

# HARMONIZING CIRCULARITY: ROMANIA'S PROGRESSIVE EFFORTS TOWARDS CIRCULAR ECONOMY INTEGRATION IN EUROPE

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**ABSTRACT:** The pursuit of a circular economy stands as a cornerstone in the global agenda for sustainable development. This paper delves into Romania's intricate journey towards circularity and its progressive efforts to integrate seamlessly into the European framework. Through an in-depth analysis of policy initiatives, institutional frameworks, and circular practices, this research aims to shed light on the pivotal role Romania plays in shaping the European landscape of circular economy transitions. Drawing upon a comprehensive review of key indicators, the study evaluates the effectiveness of Romania's strategies in harmonizing circularity within its national policies and practices. Furthermore, this paper explores the challenges encountered and potential avenues for further enhancement in Romania's quest for sustainable circular economy integration within the broader European context. The findings presented herein contribute valuable insights for policymakers, researchers, and industry stakeholders alike, fostering a collective understanding of the dynamics involved in the harmonious integration of circular economy principles at both national and regional levels.

**KEY WORDS:** circular economy, sustainability, circular framework, sustainable practices, transition.

## 1. INTRODUCTION

In the face of escalating environmental challenges and a growing awareness of the finite nature of resources, the global community has increasingly turned its attention towards sustainable and circular approaches to economic development. At the intersection of these endeavors lies the concept of a circular economy, an innovative paradigm that prioritizes resource efficiency, waste reduction, and sustainable practices. This paper delves into the specific case of Romania, exploring the nation's ongoing journey towards harmonizing circularity within its economic and environmental strategies, and its progressive efforts to seamlessly integrate into the broader framework of circular economy principles and strategies established by the European Union.

Romania, as a member state of the European Union, plays a pivotal role in shaping the regional landscape of sustainable development. The imperative to transition from a linear to a circular economy is embedded in the European policy framework, with overarching goals aimed at reducing environmental impact, enhancing resource productivity, and fostering economic resilience. Against this backdrop, Romania's distinctive socio-economic and environmental context provides a compelling lens through which to assess the challenges and opportunities associated with the circular economy transition. By scrutinizing the nation's progressive efforts, we aim to contribute valuable insights to the broader discourse on circular economy integration in Europe. As the imperatives of sustainability become increasingly urgent, understanding the dynamics and intricacies of Romania's approach is instrumental not only for the nation itself but also for other European countries navigating similar trajectories. Through this exploration, we aspire to contribute to the collective knowledge base that informs evidence-based policy making, sustainable business practices, and a harmonized circular future for Romania and the broader European community.

## 2. LITERATURE REVIEW

The circular economy is currently one of the most promoted concepts at the level of the European Union, being the subject of numerous sustainable development strategies and policies supported by national governments and even by numerous companies around the world. However, the scientific and research content of the circular economy concept does not know concrete delimitation, being a niche that is still in the conceptual development phase given the synergies that the various fields and variables involved establish at the level of their interaction.

The circular economy is approached as a solution to problems generated by production and consumption in the context in which economic growth based on the linear model is no longer sustainable, requiring the imposition of measures that are consistent with sustainable economic and ecological development. The limitations of the linear economic model have been felt since the early stages of industrialization, when the idea of material cycles was supported as an argument to reduce the negative impact on the environment and stimulate new business opportunities. (Desrochers, P., 2002.; Desrochers, P., 2004).

The notion of circular economy begins to be outlined in the 1970s (EMF, 2013b) with J. T. Lyle and Walter Stahl as supporters, who attributed to the concept a series of elements from the environmental field. Several authors, such as Andersen (2007), Ghisellini et al. (2016) and Su et al. (2013) attribute the introduction of the concept to Pearce and Turner (1989). By describing how natural resources influence the economy by providing inputs for production and consumption, as well as producing outputs in the form of waste, they investigated the limitations of the linear model. A precursor of the circular economy can be considered the ecological economy in the approach of which most of the concepts specific to the circular economy at the macro-economic level were outlined, which currently form the basis of the

formulation of policies and practices oriented towards the circularity of economic processes. And at the microeconomic level, the effects of the ecological economy have been debated in numerous scientific papers and publications specific to the field of eco-efficiency (Huppel and Ishikawa, 2009) or industrial ecology (Kenneth Korhonen and Snäkin, 2005), in which the importance of integrating flows of cyclic materials or the so-called "fourth law" invented by Georgescu-Roegen (1971).

In the theoretical foundation of the circular economy concept, numerous influences from the area of "ecological efficiency" (Braungart et al., 2007; Braungart and McDonough, 2002; Emaf, 2013; CIRAIG, 2015) and the industrial ecosystem (Graedel, 1996) can be found; Frosch and Gallopoulos, 1989; Korhonen, 2001; Ehrenfeld, J.R., 2000), but the solutions identified are highly idealized in that economic and natural systems are integrated into a single system that relies 100% on renewable energy and recycles all materials used, which makes the pattern difficult to apply and draws attention to some limitations of the circular pattern.

But the concept begins to gain momentum only in 2010 when the foundation of the Ellen MacArthur Foundation is laid, which has a special role in promoting the idea of circularity among economic policy decision-makers, influencing the academic environment and companies, so that the model of the circular economy becomes the subject of some large-scale long-term development strategies.

A much bolder and more practical approach to the implementation of the circular economy can be found on the part of China, which in 2009 became the first country to adopt a concrete legal framework to pursue the application of the circular model. In the European space, with the establishment of the Ellen MacArthur foundation, as the main promoter of the concept, the doors to the first concrete steps in the implementation of the circular economy are opened, so that, in 2013 and 2014, countries such as Canada and France established their own Circular Economy Institutes with the aim of contributing to the training of specialists to make possible the transition to circularity (Beaulieu, 2015).

The circular economy enjoys support among political and business circles (European Commission, 2008; Lacy and Rutqvist, 2016), but its implementation appears to be still in its early stages (Ghisellini et al., 2016; Stahel, 2016). China may be the only notable exception, with the country adopting the "Circular Economy Promotion Law" in 2009 and focusing on the implementation of circularity (Geißdörfer et al., 2017; Geng et al., 2013; Lieder and Rashid, 2016; Liu and Bai, 2014), although it is still far from achieving what Dijkma & Kamp (2016, p.23) called "full circularity". Some also see the Netherlands as a leader on the circular economy (van Buren et al., 2016; Bastein et al., 2013), but implementation has remained at the strategy level.

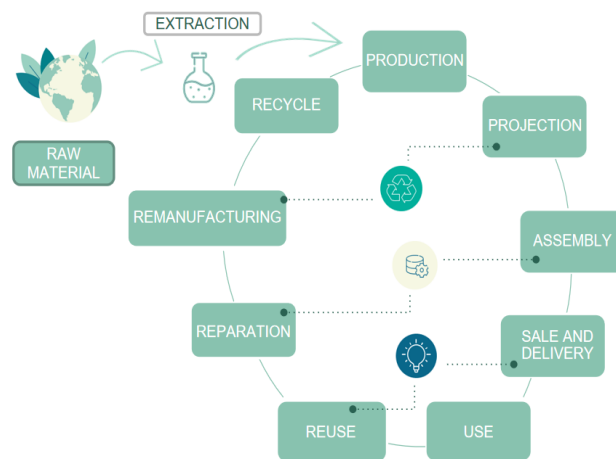
The recycling of materials resulting from economic activities that use the linear model is a form of traditional recycling that in the circular model is oriented towards policies and practices that support the reuse of the product, its components and materials, repair, reconditioning and modernization, as well as the use of energy derived from waste results along the entire production chain, thus contributing to the extension of the product life cycle (Rashid et al., 2013; Braungart et al., 2007).

From the point of view of the theoretical approach, perhaps the most well-known definition of sustainable development is that of a development that meets the needs of the present without

compromising the ability of future generations to meet their own needs. Starting from this definition and integrating it into the contemporary reality, it is observed that meeting the needs of the present generations must consider not only the efficient and rational use of resources and the reduction of waste through the conventional recycling of materials as low-quality raw materials, but also the integration of processes by which materials should first be recovered for reuse, repair and modernization, and only later the use of waste as raw materials according to traditional recycling, aspects that lay the conceptual foundations of the circular economy. Thus, sustainable development in the sense of the circular economy aims to maintain the value and quality of the products along the productive chain and the life cycle as long as possible, which also makes the process as efficient as possible from an energy point of view.

A meta-definition that is based on an analysis of 114 definitions of the concept describes the circular economy as: an economic system that is based on business models that replace the concept of "end of life" with the reduction, alternative use, recycling of materials in processes of production/distribution and consumption in order to achieve sustainable development, which involves environmental protection, economic prosperity and social equity, for the benefit of current and future generations (Kirchherr et al., 2017, pp. 224–225).

In the definition given by the Ellen MacArthur Foundation, the circular economy is restorative and eliminates waste by designing better materials, products and design systems, enabled by innovative business models, being described by Mentink (2014) as an economic system with materials in closed loop. The notion of "closed loop" is also found in the definition given to the circular economy by the Global Economic Forum, which describes the objective of the circular economy as an adaptation of the current economic model to a technically viable system in the long term by integrating within a closed system, or of a closed loop, of disassembly, depreciation and recovery processes, reuse of materials already used.



**Figure 1.** The "closed loop" system as an objective of the circular economy

The association of the circular economy model with the idea of a closed loop refers to the importance of the model, which through the tools and principles it promotes, aims to create value throughout the entire ecosystem, because the value of products and materials is maintained as much as possible, waste and resource use are minimized and resources do not leave the economic stream at the end of their life, but are reused and thus create further value. It can be observed that the

basic principles of the circular economy were formulated based on the hierarchy of waste and the principles of the "3R: reduction, reuse and recycling" (Banaite D., 2016).

As can be seen from the numerous definitions attributed to it by specialized literature, the circular economy is designed to be a regenerative system, which is based on the use of renewable energy and has as its basic idea the elimination of waste through the design of materials, products, new systems, so that they are kept as long as possible in economic processes, contributing to the creation of value by reducing costs, minimizing the volume of waste and extending the life cycle of materials and products.

### 3. STRATEGIC FRAMEWORK FOR SHIFTING TO A CIRCULAR ECONOMY

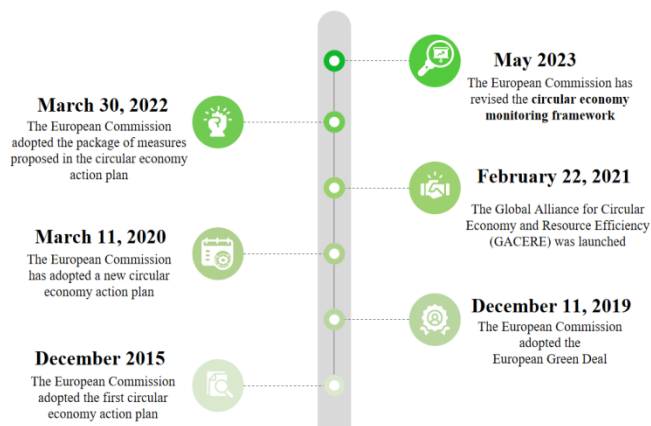
From redesigning products for longevity and reuse to establishing closed-loop systems, a legislative framework is required to enable strategies that drive economic processes towards circularity to be successfully implemented. By encouraging innovation, collaboration and responsible consumption, we can create a world where waste becomes a valuable resource, where ecosystems thrive.

The strategic framework for the Circular Economy represents the legislative and administrative structure that ensures the transition from the linear model to the circularity of economic processes. This framework is more than just a concept; it is a comprehensive and strategic approach that designs how we produce, consume and dispose of goods and services. It is a holistic paradigm that emphasizes sustainability, innovation and collaboration, encouraging a world where waste is minimized, materials are continuously recycled and economic growth is decoupled from resource use.

#### 3.1. Circular economy strategies and initiatives at European level

In order to ensure the transition to circularity, a series of steps have been taken over time to facilitate the transition to the new economic model, and a series of strategic documents have been developed aimed at achieving specific objectives in this direction. At the European level, the European Commission has taken important steps in this regard by elaborating the Framework for the development of the circular economy, the Strategy and the Action Plan in the medium and long term, applicable to all the member states of the European Union.

At the European level, the European Commission has a particularly important role in ensuring the legal framework for the development and implementation of the circular economy at the level of the single market. To accelerate the transition to a circular economy, the European Union has launched an ambitious Circular Economy Package to help "close the loop" on product life cycles through more recycling and reuse, and to bring benefits to both the environment and for economy and society (European Commission, 2016). A summary of the main strategies and measures that make up the implementation framework of the circular economy at the European level is captured in the *Figure 2*.



**Figure 2.** Strategic Framework for Circular Economy Implementation in Europe

One of the most important European actions aimed at the circular economy refers to the adoption in December 2015 of the first plan for the Circular Economy, which constituted a real framework for organizing and planning the stages required to ensure the conditions for the transition to the circular economy. Within this package, the following strategic documents were provided: the Communication on the Action Plan, the List of initiatives accompanying the plan and 4 legislative proposals regarding waste. The adoption of this Package regarding the circular economy aimed to ensure, according to the words of the Vice-President of the European Commission (Katainen, 2016), "*the conditions for the transition to the circular economy, which encourages investments in this direction, provides the necessary incentives for the business environment and for consumers, for the adoption of new business models, products, services and techniques*". The Circular Economy Strategy 2015 (Circular economy Strategy, 2015) envisages a plan of great objectives regarding ensuring the transition to the circular economy, aiming at increasing competitiveness at community level and guaranteeing sustainable economic growth and the creation of new jobs. The proposed action plan at European level, entitled "*Closing the loop - an EU action plan for the circular economy*" considers each stage of the value chain and the economic process, from production to consumption, aiming to integrate the principles of circularity (repair, recycling, reuse, re-manufacturing, etc.) at the level of all processes. Through these actions aimed at "closing the loop" and extending the life cycle of products, the benefits on environmental aspects and the possibilities to create new jobs are also pursued.

Another important step in supporting the circular economy was the adoption of the European Green Deal, a transformative and ambitious political framework launched by the European Union (EU) in December 2019. This represents the EU's commitment to address the pressing environmental and climate challenges facing the world today. This initiative encompasses a wide range of goals and actions aimed at promoting sustainability, combating climate change and boosting economic growth.

The Circular Cities and Regions Initiative is another particularly important initiative in ensuring the transition towards a circular economic and social system targeted circular regions and cities that actively follow the principles of the circular economy, aiming to promote an economic model focused on waste minimization and on the maximum utilization of resources. The importance of such circular cities is justified by efforts to reduce, reuse and recycle materials, to promote

sustainable consumption and production, and to design systems that are regenerative and restorative.

On 11 March 2020, the European Commission adopted a new Circular Economy Action Plan, which builds on the original plan launched in 2015. This updated plan aims to accelerate the transition to a circular economy in the European Union by promoting sustainable practices and waste reduction. The European Commission's Circular Economy Action Plan 2020 aims to reshape the European economy to be more sustainable, reduce environmental impact and create economic opportunities through circular practices. This plan aligns with the EU's wider goals of reducing greenhouse gas emissions and promoting sustainable development.

The Global Alliance for Circular Economy and Resource Efficiency (GACERE) was launched on February 22, 2021, as an international initiative aimed at promoting the principles of circular economy and resource efficiency on a global scale. GACERE aims to encourage the adoption of circular economy practices, which focus on reducing waste and maximizing the use of resources by emphasizing recycling, reuse and reducing the consumption of finite resources. By integrating joint efforts at European level, the alliance aims to increase resource efficiency in various sectors, including manufacturing, agriculture, energy, and through cooperation supports the exchange of knowledge between governments, businesses and other stakeholders to develop and implement policies and practices that support the circular economy and resource efficiency. The steps aimed at achieving the objectives established in the Circular Economy Action Plan take shape through the adoption on March 30, 2022 by the European Commission of the package of measures that took into account the following initiatives:

- sustainable products initiative, including the proposed regulation on eco-design for sustainable products;
- EU strategy for sustainable and circular textiles;
- proposal for revision of the Regulation on construction products;
- proposal to empower consumers in the green transition.

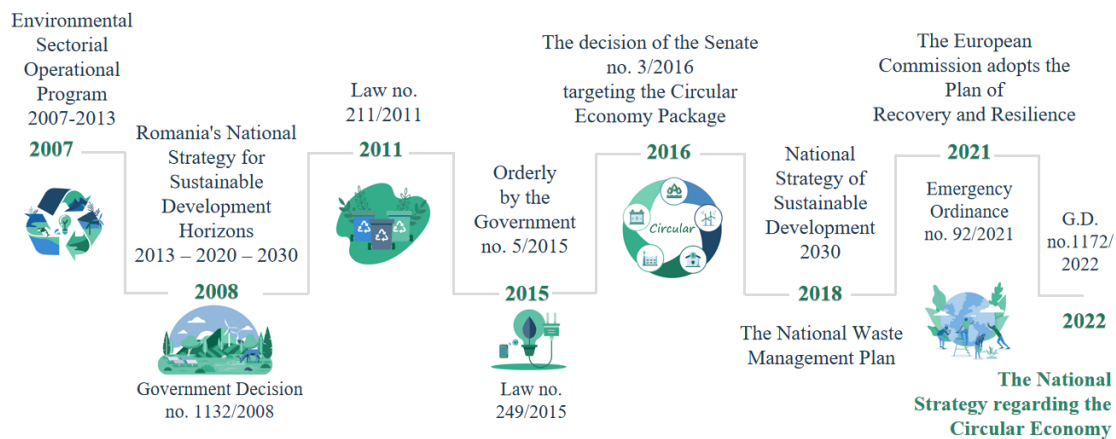
The year 2023 comes with a series of measures regarding the *monitoring framework* of the efforts that have been made to achieve circularity, taking into account the strategy and initiatives started in the previous stages. The monitoring framework includes several key sections that include a set of indicators designed to reflect the performance registered at the level of the European states in the circular economy field, referring to: Production and consumption; Waste management; Secondary raw materials; Competitiveness and innovation; Global sustainability and resilience. In addition to this general strategic framework that frames the multitude of initiatives and

strategies specific to the objectives targeted by the circular economy, other related strategies can also be mentioned at the European level, such as: The Strategy for Chemical Products for Sustainability, the Action Plan for Zero Pollution, 2030 Biodiversity Strategy, Plastics Strategy, Critical Raw Materials Action Plan, New Industrial Strategy EU Strategy for Sustainable and Circular Textiles, etc.

### 3.2. Aligning the National Framework with the European Approach for Transitioning to a Circular Economy

The implementation of European circular economy strategies at the national level is important both through the direct benefits on sustainable development at the state level, and for the harmonization of the European structures that ensure the functioning of the single market. The standardization of economic processes subordinated to the principles of the circular economy implies the promotion of the efficient use of resources, which is crucial for sustainable development. By reusing, repairing and recycling products and materials, countries can reduce their dependence on finite resources, alleviate resource scarcity and reduce environmental impact. Synchronizing the national framework with European circular economy strategies involves aligning a country's policies, regulations and initiatives with the objectives and principles of the European circular economy strategy. There are many steps that states can take to integrate European policies and practices at national level to ensure the transition to the circular economy. The evaluation of existing policies and regulations at the national level allows identifying areas of alignment and divergence with the European strategy. Engaging relevant stakeholders, such as government agencies, businesses, NGOs, academia and the public, in discussions about circular economy strategies are necessary steps to shaping effective policies and gaining support for implementation.

The establishment of specific national circular economy objectives, which can be measured in the short and medium term, and which cover areas such as waste reduction, resource efficiency, recycling rates and sustainable product design, are also particularly important. The legal framework and regulation are some of the most important levers for the implementation of circular economy policies, providing an appropriate space for coordination and monitoring aimed at ensuring alignment with the EU legal framework and providing financial incentives, subsidies and tax breaks to businesses and individuals that adopt circular economy practices. In the case of Romania, the efforts regarding the synchronization of the national framework with the European one in the field of transition to the circular economy aim at the following steps:



**Figure 3.** National Strategic Framework for Circular Economy Implementation

The first steps towards the transition towards sustainable development were achieved with Romania's accession to the European Union in 2007 and the access to European funds made available for the 2007-2013 programming period. One of the main operational programs financed by this multi annual financial framework was the Environmental Sectorial Operational Program through which numerous projects and procedures were implemented regarding environmental protection, recycling and waste reduction, promoting the efficient and sustainable use of resources, including materials, energy and water. Efforts to achieve targets to reduce waste generation and increase recycling and reuse of materials to minimize environmental impact and waste minimization have been continued in the next programming period 2014-2020 through the Large Infrastructure Operational Programme.

Government Decision no. 1132/2008 concerned the management of waste from batteries and accumulators, with the aim of mitigating environmental and health risks associated with these devices through recycling. Batteries contain various chemicals and heavy metals that can be harmful to the environment if not handled properly. By regulating these aspects it is intended that these hazardous substances are handled, recycled or disposed of in an environmentally responsible way to prevent soil and water contamination. By means of this law, the aim was to create a specific framework through which conditions are drawn for manufacturers and distributors of batteries and accumulators by establishing common rules and standards, regulations being established including in relation to the management of battery waste, requiring manufacturers to assume responsibility for the safe collection, recycling and disposal of their products. Thus the regulation of battery and accumulator practices, as well as their waste management, is crucial for protecting the environment, human health and resources, while promoting sustainable and responsible practices in the production and use of batteries.

The first concrete foundations regarding the establishment of a specific and favourable framework for sustainable development were laid by Romania's National Strategy on Sustainable Development Horizons 2013-2020-2030 (2008), which aimed at harmonizing national development objectives with those established at the European level through the appropriation and implementation of the principles and practices of sustainable development. This strategy implies a gradual and realistic transformation towards a sustainable development model, over time horizons, which will ensure the significant reduction of the economic-social gaps between Romania and the other EU member states. According to the content of the strategy (2008), the established objectives cover three time horizons, as follows:

- Horizon 2013: The organic incorporation of the principles and practices of sustainable development into the overall programs and public policies of Romania as an EU member state.
- Horizon 2020: Reaching the current average level of the European Union countries in the main indicators of sustainable development.
- Horizon 2030: Romania's significant approach to that year's average level of the EU Member States from the point of view of sustainable development indicators.

Law no. 211/2011 also brings into discussion aspects related to the circularity of economic processes, contributing to the establishment of necessary measures for the protection of the environment and the health of the population, by preventing or reducing the adverse effects determined by the generation and management of waste and by reducing the general effects of the use of resources and increasing the efficiency of their use.

Romania's intention to concentrate its efforts by transposing European legislation at the national level came to fruition in 2016 when Senate Decision no. 3/2016 regarding the Circular Economy Package. According to this document, in art.1, letter h) states that "Romania supports the main objective of the Circular Economy Package, that of stimulating the development of new markets and business models in order to develop the economy and create new jobs"; and in letter i) it is specified that "the transition to a circular economy will allow the restructuring of the economy and the improvement of European competitiveness, by reducing the consumption of raw materials, the sustainable use of resources and the valorization of waste by transforming it into products".

The National Sustainable Development Strategy of Romania 2030, adopted at November 9, 2018 represents the road-map that the national government has established to promote sustainable development through a strategy that integrates aspects of sustainability through the prism of three dimensions: economic, social and environmental. This strategy integrates the Sustainable Development Goals (SDGs) of the United Nations, providing the necessary context for alignment with global efforts to fight poverty, inequality, climate change, environmental degradation and ensure peace and justice. The year 2018 brings additions to the field of waste, with the adoption of the National Waste Management Plan regarding the methodology for the development, monitoring, evaluation and revision of the county waste management plans and the waste management plan for the municipality of Bucharest, and in 2021 the legislative framework is supplemented by the Government's Emergency Ordinance no. 92/2021 regarding the waste regime.



The decisive step in supporting the transition towards circularity was marked by the adoption of Government Decision no.1172, on September 29, 2022, when the National Circular Economy Strategy was approved, ensuring the synchronization of the national framework with the European circular economy strategies. The implementation of European circular economy strategies at national level is crucial for achieving sustainability, economic growth and environmental protection. It helps countries transition to a more sustainable, efficient and resilient model of resource use and consumption.

#### 4. RESEARCH

The methodology employed in this research paper involving a comparative analysis between Romania and the European Union (EU) in terms of their performances in supporting the transition to a circular economy is multifaceted and rigorous. The study adopts a mixed-methods approach, combining both quantitative and qualitative research techniques to provide a comprehensive understanding of the topic. Initially, a thorough review of relevant literature on circular economy practices in Romania and the EU is conducted to establish a theoretical framework. Subsequently, quantitative data is gathered through comprehensive statistical analysis of key economic indicators and performance metrics related to circular economy initiatives in both Romania and the EU member states. Quantitative data regarding the circular economy monitoring framework is collected through the official site of Eurostat offering a nuanced understanding of the strengths and weaknesses of circular economy practices in Romania compared to the broader EU context, ultimately contributing valuable insights for policymakers, businesses, and researchers involved in sustainable development. This methodology provides a structured and comprehensive approach to conducting a comparative analysis between Romania and the EU regarding their performances in supporting the transition to a circular economy.

The main aims of the research are:

- ✓ Examine and compare the policy frameworks related to circular economy in Romania and the European Union to identify key similarities, differences, and their effectiveness in promoting sustainable practices.
- ✓ Analyse economic indicators, such as resource efficiency, waste generation, and recycling rates, to measure and compare the circular economy performance of Romania and the EU-27, with a focus on identifying areas for improvement;
- ✓ Examine the level of innovation and technology adoption in both Romania and the EU concerning circular economy practices, exploring how advancements contribute to sustainable resource management and waste reduction.
- ✓ Identify and analyse the barriers hindering the transition to a circular economy in Romania, contrasting these with challenges faced by EU-27, and highlight potential opportunities for improvement in both contexts.

Hypotheses of the research:

H<sub>1</sub> - economic factors, such as GDP, investment in research and development, and industrial structure, play a crucial role in determining the success of transitioning to a circular economy.

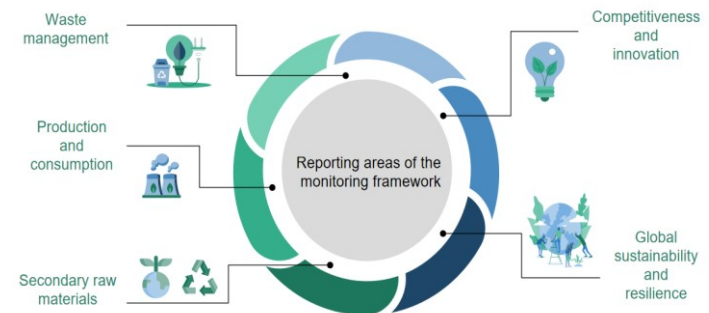
H<sub>2</sub> - differences in the adoption and integration of innovative technologies for resource efficiency and waste management

between Romania and the EU impact their respective performances in the transition to a circular economy.

H<sub>3</sub> - a more harmonized and robust regulatory environment in the EU contributes to better performance in supporting the transition to a circular economy compared to Romania's potentially less stringent regulations.

H<sub>4</sub> - potentially higher economic capacities, may demonstrate better performance compared to Romania due to increased financial capabilities for sustainable practices.

According to the circular economy monitoring framework there are five main categories of indicators that are reported by the European countries in order to present their efforts in supporting the transition to circular economy, as presented in *Figure 4*.



**Figure 4.** The Monitoring European States' Circular Economy Performance Framework

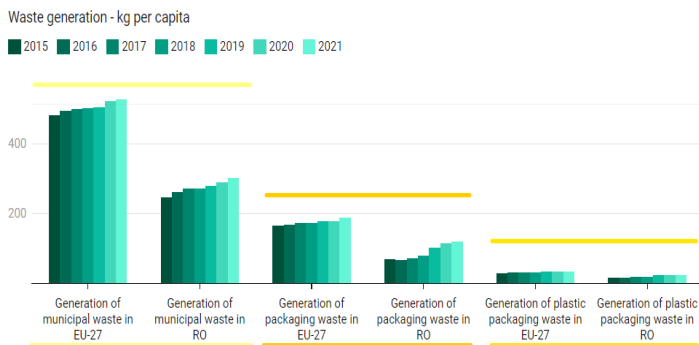
The period under analysis is 2015-2021/2022 (depending on data availability), aiming to capture the extent to which the adoption of the circular economy strategy begins to generate effects at the European and national level.

Production and consumption indicators play a crucial role in the monitoring framework of the circular economy because they provide valuable insights into the sustainability and efficiency of resource use. The indicators used to assess the production and consumption area are related to waste management, considered to be a valuable resource for the economic activity, material footprint and resource productivity. The comparative analyses between Romania and the EU-27 in reporting their efforts to support the transition to circular activities in the production and consumption area show similar tendencies but different performances from the point of view of the results obtained for the indicators analyzed during the period 2015-2021.

As it can be seen in *Figure 5*, generation of waste as a result of production and consumption is presented separately according to the source and type of waste and the provided data show a significant generation of municipal waste for both EU-27 and Romania. The generation of municipal waste refers to the total amount of waste produced by households, businesses, institutions, and other non-industrial sources within a specific municipality or city. Excessive municipal waste can lead to environmental problems, including pollution of air, soil, and water. Monitoring waste generation helps to understand and mitigate these environmental impacts. Although, the EU-27 show larger volumes of waste in comparison to Romania, a deeper analysis should be conducted as waste is considered a valuable resource in the concept of circular economy. Generation of waste, no matter the source of it: municipal waste, packaging waste, plastic waste, provides crucial information in order to implement effective waste management

systems, including collection, recycling, composting, and disposal facilities.

### Production and consumption



**Figure 5.** Comparative analysis of waste generation sources between Romania and the EU-27

The generation of packaging waste refers to the creation and accumulation of discarded materials that were used for packaging various products. This indicator had an upward trend especially in the case of Romania in the last years under analysis, and includes cardboard, glass, metal, and paper that are associated with the packaging of products. Considering these results, we suggest that more actions should address the issue of packaging waste by adopting more sustainable packaging practices, such as using recyclable or biodegradable materials, reducing unnecessary packaging, and promoting reusable alternatives. Additionally, recycling programs and waste management strategies play a crucial role in mitigating the environmental impact of packaging waste by diverting materials from landfills and promoting a circular economy approach to packaging materials.

Although it does not represent an essential component of the sources generating waste, plastic continues to be a problem when it reaches the waste phase and no processes are identified to prolong its life cycle or to be reused in various other forms.

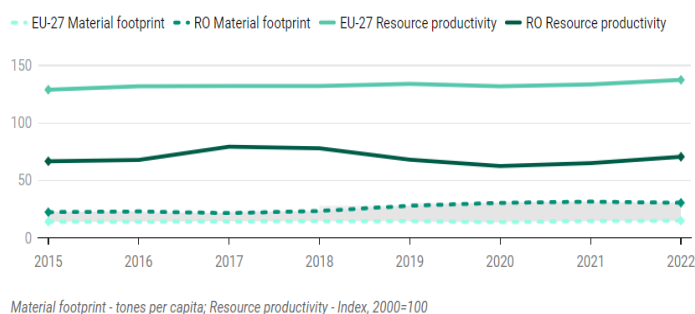
Measuring material footprints is particularly relevant in the context of sustainability assessments, life cycle assessments, and efforts to transition toward more circular and sustainable economic models. The material footprint refers to the total amount of raw materials, both renewable and non-renewable, that are used to meet the consumption demands of a person, a community, a country, or any other defined entity. It is a measure of the total environmental impact associated with the extraction, processing, and use of materials throughout the entire life cycle of products and services consumed by that entity. The material footprint takes into account not only the direct use of materials but also considers the indirect use associated with the production and consumption of goods and services. This includes the materials used in manufacturing, transportation, and disposal or recycling. It is a comprehensive indicator that provides insights into the overall resource consumption and environmental impact associated with the consumption patterns.

Relevant insights about material consumption have been presented in *Figure 6*. By comparing Romania with the average of the European Union, we found out that Romania has a

bigger material footprint than the EU-27, which indicates a higher level of resource consumption and extraction. These results show a series of vulnerabilities that Romania presents from the point of view of the impact that a higher material footprint is often associated with, such as a greater environmental impact, including habitat destruction, water use, energy consumption, and greenhouse gas emissions.

Romania registered an almost double material footprint in comparison with the EU-27, which indicates a high level of dependency on external sources for raw materials, raising the vulnerability to fluctuations in global commodity prices and supply chain disruptions.

### Material consumption

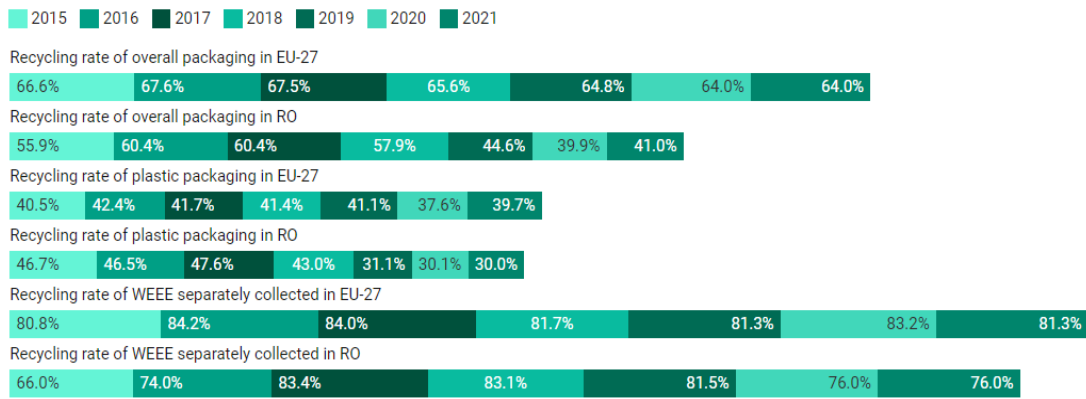


**Figure 6.** Comparative analysis of material consumption: Romania versus EU-27

Our findings are confirmed by another important indicator used to evaluate consumption and production practices, referring to resource productivity. By comparing the resource productivity of Romania in the European context, the values regarding resource productivity show that our country is less resource-productive, using more resources in order to be able to generate more economic output. Romania's poor results in terms of resource productivity show a relatively low level of competitiveness and circularity of practices at the level of national economic activities, suggesting the importance of initiatives and policies aimed at promoting sustainable resource management, circular economy practices, and technological innovations that enhance efficiency.

Considering the relatively low level of resource productivity, increasing the level of their exploitation becomes an important necessity. In the concept of the circular economy, the efficiency of the use of resources and the extension of the life cycle of products represent essential characteristics of the sustainability of economic activities. Waste management indicators help track the flow of materials through various stages, from production to consumption and eventual disposal or recycling, providing insights into how efficiently resources are being used. Waste management indicators can measure the percentage of waste that is diverted from landfills and incineration through recycling and reuse programs. By monitoring the amount of waste generated and the extent to which it is recycled or reused, policymakers and businesses can assess the overall efficiency of resource utilization in the economy. Relevant insights for the research are presented in *Figure 7*.

## Waste Management



WEEE - Waste from Electrical and Electronic Equipment

**Figure 7.** Comparative analysis of recycling rates across waste categories in Romania and the EU-27

The analysis of recycling rates by waste category highlights a lower performance in Romania compared to the European average, but favourable developments are identified in the sense of intensifying efforts to increase recycling rates by introducing recycling technologies and practices regarding collection support and appropriate recycling. From the data provided by Eurostat, it can be noticed a decline in recycling rates over the last four years for both Romania and EU-27. The last years under analysis were marked by numerous challenges that determined the slowdown of economic activity such as the COVID pandemic which can be considered a relevant explanation for the falling values preventing recycling rates. Economic downturns may lead to reduced investment in recycling infrastructure, decreased funding for recycling programs, or changes in consumer behaviour, impacting recycling rates. It can be observed that the evolutions of reducing recycling rates had a global trend; an aspect justified by a set of implications under a domino effect characterized by the interdependencies established by fluctuations in global recycling markets, supply chain disruptions and budget constraints at the government level that lead to cuts in waste management and recycling programs, affecting their overall effectiveness.

In the context of the circular economy, waste is considered particularly valuable secondary raw materials; therefore the assessment of efforts regarding recycling rates must be approached and compared with the volume of circular materials reused in the economy. The recycling rate of municipal waste becomes relevant in the context of the circular economy to the extent that it is associated with a high level of utilization rate of circular materials. This aspect highlights the extent to which collection and recycling are the result of responsible and sustainable practices and not just the result of legal constraints. The values captured by the two indicators related to the period under analysis are presented in the *Figure 8*.

## Recycling rate vs. Circular material use rate

	Recycling rate of municipal waste in EU-27	Recycling rate of municipal waste in RO	Circular material use rate in EU-27	Circular material use rate in RO
2021	48.7%	11.3%	11.3%	1.7%
2020	48.9%	11.9%	11.5%	1.7%
2019	47.2%	11.5%	11.5%	1.7%
2018	46.4%	11.1%	11.7%	1.5%
2017	46.3%	14.0%	12.0%	1.3%
2016	45.9%	13.4%	11.7%	1.5%
2015	44.9%	13.3%	11.7%	1.4%

**Figure 8.** Comparative analysis of recycling rates and circular material utilization between Romania and the EU-27

The recycling rate of municipal waste becomes relevant in the context of circular economy to the extent that it is associated with a high level of utilization rate of circular materials. This aspect highlights the extent to which collection and recycling are the result of responsible and sustainable practices and not just the result of legal constraints. As the statistics show, Romania not only has significant lower rates of recycling municipal waste, but also capitalizes on a significantly small percentage of the circular materials used, which highlights the lack of a sustainable infrastructure of economic activities as well as the lack of an appropriate legal framework to regulate sustainable practices along the entire value chain of the products and services provided. Circular material use rates in Romania are approximately eight times smaller than the average at the European level which means important discrepancies in the valorisation of circular materials. This result may be the consequence of insufficient facilities and infrastructure for collecting, sorting, and processing recyclable materials, corroborated with the absence of regulatory or economic incentives for businesses and individuals to adopt circular practices. The European average for recycling municipal waste is bigger than the recycling rate for Romania, but not sufficient for supporting circular practices for the single European market. In supporting the steps regarding the intensification of the recycling rate and use of circular materials, we consider it relevant to intensify the efforts at the European level to support the circular design of the products, to implement extended producer responsibility (EPR) programs, and to foster a circular mind-set across various sectors of society.



Trade in recyclable raw materials plays a pivotal role in advancing global sustainability efforts by fostering resource efficiency and supporting circular economy principles. As nations increasingly recognize the environmental and economic benefits of recycling, the international trade of recyclable materials becomes crucial for meeting the growing demand for secondary raw materials. Cross-border exchanges enable countries to address resource scarcity by tapping into a broader pool of recyclable resources. Additionally, trade in recyclables contributes to reduced reliance on virgin materials, lowering the ecological footprint associated with resource extraction and

manufacturing. Moreover, it supports the development of a circular economy by encouraging the efficient recovery and reuse of materials, creating economic opportunities, and promoting responsible waste management practices on a global scale. The interconnectedness of nations through the trade of recyclable raw materials underscores the collaborative and collective responsibility in building a more sustainable and resilient future. Considering these aspects, our research continues with the presentation of a set of indicators that are part of the circular economy monitoring framework, referring to the trade in recyclable raw materials, captured in the *Table 1*.

### Trade in recyclable raw materials

Year ▼	Imports from non-EU countries in EU-27	Imports from non-EU countries in RO	Exports to non-EU countries from EU-27	Exports to non-EU countries from RO	Intra EU trade EU-27	Intra EU trade RO
2021	41,388	707	37,616	2,018	91,656	869
2020	39,778	638	36,740	1,873	83,054	777
2019	40,775	679	35,625	1,500	84,722	834
2018	39,771	593	36,943	1,437	85,390	849
2017	39,746	502	36,556	1,333	84,652	834
2016	38,560	330	34,980	919	81,237	851
2015	40,186	501	30,635	1,071	80,351	549

Unit of measure - thousand tonnes

**Table 1.** Trade of recyclable raw materials in Romania and in the EU-27

Analysing the trade with recyclable raw materials, it can be seen that there is a fairly dependence on recycled materials from outside the European community, European countries importing more than exporting, which highlights that the demand for recycled materials often outstrips the available supply within the region. This has led to a situation where European countries import more recycled materials than they export, highlighting the continent's reliance on external sources to meet its resource needs. While this dependence on imports helps bolster global recycling efforts, it also emphasizes the imperative for Europe to fortify its internal recycling infrastructure, promote circular practices, and reduce the ecological footprint associated with the transportation of recyclables.

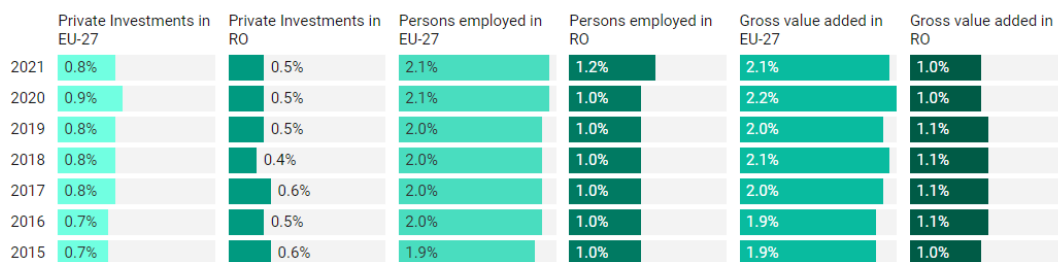
As far as Romania is concerned, we notice that it exports recyclable raw materials more than it imports, which highlights the low capacity of the national economic infrastructure to internally exploit these resources.

Intra community trade also highlights discrepancies, placing Romania in a less favourable light from the point of view of circular practices, showing that at the community level it participates with less than 1% in the trade with recyclable raw materials, in almost the entire period under analysis.

The inclusion of competitiveness and innovation indicators in the monitoring framework of a circular economy is of paramount relevance as it reflects the dynamic interplay between economic performance, sustainable practices, and technological advancements.

Competitiveness indicators provide insights into how well a country or region is positioned to thrive in a circular economy, considering factors such as cost-effectiveness, market share, and adaptability to evolving business models. Monitoring innovation indicators is equally critical, as the circular economy relies on cutting-edge technologies, eco-design strategies, and novel approaches to resource management. Innovations can drive the development of sustainable products, recycling technologies, and circular business models, fostering economic growth while minimizing environmental impact. By tracking competitiveness and innovation, policymakers gain a comprehensive understanding of a region's ability to transition successfully to a circular economy, ensuring that economic gains align with ecological sustainability and resilience in the face of global challenges. The efforts made regarding competitiveness and innovation as supporting pillars of the circular economy are shown in *Figure 9*.

### Private investment, jobs and gross value added related to circular economy sectors



Private investments - percentage of gross domestic product (GDP) at current prices; Persons employed - percentage of total employment; Gross value added - percentage of gross domestic product (GDP) at current prices

**Figure 9.** Comparative analyse regarding competitiveness and innovation indicators between Romania and the EU-27

As the records of the indicators show, private investments although play a pivotal role in propelling the transition to a circular economy, offering financial support and strategic impetus for sustainable practices, are not properly supported or encouraged. A low percentage of private investments are concentrated in supporting circular processes and practices, which can be considered a barrier for the driving force for innovation, research, and the development of circular business models. Comparing the results at the national level with the average of the European Union, we can mention that in Romania there is a relatively high interest in supporting sustainable business models, as the values obtained not being much below the trend of the European average.

Human resources play a pivotal role in supporting private investments and activities within the context of a circular economy. The percentage of persons employed in circular economic activities is not high, which highlights the lack of synchronization of the strategic framework regarding the transition to the circular economy with the training of human resources in circular practices and their motivation to be an integral part of the closed loop system. Even if the percentage of persons involved in activities subordinate to the circular economy at the European level is double compared to the case of Romania, it is still really low in order to successfully support the transition to a circular model that requires a skilled and informed workforce capable of implementing sustainable practices, driving innovation, and adapting to evolving business strategies.

The importance of circular practices is largely justified by the creation of gross value added within the economy, a particularly important aspect in supporting competitiveness. This shift toward circularity not only aligns with sustainability goals but also demonstrates the potential for economic growth and resilience through the generation of gross value added. As the static data shows there is a rather low gross value added created by circular practices as in Romania it is not much than 1% and for the European average it hardly exceeds 2%. These less encouraging results can be determined by the lack of consistency and collaboration of all interested parties in ensuring the transition to the circular economy, but there is the prospect of improving these results with the implementation of the New Circular Economy Action Plan starting in 2020, as data also suggests. Romania also is expected to increase its results regarding circular competitiveness with the adoption of the National Circular Economy Strategy from 2022.

Educated and trained professionals are essential for designing and implementing eco-friendly processes, fostering product redesign for recyclability, and optimizing resource management throughout the supply chain. A workforce well-versed in circular economy principles is crucial for private enterprises to navigate the complexities of sustainable business practices, ensuring that investments are aligned with environmental objectives. Moreover, human resources contribute to creating a culture of sustainability within organizations, promoting employee engagement and commitment to circular initiatives and even develop patents related to waste management and recycling.

### Innovation - Patents related to waste management and recycling

Year ▼	EU-27	RO
2020	207	5
2019	386	8
2018	316	10
2017	309	8
2016	326	6
2015	357	5

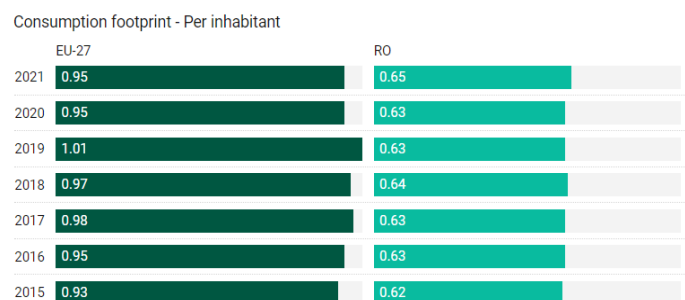
**Table 2.** Patent counts in Romania and the EU-27 associated with circular economy

The number of patents related to waste management and recycling holds paramount importance in the context of a circular economy, serving as a crucial metric for innovation and technological advancement. Patents in this domain signify the development of solutions, technologies, and processes aimed at optimizing resource utilization, reducing waste, and enhancing recycling efficiency. As it is presented in *Table 2*, the small number of patents in the case of Romania reflects a weak commitment to research and development in circular economy practices, indicating the lack of interest in the research community for finding sustainable solutions.

At the European level, more intense concerns can be distinguished in the innovation area of circular practices, noting a relatively high level of patents designed to contribute to the evolution of waste management, driving improvements in recycling technologies, waste-to-energy processes, and sustainable materials. Monitoring patent activity in waste management and recycling offers valuable insights into the level of innovation and the potential for transformative change within the circular economy landscape.

Incorporating global sustainability and resilience indicators into the monitoring framework of a circular economy is of great relevance for assessing and addressing the broader environmental and societal impacts of resource management practices. Global sustainability indicators provide a comprehensive view of how circular economy initiatives contribute to overarching goals such as climate action, biodiversity preservation and social equity. Achievements regarding global sustainability and resilience indicators are presented in *Figure 10*, *Figure 11* and *Figure 12*.

### Global sustainability from circular economy



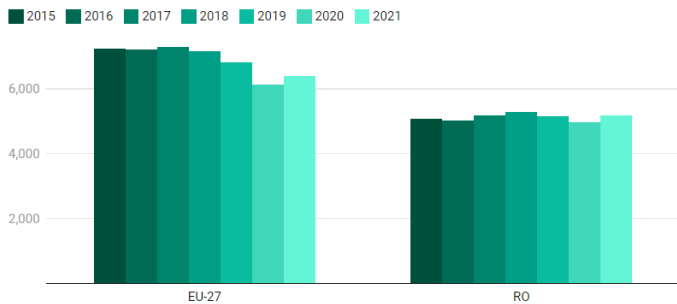
**Figure 10.** Comparative analyse of consumption footprint between Romania and the EU-27

Reporting the consumption footprint per inhabitant as a resilience indicator is crucial for assessing a country's ability to withstand environmental and economic shocks while maintaining sustainable resource use. The consumption footprint, representing the total environmental impact associated with the goods and services consumed by an individual, serves as a key metric in evaluating a nation's ecological resilience. In the case of Romania, the consumption

footprint is below the European average for the entire period under analysis, suggesting better resource utilization, than the EU-27. But the comparative analysis is not fully relevant as the indicator is reported per inhabitant.

### Global sustainability from circular economy

GHG emissions from production activities - Kilograms per capita



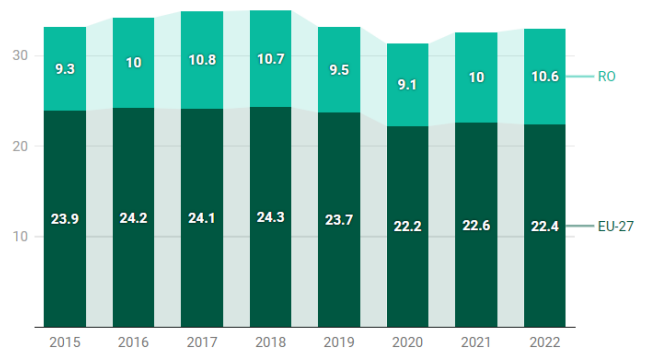
**Figure 11.** Comparative analysis of GHG emissions from production activities between Romania and the EU-27

As statistical data shows, Romania has a smaller consumption footprint and lower greenhouse gas (GHG) emissions from production activities than the EU-27, which can be explained by many facts. Romania may have a less industrialized economy compared to the EU-27, resulting in reduced production-related emissions and its structure relies less on carbon-intensive sectors. Agriculture in one of the sectors that contribute a lot to the general production and as long as it relies less on polluting technologies, it employs more sustainable and less emissions-intensive agricultural practices, that could result in lower overall environmental impacts. While the EU-27 registers tendencies to reduce greenhouse gas (GHG) emissions from production activities in the last years of the analysed period, Romania does not seem to make efforts in this regard. This imbalance underscores the importance of sustainable consumption patterns and efficient resource management to enhance a country's resilience in the face of global challenges, promoting a more equitable and environmentally sustainable approach to economic development.

Material import dependency is a critical resilience indicator for the circular economy as it sheds light on a nation's ability to sustainably manage its resources and reduce vulnerability to external shocks. High material import dependency suggests that a country relies extensively on external sources for its raw materials, making it susceptible to supply chain disruptions, market fluctuations, and geopolitical uncertainties. In the context of the circular economy, which prioritizes resource efficiency and closed-loop systems, a lower material import dependency is indicative of a nation's self-sufficiency in meeting its material needs. A reduced reliance on imported materials not only enhances economic stability but also aligns with the principles of sustainable resource management and reduced environmental impact. Monitoring material import dependency is, therefore, crucial for assessing a country's circular economy resilience, guiding policymakers in the development of strategies that promote domestic resource utilization, recycling, and the establishment of circular supply chains. Relevant insights on material import dependency are presented in *Figure 12*.

### Resilience from circular economy

Material import dependency - %



**Figure 12.** Comparative analysis of material import dependency between Romania and the EU-27

Romania's lower material import dependency compared to the EU-27 is a significant indicator of the country's enhanced resilience and self-sufficiency within the circular economy framework. This suggests that Romania has a relatively stronger capacity to meet its material needs from domestic sources, reducing its vulnerability to external disruptions and market fluctuations. The lower material import dependency aligns with the principles of the circular economy, emphasizing sustainable resource management and a reduced ecological footprint. If we comparatively analyse the developments recorded regarding the import trends of materials, we notice that although Romania has a lower dependence than the EU average, at the individual level this trend tends to increase Romania's dependence on the import of materials, while the tendency at the community level is to reduce this dependency. This positive trend at European level not only contributes to economic stability but also underscores EU's commitment to sustainable development. Moving forward, continued efforts to strengthen domestic resource utilization and circular strategies will be crucial for maintaining and further advancing Romania's positive trajectory in the pursuit of a more sustainable and resilient economic future.

## 5. CONCLUSIONS

The comparative analysis of Romania's performance with the EU-27 in supporting the transition to a circular economy reveals both notable achievements and areas for improvement. Romania has demonstrated commendable strides in promoting circular practices, as evidenced by its lower material import dependency, smaller consumption footprint, and reduced greenhouse gas emissions from production activities compared to the EU-27. These indicators underscore Romania's commitment to sustainable resource management and aligning with circular economy principles. However, challenges persist, including the need for further investment in recycling infrastructure, consumer awareness, and policy frameworks to enhance circularity.

The monitoring framework of circular economy, considering the indicators that were the subject of our analysis, is of paramount importance as it provides a structured and systematic approach to assess, measure, and guide the transition towards more sustainable economic practices. By defining and tracking key indicators such as recycling rates, resource efficiency, and waste reduction, the framework offers a comprehensive understanding of the progress made in adopting circular principles. This data-driven approach facilitates evidence-based policymaking, enabling governments, businesses, and organizations to identify

successful strategies, address challenges, and refine initiatives over time. The monitoring framework also serves as a tool for accountability and transparency, ensuring that stakeholders can assess the impact of circular economy initiatives and hold entities responsible for their commitments. Moreover, it supports international benchmarking, encouraging knowledge exchange and fostering a global community dedicated to advancing circular economy practices.

For the European countries, the monitoring framework plays a pivotal role in shaping the trajectory of the circular economy by providing the necessary insights for informed decision-making, fostering innovation, and promoting a more sustainable and resilient economic future. Our findings emphasize the importance of tailoring strategies to address specific contextual factors within Romania, such as industrial structure, economic development, and societal attitudes. Collaborative efforts at the national and European levels are essential to harnessing the full potential of the circular economy, fostering resilience, and ensuring a sustainable future for Romania within the broader European framework. Continued research, policy innovation, and stakeholder engagement will be crucial for advancing the circular economy agenda and addressing the unique challenges and opportunities within the Romanian context. Economic considerations, such as the low cost of virgin materials compared to recycled materials, can also impact the economic viability of recycling and circular practices.

The disparities registered by the analysed indicators draw attention to the harsh importance that the legal and strategic framework has in synchronizing efforts to intensify the sustainable transition towards the circular economy. Aligning

national strategies with EU directives ensures harmonization and consistency across member states. This cohesive approach facilitates a unified vision and implementation of circular economy principles, avoiding discrepancies in policy frameworks that could impede cross-border cooperation. A synchronized approach contributes to improved resource efficiency at both national and EU levels. By adopting consistent standards and practices, member states can collectively optimize resource use, reduce waste, and foster a circular economy that maximizes the value of materials throughout their lifecycle. Consistency in circular economy strategies enhances investor confidence by providing a clear and stable regulatory environment. This, in turn, encourages investments in circular initiatives, innovation, and sustainable practices, driving economic growth and job creation. By prioritizing human capital development, companies can harness the expertise needed to thrive in the circular economy, unlocking new opportunities for growth, efficiency, and environmental stewardship.

The research carried out is relevant for the analysis of national efforts to support the transition towards a circular economy in the European context, but the identification of the specific structural aspects as well as the concrete identification of the barriers that stand in the way of the transition require a more detailed analysis and focused on concrete examples of states that support and make significant progress in this direction. As a result, we propose that future research directions focus on comparative analyses with European Union states that can provide examples of good practices that Romania can integrate into its economic structures and sustainable development strategies.

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