]. The vision helps to clarify the direction in which the organization must move and often arises mainly from a single individual or a small group of people, who identify where to go and then, with the support of the managerial team, define, also thanks to a subsequent rigorous analysis, the final vision and strategy to achieve that vision[4].

From the cross-sectional analysis of the case studies, it emerges that a strong commitment and a remarkable determination (*leadership commitment*[5]) on the part of one or more key decision-makers – both in the political and corporate spheres, depending on the organization (company or municipality) – represents a crucial element to make possible the implementation of innovative strategies and policies capable of concretizing the waste hierachy principle.

The first enabling factor emerging as decisive for the implementation of projects within the waste hierachy principle is therefore the strong political and/or technical determination on the part of relevant political or managerial exponents[6], who strongly believe in the need for change, who develop a first vision, contribute to defining it more clearly, and then, with determination, insert it into formal acts.

The Resource Based View (RBV)[7] is a robust model that explains the importance of leveraging the internal resources and capabilities of a company or public organization[8], especially those that are rare, valuable,

[3] Stouten J., Rousseau D.M. & De Cremer D. (2018). Successful organizational change: Integrating the management practice and scholarly literatures. *Academy of Management Annals*, *12*(2), 752-788; Dempsey M., Geitner L., Brennan A. & McAvoy J. (2021). A review of the success and failure factors for change management. *IEEE Engineering Management Review*, *50*(1), 85-93.

[4] Kotter J.P. (2007). Leading change: Why transformation efforts fail. In: *Museum management and marketing* (pp. 20-29). Routledge.

[5] Sancak I.E. (2023). Change management in sustainability transformation: A model for business organizations. *Journal of Environmental Management*, *330*, 117165.

[6] Ha H. (2014). *Change management for sustainability*. Business Expert Press.

[7] Barney J.B. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, 17, 99-120.

[8] Bryson J.M., Ackermann F. & Eden C. (2007), Putting the Resource-Based View of Strategy and Distinctive Competencies to Work in Public Organizations. *Public Administration Review*, 67, 702-717.

non-replaceable and difficult to imitate, to gain a sustainable competitive advantage and to implement sustainable and circular business models[9] but also public policies[10]. In the context of RBV, the commitment and determination of the top management are in fact crucial and represent a fundamental intangible resource, which guides organizational strategies and behaviors, directly influencing how resources are allocated and which sustainability initiatives are defined as priorities.

In essence, a strong commitment from top management is essential – especially in light of the evidence that has emerged – to drive public and private organizations toward the adoption of effective projects aimed at implementing the waste hierarchy[11].

When municipalities or companies are intrinsically motivated to adopt the waste hierarchy principle, they tend to allocate resources, invest in innovative projects and adapt their organizational and business models accordingly[12]. This commitment from the top ensures that the organization's commitment is deep-rooted and not mere formal compliance[13]. In essence, a strong commitment of the top management represents a crucial element to successfully integrate the principle of the waste hierarchy into the organizational contexts of the municipalities and companies studied.

As has emerged in other studies[14], the commitment and priorities of corporate leadership are therefore fundamental in guiding the initiatives of organizations focused on environmental sustainability and the circular transition. Strong commitment at the top catalyzes change by motivating

[9] Bocken N.M., Short S.W., Rana P. & Evans S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of cleaner production*, *65*, 42-56.

[10] In the case of the public context, the literature also uses the concept of *livelihood scheme* as the equivalent of a business model in the private sector. See Bryson J.M., Ackermann F. & Eden C. (2007). Putting the Resource-Based View of Strategy and Distinctive Competencies to Work in Public Organizations. *Public Administration Review*, 67: 702-717.

[11] Al Rawashdeh S., Nasaj M. & Ahmad S.Z. (2024), Driving circular economy adoption through top management commitment and organisational motivation: a quantitative study on small- and medium-sized enterprises, *International Journal of Organizational Analysis*.

[12] Suchek N., Fernandes C.I., Kraus S., Filser M. & Sjögrén H. (2021). Innovation and the circular economy: A systematic literature review. *Business Strategy and the Environment*, *30*(8), 3686-3702.

[13] Al Rawashdeh S., Nasaj M. & Ahmad S.Z. (2024). Driving circular economy adoption through top management commitment and organisational motivation: a quantitative study on small- and medium-sized enterprises, *International Journal of Organizational Analysis*.

[14] See among others Cheffi W., Kaleem, Zahir-Ul-Hassan M., Omer Farooq M., Baqrain A. & Mohamed Habib Mansour M. (2023), Ethical leadership, management control systems and circular economy in SMEs in an emerging economy, the UAE. *Journal of Business Research*, 156, 113513; Haldorai K., Kim W.G. & Garcia R.F. (2022). Top management green commitment and green intellectual capital as enablers of hotel environmental performance: The mediating role of green human resource management. *Tourism Management*, 88, 104431.

both management and employees to proactively seek and implement solutions, shaping the organization's strategic direction and engaging the entire workforce.

In Paris, Mayor Anne Hidalgo has indicated on several occasions her firm desire to make a contribution to the fight against climate change[15], acting decisively on reducing the use of single-use plastics: in her opening speech at the international forum to end plastic pollution in cities that took place in Paris in May 2023, she said: "*Dependence on plastic is terribly destructive. For living organisms and for the planet*". A decision was made to take action and address the many existing limitations in waste management, starting from the first step of the hierarchy, based on the belief that the best waste is the one that is not produced. This led to a decisive reduction strategy aimed at eliminating single-use plastics, broadly defined to include all products and packaging containing even small amounts of plastic – such as cans, paper or compostable cups, and similar items.

As the public official who followed the implementation of the Parisian strategy recalls, Lila Durix: "*the ambition of the Mayor of Paris to eliminate single-use plastic was the first thing she thought of in 2016; when she offered to host the Olympic Games, she strongly wanted a 'different' candidacy. She wanted a candidacy that was compatible and compliant with the fight against the climate crisis: we had just returned from COP 21 in December 2015 where the Paris climate agreement was drafted. It was a historic agreement that we could not ignore and the mayor of Paris had been at the forefront of that decision. It brought together more than 1,000 local authorities across the city, committing them to climate action. Her determination to give a strong boost to the fight against the climate crisis was crucial, and at the same time the Olympics represented the answer to the need for a joyful project that would help Paris recover from the terrorist attack. The initiative of the Ambition zéro plastique à usage unique project was developed with determination by two aldermen of the mayor of Paris: Célia Blondel, Deputy Mayor with responsibility for climate, water and cleanliness and belonging to the ecologist group, which is part of the majority, and Jean-François Martin, deputy mayor with responsibility for sport and tourism. These two councillors set themselves the ambitious goal of eliminating single-use plastics, which immediately proved to be a 'strong' measure to show the world that Paris has contributed to environmental and social change thanks to the Games*".

The determination of the political and corporate leadership also emerges as an important factor in the other cases analyzed and related to strategies and

[15] See for example the Declaration by Anne Hidalgo, Mayor of Paris and C40 Chair – C40 City, *www.c40.org/it/news/statement-from-anne-hidalgo-mayor-of-paris-and-c40-chair/*.

policies in the different steps of the waste hierarchy. In the case of Capannori and the Daccapo reuse centers, the former councilor for the environment says that: "*the process of creating the reuse centers, supported by the municipality and the managers of the urban waste utility, was facilitated by the presence of two strong motivating factors. On the one hand, as a councilor, I represented the environmental associations and activism related to ecological issues; on the other hand, there was a motivation rooted in social solidarity and the need to support vulnerable groups. At that point, it was a convergence of multiple intentions, united by a common goal: doing good for the local community*".

In the case of Ecoambiente, the vision and commitment of the company's top management were clearly demonstrated not only through the definition and approval of the business plan, but also through their active and unified participation in the many public information events organized across the area. By "putting their face to it" they showed, day after day, their genuine belief in the value of the project, engaging in constant dialogue with citizens affected by the proposed changes.

The commitment of political or corporate leadership thus emerges as a form of vision – one that must, however, be accompanied by the ability to set clear corporate objectives, allocate resources accordingly, and regularly assess the actions taken and the results achieved[16].

In all cases, commitment is closely tied to the foresight of clearly defining a course of action through projects, resolutions, and plans, all formalized in documents that outline a clear path and facilitate subsequent implementation. The presence of a formal act is another recurring element across all the cases analyzed.

While it is often noted that failed transformations are marked by an excess of plans, directives, and programs – but lack a true vision[17] – the cross-case analysis reveals that a vision without formalization risks being gradually distorted during the implementation phase, or even left unrealized.

In Paris, in fact, the Mayor of the city, once she received the award of the Olympic Games "*18 months later, with her political team, produced the 'political vision of the Games', a document still freely available online, called Olympic Transformation, presented in June 2019. The document contains 20 measures to transform Paris in view of the Games, including the zero single-use plastic strategy*".

The project of the reuse centers in Gothenburg was pursued with

[16] Dempsey M., Geitner L., Brennan A. & McAvoy J. (2021). A review of the success and failure factors for change management. *IEEE Engineering Management Review*, *50*(1), 85-93.

[17] Kotter J.P. (2007). Leading change: Why transformation efforts fail. In *Museum management and marketing* (pp. 20-29). Routledge.

determination on the basis of an idea that turned out to be successful then formalized in a project financed with public resources ("*I saw so many things coming to be thrown away! So we developed a project to concentrate the recycling, reuse and separate collection of waste in one place, paying particular attention to the prevention of bulky household waste, such as furniture, bicycles, electronic equipment and furnishings, creating a 'park' with the availability of different activities*"; "*We then asked the public company to finance it. The public company accepted*" Martensson recalls, "*also because it was a good opportunity to invest in a 'green' project, which was also positive for the city's reputation. In any case, they built it, but it was we who decided to design it in this way and gave them the indications*").

In the same way, the Municipality of Capannori, with the formal adhesion by the City Council of the Zero Waste Strategy[18], was institutionally committed, making the path clear and the consequent decisions to be taken easier. In fact, as the councilor for the environment of the Municipality recalls that "*Ever since we shared the general strategy with the resolution to join the Zero Waste Strategy in 2007, the issues of waste reduction and reuse were placed on the agenda. In addition to door-to-door collection and pay-as-you-throw pricing, an important focus was also on initiatives aimed at waste reduction and the creation of reuse centers. From this perspective, the mayor gave us a "free hand" to ensure that the strategy we had approved would be implemented and continue to grow over time*".

In the case of Ecoambiente, the importance of having clearly predefined and formalized the key elements of the strategy – within both the area plan and the business plan – emerged as crucial to outlining a clear path and preventing pressure for changes along the way, as the Technical Director highlighted: "*The main elements of the Ecoambiente project were defined in the area plan and the business plan, based on an organizational model that includes door-to-door collection of residual dry waste, organic waste, paper, plastic and cans, glass, and green waste across the entire territory. The introduction of a pay-as-you-throw tariff system, a unified service model, a single tariff regulation, and a single service regulation constituted the pillars of the approved project. These elements were unanimously approved by the municipal shareholders, providing a solid and clear framework that supported a challenging path – one that could only be altered through new*

[18] See for further information: Connett P. (2013), *The Zero Waste Solution, Untrashing the Planet One Community at a Time*, Chelsea Green Publishing; Ercolini R. (2018). *Zero waste. the ten steps to the ecological revolution from the Nobel Prize for the environment*. BaldiniCastoldi; Romano G., Marciano C., Fiorelli M.S. (2021), *Best Practices in Urban Solid Waste Management. Ownership, Governance, and Drivers of Performance in a Zero Waste Framework*, Emerald Publishing Limited.

resolutions. This structure clearly enabled management to benefit from a kind of 'virtuous inertia' in a well-defined direction in the months and years that followed. As time passed and the various steps of the project were implemented, the possibility of 'going back' became increasingly limited".

The presence of an initial project not only helps and guides towards the achievement of the objectives, but also allows the results to be easily reported, further motivating all the stakeholders involved towards the subsequent stages of progress. the President of the Rovigo Basin Council proudly said: "*I believe that one of the fundamental and somewhat peculiar characteristics of this story is the consistency of the territory in the choices made: a strategic choice made in 2020, on January 1, 2024 it was fully implemented in an entire province*".

11.2.2. The involvement of motivated professionals and collaboration with experts

Sustainable, effective, and efficient waste management requires adequate knowledge and skills developed over time. In the cases analyzed, the importance of involving and actively collaborating with motivated experts and professionals – such as consultants, managers, and researchers – clearly emerged. As carriers of significant expertise and experience, they are able to help overcome the natural initial difficulties and to "stay the course" in pursuing the core principles of the adopted strategy[19].

Professionals and experts can be internal to the organization or external to it, therefore act as public or private managers, employees of the public organization or private company, or as consultants called pro tempore to support the change desired and outlined by the top management[20].

In both cases, the presence of women and men in key executive roles who supported the implementation of the waste hierarchy principle proved to be crucial. These individuals fully embraced the project's values and core objectives[21], to the point of becoming recognized protagonists of the transformation process and representing the decisive factor that made its realization possible[22].

[19] M. Dempsey L. Geitner A. Brennan & McAvoy J. (2021). A Review of the Success and Failure Factors for Change Management. *IEEE Engineering Management Review*, *50*(1), 85-93.

[20] Ha H. (2014). *Change management for sustainability*. Business Expert Press.

[21] Dempsey M., Geitner L., Brennan A. & McAvoy J. (2021). A review of the success and failure factors for change management. *IEEE Engineering Management Review*, *50*(1), 85-93.

[22] Kotter J.P. (2007). Leading change: Why transformation efforts fail. In: *Museum management and marketing* (pp. 20-29). Routledge.

The managerial figures involved in the project were therefore not merely expected to "approve" the change, but also to actively support it and commit themselves concretely to its implementation[23].

A cross-case analysis of the studied examples reveals that the commitment discussed in the previous paragraph is found not only at the institutional and corporate leadership levels (mayors, councilors, shareholders), but also among the key figures responsible for the execution and implementation of the project[24]. These individuals led true campaigns of persuasion[25] targeting the main stakeholders – ranging from employees to citizens, from companies potentially interested in using recycled secondary raw materials to consumers concerned with the social and environmental impacts of their purchases, and so on.

As Kim and Mauborgne have noted, in change processes the most difficult battle is to gain agreement on the root causes of current problems and on the need for change[26]. Therefore, while commitment is crucial, it is not sufficient on its own; in fact, the translation of this commitment into truly actionable – and then actually implemented – strategies depends heavily on the level of organizational motivation.

As Garvin and Roberto pointed out, it is essential to convince municipal and company employees that change is necessary and that the proposed direction is the right one, based on available data and scientific evidence. Moreover, the persuasion process must involve extensive and ongoing communication, reinforced by clear guidelines to prevent a return to old habits (backsliding).

The analysis of the Paris case highlights the crucial role played in the *Ambition Zéro Plastique à Usage Unique* project by the involvement and experience of the public manager responsible for its implementation, as well as her decisive efforts to carry out an effective persuasion process. Lila Durix stated that she invested a great deal of time in training and informing as many people as possible because "*you can't control all interactions and you can't ban single-use plastic just on the basis of one line of text: it doesn't work. If people don't understand, the strategy doesn't work*". In addition, her professionalism made it possible to develop an executive project grounded in clear definitions and authoritative studies, thereby supporting the city's

[23] Dempsey M., Geitner L., Brennan A. & McAvoy J. (2021). A review of the success and failure factors for change management. *IEEE Engineering Management Review*, *50*(1), 85-93.

[24] Kotter J.P. (2007). Leading change: Why transformation efforts fail. In: *Museum management and marketing* (pp. 20-29). Routledge.

[25] Garvin D.A. & Roberto M.A. (2005). Change Through Persuasion. *Harvard Business Review*, *83*(2):104-112.

[26] Kim W.C. & Mauborgne R. (2003). Tipping point leadership. *Harvard Business Review*, *81*(4), 60-69.

vision and its political leadership with institutional frameworks and rigorous scientific research.

Durix said: "*The definition of single-use plastic was based on indications from the European Union* [and] *we commissioned scientific studies from experts in recycling and materials science to have valid scientific support available to cope with the many pressures that purchasers routinely receive from manufacturers; the latter, in fact, sometimes propose materials presenting them as plastic-free but which, in reality, contain polymers*".

The passion, shared mission, and expertise of the management of Revet and its subsidiaries emerge clearly from the interviews conducted. All interviewees, in their respective roles, demonstrate not only a strong level of competence and the ability to effectively communicate the company's business model, but also a clear commitment to expanding the use of recycled materials or those destined for recycling. In particular, Revet's CEO, an environmental engineer, emphasized the importance of thoroughly understanding the characteristics of recycled materials in order to propose new partnerships to industries, thereby extending the actual recycling of materials. CEO Alessia Scappini underlined: "*Thanks to our unique model, a company that has its own regional collection basin, with a single logistics that brings separate waste collection within a single plant hub and where it is not only selected, but also recovered and transformed, a secondary raw material, polymers, with a very low carbon footprint is generated with a saving of 75% compared to virgin raw materials. It is a result that allows the user of these materials to make products more sustainable and that for this reason find their competitiveness on the market. This is the element that allows us to look directly at companies to propose our granulate as an alternative*".

The managerial approach, the experience of top management, and the motivation to fulfill the mission also emerge clearly in the other cases. Since 2023, ReTuna has been led by a manager with prior experience in business and commercial leadership. His approach reflects the mindset typical of private shopping center managers. For example, he stated: "*We interviewed our shopping center customers and found that all of them intend to return or bring someone else with them. This is an extraordinary result*".

And again: "*This serves both to meet customer expectations – who want to find certain items in specific seasons – and to ensure store profitability. If a store doesn't offer the right products at the right time, sales decline and profits drop*".

The director also embraced the municipality's objectives, stating: "*With this initiative, the municipality aimed – and still aims – to reduce environmental impact through the promotion of reuse and the optimization of waste management, in line with its ambitious environmental and climate goals*".

He made these goals his own and translated them into concrete actions carried out with determination and commitment.

As he explained: "*Our goal is to encourage people to think twice before making a purchase by asking two key questions: "Do I really need this?" and, if the answer is "I want it*", then "*Can I find it second-hand?". We encourage people to look for used goods first, and only buy new if the second-hand option isn't available – favoring quality products in that case. Ultimately, we are not asking people to stop shopping, but to adopt a more conscious and sustainable approach to consumption*".

Alongside internal professionalism and expertise, the cases studied also reveal the active involvement of consultants, experts, and partners. This occurred in Paris, with the participation of Circulab as a consultant; at Revet, through collaborations with various university laboratories and interested companies for the design, engineering, and development of prototypes and advanced technological systems for second-life plastic applications; and in Rovigo, at Ecoambiente, with support from Contarina and the Consiglio di Bacino Priula, as well as experts from the communication agency Achab. As the Director of the Consiglio di Bacino Rifiuti Rovigo noted: "*Achab followed the entire process for about a year and a half and helped Ecoambiente implement the transition to the pay-as-you-throw system and the distribution of new household equipment*".

In Paris, the interviews highlighted the importance of the support of consultants, who since the start of the project "*have conducted a kind of consultation with all stakeholders during a conference, to find out how we could drive change in the Paris area, how we could drive change for retailers and large companies. The consultation sought to identify the best way to work together to eliminate single-use plastic*".

External expert support can also occur "informally", as in the case of the exchanges that took place during the creation of reuse centers. It is no coincidence that Pål Mårtensson, then coordinator of the Gothenburg reuse park, took part in the inauguration of the first reuse center in Capannori – underscoring not only the inspiration drawn from the Swedish experience, but also the active collaboration that followed.

More broadly, in the fields of reuse and separate waste collection – where the case studies analyzed are all publicly managed or publicly owned – there is a strong openness to sharing experiences without exclusions. Many companies and municipalities, even those geographically distant, are welcomed and encouraged to learn from these initiatives, including through guided tours, in order to foster a process of virtuous emulation. For example, the director of ReTuna said that he usually hosts "*about 120-140 national and international study visits a year, from those interested in replicating the model*". The reuse centers in Gothenburg and Capannori are also visited

every year with the aim of learning more about the mechanisms so that they can be replicated. The statement by the director of the Gothenburg Reuse Park is emblematic of the overall approach: "*We've been receiving visitors for 18 years – they come here, see how we do things, and I assume they go on to create something similar*".

Similarly, in separate waste collection and in the introduction of incentives such as pay-as-you-throw tariff, contamination through collaboration with experts appears to be an element capable of effectively facilitating both the implementation of the political-strategic project itself, and greater speed, avoiding some errors or unforeseen events. The technical director of Ecoambiente underlined: "*The Priula model, together with the Contarina company that deals with the management of urban waste in 49 municipalities in the province of Treviso, was the one that inspired us.* […] *There was a very close collaboration both with the Contarina company, which supported Ecoambiente for the drafting of the business plan, and through the management of Bettiol of the Basin Council. It was a double channel, both corporate and institutional, which allowed a transfer of experiences, albeit with appropriate adaptations to the specific reality*".

In fact, on certain specific aspects – both in the case of Paris and in that of Ecoambiente – the interviewees explicitly emphasized how remaining steadfast in the face of uncertainty was essential, following the example and guidance of the external experts and consultants involved in the projects. They highlighted that having authoritative figures by their side – capable of offering reassurance and helping to overcome doubts and concerns – played a decisive role.

It can therefore be observed that the motivation, professionalism, and experience of both internal management and the external consultants and experts involved in implementing the waste hierarchy principle represent a key element of these projects.

11.2.3. Stakeholder engagement through information and training

It was highlighted that the processes of change and the actual transformations are impossible, "*unless hundreds or thousands of people are willing to help, often to the point of making short-term sacrifices. Employees will not make sacrifices, even if they are unhappy with the status quo, unless they believe that useful change is possible*"[27].

[27] Kotter J.P. (2007). Leading change: Why transformation efforts fail. In: *Museum management and marketing* (pp. 20-29). Routledge.

Introducing changes without the support of stakeholders, of hundreds or thousands of people who are willing to collaborate and accept sacrifices in the short term is difficult, if not impossible. The literature has therefore highlighted the importance of "*strategic alliances for innovation in the circular economy*"[28] i.e. cooperation and collaboration between promoters and stakeholders to concretely achieve the circular economy[29]. Employees are also often unwilling to make sacrifices, even if they are dissatisfied with the status quo, unless they believe that useful change is really possible. Therefore, without credible and widespread communication, it is never possible to really win the hearts and minds of the people involved: "*without credible communication, and a lot of it, the hearts and minds of the troops are never captured*"[30].

The literature has therefore highlighted how crucial it is to manage resistance to change to involve the members of the organization and effectively communicate the reasons that motivate it[31].

In the cases analyzed, a key element that emerges from the cross-case reading is the role of engagement – that is, the active involvement, both strategically and in terms of civic participation, of employees, citizens, and businesses. Engagement is fostered through broad and widespread programs of information and training focused on the higher-level motivations behind the decisions made, as well as on the essential aspects needed to implement waste reduction, reuse, and recycling initiatives.

Too often, in the face of change processes, the difficulty of pushing people out of their comfort zones has been underestimated[32]. Instead, as Kim and Mauborgne pointed out, "*once the beliefs and energies of a critical mass of people are engaged, conversion to a new idea will spread like an epidemic*"[33]: so once the beliefs and energies of a critical mass of people are activated, the spread of a new idea and the underlying reasons will spread quickly. To this end, adequate communication is essential to create

[28] Suchek N., Fernandes C.I., Kraus S., Filser M. & Sjögrén H. (2021). Innovation and the circular economy: A systematic literature review. *Business Strategy and the Environment*, *30*(8), 3686-3702.

[29] Sancak I.E. (2023). Change management in sustainability transformation: A model for business organizations. *Journal of Environmental Management*, *330*, 117165.

[30] Kotter J.P. (2007). Leading change: Why transformation efforts fail. In: *Museum management and marketing* (pp. 20-29). Routledge.

[31] Cohen M.B., McWilliams J. (2021). Coch, Lester, and John R.P. French Jr.: Overcoming Resistance to Change. In: Szabla D.B. (eds.), *The Palgrave Handbook of Organizational Change Thinkers*. Palgrave Macmillan.

[32] Kotter J.P. (2007). Leading change: Why transformation efforts fail. In: *Museum management and marketing* (pp. 20-29). Routledge.

[33] Kim W.C. & Mauborgne R. (2003). Tipping point leadership. *Harvard Business Review*, *81*(4), 60-69.

transparency, inform and involve, convey the importance of change, avoid and overcome resistance: however, information must be honest, timely and clear[34].

In all the cases analyzed, there was a deliberate intent to involve the main stakeholders, whether they are citizens-users, employees, customers, industrial partners, using different channels considered effective to reach the highest number of people and make the information and training designed effective.

For example, a major consultation conference was launched in Paris on the ambition to eliminate single-use plastics. As emerged from the interviews, "*the conference, aimed at all sports federations, local actors and trade federations, aimed to identify solutions to eliminate single-use plastic. The question was how to proceed, what are the obstacles and constraints to consider. This was the first conference that brought together all stakeholders, companies in the Paris area and the sports federation, to improve the situation and achieve the goal of zero single-use plastic. The goal was to understand how we could work with stakeholders and how we could collaborate*".

The interviews show the importance of making clear and easily understandable and implementable information available and shared: as Durix recalled, "*The work done by the Parisian administration was to convey clear and understandable information. This has made it possible to avoid falling into false solutions and bad adaptations, with respect to the waste reduction target for the Olympic Games*".

There was also a strong need for training of internal teams. The engagement therefore involved municipal employees, both those directly involved and those working in departments not directly related to the organization of the Games or procurement. The official in charge of the Ambition zéro plastique à usage unique project reported that she had "*went around all the management committees and all the departments in the city, which was unprecedented, just to present the approach,* [and also] *produced an administrative guide, which was then made available to everyone*", and "*formed teams that had nothing to do with the Olympic Games and the ambition zero single-use plastic. In order for the underlying message to spread widely, it was very important that there was a global understanding, which could spread throughout the city*".

Experience demonstrates the importance highlighted by Stouten, Rousseau and De Cremer of mobilizing energy for change, i.e. planning the

[34] Dempsey M., Geitner L., Brennan A. & McAvoy J. (2021). A review of the success and failure factors for change management. *IEEE Engineering Management Review*, *50*(1), 85-93.

effective implementation of change on multiple levels of the organization and empowering stakeholders to act in a way that is consistent with the vision[35].

In Ecoambiente's experience, the changes related to the introduction of the new waste management tariff were communicated extensively to citizens in the affected municipalities through a well-structured information campaign. This included public meetings held throughout the service area, preceded by door-to-door leaflet distribution, press releases, and the gradual rollout of more than 400,000 new household bins – ensuring that all users were reached.

As reported by the interviewees, the public meetings became the centerpiece of the communication effort. Initially, there was concern about low turnout, but this proved to be unfounded: the events were highly successful, both in person and online, with full rooms and between 20,000 and 30,000 views.

The high level of participation observed in both the Paris and Ecoambiente cases highlights the strong interest of citizens and employees in acquiring information not only about specific projects that directly affect them, but also more broadly about waste management, with the aim of enhancing their ability to contribute to the common good[36].

The reuse centers studied have become very well known both in Sweden and in Italy, together with the services offered. In all the cases studied, the institutional websites of the Municipalities report the presence of the reuse initiative; in addition, dedicated pages have been activated on social networks such as Facebook: ReTuna has about 23 thousand followers, Alelyckan almost 11 thousand and Daccapo 7 thousand. Information on activities, promotions, and the most valuable objects available are periodically published on social networks, together with the underlining of positive messages on environmental and social impacts. For example, on ReTuna's Facebook page you can read posts like these: "Welcome to the climate-smart and sustainable shopping center in all its stores", or "Bike season is here! Does your bike need a little extra love and care? Take it to Rebuyke here at ReTuna and you'll get help doing a bike check, lubricating the chain and checking the brakes, and more".

Revet has launched specific initiatives aimed at fostering new opportunities for the use of recycled materials, developing direct projects

[35] Stouten J., Rousseau D.M. & De Cremer D. (2018). Successful organizational change: Integrating the management practice and scholarly literatures. *Academy of Management Annals*, *12*(2), 752-788.

[36] Minoja M. & Romano G. (2024). Effective stakeholder governance in circular economy: Insights from Italian companies. *Journal of Cleaner Production*, 474, 143584.

in collaboration with industrial districts and companies. One of the key strengths of its business model is its ability to work directly with plastic product manufacturers. Revet supports these companies by studying their specific application needs, conducting industrial tests on their machinery, and proposing tailored solutions.

These joint projects help advance recycling efforts while simultaneously driving Revet's own development, creating new business opportunities. The collaboration between Lucart and Revet, for example, represents a virtuous case of circular economy, where technological innovation, integrated waste management, and industrial synergy make it possible to maximize material recovery and reduce the environmental impact of Tetrapak in Tuscany.

Similarly, the Tuscan horticultural sector has taken a significant step toward integrated sustainability – not only in agricultural practices but also in the management of plastic materials – thanks to Revet's initiative and the collaboration among companies within the district. This stands as a concrete example of applied ecological transition and achieved circularity.

In fact, despite growing commitment to sustainable production, the plastic pots used to sell plants had often been overlooked from an environmental perspective. Many producers were unaware of their composition or end-of-life fate – materials that are plastic-based and difficult to recycle. Revet has played a pivotal role in raising awareness of this issue within the Tuscan horticultural sector, highlighting the importance of extending sustainability efforts to include pots and plastic irrigation components, and encouraging a broader vision that embraces the entire value chain.

11.2.4. The availability of adequate human and financial resources

Changes require investments in new technologies, new processes, staff training, marketing and engagement of citizens and customers, and so on[37]. Projects related to innovation in the implementation of the waste hierarchy principle therefore require adequate human (knowledge and skills) and financial resources.

While financial aspects play a crucial role in determining how businesses and society can advance in the transition to the circular economy, creating the conditions for the planned projects and investments, surprisingly little research has focused on how the availability of financial resources can influence the transformation of the current linear economic model into a

[37] Lauer T. (2020). *Change management: fundamentals and success factors*. Springer Nature.

circular one[38]. Some studies have provided supporting elements such as, for example, the presence of high initial costs and the low profitability of circular business models[39]; they have also highlighted the importance of public financial support[40].

In the cases analyzed, the availability of adequate initial financial and/or human resources emerged as a decisive enabling factor for the implementation of concrete and effective projects aligned with the waste hierarchy principle. The presence of dedicated personnel and financial support appears essential to allow focused efforts and to provide a solid foundation for project development.

Without sufficient human and financial resources in the start-up phase, it becomes extremely difficult to ensure the long-term sustainability of such projects. In all the cases studied, there are, in fact, human resources permanently engaged in initiatives related to waste reduction, reuse, separate collection, and recycling. As previously noted, these individuals are highly motivated and often hold leadership roles. Without their presence and ongoing commitment, it would be difficult to make meaningful progress along the planned development paths.

Revet secured the necessary resources not only through self-financing and support from public shareholders, but also by opening its capital and establishing joint ventures with major private companies. In other cases, public investment played a decisive role.

In the case of Gothenburg, the project to build the reuse park adjacent to the new city recycling center required support from the public real estate company, which agreed to carry it out with an investment of approximately 20 million SEK (around 2-3 million euros). This investment – without which the project would not have been realized – was later recovered through rental payments from the Municipality of Gothenburg. The municipality, in turn, covers this cost partly through the urban waste management tax and partly through rent paid by the shops and the on-site café/restaurant.

As the director at the time stated, "*The public company accepted also because it was a good opportunity to invest in a 'green' project, which was also good for the city's reputation*". Investing in projects capable of climbing

[38] Saarinen A. & Aarikka-Stenroos L. (2023). Financing-Related Drivers and Barriers for Circular Economy Business: Developing a Conceptual Model from a Field Study. *Circular Economy and Sustainability*, 3, 1187-1211.

[39] Kirchherr J., Piscicelli L., Bour R. *et al*. (2018) Barriers to the circular economy : evidence from the European Union (EU). *Ecological Economics*, 150: 264-272.

[40] Aranda-Usón A., Portillo-Tarragona P., Marín-Vinuesa L.M. & Scarpellini S. (2019). Financial resources for the circular economy: a perspective from businesses. *Sustainability*, 11.

the waste hierarchy represents an opportunity to create new jobs, reduce the cost of waste disposal and generate new economic opportunities.

In the case of ReTuna, the interviews showed that "*With this initiative, the municipality aimed – and still aims – to reduce environmental impact through the promotion of reuse and the optimization of waste management, in line with its ambitious environmental and climate goals. These include reducing the amount of waste through reuse, lowering the costs associated with recycling, and supporting environmental objectives such as cutting the Municipality's carbon emissions by 80% by 2030 and achieving effective climate positivity by 2045*".

To achieve such ambitious goals, adequate resources must be invested. The municipal energy and waste management company EEM has invested around €7.3 million to build the recycling center and redevelop a former adjacent logistics facility. This has made it possible to provide suitable space for receiving donations, functionally separating items for future recycling, and creating a shopping center that includes not only retail stores but also cafés, restaurants, schools, laboratories, conference areas, and proper storage facilities for donated goods.

In Capannori, although the Daccapo reuse centers still rely heavily on volunteer work and community associations, they benefit from at least the free use of the buildings that house the centers (with the exception of one, which is rented by the cooperative), as well as support from the Archdiocese of Lucca and the Caritas Pastoral Office.

The City of Paris has established a dedicated "mission" for the elimination of single-use plastics, within the Directorate for Ecological Transition and Climate. From an organizational standpoint, assigning a full-time, dedicated person means allocating a qualified human resource and enabling them to focus exclusively on the project.

As noted in the interviews, Lila Durix succeeded in reaching a very large number of municipal employees: "*the training involved over 1,500 municipal employees, because I am one person, I can't do everything, but I saw that good decisions were made by training people and it was necessary to reach as many people as possible*".

The cross-case evidence confirms the crucial importance of public sector funding, which can serve as a model for the private sector in the future. As the director of ReTuna stated, public investment can provide a strong incentive for private entrepreneurship: "*It's incredible that we, as a public energy and waste management company, also manage a shopping center – and do so in an economically sustainable way, with solid finances. We can show the private sector that it's possible; if we can do it, it should be even easier for them*".

11.2.5. Flexibility to adapt to emerging needs without distorting the overall design

Change processes require adaptations to the specific environment in which the project develops[41]. From the transversal analysis of the cases analyzed, a further enabling factor for the implementation of projects capable of climbing the waste hierarchy is precisely the flexibility in adapting the initial project, in terms of time and methods, to actual needs. Flexibility should not be confused with what Garvin and Roberto call "analysis paralysis", i.e., situations in which a continuous flow of proposals and relationships is produced, with decision makers making small changes and refinements without ever reaching a final decision[42].

From the interviews carried out, flexibility emerges as a positive transversal element: the ability to make the most important stakeholders involved in the projects perceive openness and willingness to make adjustments, taking into account emerging needs, welcoming useful suggestions and progressively internalizing new solutions to emerging problems.

In the case of Paris, for example, in the interviews it was in fact told by the official in charge of the project that "*the way I approached the topic was first of all to move from disposable to sustainable reduction. There is no one-size-fits-all solution, so we have to adapt to each use case, i.e. we will not have the same solution for a food truck as for a stadium, for a cinema as for a museum, for an outdoor event as for an administrative building. So what's really important is to adapt to every setup, every type of user or customer. You can't have the same relationship with children or with a nursing home or with people who come to attend a festival. First of all, to reassure the many people I spoke to, I said that we could adapt, we could reduce with reusable containers, we could reduce with large format bottles. The simplest solution was to no longer use cans or small-format plastic bottles, but to serve drinks in 1.5-2 liter plastic bottles, which also makes more economic sense. We had to adapt to each use case, not have preconceptions, but be really open and experiment*".

The same flexible approach has also emerged in other cases, such as in Ecoambiente's transition toward improving both the quantity and quality of separate waste collection. Also for this case, during the interviews, it was

[41] Dempsey M., Geitner L., Brennan A. & McAvoy J. (2021). A Review of the Success and Failure Factors for Change Management. *IEEE Engineering Management Review*, *50*(1), 85-93; Lauer T. (2020). *Change management: fundamentals and success factors*. Springer Nature.

[42] Garvin D.A. & Roberto M.A. (2005). Change Through Persuasion, *Harvard Business Review*, *83*(2): 104-112.

stated by the CEO that "*The process followed for the province-wide unified management project was as follows: approval of the area plan, approval of the industrial plan, and in-house assignment, with a system-wide vision and the goal of implementing projects gradually, in line with the specific characteristics and complexity of the territory*".

Openness to listening and adaptation appears to be crucial in allowing a "tailored" approach to the needs of the territories served[43]. The interviews highlighted the importance of listening and, when appropriate, adjusting the initial project to meet the demands of key stakeholders – namely, the citizens. In the case of Ecoambiente "*The evenings were in fact a double channel, information for citizens, but also useful ideas for us; each evening was rather similar to the others, but in each evening there was always at least one "new" question that differed from those made in previous meetings. We have learned a lot and made some changes to the initial plan*".

Flexibility is essential not only for implementing effective systems of separate waste collection, but also for finding new solutions and creating new supply chains to ensure efficient recycling. This approach allows waste to be transformed into secondary raw materials, giving it new life.

Revet has not only equipped its facilities with areas suitable for storage to meet the various needs of customers in a flexible and dynamic way, but it also leverages satellite centers distributed throughout the region.

Moreover, Revet's business model is based on a deep knowledge of materials and a strong capacity for innovation. This enables the company to offer plastic granules that can be adapted to the requirements of different industries and businesses – whether for new packaging or for the production of items ranging from furniture to components for cars and motorcycles.

The adaptability of Revet's granules is, in fact, one of the company's main strengths.

From the interviews, it emerged that the company's approach is not to replace a specific virgin polymer with the same recycled polymer. Instead, they analyze the mechanical properties required for a given product – such as UV resistance for outdoor use, water resistance, or fire protection – and aim to achieve the same performance using a recycled polymer. This allows them to offer a raw material with similar performance but lower environmental impact, while also contributing to the circular economy and, ultimately, the common good[44].

[43] Romano G. (ed.) (2024), *La buona gestione e il buon governo delle aziende di servizi pubblici locali. Tratti distintivi e fattori critici di successo delle aziende a totale capitale pubblico*. FrancoAngeli.

[44] Minoja M. & Romano G. (2024). Effective stakeholder governance in circular economy: Insights from Italian companies. *Journal of Cleaner Production*, 474, 143584.

In the case of the reuse centers in Capannori, organizational flexibility supported the development of the project by giving the local area and its citizens adequate time to appreciate its impact. This gradual approach made it possible to identify the most appropriate solutions to achieve the social goals intrinsic to the Daccapo project. As one of the policymakers who oversaw the creation of the centers recalls: "*After two or three years, more or less, when the cooperative was also established, the business became better structured, also enabling laboratory activities and repairs. Then, once the cooperative was consolidated, it decided to invest further by renting an additional warehouse adjacent to one of the reuse centers. There, the artistic reworking of some movable assets was further developed, along with the tailoring workshop and all the other cooperative's activities*".

Projects can and in some cases must be scaled progressively, as they become consolidated. In ReTuna, for example, the shopping center has the possibility of expanding further in the future: in fact, "*the exclusive ownership of the building – which currently also houses two logistics companies – gives us a significant advantage: the possibility of expanding our shopping center by 7,000 to 8,000 square meters in the future*".

Therefore, thinking about projects within the waste hierarchy in a flexible way, guaranteeing the conditions, including logistical ones, for further developments, is a crucial element to allow management and strategies that look with confidence to the future development of the circular economy.

11.3. Circular economy bottlenecks holding back the implementation of the waste hierarchy principle

11.3.1. The lack of clear rules and adequate incentives

The case studies, through document analysis and interviews, also highlighted the main bottlenecks encountered in the implementation of ambitious projects aimed at applying the waste hierarchy principle, as well as the barriers to the development of circular economy transition pathways – some of which have already been identified in the literature[45].

[45] See, among others (together with the bibliography cited therein): Losa R. (2025). Public policies on circular economy: A systematic review. *Ecological Economics*, 228, 108452; Kirchherr J., Piscicelli L., Bour R., Kostense-Smit E., Muller J., Huibrechtse-Truijens A. & Hekkert M. (2018). Barriers to the circular economy: Evidence from the European Union (EU). *Ecological Economics*, 150, 264-272; Ranta V., Aarikka-Stenroos L., Ritala P. & Mäkinen S.J. (2018). Exploring institutional drivers and barriers of the circular economy: A cross-regional comparison of China, the US, and Europe. *Resources, Conservation and Recycling*, *135*, 70-82; European Commission: Directorate-General for Environment, BIO

The first two bottlenecks identified by the cross-sectional study share a common root: resistance to change in established habits and interests. As is well known, the literature on resistance to change has extensively addressed resistance to organizational transformation[46], as well as the cultural, market, regulatory, and technological barriers to change[47].

Regulatory barriers have been highlighted by several studies as a significant obstacle to the development of the circular economy, mainly due to the lack of effective and consistent supporting regulations[48].

"*Why is change so hard? First of all, most people are reluctant to alter their habits*", Garvin and Roberto said in 2005[49]. In particular, the authors highlighted the existence of "dysfunctional routines" – that is, obstacles to action and change that are partly linked to an attachment to practices or elements that were once appropriate but have since become outdated or in need of replacement. This is exemplified, for instance, by the resistance that can arise when adapting laws and regulations to evolving socio-environmental needs. A cross-case analysis reveals that a major bottleneck lies in the persistent lack of rules, standards, and regulations that would not discourage but rather promote strategies and initiatives aimed at waste reduction, reuse, and recycling.

Intelligence Service, Ecologic, IEEP, IVM and psi (2014). *Scoping study to identify potential circular economy actions, priority sectors, material flows and value chains – Final report*, Publications Office, *data.europa.eu/doi/10.2779/29525*; De Jesus A. & Mendonça S. (2018). Lost in transition? Drivers and barriers in the eco-innovation road to the circular economy. *Ecological economics*, *145*, 75-89.

[46] Coch L. & French J.R.P. (1948). Overcoming Resistance to Change. *Human Relations*, 1(4), 512-532; Piderit S.K. (2000). Rethinking resistance and recognizing ambivalence: A multidimensional view of attitudes toward an organizational change. *Academy of management review*, *25*(4), 783-794; Warrick D.D. (2023). Revisiting resistance to change and how to manage it: What has been learned and what organizations need to do. *Business Horizons*, *66*(4), 433-441.

[47] Kirchherr J., Piscicelli L., Bour R., Kostense-Smit E., Muller J., Huibrechtse-Truijens A. & Hekkert M. (2018). Barriers to the circular economy: Evidence from the European Union (EU). *Ecological Economics*, 150, 264-272.

[48] Kirchherr J., Piscicelli L., Bour R., Kostense-Smit E., Muller J., Huibrechtse-Truijens A. & Hekkert M. (2018). Barriers to the circular economy: Evidence from the European Union (EU). *Ecological Economics*, 150, 264-272; Ranta V., Aarikka-Stenroos L., Ritala P. & Mäkinen S.J. (2018). Exploring institutional drivers and barriers of the circular economy: A cross-regional comparison of China, the US, and Europe. *Resources, Conservation and Recycling*, *135*, 70-82; European Commission: Directorate-General for Environment, BIO Intelligence Service, Ecologic, IEEP, IVM and psi (2014). *Scoping study to identify potential circular economy actions, priority sectors, material flows and value chains – Final report*, Publications Office; De Jesus A. & Mendonça S. (2018). Lost in transition? Drivers and barriers in the eco-innovation road to the circular economy. *Ecological economics*, *145*, 75-89.

[49] Garvin D.A. & Roberto M.A. (2005). Change Through Persuasion, H*arvard Business Review*, *83*(2):104-112.

The cases revealed that, across the various stages of the waste hierarchy, there are obstacles stemming from terminological ambiguities. These ambiguities allow for broad interpretations of the rules, creating multiple and varied risks of disregarding the guidelines and requirements set by policymakers.

The Paris case, in particular, clearly demonstrated the importance of clarifying the concept of single-use plastic, by relying on and applying an authoritative definition – both of what constitutes "plastic" and of what should be considered "reusable" ("*We have adopted the indications from the European Union, thus including everything that contains totally or partially plastic, even in a small part*"; "*we have set a threshold of duration of use, less than one year, to define what was disposable and what was reusable*"). The absence of clear, unambiguous, and non-negotiable rules slows down both the design and the implementation of ambitious projects, as it leaves room for alternative solutions that do not truly challenge or change the status quo.

Even in the most virtuous recycling efforts, the lack of clear regulations – for example, regarding the import of goods from abroad – fails to support sustainable recycling chains. As previously noted, these chains require significant investments that should not be undermined by competition from less sustainable production.

As emerged from the interviews carried out for the Revet case, "*we are aware that companies still try to produce at low cost; therefore, the fact that we have imports that are not particularly controlled or regulated also in terms of sustainability or product safety, does not help our recycling chains*".

The incentives for the projects analysed still appear to be insufficient. In particular, with regard to reduction and reuse, the need for stronger institutional support for the circular economy was emphasized. To enable circular economy to realize its potential as a model for sustainable growth, support is needed not only for recycling, but also for reducing the consumption of products and materials, as well as for promoting reuse[50].

In addition to cultural barriers, a particularly significant issue concerns the repeated application of value-added tax (VAT) on each reintroduction of goods into the economic system in the case of reuse. According to the interviewees, this tax should instead be eliminated or at least reduced, in order to avoid multiple tax payments on the same reused item. Reducing or removing this tax burden would allow for higher margins for those involved in the selection and sale of second-hand goods, making these businesses

[50] Ranta V., Aarikka-Stenroos L., Ritala P. & Mäkinen S.J. (2018). Exploring institutional drivers and barriers of the circular economy: A cross-regional comparison of China, the US, and Europe. *Resources, Conservation and Recycling*, *135*, 70-82.

more financially robust and better positioned to grow and hire additional staff.

The experience of ReTuna and IKEA gives a clear picture of the problem: "*IKEA applies new barcodes to all products, registers them at the time of sale, and if the exact same item is returned, they re-register it to track resales. Over the course of three years, some items have been resold up to five times. This means that both our customers and shops end up paying tax on the same item multiple times*".

Similar instances were shown by Revet, which has "*always tried to ask for the VAT reduction. if an object is made of recycled plastic, this plastic has already paid VAT once*" is the question that recycling chains such as reuse ones have been asking themselves for some time.

From a political point of view, also taking into account the high economic and social cost of unemployment, as the director of ReTuna highlighted: "*Considering the high cost of unemployment for our country, a reduction or elimination of second-hand taxes could lead to the creation of new jobs, thus compensating for the loss of tax revenue with the reduction of unemployment benefits*".

Added to this, of course, are the cost savings related to reduced waste treatment and disposal (less need for incineration and landfilling), as well as the environmental benefits of avoiding the overproduction of goods.

There is also significant potential to create synergies between reuse and reduced public spending on social assistance and education. By supporting reuse, it becomes possible to provide aid to people in need – as seen in Capannori and Sweden – where materials are also made available free of charge to teachers and students in public schools for educational and creative activities.

Finally, bureaucracy should serve to support – not hinder – the development of new projects focused on reduction, reuse, and recycling.

The case of ReTuna has highlighted the importance of being able to activate promotional activities and carry out works more easily than the possibilities offered by the current regulatory-bureaucratic framework provided for public initiatives. Among the "significant constraints" highlighted are the strict regulation: "*We are subject to strict regulations that state that only companies approved by the municipality or by our own company can carry out certain constructions within our area. This can result in higher costs, due to lack of competition, or longer lead times. In addition, our public nature requires us to manage our finances extremely prudently, always acting in the interests of our citizens and taking every decision with a long-term view*".

ReTuna's message, ultimately, is that despite these limitations related to the public nature of the project and management, satisfactory results can also be achieved from an economic point of view, and not only from an

environmental and social point of view. "*If we had been a private company, we would have been able to solve many problems more quickly*".

Therefore, public and private realities must increasingly find the convenience, incentives and facilitations, to undertake new paths for the application of the waste hierarchy principle.

As companies invest in separating glass by color, resulting in higher-quality recyclable materials for glassworks, and increase their ability to select polymers to produce secondary raw materials that meet market demands, it becomes crucial to have legislation and regulations in place to help bring them to market. It is therefore necessary to enhance the efforts made in terms of reducing the carbon footprint, recovering materials and contributing to the circular transition, through concrete incentives and through the creation of new commercial outlets. In this perspective, a key role can be played by green public procurement, which is increasingly sustainable and aligned with the principles of the waste hierarchy.

From the interviews with Revet, the importance of activating legislative, regulatory and engagement solutions that help facilitate consumer acceptance of products and packaging with a high content of recycled material also emerges. As highlighted by the European Commission, an important contribution in this sense could come from promoting recycling and its benefits and encouraging an approach to consumption based on the "user" rather than the "buyer": it is therefore a matter of involving and informing consumers more about the benefits of the circular economy and the need for future changes[51]. In fact, as effectively illustrated by Hopkinson and colleagues, "*the responsibility for circular economy should not be left with manufacturing and operations managers. Marketing is very much needed to do its share, and it is a change in the culture of consumers (including business users) that should be the focus of marketers. There is no question that the industry has spent the better part of a century educating consumers that new is best. However, with marketing work, this could change*"[52].

The experience of the Revet case shows the importance of acting, even using the legislation, to break the "false" belief, still very present in companies, that consumers are not yet ready to accept less fluorescent and colorful packaging,

[51] European Commission: Directorate-General for Environment, BIO Intelligence Service, Ecologic, IEEP, IVM and psi (2014). *Scoping study to identify potential circular economy actions, priority sectors, material flows and value chains – Final report*, Publications Office, *data.europa.eu/doi/10.2779/29525*; Confente I., Scarpi D. & Russo I. (2020). Marketing a new generation of bio-plastics products for a circular economy: The role of green self-identity, self-congruity, and perceived value, *Journal of Business Research*, 112, 431-439.

[52] Hopkinson P., Zils M., Hawkins P. & Roper S. (2018). Managing a Complex Global Circular Economy Business Model: Opportunities and Challenges. *California Management Review*, 60(3), 71-94.

in exchange for an active contribution to environmental sustainability and the circular economy. The efforts described by Revet to collaborate with numerous companies and convince them to use recycled granules instead of virgin raw materials are sometimes undermined by factors unrelated to substance – such as the functional properties of the packaging – and instead tied only to appearance, like a less vibrant or less fluorescent color. As pointed Scappini out: "*Since there is no legislation that generally provides that in all plastic products there is at least a minimum recycled content, recycling is in fact left to the sensitivity of producers and information for consumers. For us, it is important to let citizens know that high-quality plastic can be produced through separate waste collection, and to show businesses that there are concrete opportunities for using recycled plastic. This is a key activity for us, with an economic impact as well. In fact, we have an in-house research and development department, including a dedicated division with a laboratory for material characterization and a pilot plant that allows us to simulate what happens when the granule is used in a specific type of application*".

Policymakers, therefore, in addition to accelerating the introduction of stronger obligations and incentives, could – and should – launch awareness campaigns targeted at citizen-consumers. These campaigns could amplify the messages already promoted by economic actors active in this area – such as CONAI supply chain consortia, companies, associations, and ESG-conscious investors – by adding an institutional voice at the national, regional, or municipal level. The goal would be to further raise consumer awareness of the importance of choosing products and packaging that are actively part of circular transition pathways.

11.3.2. The presence of political and industrial lobbies

The literature has shown that organizational changes which challenge the status quo – such as the transition from unsustainable to more sustainable practices – are inherently likely to encounter resistance[53]; it is frequent, in fact, that consolidated and powerful interests can oppose change and, often, the strongest opposition to reforms comes from outside. Change processes have repercussions on other organizations and tend to be opposed by those who benefit from the status quo[54].

[53] Lozano R. (2024). Resistance to Sustainability Change in Organisations and Strategies to Overcome It. In: *Organisational Change Management for Sustainability. Strategies for Sustainability*. Springer.

[54] Kim W.C. & Mauborgne R. (2003). Tipping point leadership. *Harvard Business Review*, *81*(4), 60-69.

As highlighted by some authors: "*The shift to a circular economy is not straightforward, and the current transitional phases may collide against many entrenched features of the highly successful and much older linear economy model*"[55]. In essence, the transition to the circular economy and the application of the waste hierarchy principle can physiologically clash with what has been ingrained for a long time of the linear economy model.

The presence of opponents who use their influence and who try to oppose change with strong resistance, all the stronger the more they perceive the risk of real change, is an element that must be foreseen[56]. Resistance to change can seriously damage, if not wreck, the process of change decided. Knowledge and prevention of lobbying dynamics therefore becomes decisive, identifying and neutralizing the most influential opponents in advance[57].

The cross-case analysis confirmed that resistance – often expressed by political and/or industrial lobbies capable of opposing the most innovative and ambitious strategies – is a common feature across the cases examined.

The change processes developed to move up the waste hierarchy frequently encountered resistance: "walls of no" that involved a wide range of concerns. "*It's not hygienic, it will be dangerous, it's not practical, it's not cheap*" are just some of the objections raised during the interviews. This "culture of no", according to Garvin and Roberto, has two origins: a culture that overvalues criticism and analysis, and complex decision-making processes that require many approvals and steps and during which anyone can say "no", but no one alone can say "yes"[58]. As highlighted, this bottleneck can be particularly frequent in organizations divided into large subunits or sectors or that have local leaders with large powers, often reluctant to comply with directives from higher levels.

The situation described by Garvin and Roberto[59] can be found in the case of ParisThe *Ambition Zéro Plastique à Usage Unique* project had to contend with resistance from many companies and business associations – including Olympic sponsors and event suppliers – that attempted to influence both central and local decision-making processes. These actors sought to exploit political hesitations and to persuade buyers or other local-level stakeholders

[55] Hopkinson P., Zils M., Hawkins P. & Roper S. (2018). Managing a Complex Global Circular Economy Business Model: Opportunities and Challenges. *California Management Review*, 60(3), 71-94.

[56] Kim W.C. & Mauborgne R. (2003). Tipping point leadership. *Harvard Business Review*, *81*(4), 60-69.

[57] *Ibidem*.

[58] Garvin D.A. & Roberto M.A. (2005), Change Through Persuasion, *Harvard Business Review*, 83(2):104-112.

[59] *Ibidem*.

within the complex governance structure of the City of Paris and its many departments and branches, often promoting "false alternatives".

The strong determination of the mayor and her councilors made it possible to overcome several obstacles – from the fact that the Olympics are primarily under the authority of the IOC rather than the host city, to the involvement of major sponsors such as multinationals like Coca-Cola and Danone.

It was only the deep conviction of the city's main political leader that made it possible to firmly convey the importance of sustainably managing an event of global significance. This led to the creation of clear and authoritative policy documents, which enabled the many actors involved in subsequent decision-making and procurement processes to make informed choices aligned with the city's strategic direction.

The mayor's commitment allowed the municipality to engage directly with the highest decision-making levels of these multinational corporations, prompting them to reconsider practices that might have once seemed self-evident – such as the free distribution of cans, promotional gadgets, or single-use packaging.

From the interviews carried out for the Paris case, it is clear that "*The greatest lobbying pressures around the strategy, were carried out by Coca Cola and the organization that represents and promotes the beverage can industry in France, called boîte boisson*". To counter these pressures, the intervention of the political leadership was decisive (the mayor and the aldermen and their political cabinets had direct meetings with the top management of Coca Cola, for example) and the presence of solid legislation on the activities and methods of lobbying allowed (the presence of attentive and prepared Legal Affairs Offices and a "High Authority for Public Life" made it possible to effectively stem and hinder the pressures.

From the interviews, the lobbying activity of multinationals and business associations is described as a real "encirclement" that consists of meeting "*with all the departments, the Department of Waste Management, the Department of Water, the Department of Circular Economy, and four councilors to convince them that cans are the solution to single-use plastic and that they do not contain plastic. They also met with elected representatives, asking to meet them and bombarding them with emails*".

It is therefore a matter of foreseeing the presence of pressures and organizing adequate organizational and institutional structures capable of concretely curbing lobbying activities[60].

[60] Lozano R. (2024). Resistance to Sustainability Change in Organisations and Strategies to Overcome It. In: *Organisational Change Management for Sustainability. Strategies for Sustainability*. Springer.

In public realities such as Ecoambiente and the reuse centers analyzed, especially in the initial and design phase, there was some political resistance, from those who feared an increase in management costs for citizens and municipalities. In fact, the interviews showed that "*some mayors in the past had a critical position towards the company*", or "*Initially, there was no certainty of success, so much so that the first political vote did not give a positive result and a second vote was necessary, which fortunately was favorable*". The skepticism and resistance of the political opposition are also stemmed by the demonstration of positive results in economic, environmental and social terms and by the timely reporting of the investments made and their returns.

For example, the reuse centers of Capannori every year present a report to the municipalities concerned (Lucca and Capannori), to the managers of the urban waste collection and management service and to the Archdiocese of Lucca – Caritas Pastoral Office that contribute to the activities of the centers: "*Through transparent reporting, citizens understand that reuse is not a cost to the community. They see how these enormous flows of items – which should not be treated as waste – are instead recovered. As a result, not only are disposal costs avoided, but social value is also created through solidarity initiatives that support those in need*".

From a political point of view, another pressure comes in the field of reuse activities from those who fear excessive competition with other commercial and second-hand activities already existing. ReTuna's choice was, for example, to offer opportunities for everyone to be welcomed, then demonstrating over time that new activities focused on reuse that adopt an innovative approach, not only do not hinder existing realities, but enhance them: "*I invite all second-hand stores to open their stores inside ReTuna. Some accepted and opened here, while others preferred not to. Unexpectedly, the opening of ReTuna had a positive effect on the entire second-hand market: more people started buying second-hand items, and as a result, sales of the pre-existing stores also increased in their original locations*".

Finally, bottlenecks are linked to resistance to the introduction of conditions that favor an extension of reuse and recycling, through, for example, tax reductions. As already anticipated and emerged from the interviews of Revet and ReTuna, many initiatives have been made to convince the legislator to grant at least VAT reductions. These resistances have not yet been overcome despite their efforts.

11.3.3. Discontinuity in allocating human and financial resources and the need for a comprehensive cost-benefit assessment

The implementation of the waste hierarchy principle should follow the recent indications of the European Environment Agency: to facilitate the transition to a circular economy and reduce the environmental impact of the use of natural resources, waste management policies based on the waste hierarchy principle should be continuous and ambitious in incentivizing recycling and discouraging landfill and incineration.

Changes, especially if linked to "continuous and ambitious" strategies, as is well known, generate costs: for new investments, for new processes, for staff training, for the engagement of citizens and customers and so on[61]. The economic and financial constraints related to investments in the development of the circular economy are widely considered a barrier to new projects[62]: It is, in fact, difficult to convince owners or decision-makers to invest in these projects, which often require substantial upfront investments and have a long-term time horizon before generating returns[63], as well as short-, medium- and long-term environmental and social impacts to be measured.

The difficulty in securing the resources needed to cover the associated costs makes circular economy projects – and those related to the waste hierarchy principle – vulnerable to shifting political priorities and changing economic conditions[64]. However, investments in the circular economy are fully part of sustainable investing and, for this reason, should benefit from the megatrend that is driving the growth of this sector[65].

The cross-sectional analysis of the cases studied reveals a significant bottleneck that hinders the implementation and dissemination of reduction, reuse, and recycling projects: the discontinuity in securing or investing human

[61] Lauer T. (2020). *Change management: fundamentals and success factors*. Springer Nature.

[62] De Jesus A. & Mendonça S. (2018). Lost in transition? Drivers and barriers in the eco-innovation road to the circular economy. *Ecological economics*, *145*, 75-89; Araujo Galvão G.D., de Nadae J., Clemente D.H., Chinen G. & Monteiro de Carvalho M. (2018). Circular Economy: Overview of Barriers. *Procedia CIRP*, 73, 79-85; Aranda-Usón A., Portillo-Tarragona P., Marín-Vinuesa L.M., Scarpellini S. (2019). Financial resources for the circular economy: a perspective from businesses. *Sustainability*, 11.

[63] Klein N., Ramos T.B. & Deutz P. (2022). Factors and strategies for circularity implementation in the public sector: An organisational change management approach for sustainability. *Corporate Social Responsibility and Environmental Management*, *29*(3), 509-523.

[64] *Ibidem*.

[65] Saarinen A. & Aarikka-Stenroos L. (2023). Financing-Related Drivers and Barriers for Circular Economy Business: Developing a Conceptual Model from a Field Study. *Circular Economy and Sustainability*, 3, 1187-1211.

and financial resources. These resources must be adequate not only during the initial phase of the project[66], but also to ensure continuous, long-term commitment to implementing the waste hierarchy principle in a sustainable way, with lasting solutions.

As previously mentioned, the development of ambitious strategies and policies requires strong political commitment – particularly from the leadership of municipalities and companies promoting them – but also from managerial and technical figures. These actors must embrace the core values of circularity and sustainability and be willing to allocate the necessary resources to consolidate existing experience and pave the way for new development paths.

To overcome this bottleneck, for example, Revet managed to bypass the typical budgetary constraints faced by companies and public bodies by creating a joint venture with a major industrial player, Zignago Vetro. This partnership aimed to build a new plant closer to the glassworks, using advanced technologies with higher performance than those currently in use. Revet also opened its capital to an industrial partner, Montello, with the goal of developing a technologically advanced plastic recycling hub serving as a reference point for central Italy.

The Gothenburg reuse center benefits from the financial investment of the Municipality, which supports its most important activities over time, such as those of the recycling and reuse park management and the resale of all types of building materials, as well as electronic and garden products, guaranteeing its own staff, as well as the availability of the large spaces under management.

A similar approach was replicated in Eskilstuna and Capannori. This combination of business vision and management and financial support from public bodies and companies makes it possible to carry out projects with a high environmental and social value, without burdening the taxation of citizens and making them aware of the advantages of this investment of material and human resources: savings in waste disposal costs, training and reintegration into work for disadvantaged and struggling citizens and the reduction of the environmental impact.

It is therefore important to always conduct a cost-benefit assessment of projects that considers not only economic factors, but also environmental and social dimensions.

It is essential to maintain dedicated human resources who, over time, have become experts – often internationally recognized – and who play a key role in increasingly promoting and disseminating best practices.

[66] De Jesus A. & Mendonça S. (2018). Lost in transition? Drivers and barriers in the eco-innovation road to the circular economy. *Ecological economics*, *145*, 75-89.

The literature has highlighted how economic motivations, often perceived as an obstacle, can instead turn into a driving factor when decision-makers recognize the value of the benefits deriving from circular economy projects, in terms of economic, environmental and social savings[67]. In order for projects to attract adequate investments in a structural way, it is necessary to overcome the resistance inherent in valuation approaches that limit themselves to considering only economic and financial data, neglecting the savings and returns related to environmental and social impacts[68].

In this context, the adoption of a triple bottom line approach proves to be particularly effective[69], especially from a valuation perspective oriented towards "Value for Money" (VfM)[70]. VfM has been defined as the "good use of resources", i.e. an approach aimed at understanding and communicating how economically, effectively and efficiently the resources invested in a project have been used and whether this use is justifiable, also in light of the opportunity costs[71]. It is therefore a matter of evaluating the so-called "5E": cost-effectiveness, efficiency, effectiveness[72], but also equity and cost-effectiveness, thus also assessing the final impact of the proposed or implemented project[73]. A Value for Money (VfM)-inspired approach to evaluation helps strengthen not only transparency in the use of resources, but also accountability – particularly in the use of public, but also private, funds invested in the implementation of the waste hierarchy principle[74].

[67] Klein N., Ramos T.B. & Deutz P. (2022). Factors and strategies for circularity implementation in the public sector: An organisational change management approach for sustainability. *Corporate Social Responsibility and Environmental Management*, 29(3), 509-523.

[68] *Ibidem*.

[69] Elkington J. (1997). *Cannibals with Forks: The Triple Bottom Line of 21st Century Business*. Capstone Publishing.

[70] Glendinning R. (1988). The concept of value for money. *International Journal of Public Sector Management*, *1*(1), 42-50.

[71] See King J., Wate D., Namukasa E., Hurrell A., Hansford F., Ward P. & Faramarzifar S. (2023). *Assessing Value for Money: the Oxford Policy Management Approach*. Oxford Policy Management (and the citations contained therein).

[72] Glendinning R. (1988). The concept of value for money. *International Journal of Public Sector Management*, *1*(1), 42-50.

[73] See King J., Wate D., Namukasa E., Hurrell A., Hansford F., Ward P. & Faramarzifar S. (2023). *Assessing Value for Money: the Oxford Policy Management Approach*. Oxford Policy Management (and the citations contained therein).

[74] See King J., Wate D., Namukasa E., Hurrell A., Hansford F., Ward P. & Faramarzifar S. (2023). *Assessing Value for Money: the Oxford Policy Management Approach*. Oxford Policy Management (and the citations contained therein).

11.4. Concluding remarks

The empirical study aimed to identify the main enabling factors and bottlenecks in the implementation of the waste hierarchy principle, through a cross-sectional analysis of several Italian and European case studies. The objective was to move from a theoretical understanding to the transformative practice of a circular economy.

This cross-case analysis revealed several enabling factors – that is, essential elements required to ensure that practical implementations of the waste hierarchy principle are effective and successful:

1. *Decision Maker Commitment and Formalization of Strategies*. The success of a project depends heavily on the commitment and vision of the political or corporate leadership. Formalization through public deeds, plans and resolutions is crucial for the continuity and effectiveness of projects.
2. *Motivated Professionals and Collaboration with Experts*. The involvement of competent and motivated experts (internal or consultants) strengthens and makes effective the implementation of the projects. Key figures have distinguished themselves for their ability to build consensus, address resistance and implement solutions based on data and studies.
3. *Stakeholder Engagement through Information and Training*. The involvement of citizens, businesses, and employees through widespread and transparent information is essential. Public events and targeted communication play a crucial role in securing the participation and buy-in of key stakeholders. Social media and public initiatives have helped foster awareness and build trust in the projects.
4. *Adequate Human and Financial Resources*. Projects require initial and ongoing investment. The cases show the importance of public funds, private co-financing and dedicated human resources. Targeted investments can generate positive environmental, social and economic impacts.
5. *Flexibility in Project Adaptation*. The ability to adapt to specific contexts and emerging needs is essential. Flexibility allows for operational changes without compromising vision.

Some bottlenecks also emerged from the cross-sectional analysis:

1. *Lack of Clear Rules and Adequate Incentives*. The lack of regulatory clarity and (tax) incentives (e.g. VAT on reuse) hinder change. Ambiguous rules and the absence of minimum standards (e.g. recycled content in packaging) slow down processes. The cases highlight frustration due to repeated taxation and failure to recognize environmental benefits.

2. *Presence of Political and Industrial Lobbies*. There is often organized resistance from established industrial groups or political opposition, driven both by a fear of change and by instrumental interests. Lobbies exert influence through political pressure, counter-narratives, and regulatory obstacles. Only strong and consistent political commitment can overcome these pressures.
3. *Discontinuity in Resources and Inadequate Valuations*. Resources (human and financial) must be guaranteed in the long term. A cost-benefit assessment is needed that includes environmental and social impacts, as well as economic ones. The "triple bottom line" (economic, environmental, social) and Value for Money (VfM) approach is considered essential to properly evaluate projects that implement the waste hierarchy principle.

The cross-case analysis of the case studies highlights that it is indeed possible to move up the waste hierarchy and promote the circular economy through a strong vision and leadership, the availability of adequate resources, broad stakeholder engagement, a flexible management approach, and the ability to overcome structural and cultural barriers.

Change is possible, but it requires integrated governance, policy coherence among institutions and decision-makers, and – during the progressive implementation phase – sustained investment and a virtuous alliance between public, private, and citizen-consumer actors.

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Postscript

When, in 2022, together with Giulia Romano and Ginevra Lombardi, we presented the CLIWEP project – an acronym for "Climbing the Waste Hierarchy: enabling factors and policies" – at PRIN – a common need for knowledge motivated us, despite the diversity of disciplinary perspectives.

To put it very simply: there is a huge gap between the theory of the circular economy and its practice. On the one hand, the theory affirms that a transition from the "linear" models of dissipative consumerism to the regenerative logic of the circular economy and "industrial symbiosis" is a winning strategy in every respect: the environment is better off, the climate is better off, we are better off, and we also save money. A win-win game, where everyone wins and no one loses. On the other hand, it is even too evident that the transition, which has more or less been set in motion, is extremely slow and far from having acquired those principles and solutions in a generalized and lasting way. Above all, even if the examples of companies that have made circularity become an innovative and winning business model are multiplying, this model has not yet imposed itself as a new paradigm, it has not definitively replaced the "linear" one; nor is there any shortage of cases of companies that, starting with the best intentions and great enthusiasm, have then had to ascertain the economic unsustainability of many circular projects.

While the transition is moving with difficulty and some false starts, above all, the fruits promised on the environmental and climatic side are missing. CO_2 emissions, while slowing down, continue to grow. The volumes of waste to be managed may stop growing, but they have not yet begun to decrease. No matter how much effort has been put in place, the goal of "good ecological status" is still far away in most of the water bodies of the European continent.

Nonetheless, wanting to remain with the central theme of the project, the "waste hierarchy", some important progress has been made. 2025 means a quarter of a century since the start of the reforms that have profoundly transformed the waste industry in Europe and Italy. A comparison with that

time in many ways should make us proud (even if we can divide, as always, between "half-fullers" and "half-emptyists", in the sense of the glass).

In Italy, until the turn of the century, the growth in the quantity of waste was constant and in an almost linear relationship with the growth of GDP. For a couple of decades now, however, the figure seems to have stabilized; not yet reversed, of course, and therefore the annual volumes to be managed are more or less always the same, around 30 Mt. It could perhaps be observed that in today's 30 Mt we are more certain than before that all or almost all the waste generated is contained – *littering*, i.e. uncontrolled abandonment or burning in the stove are fortunately a distant memory almost everywhere.

At that time, a sort of monoculture of the landfill reigned, to which more than 90% of the waste that was managed was directed. Today only 15.6% goes to landfills (according to ISPRA; a little more, according to a recent study I conducted with Andrea Sbandati[1]), so much so that the goal of falling below 10% by 2035 seems within reach, and this also bearing in mind that the values of the indicators referring to Italy are always a Trilussian average between a North that is to all intents and purposes "European" and a South still lagging behind on ancient models. But finally, even the disastrous Sicily has exceeded the threshold of 50% of separate waste collection.

The recycling rate of total waste is still far from the goal – 50.8% when the bar is at 65% – but some regions have reached the bar or are close to doing so. All packaging – except plastic, which is not far away – has already reached and exceeded the recycling targets set for 2030, years in advance.

There is discussion, and there will be a long debate, whether Rome and Sicily really needed waste-to-energy plants; and whether other parts of Italy, such as Tuscany or Liguria can continue to do without it, perhaps focusing on futuristic solutions but not yet tested on an industrial scale such as "chemical recycling". In this regard, the "hierarchy" can provide useful arguments to both the supporters of yes and no: the latter, affirming the need to go as high as possible on the "ladder", the former noting that there is no country in the world that has achieved a goal of zero landfill without a certain fraction of energy recovery, and therefore that the necessary efforts to increase the recovery of material have no hope of "closing the circle" on their own. Even within our small research group, there are quite divergent opinions.

Be that as it may, in Rome the building yard for the Santa Palomba plant has started, for the two Sicilian plants the tender should have started, throughout Italy there are numerous projects for anaerobic plants for the organic fraction.

Above all, it seems that the waste management system in Italy has given a decisive acceleration towards the adoption of industrial models that are

[1] Massarutto A. & Sbandati A. (2025). Alla ricerca del rifiuto perduto, *Energia*, 2/25.

finally adequate, also thanks to the valuable stimulating role played by the national regulator[2].

On other indicators we are still behind, but overall we cannot say that everything is bad. But if those targets are to be taken seriously, there is no doubt that there is still a long way to go.

The desire to understand the reasons for the gap between what we say we want to do and what we are capable of doing was the glue that held the research project together. Then everyone took their own path. Giulia Romano's study, of which this volume is excellent testimony, focused on practice: she asked, in other words, given the targets, what factors have slowed down the transition, and which ones have pushed it positively. The task of politics is to remove the former and strengthen the latter.

The group directed by Ginevra Lombardi has also oriented itself in search of successful case studies using econometric tools.

My unit followed a somewhat different path, which began with critically analyzing the fundamentals of the theory. If theory says one thing and the world does another, it may well be that the world is wrong – helped to be wrong by the coalition of the many opposing interests, those that lived and prospered in the "world of yesterday". It is the thesis of the "negative-sum game", in which the beneficiaries nevertheless have powerful political allies and a "voice" that imposes itself in the public discussion. It is the famous *lobbies* that row against changing the status quo, whose existence it is necessary to postulate to explain why the "world" is reluctant to welcome the Good News. This kind of explanation has always left me rather unsatisfied.

I am a fierce and tireless Europeanist, but I have never hidden my perplexities about the dogmatic and extremist approach often adopted by the European Union. As an "ecological economist", to whose category I profess to belong, I have tried to apply the cornerstones of this discipline to the circular economy. What are the reasons that motivate it?

If we want to stay within the framework of neoclassical economics, the test to pass is the classic cost-benefit analysis. It is desirable to do what creates value, and to refrain from doing what destroys value. Where "costs" and "benefits" must contemplate not only market prices, but also the value of all components that have social relevance – from greenhouse gas emissions to the harmful effects of pollution. If this approach does not fully satisfy us

[2] I refer the interested reader to two other recent works of mine, both in the process of publication: Massarutto A. (2025). Eppur si muove. The Italian waste industry and the transition to the circular economy. *Public Economy*; Massarutto A. (2025). Independent regulation and management of urban waste in the circular economy. An initial assessment of ARERA's experience in Italy. *Market Competition Rules*.

– due to the peculiar characteristics of natural capital – there are other tests to ascertain whether and to what extent natural capital and the "ecosystem services" it provides are or are not "critical", and whether or not they should be preserved with a "precautionary principle" beyond what economic calculation suggests.

However, even applying this approach most generously, no economic study has ever concluded in favor of a drastic shift to the circular economy. If a certain level of circularity – measured as one wishes – is undoubtedly desirable, no study argues for the desirability of going beyond certain thresholds, and this is essentially because there is a sort of "law of entropy" in the use of matter, which degrades it and implies increasing costs in trying to bring it back to its primordial state as a raw material.

Following this line of reasoning, one is persuaded that the principle of hierarchy is a very healthy and very reasonable conceptual map as long as it remains a "rule of thumb", an order of priority to be followed in general; but it turns into an absurd Procrustean bed if one claims to apply it literally, even when there is no convincing empirical evidence of the advantages of passing to the higher rungs.

The indicators applied by the EU to measure the "circularity rate" add apples with pears, cement with wood and with lithium and glass, in a single pile of materials in which the truly critical ones may be weighed in kilos and not in tons, and therefore affect the indicator less than the third decimal place. In this way, there is a risk of dealing with the complexity of the problems in a simplistic way, and losing sight of the objectives we want to achieve. What is the priority we pursue: to avoid dissipative forms of disposal? Reducing CO_2 emissions? Recovering critical materials? Limit the negative externalities of pollution? Who is our enemy, plastic islands in the ocean, climate change, material consumption? Or perhaps capitalism?

The war on single-use disposable items strikes one of the emblems of the consumer society, which dissipates resources, and therefore hits the mark by targeting a raw nerve of our civilization. But at the end of the day, "disposable" is not synonymous with "throw on the street": disposable, if directed after use to recovery and recycling, is a very different thing. Between a material used once but then recycled, and one that is reused, and perhaps in order to be reused must be washed, disinfected, transported back to the production centers, the difference becomes more blurred and many certainties vanish.

The dogma of material efficiency is presented as equivalent to sustainability and the prevention of climate change, but most studies show that this is only partially true, and beyond a certain level its opposite is true. One of the studies we have carried out as part of CLIWEP, for example, shows that the superiority of reuse over recycling, in purely environmental and non-

economic terms, depends critically on the distance that reusable packaging should travel. In the case we studied, that of large household appliances, the critical distance is a couple of hundred km at most.

The contrast that the European Commission exhibits against incineration with energy recovery has always appeared dogmatic and unjustified to me – especially if we take into account that the virtuous countries, those that stand at the top of the rankings of the circular economy, make extensive use of this technology, not in antithesis to recycling and reuse, but rather as a complementary and necessary tool to really and definitively ban landfills.

The rhetoric of the circular economy makes it appear as if it were a way to save precious raw materials that have become scarce: but in reality this may be true at most for some very particular materials – the "critical raw materials", such as rare earths – but not for the generality of materials. If the price of virgin material, even corrected to take into account the various externalities, remains lower than that of the recycled product, forcing the use of the latter involves higher economic costs, which must be justified with other arguments.

But on closer inspection, whatever argument one tries to use, it justifies a certain level of circularity, but not absolute circularity. Reducing landfills is desirable and appropriate, especially in Europe, where we have less and less adequate space to build them. But landfill can be reduced in many ways, and not only with reuse or recycling.

Elsewhere it is argued that the motivation of the circular economy is the mitigation of climate change through the reduction of emissions: but even in this case, an endless literature shows that this is true in many cases, but not always; that going beyond certain levels not only costs more in economic terms, but even produces zero or even negative environmental benefits.

The new Packaging Regulation solemnly proclaims the desire to save the planet from the proliferation of single-use containers, especially if they are made of plastic. But few have noticed that it is the Commission itself that tells us that the measures envisaged – some extremely ambitious, such as a 30% reduction in total packaging placed on the market, reuse and reuse targets to replace those on recycling, and generalised obligations to use returnable and refillable packaging – will impact European emissions by a measly 0.08%.

All this reasoning may seem idle, and in part it is if we consider that, in any case, we are still abundantly in deficit. Whether the optimal circularity rate is 50, 70 or 99% we can calmly discuss, as we strive to rise beyond the current level, which is almost certainly below optimal. The direction of travel, at least that, is clear.

And so let's go back to the reasons that motivated this research project.

On one issue, at least, my vision and that of the authors of this volume coincides perfectly, and that is the importance of what in economics are called "transaction costs". If innovation struggles to establish itself, it is also because in order to best deploy its benefits, it requires a coordinated set of actions. The value of what I collect and separate also depends on the availability of subjects who know what to do with this material (technology) and have the necessary processing capacity. If a new material has superior performance, users must use it, suppliers must supply it, and the "value chain" must be built around it.

When I started dealing with waste, at the end of the 80s, no one was seriously convinced that significant results could be expected from separate collection and recycling. Everyone was focused on the plants that were missing, in the face of the mountain of waste that was growing. Separate waste collection was done more than anything else to satisfy some political pressure, or to remove alibis from those who protested against the plants. No one seriously believed that it could significantly affect the volumes to be disposed of. Today we recycle 50.8%: more than half of those 30 Mt is no longer waste (and we should add another almost 10% that cannot be defined as recycling under European standards but is still secondary recovery of material that, if nothing else, does not pollute and replaces some inert quarry.

If we have come this far, we also owe it to an organizational innovation that many looked at with skepticism at the time: the principle of "extended responsibility", by virtue of which it is up to producers, and not to citizens and the public service, to take care of the "end of life" of the products we consume. We started with lubricating oils and car batteries, continued with packaging, moved on to electronic waste, and then to many other fractions, from demolition rubble to mattresses, from textiles to furniture. We have built an organic waste supply chain, thanks to which we first recover biomethane from this waste and lately compost. If all this has become a reality, it is also because the responsibility of the producer has created the conditions for the production system to take the problem into its own hands and address it with technological innovation and industrial organization.

The book you hold in your hands fits into this groove. The analysis of successful experiences is useful to highlight the contextual factors that made them possible and to try to replicate them in other contexts. It allows us to understand that it is often the details that decide whether an experience will be a success or a failure. They make us touch the systemic nature of the processes of change, to grasp the "virtuous circles" that strengthen them as well as the "vicious" ones that can jeopardize their outcome.

I hope that this book – and all the work carried out in the context of CLIWEP – can provide a useful contribution not only to scholars, but above

all to those who are involved in politics in this sector, and to those who have an interest in approaching it not already presuming to know the solutions, but with the desire to grasp the enormous complexity of the transition.

Udine, June 2025

Prof. Antonio Massarutto
University of Udine National Coordinator of the research project of relevant national interest (PRIN) Climbing the Waste Hierarchy: enabling factors and policies, CLIWEP

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The Authors

Laura Carosi is Full Professor of Mathematical Methods of Economics and Actuarial and Financial Sciences at the Department of Economics and Management of the University of Pisa. She is the author of numerous publications of national and international relevance in the field of optimization and mathematical methods for performance evaluation, with particular reference to waste management and water resources.

Giovanna D'Inverno is Associate Professor of Mathematical Methods of Economics at the Department of Economics and Management of the University of Pisa. She is also an associate researcher at the Leuven Economics of Education Research (LEER) center at KU Leuven. She is the author of numerous scientific articles on the development of mathematical methods for performance evaluation in the public sector, with a particular focus on sustainability issues such as waste and water management, education, and local government spending. She participates in various national and international research projects, collaborating with consulting agencies and public institutions.

Maria Silvia Fiorelli is Lecturer in Business Organization at the University of Pisa; her research activity focuses particularly on the study of small and medium enterprises and organizational network systems, developing particular attention to inter-organizational relationships and the role of human resources in trust mechanisms and competence development.

Giovanni Giaretti, lawyer, has combined his profession with commitment to recycling and waste reduction issues, towards a zero-waste community. Over these years, he has handled corporate compliance for various in-house companies, with particular reference to urban hygiene companies. He is currently the Sole Administrator of Medionovarese Ambiente spa, a publicly controlled company of the Medionovarese Consortium.

Sara Latini held the role of research fellow at the Department of Economics and Management of the University of Pisa within the project "Climbing the Waste Hierarchy: enabling factors and policies". She obtained her PhD in Mathematics and Models from the University of L'Aquila. Her research interests include the study of equilibrium problems applied to waste management and electricity market models, as well as the analysis of numerical methods.

Paolo Rognini is a Researcher at the University of Pisa in the Department of Civilizations and Forms of Knowledge and is Lecturer in Environmental Geoanthropology within the master's degree course in Environmental Sciences. He is a member of the Italian Society of Anthropology, Ethnology and Comparative Psychology. His studies have focused on behaviors and activities that, generating macroscopic environmental alterations, cause damage to the environment, health, and living conditions in the contemporary world. He has published numerous books and articles in various fields of social psychology, anthropology, and human geography.

Giulia Romano is Associate Professor of Business Economics at the Department of Economics and Management of the University of Pisa, where she teaches Business Economics, Corporate Governance, and Public Services Management. She is the author of numerous publications of national and international relevance on the topics of public services, corporate governance, sustainability, and business performance and coordinates the University of Pisa research unit of the research project of significant national interest (PRIN) Climbing the Waste Hierarchy: enabling factors and policies, CLIWEP.

Raphael Rossi, Italian-French, has been both a designer of virtuous waste management systems and administrator of public environmental management companies for over 20 years. He has collaborated with the Joint Research Centre of the European Commission as well as in various international projects. In Italy, he has designed virtuous waste management systems for many cities and territories, including Turin, Trento, Rome, Bari, and Messina. He has administered the public environmental companies of Turin, Naples, Reggio Calabria, Parma, Piacenza, Reggio Emilia, Foggia, and Livorno. He has been called in four cases of municipal dissolution due to organized crime infiltration, in Reggio Calabria, in Gargano, in Foggia, and in Aprilia (LT).

Waste Hierarchy in Action. Italian and European Models for a Sustainable Future

Policy Brief

Executive Summary

Italy and the European Union are facing urgent challenges in waste management. Although the waste hierarchy principle lies at the core of environmental policies, **its practical implementation remains uneven and insufficient**. Waste generation continues to rise, decoupling from GDP is still incomplete, and many valuable materials end up in landfills or incineration.

This brief summarizes scientific evidence and exemplary case studies, providing concrete recommendations for policymakers engaged in the ecological transition.

Context: An Incomplete Transition

Directive 2008/98/EC introduced the waste hierarchy: prevention, reuse, recycling, recovery, and disposal. However:

1. Only **48%** of municipal waste in Europe is recycled (Source: Eurostat, as of 2023);
2. In Italy, waste generation **increased** despite GDP remaining stable between 2010 and 2022 (European Environment Agency, 2025);
3. Prevention and reuse remain **marginal** in both statistical reporting and active policy measures;
4. Regulatory, economic, and cultural **bottlenecks** persist.

According to the European Environment Agency, without a radical acceleration in prevention and reuse efforts, the EU's 2030 and 2035 targets are at **risk**.

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Evidence and Best Practices

Three virtuous steps, six emblematic cases:

- **Prevention**: Paris and the "Ambition Zéro Plastique à Usage Unique" initiative in preparation for the 2024 Olympic Games.
- **Reuse**: Alelyckan (Sweden), ReTuna (Sweden), and Daccapo (Tuscany): centers for repair and circular commerce.
- **Separate Collection and Recycling**: Ecoambiente (Rovigo) and Revet (Tuscany): high-performance separate collection systems combined with innovative facilities enabling effective recycling.

Enabling Factors

- Clearly stated and formalized political commitment (e.g., manifestos, approved plans)
- Involvement of skilled and motivated managers and consultants in both the design and implementation phases
- Motivated stakeholders (employees, citizens, suppliers) supported by clear, effective, and inclusive communication
- Dedicated human and financial resources
- Project flexibility and adaptive capacity

Structural Barriers

- Lack of clear and incentivizing regulations
- Lobby politiche e industriali resistenti al cambiamento Political and industrial lobbies resistant to change
- A prevailing tendency to assess investments solely in terms of economic and financial returns, without accounting for environmental and social impacts (value for money logic and the triple bottom line)

Recommendations for political action

1. Make eco-design mandatory and promote repairable and durable products through the Minimum Environmental Criteria (CAM).
2. Investing in territorial reuse centres that are affordable and accessible to everybody.
3. Introduce effective economic levers: pay-as-you-throw (PAYT) schemes, eco-taxes on single-use packaging.
4. Reform waste management governance, enhancing coordination and shared responsibility.
5. Launch national and local environmental education campaigns focused on prevention, reuse, and high-quality waste sorting.

Concrete Actions

Policymakers can immediately initiate targeted and feasible actions based on existing legal and financial frameworks. Specific regulatory amendments at the regional and municipal levels can strongly support waste reduction (e.g., banning unnecessary giveaways and disposable items at sports events, fairs, schools, and canteens), encourage the creation of reuse centers, and promote the use of second-hand goods (in connection with social services, for school creative workshops, for adult education or social reintegration). Truly circular public procurement practices can be promoted, and synergies among municipalities and sectoral companies fostered. At the national level, CAM adoption could be made mandatory, with strict performance criteria focused on reduction, reuse, and actual recycling outcomes.
Furthermore, reforming the tariff system is a viable step, linking citizens' waste production to their economic contributions through PAYT models. In parallel, innovative public campaigns at the local level – featuring public meetings, video creation, social media outreach, and the systematic inclusion of environmental education in school curricula – can foster a broad cultural shift. When integrated and supported over time, these actions can bring the waste hierarchy principles into immediate and tangible practice.

Conclusion: A Transformative Vision

Implementing the waste hierarchy is not merely a technical or environmental priority, but a political vision and choice. The case studies examined demonstrate that it is indeed possible to reduce waste, support local economies, and improve community well-being.

Public administrations play a pivotal role – as regulators, as partners in virtuous initiatives, and as purchasers. Public procurement, Green Public Procurement (GPP), and extended producer responsibility policies must become active tools of transformation, promoting not only recycling but also reduction and reuse.

The time for waiting is over: ambitious projects must now be widely launched by municipalities, regions, and companies. Clear and effective rules, together with targeted and dedicated investments, are essential to support Italy's full transition toward a circular economy. The models to replicate already exist – what is needed now is determination and consistency.

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La passione per le conoscenze

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The "waste hierarchy" principle is a pillar of European environmental policy. Despite the presence of common objectives set by the European Union, each country maintains a wide margin of autonomy in implementation, deciding how to incentivize the most effective actions (reduction, reuse, recycling) and discourage those that are less sustainable (incineration and landfill). This causes considerable heterogeneity, both in the strategies adopted and in the results obtained: some countries have achieved significant milestones, while others still show significant room for improvement.
Intervening with targeted and ambitious policies is increasingly urgent. Through the analysis of six emblematic cases, the volume identifies the necessary conditions to make the waste hierarchy principle a reality. Strong determination from political or corporate leadership, the involvement of authoritative and passionate experts, stakeholder engagement, the availability of adequate resources, and project flexibility emerge as decisive enabling factors to overcome bottlenecks and the many regulatory, cultural, and industrial resistances.
From the cross-sectional reading of the cases, it emerges that there is no ideal context or single model for scaling the waste hierarchy, just as no single "best practice" can be identified, but rather a plurality of good practices that can be combined synergistically.
The book is aimed at anyone who wants to understand how the circular economy can move from vision to transformative practice: public decision-makers, managers, scholars, and citizens engaged in ecological transition, offering concrete examples and a replicable model for implementing strategies capable of reconciling economic balance, environmental sustainability, and social equity. A work that not only describes good practices, but wants to make them systematic and scalable, helping to overcome the many "walls of no" and instilling positive replication effects.

Giulia Romano is an Associate Professor of Business Administration at the University of Pisa, where she teaches Business Administration, Corporate Governance, and Public Service Management. She is the author of numerous publications of national and international relevance on the topics of public services, corporate governance, sustainability, and business performance, and coordinates the University of Pisa research unit for the nationally significant research project (PRIN) Climbing the Waste Hierarchy: enabling factors and policies, CLIWEP, CUP N.I53D23002730006.

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