Digital innovation and circular economy ecosystems analysis

Interreg Europe

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CEI BOOST – Boosting Circular Economy Innovation through emerging technologies application

The CEI BOOST – Boosting Circular Economy Innovation through emerging technologies application project aims to increase the use of digital innovations to support the circular economy. The goal is to enhance the development and implementation of sustainable digital solutions in the circular economy, especially in relation to new technologies, and to ensure that the solutions are used to accelerate the transition to a sustainable circular economy. The countries participating in the project are Bulgaria, Finland, France, Greece, Lithuania, Portugal, Romania, Spain and Sweden.

Digitalization is a wide spectrum, and most people and companies use digital solutions to some extent. However, the degree of use and purpose varies. Digitalization should be looked at as a whole, when e.g., developing the level of digitalization in the businesses. It would also be beneficial to have a strategic approach.

Common everyday solutions which combine circular economy and digitalization we use are applications and platforms. We have city bikes, online flea markets and apps to purchase surplus lunch. On the bigger scale, our waste goes through a massive waste separation plant, that separates recyclable items from the waste stream with the help of separators, magnets and optical sorters using the state-of-art technology.

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While policymakers are yet to actively link digitalization with wider sustainability efforts when developing policies and financing projects, there is a growing need to align the circular and digital agendas. The Green Deal recognises that circular economy and strong involvement from industry is central to making the EU's economy sustainable.

The CEI Boost project aims at improving policies for easing and speeding up the twin transition to ensure that Green Growth and Digital Transformation go hand in hand to drive regions' recovery and prosperity. The project focuses at enhancing policies conditions in 9 countries for boosting the application of emerging digital innovations to support the growth of circular economy at regional, local or national level, gathering expertise from different regions, different levels' policymakers and leading innovation ecosystems' actors. (CEI Boost 2023)

One of the first activities of the project has been to identify the actors and stakeholders related to both digitalization and the circular economy, and to analyse the current state and maturity of the regions in digitalization and circular economy.

The analyses by the regions highlight potential projects and approaches that have already exploited the potential of digitalization to boost sustainable development and the circular economy in particular.

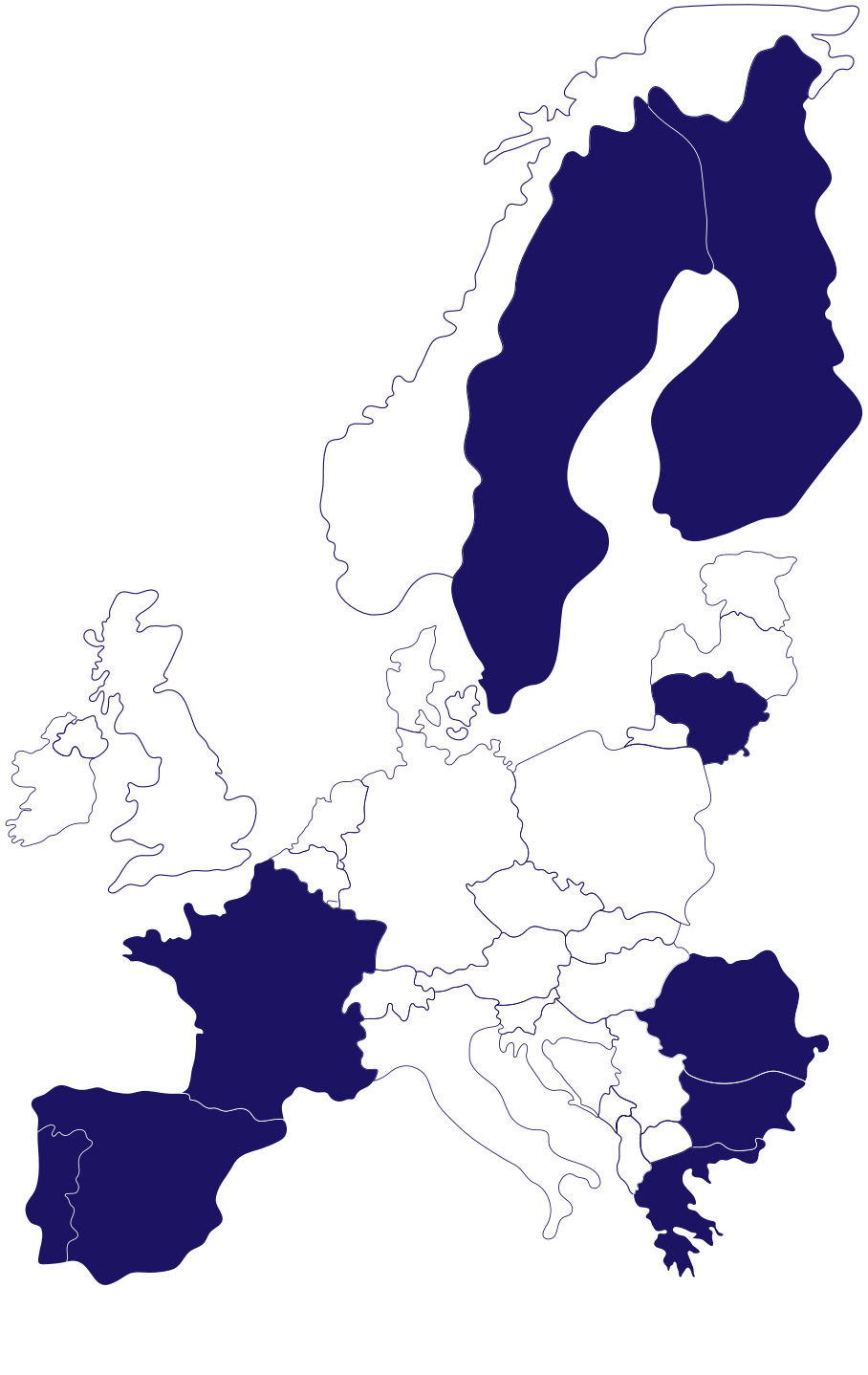
The analysis shows that the level of maturity of the regions in the field of digitalization and circular economy varies, but the general observation is that all the regions included in the analysis have made recent progress and many policies and potential projects are underway and recently initiated. On the other hand, the full potential of digitalization to promote and boost the circular economy has not been exploited.

In conclusion, the analysis carried out confirms the need for policies and development work that uses digitalization in an intelligent, user-driven and justified way to boost the circular economy.

This document analyses the current state of Digital Innovation and Circular Economy in Romania. The analyses of each partner region and more information of the CEI Boost can be found on the project website: *interregeurope.eu/cei-boost*

CEI Boost Partners

Sweden	Region Västerbotten
Finland	Regional Council of Päijät-Häme LAB University of Applied Sciences
Lithuania	Public Institution Lithuanian Innovation Centre Innovation agency
Bulgaria	Business Agency Association
Romania	Institute for Research in Circular Economy and Environment “Ernest Lupan” West Regional Development Agency
Greece	Industrial Systems Institute
Spain	Tarragona Provincial Council
Portugal	Business Development Institute of the Autonomous Region of Madeira
France	Laval Mayenne Technopole



Romania

Romania is a country of approximately 19.7 million inhabitants in Eastern Europe, encompassing diverse regions each with its unique characteristics. It includes bustling cities, historical towns, and scenic rural landscapes. The capital, Bucharest, is the largest city, known for its vibrant culture and architecture.

Romania's economy is diverse, with strong sectors in automotive, IT, electronics, and agriculture products like wheat, maize, and sunflower oil. As a regional leader in electronics, IT, and motor vehicle production, it excels in mobile technology and information security. The country also produces key agricultural products and textiles, while balancing its energy sector between renewable and traditional sources. Tourism is a growing industry in Romania, attracting visitors to its medieval castles, the Carpathian Mountains, and the Black Sea resorts. The country's rich cultural heritage, including the famous region of Transylvania, offers a mix of historical sites, folklore, and natural beauty.

Romania's strategic location in Southeast Europe and membership in the European Union further contribute to its economic and cultural significance on the continent.

Digital innovations and digitalization in Romania

Based on the 2022 Digital Economy and Society Index (DESI), Romania ranks 27th out of the 27 EU member states. The country's performance in terms of the maturity of digital technologies and digital public services is poor compared to other EU Member States. The share of SMEs that have at least a basic level of digital intensity (22 %) and the percentage of businesses that exchange information electronically (17 %) are the lowest in the EU. The low level of digitization and relatively slow progress prevent Romania's economy from taking full advantage of the opportunities offered by digital technologies.

The National Strategy for Research, Innovation and Smart Specialization (SNCISI) is developed by the Ministry of Research, Innovation and Digitalization and includes solutions for digitalization. This Ministry is also the coordinator of the research-innovation and smart specialization policy in Romania one of the national funding programs associated with RDI and of regulating the legal framework associated with these processes, and has the role of an intermediate research body for the Operational Program for Smart Growth, Digitization and Financial Instruments 2022-2027.Another important strategyis Romania's Education Digitization Strategy 2021-2027-SMART-Edu-, that calls for closer cooperation between EU member states, so that education and training systems become appropriate for the digital age, given the impact of digital transformation on societies , on the labor market and its future, as well as on education and training systems.

Regarding projects that support and contribute to the development of digitalization, we can mention the Digital Innovation Centers. Digital Innovation Centers in Romania are visionary, multi-actor ecosystems that use leading technologies such as Artificial Intelligence, High Performance Computing, Blockchain and Cyber Security, to enhance innovation and competitiveness of national and regional priority areas, of intelligent specialization, by supporting the process of digital transformation of companies, especially SMEs, as well as of local public administrations.

Future prospects for promoting digitalisation

The National Recovery and Resilience Plan supports investments for the digitization of SMEs in order to increase their competitiveness, by allocating a budget of EUR 500 million for this purpose. Two instruments are available:

- grants to entrepreneurs for the development of advanced digital technologies such as artificial intelligence, data and cloud computing, blockchain technology, high performance computing, quantum, Internet of Things, cyber security and
- grants in value of up to EUR 100,000 per enterprise for the adoption of digital technologies, i.e. the purchase of ICT hardware, the development or adaptation of software applications/software licenses, the purchase of AI systems, demonstration websites, training staff training in the IT field, etc. The measure is expected to be completed by mid-2024.

Policy instruments for boosting digitalization

- National Strategy for Research, Innovation and Intelligent Specialization (SNCISI),
- The Strategy for Digitization of Education in Romania 2021-2027-SMART-Edu,
- The National Resilience and Recovery Plan (The challenges identified in the digitalization field will be addressed through the following actions: Action 2.1 Support for projects in innovation and in the adoption of advanced technologies in the context of digital transformation Action 2.2 E-government and digitalization for the benefit of citizens Action 2.3 Digitization of SMEs achieved through Hubs of European Digital Innovation from RO,
- The Operational Program for Smart Growth, Digitization and Financial Instruments.

Status of the digital innovations and digitalization

Romania performs inadequately in the area of integrating digital technology, as all indicators are still significantly below the EU average and have either fallen or stalled over the past few years:

- 22% of SMEs had at least a basic degree of digital intensity, compared to 55% for the EU as a whole. To achieve the Digital Decade goal of 90% of SMEs achieving a basic level of digital intensity by 2030, efforts must be intensified;
- Romania lags behind the majority of EU Member States in terms of internet sales, with only 12% of SMEs selling online and 4% selling cross-border;
- The take-up of advanced technologies like cloud reached only 11% compared to the EU average of 34%.
- Only 1% of businesses have used artificial intelligence technologies (EU average: 8%). Big data usage is still below average in the EU, at 5% vs the average of 14%. To meet the Digital Decade goal by 2030, a sizable gap must be bridged.

Circular economy in Romania

Despite some economic progress in the past decade, Romania's economic growth is not yet decoupled from the generation of waste. In addition, waste management in Romania significantly lags behind, as landfilling, and often illegal dumping, is still the dominant form of waste management. However, Romania, with one of the lowest and declining waste generation per domestic material consumption among the EU countries, has favorable prospects for improving the country's performance in adopting CE practices. It can be concluded that Romania has significant potential for improvement across all stages of CE, from higher resource efficiency and use of secondary materials in production to waste prevention and better waste management.

The data collected through the Special Eurobarometer 501: Attitudes of European citizens towards the Environment (2019)[1] data also shows a low level of involvement, below the EU average, of Romanian citizens in circular economy activities like purchasing used goods, commissioning product repair, avoiding single-use plastics and packaging, or choosing goods made locally and/or with an environmental label. Positively, among EU nations, Romania has one of the lowest and fastest-declining waste generation rates per domestic material consumption (DMC) and has promising chances for raising its performance in implementing circular economy principles[2].

Romania has a strategy for circular economy that was adopted by the Romanian Government in 2022. The key objective of the Romanian National Circular Economy Strategy is to provide the framework guiding the country on its endeavours to transition towards CE by means of implementing the Action Plan. The primary goal of this plan is strongly related to the global SDGs and climate targets as well as the new CEAP targets set by the EU, in keeping with the ideas and initiatives supported by the EU Green Deal. At the national level, Romania's National Recovery and Resilience Plan and Sustainable Development Strategy 2030 both include parts of the country's transition to a circular economy.

Future prospects for promoting circular economy

IRCEM is currently working on The Circular Economy Action Plan (CEAP) as a part of recent governmental efforts to accelerate the transition to a circular economy in Romania. The CEAP builds on and complements the Circular Economy Strategy (CES) adopted through Governmental Decision 1172 from September 21, 2022. In essence, while CES provides general directions and objectives to be pursued through subsequent policies, the CEAP introduces concrete actions to reach these goals and advance the transition towards circular economy. The list bellow illustrates the priority actions for more general cross cutting issues, but nonetheless the CEAP contains measures for specific sectors as well (textiles, buildings, agriculture, etc.)

1 https://europa.eu/eurobarometer/surveys/detail/2257

2 https://dezvoltaredurabila.gov.ro/strategia-nationala-privind-economia-circulara-13409762

- Integration of circular economy principles and competences in educational and professional training programs, based on skill gap assessments;
- Enhancement of the capacity of the public sector to implement the CES&AP, and facilitate transition towards circular economy;
- Integration of circularity criteria in public purchasing and facilitation of its uptake;
- Development of a digital platform to track and communicate about circular economy action implementation, performance indicators and other relevant information;
- Facilitation of R&D&I funding for circular economy practices and technologies, with emphasis on digitalization;
- Expansion of public financial support for circular economy projects to the private sector, targeted towards the implementation of action plans and with an emphasis on digital solutions.

Policy instruments for boosting circular economy

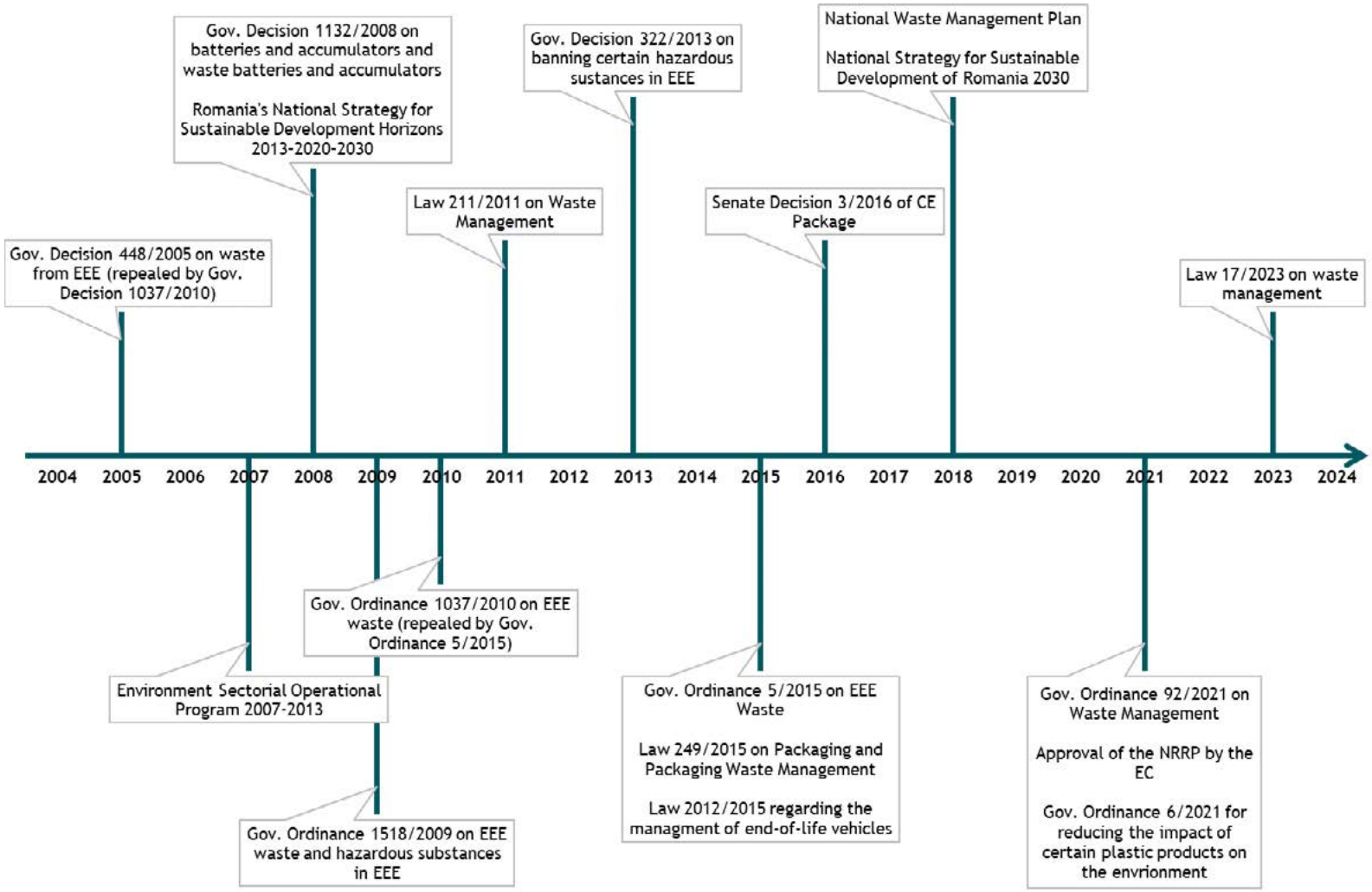
In terms of its general legal and regulatory framework, Romania has achieved significant improvements since entering the EU in 2007 by adopting national laws, regulations, and policies, transposing EU directives and regulations, and developing several initiatives and plans. Despite this noteworthy development, Romania's legal and policy environment still has a number of serious deficiencies that impede the country's transition to a circular economy. Since joining the EU in 2007, Romania has dealt with many cases of infrigmenets (169-81 of which are still ongoing and involve CE-relevant issues such waste and wastewater- up to 2022). The figure bellow illustrates the key aspects and timeline of environmental policy of relevance to circular economy in Romania (figure 1).

Most of the existing national regulations and policy initiatives related to CE principles are concerned with waste management, meaning that they only address the end-of-life phase of products.

An important thing to notice is that the design phase of products is little to completely unregulated and strategies for the reuse and repurposing of products that reach their end of life are missing. However, a few exceptions exist. For example, the Governmental Ordinance 92/2021 establishes a waste hierarchy in which dumping is on the last place, thus encouraging prevention, reuse, and recycling.

Next, Law 2012/2015 with its modification from 2020 regarding the management of vehicles at their end of life requires, at its Art. 3b, that the new vehicles must be designed with the view of dismantling for the reuse and recycling of the component parts. Additionally, Art. 3c mandates the use of recycled materials (secondary raw materials) in the manufacture of new automobiles and their components. These specifications lack specifics, though, and are somewhat imprecise. Romania must consequently continue its efforts to establish a thorough and consistent regulatory framework that covers the entire product lifecycle.

Figure 1. Key existing policies regarding circular economy in Romania[3]



3 https://dezvoltaredurabila.gov.ro/strategia-nationala-privind-economia-circulara-13409762

Status of circular economy in Romania

As shown in figure 2, Romania's performance in circular economic indicators is below the average of EU Member States. In 2019, Romania had the lowest resource productivity[4] among the EU Member States, corresponding to only 0.7851 EUR (Purchasing Power Standard) per kilogram[5]. Resource productivity is an important indicator of the sustainable development goal related to responsible consumption and production. [6]

In general, when the population and industry expand, there is an increase in the requirement for materials, water, and energy. The manufacturing sector has to use more manufacturers who choose to use secondary raw materials, reuse materials, and innovate in their industry because it is particularly reliant on mining materials. In contrast to the EU average of 12.8%, Romania's Circular Material Use Rate (CMUR), which measures the contribution of recycled materials to overall materials use, was only 1.3%. CMUR has decreased in Romania, but it has significantly improved across the EU.

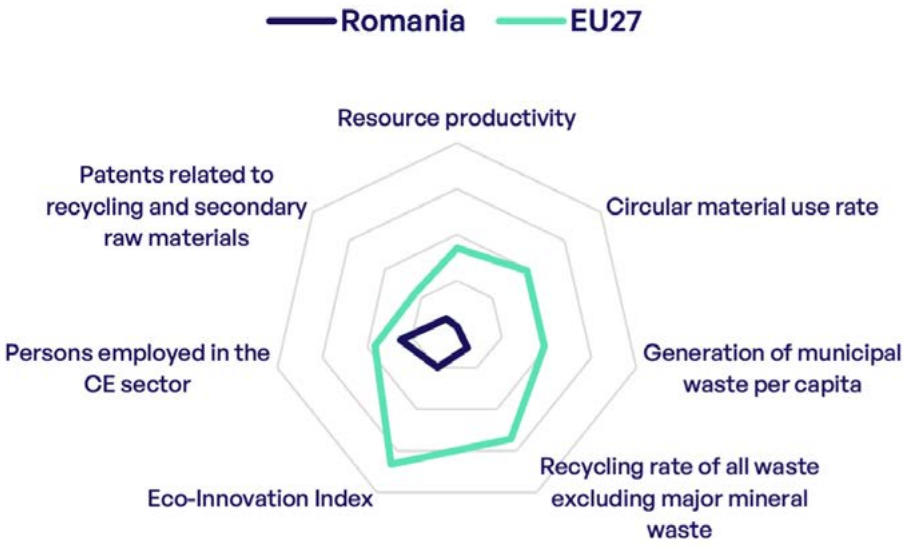


Figure 2. Romania's Performance on the main CE indicators
Source: Romanian Strategy for CE 2030, Data based on Eurostat (2022).

4 Resource productivity is measured as the ratio of the gross domestic product to domestic material consumption.

5 Eurostat (2022) *https://ec.europa.eu/eurostat/databrowser/view/ENV_AC_CUR__custom_1598253/default/table?lang=en*

6 *https://ec.europa.eu/info/publications/2022-european-semester-country-reports_en*

The table below depicts the CE problems and opportunities, as analysed in the strategy for circular economy for the main sectors of the Romanian Economy.

Table 2. Sectorial Analysis of CE opportunites and shortcomings

Sector	GDP share	Problems	CE Opportunities/solutions
Metallurgical industry	2%	Low level of recycling activities	Implement Eco-design criteria and requirements, improve technologies, enhance the recovery of materials
Machine building industry	1%	Low recycling rate	Design for disassembly, apply low-carbon technologies and fuels, encourage repair, remanufacture and recycling, increase share of recycled materials
Automotive sector	14%	Missing infrastructure for complex recycling, low recycling of certain parts	Increase eco-design, increase use of recycled parts, investments in repair shops
Construction	9%	High landfilling rate, low recycling, low enforcement, lack of incentives for recycling, lack of legal framework for construction waste re-usage	Design for disassembly, flexibility, modularity; utilization of sustainable materials, increase renovation programmes, develop EPR scheme, support recovery and re-use of construction materials from waste, prioritize disassembly over demolishing, invest into recycling capacity
Food, beverages and tobacco	5%	Low recycling of food waste, littering of cigarette buds, unsustainable use of packaging (and its low recycling)	Increase separate collection of food waste, increase waste prevention (food donations, GPP), sustainable production incl. packaging prevention
Textiles	2%	Low consumer awareness, low recycling and separate collection (1kg per capita)	Increase separate collection, promote repair/reuse, R&D support: waterless dyeing and water reuse in textile industry
Plastics	1%	Low recycling (31%), low recycled content in new products, Low consumer awareness	Increase separate collection, increase use of secondary material in production, eco-design, increase consumption of more sustainable products, R&D support
Electrical equipment and electronic products	2%	Low recycling (27%)	Increase separate collection, repairability, durability, reuse
Furniture	1%	Low consumer awareness, a majority of waste is landfilled	Implement circular design principles, reduce the utilization of synthetic materials, increase separate collection, invest into reverse infrastructure and recycling technologies
Tourism	6.5%	Low consumer awareness in sustainable tourism	Sustainable infrastructure and building construction (considering cultural heritage, local labour), eco-tourism promotion, local production of food, transportation, waste prevention incentives

Digitalization & Circular economy

Overall, the transition to a resource-efficient and circular economy is hampered by some significant market failures that can be fixed through digitalization. The business case for current circular economy operations is strengthened by digital transformation and the data, information, and knowledge it helps generate. This also makes it possible to create new circular business models. However, a supportive policy framework that encourages digitally enabled circular activities while reducing the hazards these activities pose will need to be built in order to realize this potential, and this is the case for Romania as well. Some of the key elements of such policy framework would be:

- Fostering the creation of appropriate digital applications for the circular economy through R&D policies and programs that accelerate the transformation;
- Promoting the creation of standardized data protocols and standards, which are essential for the use of digital technologies in the circular economy;
- Supporting the development of circular economy policies using digital technologies and the data they generate.

However, one sector in which digitalization strongly supports circular economy solutions in Romania is waste management. Precisely, almost 14,000 digitized eco-islands for separate waste collection must be operational by June 30, 2026. The budget from the National Plan for Recovery and Resilience (PNRR) allocated to these investments is 200.1 million euros. The eligible beneficiaries will be the Administrative-Territorial Units (including their subdivisions/sectors) organized at municipality and city level. Ecological islands are composed of a set of containers for the separate collection of waste:

- They can be placed underground (requiring construction and installation work) or above ground (requiring no construction and installation)
- protected against vandalism and against unauthorized access,
- GSM module for data transmission,
- database on service beneficiaries and
- billing interface for all beneficiary UATs.

The data is aggregated and used in a digital system, the main monitoring and reporting tool. Information is collected on the volumes and types of waste collected as well as the people who put the waste in the containers.

There are several initiatives that prove that digital inovation and circular economy can have a strong synergic relationship in Romania as well. A relevant example would be Katty Fashion, a small company that works with many foreign fashion houses, producing on average 30,000 pieces of clothing annually, for which it processes about 140,000 square meters of fabrics and knitwear, generating over 20,000 square meters of material waste. With the 58,000 euro voucher won within the European C-Voucher project, the Katty Fashion company managed to

optimize the product development process by improving the technology used in the design and prototyping of women's clothing items. By implementing a 3D CAD/CAM software for digitalization and virtual prototyping for the clothing industry and adapting to company-specific production, material consumption, delivery time and textile waste resulting during manufacturing processes have been reduced.

Nonetheless, as the the DEXI indexed shows (discussed in the previous sections) there is still a lot to do in terms of boosting digitalization and overcorming barriers . In a study released in April 2021, The National Authority for Digitalization highlighted the barriers on the path to digital for the public and private sector in Romania:

- lack of effective and efficient IT infrastructure for the management of electronic public services,
- lack of information systems for operationalizing the electronic public services,
- human capital (low digital skills, digital skills specific to SME management is under represented and to a lesser extent the number of IT specialists working on SMEs);
- Insufficient financing for adopting the advanced digital technologies along with the support for expertise and consulting;
- lack of clarity and a coherent evolution of e-government tools.

Stakeholders of digitalization and digital innovation

Companies

- Alesonor
- AROUND SR
- Bitdefender
- CONTACT GRADUAL INNOVATION SRL
- DIH4Society
- METRO SYSTEMS Romania
- PITECH PLUS
- STARTMEB SRL
- RADIO TEEN SRL-D

Policy makers

- Ministry of Research, Innovation and Digitalization

Academia

- Babeş Bolyai University of Cluj-Napoca
- Tehnical University of Cluj-Napoca

Associations

- CiTyInnoHub
- CivicNet Association
- Danube Cyber Security Alliance – DACSA
- FIT EDIH
- Innovation Cluster for the Development of Advanced Technologies For The Consolidation Of Societal Resilience And Critical Infrastructure - Citadela
- Integrated Consulting Group
- Legallica Association
- Wallachia eHub

Stakeholders of circular economy in the region

Companies

- LanaTerm- Thermal insulation for buildings made of sheep's wool
- EcoBihor
- Eco Synergy - Organization for the Implementation of Extended Producer Responsibility (OIREP)
- Green Group Holding
- Heilderberg Cement
- PETStar Recylcling
- ROMBAT
- ROMWaste Solutions

Policy makers

- The Sustainable Development Department of the Romanian Government
- The Ministry of Environment
- The Ministry of Economy, Entrepeneurship and Toursim
- National Environment Fund
- Ministry of European Projects and Ivestments

Academia

- Babeş Bolyai University of Cluj-Napoca
- National Research and Development Institute for Food Bioresources - IBA Bucharest
- National Research-Development Institute for Environmental Protection – INCDPM
- Research Center for Sustainable Development UBB Cluj-Napoca
- Tehnical University of Cluj-Napoca
- University of Agricultural Science And Veterinary Medicine Cluj-Napoca

Associations

- Agro-Transilvania Cluster
- CLEMS – Eco-innovative cluster for sustainable development
- Ecoteca
- Ecotic Association
- The Federation of Romanian Food Banks – FBAR
- Green Energy Cluster
- ROCESP-Romanian Circular Economy Stakeholder Platform
- R3Green Cluster
- Sustainability Ambassy in Romania

Stakeholders boosting circular economy with digitalizion

Companies

- Best Tools
- Ecotree
- Genesis Biopartners
- Katy Fashion
- Waste Digital Revolution

Policy makers

- Ministry of Research, Innovation and Digitalization
- Ministry of European Projects and Investments
- The National Authority for digitalization in Romania of the Romanian Government
- Regional Development Agencies

Academica

- The Polytechnic University of Bucureşti
- The Polytechnic University of Timisoara
- Technical Univerisity of Cluj-Napoca

Associations

- Green Cluster
- Sustainability Ambassy in Romania

Summary

There is widespread consensus that digital technologies are critical to the shift to a more circular – and less linear – economy. And, while their significance is undeniable, the maturity level of digital technologies is debatable[7]. Romania's performance in terms of the maturity of digital technologies and digital public services is still poor compared to other EU Member States, but significant progress is visibile through the recent policies and funding opportunities offered by the national authorities. Digital inovation and circular economy can have a strong synergistic relationship in Romania given the fact that circular economy became a priority in order to obtain a beneficial relationship between economic development and nature preservation, as demonstrated by the Circular Economy Strategy and Action Plan issued by the Romanian Government.

7 Pagoropoulos, A., Pigosso, D. C., & McAloone, T. C. (2017). The emergent role of digital technologies in the Circular Economy: A review. Procedia cirp, 64, 19-24.

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